A Biological Inventory and Conservation Recommendations for the Great Sand Dunes and San Luis Lakes, Colorado

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Users Guide/Background Information

The Colorado Natural Heritage Program began an inventory of the Great Sand Dunes and San Luis Lakes areas during 1997 as part of the biological inventory of Saguache County (Rondeau and others 1998). This report represents a more in depth view of these two significant areas.

Glossary

biodiversity- The diversity of living things within an ecosystem ranging from genetic diversity within a species to diversity within a natural community.

ecological processes- A variety of natural forces that influence and direct changes in ecosystems. These forces can be physical (slope erosion, river meandering, flooding), biological (vegetation growth, animal grazing, predation, pollinization), or both (fire cycles, soil development).

ecosystem- The basic functional unit of nature that includes living things, their non-living environment, and the ecological processes that sustain them. Examples of San Luis Valley ecosystems include the sand dunes, shallow wetlands, and coniferous forests.

element- Species and plant communities are considered an element of natural diversity, or simply an element.

endemic- Life forms that are restricted to a particular locality, such as the Great Sand Dunes tiger beetle, which is found only in the Great Sand Dunes of the San Luis Valley.

non-native/exotic- A term used to describe animal or plant species which are not native to a given region or ecosystem. Most noxious weeds fall into this category, having evolved in areas with a long history of human-caused or natural disturbance. In most cases, invasion by non-native species is more closely linked to human-caused disturbance than deliberate introductions, with the exception of aquatic habitats, where non-native gamefish have been widely introduced.

watershed- The area from which a surface watercourse or groundwater system derives its water, e.g. the Rio Grande watershed includes most of south-central Colorado, much of New Mexico, west Texas, and northern Mexico.

Acknowledgments

The Colorado Natural Heritage Program (CNHP) would like to acknowledge and sincerely thank many agencies and individuals. The Nature Conservancy, especially Nancy and Chuck Warner, helped to secure the funding as well as generously provide CNHP with the assistance of their intern, Colorado Cordova. The Great Sand Dunes National Monument was an intergral part of this entire project. Fred Bunch supplied us not only with gratis camping and sand dune transportation, but kept the humor factor high. Hobey Dixon, from Adams State College spent numerous days in the field with us; his knowledge of the San Luis Valley flora made our job much easier. Thanks to Rocky Mountain Bison Ranch, especially Hisa Ota, for the unlimited access to the Medano/Zapata ranch. Identification of the insects would have been impossible without the expertise of Boris Kondratieff and Howard Evans. Moreover, much of the existing knowledge of the invertebrate assemblage of the Great Sand Dunes would not exist were it not for the extensive research done by Michael Weissmann.

We greatly appreciate the numerous volunteers and interns who helped us with both field and office work. Special thanks to Jamie Jones for spending three windy, buggy, hot field-weeks with us. The information management staff with CNHP was responsible for integrating the data into the Biological Conservation Database, especially Danielle Zoellner, Jennifer Lord, Tom Brophy, Jeremy Siemers, Jill Handwerk and Georgia Doyle. Numerous volunteers, coordinated by Ken Benda, helped with this project from beginning to end.

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EXECUTIVE SUMMARY

The Great Sand Dunes and the San Luis Lakes areas are adjacent to one another and lie in the southeast portion of the Closed Basin of Colorado (Figure 1, page 4). The area contains a diverse array of valley bottom habitats, including sand dunes, grasslands, riparian, wetlands, and shrublands. In 1997, the Colorado Natural Heritage Program documented a plethora of biologically significant elements within this area and identified the Great Sand Dunes and San Luis Lakes as Potential Conservation Areas (Rondeau and others 1998). In order to further understand the biological significance of these two Potential Conservation Areas, the Colorado Natural Heritage Program conducted a follow-up inventory in 1998; the results of which are included in this report.

With funding from Great Outdoors! Colorado (GOCO), the Nature Conservancy, a private nonprofit conservation organization, contracted the Colorado Natural Heritage Program to inventory the study area for species and plant communities of special biological significance. The primary goal of the project was to identify the locations that have natural heritage significance, with a special emphasis on private lands. Such locations were identified by: 1) examining existing biological data from the Colorado Natural Heritage Program database, 2) accumulating additional existing information on rare or imperiled plant species, animal species, and significant plant communities (collectively called **elements**), and 3) conducting extensive field surveys.

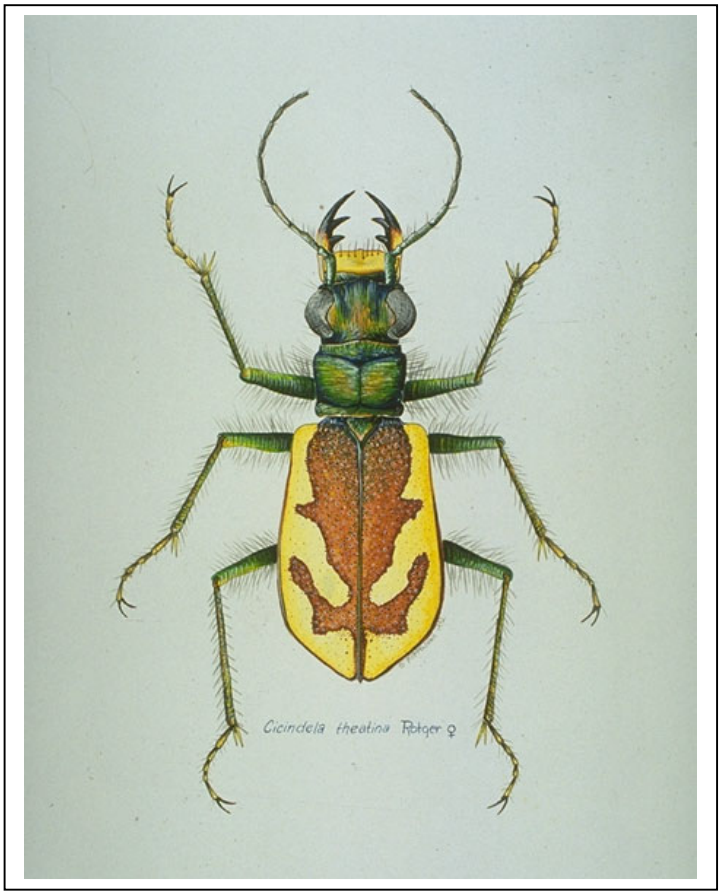
This study combined with previous studies recognizes a total of 46 biologically significant elements the Colorado Natural Heritage Program tracks, including 15 plant communities, 14 insects, nine birds, four plants, three mammals, and one fish. Many of these elements are restricted in range, either known to be endemic to the Great Sand Dunes system, or endemic to the San Luis Valley. Considering the relatively compact

size of this study area, the number of significant elements indicates that this is an area of remarkably high biological wealth.

Of particular interest is the number of endemic invertebrate species found only at the Great Sand Dunes site. At least six insects exhibit a range that appears to be limited to the sand dunes area, a range of approximately 419 km² (162 mi²). These insects include five beetle species and one robber fly: *Amblyderus werneri, A. triplehorni, Cicindela theatina, Hypocaccus* undescribed sp.*, Eleodes hirtipennis, and Proctacanthus* n. sp..

The two sites or "potential conservation areas" presented in this report are described and prioritized in order of their **biodiversity significance rank.** The Great Sand Dunes and San Luis Lakes potential conservation areas are ranked B1 and B2, respectively, and deserve high priority for conservation action.

Overall, the concentration and quality of imperiled elements and habitats attest to the fact that conservation efforts in both the Great Sand Dunes and San Luis Lakes potential conservation areas will have both global and state significance. In order to enhance conservation efforts in these areas, a list of the major threats to biodiversity and nine recommendations for enhancing conservation efforts have also been provided.



INTRODUCTION

Purpose

In 1997, the Great Sand Dunes and the San Luis Lakes, both located in the southeast corner of the San Luis Valley Closed Basin (Figure. 1) were identified as areas of outstanding and remarkable biological diversity and important conservation sites (Rondeau and others 1998). In 1998, the Colorado Natural Heritage Program (CNHP) followed up on their 1997 survey and conducted a more thorough inventory of the Alamosa County portion of the Great Sand Dunes and San Luis Lakes sites.

The primary goal of this project was to further identify elements of natural heritage significance and define or redefine the site boundaries in which they were found. These elements and locations were identified by:

- Examining existing biological data from CNHP and other biological sources;
- Augmenting the existing data through additional research on rare or imperiled plants, animals, and significant plant communities (collectively referred to as **elements**);
- Conducting field inventories.

Locations in the Great Sand Dunes/San Luis Lakes area with natural heritage significance are presented within this report as proposed conservation areas. **The proposed conservation area boundaries delineated in this report do not confer any regulatory protection of the site.** Boundaries are primarily established on the ecological processes known to support the elements within the site.

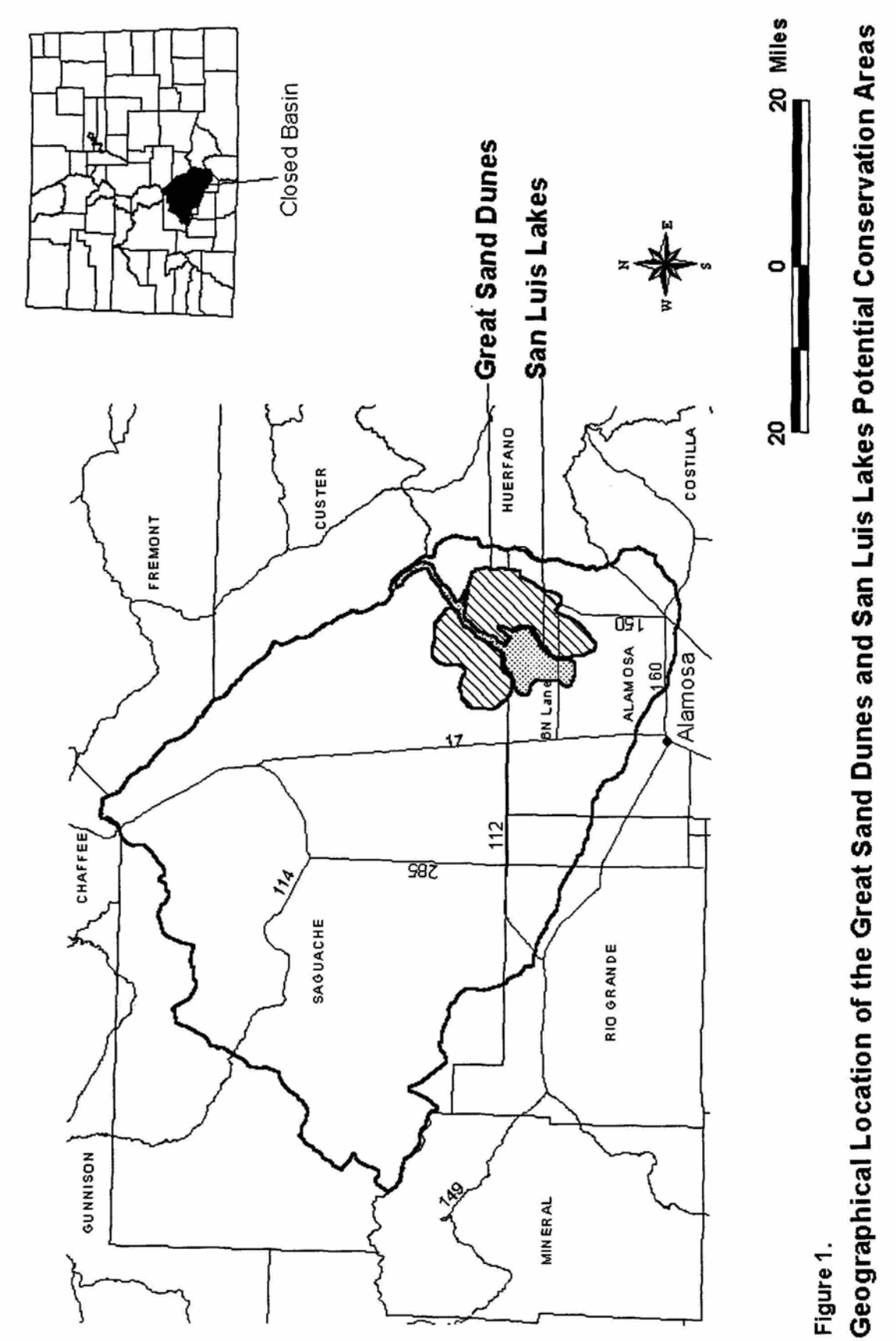


Figure 1.
Geographical Location of the Great Sand Dunes and San Luis Lakes Potential Conservation Areas

Study Area

Climate

Frigid winters and cool summers characterize the Great Sand Dunes and San Luis Lakes areas. Less than 35 cm (14 in) of precipitation fall in this area per year, with summer temperatures averaging 18.3°C (65°F) (July), and winter temperatures averaging -7°C (19°F) (January) (Fryberger and others 1990). True to its eolian characteristic, windy days in this area are frequent and winds often include gusts of 90 to 125 kilometers per hour (55 to 75 mph). The floral and faunal components of the area must further respond to a very brief growing season of approximately 60 frost-free days (Fryberger and others 1990).

Geology and soils

The San Luis Valley is a basin that has been filled by lacustrine, alluvial, and some volcanic sediments (Fryberger and others 1990). The eolian sands making up the sand dune depositional setting are mostly derived from the Pliocene-Miocene Santa Fe Formation in the west, and alluvial fans of roughly the same age in the east (Gaca and Karig 1966). Most authorities consider the ancestral Rio Grande to be the main source of the sand. The sands are composed of 20% quartz and 52% volcanic rock fragments (Burford 1961, Johnson 1967, Wegmann 1939, Wiegand 1977). Some feldspathic sands and gravels and carbonate fragments are also supplied to the dunes through runoff from the Sangre de Cristo Mountains along Medano and Sand Creeks.

Prevailing southwesterly winds move the sediment load northeastward toward the Sangre de Cristo Mountains and Medano Pass, where cooler temperatures from the mountain tops cool the prevailing southwesterly winds and force the sediment to dump at the base of the mountains, resulting in a pile-up of sand. Sand is washed downstream with runoff and carried further by Medano and Sand Creeks only to be picked up later by the southwesterlies and redeposited at the sand dune mass.

Two distinct soil types characterize the region. The soil typically encountered at the Great Sand Dunes National Monument consists of excessively drained and coarse-textured sand characterized by deep and rolling topography. Those soils typical of the San Luis Lakes region are deep, nearly level to hummocky, well-drained soils of varying textures that are strongly affected by alkalinity levels (USDA Forest Service 1973).

The Great Sand Dunes eolian depositional system

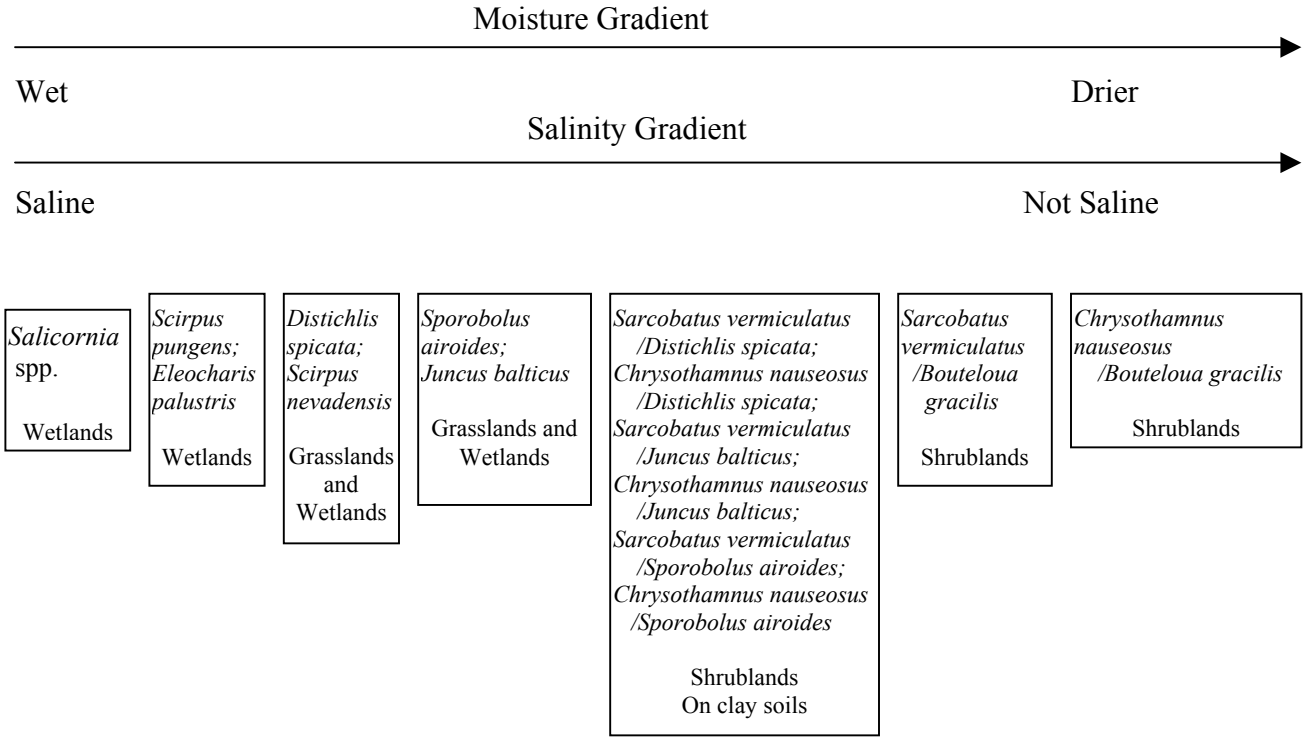
The Great Sand Dunes eolian depositional system covers about 800 km² (497 mi²) in the San Luis Valley of Colorado. This system is considered to extend from the Rio Grande northeastward to the Sangre de Cristo Mountains. This system can be understood most simply as three depositional provinces: Province I, the playa lakes area; Province II, the vegetated sand sheet; and Province III, the main sand dunes mass (Fryberger and others 1990). See Figure 2, page 10, for a map of the three Provinces.

Playa Lakes region, Province I

Province I is the most upwind province of this ecosystem. This province is characterized as alkaline lakes and flats with sand dune and berms formed on the downwind margins of the ephemeral lakes. This area is referred to as the **playa lakes region**. The playa lakes region is the lowest in elevation of the three entities, about 2290 to 2320 m (7,500 to 7,600 ft). Vegetation in this area consists primarily of alkali tolerant plant communities, such as salt meadow grasslands (*Distichlis spicata*), bulrush wet meadows (*Scirpus nevadensis*), and greasewood/salt meadow shrublands (*Sarcobatus vermiculatus/Distichlis spicata*).

Slender spiderflower (*Cleome multicaulis*)

The mosaic of communities in the playa lakes region and their associated moisture/salinity regime observed by CNHP in 1997 and 1998 are depicted below:



Province II is the extensive vegetated sand sheet that exists between the alkaline, playa lakes region of Province I and the main sand dune mass (Figure 2, page 10). At an elevational range of approximately 2320 to 2380 m (7,600 to 7,800 ft) it is characterized by mostly flat bedded sand deposits with scattered groups of parabolic dunes, many of which have trailing "arms" of sand anchored by grassy or brush vegetation. Water percolates from the main dune mass and emerges at a line of springs, which is believed to be an ancient channel in the Medano Creek drainage concealed over thousands of years by sand deposits (Fryberger and others 1990). Southwesterly prevailing winds cut to the water table and reveal interdunal wetlands in this province. Several plant communities typify Province II. The flatter sand sheets are dominated by rabbitbrush/Indian ricegrass shrublands (*Chrysothamnus nauseosus/Oryzopsis hymenoides*), or needle-and-thread grass-Indian ricegrass grasslands (*Stipa comata-Oryzopsis hymenoides*). While the parabolic dune blowouts are dominated by blowout grass grasslands with scurfpea (*Redfieldia flexuosa-Psoralidium lanceolatum*). Narrow leaf cottonwood trees (*Populus angustifolia*), coyote willow (*Salix exigua*), baltic rush (*Juncus balticus*), or bulrush (*Scirpus pungens*) may be encountered in the riparian corridors or the wetlands areas.

Needle-and-thread grass-Indian ricegrass grasslands of sand sheet, Province II

Province III embodies the most active sands which comprise the large dunes for which Great Sand Dunes National Monument is noted. The area covers about 75 km² (29 mi²). This province is nestled at the base of the Sangre de Cristo Mountains and is the most downwind of the three provinces. Province III is situated at an elevation of about 2380 to 2680 m (7,800 to 8,800 ft), and lies at the base of the Sangre de Cristo Mountains. In this province, the southwest winds and the east winds are nearly balanced, resulting in continued and upward growth of the dunes, and an imperceptible migration to the east. Here, the massive dunes form "star" formations reaching a height of over 200 m (700 ft) above the valley floor. The dunes here are sparsely vegetated with sand dune blowout grass, scurfpea, or Indian ricegrass, which mostly exists in the depressions and bowls between the dunes.

Active sands and interdunal wetland, Province III

Cultural history

(The following anthropological history is summarized from (Carter 1990). The earliest known inhabitants of the Great Sand Dunes area were Clovis and Folsom peoples who inhabited the area from 10,500 to 11,000 years ago. These were hunter-gatherer cultures who hunted large game such as mammoth and bison. In post-archaic times, the Utes were the predominant tribe in the San Luis Valley from the late 16th to early 20th century. At that time, the Utes were nomadic, taking advantage of the plentiful game and plants in the mountains during the summer and returning to the foothills and other protected areas as the weather turned colder. As early as the mid-15th century, Spanish explorers were traveling throughout much of the southwest, searching for precious minerals. Zebulon Pike made the first known documentation of the dunes in 1807. He and other explorers entered the San Luis Valley through Medano and Mosca Passes. In 1871, Mosca Pass was converted into a toll road. Pioneers, trappers, and prospectors traveling into the valley used this road. Farming, mining, and ranching were the chief industries of the San Luis Valley in the early 1900s. In 1932, Great Sand Dunes was declared the 36th National Monument of the National Park Service. Currently, major land uses at the site include recreation within the National Monument and bison and cattle ranching on the adjacent private, state, and federal lands. Recreation includes hiking, camping, sandboarding and skiing on the dunes, and wading in Medano Creek.

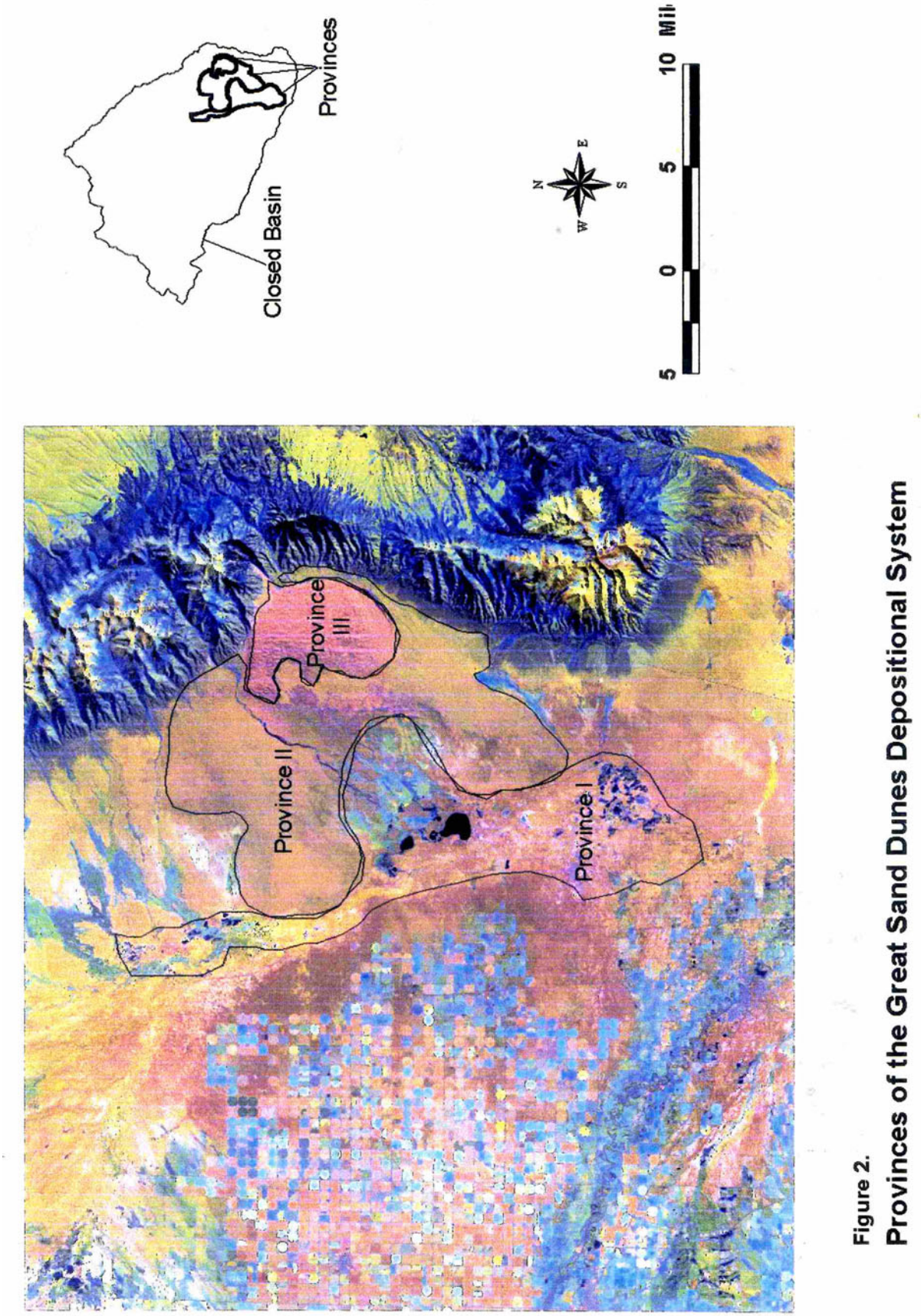


Figure 2.
Provinces of the Great Sand Dunes Depositional System

MAJOR THREATS AND STRESSES TO THE BIODIVERSITY OF THE GREAT SAND DUNES AND THE SAN LUIS LAKES

1. Hydrological Modification. Perhaps the greatest threat to the stability of the Great Sand Dunes and San Luis Lakes areas is anthropogenic hydrological modification. Groundwater pumping and surface water impoundments and diversions are the threats most prevalent in this context and are thought to present the most detrimental consequences to the flora and fauna inhabiting this region.

The playa lake ecosystems of the San Luis Valley floor depend upon a complex interaction of surface and groundwater sources undergoing characteristic seasonal and inter-annual fluctuations. Extensive wetlands have developed where sources of fresh surface water, such as creeks or springs, build on the shallow water table to create seasonal groundwater mounds. Preliminary work has shown that not only are hydrologic dynamics in the valley complex, but that the differing water sources vary widely in water quality (Cooper and Severn 1992). Wetland vegetation is strongly affected by water salinities, and valley wetlands have developed unique floristic patterns based on the quantity and quality of water they receive. Water uses perturbing the timing or magnitude of surface flows, or affecting the water table affect valley bottom wetlands. Even minor changes in the water depth or duration of inundation in the wetland basins can have profound effects on soil salinities, and consequently, on wetland vegetation. Cooper and Severn (1992) observed that the entire range of soil moisture and salinity, and associated plant communities, from permanently saturated wetland to saline flat to rain-rinsed upland, occurred over an elevation range of only 1.5 to 2.4 m (5 to 8 ft.). Wetland dependent fauna, such as nesting waterbirds, amphibians, or invertebrates may be affected by even brief fluctuations in wetland hydrology.

For approximately the past ten years, the Bureau of Reclamation's Closed Basin Project has pumped shallow groundwater to supplement Rio Grande flows, in order to meet Colorado's commitments to New Mexico, Texas, and Mexico under the Rio Grande Compact (Leonard and Watts 1989). Impacts from this project are purported by land owners and researchers (Cooper and Severn 1992), but not yet quantitatively described. Plans by Stockman's Water Corporation to pump confined aquifer water from the Baca Ranch for trans-basin use represent a serious concern given such scientific uncertainty.

Despite considerable debate, the hydrological connections between surface water resources, (as well as shallow and deep groundwater resources) and valley bottom wetlands remain poorly understood. The confusing array of past, present, and anticipated hydrologic disturbances make it exceedingly difficult to accurately estimate management needs and viability potential for the rare plants, animals, and plant communities at many valley bottom sites. Although information needs are immense, independent research has been minimal to date (Cooper and Severn 1992). Effective management of wetlands will require a much better understanding of the hydrologic connections between surface, shallow, and deep groundwater resources of the Closed Basin, and how they vary in time and space. Management of the valley bottom sites presented in this report will require, therefore, not only local protection of on-site wetland elements, but secure water resources and greater understanding of how current and anticipated water uses within the watershed will affect the wetlands. For an accurate assessment of the risks to Closed

Basin biodiversity posed by water development, further quantitative research linking hydrology, vegetation, and wetland fauna is imperative. Several research projects adressing some of these issues are currently underway by researchers at Colorado State University.

2. Agriculture Development. Hydrologic developments, both through pivot irrigation systems and through water impoundments upwind of the Great Sand Dunes, may have a profound effect on the amount of sediment that would naturally be redeposited in the sand dunes. How these developments affect these sediment loads is not well understood. From one standpoint, it is thought that the pivot irrigation practices prohibit sediment from becoming airborne in the prevailing southwesterly winds that are responsible for sediment deposition within the Great Sand Dunes. It is also postulated that the trapping of sediments in impoundments (e.g., reservoirs) has a profound impact on the amount of sediment that under natural conditions would reach the Rio Grande and be redeposited at the Great Sand Dunes. Both of these processes could decrease the amount of sand being redeposited at the Great Sand Dunes. From another standpoint, cultivation of fields (ploughing, disking) prior to planting during the high spring winds may increase the sediment load temporarily and deposition of contaminated soils (pesticides, herbicides) may take place at the Great Sand Dunes. Any of these practices could, over time, affect the growth patterns and types of vegetation found within the sand dune system, and in turn, affect the unique invertebrate assemblage inhabiting the Great Sand Dunes.

3. Livestock Grazing. Another traditional industry of the area, domestic livestock grazing, has left a much broader and often subtle impact on the landscape. Historic livestock grazing probably had a large influence on the composition of nonforested communoties on the Rio Grande National Forest (USDA Forest Service 1996). As early as 1820, there were records of cattle being brought into the San Luis Valley. By the close of the century, and through the early part of the 20th century, there were high numbers of livestock. It appears that by 1929, stocking rates started declining dramatically due to documented overuse of the resource (USDA Forest Service 1996).

The effects of livestock grazing on the Great Sand Dunes and playa lakes are unknown. Historically, bison were known to inhabit this region, although numbers of animals and length of stay is speculative. The Great Sand Dunes National Monument management does not allow livestock grazing within its boundaries, although trespass grazing is a recurring issue. Currently, the private ranches in the area are livestock operations, with the Rocky Mountain Bison Ranch raising more bison than cattle.

Plant species generally react in predictable outcomes to repeated livestock grazing. As more palatable plants are reduced or eliminated from a community over time, there are other native plants that increase in prominence. There are also introduced plants that increase significantly under frequent, repeated livestock grazing. Depending on grazing practices and local environmental conditions, impacts can be minimal, moderate and largely reversible (slight shifts in species composition, willow browsing), or severe and irreversible (extensive gullying, introduction of non-native forage species, extirpation of local willow populations). Stresses due to sediment deposition and water

quality changes from improper grazing practices are more difficult to judge, but they may be detrimental to aquatic biota (Gifford and others 1975).

Observations during the 1998 field assessment for this report indicated that impacts from livestock were more localized and not widespread.

4. Recreation. Recreation within the Great Sand Dunes potential conservation area is primarily limited to tourism where most use is pedestrians or limited to camping in designated areas. The Great Sand Dunes' high and barren dune formations infrequently attract recreationists preferring to sand ski and sand surf. However, recreation of this type is thought to have a low impact due to its relatively localized nature. The San Luis Lakes lends itself to water recreational sports, mostly boating and fishing. Recreational impacts are not thought to be highly detrimental to the elements within either the Great Sand Dunes or San Luis Lakes potential conservation areas.

5. Roads. The Great Sand Dunes and the San Luis Lakes potential conservation areas are not traversed by many developed roads. Most roads are undeveloped dirt roads or two tracks with fewer roads within the Great Sand Dunes National Monument and numerous roads on the other lands of both sites. The low road density within the Monument is considered noteworthy, for many areas of the site are not easily accessed by any means other than foot, especially to the wetlands areas, and thus maintains road impacts are minimized. However, any expansion of the existing road network will detrimentally affect the natural heritage values of the region. Roads are associated with a wide variety of impacts to natural communities, including invasion of non-native plant species, increased depredation and parasitism of bird nests, increased impacts of pets, fragmentation of habitats, erosion, pollution, and road mortality (Noss and others 1997).

6. Non-native Species. Although non-native species are mentioned as stresses in the above discussions, because they can come from so many activities they are included here as a specific threat as well. Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and essentially dominate a previously natural area, e.g., scraped roadsides. This can generate secondary effects on animals (particularly insects) that depend on native plant species for forage, cover, or propagation. Whitetop (*Cardaria* spp.) is an introduced, highly aggressive weed found in irrigated areas and low wetlands and is very difficult to control. Cheatgrass (*Bromus tectorum*), smooth brome (*Bromus inermis*), and crested wheatgrass (*Agropyron spicatum*) are hardy, xeric grasses from Eurasia that are also very difficult to control (H. Dixon, pers. comm.). Although the CNHP considers much of the Great Sand Dunes and the San Luis Lakes sites to be weed-free, we also identified some areas with serious weed infestations. Most of these areas are concentrated around wetlands, especially in the western portion of the San Luis Lakes site.

RECOMMENDATIONS

The following recommendations are based on the needs of the elements identified at the Great Sand Dunes and San Luis Lakes sites during the 1997 and 1998 field seasons.

1. **Encourage well-planned and proper management of natural heritage resources existing within the Great Sand Dunes and San Luis Lakes sites, and recognize that identification of conservation areas and wilderness or open space designations do not necessarily confer complete protection of the plants, animals, and plant communities.** Developing a conservation plan is just one of many steps necessary to preserve natural heritage resources. Some of the most serious threats, however, are understood within an ecosystem context. For example, residential encroachment, recreational development, fire suppression, noxious weed invasion, and altered hydrology are detrimental anthropogenic influences that often negatively affect habitat integrity and survival of natural heritage elements. Consideration of all ecosystem influences is meaningful when considering management plans for a site. In this context, building partnerships with other agencies and entities is essential in development of plans for long-term protection of a site. Developing partnerships to encourage research and development of techniques to maintain or restore sites for preservation of rare natural heritage elements would be beneficial. There are many agencies and organizations available for consultation in the development of conservation plans, including the Colorado Natural Heritage Program, the Colorado Natural Areas Program, The Nature Conservancy, Colorado Division of Wildlife, and various academic entities.

2. **Develop a research and monitoring plan for the most rare and imperiled plants, animals, and plant communities.** Among those included would be those insect species that are endemic to the Great Sand Dunes, the slender spiderflower (*Cleome multicaulis*) occurrences, the wetlands, and the grasslands or shrubland/grassland communities that are characterized by their preference for the sandy and alkaline soils in this area.

3. **Develop a research and monitoring plan for the most serious threats.** The two most prevalent threats are hydrology issues and noxious weed invasion.

4. **Incorporate the information included in this report into review of proposed activities in or near conservation sites so that these activities do not adversely affect the natural heritage elements found within.** The natural heritage elements presented in this report represent species of global and statewide significance. Management and development activities, either in or near the site, may affect the elements present. Should a proposed activity potentially impact the site, review of the plans by local, state, and federal personnel is recommended. If necessary, planning personnel should contact persons, organizations, or agencies with the appropriate expertise in order to obtain detailed comments and feedback.

5. **Encourage cooperation among landowners, government agencies, and conservation organizations to protect natural diversity.** Combine efforts with interested allies including the U.S. Forest Service, The Nature Conservancy, and private landowners to design and effect a practical strategic plan aimed for the long-term survival of these significant species and their habitats.

6. **Natural heritage resource inventories should be continued when and where necessary, including inventory for species that cannot be adequately surveyed in one field season.** Further inventories, research, and monitoring are necessary to acquire a more thorough comprehension of significant species and their habits and habitats. We recommend continuation of monitoring to document and verify both known and predicted localities for targeted species. Furthermore, despite our best efforts during the field season, it is very likely that some elements were not detected and may be identified during future surveys.

7. **Increase public awareness of the benefits of protecting significant natural areas.** Increase public awareness that sensitive natural resources exist in these special sites and that certain activities may be detrimental to these resources.

8. **Prohibit the introduction of non-native species known to negatively and profoundly affect natural areas.** Strategies to decrease exotic floral invasion and possibly increase the quality of native flora communities in the area should be developed. Exotic plant invasion compromises quality habitat for native flora and also for dependent invertebrate fauna. Public agencies and private landowners should be strongly encouraged to remove these species from their properties. Property owners immediately adjacent to these designated areas should be encouraged to consider xeriscaping with locally native flora to minimize the further spread of noxious weeds and exotics into natural areas. If restoration of an area becomes necessary, CNHP recommends the use of locally grown native flora for revegetation efforts.

9. **Develop a conservation agreement with the Luis Maria Baca Ranch.** Although conservation efforts are underway for much of the San Luis Lakes and Great Sand Dunes potential conservation areas, the Baca Ranch comprises a significant portion of these. In order to protect these extremely biologically important areas in their entirety, it is necessary to develop a conservation plan for the Baca Ranch.

BACKGROUND

Colorado's Natural Heritage Program

To place this document in context, it is useful to understand the history and functions of the Colorado Natural Heritage Program (CNHP).

CNHP is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in Colorado for 14 years, the Program was relocated from the State Division of Parks and Outdoor Recreation to the University of Colorado Museum in 1992, and more recently to the College of Natural Resources at Colorado State University.

The multi-disciplinary team of scientists and information managers gathers comprehensive information on rare, threatened, and endangered species and significant natural communities of Colorado. Life history, status, and locational data are incorporated into a continually updated data system, the Biological Conservation Data System (BCD). Sources include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists. Information management staff carefully plots the data on 1:24,000 scale USGS maps and enter it into the BCD. The BCD can be accessed by many categories, including taxonomic group, global and state rarity rank, federal and state legal status, source, observation date, county, quadrangle map, watershed, management area, township, range, and section, precision, and conservation unit.

The CNHP is part of an international network of conservation data centers that use the Biological and Conservation Data System developed by The Nature Conservancy. The CNHP has effective relationships with several state and federal agencies, including the Colorado Natural Areas Program, Colorado Department of Natural Resources, the Colorado Division of Wildlife, the U.S. Environmental Protection Agency, and the U.S. Forest Service. Numerous local governments and private entities also work closely with CNHP. Use of the data by many different individuals and organizations, including Great Outdoors! Colorado, encourages a proactive approach to development and conservation thereby reducing the potential for conflict. Information collected by the Heritage Programs throughout the globe provides a means to protect species before the need for legal endangerment status arises.

Concentrating on site-specific data for each element of natural diversity allows us to evaluate the significance of each to the conservation of Colorado's, and indeed a global natural biological diversity. By using species rarity ranks and occurrence quality ratings, priorities can be established for the protection of the most sensitive or imperiled sites. An updated locational database and priority-setting system such as CNHP provides is an effective, proactive land-planning tool.

The Natural Heritage Network and Biodiversity

Colorado is well known for its rich diversity of geography, wildlife, plants, and natural communities. However, like many other states, it is experiencing a loss of much of its flora and fauna. This decline in biodiversity is a global trend resulting from human population growth, land development, and subsequent habitat loss. Globally, the loss in species diversity has become so rapid and severe that it has been compared to the phenomenon of the great natural catastrophes at the end of the Paleozoic and Mesozoic eras (Wilson 1988).

The need to address this loss in biodiversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country were not based upon preserving biodiversity; instead, they primarily focused on preserving game animals, striking scenery, and locally favorite open spaces. To address this absence of a methodical, scientifically based approach to preserving biodiversity, Robert Jenkins, in association with The Nature Conservancy, developed the Natural Heritage Methodology in 1978.

Recognizing that rare and specialist species are more likely to become extinct than common and generalist species, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is scientifically based upon the number of known locations of the species as well as its biology. By ranking the relative rarity or imperilment of a species, the quality of its populations, and the importance of associated conservation sites, the methodology can facilitate prioritizing conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community began to realize that plant communities are as equally important as individual entities, this methodology has also been applied to ranking and preserving significant natural plant communities. By protecting and managing aggregate units, associated species that we do not track can be included and protected.

Natural Heritage Programs throughout North, Central, and South America utilize the Natural Heritage Methodology, which form an international database network. Natural Heritage Network data centers are located in each of the 50 U.S. states, five provinces of Canada, and 13 countries in Central and South America and the Caribbean. This network enables scientists to monitor the status of species from a state, national, and global perspective. It also enables conservationists and natural resource managers to make informed and objective decisions in prioritizing and focusing conservation efforts.

What is Biological Diversity?

Protecting biological diversity has become an important management issue for many natural resource professionals. Biological diversity at its most basic level includes the full range of species on Earth, from species such as viruses, bacteria, and protists, through multicellular kingdoms of fungi, plants and animals. At finer levels of organization, biological diversity includes the genetic variation within species, both among geographically separated populations and among individuals within single populations. On a wider scale, diversity includes variations in the biological communities in which species live, the ecosystems in which communities exist, and the interactions among these levels. All levels are necessary for the continued survival of

species and natural communities, and all are important for the well being of humans. It stands to reason that natural diversity should be of concern to everyone.

The biological diversity of an area can be described at four levels:

1. Genetic Diversity. The genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species is variable between populations of a species within its geographic range. Loss of a population results in a loss of genetic diversity for that species and a reduction of total biological diversity for the region. This unique genetic information cannot be reclaimed.

2. Species Diversity. The total number and abundance of plant and animal species and subspecies in an area.

3. **Community Diversity**. The variety of natural communities or ecosystems within that area. These communities may be diagnostic or even endemic to an area. It is within these ecosystems that all life dwells.

4. **Landscape Diversity**. The type, condition, pattern, and connectedness of natural communities. A landscape consisting of a mosaic of natural communities may contain one multifaceted ecosystem, such as a wetland ecosystem. A landscape may also contain several distinct ecosystems, such as a riparian corridor meandering through shortgrass prairie. Fragmentation of landscapes, loss of connections, and migratory corridors, and loss of natural communities all result in a lost of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

The conservation of natural diversity must include all levels of diversity: genetic, species, community, and landscape. Each level is dependent on the other levels and inextricably linked. In addition, and all too often omitted, humans are also linked to all levels of this hierarchy. We at the Colorado Natural Heritage Program believe that a healthy, natural environment and human environment go hand in hand, and that recognition of the most imperiled elements is an important step in comprehensive conservation planning.

The Natural Heritage Ranking System

Information is gathered by CNHP on Colorado's plants, animals, and natural communities. Each of these species and natural communities is considered an **element of natural diversity**, or simply an **element**. Each element is assigned a rank that indicates its relative degree of imperilment on a five-point scale (i.e., 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences, i.e., the number of known distinct localities or populations. This factor is weighted more heavily because an element found in one place is more imperiled than something found in twenty-one places. Other important factors are: size of the geographic range, number of individuals, trends in both population and distribution, identifiable threats, and number of already protected occurrences.

Element rarity ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State or S-rank) and the element's level of imperilment over its entire range (its Global or G-rank). Taken together, these two ranks give an instant picture of the degree of imperilment of an element. CNHP actively collects, maps, and electronically processes specific occurrence information for elements considered extremely imperiled to imperiled (S1 - S3). Those with a ranking of S3S4 are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. Watchlisted species are noted in the lists by an asterisk (*) next to the species name. A complete description of each of the Natural Heritage ranks is provided on pages 15 through 20.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 1, ranks followed by a "B", i.e., S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N", i.e., S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Table 1. Definition of Colorado Natural Heritage Rarity Ranks.

Global rarity ranks are based on the range-wide status of a species. State rarity ranks are based on the status of a species in an individual state. State and Global ranks are denoted, respectively, with an "S" or a

G/S1 Critically imperiled globally/state because of rarity (five or fewer occurrences in the world/state; or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction.

G/S2 Imperiled globally/state because of rarity (six to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range.

G/S3 Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences).

G/S4 Apparently secure globally/state, though it might be quite rare in parts of its range, especially at the periphery.

G/S5 Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GX Presumed extinct.

G#? Indicates uncertainty about an assigned global rank.

G/SU Unable to assign rank due to lack of available information.

GQ Indicates uncertainty about taxonomic status.

G/SH Historically known, but not verified for an extended period, usually.

G#T# Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.

S#B Refers to the breeding season imperilment of elements that are not permanent residents.

S#N Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used

SZ Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.

SA Accidental in the state.

SR Reported to occur in the state, but unverified.

S? Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Note: Where two numbers appear in a state or global rank (e.g., S2S3), the actual rank of the element falls between the two numbers.

Protection Urgency Ranks

Protection urgency ranks (P-ranks) refer to the time frame in which conservation protection must occur. In most cases, this rank refers to the need for a major change of protective status (e.g., agency special area designations or ownership). The urgency for protection rating reflects the need to take legal, political, or other administrative measures to alleviate threats that are related to land ownership or designation. The following codes are used to indicate the rating best describing the urgency to **protect** the area:

P1 Immediately threatened by severely destructive forces to occur within one year of rank date; protect now or never!
P2 Threat expected within five years.
P3 Definable threat but not in the next five years.
P4 No threat known for foreseeable future.
P5 Land protection complete or adequate reasons exists not to protect the site; do not act on this site.

A protection action involves increasing the current level of legal protection accorded one or more tracts at a potential conservation area. It may also include activities such as educational or public relation campaigns or collaborative planning efforts with public or private entities to minimize adverse impacts to element occurrences at a site. It does not include management actions, i.e., any action requiring stewardship intervention. Threats that may require a protection action are as follows:

1. Anthropogenic forces that threaten the existence of one or more element occurrences at a site; e.g., development that would destroy, degrade or seriously compromise the long-term viability of an element occurrence and timber, range, recreational, or hydrologic management that is incompatible with an element occurrence's existence;
2. The inability to undertake a management action in the absence of a protection action; e.g., obtaining a management agreement;
3. In extraordinary circumstances a prospective change in ownership management that will make future protection actions more difficult.

Management Urgency Ranks

Management urgency ranks (M-ranks) indicate the time frame in which a change in management of the element or site must occur. Using best scientific estimates, this rank refers to the need for management in contrast to protection (e.g., increased fire frequency, decreased herbivory, weed control, etc.). The urgency for management rating focuses on land use management or land stewardship action required to maintain element occurrences at the potential conservation area.

A management action may include biological management (prescribed burning, removal of exotics, mowing, etc.) or people and site management (building barriers, rerouting trails, patrolling for collectors, hunters, or trespassers, etc.). Management action does not include legal, political, or administrative measures taken to protect a

potential conservation area. The following codes are used to indicate the action needed to be taken at the area:

M1 Management action required immediately or element occurrences could be lost or irretrievably degraded within one year.
M2 New management action will be needed within five years to prevent the loss of element occurrences.
M3 New management action will be needed within five years to maintain current quality of element occurrences.
M4 Although not currently threatened, management may be needed in the future to maintain the current quality of element occurrences.
M5 No serious management needs known or anticipated at the site.

Element Occurrence Ranks

Actual locations of elements, whether they be single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. In order to prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the estimated viability or probability of persistence (whenever sufficient information is available). This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on three factors:

1. **Size**: a quantitative measure of the area and/or abundance of an occurrence such as area of occupancy, population abundance, population density, or population fluctuation.

2. **Condition**: an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include reproduction and health, development/maturity for communities, ecological processes, species composition and structure, and abiotic physical or chemical factors.

3. **Landscape Context**: an integrated measure of the quality of biotic and abiotic factors, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include landscape structure and extent, genetic connectivity, and condition of the surrounding landscape.

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then averaged to determine an appropriate EO-Rank for the occurrence. If there is insufficient information available to rank an element occurrence, an EO-Rank is not assigned. Possible EO-Ranks and their appropriate definitions are as follows:

A Excellent estimated viability.
B Good estimated viability.
C Fair estimated viability.
D Poor estimated viability.
E Verified extant, but viability has not been assessed.
H Historically known, but not verified for an extended period of time.
I Introduced populations of imperiled species.

Potential Conservation Areas

To successfully protect populations or occurrences, it is necessary to delineate potential conservation sites. These potential conservation sites focus on capturing the ecological processes that are necessary to support the continued existence of a particular element of natural heritage significance. Potential conservation sites may include a single occurrence of a rare element or a suite of rare elements or significant features.

The goal of the process is to identify a land area that can provide the habitat and ecological processes upon which a particular element or suite of elements depends for their continued existence. The best available knowledge of each species' life history is used in conjunction with information about topographic, geomorphic, and hydrologic features, vegetative cover, as well as current and potential land uses. The proposed boundary does not automatically exclude all activity. It is a hypothesis that some activities will prove degrading to the element or the process on which they depend, while others will not. Consideration of specific activities or land use changes proposed within or adjacent to the potential conservation planning boundary should be carefully considered and evaluated for their consequences to the element on which the conservation unit is based.

Potential Conservation Area Boundaries

Once the presence of rare or imperiled species or significant natural communities has been confirmed, the first step towards its protection is the delineation of a potential conservation site planning boundary. In general, the potential conservation site planning boundary is an estimate of the landscape that supports the rare elements as well as the ecological processes that allow them to persist. In developing such boundaries, CNHP staff considers a number of factors that include, but are not limited to:

- the extent of current and potential habitat for the elements present, considering the ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the site and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater, e.g., by protecting recharge zones;
- land intended to protect the site against future changes in the use of surrounding lands;

- exclusion or control of invasive exotic species;
- land necessary for management or monitoring activities.

As the label "potential conservation site planning" indicates, the boundaries presented here are for planning purposes. They delineate ecologically sensitive areas where land-use practices should be carefully planned and managed to ensure that they are compatible with protection goals for natural heritage resources and sensitive species. All land within the potential conservation site planning boundary should be considered an integral part of a complex economic, social, and ecological landscape that requires wise land-use planning at all levels.

Off-Site Considerations

Furthermore, it is often the case that all relevant ecological processes cannot be contained within a site of reasonable size. Taken to the extreme, the threat of ozone depletion could expand every site to include the whole globe. The boundaries illustrated in this report signify the immediate, and therefore most important, area in need of protection. Continued landscape level conservation efforts are needed. This will involve broad-county-wide or regional efforts as well as coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies.

Ranking of Conservation Areas

One of the strongest ways that the CNHP uses these element and element occurrence ranks is to assess the overall biodiversity significance of a site, including one or many element occurrences. Based on these ranks, each site is assigned a **biodiversity** (or B-) **rank**:

B1 Outstanding Significance: only site known for an element or an excellent occurrence of a G1 species.

B2 Very High Significance: one of the best examples of a community type, good occurrence of a G1 species, or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type, good occurrence of a G3 species, or a large concentration of good occurrences of state rare species.

B4 Moderate or Regional Significance: good example of a community type, excellent or good occurrence of state-rare species.

B5 General or Local Biodiversity Significance: good or marginal occurrence of a community type, S1, or S2 species.

Legal Designations

Natural Heritage rarity ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, all rare species do not receive legal protection. Legal status is designated by either the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as "Sensitive," as does the Bureau of Land Management. Table 2 defines the special status assigned by these agencies and provides a key to the abbreviations used by CNHP.

Please note that the U.S. Fish and Wildlife Service has issued a Notice of Review in the February 28, 1996 Federal Register for plant and animal species that are "candidates" for listing as endangered or threatened under the Endangered Species Act. The revised candidate list replaces an old system that listed many more species under three categories: Category 1 (C1), Category 2 (C2), and Category 3 (including 3A, 3B, 3C). Beginning with the February 28, 1996 notice, the Service will recognize only those species that would have been included in the former Category 1 as candidates for listing. This includes those species for which the Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act.

Candidate species listed in the February 28, 1996 Federal Register are indicated with a "C". While obsolete legal status codes (Category 2 and 3) are no longer used, CNHP will continue to maintain them in its Biological and Conservation Data system for reference.

Table 2. Federal and State Agency Special Designations.

1. *U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996*):
   - **LE** Endangered; taxa formally listed as endangered.
   - **E(S/A)** Endangered due to similarity of appearance with listed species.
   - **LT** Threatened; taxa formally listed as threatened.
   - **PE/PT** Proposed E or T; taxa formally proposed for listing as endangered or threatened.
   - **C** Candidate: taxa for which the Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.
2. *U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S"):*
   - **FS** Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:
     a. Significant current or predicted downward trends in population numbers or density.
     b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.
3. *Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S"):*
   - **BLM** Sensitive: those species found on public lands that could easily become endangered or extinct in a state, as designated by a State Director
4. *State Status (Colorado Division of Wildlife):*
   - **E** Endangered
   - **T** Threatened
   - **SC** Special Concern

METHODS

The methods for assessing and prioritizing conservation needs over any substantial area require numerous procedures. This study followed a general methodology that the Colorado Natural Heritage Program has successfully employed and continually develops for inventory of rare or imperiled species inventories and both common and rare plant communities. The biological inventory for the Great Sand Dunes and San Luis Lakes region was organized in several phases and is described below.

Existing information collection. Prior to commencing fieldwork, the CNHP databases were updated with information regarding known locations of species and significant plant communities known from the study area. A variety of information sources were searched including the Colorado State University museums and collections. Plant and animal collections at the University of Colorado, Adams State College, Rocky Mountain Herbarium, and local private collections were searched as well. Additionally, general and specific literature sources were sought out and incorporated into CNHP databases. These sources contained either locational data for targeted species, or biological information pertaining to targeted species. Consultation with experts including university affiliates, local naturalists, and knowledgeable National Park Service staff members also provided sources of non-published information.

Identify potentially occurring species. The information collected in the previous step was then utilized to clarify the list of potential elements and to refine our search areas. In general, a list of known and potential rare or imperiled plants, animals, and plant communities for the Great Sand Dunes and San Luis Lakes regions was compiled (Table 3). The potentials were based on elevation range and preferred habitat type.

The inventory effort given for each of these elements was prioritized according to the element's rank. Globally rare (G1-G3) elements were given higher priority, and state rare elements were secondary.

Select and prioritize Targeted Inventory Areas. Targeted Inventory Areas (TIAs) were selected by identifying suitable habitats for the targeted elements. Use of aerial photographs, geology, and soils maps, 7.5 minute topographic maps, vegetation surveys and maps, personal recommendations from knowledgeable local scientists and residents, and roadside surveys proved particularly useful. Inclusion of precisely known element locations was always incorporated so that these could be verified and their data updated. If an element was known from a general or ambiguous location, i.e., "Playas near Arena Creek," survey sites were then chosen in likely areas in the general vicinity. The survey areas were prioritized by CNHP ranking, the time of year the species is most easily recognized, and by estimated habitat condition.

Landowner Contact. Attaining permission to conduct surveys on private property or leased property was essential to the success of this project. The majority of the private land for our study was part of the Rocky Mountain Bison Ranch (RMBR), also known as the Zapata and Medano Ranches. The CNHP very much thanks the RMBR for unrestricted accesses to these lands.

Field Surveys. Field surveys took place during times concordant with the time of year the species were most easily detected and recognized. For example, breeding birds cannot be surveyed outside of the breeding season, plants are often difficult to identify without flowers or fruit, and many insects have very specific and limited time frames when in the easily recognized adult stage. Most surveys took place during June, July, and August.

Methods used to detect targeted elements are fundamentally diverse, according to each targeted element's nature of habit and habitat. Many elements may be visually recorded, if their markings are easily and positively recognized in the field. Others required the use of special techniques for consequential detection. These are summarized below:

- **Plant Communities:** Visual, collection of qualitative or quantitative composition data;
- **Wetland Plant Communties:** Visual, collection of qualitative or quantitative composition data, soil, hydrological, function, and value data;
- **Insects:** Visual, aerial nets, pitfall traps, mercury vapor lamps, black light lamps;
- **Fishes:** Seining, observation;
- **Amphibians:** visual or with aquatic nets;
- **Mammals:** Sherman live traps, pitfall traps;
- **Birds:** Visual, or by song/call, evidence of breeding was sought (nesting, or pairs).

When a targeted element was encountered, the precise location and observed extent was recorded on 1:24,000 scale topographic maps. Collection was limited to voucher specimens of targeted species, and to those species difficult to distinguish in the field. The relative "quality" of each occurrence of each targeted species was estimated and a brief assessment of relevant ecological processes, threats, and management concerns was noted during the surveys. These estimated factors are later combined into an **element occurrence rank**, which is useful in refining conservation priorities. See the section on **Natural Heritage Methodology** for more about element occurrence rankings.

Delineation of potential conservation area planning boundaries. As the objective for this study was to prioritize specific areas for conservation efforts, proposed conservation sites were delineated. This boundary is an estimation of the minimum area needed to assure viable persistence of the elements. In addition to this boundary, a number of ecological processes was considered including: sufficient habitat for rare species, protection of water quality, protection from potentially detrimental land uses, and maintenance of ecological processes necessary to perpetuate the viability of significant elements. The preliminary conservation boundary exists to include features on the surrounding landscape to provide these ecological functions. In addition to data collected in the field, aerial photography was also used to assist in delineation of these boundaries. These boundaries are considered preliminary and additional information about a site or an element may alter the boundaries at a later date. **The proposed conservation area**

boundaries delineated within this report to do not confer any regulatory protection of the site.

RESULTS

Targeted Inventory Areas

A total of 26 targeted inventory areas (TIA's) were outlined for the study area (Figure 3). All habitat types were included: sand dunes, sand sheet, interdunal wetlands, playa lakes, playa lake shrublands, and wet meadows. Table 3, provides a list of the targeted elements for the Great Sand Dunes and the San Luis Lakes area.

Table 4, lists each TIA and its most significant elements targeted for each, with an indication of whether the TIA was visited or not. All habitat types were visited, although time did not permit for all TIAs to be visited.

Big Spring Creek on the Rocky Mountain Bison Ranch. Slender spiderflower habitat.

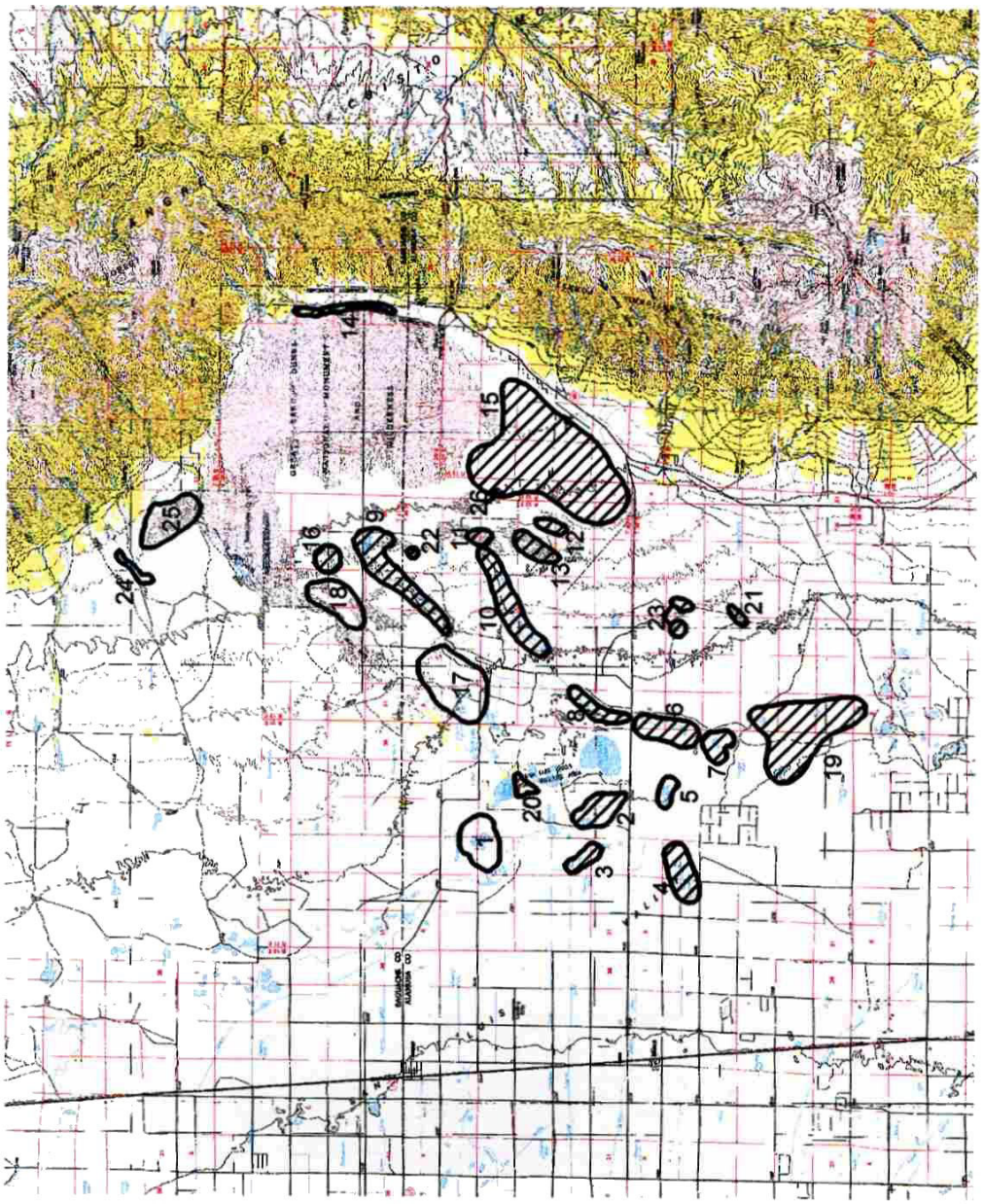


Figure 3.
Targeted Inventory Areas for the 1998 Biological Inventory

Table 3. Rare or Imperiled Plants, Animals, and Plant Communities Potentially Occurring on the Great Sand Dunes and San Luis Lakes Region. Known elements are in bold type.

Scientific Name	Common Name	Global Rank	State Rank	Topographic Relief	Habitat Type	Habitat Comments	Search Dates
Plants							
Astragalus bodinii	**Bodin's milkvetch**	**G4**	**S2**	**V**	**WT**	**moist sedge meadows**	**JUL AUG SEP**
Cleome multicaulis	**Slender spiderflower**	**G2G3**	**S2S3**	**V**	**WT**	**Alkaline soils**	**JUN2 JUL AUG**
Cryptantha cinerea var pustulosa	**James' cateye**	**G5T?**	**S1?**	**V**	**SD, GR**	**Sandy grasslands**	**JUN JUL**
Epipactis gigantea	Helleborine	G4	S2	VF	WT,RP, HS,SP	Wet places often at base of cliffs with seeps	JUN JUL
Platanthera sparsiflora var. ensifolia	**Canyon bog orchid**	**G4G5 T3**	**S2**	**FM**	**WT, RP, HS,SP**		**JUN JUL**
Rorippa coloradensis	Colorado watercress	GX	SX	VF	RP	Lower montane wood and shrublands along river	
Sisyrinchium demissum	Blue-eyed grass	G5	S2	VF	WT,RP,SP	Often saline alkaline	JUN JUL AUG
Sisyrinchium pallidum	Pale blue-eyed grass	G2G3	S2	VF	WT,RP	Alkaline soils	JUN2 JUL1
Plant Communities							
Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum	**Montane riparian forest**	**G1**	**S1**	**FM**	**RP**		
Abies lasiocarpa-Picea engelmannii/Alnus incana	Montane riparian forest	G5	S5	M	RP		
Alnus incana-mixed salix species	**Thinleaf alder-mixed willow species**	**G3**	**S3**	**FM**	**RP**		
Alnus incana-Salix drummondiana	Montane riparian shrublands	G3	S3	FM	RP		
Caltha leptosepala	Montane wet meadows	G4	S4	MA	WT,RP		

Scientific Name	Common Name	Global Rank	State Rank	Topographic Relief	Habitat Type	Habitat Comments	Search Dates
Carex lanuginosa	Wet meadow	G4	SU	V	WT		
Carex nebrascensis	Wet meadow	G4	S3?	V	WT		
Carex simulata	**Wet meadow**	**G3**	**S3**	**V**	**WT**		
Carex vesicaria	Wet meadow	GU	S1?	V	WT		
Catabrosa aquatica-Mimulus glabratus	**Spring wetland**	**GU**	**S3**	**VFM**	**WT,RP**		
Cornus sericea				FM	RP		
Distichlis spicata	**Salt meadow**	**G5**	**S3**	**V**	**WT,GR**		
Eleocharis palustris	**Spikerush wetland**	**G5**	**S3S4**	**V**	**WT**		
Glaux maritima	Alkaline flats	GU	SU	V	WT		
Glyceria maxima	Wet meadow	GU	SU	V	WT		
Hippuris vulgaris	**Mare's tail wetland**	**GU**	**SU**	**V**	**WT**		
Juncus balticus	Wet meadow	G4G5	SU	V	WT		
Oryzopsis hymenoides – Psoralidium lanceolatum	**Sand dune grassland**	**G3Q**	**S1**	**V**	**SD**		
Phragmites communis wetland	Western slope marshes	G4	S3	V	WT		
Picea pungens/bare ground	Montane riparian forest	GU	SU	M	RP		
Picea pungens/Cornus sericea	Montane riparian forest	G4	S2	M	RP		
Polygonum amphibium	Submergent wetland	GU	SU	V	WT		
***Polygonum amphibium* montane wetland**	**Montane wet meadow**	**G2**	**SU**	**V**	**WT**		
Populus angustifolia/ Alnus incana	**Montane riparian forest**	**G3?**	**S3**	**FM**	**RP**		
Populus angustifolia/Salix drummondiana-Acer glabrum	**Montane riparian forest**	**G1**	**S1**	**FM**	**RP**		
***Populus angustifolia*/Sand dune forest**	**Sand dune riparian forest**	**G1**	**S1**	**VF**	**RP,SD**		
Potamogeton pusillus-Zanichellia palustris	Submergent wetland	GU	SU	V	WT	The most common submerged community	
Redfieldia flexuosa-(Psoralidium lanceolatum)	**Sand dune blowout grassland**	**G1?**	**S1?**	**VF**	**SD**		
Salicornia rubra	Western slope salt meadow	G2	S1?	V	WT		

Salix eriocephala var. ligulifolia	Montane willow carr	G2G3	S2S3	VF	RP		
***Salix exigua*/barren ground**	**Coyote willow/bare soil**	**G5**	**S5**	**VFM**	**RP**		
Salix geyeriana-Salix monticola/mesic forb	Geyer's willow-Rocky Mountain willow/mesic forb	G3	S3	M	RP		
Salix lucida ssp. caudata	Montane riparian shrubland	G3Q	S2S3	VFM	RP		
Salix monticola/Carex aquatilis	Montane riparian willow carr	G3	S3	FM	RP,WT		
*Salix monticola/*mesic forb	Montane riparian willow carr	G3	S3	FM	RP,WT		
Sarcobatus vermiculatus/ Distichlis spicata	**Saline bottomland shrubland**	**GU**	**SU**	**V**	**SH,WT**		
Scirpus maritimus wetland	Emergent wetland (marsh)	G4	S?	V	WT		
Scirpus pungens	**Bulrush wetland**	**G3G4**	**S3**	**V**	**WT**		
Scirpus tabernaemontani-Scirpus acutus	Emergent wetland (marsh)	G5	SU	V	WT		
Sparganium eurycarpum	Broodfruit burreed	GU	SU	V	WT		
Spartina gracilis	Alkaline wet meadow	G4	S3	V	WT		
Sporobolus airoides	Great plains salt meadow	G2?	SU	V	WT,RP		
Sporobolus airoides-Distichlis spicata	Great plains slat meadow	G3G5	SU	V	WT,RP		
Stipa comata-Oryzopsis hymenoides	**Sand Grassland**	**G2**	**S1**	**V**	**SD, GR**		
Typha latifolia-Typha angustifolia	Emergent wetland (marsh)	G5	S3?	V	WT		
Insects							
Aeshna clarki virginalis	Lance-tailed darner	G5	S1?				
Aeshna constricta	**Lance-tailed darner**	**G5**	**S1?**				
Amblyderus werneri	**Ant-like flower beetle**	**G1?**	**S1?**	**V**	**SD**	**Great Sand Dunes endemic**	

Amblyderus triplehorni	**Ant-like flower beetle**	**G1?**	**S1?**	**V**	**SD**	**Great Sand Dunes endemic**	
Callicorixa polhemusi	A water boatman	G1?	S1?	V	WT	Colorado endemic, aquatic habitat	
Cicindela theatina	**Great Sand Dunes tiger beetle**	**G1**	**S1**	**V**	**SD**	**GSD endemic, burrows in pm due to high winds**	**MAY JUN JUL AUG SEP**
Daihinibaenetes giganteus	**Giant sand treader cricket**	**G3**	**S1**	**VF**	**SD**		
Eleodes hirtipennis	**Circus beetle**	**G1**	**S1**	**VF**	**SD**	**Great Sand Dunes endemic**	
Euphilotes rita coloradensis	**Colorado blue**	**G4T2 T3**	**S2**				
Euproserpinus wiesti	Wiest's primrose sphinx moth	G3G4	S2	V	SD	Sandy washes in sand dunes with *Oenothera latifoli*	MAY2 JUN1
***Hypocaccus* undesc. sp.**	**Hister beetle**	**G1**	**S1**	**V**	**SD**		
Notonecta unifasciata	Backswimmer	G?	S?	VF?	WT,RP	Habitat restricted? Aquatic habitat	
Oecetis immobilis	A long horned caddisfly	G?	S?	VF?	WT,RP	Disjunct population? Aquatic habitat	
Physa skinneri	Skinner's physa	G?	S2				
Polites rhesus	**Rhesus skipper**	**G4**	**S2S3**				
Polites sabuleti ministigma	**San Luis Valley sand hills skipper**	**G5T3**	**S3**	**VF**	**SD**	**Alkali sandy soil or dunes with *Eragrostis trichodes***	**JUN2 JUL**
Proctacanthus n.sp.	**A robber fly**	**G1?**	**S1**	**V**	**SD**		
Prochoerodes n.sp.	Geometrid moth	G2?	S1?	V	SD		
Pygrus xanthus	**Xanthus skipper**	**G3G4**	**S3**				

Schinia avemensis	**Golden-edged gem**	**G3?**	**S1**	**V**	**SD**	**Day flying, found on *Helianthus***	**AUG1**
Sphinx dollii	**A sphinx moth**	**G?**	**S2?**				
Amphibians							
Rana pipiens	Northern leopard frog	G5	S3	VFMA	WT,RP	Marshes, ponds, lakes, reservoirs, beaver ponds	MAY JUN JUL AUG SEP
Birds							
Amphispiza belli	**Sage sparrow**	**G5**	**S3B, SZN**	**V**	**GR,SH**		
Ardea albus	Great egret	G5	S1B, SZN	V	WT,RP		
Ardea herodias	Great blue heron	G5	S3B, SZN	VF	RP		
Asio flammeus	**Short-eared owl**	**G5**	**S2B,SZN**	**V**	**GR,WT**		
Asio otus	Long-eared owl	G5	S3S4B	VFM	WT,RP,SH,OW,WD,PJ,AS		
Aythya valisineria	Canvasback	G5	S2B,SZN	VF	WT	Monte Vista wildlife refuge	MAY JUN JUL AUG
Botaurus lentiginosus	American bittern	G4	S3S4B,SZN	VF	WT	Cattail marshes	APR MAY JUN JUL AUG
Buteo regalis	**Ferruginous hawk**	**G4**	**S3B S4N**	**VF**	**GR**		
Catoptrophorus semipalmatus	Willet	G5	S1B, SZN	V	WT		
Charadrius alexandrinus nivosus	**Western snowy plover**	**G4T3**	**S1B, SZN**	**V**	**WT**	**Alkaline beaches**	
Chlidonias niger	Black tern	G4	S3S4B,SZN	VF	WT	Large cattail marshes adjacent to open water	JUN JUL
Circus cyaneus	Northern harrier	G5	S3B,SN	VFM	WT,GR,SH		APR MAY JUN JUL
Cistothorus palustris	Marsh wren	G5	S3B,SZN	V	WT	Cattail marshes	MAY JUN JUL AUG1
Egretta thula	Snowy egret	G5	S2B,SZN	V	WT	Nests in shrubs and trees adjacent to	MAY JUN JUL AUG1

						reservoirs and marshes	
Grus canadensis tabida	Greater sandhill crane	G5T4	S2B, S4N	V	RP	With willow and aspens	APR MAY JUN JUL
Haliaeetus leucocephalus	Bald eagle	G4	S1B, S3N	VFM	RP		APR MAY JUN JUL AUG1
Himantopus mexicanus	Black-necked stilt	G5	S3B, SZN	V	WT		
Ixobrychus exilis	Least bittern	G5	S2B, SZN	V	WT	Cattail marshes	
Larus delawarensis	Ring-billed gull	G5	SHB, SZN	VFM	WT	Nests on islands in reservoirs	
Numenius americanus	**Long-billed curlew**	**G5**	**S2B, SZN**	**V**	**GR,WT**		**APR MAY JUN JUL AUG**
Nycticorax nycticorax	**Black-crowned night-heron**	**G5**	**S3B, SZN**	**V**	**WT**		**APR MAY JUN JUL AUG**
Pandion haliaetus	Osprey	G5	S3B, SZN	VFM	WT	Reservoirs and large lakes	MAY JUN JUL AUG
Pelecanus erythrorhynchos	American white pelican	G3	S1B,SZN	VFM	WT,RP	Islands in large reservoirs	JUN JUL AUG
Picoides scalaris	Ladder-backed woodpecker	G5	S3	VF	SD		
Plegadis chihi	**White-faced ibis**	**G5**	**S2B, SZN**	**V**	**WT**		**APR2 MAY JUN JUL**
Podiceps nigricollis	**Eared grebe**	**G5**	**S3B, SZN**	**V**	**WT**	**Breeds in marshes with cattails**	**APR MAY JUN JUL AUG**
Sterna forsteri	**Forster's tern**	**G5**	**S2B S4N**	**VF**	**WT**	**Nests in cattail marshes near open water**	**MAY2 JUN JUL1**
Mammals							
Cynomys gunnisoni gunnisoni	**Gunnison's prairie dog subsp.**	**G5T3**	**S3**	**VFM**	**GR**		
Dipodomys ordii montanus	Ord's kangaroo rat subsp.	G5T?	S1	V	RP	Sandy habitats preferred	
Perognathus flavescens relictus	**Plains pocket mouse subsp.**	**G5T2**	**S2**	**V**	**SD,GR**		

Perognathus flavus sanluisi	**Silky pocket mouse subsp.**	**G5T3**	**S3**	**V**	**SD,GR**		
Plecotus townsendii pallescens	Townsend's big-eared bat	G4T4	S2	FM	Caves		
Fish							
Catostomus plebeius	Rio Grande sucker	G4	S1	VFM	RP		
Oncorhynchus clarki virginalis	**Rio Grande cutthroat**	**G4T3**	**S3**	**FM**		**Rapidly flowing water with eddies**	

Topographic Relief: ***V = Valley bottom; F = Foothills; M = Montane; A= Alpine.***
Habitat Type: ***AS = Aspen; GR= grassland; HS = Hot spring, OW = Open woodland; PJ = Piñon-juniper; RP = Riparian; RS = Rocky Slope, RO = Rock outcrop; SD = Sand dune; SH = Shrubland; SP = Spring/seep; WD = Woodland; WT = Wetland.***

Table 4. Targeted Inventory Areas for the Great Sand Dunes and the San Luis Lakes Areas.

TIA #	Targeted Inventory Area (TIA)	Targeted Elements	Visited?
1	Head Lake Northwest	*Cleome multicaulis*, Wetland plant communities, *Amphispiza belli, Egretta thula, Nycticorax nycticorax, Plegadis chihi, Podiceps nigricollis, Sterna forsteri, Perognathus flavescens relictus, Perognathus flavus sanluisi, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	N
2	San Luis Creek	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Asio flammeus, Sterna forsteri, Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
3	Bachelor Lake	*Cleome multicaulis* Wetland plant communities, *Amphispiza belli, Egretta thula, Nycticorax nycticorax Plegadis chihi, Podiceps nigricollis, Sterna forsteri, Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
4	Prairie Ditch	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Charadrius alexandrinus nivosus, Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	Y
5a,b	Flowing Wells	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Charadrius alexandrinus nivosus, Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	N
6	San Luis Lake South	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Charadrius alexandrinus nivosus, Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	Y
7	Crescent Shaped Playa	*Cleome multicaulis,* Wetland plant communities, *Polites sabuleti ministigma, Amphispiza belli, Charadrius alexandrinus nivosus, Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	Y

TIA #	Targeted Inventory Area (TIA)	Targeted Elements	Visited?
8	Twin Lakes	*Cleome multicaulis, Eleocharis palustris,* Wetland plant communities, *Gila pandora, Amphispiza belli, Charadrius alexandrinus nivosus, Podiceps nigricollis, Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
9	Big Spring Creek/Indian Spring	*Cleome multicaulis,* Riparian communities, Wetland plant communities, *Gila pandora, Amphispiza belli, Nycticorax nycticorax Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
10	Little Spring Creek	*Cleome multicaulis,* Wetland plant communities, *Gila pandora, Amphispiza belli Asio flammeus, Nycticorax nycticorax, Podiceps nigricollis, Sterna forsteri, Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
11	Little Spring Creek Sand Wetland	*Cleome multicaulis, Scirpus pungens* Wetland plant communities, *Cicindela theatina, Polites sabuleti ministigma, Amphispiza belli, Podiceps nigricollis, Sterna forsteri,Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
12	Southwest Sand Dunes Scrub	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Buteo regalis Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus,Spermophilus tridecemlineatus blanca*	N
13	Small Sand Dune North of Scrub	*Cleome multicaulis,* Wetland plant communities, *Amphispiza belli, Asio flammeus, Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	Y
14	Medano Creek	*Cleome multicaulis,* Wetland plant communities*, Amphispiza belli,Perognathus flavus sanluisi, Perognathus flavescens relictus, Reithrodontomys montanus montanus,Spermophilus tridecemlineatus blanca*	Y
15	Zapata Ranch Grasslands	*Cleome multicaulis,* Grassland community, *Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.*¸Schinia avemensis, Amphispiza belli, Asio flammeus, Perognathus flavescens relictus, Perognathus flavus sanluisi, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
16	East/West Elk Wetlands	*¸Cleome multicaulis,* Wetland plant communities *Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.*¸Schinia avemensis, Asio flammeus, Amphispiza belli, Circus cyaneus, Perognathus flavescens relictus, Perognathus flavus sanluisi, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus*	Y
17	Medano Mountain	*Cleome multicaulis,* Wetland plant communities*, Polites sabuleti ministigma, Amphispiza belli, Asio flammeus, Numenius americanus, Perognathus flavescens relictus, Perognathus flavus sanluisi, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	Y

18	Sand Creek Scrubland	*Amphispiza belli, Asio flammeus, Perognathus flavescens relictus, Perognathus flavus sanluisi, Reithrodontomys montanus montanus, Spermophilus tridecemlineatus blanca*	N
19e	Playa Lakes	*Daihinibaenetes giganteus, Polites sabuleti ministigma, Charadrius alexandrinus nivosus, Egretta thula, Plegadis chihi, Nycticorax nycticorax, Podiceps nigricollis, Perognathus flavescens relictus, Perognathus flavus sanluisi, Spermophilus tridecemlineatus blanca*	Y
20	Head Lake	*Daihinibaenetes giganteus, Polites sabuleti ministigma, Cleome multicaulis*, Wetland plant communities*, Amphispiza belli, Egretta thula, Nycticorax nycticorax, Plegadis chihi, Sterna forsteri, Perognathus flavus sanluisi, Perognathus flavescens relictus, Spermophilus tridecemlineatus blanca, Reithrodontomys montanus montanus, Podiceps nigricollis*	N
21	Twin Sand Dune Mass	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.¸*Schinia avemensis*	Y
22	Spring Creek Sand Dunes	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Polites sabuleti ministigma, Procatacanthus* n.sp.¸*Schinia avemensis*	Y
23	Jeep Trail	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.¸*Schinia avemensis, Amphispiza belli, Charadrius alexandrinus nivosus Perognathus flavescens relictus, Perognathus flavus sanluisi, Spermophilus tridecemlineatus blanca*	Y
24	Pole Creek	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.¸*Schinia avemensis*	N
25	Northern Escaped Dune	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.¸*Schinia avemensis*	N
26	Beaver Wetland	*Cicindela theatina, Daihinibaenetes giganteus, Eleodes hirtipennis, Amblyderus werneri, Amblyderus triplehorni, Hypocaccus* undesc.sp., *Procatacanthus* n.sp.¸ *Polites sabuleti ministigma, Schinia avemensis, Perognathus flavescens relictus, Perognathus flavus sanluisi, Asio flammeus*	Y

Elements of Biodiversity Significance

This study combined with previous studies recognizes a total of 46 biologically significant elements the Colorado Natural Heritage Program tracks, including 15 plant communities, 14 insects, nine birds, four plants, three mammals, and one fish (Tables 5 and 6). Many of these elements are restricted in range, either known to be endemic to only the Great Sand Dunes system, or endemic to the San Luis Valley. Considering the relatively compact size of this study area, the number of significant elements indicates that this is an area of remarkably high biological wealth.

All data collected and processed during this survey are housed and maintained in the Biological Conservation Database System (BCD) at the Colorado Natural Heritage Program.

Some of the most significant findings of the 1997/1998 field surveys are summarized below.

Insects. Of particular interest is the number of endemic invertebrate species found at the Great Sand Dunes site. At least six insects exhibit a range that appears to be limited to the sand dunes and sand dune blowouts within the sand sheet, a range of approximately 420 km² (160 mi²). These insects include five beetle species and one robber fly: *Amblyderus werneri, A. triplehorni, Cicindela theatina, Hypocaccus* undescribed sp*., Eleodes hirtipennis, and Proctacanthus* n. sp. Aside from distribution, little else is known about the natural history of these rare insects (Appendix A).

Within the boundaries of the Great Sand Dunes National Monument, we detected a new location for the ant-like flower beetle, *Amblyderus werneri*, at the Ghost Forest, on the eastern edge of the Great Sand Dunes National Monument. This beetle was previously considered to only occur west of Sand Creek (M. Weissmann pers. comm.) *A. triplehorni*, another ant-like flower beetle was not detected in any of our inventories, and is thought to prefer the very dynamic and sparsely vegetated star dunes of the Monument (M. Weissmann pers. comm.) Both of these species have recently been described (Weissmann and Kondratieff *in press*). The histerid beetle, *Hypocaccus* undescribed sp., is encountered randomly mostly in the vegetated sand sheet areas. This beetle is currently undergoing formal description by Dr. Michael Weissmann.

Although our study targeted all of the endemic insects, we are most knowledgeable about the distribution of the Great Sand Dunes tiger beetle, *Cicindela theatina*. We are fairly certain that the tiger beetle is widespread within the Great Sand Dunes potential conservation area. Using vegetation and sand dune type as habitat indicators, we could confidently predict encounters with this tiger beetle. Small isloated blowout dunes scattered throughout the sand sheet province typically harbor these beetles, usually typified by the presence of dune blowout grass, *Redfieldia flexuosa* and scurfpea, P*soralidium lanceolatum*. See Appendix A for a description of the most significant insects.

Also confirmed from the Medano Ranch was the occurrence of the golden-edge gem moth, *Schinia avenmensis*. The only other locations known for this species are sandy areas in Manitoba, Canada, and from one other Colorado eastern plains location.

Vertebrates. Trapping for small mammals detected the plains pocket mouse (*Perognathus flavescens relictus*), a subspecies of mouse that is nearly endemic to the Great Sand Dunes site. Although previously collected in the Great Sand Dunes National Monument during the 1970's (Armstrong 1972) it was not detected again until 1998 during CNHP trapping surveys. Curiously, this animal was not detected in 1997, although small mammal trapping in 1997 was conducted in congruous habitat.

Plants. The San Luis Lakes proposed conservation area supports one of the largest populations known of the globally rare slender spiderflower (*Cleome multicaulis*). The slender spiderflower has a fairly large global range from southern Wyoming to central Mexico. In spite of its large geographic range, the plant is spatially limited by its specific habitat requirements. It requires moist, alkaline soils for germination and

growth. In addition to stringent moisture and alkaline needs, the slender spiderflower appears to do well with some form of soil disturbance. These discriminating restrictions limit the slender spiderflower to the edges of alkaline playa lakes and wetlands. The Closed Basin of Colorado contains the most numerous, largest, and healthiest populations of the slender spider-flower known in the world. The largest populations are at Russell Lakes proposed conservation area, San Luis Lakes proposed conservation area, and Blanca wetlands proposed conservation area.

Potential Conservation Areas

Due to the very distinct geomorphology as well as the distribution of the endemic insects, we have delineated two proposed conservation sites that are adjacent to each other: the Great Sand Dunes Site and the San Luis Lakes site. The Great Sand Dunes site is globally significant and has been given the highest biodiversity rank of B1. This rank portrays the uniqueness of the area. The Natural Heritage Program considers B1 sites irreplaceable, that is, if we were to lose the endemic species within this site, the species would most likely become extinct. The Colorado Natural Heritage Program recognizes approximately 25 B1 sites in Colorado, of which the Great Sand Dunes site is the largest and hosts more endemic species per area than any other site in Colorado. The extraordinary assemblage of insects and especially the number of endemic insects known from the area, establish this as one of the most important conservation sites in Colorado.

The San Luis Lakes site is also a globally significant site (B2) in that it provides some of the best habitat for the globally rare slender spiderflower. In addition it is an important area for nesting water birds.

POTENTIAL CONSERVATION AREA PROFILE

Potential Conservation Area Format

Each potential conservation area is described in a standard site report reflecting data fields in CNHP's Biological and Conservation Data System (BCD). The sections of this report and the contents are outlined and explained below.

Biodiversity Rank (B-rank): The overall significance of the site in terms of rarity of the Natural Heritage resources and the quality (condition, abundance, etc.) of the occurrences. For rank definitions, please see the **Natural Heritage Ranking System** section of this report.

Protection Urgency Rank (P-rank): An estimate of the time frame in which conservation protection must occur. This rank generally refers to the need for a major change of protective status (i.e., ownership or designation as a natural area). For rank definitions, please see the **Natural Heritage Ranking System** section of this report.

Management Urgency Rank (M-rank): An estimate of the time frame in which conservation management must occur. Using best scientific estimates, this rank refers to the need for management in contrast to protection (legal, political, or administrative measures). For rank definitions, please see the **Natural Heritage Ranking System** section of this report.

Location: General location and specific road/trail directions.

Legal Description: USGS 7.5 minute quadrangle name and Township and Range.

General Description: A brief narrative of the topography, vegetation, and current use of the potential conservation area. Common names are used along with scientific names.

Biodiversity Rank Justification: A synopsis of the significant elements occurring in the site. A table within the site profile lists the element occurrences found within the site, their rarity ranks, the occurrence ranks and federal and state agency special designations. The species or community that is the primary element of concern is flagged within the table. See Table 1 for explanations of ranks and Table 2 for legal designations.

Boundary Justification: Justification for the location of the potential conservation site planning boundary delineated in this report, including all known occurrences of natural heritage resources and, in some cases, adjacent lands required for their protection.

Protection Rank Justification: A summary of major land ownership issues that may affect the site and the element(s) within the site.

Management Rank Justification: A summary of site management issues that may affect the long-term viability of the site.

GREAT SAND DUNES

Biodiversity Rank: B1 (Outstanding signficance)
The Great Sand Dunes ecosystem is one of the most significant biological sites in Colorado. The wind driven system of the Great Sand Dunes provides habitat for at least six endemic species of insects, whose entire global range is restricted to the shifting sands of Great Sand Dunes National Monument and adjacent areas. Although approximately 900 insects are documented, experts estimate that possibly 2,000 invertebrate species are present in this system. The presence of 14 rare invertebrate species, eight plant communities, two rare plant species, and three mammalian subspecies combine to make this a locality of remarkable biodiversity.

Protection Urgency Rank: P2 (Definable threat but time frame unknown)
Twenty-five percent of this site has formal protection within the Great Sand Dunes National Monument. The remaining 75% is designated as state and private lands (Figure 4). The state lands, 50% of the site, are on the south and western portion. The private lands that make up the northern portion are part of the Luis María Baca No. 4 land grant, while the private lands on the west are within the Rocky Mountain Bison Ranch. The comparatively simple land ownership of this site makes it possible to develop a conservation plan that would protect many components of an entire ecosystem. Several tools exist including conservation easements, habitat conservation plans, direct acquisition, and cooperative management plans are available to aid in conservation planning. The development of a conservation plan at this stage may prevent the federal listing of the endemic species of insects. The Nature Conservancy has signed an agreement to purchase the Rocky Mountain Bison Ranch which will protect a significant portion of the area. The P2 rank is primarily driven by the lack of a protection strategy for the Luis Maria Baca Ranch.

Management Urgency Rank: M4 (Not currently threatened, but future management plans needed to maintain current quality of occurrences)
Due to the high quality condition of most element occurrences at this site, current surface management of both the private and public portions of this site appears adequate. However, groundwater management is not as clear. (Hammond 1998) documented a 50% decline in the number of interdunal wetlands between the 1930's and 1995. To further understand viability needs of the insects and their associated plant communities, future research might address livestock-insect interactions, insect-plant interdependency, impacts of recreation on insects, groundwater-interdunal wetland relationships, effects of grazing and fire on grass and shrublands, and a more thorough inventory of the invertebrate fauna.

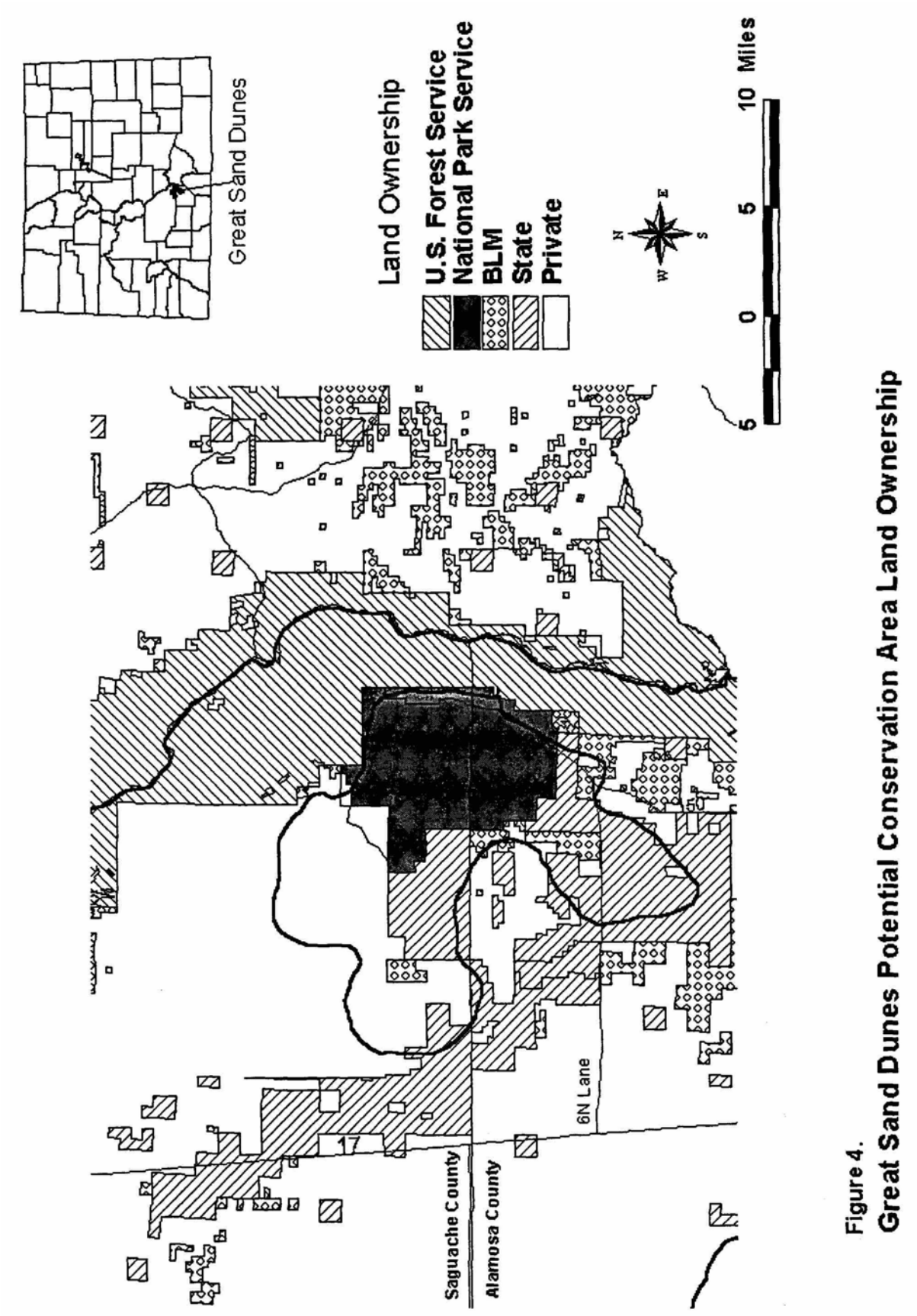


Figure 4.
Great Sand Dunes Potential Conservation Area Land Ownership

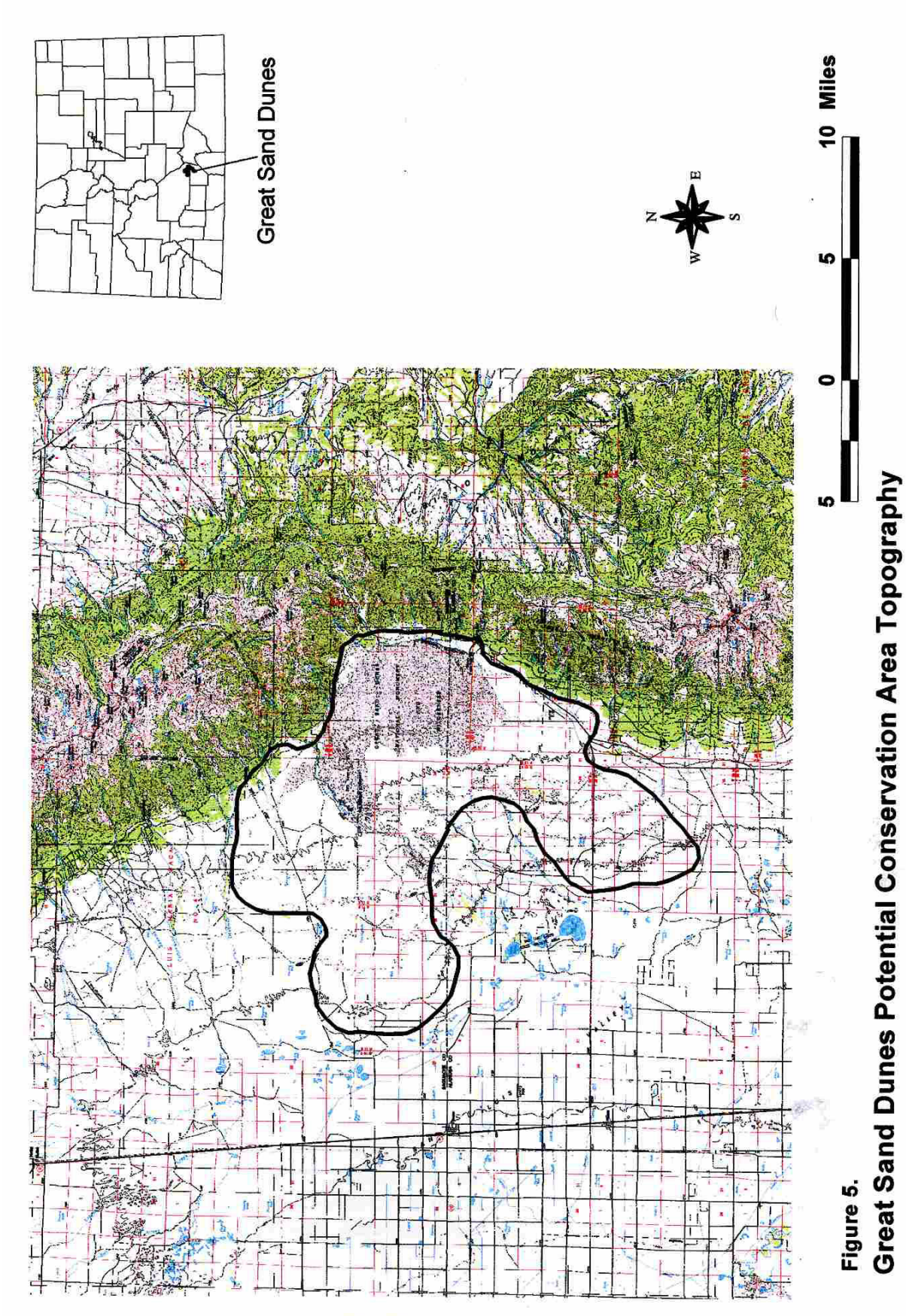


Figure 5.
Great Sand Dunes Potential Conservation Area Topography

Location: The Great Sand Dunes site straddles the border of Alamosa and Saguache Counties, Colorado. It is located in the southeast portion of the San Luis Valley's Closed Basin and lies at the base of the Sangre de Cristo mountain range. See Figure 5 for exact location.

Legal Description: **USGS 7.5 minute quadrangles: Crestone, Sand Camp, Medano Ranch, Dry Lakes, Twin Peaks, Zapata Ranch, Liberty, Medano Pass; Townships and Ranges: 042N012E, 041N012E, 041N011E, 040N012E, 039N012E, 028S073W, 040N013E, 027S073W, 039N013E, 026S073W, 026S074W, 025S074W, 026S073W.**

General Description: The Great Sand Dunes potential conservation area is the major part of an eolian depositional system that covers approximately 800 square kilometers (300 sq. mi.) in the San Luis Valley of Colorado (Fryberger and others 1990) and ranges in elevation from 2,290 m to 2,620 m (7,525 to 8,600 ft.). This system has three recognized geomorphological entities: Province I, Province II and Province III (Andrews 1981; Figure 2). Province I is the playa lakes system (dry lakes) area on the upwind portion of the depositional system (see San Luis Lakes Potential Conservation Area for description). Province II is the extensive sand sheet that lies between the main sand dune mass and the dry lakes area. Province III is the main sand dune mass existing at the downwind end of the system. This site encompasses nearly all of Province II and all of Province III. Province II and III cover approximately 420 square kilometers (162 sq. mi.), with the most active sand, comprising the large dune mass, mostly within the Great Sand Dunes National Monument, covering about 75 square kilometers (29 sq. mi.).

Province II is an extensive vegetated sand sheet composed of a mosaic of stable and shifting sand components. The stable sand component is characterized by rabbit brush (*Chrysothamnus nauseosus*), needle-and-thread grass (*Stipa comata*), and Indian ricegrass (*Oryzopsis hymenoides*), while scurfpea (*Psoralidium lanceolatum*), skeleton weed (*Lygodesmia juncea*), and blowout grass (*Redfieldia flexuosa*) characterize the shifting sand component. The sand sheet also includes scattered groups of parabolic dunes with very little vegetation, and wetlands/springs. At the springline, winds scour out depressions down to the water table and expose interdunal wetlands. Although the vegetation components vary among these springs, they may be characterized by coyote willow (*Salix exigua*), baltic rush (*Juncus balticus*), bulrush (*Scirpus pungens*) and less frequently the globally rare slender spiderflower (*Cleome multicaulis*).

Province III is also known as the main mass of active dunes and is perhaps the most visible component of the Great Sand Dunes site. This province is comprised of the large star dunes that are mostly devoid of vegetation and tower up to 210 m (700 feet) from the valley floor. Although its appearance is deceptively dry, the subsurface is actually very damp. The main sand dune mass is stabilized by adhesion when the dry wind blown sand encounters a water source. Spring runoff from the Sangre de Cristo mountain range, most visibly characterized by Sand and Medano Creeks is the most obvious and plentiful water source. The unconfined aquifer is also believed to be an important source of water (A. Davy pers. com.). Sand Creek's union with the dune mass begins in the northeast and rounds out the northeastern, northwestern, and western edges of the dune mass, slicing through the northern portion of the sandsheet. Medano Creek merges with the dunes some 6 km (4 mi) to the southeast of Sand Creek, and rounds out the eastern and southeastern reaches of the dune mass, traversing the southern portion of

the sand sheet. Sand Creek supports a newly described riparian vegetation type of narrowleaf cottonwood (*Populus angustifolia*) and shifting sand.

The sands that constitute Provinces II and III are believed to originate from the ancestral Rio Grande (Fryberger and others 1990). Presently, winds from the southwest drive sand from the Rio Grande River northeastward towards Medano Pass, where winter easterlies have caused the dunes to advance slowly and also grow vertically. As the winds rise over the Sangre de Cristo Mountain Range, they lose their velocity due to the cooler temperatures present at higher elevations and the sand is deposited at the base of the range. As Sand and Medano Creeks wind their way through this system during the spring and summer, they carry sediment away from the dune mass, which is later picked up by prevailing winds, and redeposited. Provinces II and III are maintained by hydrological adhesion, which stabilizes this system although internally it is very dynamic.

Currently, major land uses at the site include recreation which the Great Sand Dunes National Monument and bison and cattle ranching on the adjacent private, state, and federal lands. Recreation includes hiking, camping, sandboarding, skiing on the dunes, and wading in Medano Creek

Biodiversity Rank Justification: The Great Sand Dunes ecosystem is the most outstanding site in the San Luis Valley and is one of approximately 20 B1 sites in Colorado. Six endemic species of insects (five beetles and one robber fly) are known from this ecosystem, including the Great Sand Dunes tiger beetle (*Cicindela theatina*), two ant-like flower beetles (*Amblyderus triplehorni* and *A. werneri*), an undescribed histerid beetle (*Hypocaccus* sp.), a circus beetle (*Eleodes hirtipennis*), and an undescribed robber fly (*Proctacanthus* n.sp) (M. J. Weissmann pers. comm). Although there are approximately 900 insects known from the Great Sand Dunes, experts have estimated that at least 2,000 insects possibly reside here (Weissmann and Kondratieff *in press*). In addition to the rare and rich invertebrate assemblage found here, a wide variety of plants, plant communities, and vertebrates also are of biological significance. The sand sheet (Province II) harbors approximately 6,000 ha (15,000 acres) of a grassland dominated by needle and thread grass with Indian ricegrass (*Stipa comata-Oryzopsis hymenoides* grassland). Interdunal and isolated wetlands provide important habitat for unusual plant communities and rare plants. Several of these wetlands have small populations of the globally rare slender spiderflower (*Cleome multicaulis*). This system is also important habitat for the endemic mammals of the San Luis Valley, especially Ord's kangaroo rat (*Dipodomys ordii montanus*), silky pocket mouse (*Perognathus flavus sanluisi*), plains pocket mouse (*Perognathus flavescens relictus*), and northern pocket gopher (*Thomomys talpoides agrestis*).

Table 5. Natural Heritage Occurrences at the Great Sand Dunes potential conservation area. Multiple listings of the same element represent subpopulations or suboccurrences.

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	Last Observation Date	*EO Rank
Plants						
Cleome multicaulis	Slender spiderflower	G2G3	S2S3		1998-08-14	C
Cleome multicaulis	Slender spiderflower	G2G3	S2S3		1997-06-10	C
Cleome multicaulis	Slender spiderflower	G2G3	S2S3		1986-07-07	Unranked
Cryptantha cinerea var *pustulosa*	James' cateye	G5T?	S1?		1998-08-14	A
Plant Communities						
Alnus incana-mixed Salix species	Thinleaf alder-mixed willow species	G3	S3		1997-07-23	A
Oryzopsis hymenoides-Psoralidium lanceolatum	Indian ricegrass-scurfpea sand community	G3Q	S1		1997-06-11	A
Populus angustifolia/Alnus incana	Montane riparian forest	G3?	S3		1997-07-24	B
*Populus angustifolia/*Sand dune forest	Sand dune riparian forest	G1	S1		1997-07-10	A
Redfieldia flexuosa-(Psoralidium lanceolatum)	Sand dune graminoid community	G1?	S1?		1997-06-11	A
*Salix exigua/*bare ground	Coyote willow/bare ground	G5	S5		1997-07-08	A
Scirpus pungens	Bulrush	G3G4	S3		1997-06-11	A
Stipa comata-Oryzopsis hymenoides	sand grassland	G2?	S1		1997, 1998	A
Insects						
Aeshna constricta	Lance-tailed darner	G5	S1?		No date	Unranked
Amblyderus triplehorni	An ant-like flower beetle	G1?	S1		No date	Unranked
†*Amblyderus werneri*	An ant-like flower beetle	G1?	S1		1998-06-21	A
†*Cicindela theatina*	Great Sand Dunes tiger beetle	G1	S1		1998-08-14	A
Daihinibaenetes giganteus	Giant sand treader camel cricket	G3?	S1		1998-07-01	A
Eleodes hirtipennis	Circus beetle	G1	S1		No date	Unranked
Euphilotes rita coloradensis	Colorado blue	G4T2T3	S2		No date	Unranked
†*Hypocaccus* undescribed sp.	A histerid beetle	G1?	S1		1998-06-17	A
Polites rhesus	Rhesus skipper	G4	S2S3		No date	Unranked
Polites sabuleti ministigma	San luis sandhill skipper	G5T3	S3		1998-06-18	B
†*Proctacanthus* n.sp.	A robber fly	G1?	S1		1998-08-14	A
Pyrgus xanthus	Xanthus skipper	G3G4	S3		No date	Unranked
Schinia avemensis	Golden-edged gem	G3	S1		1998-08-14	A
Sphinx dollii	A sphinx moth	G?	S2?		No date	Unranked
Fish						
Oncorhynchus clarki virginalis	Rio Grande cutthroat	G4T3	S3		1988-07-13	Historic

Scientific Name	Common Name	Global Rank	State Rank	Federal and State Status	Last Observation Date	*EO Rank
Birds						
Amphispiza belli	Sage sparrow	G5	S3B,SZN		1998-06-22	B
Buteo regalis	Ferruginous hawk	G4	S3B,S4N		1998-06-20	B
Mammals						
Cynomys gunnisoni gunnisoni	Gunnison's prairie dog subsp.	G5T3	S3		1998-07-04	B
Perognathus flavescens relictus	Plains pocket mouse subsp.	G5T2	S2		1998-07-02	B
Perognathus flavus sanluisi	Silky pocket mouse subsp.	G5T3	S3		1997-06-27	A
Perognathus flavus sanluisi	Silky pocket mouse subsp.	G5T3	S3		No date	Historic

*= Element Occurrence
† = Basis for Biodiversity Rank

Boundary Justification: The boundary encompasses the majority of Province II and all of Province III. The boundary encompasses all known habitat for the six endemic species of insects. The boundary was specifically drawn for the Great Sand Dunes tiger beetle, which inhabits nearly all of the isolated sand dune blowouts that are scattered throughout the sand sheet (Province II).

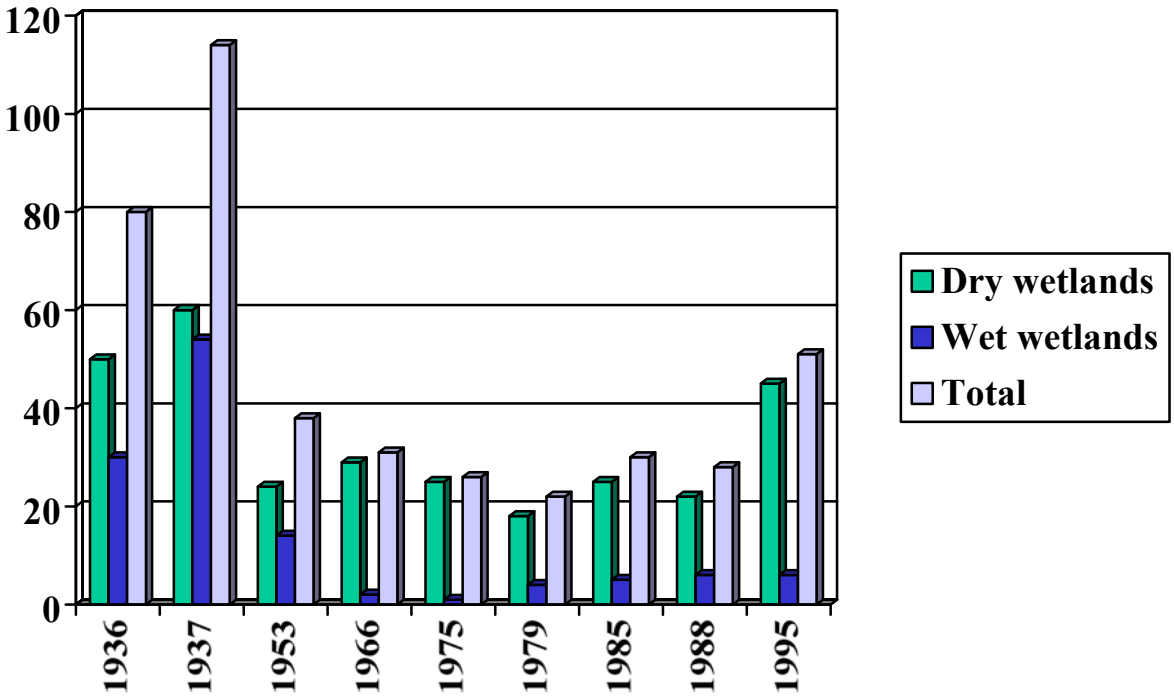
Protection Rank Justification: Only 25% of this site has formal protection within the Great Sand Dunes National Monument. The other 75% is private and state land. The state lands (50%), on the south and western portion of the site, are mostly under lease by Rocky Mountain Bison Ranch. The private lands (25%) on the north are part of the Luis Maria Baca Ranch. The most significant threat identified for both the San Luis Lakes and Great Sand Dunes sites is altered hydrology (The Nature Conservancy, pers. comm.) The natural hydrology of the San Luis Valley has been altered for nearly a century, and such hydrological perturbations may be responsible for the loss of the interdunal wetlands reported by the National Park Service (Fred Bunch, pers. comm.). Groundwater pumping is proposed for the Baca Ranch, which could further affect the hydrology of the area. Although the role that hydrology plays in the lives of the biological components of the Great Sand Dunes is not well understood, it is absolutely essential in the maintenance and stability of the dunal habitat and consequently to its inhabitants. Addressing nearby water development as part of a protection package is essential for this site.

Management Rank Justification: Current surface management of both the private and public portions of this site appears adequate. To further understand viability needs of the insects and their associated plant communities, future research should address the role of hydrology in maintaining the Great Sand Dune ecosystem, the groundwater-interdunal wetland relationships, and the relationship between hydrology and the floral and faunal inhabitants. [Hammond (1998]) documented a declining trend in the number of interdunal wetlands (Figure. 6). The critical roles of fire and grazing in the maintenance of grasslands are globally recognized (Milchunas and Lavenroth 1993),

although the importance of these processes to the flora and fauna of the Great Sand Dunes is not known. Additionally, future research might address livestock-insect interactions, impacts of visitors and recreation on insects, and a more thorough inventory of the insect fauna (Weissmann 1995). As recreation activities and plans at the Great Sand Dunes National Monument change, insect/recreation interaction should be considered in order to insure protection of the insect fauna. Models developed to help understand the intricacies of these and other ecological processes supporting this unique habitat would be useful tools for future management decisions.

Recreation within the Great Sand Dunes site is primarily limited to tourism at the Great Sand Dunes National Monument where most use is by pedestrians or limited to camping in designated areas. The Great Sand Dunes' high dune formation infrequently attracts recreationists preferring to sand ski and sand surf; however, this recreation is believed to be of low impact. Should this type activity increase, the types of allowable recreation or limitations on recreation should be reconsidered.

Figure 6. Number of Great Sand Dunes wetlands identified from aerial photography between 1936-1995 (Hammond 1998).



SAN LUIS LAKES

Biodiversity Rank: B2 (Very high significance)
The San Luis Lakes Potential Conservation area contains one of the largest occurrences of the globally imperiled (G3S3) slender spider flower (*Cleome multicaulis*), with over a million plants estimated on the Zapata/Medano Ranch. Also eight plant communities, of which four are globally rare, three other rare plant species, two rare mammal subspecies, seven state rare birds, and two globally rare insect species.

Protection Urgency Rank: P3 (Definable threat but time frame unknown)
The majority of this site is state owned land and the remainder is owned by two large ranches. (Figure 7). The majority of the state lands have just been designated as Stewardship Trust Lands while The Nature Conservancy has signed an agreement to purchase the Zapata/Medano Ranch. The San Luis Maria Baca Ranch is unprotected. Potentially detrimental to this site and its associated elements are the ongoing and future hydrological modifications within the San Luis Valley. Its proximity and ecological continuity to the Great Sand Dunes site, and its concentration of biologically significant elements make this an excellent site to include in a habitat conservation plan.

Management Urgency Rank: M3 (Management is needed on parts of this site, but the time frame is unknown)
The current management at this site is oriented towards recreation at San Luis Lakes and livestock grazing within the ranches. Surface impacts from these management regimes appear moderate at this time. Hydrologic modifications (e.g., ditches and canals) disturb the natural surface water resources, and although these modifications provide necessary and crucial water to the wetland habitats, they should not be considered substitutes for natural hydrological regimes.

Location: This site extends northeast from San Luis Lakes State Park and is located 17 air miles northeast of Alamosa, Colorado in the San Luis Valley of southern Colorado. See Figure 8 for exact location.

Legal Description: USGS 7.5 minute quadrangles: Hooper East, Medano Ranch, Sand Camp, Liberty, Crestone Peak, Beck Mountain. Townships and Ranges: 039N011E, 039012E, 040N11E, 040N012E,041N12E, 025S073W, 024S073W.

Elevation: 2,290 to 3,670 m (7,500 to 12,050 ft.) **Acreage**: 14,100 ha (34,815 acres)

General Description: The San Luis Lakes site represents a portion of Province I of the Great Sand Dunes eolian depositional previously described (Fryberger and others 1990), and ranges in elevation from approximately 2,290 m (7,500 ft) at the bottom of San Luis Lake to 3,670 m (12,050 ft) at the headwaters of Sand Creek. This site, known geomorphologically as Province I, is the most upwind of the three provinces in this depositional system. This large site encompasses nearly 14,100 hectares (35,000 acres) in the southern part of the Closed Basin playa-wetland system and is adjacent to the Great

Sand Dunes site. This site encompasses the San Luis Lakes State Park and Sand Creek, one of its primary water sources.

There are two natural lakes at the San Luis Lakes site which have no outlet in most years. The surrounding upland habitats are saline basins or eolian sand deposits with a decidedly saline character, supporting greasewood (*Sarcobatus vermiculatus*) and saltgrass (*Distichlis spicata*) vegetation. One of the major sources of water to the lakes is Big Springs Creek, originating at Indian Spring approximately 11 km (seven miles) northeast of the lakes. The area between Indian Spring and San Luis Lakes supports the highest concentration of freshwater wetlands in the southern Closed Basin. Common wetland plant species include beaked sedge (*Carex utriculata*), water sedge (*Carex aquatilis*), mare's tail (*Hippuris vulgaris*), and water smartweed (*Polygonum amphibium*). Big Springs Creek receives groundwater from the extensive aquifer under Great Sand Dunes National Monument immediately to the east. Other major habitats of the site include subsaline wetlands in the San Luis Lakes basins, alkali cordgrass (*Spartina gracilis*) meadows around the lake periphery, and rabbitbrush (*Chrysothamnus nauseosus*) shrubland on stabilized dunes. Freshwater dune ponds occur at the eastern edge of the site and support unique wetlands of American three-square (*Scirpus pungens*) and coyote willow (*Salix exigua*).

Sand Creek drains the western slopes of the Sangre de Cristo Mountains. It originates as a steep mountain stream, eventually becoming a braided, sand bottomed stream as it flows out on the San Luis Valley floor and skirts the northern edge of Great Sand Dunes National Monument. In the mountains, Sand Creek is in a wide, steep valley floor with no roads or heavily used trails. On the valley floor, the creek and riparian zone exhibit a unique habitat produced by active fluvial processes (meandering, braiding) juxtaposed with moving sand dunes. Along its course, Sand Creek supports several globally rare riparian plant associations.

With the exception of San Luis Lakes State Park, which is focused on recreation, and the headwaters of Sand Creek, the majority of this site is used as open range at the present time. The Medano-Zapata Ranch maintains large herds of cattle and bison, which graze the private ranch lands and leased state lands contained in the site. Grazing intensity appears moderate at this time. Elk (*Cervus elaphus*) are also numerous at the site and browse the wetland habitats extensively. A number of two track roads traverse the site, but are lightly used.

Although the site hydrology is largely natural over most of the site, there are several ditches which disperse water on the Zapata/Medano Ranch, and water levels at San Luis Lakes State Park have been stabilized by water input from the Closed Basin Project.

Biodiversity Rank Justification: This site supports 22 elements of concern: eight plant communities, three plant species, two mammal subspecies, seven birds, and two insect species. Five significant wetland communities are found at this site: small flowered sedge (*Carex simulata*) wet meadow, aquatic catabrosa/common monkeyflower (*Catabrosa aquatica/Mimulus glabrata*) spring wetland, spikerush (*Eleocharis palustris*) wetland, mare's tail (*Hippuris vulgaris*) wetland, and aquatic smartweed (*Polygonum amphibium*) wetland. Three riparian communities found at this site are globally-rare. These include the white fir-blue spruce-narrowleaf cottonwood/Rocky Mountain maple

(*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum*) montane riparian forest, narrowleaf cottonwood/Drummond's willow-Rocky Mountain maple (*Populus angustifolia/Salix drummondiana-Acer glabrum*) montane riparian forest, and narrowleaf cottonwood/bare sand (*Populus angustifolia*/bare sand) montane riparian forest. The globally-rare slender spiderflower (*Cleome multicaulis*), the globally-rare canyon bog-orchid subspecies (*Platanthera sparsiflora* var. *ensifolia*), and one state rare plant species, Bodin's milkvetch (*Astragalus bodinii*), have recently been recorded at this site. During the 1875 Hayden expedition, botanist T. S. Brandegee collected the only known specimen of the Colorado watercress (*Rorippa coloradensis*) (Stuckey 1972], pp. 303-305). It is presumed that the specimen came from "Lakes of San Luis valley", which implies the San Luis Lakes region. This plant has not been documented since that date. Given the imprecise nature of this information, this species occurrence is not listed for this site. Should this species be found here in the future, it would dramatically increase this site's biodiversity significance.

The San Luis Lake site supports one of the largest populations known of the globally rare slender spiderflower. The slender spiderflower has a fairly large global range from southern Wyoming to central Mexico. In spite of this large range, populations of this plant have decreased sharply in the last 100 years, particularly in the southwestern states. The plant is also restricted to very specific microhabitats of moist alkaline soils. The slender spiderflower also appears to respond well to some forms of soil disturbance, which presumably limits interspecies plant competition. These discriminating habitat requirements limit the slender spiderflower to the edges of alkaline playa lakes and wetlands. The Closed Basin of Colorado contains the most numerous, largest, and healthiest known populations in the world.

Several imperiled animal species are represented at the site, as well. Two mammal subspecies, the plains pocket mouse (*Perognathus flavescens relictus*) and silky pocket mouse (*Perognathus flavus sanluisi*), have been recorded from the dunes and alkali shrublands on the lower elevations of the site. Two invertebrate species, the giant sand treader camel cricket (*Daihinbaenetes giganteus*) and San Luis sandhill skipper (*Polites sabuleti ministigma*), have been recorded from the dune habitats which comprise the eastern edge of the site. Six state or globally rare bird species which use the site include: short-eared owl (*Asio flammeus*), western snowy plover (*Charadrius alexandrinus nivosus*), long-billed curlew (*Numenius americanus*), black-crowned night-heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), and Forster's tern (*Sterna forsteri*).

Table 6. Natural Heritage Occurrences at the San Luis Lake Potential Conservation Area. Multiple listings of the same element represent subpopulations or suboccurrences.

Element	Common Name	Global Rank	State Rank	Federal and State Status	Last Observation Date	*EO Rank
Plants						
Astragalus bodinii	Bodin's milkvetch	G4	S2		1991-07-30	Unranked
†*Cleome multicaulis*	Slender spiderflower	G2G3	S2S3	(C2)	1991-07-30	A
†*Cleome multicaulis*	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	A
†*Cleome multicaulis*	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	A
†*Cleome multicaulis*	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	A
†*Cleome multicaulis*	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	A
Cleome multicaulis	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	B
Cleome multicaulis	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	B
Cleome multicaulis	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	B
Cleome multicaulis	Slender spiderflower	G2G3	S2S3	(C2)	1998-08-05	C
Platanthera sparsiflora var. *ensifolia*	Canyon bog orchid	G4G5T3	S2		1997-06-28	C
Plant communities						
†*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum*	Montane riparian forest	G1	S1		1997-07-25	A
†*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum*	Montane riparian forest	G1	S1		1997-07-25	B
Carex simulata	Wet meadow	G3	S3		1997-06-10	A
Catabrosa aquatica-Mimulus glabratus	Spring wetland	GU	S3		1997-06-10	B
Distichlis spicata	Salt meadow	G5	S3		1998-06-21	
Eleocharis palustris	Spikerush wetland	G5	S3S4		1997-06-11	B
Hippuris vulgaris	Mare's tail wetland	GU	S3		1997-08-22	A
Polygonum amphibium montane wetland	Montane wet meadow	G2	SU		1997-08-22	B
Populus angustifolia/Salix drummondiana-Acer glabrum	Montane riparian forest	G1	S1		1997-07-25	A
Populus angustifolia/sand dune forest	Sand dune riparian forest	G1	S1		1997-07-10	A
Sarcobatus vermiculatus/Distichlis spicata	Saline bottomland shrubland	G4	S1		1998-06-21	A
Insects						
Daihinibaenetes giganteus	Giant sand treader camel cricket	G3?	S1		1997	A
Polites sabuleti ministigma	San Luis sandhill skipper	G5T3	S5		1997-06-13	B
Birds						
Asio flammeus	Short-eared owl	G5	S2B,SZN		1993-06-23	Unranked
Charadrius alexandrinus nivosus	Western snowy plover	G4T3	S1B,SZN	LT, SC, FS	1992-06-03	Unranked

Element	Common Name	Global Rank	State Rank	Federal and State Status	Last Observation Date	*EO Rank
Charadrius alexandrinus nivosus	Western snowy plover	G4T3	S1B,SZN	LT, SC, FS	1992-05-19	Unranked
Numenius americanus	Long-billed curlew	G5	S2B,SZN	(3C), SC, FS	1975-06	Unranked
Numenius americanus	Long-billed curlew	G5	S2B,SZN	(3C), SC, FS	1975-06-15	Unranked
Nycticorax nycticorax	Black-crowned night-heron	G5	S3B,SZN		1993-05-26	Unranked
Nycticorax nycticorax	Black-crowned night-heron	G5	S3B,SZN		1993-05-21	Unranked
Plegadis chihi	White-faced ibis	G5	S2B,SZN	(C2), FS	1998-06-25	A
Plegadis chihi	White-faced ibis	G5	S2B,SZN	(C2), FS		Unranked
Podiceps nigricollis	Eared grebe	G5	S3B,SZN			A
Sterna forsteri	Forster's tern	G5	S2B,S4N		1994-05-26	Unranked
Sterna forsteri	Forster's tern	G5	S2B,S4N		1994-08-01	Unranked
Mammals						
Perognathus flavescens relictus	Plains pocket mouse subsp.	G5T2	S2		1998-06-21	B
Perognathus flavus sanluisi	Silky pocket mouse subsp.	G5T3	S3		1998-06-21	Unranked
Perognathus flavus sanluisi	Silky pocket mouse subsp.	G5T3	S3		1972	Historic
Perognathus flavus sanluisi	Silky pocket mouse subsp.	G5T3	S3		1972	Historic

† = Basis for Biodiversity Rank

Boundary Justification: The San Luis site boundary includes all of the known occurrences listed for the site. It also includes immediate potential habitat that has not been thoroughly inventoried, but is likely to include many of the elements of concern. The adjacent Blanca Wetlands site contains similar habitat and the sites may be regarded as functionally connected. This site should also be regarded as ecologically and intrinsically connected as part of the Great Sand Dunes eolian depositional system. The site boundary was based on initial aerial photo analysis, field visits by several CNHP scientists, and subsequent validation with satellite imagery.

Protection Rank Justification: Approximately 60% of this site is state land. The remaining 40% is owned by two notable landowners, and the ranches are known by the Zapata/Medano Ranch and the Luis María Baca No. 4. The majority of this site is unprotected, although efforts are underway as much of the state lands have been recently designated as Stewardship trust Lands and The Nature Conservancy is pursuing an agreement to purchase the Zapata/Medano Ranch. Considering the proximity of this site to the Great Sand Dunes site, its inclusion in the Great Sand Dunes ecosystem, and the concentration of biological elements contained within both areas, this would be an exemplary site for inclusion in a Habitat Conservation Plan, or other regional conservation plan.

Threats to the San Luis Lakes site include disturbances to site hydrology as a direct result of current and potential hydrological disturbances in the entire watershed. The Closed Basin Project, which bisects the site, began pumping groundwater from the unconfined aquifer and transporting it to the Rio Grande during the late 1980s.

Cumulative effects from this and other proposed water development projects are presently unknown, but are primarily detrimental to the aquatic elements, and to all other significant elements at this site.

Management Rank Justification: Current non-hydrologic management appears to be adequate in maintaining the quality of element occurrences at this site. Current management goals include recreation and wetland conservation at San Luis Lakes State Park, livestock production on private and state leased lands, and wilderness preservation in the upper Sand Creek watershed. Surface impacts appear moderate at this time.

Hydrologic connections with the natural surface water sources have been disturbed by the Franklin-Eddy canal, which passes through the site. Management within the San Luis Lakes State Park appears to be supporting and, in some cases, enhancing the element occurrences there. Historically, runoff reached the valley bottom wetlands near San Luis Lakes from the northeast, *via* Big Springs Creek. Maintenance of the seasonal groundwater mound underlying this natural flow pattern is crucial to the viability and permanence of the wetland habitats along and downstream of Big Springs Creek. This groundwater is also important to the stability of the sand dunes that flank the eastern edge of this site. Water from Franklin-Eddy canal, while invaluable for wetlands at San Luis Lakes, is not an equivalent, nor a natural substitute for natural groundwater discharge entering the site from the east.

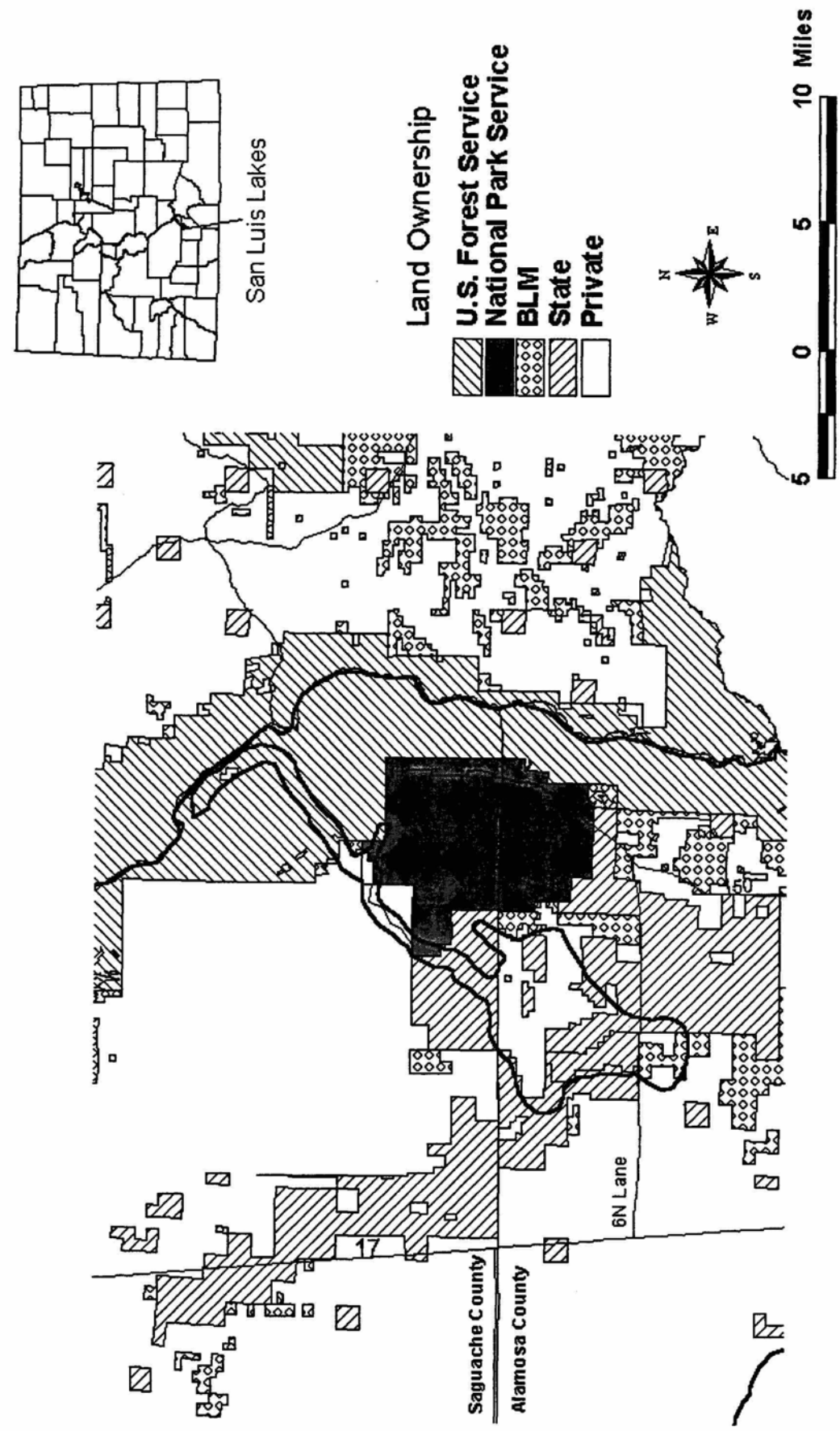


Figure 7.
San Luis Lakes Potential Conservation Area Land Ownership

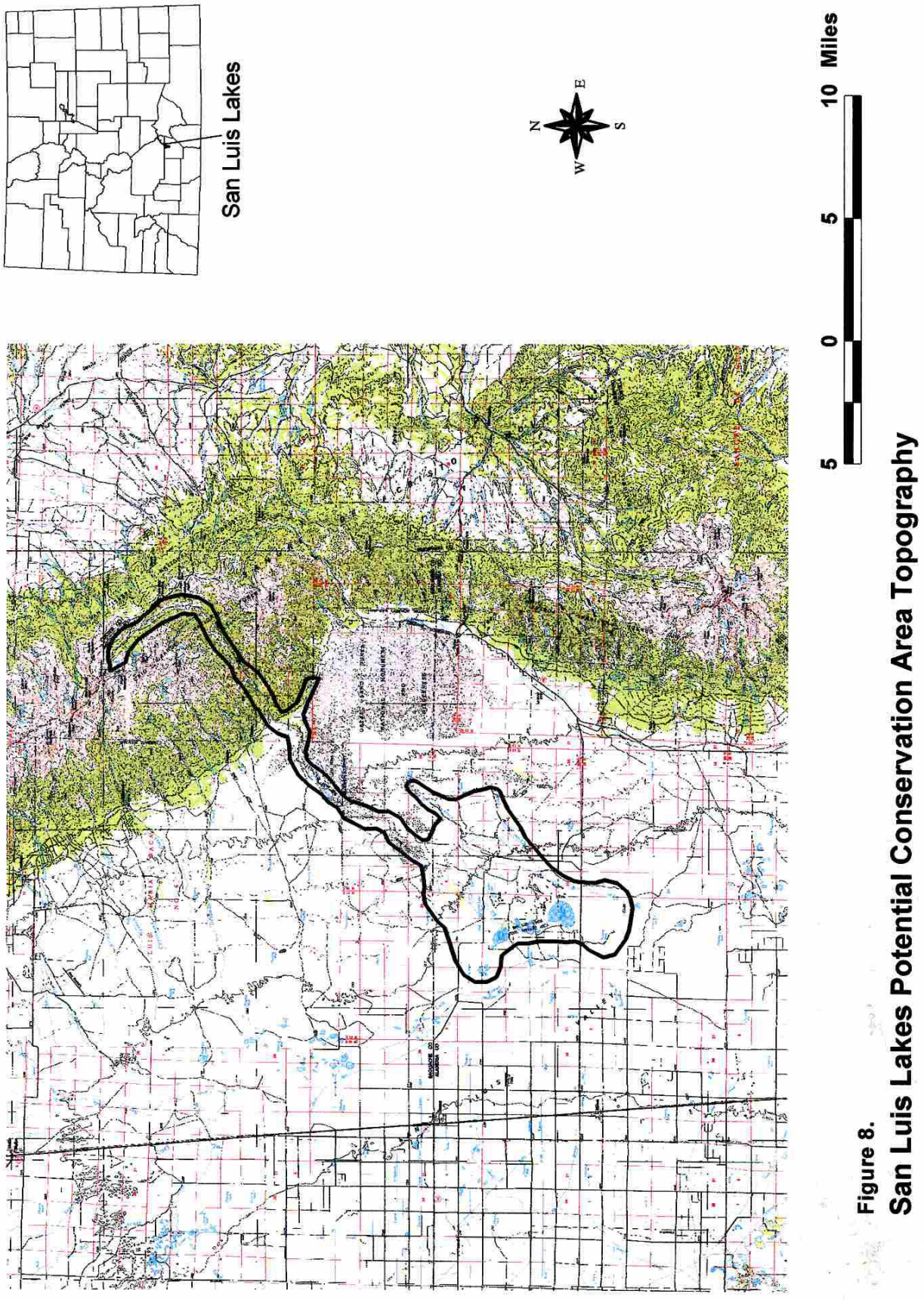


Figure 8.
San Luis Lakes Potential Conservation Area Topography

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Appendix A. Characterization Abstracts

Appendix A provides some brief background information (characterization abstracts) regarding the most significant species of concern or Colorado endemic species found at the Great Sand Dunes and the San Luis Lakes proposed conservation areas. It may be useful to incorporate some of this information as a management tool for any plans or actions taken by current owners and managers.

Each abstract gives information with respect to taxonomy, global and state distribution, habitat, phenologies, and management issues. These are only intended to be a guide for basic information regarding these species. If more detailed information is desired, please refer to the references as they are cited in the REFERENCES AND LITERATURE CITED section at the end of Appendix A.

Insects

Invertebrate Characterization Abstract
Amblyderus triplehorni
An ant-like flower beetle

Taxonomy:
Class: Insecta
Order: Coleoptera
Family: Anthicidae
Genus: *Amblyderus*

Taxonomic Comments: **Amblyderus triplehorni** *Weissmann and Kondratieff* can be easily distinguished from all other North American *Amblyderus* by its larger size and tapered segment of the aedeagus (Weissmann and Kondratieff *in press*).

CNHP Rank: G1?S1

Distribution: Global range: This species is currently considered to be an endemic beetle and known only within the boundaries of the Great Sand Dunes National Monument, in the San Luis Valley of southern Colorado. State range: Positively confirmed within the wildnerness boundaries of the Great Sand Dunes National Monument, Alamosa and Saguache Counties in southern Colorado (Weissmann and Kondratieff *in press*).

Habitat Comments: This species has been encountered in large numbers in the main sand dune mass within debris pockets where bits of grass and dead insects are dropped by wind (Weissmann and Kondratieff *in press*).

Phenology: Biology and ecology of this species are relatively unknown. Mating pairs were observed (8 July 1997) and duration of copulation was variable, apparently interrupted by large wind gusts or the approach of another individual (Weissmann and Kondratieff *in press*).

Food Comments: (Summarized from Weissmann and Kondratieff *in press*). During windy periods, individuals were observed to move rapidly between gusts across the dune surface to scavenge for food and would occasionally stop to feed on any small dead insects trapped in the debris pockets by strong winds. As winds tapered off, large groups of individuals were observed to move up to the dune crests, stopping at dead insect remnants and feeding on any parts that were presumably not desiccated.

Known Threats and Management Issues: As this species is newly described, biology and ecology are necessary to facilitate an understanding of the habitat requirements for this species, and also to support plans for conservation management. Continued studies are encouraged to further determine distribution and range. The importance of hydrology in habitat maintenance and viability of this species is of concern, especially in the San

Luis Valley, due to past, present, and future water development in the Valley (Rondeau et al. 1998).

Invertebrate Characterization Abstract
Amblyderus werneri
An ant-like flower beetle

Taxonomy:
Class: Insecta
Order: Coleoptera
Family: Anthicidae
Genus: *Amblyderus*

Taxonomic Comments: **Amblyderus werneri** Weissmann and Kondratieff is similar in size to the sympatric, and more widely distributed, *A. pallens*, but is darker in color and the pygidium is visible dorsally.

CNHP Rank: G1?S1

Distribution: Global range: This species is currently considered to be an endemic beetle and known only from the Great Sand Dunes National Monument and surrounding habitat in Alamosa and Saguache Counties of southern Colorado (Weissmann and Kondratieff *in press*). State range: Known from Sand Creek in Saguache County, near Buck Creek in Saguache County, and near Big Spring Creek in Alamosa County (Weissmann and Kondratieff *in press*, specimens C.P. Gillette Museum, Colorado State University).

Habitat Comments: Appears to prefer the more vegetated edges of the dune mass, and the dynamic sand blown areas within the sand sheet. Characteristic vegetation of preferred habitat is blowout grass *(Redfieldia flexuosa)* and scurfpea (*Psoralidium lanceolatum)* (Weissmann and Kondratieff *in press*, Rondeau and Pineda pers. obs).

Phenology: Biology and ecology of this species is relatively unknown.

Food Comments: This species is believed to scavenge on dead insect parts that are blown over the sand by the prevailing winds (B. Kondratieff pers. comm).

Known Threats and Management Issues: As this species is newly described, biology and ecology are necessary to facilitate conservation management and planning. Continued studies are encouraged to further determine distribution and range. The importance of hydrology in habitat maintenance and viability of this species is of concern, especially in the San Luis Valley, due to past, present, and future water development in the Valley (Rondeau et al. 1998).

Invertebrate Characterization Abstract
Cicindela theatina
The Great Sand Dunes tiger beetle

Taxonomy:
Class: Insecta
Order: Coleoptera
Family: Cicindelidae
Genus: *Cicindela*

Taxonomic Comments: Described by Bernard Rotger in 1944, this species is a narrow endemic occurring only in the Great Sand Dunes of the San Luis Valley in south-central Colorado (Boyd et al. 1982, Kippenhan 1994). There are no subspecies or forms listed for this tiger beetle.

CNHP Rank: G1S1

Distribution: Global range: This species is habitat restricted and an endemic species. Its habitat range of approximately 420 km² (162 mi²) is located at the Great Sand Dunes of southern Colorado. There are also dubious records from New Mexico, but no specimens have emerged to verify this locale (Boyd et al. 1982, Kippenhan 1994, Pearson et al. 1997, Rondeau et al. 1998). State range: Positively confirmed in Saguache and Alamosa Counties of southern Colorado at the Great Sand Dunes National Monument and surrounding habitat. Historic records from near Fort Garland in Costilla County have not been recently confirmed.

Habitat Comments: Adults of the species are encountered in sandy blowouts with early successional vegetation, i.e., blowout grass (*Redfieldia flexuosa*) and scurf pea (*Psoralidium lanceolatum*)(Rondeau et al. 1998). Adults may be found in the sparsely vegetated edges of the dunes in shifting sand (Kippenhan 1994, Rotger 1944). This species of tiger beetle is not encountered in the vertical open faces of the dunes (Rondeau et al. 1998, Weissmann 1995). Larvae are restricted to burrowing in the cooler, more moist, and leeward northeast slopes of the dunes and require permanent and relatively stable dunes which they associate with moist substrate microhabitats (B. Kondratieff, pers. comm.).

Phenology: Cicindela theatina is considered to be a spring-fall species. Life span for this species is approximated at 2.5 years. Adults and larvae are active mostly during the warmer months, with inactivity (hibernation) occurring during the cooler months (Kippenhan 1994). Adults are diurnal, with most observations made between 0800 and 1130, and burrow into sand during the afternoon due to heat and extremely high winds (Rondeau and Pineda per. obs., Kippenhan 1994). Larvae are believed to be nocturnal in their predatory habits.

Food Comments: Adults and immature stages of this genus are known to be carnivorous, with a diet consisting of other invertebrates sharing its habitat. Ants are known to make up a considerable portion of their diet (Wallis 1961). An individual adult was observed in the field to consume sand mites commonly found in shared habitat (Rondeau and Pineda per. obs.).

Known Threats and Management Issues: Continued surveys are encouraged to further determine the range, and to verify the presence/absence of this species in historically noted areas of presence (e.g. Costilla County, Colorado) (Kippenhan 1994, Rondeau et al. 1998). The importance of hydrology in habitat maintenance and viability of this species is of concern, due to past, on-going, and future water development in the San Luis Valley (Rondeau et al. 1998). Visitor and grazing impacts also deserve study (Weissmann 1995).

Invertebrate Characterization Abstract
Daihinibaenetes giganteus
Giant sand treader camel cricket

Taxonomy:
Class: Insecta
Order: Orthoptera
Family: Rhaphidophoridae
Genus: *Daihinibaenetes*

Taxonomic Comments: New genus and species described by E.R. Tinkham (1962). Closely resembles *Daihinia brevipes* Haldeman. Tinkham (1962) described three new species of *Daihinibaenetes* at this time.

CNHP Rank: G3?S1

Distribution: Global range: Knowledge of the range of this cricket remains incomplete. Originally thought to be endemic to the Great Sand Dunes of Colorado, it is now also known from Ghost Ranch in Arriba County, New Mexico, and near Glenn Canyon City in Kane County, southern Utah (Weissmann 1997). State range: Known only from the Great Sand Dunes National Monument and surrounding habitat in Saguache and Alamosa Counties, Colorado (Rondeau and others 1998, Weissmann 1997).

Habitat Comments: The study site of this cricket in 1993 and 1994 consisted of a flat surface layer of coarser gravel and rock a few centimeters deep overlying the more typical find sand. Indian ricegrass (*Oryzopsis hymenoides*) sparsely covered the area, along with scurfpea (*Psoralidium lanceolatum*), skeleton weed (*Lygodesmia juncea*), and prairie sunflower (*Helianthes petiolaris*). Slope areas of the site were almost devoid of vegetation due to the shifting surface caused by daily wind activity (Weissmann 1997).

Phenology: Both adults and larval instars are mostly active during dusk and throughout the night. Adults are first encountered in late June and females begin cohabitating with the males in early July. Small first instar nymphs are first observed in mid-July, with fourth instar being most evident during late August. At this time, relatively few live adults are observed. By the following May, fifth instar nymphs are encountered and sexual dimorphism is evident. Sixth instars are evident during mid-June. Knowledge of oviposition remains a mystery at this time (Weissmann 1997).

Food Comments: Sand treaders are omnivorous (Weissmann 1997). They forage at sundown, even when temperatures hover near zero centigrade. They have been observed to feed on dead and live plant material, insects, and mammal fecal material (when available). Plants fed on included living and dead stems of scurfpea, Indian ricegrass, skeleton weed, and occasionally scurfpea root and seed pieces. Scavenging on dead insects is not uncommon. This species was observed scavenging on adult beetles,

noctuid moths and caterpillars, ants, and bees. Predation was observed on living insects, including aphics, microlepidopterans, noctuid pupa, and noctuid larvae.

Known Threats and Management Issues: Continued studies are encouraged to further determine distribution and range. Oviposition remains a mystery with respect to the location of oviposition and the number of eggs laid (Weissmann 1997). The importance of hydrology in habitat maintenance and viability of this species is of concern, especially in the San Luis Valley, due to past, present, and future water devlopment in the Valley (Rondeau et al 1998). Visitor and grazing impacts also deserve study (Weissmann 1997).

Invertebrate Characterization Abstract
Eleodes hirtipennis
Circus beetle

Taxonomy:
Class: Insecta
Order: Coleoptera
Family: Tenebrionidae
Genus: *Eleodes*

Taxonomic Comments: No subspecies or forms have been described for *Eleodes hirtipennis* Triplehorn.

CNHP Rank: G1?S1

Distribution: Global range: This species is habitat restricted and no other speciems are known from anywhere else in North America (Weissmann 1995), it is considered to be an endemic species. Apparently, it has only been encountered within the boundaries Great Sand Dunes National Monument of the San Luis Valley of Colorado. Knowledge of the distribution of this species, however, remains incomplete. To date, no records or specimens have been encountered outside of the Monument boundaries. (B. Kondratieff pers. comm.). State range: Positively confirmed in Alamosa County of southern Colorado at the Great Sand Dunes National Monument.

Habitat Comments: Members of this beetle family (Tenebrionidae) are known to inhabit all habitat types, except aquatic habitats (Arnett 1968). **Eleodes hirtipennis** is apparently restricted to the sandy habitat of the Great Sand Dunes National Monment and surrounding areas; however, its habitat preference (shifting sand habitats or stabilized sand habitats) is unclear. Further research into the ecology of the species is encouraged.

Phenology: The biology of many species in this family is poorly known (Arnett 1968).

Food Comments: Most members of this family of beetles are known to be scavengers (Arnett 1968). Several are known to feed on decaying vegetation, animal wastes, seeds, fungi, and sometimes on living plants, tubers, or flowers (Arnett 1968).

Known Threats and Management Issues: Continued surveys are encouraged to further determine range of this species within the Great Sand Dunes and surrounding areas. Additionally, visitor and grazing impacts on this species may deserve study. Research on the biology and ecology are necessary to facilitate an understanding of the habitat requirements for this species. The importance of hydrology in habitat maintenance and viability of this species is of primary concern, due to past, on-going, and future water development in the San Luis Valley (Rondeau et al. 1998).

Invertebrate Characterization Abstract
Hypocaccus undesc. sp.
Histerid beetle

Taxonomy:
Class: Insecta
Order: Coleoptera
Family: Histeridae
Genus: *Hypocaccus*

Taxonomic Comments: The genus **Hypocaccus** is currently being revised. Specimens from the Great Sand Dunes apparently are undescribed, representing a new species (M. Weissmann pers. comm).

CNHP Rank: G1?S1

Distribution: Global range: This undescribed species is considered at this time to be an endemic species. Its habitat range of approximately 420 km² (162 mi²) is located at the Great Sand Dunes of southern Colorado (M. Weissmann pers. comm). State range: Positively confirmed in Saguache and Alamosa Counties of southern Colorado at the Great Sand Dunes National Monument and surrounding habitat.

Habitat Comments: Many species in this genus are known to inhabit sandy areas, especially along the Great Lakes shorelines of the northeastern United States (Downie and Arnett 1996). This particular undescribed species has been encountered in the sparsely vegetated dunes in shifting sand (Weissmann pers. comm., Rondeau and Pineda pers. obs).

Phenology: The biology of many species within this group is poorly known (Arnett 1968).

Food Comments: Within this family (Histeridae), the adults as well as the larvae are mostly carnivorous. Many are found to prey upon insects and their larvae and other small animals. Additionally, individuals may be detected on carrion, excrement, decomposing plant materials, and similar substances. The larvae of *Hypocaccus* spp. live in sand at the roots of dune grasses and probably feed on the larvae of weevils and possibly also feeding on fly larvae (Arnett 1968).

Known Threats and Management Issues: As this species is currently undescribed, description, taxonomic status, biology and ecology are necessary to facilitate conservation management and planning. Continued studies are encouraged to further determine distribution and range. The importance of hydrology in habitat maintenance and viability of this species is of concern, especially in the San Luis Valley, due to past, present, and future water development in the Valley (Rondeau et al. 1998).

Invertebrate Characterization Abstract
Polites sabuleti ministigma
San Luis sandhill skipper

Taxonomy:
Class: Insecta
Order: Lepidoptera
Family: Hesperiidae
Genus: *Polites*

Taxonomic Comments: *Polites sabuleti ministigma* Scott is a geographically isolated subspecies of a wider spread species (Scott 1982). Limited to the San Luis Valley and Arkansas River canyon in southern Colorado (Scott 1982).

CNHP Rank: G5T3S3

Distribution: Global range: Limited to the San Luis Valley and Arkansas River Canyon of Southern Colorado (Scott 1982). State range: Known from Saguache County, near the towns of Crestone and Moffat; Alamosa County, at the Great Sand Dunes National Monument, near Big Spring Creek, and near White Ranch; Chafee County, near Salida; and Hayden Creek in Fremont County (Pineda 1998, Rondeau et al. 1997, Scott 1982).

Habitat Comments: Rondeau *et al*. (1998) reports that this species apparently prefers the lower lying, moister habitats where its host plant, alkaline salt grass (*Distichlis spicata*) is encountered. This graminoid is often found in the more alkaline areas of the playa lakes system, and along some shorelines at springs within the sand sheet near the Great Sand Dunes National Monument.

Phenology: Flight as adults takes place in June (Scott 1986). Little is known about its immature stages.

Food Comments: The larval hostplant is known to be alkaline salt grass (*Distichlis spicata*).

Known Threats and Management Issues: Continued surveys are encouraged to further determine range of this species within the San Luis Valley and the Arkansas River watershed. Additionally, as this species is considered to be an isolated and endemic subspecies (Scott 1982), research to determine the validity of its subspecies status is highly encouraged. Research on the biology and ecology are necessary to facilitate an understanding of the habitat requirements for this species. Adults are encountered in the playas of ephermeral lakes after the water has evaporated and the larval host plant has appeared in its place; therefore, emphasis on understanding the importance of hydrology in habitat maintenance and viability of this species is of primary concern, due to past, on-going, and future water development in the San Luis Valley (Rondeau et al. 1998).

Invertebrate Characterization Abstract
Proctacanthus n.sp.
A robber fly

Taxonomy:
Class: Insecta
Order: Diptera
Family: Asilidae
Genus: *Proctacanthus*

Taxonomic Comments: Specimens taken from the Great Sand Dunes of Colorado apparently do not match other known specimens in this genus (Weissmann 1995). Currently considered a new and undescribed species (Weissmann 1995). This genus is undergoing revision by Charles R. Nelson at the University of Texas in Austin. Formal description of this species is pending at the time of the revision of the genus.

CNHP Rank: G1?S1

Distribution: Global range: This species is currently considered to be an endemic fly species and known only from the Great Sand Dunes National Monument and surrounding habitat in Alamosa and Saguache Counties of southern Colorado (Weissmann and Kondratieff *in press*). State range: Positively confirmed within the wilderness boundaries of the Great Sand Dunes National Monument and surrounding areas, Alamosa and Saguache Counties in southern Colorado (Weissmann and Kondratieff *in press*).

Habitat Comments: A characteristic genera of the Nearctic region, many species are known to inhabit sandy areas, often found on streamside sand bars, and sandy areas within grassland habitats (Hull 1962). Many individuals have been observed frequently sandy blowouts during the late summer (August) in areas of high insect densities and activity, presumably in search of prey (Pineda and Nosaka pers. obs.).

Phenology: Biology and ecology of this species are relatively unknown.

Food Comments: A large and conspicuous predatory fly, often surpassing 2.5 cm (1 inch) in length. Has been observed taking prey nearly matching itself in size, and was observed to predate *Bembix* spp. wasps (Pineda and Nosaka pers. obs.).

Known Threats and Management Issues: Continued surveys are encouraged to further determine range of this species within the Great Sand Dunes and surrounding areas. Research on the biology and ecology are necessary to facilitate an understanding of the species and its habitat requirements. Impacts that hydrological development in the San Luis Valley might have on its habitat and prey is of primary concern, due to ongoing and possible future hydrological projects in this area.

Invertebrate Characterization Abstract
Schinia avemensis
Golden-edged gem

Taxonomy:
Class: Insecta
Order: Lepidoptera
Family: Noctuidae
Genus: *Schinia*

Taxonomic Comments: No subspecies or forms are described for *Schinia avemensis* Dyar. Description based on two male specimens taken at Aweme, Manitoba in Canada (Hardwick 1996).

CNHP Rank: G3?S1

Distribution: Global range: Currently known from three locations in North America: the sand dunes area southeast of Brandon, Manitoba in Canada, the Great Sand Dunes in Colorado (Hardwick 1996), and near Roggen in Weld County, Colorado (B.C. Kondratieff specimen, C.P. Gillette Museum, Colorado State University). State range: Confirmed from Alamosa County, Medano Ranch near the Great Sand Dunes National Monument, and from three miles north of Roggen, Weld County (P. Pineda pers. obs, B.C. Kondratieff specimen).

Habitat Comments: Associated with western sand dune areas where the larval host plant *Helianthus petiolaris* is found (Hardwick 1996). Within the Great Sand Dunes depositional system, this moth is found within Province II, or the shifting sands of the vegetated sand sheet area.

Phenology: Biology and ecology of this species is relatively unknown. This species is believed to be univoltine. Adults may be found resting crypically on the disk flowers of prarie sunflower (*Helianthus petiolaris*) during the first week of August (Pineda and Nosaka pers. obs.). In Manitoba, Canada and in Colorado, adult flight takes place between mid-July and the third week of August (Hardwick 1996). Adults will deposit eggs on the flowering heads of the host plant. Larvae emerge within a week and feed on the flowers at night, and take cover underground at the roots during the day (Hardwick 1996). Larvae will burrow and pupate and overwinter in the soil. Many species in this genus that inhabit arid regions have the ability to remain in the pupal stage for a number of years (Hardwick 1996). Evidentally, this is necessary to correlate their emergence when enough moisture exists to permit growth of their larval host plants (Hardwick 1996).

Food Comments: In Manitoba, Canada, the larval stages feed in the heads of *Helianthus petiolaris* (Hardwick 1996). Adults are encountered during daylight hours on the disk flowers of this plant species, but it is unknown if they feed on these same flowers or not.

Known Threats and Management Issues: Surveys to determine the North American range are recommended, and it is possible that future encounters of this species will be within similar western North American sandy habitats (Hardwick 1996). Research on the biology and ecology are necessary to facilitate and understanding of the species and its habitat requirements. Impacts that hydrological development in the San Luis Valley might have on its habitat and hostplant is of primary concern, due to ongoing and possible future hydrological projects in this area.

Mammals

Vertebrate Characterization Abstract
Cynomys gunnisoni gunnisoni
Gunnison's prairie dog subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Sciuridae
Genus: *Cynomys*

Taxonomic Comments: One of two subspecies of **Cynomys gunnisoni** is found in the south-central portions of Colorado. This species is often mistaken for the Wyoming ground squirrel due to its small size (Fitzgerald *et al*. 1994).

CNHP Rank: G5T3S3

Distribution: Global range: This species occurs in the Four Corners region of Colorado, Utah, Arizona, and New Mexico (Fitzgerald *et al*. 1994). This subspecies is found in small colonies in many areas of south-central Colorado, whereas *C. g. zuniensis* occurs at lower elevations in southwestern Colorado. Much of this subspecies historical range has diminished due to plague and poisoning (Fitzgerald *et al*. 1994). State range: Gunnison's prairie dogs are restricted to south-central and southwestern Colorado, at elevations ranging from 1,800 to 3,700 m (6,000-12,000 ft). *C. g. gunnisoni* occurs in the Gunnison River drainage, the upper Arkansas and South Platte drainages, and the San Luis Valley (Fitzgerald *et al*. 1994).

Known Locations within the Study Site: During this survey this species was successfully located at the eastern edge of the Zapata Ranch at Highway 6N, Alamosa County.

Habitat Comments: Gunnison's prairie dogs are found in grasslands, semidesert and montane shrublands, and subsist primarily on grasses and sedges (Fitzgerald *et al*. 1994). However, they have also been documented using forbs, rushes, sage, and rabbitbrush (J. Fitzgerald and Lechleitner 1974).

Known Threats and Management Issues: Plague and poisoning have reduced the populations of this species. In Colorado all prairie dogs, including *Cynomys gunnisoni*, are managed as small game species and are provided no protection from harvest. Prairie dog species are all suseptible to losses from sylvatic plague, and habitat loss to various land uses. Conservation of this subspecies can only occur in Colorado, via habitat conservation and a change of management designation.

Vertebrate Characterization Abstract
Dipodomys ordii montanus
Ord's kangaroo rat subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Heteromyidae
Genus: *Dipodomys*

Taxonomic Comments: There are eight subspecies of **Dipodomys ordii** that occur in Colorado. Two are widespread and the others are restricted to particular river valleys *Dipodomys ordii montanus* is restricted to the San Luis Valley (Fitzgerald *et al*. 1994).

CNHP Rank: G5T3S5

Distribution: Global range: This species ranges from central Mexico north across the western United States into Southern Canada (Fitzgerald *et al*. 1994). State Range: This subspecies is found in the San Luis Valley of Colorado and adjacent New Mexico (Armstrong 1972).

Known Locations in Study Site: During this study, this subspecies was located in every trapping location.

Habitat Comments: Elevation range is 2300 to 2500m (7480 to 8200 feet). They are most common on sandy soils. They can be found in a variety of habitats from semi-desert shrublands and piñon-juniper woodlands to shortgrass or mixed prairie and silvery wormwood (*Artemisia filifolia*) . In suitable habitat they often are abundant and conspicuous (Fitzgerald *et al*. 1994).

Known Threats and Management Issues: Past conversions of San Luis Valley lands to croplands reduced the amount of suitable habitat; however, this subspecies seems to have adapted well to the remaining habitat. Current threats are considered low, and this subspecies is no longer tracked by CNHP, but is included here as an associated vertebrate species.

Vertebrate Characterization Abstract
Perognathus flavescens relictus
Plains Pocket Mouse subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Heteromyidae
Genus: *Perognathus*

Taxonomic Comments: There are four subspecies of *Perognathus flavescens* found in Colorado. Populations on the eastern plains are apparently not in genetic contact with those from either the San Luis Valley or the Western Slope. Previously *Perognathus apache* was used to classify *Perognathus flavescens flavescens*, *P. f. relictus* and *P. f. apache*. *P. f. relictus* is restricted to the San Luis Valley (Fitzgerald *et al*. 1994).

CNHP Rank: G5T1S1

Distribution: Global range: *Perognathus flavescens* occurs from Minnesota and southeastern North Dakota south to western Texas and New Mexico, then west to Utah (Fitzgerald *et al*. 1994). State range: *P. f. relictus* is only known from the Great Sand Dunes area in the San Luis Valley (CNHP 1997).

Known Locations in Study Site: During this study (CNHP 1998) several individuals were trapped in the Great Sand Dunes study site. Last known observations of this species were during 1972 (Armstrong 1972). Twelve individuals were successfully located along the Great Sand Dunes National Monument Boundary. Two individuals were trapped at the East/West Elk wetlands. Near Buck Creek's intersection with Medano Creek one specimen was taken in a pitfall trap. Historically a record of *Perognathus apache* was found on Medano Ranch near the San Luis Lakes (Cary 1911).

Habitat Comments: Elevation range 2,300 to 2,500m (7,700 to 8,200 feet). During this study (CNHP 1998), they were found on outlying sand dunes in the sand sheet region (Province II) with the following vegetation present: *Oryzopsis hymenoides, Stipa comata, Muhlenbergia pungens, Sporobolus cryptandrus, Chrysothamnus nauseosus, Yucca glauca, Opuntia* sp. and *Psoralidium lanceolatum*. It inhabits semi-arid sagebrush shrublands, grasslands and perhaps pinyon-juniper, favoring sandy soils in each habitat (Fitzgerald *et al*. 1994).

Known Threats and Management Issues: Little is known about the population or density of this species in the San Luis Valley (CNHP 1997). This subspecies is considered imperiled in Colorado because of the small number of records and its extremely limited range (CNHP 1997).

Vertebrate Characterization Abstract
Perognathus flavus sanluisi
Silky pocket mouse subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Heteromyidae
Genus: *Perognathus*

Taxonomic Comments: Three subspecies of *Perognathus flavus* are found within Colorado. D. Wilson (1973), in Fitzgerald *et al*. (1994), argued that *P. merriami* of the Southern Great Plains is synonomous with *P. flavus* therefore a review of the literature on Merriam's pocket mouse from Texas and New Mexico may be useful (Fitzgerald *et al*. 1994).

CNHP Rank: G5T3S3

Distribution: Global range: Central Mexico north to South Dakota and Wyoming and west to eastern Utah. State range: *Perognathus flavus sanluisi* is endemic to the San Luis Valley (Fitzgerald *et al*. 1994), and is disjunct (Armstrong 1972). The status of the species is unclear, as it is not known to be abundant in any location (Fitzgerald *et al*. 1994).

Known Locations in Study Site: During this survey (CNHP 1998) *Perognathus flavus sanluisi* was not trapped, however; during the 1997 survey it was trapped near the northwest portion of the Great Sand Dunes site.

Habitat Comments: Elevation range: 2,300 to 2,500m (7,400 to 8,200 feet). Little is known about this subspecies, therefore species information is used to help locate this subspecies. According to Fitzgerald *et al*. (1994), this species seems to require continuous midgrass prairie or herbaceous cover on loamy soils with small patches of bare ground. This species has been trapped in low numbers on sand, loamy sand, and sandy loam soils. Burrow entrances of two to three are usually found at the base of yucca, cactus, or shrubs, and are plugged during the day. Individuals usually do not move more than 40 to 60m (130 to 200 feet) from the burrow (Fitzgerald *et al*. 1994).

Known Threats and Management Issues: Due to the limited information about this subspecies, further information would assist in clarifying limiting factors. At this time the documented locations do not appear to be threatened, and current management seems adequate. Lower elevation locations could face threats of agricultural development or land use changes in the future, but further data collection on this subspecies is necessary to establish direct and indirect threats.

Vertebrate Characterization Abstract
Spemophilus tridecemlineatus blanca
Thirteen-lined ground squirrel subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Sciuridae
Genus: *Spermophilus*

Taxonomic Comments: In Colorado, there are four recognized subspecies of the thirteen-lined ground squirrel (Armstrong 1972, Fitzgerald *et al*. 1994**).** ***Spermophilis tridecemlineatus blanca*** is known from a restricted area of the San Luis Valley, and is endemic to Colorado.

CNHP Rank: G5T3/S3

Distribution: Global range: This species national distribution is shown from mid-central Canada south through the Great Plains to southern Texas, and from eastern Ohio to Utah (Fitzgerald *et al*. 1994). State range: This species ranges at lower elevations throughout Colorado, but *S. t. blanca* is restricted to the San Luis Valley (Fitzgerald *et al*. 1994).

Known Locations in Study Site: During the 1998 inventory, this subspecies was trapped once in the San Luis Lakes site, on the southern portion of the Zapata Ranch.

Habitat Comments: During the 1998 inventory, the habitat where this subspecies was trapped included greasewood (*Sarcobatus vermiculatus*) and salt grass (*Distichlis spicata*) in a dry playa system. Associated vertebrate taxa in the area include deer mice, kangaroo rats, and grasshopper mice. According to Fitzgerald *et al*. (1994), this species is typical of short to mid-length grasslands and modified landscapes in a variety of soil types. The diet includes both plant and animal matter (Fitzgerald *et al*. 1994).

Known Threats and Management Issues: The habitat availability for this subspecies seems to have declined with the increase of agricultural land use in the Valley, however, this is not well documented, nor are the current trends for this subspecies. Current threats to this subspecies are considered low because of the slow rate of increase of land use change (CNHP 1997). The location where this subspecies was found during the 1998 inventory was not being used for any human needs (i.e. no cattle or bison grazing, and no obvious development). However, the surface and ground water changes occurring in the Valley could alter the vegetative composition and therefore be completely inhospitible to this and many other species. This land is currently private or state owned, and subject to alteration at any time.

Vertebrate Characterization Abstracts
Thomomys talpoides agrestis
Northern pocket gopher subsp.

Taxonomy:
Class: Mammalia
Order: Rodentia
Family: Geomyidae
Genus: *Thomomys*

Taxonomic Comments: There are nine subspecies of **Thomomys talpoides** found in Colorado (Fitzgerald *et al*. 1994). This subspecies is endemic to the San Luis Valley.

CNHP Rank: G5T3S5

Distribution: Global range: Northern pocket gophers occur over much of the northern Great Plains from southern Canada south to northern New Mexico and Arizona. State range: *T. t. agrestis* occurs in a narrow Colorado Range in the San Luis Valley, north and east of the Rio Grande (Armstrong 1972).

Known Locations in Study Site: During this study (CNHP 1998), *T. t. agrestis* was found at Denton Spring. A 1997 CNHP Saguache County study found this subspecies in most areas that did not have sandy soils, mostly clay derived soils, in the higher and lower elevations away from the main sand dune mass.

Habitat Comments: Historical elevation range of 2,750 to 3,350m (9,000 to 10,000 feet) as stated in Fitzgerald *et al*. (1994). This subspecies was found from 2,300 to 2,600m (7,400 to 8,500 feet) in the San Luis Valley during inventories by CNHP in 1997 and 1998. Predominately grass vegetation was found with occurrences of this subspecies. Baltic rush (*Juncus balticus*)was the dominant vegetation at Denton Spring, with needle-and-thread grass (*Stipa comata*) in the upland.

Known Threats and Management Issues: This subspecies is not actively tracked by CNHP, and is only documented as an associated species to the site. There are no recent population studies of this subspecies, but field observations suggest that this subspecies' population may be stable at several sites in the San Luis Valley (C.A. Pague, unpubl. data). Land-use conversion could have negative impacts on the viability of this subspecies (CNHP 1997).

Birds

Vertebrate Characterization Abstract
Amphispiza belli
Sage sparrow

Taxonomy:
Class: Aves
Order: Passeriformes
Family: Emberizidae
Genus: *Amphispiza*

Taxonomic Comments: There are no documented subspecies for the Sage Sparrow.

CNHP Rank: G5S3B,SZ

Distribution: Global range: Breeding range includes interior southern Washington state south into Nevada, Utah, Colorado, and New Mexico, and east into Idaho, and Wyoming. Year-round range includes central and south California, the upper half of the Baja of California, southern Nevada, southwestern Utah, Arizona, and western New Mexico. Winter range includes southern Nevada, southeast California, Arizona, southwestern New Mexico, southwest Texas, and the northern half of Mexico (National Geographic Society 1987). State range: According to Andrews and Righter (1992) a population is known in the southeastern portion of the San Luis Valley, but this species is probably most common in northwestern Colorado, in Moffat County (Breeding Bird Atlas 1997). This species is known from Costilla, Alamosa, and Saguache Counties in the San Luis Valley (CNHP 1997).

Known Locations in Study Site: During the 1998 inventory, this species was documented at the property boundary between the Great Sand Dunes National Monument and the Medano-Zapata Ranch.

Habitat Comments: Elevational range: 2400 to 2440m (7800 to 8000 feet). Andrews and Righter (1992) note that this species breeds in sagebrush shrublands. National Geographic Society (1987) describes the species as fairly common on alkaline flats in sagebrush and saltbush; open arid desert in winter. During the 1998 survey, the habitat where the species was observed was a large open grassland at the edge of the main dune mass (Province II). The vegetation there included the following: Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread grass (*Stipa comata*) , sandhill muhly (*Muhlenbergia pungens*), sand dropseed (*Sporobolus cryptandrus*), rabbitbrush (*Chrysothamnus nauseosus*), small soapweed (*Yucca glauca*), prickly-pear cactus (*Opuntia* sp.), and scurf pea (*Psoralidium lanceolatum*).

Known Threats and Management Issues: Currently, the location is managed by the National Park Service and private land ownership. Protection for the habitat only exists within the boundaries of the Great Sand Dunes National Monument, and the remaining

habitat within private landownership is subject to alteration or development. On a large scale, the impacts that continued and future hydrological development in the San Luis Valley have on the viability of this species and its habitat is of concern (Rondeau *et al*. 1998).

Vertebrate Characterization Abstract
Buteo regalis
Ferruginous Hawk

Taxonomy:
Class: Aves
Order: Falconiformes
Family: Accipitridae
Genus: *Buteo*

Taxonomic Comments: There are no subspecies documented for this species.

CNHP Rank: G4S3B, S4N

Distribution: Global range: This species winters in the southern United States and the northern interior parts of Mexico (Bechard and Schmutz 1995). State range: About 1,200 birds winter in Colorado (Johnsgard 1990), comprising about twenty percent of the total winter population in the United States (Andrews and Righter 1992). Fairly common winter resident but a rare to uncommon summer resident on eastern plains (Andrews and Righter 1992).

Known Locations in Study Site: A pair was located within the study site at a Colorado Division of Wildlife nesting structure approximating the Gunnison's prairie dog popuulation.

Habitat Comments: Grasslands and shrublands consisting of Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread grass (*Stipa comata*) with some rabbitbrush (*Chrysothamnus nauseosus*) dominated the habitat where the nest structure was located. The Ferruginous Hawk prefers open grasslands, shrublands and deserts (Bechard and Schmutz 1995). Breeding pairs nest in isolated trees, on rock outcrops, structures such as windmills and power poles, or on the ground. Winter populations concentrate around prairie dog towns (Andrews and Righter 1992).

Known Treats and Management Issues: Local population declines are attributed to the effects of cultivation, grazing, poisoning small mammals, mining and fire in nesting habitats (Bechard and Schmutz 1995). Colorado's breeding population is considered vulnerable (S3B) based on human reduction of the primary winter prey base (prairie dog colonies), small population size, and human encroachment into available habitat (CNHP 1997).

Fish

Vertebrate Characterization Abstract
Oncorhynchus clarki virginalis
Rio Grande cutthroat trout

Taxonomy:
Class: Osteichthyes
Order: Salmoniformes
Family: Salmonidae
Genus: *Oncorhynchus*

Taxonomic Comments: Readily hybridizes (or introgresses) with other spring spawning trout such as introduced rainbow trout or other subspecies of cutthroat (Sublette *et al*. 1990). See Behnke (1992) for a discussion of taxonomic history.

CNHP Rank: G4T3/S3

Distribution: Global and State range: Historic range is not definitely known, but probably encompassed all "trout waters" in the Rio Grande drainage, including the Chama, Jemez, and Rio San Jose drainages (Sublette *et al*. 1990).

Known Locations in Study Site: During the 1998 survey this subspecies was not actively searched for, however, previous documentation places this subspecies in the watershed that flows through the study area.

Habitat Comments: Most populations are restricted to small headwater streams (Behnke 1992) where allochthonous materials are the primary energy input (Sublette *et al*. 1990). As with other subspecies, the native habitat included lakes and higher order streams.

Known Threats and Management Issues: Habitat degradation or loss and threats from fish diseases are believed to be important threats to this subspecies (Sue Swift, pers. comm.). Other threats include hybridization (or introgression) and competition with introduced salmonids. Breeding stock for reintroduction and other management purposes is being developed at Mescalero National Fish Hatchery (Sublette *et al*. 1990). It is estimated that the Rio Grande cutthroat trout occupies less than 1% of its original habitat in Colorado (Alves 1996). Genetically pure populations tend to be found only in small, isolated headwater streams (Propst and McInnis 1975). To help manage and conserve this subspecies in Colorado, remaining habitat should be protected and non-native fishes removed and kept out.

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