APPENDIX E

COMPATIBILITY ANALYSIS: LIVESTOCK GRAZING ON THE SDNM

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E.1 BACKGROUND

Under the authority of the Antiquities Act of 1906 (16 USC 431-433), President Clinton designated the Sonoran Desert National Monument (SDNM) by Presidential Proclamation 7397 on January 17, 2001 (Appendix A, *Sonoran Desert National Monument Presidential Proclamation*). The Monument comprises approximately 486,400 acres of public lands administered by the Bureau of Land Management (BLM), and is generally located 60 miles southwest of Phoenix, Arizona. Among other provisions, and with respect specifically to the practice of livestock grazing on these public lands, the President directed:

> *Laws, regulations, and policies followed by the Bureau of Land Management in issuing and administering grazing permits or leases on all lands under its jurisdiction shall continue to apply with regard to the lands in the monument; provided, however, that grazing permits on Federal lands within the monument south of Interstate Highway 8 shall not be renewed at the end of their current term; and provided further, that grazing on Federal lands north of Interstate 8 shall be allowed to continue only to the extent that the Bureau of Land Management determines that grazing is compatible with the paramount purpose of protecting the objects identified in this proclamation [emphasis added].*

Livestock grazing ceased in 2008-2009 on allotments located south of Interstate 8 (I-8) in the SDNM. From this time forward, the public lands south of I-8 (155,900 acres) will remain unavailable for livestock use, and the grazing preferences (7,884 AUMs) attached to the base properties for permitted use on the allotments will be cancelled. Forage previously allocated for livestock grazing will be available for other resource uses such as wildlife habitat, watershed values, recreation, etc. In addition, 78,000 acres were closed to grazing in 1941 in Area A for a total of 233,900 acres on the Monument (48 percent of the total) that are currently and will remain unavailable for livestock grazing. This document describes the BLM's analysis of livestock grazing on 252,500 acres of public lands that are currently available for livestock grazing north of I-8 within SDNM (52 percent of the total). The following analysis will be used to determine whether livestock grazing is compatible with the paramount purpose of the Monument, which is to protect the objects identified in the proclamation.

E.1.1 A BRIEF HISTORY OF GRAZING ON PUBLIC LANDS

During the era of homesteading, western public rangelands were often overgrazed because of policies designed to promote the settlement of the West and a lack of understanding of arid ecosystems. In response to requests from western ranchers, Congress passed the Taylor Grazing Act of 1934, which led to the creation of grazing districts in which grazing use was apportioned and regulated. Under the Taylor Grazing Act, the first grazing district to be established was Wyoming Grazing District Number 1 on March 23, 1935. Secretary of the Interior Harold Ickes created a Division of Grazing within the

Department of Interior to administer the grazing districts; this division later became the US Grazing Service and was headquartered in Salt Lake City.

In 1946, as a result of government reorganization by the Truman Administration, the Grazing Service was merged with the General Land Office to become the Bureau of Land Management.

The unregulated grazing that took place before enactment of the Taylor Grazing Act caused damage to soil, plants, streams, and springs in some places. As a result, grazing management after enactment was initially designed to increase productivity and reduce soil erosion by controlling grazing through fencing and water projects and by conducting forage surveys to balance forage demands with the land's productivity ("carrying capacity").

These initial improvements in livestock management, which arrested the degradation of public rangelands while improving watersheds, were appropriate for the times. However, by the 1960s and 1970s, public appreciation for public lands and expectations for their management rose to a new level, as made clear by passage of the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and the Federal Land Policy and Management Act of 1976. Consequently, the BLM moved from managing grazing in general to better manage and protect specific rangeland resources and other multiple-use resources, such as riparian areas, threatened and endangered species, sensitive plant species, and cultural and historical objects. Consistent with this enhanced role, the Bureau developed or modified the terms and conditions of grazing permits and leases and implemented new range projects to address these specific resource issues or promote continued improvement of public rangeland conditions.

E.1.2 HISTORIC USE OF GILA BEND, ARIZONA, AND SURROUNDING AREAS

Livestock grazing in Gila Bend and surrounding areas began in the late 1700s in Indian rancherias along the Gila River. At that time, livestock largely were confined to the flood plains of the Gila River, which was the only reliable water source able to support livestock year-round. It also is likely that the mountains and bajadas adjacent to the river would have received some use by livestock, particularly during wetter periods when temporary waters would have been available in potholes or from the few springs in the area. Livestock use prior to this time occurred from movement along the route taken by the Spanish immigrants in the 18th century along what is now the Juan Bautista de Anza National Historic Trail (NHT). Records indicate that 240 people on horseback or mule moved from towns in Sonora and Sinaloa to a new settlement in the San Francisco area along with 1,000 head of livestock.

Starting in the 1860s, settlers began to move into the area along the Gila to start farming operations. Livestock associated with these farms also were likely confined to the river floodplain and adjacent bajadas. More widespread livestock use of the drier valleys and mountains did not occur in the area until dirt stock tanks were developed and wells were dug in the early 1900s. The first of these was a dirt stock tank developed around 1900 in the Little Rainbow Valley just north of the current Monument boundary. The first wells in the area were drilled in Rainbow Valley between 1910 and 1912. One of these wells was dug north of Mobile, which would have provided some livestock access to what is now the SDNM. The only waters in the Vekol Valley area at that time consisted of a couple of dirt waterholes, or "charcos," that provided temporary water for cattle belonging to the Tohono O'odham

people. The Vekol Valley within the current SDNM boundaries was not developed for additional livestock use until the 1920s and 1930s.

Larger-scale ranching operations did not begin in the Sand Tank Mountain area until 1917. The first water sources for livestock included two hand-dug wells, Lost Horse Tank (earthen), and the development of two natural water sources at Sand Tank and Mesquite Tank (Robinett 1997).

After the development of necessary water sources, ranching in the area consisted of year round cow-calf operations with herds that the operator would adjust based on weather conditions and available forage. The practice of moving large numbers of steers to utilize the ephemeral forage brought by a wet winter or spring did not occur until during and after World War II in the middle of the 20th century (Robinett 1997).

E.1.3 CURRENT LAND HEALTH STANDARDS AND GUIDELINES FOR GRAZING MANAGEMENT ON PUBLIC LANDS

Today, the BLM manages livestock grazing to achieve and maintain public land health. To achieve desired conditions, the agency uses rangeland health standards and guidelines, which the BLM developed in the 1990s with input from the citizen-based Resource Advisory Councils across the West. Standards describe specific conditions needed for public land health, such as the presence of stream bank vegetation and adequate canopy and ground cover. Guidelines are the management techniques designed to achieve or maintain healthy public lands, as defined by the standards.

E.1.4 CURRENT LIVESTOCK GRAZING MANAGEMENT ON THE SDNM

Portions of six livestock grazing allotments are located within SDNM north of I-8, encompassing a total of 252,500 acres (**Map E-1**, SDNM Grazing Allotments). The allotments, their classifications, size, and amount of permitted use are listed in **Table E-1**, Acres of Public Lands and Permitted Use within SDNM Grazing Allotments. Permitted use is expressed in animal unit months (AUMs) which means the amount of forage necessary for the sustenance of one cow, or its equivalent, for a period of one month. Facilities constructed to manage livestock grazing within these allotments include: 16 ephemeral reservoirs, 9 wells, 8 corrals, and approximately 46 miles of allotment boundary and pasture barbed-wire fences.

The six allotments within the SDNM north of I-8 received their classifications between 1973 and 1976. Five of the allotments were classified as perennial-ephemeral. "Perennial" refers to the grazing preference authorized on the permit. "Ephemeral" applies to additional annual forage that occurs in years with above average precipitation. Livestock operators on these five allotments are offered 10-year permits from the BLM that state the number and kind of livestock as well as the period of use for each allotment. Ephemeral forage is utilized through ephemeral use-authorizations in accordance with land health standards and the Arizona grazing guidelines (Guidelines) discussed in the Lower Sonoran-SDNM Resource Management Plan (RMP) (see Appendix L in the Lower Sonoran-SDNM PRMP/FEIS). The sixth allotment (Arnold Allotment) is authorized for ephemeral grazing only.

Table E-1
Acres of Public Lands and Permitted Use within SDNM Grazing Allotments

Allotment	Rangeland Classification	Allotment Number	Public Land Acres	% of Public Land Acres	Current Permitted Use AUMs
Big Horn	Perennial-Ephemeral	03009	92,204	95%	2,812**
Beloat	Perennial-Ephemeral	03007	33,600	26%	776
Conley	Perennial-Ephemeral	03018	77,708	88%	3,403
Hazen	Perennial-Ephemeral	03042	31,926	75%	886
Lower Vekol	Perennial-Ephemeral	03053	15,409	71%	826
Arnold	Perennial-Ephemeral	03004	1,609	7%	0
		Totals	252,456	n/a	8,703

* The acres and AUM percentages were prorated by using inventory data and base water properties instead of percentage of public land acreage.
** This figure represents the prorated remaining portion of the Big Horn allotment after 53,144 acres south of I-8 were made unavailable in 2008.

E.1.5 LEGAL MANDATES RELATING TO PUBLIC LANDS GRAZING

Laws that apply to the BLM's management of public lands grazing include the Taylor Grazing Act of 1934, the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, the Federal Land Policy and Management Act (FLPMA) of 1976, and the Public Rangelands Improvement Act of 1978. The Federal regulations that govern livestock management are found at 43 CFR 4100.

As directed by the proclamation that established the SDNM, authorized grazing use and associated management practices within the SDNM can continue only to the extent that livestock grazing is determined to be compatible with the paramount purpose of protecting the biological, ecological, scientific, and historic and archaeological objects of the Monument.

The BLM utilizes a Land Health Evaluation (LHE) process to ascertain whether the Arizona Rangeland Health Standards (land health standards) are met. When standards are not being met, a draft determination is made to identify causal factors of non-achievement. Causal factors can include current grazing practices, historical livestock use, drought, fire, OHV use, general recreation, etc. Technical recommendations from the LHE identify appropriate actions needed in order to make significant progress toward achieving the standards where they are not being achieved.

The land health standards, specifically Standard 1 and Standard 3, directly address and measure indicators associated with the biological, ecological and cultural resources, or "objects" identified for protection in the Monument's proclamation. In the case of the SDNM, the LHE analyzed the Monument's desert ecosystems for proper functioning condition; considered the anticipated diversity of plant species; examined the long-term recruitment and maintenance of saguaro cactus forests; addressed the effect of grazing on wildlife and associated habitat; and evaluated the functioning, health, diversity and sustainability of key vegetation communities.

For the purposes of this assessment, livestock grazing will be considered incompatible with the SDNM Proclamation when Monument objects are impaired due to present livestock grazing practices.

The following process comprises the draft compatibility analysis and determination:

- Identify the "Monument objects" specific to the SDNM,
- Conduct a literature review,
- Conduct an LHE addressing the effects of livestock grazing on Monument objects,
- Perform an analysis of the effects of livestock grazing on archaeological and historical Monument objects,
- Present draft compatibility analysis findings and determination,
- Set parameters to develop a full range of livestock grazing management alternatives for analysis in the RMP.

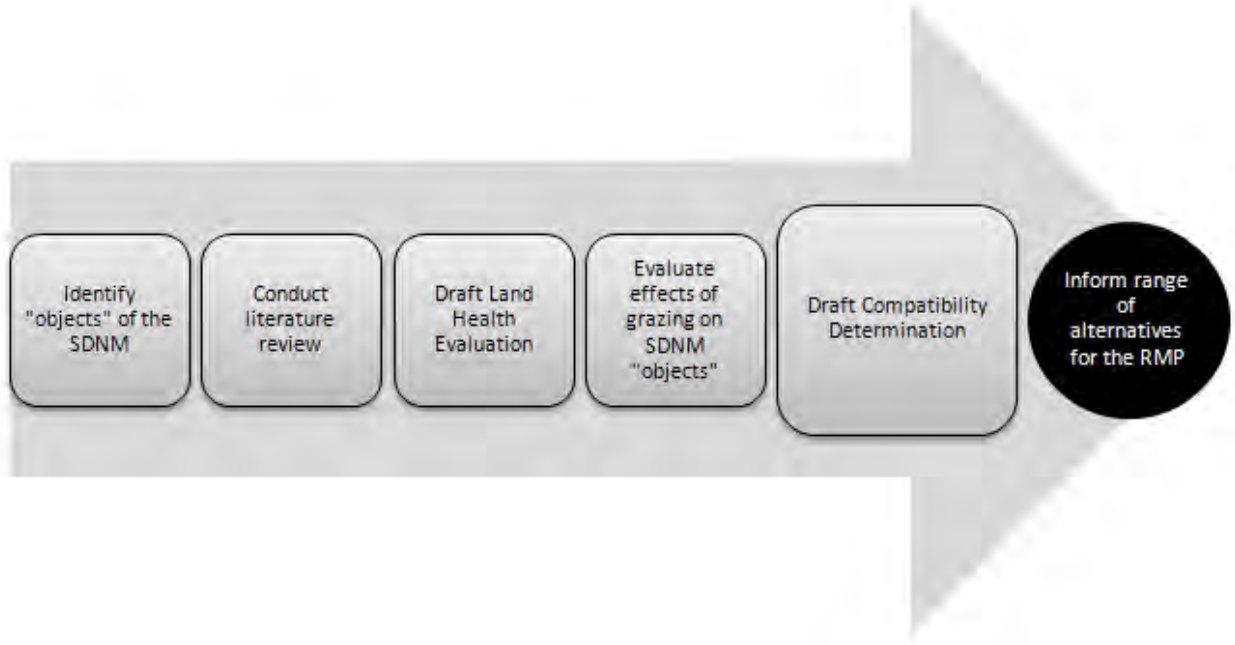


Figure E-1. Compatibility Analysis Process

E.1.6 STEP 1: IDENTIFY THE MONUMENT OBJECTS SPECIFIC TO THE SDNM

The first eight paragraphs of Presidential Proclamation 7397 outline the reasons why President Clinton chose to designate the SDNM and, as such, provide the most direct expression of the Monument objects to be conserved, protected, and restored for the benefit of current and future generations. The identified objects are described in **Table E-2**, Monument Objects Specific to the SDNM. The subsequent analysis of impacts of livestock grazing on these objects assists in the determination of grazing compatibility. It also informs the range of alternatives developed and analyzed in the Lower Sonoran-SDNM RMP.

Table E-2
Monument Objects Specific to the SDNM

Monument Object	Paragraph from Presidential Proclamation 7397	Indicator
Functioning desert ecosystem	1. "The Sonoran Desert National Monument is a magnificent example of untrammeled Sonoran desert landscape. The area encompasses a functioning desert ecosystem with an extraordinary array of biological, scientific, and historic resources. The most biologically diverse of the North American deserts, the Monument consists of distinct mountain ranges separated by wide valleys, and includes large saguaro cactus forest communities that provide excellent habitat for a wide range of wildlife species."	Diversity, density, and distribution of saguaro cactus forest, habitat for a wide range of wildlife species
Diversity of plant and animal species	2. "The Monument's biological resources include a spectacular diversity of plant and animal species. The higher peaks include unique woodland assemblages, while the lower elevation lands offer one of the most structurally complex examples of palo verde/mixed cacti association in the Sonoran Desert. The dense stands of leguminous trees and cacti are dominated by saguaros, palo verde trees, ironwood, prickly pear, and cholla. Important natural water holes, known as tinajas, exist throughout the Monument. The endangered acuña pineapple cactus is also found in the Monument."	Health, density, and distribution of saguaro cactus and nurse plants
	3. "The most striking aspect of the plant communities within the Monument are [sic] the abundant saguaro cactus forests. The saguaro is a signature plant of the Sonoran Desert. Individual saguaro plants are indeed magnificent, but a forest of these plants, together with the wide variety of trees, shrubs, and herbaceous plants that make up the forest community, is an impressive site [sic] to behold. The saguaro cactus forests within the Monument are a national treasure, rivaling those within the Saguaro National Park."	Health, density, and distribution of saguaro cactus and nurse plants
Saguaro cactus forests	4. "The rich diversity, density, and distribution of plants in the Sand Tank Mountains area of the Monument is especially striking and can be attributed to the management regime in place since the area was withdrawn for military purposes in 1941. In particular, while some public access to the area is allowed, no livestock grazing has occurred for nearly 50 years. To extend the extraordinary diversity and overall ecological health of the Sand Tanks [sic] Mountains area, land adjacent and with biological resources similar to the area withdrawn for military purposes should be subject to a similar management regime to the fullest extent possible."	Diversity, density, and distribution of plants (palo verde-mixed cacti vegetation community)
Sand Tank Mountains	5. "The Monument contains an abundance of packrat middens, allowing for scientific analysis of plant species and climates in past eras. Scientific analysis of the midden [sic] shows that the area received far more precipitation 20,000 years ago, and slowly became more arid. Vegetation for the area changed from juniper-oak-pinion pine woodland to the vegetation found today in the Sonoran Desert, although a few plants from the more mesic period, including the Kofa Mountain barberry, Arizona rosewood, and junipers, remain on higher elevations of north-facing slopes."	Preservation, health, and distribution of packrat middens, Kofa Mountain barberry, Arizona rosewood, junipers

Table E-2
Monument Objects Specific to the SDNM

Monument Object	Paragraph from Presidential Proclamation 7397	Indicator
Vegetation communities: creosote-bursage, desert grassland, and washes	6. "The lower elevations and flatter areas of the Monument contain the creosote-bursage plant community. This plant community thrives in the open expanses between the mountain ranges, and connects the other plant communities together. Rare patches of desert grassland can also be found throughout the Monument, especially in the Sand Tank Mountains area. The washes in the area support a much denser vegetation community than the surrounding desert, including mesquite, ironwood, palo verde, desert honeysuckle, chuperosa, and desert willow, as well as a variety of herbaceous plants. This vegetation offers the dense cover bird species need for successful nesting, foraging, and escape, and birds heavily use the washes during migration."	Health, diversity, and distribution of creosote bush-bursage vegetation community, desert grassland, washes
Wildlife	7. "The diverse plant communities present in the Monument support a wide variety of wildlife, including the endangered Sonoran pronghorn, a robust population of desert bighorn sheep, especially in the Maricopa Mountains area, and other mammalian species such as mule deer, javelina, mountain lion, gray fox, and bobcat. Bat species within the Monument include the endangered lesser long-nosed bat, the California leaf-nosed bat, and the cave myotis. Over 200 species of [song] birds are found in the Monument, including 59 species known to nest in the Vekol Valley area. Numerous species of raptors and owls inhabit the Monument, including the elf owl and the western screech owl. The Monument also supports a diverse array of reptiles and amphibians, including the Sonoran desert tortoise and the red-backed whiptail. The Bureau of Land Management has designated approximately 25,000 acres of land in the Maricopa Mountains area as critical habitat for the desert tortoise. The Vekol Valley and Sand Tank Mountain areas contain especially diverse and robust populations of amphibians. During summer rainfall events, thousands of Sonoran green toads in the Vekol Valley can be heard moving around and calling out."	Distribution and health of Sonoran desert tortoise, desert bighorn sheep, red-backed whiptail lizard, raptors, owls (including elf owl and western screech owl), mule deer, Sonoran pronghorn, javelina, mountain lion, gray fox, bobcat, lesser long-nosed bat (see above), California leaf-nosed bat, cave myotis bat, Sonoran green toads.
Archaeological and historic sites	8. "The Monument also contains many significant archaeological and historic sites, including rock art sites, lithic quarries, and scattered artifacts. Vekol Wash is believed to have been an important prehistoric travel and trade corridor between the Hohokam and tribes located in what is now Mexico. Signs of large villages and permanent habitat sites occur throughout the area, and particularly along the bajadas of the Table Top Mountains. Occupants of these villages were the ancestors of today's O'odham, Quechan, Cocopah, Maricopa, and other tribes. The Monument also contains a much used trail corridor 17 miles long in which are found remnants of several important historic trails, including the Juan Bautista de Anza NHT, the Mormon Battalion Trail, and the Butterfield Overland Stage Route."	Preservation of rock art sites, lithic quarries, scattered artifacts, Vekol Wash, Table Top Mountain bajadas, Juan Batista de Anza NHT, Mormon Battalion Trail, and Butterfield Overland Stage Route.

Because the objects in the proclamation are identified at the landscape level, biological "indicators" for the objects were identified that can be measured at the site-specific level. For each Monument object, corresponding "indicators" are identified. See **Table E-2**.

E.1.7 STEP 2: CONDUCT A LITERATURE REVIEW

In order to determine possible effects of livestock grazing on resources and objects in the Monument, the BLM conducted a thorough review of pertinent scientific literature specific to livestock grazing in the Sonoran Desert. The literature addressing the potential effects of livestock grazing in the arid West is voluminous; however, limited literature addresses the Sonoran Desert specifically. Thus, this review is limited to documents that have a close relationship to Monument objects. Literature reviewed included materials submitted by interested parties, groups, and individuals outside the BLM. A list of references reviewed and an evaluation of the body of literature for its relevance to the assessment of grazing compatibility in SDNM is compiled into a separate document and is available from the BLM on request.

The following literature review is organized by Monument object type. Results of some studies refer to more than one object type but are classified below to the most likely type for the purposes of organization.

E.1.7.1 Functioning Desert Ecosystem

The zone of effect around a livestock watering source has been termed the "piosphere" (Andrew 1988). Particularly in arid environments, the distribution of impacts resulting from concentrations of large herbivores is patterned, ranging from impacts many times higher than the overall average at the watering point to many times lower than the average along a gradient until the foraging range of the animal is exceeded. Such concentrated impacts include the accumulation of livestock feces, increased soil nutrients near water and depletion further away from it, livestock trails, soil compaction, reduced cryptogamic crust cover, increased bare soil, decreased herbage biomass, and increased herbage defoliation. Similar, albeit more subtle, patterns of impact may occur around shade, campsites, and salt licks (Andrew 1988).

Bahre (1991) summarized previous studies in assessing the effects of human use on arroyo cutting and gully erosion in the arid Southwest. While overgrazing by livestock is often cited as an initiating factor, woodcutting, agricultural clearing, road and railroad construction, and construction of water diversions such as canals and levees, combined with changing rainfall patterns, are also cited as important contributing factors. An alternate view, stimulated by the observation that arroyo cutting and filling also occurred in prehistoric times, postulates that downward movement of soils leads to cumulatively steeper gradients of outwash plains until a tipping point is reached (i.e., when increased runoff velocity causes a soil cutting process that continues until slopes and runoff velocities are again in equilibrium). This view suggests that because only natural mechanical processes are involved in gully erosion, no human intervention is required to address it (Cooke and Reeves 1976).

Hovorka (1996) studied the relationship between livestock grazing and Sonoran Desert vegetation, insects, and insectivorous bats at sites in the Rincon, Tucson, and Silver Bell Mountains. He found that the influence of grazing history on plant community composition of the Sonoran Desert was significantly weaker than that of both moisture availability and elevation; however, small perennials and saguaro were

more abundant on ungrazed study plots than on grazed study plots. The study also showed that grazing history did not have a significant influence on insect or bat abundance.

E.1.7.2 Saguaro Cactus Forests

Studies of saguaro cactus (*Carnegia gigantea*) at Saguaro National Park suggest that livestock grazing has an adverse effect on the recruitment of young saguaro, which germinate and grow during the first decade under the shade and protection of shrubs and trees known as "nurse" plants. Abouhaidar (1992) found significantly fewer saguaros aged 11-20 years on a grazed area of Saguaro National Park relative to an ungrazed area, and observed that saguaro recruitment following cessation of livestock grazing appeared to experience a lag of approximately 10 years, after which saguaro germination and growth markedly increased as the density of protective cover increased. This pattern of delayed recruitment was also documented by Holden et al. (2000) in a re-survey of saguaro monitoring plots at Saguaro National Park, although these writers noted that inability of earlier researchers to locate tiny saguaro seedlings and several subsequent years of above average rainfall may have contributed to this effect.

Available literature is conclusive that saguaro populations are strongly influenced by forces that alter the density of shade producing perennial plants under which saguaro germinate and grow early in life, and also suggests that saguaro tend to establish in cohorts when climatic conditions are favorable (see Niering et al. 1963; Steenbergh and Lowe 1977; Turner et al. 1966). In general, favorable seasonal rainfall increases the likelihood of saguaro germination and contributes to increased cover of nurse plants. Livestock can crush nurse plants or trample seedlings as they rest in the shade of larger trees, or directly feed on nurse plants, which would reduce protective cover for young saguaro and adversely affect saguaro germination and establishment. Such effects generally occur where livestock congregate, such as near watering areas or washes with large trees. However; Bowers and Turner (2002) also speculated that livestock grazing "may have indirectly benefited palo verde populations by reducing small mammal populations via competition for forage."

E.1.7.3 Vegetation Communities

The few peer-reviewed scientific studies that attempt to measure or infer the direct and indirect effects of livestock grazing on specific elements of the Sonoran Desert ecosystem focus on annual and perennial vegetation, saguaro cactus, insects and insectivorous bats, lizards, rodents, and bighorn sheep.

Several studies examining changes in Sonoran Desert vegetation have been conducted at a site near Tucson called Tumamoc Hill that has been fenced and protected from livestock grazing since 1907 (Blydenstein et al. 1957; Goldberg and Turner 1986; Shreve 1929; and Shreve and Hinckley 1937). These studies are not conclusive in determining whether the presence or absence of livestock grazing significantly affects plant density and species composition. Blydenstein et al. (1957) found that plant density, particularly with regard to the presence of perennial grasses and white ratany (*Krameria grayi*), was notably greater on the protected study site than at an adjacent area that was not protected from "occasional light" livestock grazing; however, no significant difference in plant species composition between the two areas was observed. In a subsequent study, Goldberg and Turner (1986) also documented increased plant density over time but observed that, while increased plant density might be related to protection from livestock grazing, the recruitment of new plants occurs very slowly and is critically dependent upon suitable climatic conditions. Goldberg and Turner (1986) also found that the number of plant species increased in all study plots. Because the study plots were located in areas that

were believed to have historically received differing levels of use by livestock, these writers concluded that there were no consistent directional changes in the vegetation composition of the study area, despite having been protected from livestock grazing for nearly 70 years, and that the observed changes in cover and density appeared to be responses to sequences of either exceptionally wet years or exceptionally dry years (Goldberg and Turner 1986).

A two-year study of grazed and ungrazed plots adjacent to the northern boundary of the Organ Pipe Cactus National Monument found that the composition of annual plant species declined with recent grazing by livestock (Waser and Price 1981). This reduction of plant diversity was not caused by turnover in common species but by the disappearance of rarely encountered, inconsistently distributed species. Within each study year, an overall reduction of plant diversity following recent grazing was determined to be significant; however, the relationship between livestock grazing and species composition between the two years was less clear due to variance in annual precipitation. Even considering that varying precipitation levels tend to obscure grazing effects on species composition on a year-to-year basis, Waser and Price (1981) speculated that the effects of livestock grazing and winter precipitation on plant species diversity are cumulative and that recovery of plant species diversity would occur more rapidly in the absence of continued livestock grazing.

During a study of the effects of livestock grazing on jojoba shrubs (*Simmondsia chinensis*), Roundy and Ruyle (1989) found that plant species density and composition inside an area near Roosevelt Lake that was protected from livestock grazing for 48 years was similar to the area outside of the exclosure that had been continuously grazed during the same period. Although the density of jojoba was similar in the two areas, the plants were smaller and the canopy cover was less outside than inside the exclosure. Jojoba grazed by livestock had greater twig growth than ungrazed shrubs, but grazed shrubs had lower male and female flower densities than ungrazed shrubs. The researchers observed that heavy grazing, such as near a stock water pond, resulted in much smaller branches and canopies, leading to lower overall forage production in comparison to moderately grazed shrubs. Based on their findings, they recommended rest from grazing from March to May when warm temperatures and available water in the soil would allow maximum re-growth and seed production.

E.1.7.4 Wildlife

Jones (1981) studied the effects of livestock grazing on lizard abundance and diversity at three locations on the BLM Phoenix District. Fourteen sample sites, comprised of seven sites located in areas characterized as "heavily" grazed and seven sites as "lightly grazed," were established in chaparral, desert grassland, mixed riparian scrub, cottonwood-willow riparian, and Sonoran desert scrub vegetative communities. All the lightly grazed sites had greater lizard abundance and species diversity than the heavily grazed sites except in Sonoran desert scrub communities where no differences were detected. Jones (1981) concluded that livestock grazing reduced overall lizard abundance and species diversity when associated with changes in structural composition of a given vegetative community. In Sonoran desert scrub, cattle did not reduce the amount of abundant, non-palatable shrubs; thus, little change in low-height perennial structure occurred, and lizard populations appeared to be unaffected.

The effect of livestock grazing on rodents is ambiguous but appears to depend on habitat preference for dense cover. Species that prefer open habitats such as Arizona pocket mouse (*Perognathus amplus*), silky pocket mouse (*P. flavus*), hispid pocket mouse (*P. hispidus*), and Merriam's kangaroo rat (*Dipodomys merriami*) may thrive where livestock grazing reduces vegetative cover without substantially reducing

seed production. In contrast, species that prefer heavy cover such as Price pocket mouse (*P. penicillatus*) and Bailey pocket mouse (*P. baileyi*) may be negatively affected (Fagerstone and Ramey 1996). Steenbergh and Lowe (1977) discussed the possible interrelationship between livestock grazing, rodent populations, and recruitment of young saguaro. While their review suggested that rodents consume saguaro seedlings and young plants, these writers did not find sufficient evidence to show a relationship between livestock grazing and effects to vegetative composition and cover such that increased rodent populations, and a resulting decrease in numbers of young saguaro, ultimately occurred.

In a study of livestock grazing influence on desert bighorn sheep (*Ovis canadensis mexicana*), Dodd and Brady (1986) examined differences between Sonoran Desert bighorn sheep habitat that had not been grazed for 26 years and recently grazed habitat. The main differences are that bighorn sheep preferred steep slopes while livestock predominantly used level terrain, and bighorn sheep primarily ate shrubs and cacti whereas cattle predominantly ate perennial grasses. The percentage of dietary overlap between bighorn sheep and cattle averaged only 35 percent, and no significant differences between grazed and ungrazed shrub and cacti cover were noted at any slope. On level slopes, annual grass and forb cover was significantly greater on the ungrazed area relative to the grazed areas. Dodd and Brady (1986) concluded that competition between bighorn sheep and cattle was low due to a dissimilarity in diets and distinct spatial segregation based on slope steepness. Krausman et al. (1996) also observed that ranges used by livestock and desert bighorn sheep usually do not overlap spatially; however, these writers described numerous instances of "social intolerance" in desert bighorn sheep: as livestock moved into core areas of habitat, bighorn sheep moved away. Due to this tendency to avoid contact with livestock, Krausman et al. (1996) suggested that even seasonal livestock grazing may fragment desert bighorn sheep habitat, effectively resulting in the exclusion of sheep from what is otherwise acceptable habitat.

With the exception of possible social intolerance of livestock by bighorn sheep, potential effects of livestock grazing on Sonoran Desert fauna is closely related to the effects of livestock grazing on Sonoran Desert vegetation. What is known about such effects is summarized below:

The very limited number of studies does not allow for strong conclusions to be drawn. Plant diversity appears to decline with grazing, although overall changes in species composition are relatively small. Grazing does not appear to have large effects on the major woody components, but impacts the less abundant and smaller species. Regeneration of saguaro cacti in areas of the Sonoran Desert can be negatively impacted. Recovery of a perennial herbaceous understory may be site dependent, and it is not clear whether the difference in recovery is due to site potential to support an herbaceous understory or due to the intensity of historic grazing (Milchunas 2006).

E.1.7.5 Archaeological and Historic Sites

Archaeological Resources

There are few published empirical studies of effects on cultural resources from livestock grazing. However, unpublished literature and published archaeological reports from the American Southwest describe incidents of damage associated with grazing. Reported effects of trampling include artifact breakage; vertical and horizontal displacement of artifacts; physical disturbance of archaeological features, such as collapse of walls; contamination of organic materials; and accelerated erosion that can disturb cultural deposits and obscure the visibility of artifacts, trails, and other features. There have also been reports of cattle damaging rock art panels by rubbing against them.

Such disturbances affect the quality that archaeologists refer to as "integrity." A site with good archaeological integrity has archaeological deposits that are relatively intact and complete. These deposits retain the spatial patterning of surface and subsurface artifacts and features, as well as qualities of "context" that can yield critical information for scientific studies. Aspects of integrity, used to evaluate the eligibility of historic properties for nomination to the National Register of Historic Places, also include "setting" and "feeling." Setting is "the physical environment of a historic property … elements such as topographic features, open space, viewshed, landscape, vegetation" (Little et al. 2000). Feeling is "a property's expression of the aesthetic or historic sense of a particular period of time" (Little et al. 2000). Intact qualities of setting and feeling enhance opportunities to interpret sites for public visitation and education. Disturbances to these qualities, from grazing impacts or other sources, can limit opportunities for research and interpretation.

In some cases, it is difficult to determine whether adverse impacts to archaeological sites have been caused by grazing, recreational activities such as camping, or a combination of factors. A small number of controlled studies have examined grazing impacts by mapping the locations and condition of artifacts in clearly defined plots, before and after grazing use (Osborn and Hartley 1991, Osborn et al. 1987, Roney 1977, Van Vuren 1982). Alan Osborn and his colleagues examined the effects of domestic livestock grazing on archaeological resources of Capitol Reef National Park in southern Utah. The study included reconnaissance and observations at recorded sites, and the creation of experimental and control plots containing several types of newly manufactured lithic and ceramic artifacts. Several study plots were located close to water sources. The artifacts were made, measured, weighed, placed, and mapped. Following 6 months of grazing use, they were again mapped, weighed, and examined. Osborn found that 93 percent of the artifacts remained intact, and 84 percent remained visible. Pottery shards were more prone to breakage. Mapping revealed that 23 percent of artifacts were displaced, but about 75 percent of the displaced artifacts had moved less than 15 centimeters. The results varied by the location of the plot. The impacts were greatest in plots close to water sources, which received a higher degree of grazing use. Osborn and Hartley (1991) concluded, "the degree of effect is a direct reflection of grazing intensity and dependence on limited water sources in this cold desert environment."

In summary, these studies indicate that impacts are a concern in areas of concentrated livestock use, such as water sources and corrals, more so than in areas of dispersed use. This conclusion is reflected in a study that examined lithic artifact breakage in areas of variable livestock use along the Central Arizona Project aqueduct in the western Arizona desert (Brown and Stone 1982). Collections of lithic artifacts from six archaeological sites located along different segments of the aqueduct route exhibited breakage rates ranging from 13 to 17 percent. These rates of breakage may be related to multiple factors, including grazing and off-highway vehicle use. In contrast, 52 percent of the artifacts from a seventh site located near a reservoir used by cattle were broken.

Historical Resources

As identified in Table E-2, the Monument contains the Juan Bautista de Anza Trail (Anza trail) corridor, a National Historic Trail. Approximately 17 miles in length, the corridor also contains remnants of other later traveled historic trails: the Mormon Battalion and the Butterfield Overland Stage Route. Although no visible physical remnants remain of the Anza trail, the historic corridor, as defined by the National Park Service, varies in width depending on the information.

E.1.7.6 Summary of the Literature Review

There are few studies of livestock grazing effects within the Sonoran Desert and none conducted within the SDNM. Most of the livestock-grazing management studies in the Sonoran desert in this literature review appear to compare effects on fauna, flora, and soil from an unknown and unquantified, amount of livestock grazing to no grazing. The lack of quantification of the intensity, frequency, and timing of livestock grazing makes it difficult to ascertain the levels of livestock grazing that are causing the effects. Despite these problems, the body of literature does provide some general potential effects of livestock grazing within the Sonoran desert that can be extrapolated to the SDNM and to some biological and cultural objects on the SDNM.

Potential negative effects of livestock grazing to annual and perennial vegetation, saguaro cactus, insects, insectivorous bats, lizards, rodents, and bighorn sheep were found from the literature review, and these potential effects can be related to the diversity of the plant species biological object, the saguaro cactus forest biological object, and the wildlife biological object.

Livestock grazing in the Sonoran Desert can potentially reduce plant species diversity and the presence of young saguaros in localized areas. Livestock grazing had no significant effects on insectivorous bats such as the lesser long-nosed bat, the California leaf-nosed bat, or the cave myotis bat. Livestock grazing had little to no effect on lizard abundance in Sonoran desert scrub plant communities, which are the habitat of the red-backed whiptail lizard (a noted wildlife object); therefore, livestock grazing is predicted to have little to no effect on the red-backed whiptail lizard. Livestock have the potential to cause social intolerance in desert bighorn sheep. This manifests itself in desert bighorn sheep moving away from areas when livestock are in the vicinity.

There are descriptions in the published record of damage to archaeological resources associated with livestock grazing. Reported adverse effects to site integrity include artifact breakage by trampling, displacement of artifacts, and the physical disturbance of archaeological features. Accelerated erosion can disturb cultural deposits and obscure the visibility of artifacts, trails, and other features. Studies indicate that breakage impacts are more of a concern in areas of concentrated livestock use, such as water sources and corrals, than in areas of dispersed use. Impacts on cultural resources by camping, off-road vehicles and other human activities can have the same effects as described above.

E.1.8 STEP 3: CONDUCT A LAND HEALTH EVALUATION

A land health evaluation (LHE) was completed in 2011 for this compatibility analysis (see **Appendix F**). The purpose of the SDNM LHE is to gauge whether the Arizona Standards for Rangeland Health are being met on the Monument. If the LHE documents that standards are not met in the assessment area, the authorized officer must determine significant causal factors for non-achievement. Further, if existing grazing management practices or levels of grazing use on public land are significant causal factors for the non-achievement of standards, then BLM has determined that such grazing is not compatible with the protection of the objects of the Monument.

Rangeland Health Standards (now referred to as Land Health Standards) are measurable and attainable goals for the desired condition of biological resources and physical components/characteristics of desert ecosystems found within the Monument that were identified as Monument objects by Presidential

Proclamation 7397. BLM typically evaluates indicators of land health by ascertaining the effects of livestock grazing on natural resources on landscape units called ecological sites. The BLM does not have site-specific data for every ecological site within the Sonoran Desert but does try to collect data on prevalent ecological sites within pastures or allotments. Comprehensive data on the Sonoran Desert do not exist from other sources. The BLM typically monitors change on ecological sites in response to management or weather but makes livestock-grazing management changes on a management unit of pastures or allotments rather than ecological sites because ecological sites are typically too small in size to manage separately for livestock grazing. Prevalent ecological sites within pastures or allotments are typically monitored through use of key areas or critical areas. Response to management or weather on these key areas or critical areas is used as a basis for judging whether livestock-grazing management is in need of change within pastures or allotments.

As part of the LHE process, desired plant community (DPC) objectives were established for the biological objects of the Monument. The DPC objectives were used as an indicator of ecosystem function and land health. This was accomplished by identifying indicators for the biological objects, which are identified in Table 2. If standards are being achieved then ecosystem functionality is not at risk. If standards are not achieved, then ecosystem functionality may be at risk on the Monument.

The Arizona Rangeland Health Standards are defined below:

- Standard 1 - Upland Sites: Upland soils exhibit infiltration, permeability, and erosion rates that are appropriate to soil type, climate, and landform (ecological site). To achieve Standard 1, rangelands cannot show signs of accelerated soil erosion by wind or water. If achieved, the health of the rangelands is determined to not be at risk. If the standard is not achieved, the health of the ecological site is at risk due to clear evidence of soil loss and hydrologic function.

- Standard 2 - Riparian-Wetland Sites: Riparian-wetland areas are in proper functioning condition (not applicable).

- Standard 3 - Desired Resource Conditions: Productive and diverse upland and riparian-wetland communities of native species exist and are maintained. To achieve Standard 3, the ecological site must be producing desirable forage, cover and soil protection. For wildlife, including desert tortoise, this means "healthy" rangeland is more likely to provide the necessary food and cover to sustain the species. If achieved, ecological sites are determined to contain productive and diverse communities of native species resulting in proper ecosystem function. If the standard is not achieved, the soil conditions and ecosystem function described in Standard 1 are at risk of losing soil, and not providing forage and habitat for wildlife and livestock.

Standard 1 and Standard 3 apply to public lands within the SDNM. There are no riparian areas located within the Monument; therefore, land health Standard 2 is not applicable and was not evaluated. The Barry M. Goldwater Range (BGR) and Area A (Sand Tank Mountains area) were used as comparison areas to set conservative resource condition objectives. The area has not been open to livestock grazing since the 1940s.

As part of the LHE process, a draft of the evaluation was sent out for a technical peer review. Contributors to the technical peer review are four rangeland ecologists who each have an extensive publications record and are recognized experts in Sonoran Desert ecosystem functions. These included an Assistant Professor of Natural Resources, University of Arizona, and Extension Specialist in Range Management, University of Arizona, a professor Emeritus, University of Arizona, Tucson and a Professor Emeritus, New Mexico State University, Las Cruces. The peer reviewers were asked the following questions:

1. Are the conclusions supported by analysis of the data?

2. Are the data collected sufficient to permit the BLM to draw the conclusions made?

3. If data are not deemed sufficient, what improvements could be made to existing data, what new types of data could be collected, and what methods could be used to obtain the data to improve BLM's ability to generate conclusions?

Recommendations received from the peer review were considered before completing the draft LHE. In addition, future study design recommendations from the peer reviewers will be considered in any monitoring plan for the SDNM. Comments submitted by stakeholders and interested publics will be considered for the final LHE and final compatibility analysis.

E.1.8.1 Data Collection and Analysis

Direct measurements of the resource conditions on the Monument began with a BLM rangeland soil and vegetation inventory, which was completed for SDNM allotments in 1981 as part of the planning effort for the Lower Gila South RMP/EIS. Ecological sites were mapped for each allotment within the Monument. Data were collected for the rangeland survey from 1979 to 1981. The BLM's rangeland inventory production data and the Soil Conservation Service (now NRCS) range site guides were used to determine range condition (ecological status) and apparent trend.

In 2002, the Pacific Biodiversity Institute (PBI), which was a subcontractor of The Nature Conservancy through an assistance agreement with the BLM, collected estimates of vegetative canopy cover to assess the ecological condition of SDNM. This was designed to be used as a baseline for changes and trends in the condition of the natural communities within the Monument. Data were also collected by PBI in the BGR and the southern portion of Area A. Historical records indicate that livestock use in this area has been absent or relatively light since the 1940s. Data from the 48 PBI study sites were used as part of the analysis.

In 2008, a BLM interdisciplinary team collected data at 35 key areas within the SDNM allotments for the purpose of conducting an LHE. Key areas were selected based on their location, distance to water, livestock and wildlife habitat values, and included representations of all major ecological sites. Key areas were not placed within small, localized disturbance areas around wildlife and livestock watering facilities, as they are not representative of the overall range conditions.

Vegetative attribute data collected includes ground cover, frequency, relative production, structure, composition, and canopy cover (Interagency Technical Team 1996a). Utilization data were also collected at several key areas, and use-pattern mapping was conducted during a year of average livestock use for

each of the allotments (Interagency Technical Team 1996b). Detailed methodology for each of these data collection techniques is provided in Appendix F, *Arizona Land Health Evaluation for the Sonoran Desert National Monument*, Arizona Land Health Evaluation for the Sonoran Desert National Monument.

The plant communities found on an ecological site are naturally variable. Composition and production vary with yearly conditions, location, aspect, and the natural variability of the soils. The "historical climax plant community" represents the natural potential plant communities found on relic or relatively undisturbed sites. Other plant communities described here represent plant communities that are known to occur when the site is disturbed by factors such as fire, grazing, or drought (NRCS 2010). Given this natural variability, rather than using the absolute value to determine achievement of the objective, the site was considered achieving the objective if the vegetative attributes measured were within 80 percent of the attribute value.

For the ecological site within an allotment to be considered achieving land health Standard 3, a majority of the key areas and PBI plots (more than 50 percent) representing an ecological site had to meet all the desired plant community objectives. This represents a preponderance of evidence approach to ascertain whether land health Standard 3 was met.

The departure from achievement of a standard may be negligible, minor, moderate or major. Level and intensity of use is the indicator used of whether or not an activity is a significant causal factor for not achieving a land health standard. The percent of the vegetative community/object affected by livestock use are also summarized by cumulative acres and miles.

E.1.8.2 Analysis, Interpretation & Evaluation of Effects of Livestock Grazing on Monument Objects

The following analysis and interpretation summarizes the results of the LHE (Appendix F, *Arizona Land Health Evaluation for the Sonoran Desert National Monument*). It is based on the cumulative acres of ecological sites found within the vegetative community Monument object. The results of the LHE indicate that Standard 1 is being achieved throughout the Monument. Qualitative assessments of the soil-related indicators (rills, flow patterns, pedestals, bare ground, gullies, litter movement, and soil compaction etc.) did not indicate any signs of accelerated erosion at any site. Upland soils exhibit infiltration, permeability, and erosion rates that are appropriate for the ecological sites. Quantitative cover data indicates that vegetative and microbiotic crust cover levels are appropriate across the majority of the ecological sites assessed, and are comparable to the BGR/Area A areas that have not been grazed in 60 years (Map E-3). Because Standard 1 is being achieved throughout the Monument, it is not analyzed further. However, Standard 3 is not achieved in all areas.

Utilization data is analyzed in conjunction with vegetation cover and composition, livestock-use levels (AUMs), and precipitation to determine causal factors for non-achievement of standards and to determine whether changes in current management practices are necessary. Proper utilization levels are needed to provide for plant maintenance and watershed health values.

The analysis below includes a determination as to whether or not livestock grazing is the causal factor when Standard 3 is not achieved. The SDNM is comprised primarily of shrubs. Shrub utilization exceeding 40 percent of current year's growth can impede shrub viability (i.e. vigor, reproductive capacity, etc.) (Holechek et al. 1999). Therefore, current livestock grazing is determined to be a

significant causal factor for non-achievement of standards in those areas where patterns of livestock use are greater than 40 percent utilization. If livestock grazing is determined not to be the causal factor, other factors may be contributing to non-achievement of Standard 3.

Effects of grazing were analyzed by vegetative community and by permitted allotment.

Analysis of the Biological Objects by Vegetative Community

Creosote Bush-Bursage Vegetation Community

This community consists of the limy fan, limy upland deep and Sandy Loam deep ecological sites and provides habitat for wildlife objects (identified in **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object); see also **Map E-1**, SDNM Grazing Allotments and Vegetation Communities from Land Health Evaluation). It comprises 151,643 acres within the Monument. Standard 3 is being achieved on 45,633 acres within this community. Standard 3 is not being achieved on 106,010 acres within this community, due in large part to a minor departures from the reference state of vegetation canopy cover and composition (See **Table E-3**, Creosote Bush-Bursage Land Health Standard Achievement Status). Utilization data indicate that existing grazing-management practices are causal factors in failing to achieve Standard 3 on 7,980 acres (5 percent) of the creosote bush-bursage community. The remaining 98,030 acres of the vegetation community not achieving Standard 3 could not be attributed to current livestock-grazing practices. Long-term trend data are not available to ascertain whether progress is or is not being made toward achievement of Standard 3 (See **Map F-5** in the LHE Appendix F).

Table E-3
Creosote Bush-Bursage Land Health Standard Achievement Status

	Standard 1	Standard 3
1. Acres achieving land health standards	151,643	45,633
2. Acres not achieving land health standards	0	106,010
a. Due to current livestock grazing	0	7,980
b. Due to other causes*	0	98,030
3. Acres not achieving land health standards but making significant progress	0	0
Total acres in the SDNM	**151,643**	

*May include historic livestock grazing, livestock use patterns, fire, drought, OHV use, etc.

Palo Verde-Mixed Cacti Vegetation Community and Saguaro Cactus Forest

This community (see **Map E-1**) consists of the limy upland and granitic hills ecological sites and provides habitat for wildlife objects (identified in Table E-7, Results of the Land Health Evaluation (LHE Objectives by Monument Object)). It comprises 87,366 acres within the Monument. Standard 3 is being achieved on 65,827 acres within the Monument. Standard 3 is not being achieved on 21,539 acres within this community, due in large part to a minor departure from the reference state of vegetation canopy cover or composition (see **Table E-4**, Palo-Verde Mixed Cactus Land Health Standard Achievement Status). Utilization data indicate that existing grazing-management practices are factors in failing to achieve Standard 3 on 511 acres (approximately 1 percent of the community). The remaining 21,028 acres of the vegetation community not achieving Standard 3 could not be attributed to current livestock-grazing practices.

Table E-4
Palo-Verde Mixed Cactus Land Health Standard Achievement Status

	Standard 1	Standard 3
1. Acres achieving land health standards	87,366	65,827
2. Acres not achieving land health standards	0	21,539
a. Due to current livestock grazing	0	511
b. Due to other causes*	0	21,028
3. Acres not achieving land health standards but making significant progress	0	0
Total acres in the SDNM	**87,366**	

*May include historic livestock grazing, livestock use patterns, fire, drought, OHV use, etc.

The results of the PBI saguaro study indicate that recruitment of saguaros is occurring within the grazed portion of SDNM north of I-8 at appropriate rates compared to Area A and BGR.

Desert Wash Community

This community consists of the sandy wash and loamy swale ecological sites and provides habitat for wildlife objects (identified in **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object)). The community covers 490.5 miles within the Monument (see **Table E-5**, Desert Wash Community Land Health Standard Achievement Status). Standard 3 is being met on 196.5 miles within the Monument. Standard 3 is not being met on 294 miles within this community, due in large part to a minor departure from the reference state of vegetation canopy cover or composition. Utilization data indicate that existing grazing management practices are factors in failing to achieve Standard 3 on 12 miles (approximately 2 percent) of the community. The remaining 282 miles of the vegetation community not achieving Standard 3 could not be attributed to current livestock-grazing practices.

Table E-5
Desert Wash Community Land Health Standard Achievement Status

	Standard 1	Standard 3
1. Miles achieving land health standards	490.5	196.5
2. Miles not achieving land health standards	0	294.0
a. Due to current livestock grazing	0	12.0
b. Due to other causes*	0	282.0
3. Miles not achieving land health standards but making significant progress	0	0
Total Miles	**490.5**	

*May include historic livestock grazing, livestock use patterns, fire, drought, OHV use, etc.

E.1.8.3 Analysis of the Diversity of Plant Species Biological Object

Plant species diversity is most simply defined as the number of plant species occurring in a given plant community or landscape. Plant diversity is a vegetation attribute based on other attributes such as presence, cover or biomass -- it is a calculated or synthesized value, not a directly observable attribute of vegetation. Cover was used as a diversity attribute in this analysis. This use is an accepted methodology and was employed by Waser and Price (1981).

The plant diversity found within any vegetation community can be highly variable and is affected by factors such as slope, aspect, local climate and the natural variability of the soils. In addition, drought, fire, herbivory, and other factors have an effect on the diversity of a community. As mentioned earlier, the plant communities within the SDNM are shrub-dominated communities, typical of the Sonoran Desert scrub vegetative communities.

The analysis was based on cover data from PBI plots. Data collected on the Monument north of I-8 was compared to the average number of perennial species per plot on BGR and Area A lands within similar ecological sites. The BGR and Area A are considered reference areas for plant species diversity for the SDNM (**Map E-3**). The results are summarized in **Table E-6**, Average Number of Perennial Species Per Plot (Diversity).

Table E-6
Average Number of Perennial Species Per Plot (Diversity)

Plant Community (ecological site)	BGR/ Area A	Big Horn	Conley	Beloat	Hazen	Lower Vekol
Creosote-bursage (limy fan)	2	3	2.6	2.7	5.5	**
Palo verde-mixed cacti (granitic hills)	9*	14	12.5	18.8	16	19
Creosote-bursage (limy upland deep)	4.6	4.3	**	**	**	**
Desert wash (sandy wash)	12	17.7	6	**	10	**

*Only one plot in this ecological site in BGR
**No data collected

Based on the results summarized in the table, the average number of species per plot for all allotments are similar to BGR/Area A average species with the exception of the Conley allotment sandy wash ecological site. This would indicate that the diversity of perennial species is relatively similar to that of the comparison area, which has not been grazed in more than 50 years.

E.1.8.4 Analysis of the Biological Monument Objects by Allotment

Big Horn (92,204 Acres)

The palo verde-mixed cacti vegetation community and saguaro cactus forest Monument objects (limy upland and granitic hills ecological sites) represent 28,836 acres within the allotment. Both ecological sites within this community are achieving Standard 1 and Standard 3.

The creosote bush-bursage vegetation community Monument object (limy fan, limy upland deep, and Sandy Loam deep ecological sites) represents 59,240 acres within the allotment. The limy fan and sandy loam deep ecological sites (29,856 acres) are meeting Standard 1 and Standard 3. The limy upland deep ecological site is meeting Standard 1 but not Standard 3 (29,384 acres). Utilization data indicate that existing grazing-management practices are factors in failing to meet Standard 3 on 2,974 acres (5 percent) of the creosote bush-bursage community. The failure of the remaining acres of the limy upland deep ecological site to meet Standard 3 could not be attributed to current livestock grazing.

The desert wash Monument object (sandy wash and loamy swale ecological sites cover 192 miles within the allotment (see **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object)). Both ecological sites within this community are meeting Standard 1 and Standard 3.

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
Monument Object: Functioning Desert Ecosystem		
See Monument object: saguaro cactus forest		
See Monument object: vegetation communities		
Habitat for a wide range of wildlife species (See Monument object: wildlife)		
Monument Object: Diversity of Plant and Animal Species		
Woodland assemblages	Do not occur north of I-8. Occur in the higher peaks of the Table Top and Sand Tank Mountains.	
Palo verde-mixed cacti vegetation community	**Land Health Standard 1:** Assessments of soil/site stability and hydrologic function on granitic hills and limy upland ecological sites. **Land Health Standard 3**: Vegetative canopy cover objective for the limy upland and granitic hills ecological sites. palatable shrub composition objective for the limy upland ecological sites	**Big Horn:** Achieves Standard 1 Achieves Standard 3 for the limy upland and granitic hills ecological sites
		Beloat: Achieves Standard 1 Achieves Standard 3 for the limy upland and granitic hills ecological sites
		Conley: Achieves Standard 1 Does not achieve Standard 3 for the limy upland and granitic hills ecological sites
		Hazen: Achieves Standard 1 Achieves Standard 3 for the granitic hills ecological site
		Lower Vekol: Achieves Standard 1 Achieves Standard 3 for the granitic hills ecological site Does not achieve Standard 3 for the limy upland ecological site. Does not achieve the palatable shrub composition DPC objective.
Saguaro cactus and nurse plants	**Land Health Standard 1**: Assessments of soil/site stability and hydrologic function on granitic hills and limy upland ecological sites - provides suitable soil and hydrologic conditions for saguaros and	**All SDNM:** PBI recruitment of saguaros is occurring within the grazed portion of the SDNM at appropriate rates compared to ungrazed portions of the SDNM

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
	nurse plants. **Land Health Standard 3:** Vegetative canopy cover objectives for the limy upland and granitic hills ecological sites - provides vegetative cover of nurse plants. **Land Health Standard 3:** Saguaro recruitment objectives for the limy upland and granitic hills ecological sites	and BGR Area A. See **Map E-3**.
		Big Horn: Achieves Standard 1, Achieves Standard 3 for the limy upland and granitic hills ecological sites
		Beloat: Achieves Standard 1 Achieves Standard 3 for the limy upland and granitic hills ecological sites
		Conley: Achieves Standard 1 Does not achieve Standard 3 for the limy upland and granitic hills ecological sites
		Hazen: Achieves Standard 1, Achieves Standard 3 for the granitic hills ecological site.
		Lower Vekol: Achieves Standard 1, Achieves Standard 3 for the granitic hills ecological site Does not achieve Standard 3 for the limy upland ecological site; however, does achieve the canopy cover objective for nurse plants.
Monument Object: Sand Tank Mountains		
Sand Tank Mountains	Mountain range not in analysis area (located south of I-8)	
Monument Object: Vegetation Communities: Creosote-Bursage, Desert Grassland, and Desert Washes		
Creosote-bursage vegetation community	**Land Health Standard 1:** Assessments of soil/site stability and hydrologic function on limy fan, limy upland deep, and/or sandy loam deep ecological sites **Land Health Standard 3:** Vegetative	**Big Horn:** Achieves Standard 1, Achieves Standard 3 for the limy fan ecological site, Achieves Standard 3 for the sandy loam deep ecological site, Does not achieve Standard 3 for

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
	canopy cover objectives and composition objectives for the limy fan, limy upland deep, and sandy loam deep ecological sites	the limy upland deep ecological site. Several sites do not meet canopy cover objectives.
		Beloat: Achieves Standard 1, Does not achieve Standard 3 for the limy fan ecological site.
		Conley: Achieves Standard 1, Does not achieve Standard 3 for the limy fan ecological site. Species composition objectives were not met at multiple sites, Does not achieve Standard 3 for the limy upland deep ecological site.
		Hazen: Achieves Standard 1, Achieves Standard 3 for the limy upland deep ecological site, Does not achieve Standard 3 for the limy fan ecological site.
		Lower Vekol: Achieves Standard 1, Achieves Standard 3 for the limy upland deep ecological site.
		Arnold: Achieves Standard 1, Does not achieve Standard 3 for the limy fan ecological site.
Desert washes	**Land Health Standard 1:** Assessments of soil/site stability and hydrologic function on sandy wash and loamy swale ecological sites.	**Big Horn:** Achieves Standard 1, Achieves Standard 3 for the sandy wash and loamy swale ecological sites.
	Land Health Standard 3: Vegetative canopy cover and palatable shrub composition objectives for the sandy wash ecological site, and vegetative canopy cover and perennial grass composition objectives for the loamy swale ecological	**Beloat:** Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site.

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
	site.	**Conley:** Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site.
		Hazen: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site.
		Lower Vekol: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site.
Desert Grassland	Does not occur north of I-8	
Monument Object: Wildlife*		
Sonoran desert tortoise, Desert bighorn sheep, Red-backed whiptail lizard, Elf owl, Western screech owl, Mule deer.	**Land Health Standard 1:** Assessments of soil/site stability and hydrologic function on granitic hills and limy upland ecological sites (palo verde-mixed cacti vegetation community). **Land Health Standard 3:** Vegetative canopy cover objectives for the limy upland and granitic hills ecological sites. **Land Health Standard 3:** palatable shrub plant species composition objective for the limy upland ecological site.	**Big Horn:** Achieves Standard 1, Achieves Standard 3 for the limy upland and granitic hills ecological sites.
		Beloat: Achieves Standard 1, Achieves Standard 3 for the limy upland and granitic hills ecological sites.
		Conley: Achieves Standard 1, Does not achieve Standard 3 for the limy upland and granitic hills ecological sites.
		Hazen: Achieves Standard 1, Achieves Standard 3 for the granitic hills ecological site.
		Lower Vekol: Achieves Standard 1, Achieves Standard 3 for the granitic hills ecological site, Does not achieve Standard 3 for the limy upland ecological site.

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
Mule deer, Elf owl, Western screech owl, Cactus ferruginous pygmy-owl (not identified in the proclamation).	**Land Health Standard 1:** Assessments of soil/site stability and hydrologic function on sandy wash ecological site. **Land Health Standard 3:** Vegetative canopy cover and palatable shrub composition objectives for the sandy wash ecological site, and vegetative canopy cover and perennial grass composition objectives for the loamy swale ecological site, and for potential cactus ferruginous pygmy-owl (CFPO) habitat in the sandy wash ecological site	**Big Horn:** Achieves Standard 1, Achieves Standard 3 for the sandy wash and loamy swale ecological sites, Achieves CFPO canopy cover objective.
		Beloat: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site, Achieves CFPO canopy cover objective.
		Conley: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site, No identified potential cactus ferruginous pygmy-owl (CFPO) habitat.
		Hazen: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves CFPO canopy cover objective.
		Lower Vekol: Achieves Standard 1, Does not achieve Standard 3 for the sandy wash ecological site, Achieves Standard 3 for the loamy swale ecological site, No identified potential cactus ferruginous pygmy-owl (CFPO) Habitat.
Sonoran pronghorn	Does not occur in the Monument.	
Javelina	Occurrence of this species north of I-8 in the SDNM is unconfirmed.	
Mountain lion	Evaluation of palo verde-mixed cacti and washes communities (granitic hills, limy upland and sandy wash ecological sites) addresses suitable habitat for prey species (i.e. mule deer, bighorn sheep, rodents, etc.).	
Gray fox	Evaluation of all vegetative communities addresses suitable habitat for prey species (i.e. quail, birds, rodents, lizards, etc.).	

Table E-7
Results of the Land Health Evaluation (LHE Objectives by Monument Object)

Biological Indicator	Applicable Standards	Evaluation Results
Bobcat	Evaluation of all vegetative communities addresses suitable habitat for prey species (i.e. quail, birds, rodents, lizards, etc.).	
Lesser long-nosed bat (see above)	Evaluation of saguaro cactus forests conditions and applicable ecological sites evaluates habitat needs within the SDNM north of I-8 for this species.	
California leaf-nosed bat	Evaluation of all vegetative communities addresses suitable forage habitat. No known roost sites on the SDNM (Arizona Bat Resource Group, 2003). Forage (insects) area could occur within the Monument.	
Cave myotis bat	Evaluation of all vegetative communities addresses suitable forage habitat. No known roost sites on the SDNM (Arizona Bat Resource Group, 2003). Forage (insects) area could occur in the Monument.	
Elf owl (see above)	Evaluation of palo verde-mixed cacti and washes communities (granitic hills, limy upland and sandy wash ecological sites) addresses suitable forage habitat.	
Western screech owl (see above)	Evaluation of palo verde-mixed cacti and washes vegetation communities (granitic hills, limy upland and sandy wash ecological sites) addresses suitable forage habitat (i.e. small birds, rodents, lizards, insects etc.).	
Red-backed whiptail lizard (see above)	Evaluation of palo verde-mixed cacti vegetation community (granitic hills and limy upland ecological sites) addresses the habitat needs for this species.	
Sonoran green toad	Located in Vekol Valley spreader dikes and stock tanks outside the SDNM north of I-8.	

* Under Standard 3, when DPC objectives for wildlife habitat are being achieved, the site is producing desirable forage, cover, and soil protection. For wildlife, including the desert tortoise, this means "healthy" rangeland is more likely to provide the necessary food and cover to sustain the species that live there.

Beloat (33,600 Acres)

The palo verde-mixed cacti vegetation community and saguaro cactus forest objects (limy upland and granitic hills ecological sites) cover 12,113 acres within the allotment. Both ecological sites within this community are achieving Standard 1 and Standard 3.

The creosote bush-bursage vegetation community Monument object (limy fan and limy upland deep ecological sites) represents 21,487 acres of the allotment. Both ecological sites within this community are achieving Standard 1, but the limy fan ecological site (17,906 acres) is not achieving Standard 3. Because the livestock utilization was less than 40 percent, grazing is determined not to be a causal factor for failing to achieve Standard 3.

The desert wash Monument object (sandy wash and loamy swale ecological sites) covers 64 miles within the allotment. The loamy swale ecological site (1 mile) is achieving Standard 1 and Standard 3. The sandy wash ecological site is achieving Standard 1 but not Standard 3 (63 miles). Grazing management practices are not factors in failing to achieve Standard 3, as livestock use levels were negligible (0-5 percent) and slight (6 to 20 percent) levels.

Conley (77,708 Acres)

The palo verde-mixed cacti vegetation community and saguaro cactus forest Monument objects (limy upland and granitic hills ecological sites) cover 20,963 acres within the allotment. The limy upland and granitic hills ecological sites are achieving Standard 1 but not Standard 3. Utilization data indicate it is more likely than not that existing grazing management practices or levels of grazing use are factors in failing to achieve the Standard 3 on 511 acres (2 percent) of the palo verde-mixed cacti vegetation community. The failure of the remaining acres of the community to meet Standard 3 could not be attributed to current livestock grazing.

The creosote bush-bursage vegetation community Monument object (limy fan and limy upland deep ecological sites) covers 52,315 acres of the allotment. The limy fan and limy upland deep ecological sites are achieving Standard 1 but not Standard 3 (52,315 acres). Utilization data indicate it is more likely than not that existing grazing management practices or levels of grazing use are factors in failing to achieve Standard 3 on 5,006 acres (10 percent) of the creosote bush-bursage community. The failure of the remaining acres of the vegetation community to meet Standard 3 could not be attributed to current livestock grazing.

The desert wash Monument object (sandy wash and loamy swale ecological sites) covers 155 miles of the allotment. The loamy swale ecological site (1 mile) is achieving Standard 1 and Standard 3. The sandy wash ecological site (154 miles) is achieving Standard 1 but not Standard 3. Utilization data indicate it is more likely than not that existing grazing-management practices and levels of grazing use are factors in failing to achieve Standard 3 on 10 miles (6 percent) of the desert wash community.

Hazen (31,926 Acres)

The palo verde-mixed cacti vegetation community and saguaro cactus forest Monument objects (limy upland and granitic hills ecological sites), which provide habitat for wildlife objects, cover 17,713 acres of the allotment. The ecological sites within this community are achieving Standard 1 and Standard 3. The creosote bush-bursage vegetation community Monument object (limy fan and limy upland deep ecological sites) covers 14,213 acres of the allotment. The limy upland deep ecological site (8,514 acres) is achieving Standard 1 and Standard 3. The limy fan ecological site is achieving Standard 1 but not Standard 3 (5,699 acres). It is more likely than not that the failure of this site to meet Standard 3 is not due to existing grazing-management practices or levels of grazing use, as livestock use levels were at negligible (0 to 5 percent) and slight (6 to 20 percent) levels.

The desert wash Monument object (sandy wash ecological site) covers 59 miles of the allotment (see **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object)). The ecological site is achieving Standard 1 but not Standard 3. It is more likely than not that the failure of this site to meet Standard 3 is not due to existing grazing management practices or levels of grazing use, as livestock use levels were at negligible (0 to 5 percent) and slight (6 to 20 percent) levels.

Lower Vekol (15,409 Acres)

The palo verde-mixed cacti vegetation community and saguaro cactus forest Monument objects (limy upland and granitic hills ecological sites covers 6,838 acres of the allotment (see **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object)). The granitic hills ecological site

(6,262 acres) is achieving Standard 1 and Standard 3. The limy upland ecological site (576 acres) is achieving Standard 1 but not Standard 3. It is more likely than not that the failure of these sites to meet Standard 3 are not due to existing grazing management practices or levels of grazing use, as livestock use levels were at slight (6 to 20 percent) and light (21 to 40 percent) levels.

The creosote bush-bursage vegetation community Monument object (limy fan and limy upland deep ecological sites covers 3,682 acres of the allotment. See **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object). Both ecological sites within this community are achieving Standard 1 and Standard 3.

The desert wash Monument object (sandy wash and loamy swale ecological sites) covers 18.5 miles of the allotment. The loamy swale ecological site (0.5 miles) is achieving Standard 1 and Standard 3. The sandy wash ecological site is achieving Standard 1 but not Standard 3 (18 miles). Utilization data indicate it is more likely than not that existing grazing management practices or levels of grazing use are factors in failing to achieve Standard 3 on 2 miles (11 percent) of the desert wash community.

Arnold (1,609 Acres)

The creosote bush-bursage vegetation community Monument object (limy fan ecological site) covers 706 acres of the allotment. The ecological site is meeting Standard 1 but not Standard 3. It is more likely than not that the failure of these sites to meet Standard 3 are not due to existing grazing management practices or levels of grazing use, as livestock use levels were at slight (6 to 20 percent) levels. **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object) identifies which land health objectives apply to each biological indicator of the Monument objects. Because the objects in the proclamation are identified at the landscape level, biological "indicators" for the objects were identified that can be measured at the site-specific level. These were identified in Table E-2, Monument Objects Specific to the SDNM. For each Monument object, corresponding "indicators" are identified.

E.1.8.5 Summary of Land Health Evaluation Findings by Monument Object

Where livestock grazing was determined to be a significant causal factor for of the failure to meet land health standards, it was determined that livestock grazing is not compatible with the protection of the Monument objects (see **Map E-2** and **Map E-3**). Current livestock grazing was determined to be a significant causal factor for non-achievement of standards in those areas where unacceptable patterns of livestock use (greater than 40 percent utilization levels) occurred. See **Table E-8**, Land Health Standard Status & Causal Factor Determination by Allotment/Ecological Site.

Functioning Desert Ecosystem

The functioning desert ecosystem in the SDNM including saguaro cactus forests, various vegetation communities, and habitat for a wide range of wildlife species is generally unaffected by grazing. Livestock grazing north of I-8 is not having an adverse effect on the ecosystem function of 99 percent of the palo verde-mixed cacti community, 99 percent of the saguaro cactus forest community, 95 percent of the creosote bush-bursage community, and 98 percent of the desert wash vegetation community or associated wildlife identified in **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object) and discussion below. In these locales, current livestock-grazing practices are compatible with protection of Monument objects.

Table E-8
Land Health Standard Status & Causal Factor Determination by Allotment/Ecological Site

Ecological site	Total (acres)	Achieving LH Standards (acres)	Not achieving LH Standards (acres)	Acres where livestock use is a causal factor	% of total where livestock use is a causal factor
Big Horn					
Limy fan	28,390	28,390	0	0	0
Limy upland deep	29,384	0	29,384	2,974	10%
Sandy loam deep	1,466	1,466	0	0	0
Creosote bush-bursage total	**59,240**	**29,856**	**29,384**	**2,974**	**5%**
Limy upland	6,898	6,898	0	0	0
Granitic hills	21,938	21,938	0	0	0
Palo verde-mixed cacti total	**28,836**	**28,836**	**0**	**0**	**0**
Misc. ecological sites*	4,128	4,128	0	0	0
Total acres	**92,204**	**62,820**	**29,384**	**2,974**	**3%**
Loamy swale	2 miles	2 miles	0 miles	0	0
Sandy wash	190 miles	190 miles	0 miles	0	0
Beloat					
Limy fan	17,906	0	17,906	0	0
Limy upland deep	3,521*	3,521*	0	0	0
Creosote bush-bursage total	**21,487**	**3,581**	**17,906**	**0**	**0**
Limy upland	5,403	5,403	0	0	0
Granitic hills	6,710	6,710	0	0	0
Palo verde-mixed cacti total	**12,113**	**12,113**	**0**	**0**	**0**
Total acres	**33,600**	**15,694**	**17,906**	**0**	**0**
Loamy swale	1 mile	1 mile	0 miles	0	0
Sandy wash	63 miles	0 miles	63 miles	0	0
Conley					
Limy fan	38,537	0	38,537	5,006	0
Limy upland deep	13,778	0	13,778	0	0
Sandy loam deep	0	0	0	0	0
Creosote bush-bursage total	**52,315**	**0**	**52,315**	**4,971**	**10%**
Limy upland	5,053	0	5,053	320	0.6%
Granitic hills	15,910	0	15,910	191	0.01%
Palo verde-mixed cacti total	**20,963**	**0**	**20,963**	**511**	**0.02%**
Misc. ecological sites*	4,430	0	0	0	0
Total acres	**77,708**	**0**	**73,278**	**5,517**	**7%**
Loamy swale	1 mile	0	0 miles	0	0
Sandy wash	154 miles	0	154 miles	10 miles (35 acres)**	6%

Table E-8
Land Health Standard Status & Causal Factor Determination by Allotment/Ecological Site

Ecological site	Total (acres)	Achieving LH Standards (acres)	Not achieving LH Standards (acres)	Acres where livestock use is a causal factor	% of total where livestock use is a causal factor
Hazen					
Limy fan	5,699	0	5,699	0	0
Limy upland deep	8,514	8,514	0	0	0
Creosote bush-bursage total	**14,213**	**8,514**	**5,699**	**0**	**0**
Limy upland	4,831*	4,831*	0	0	0
Granitic hills	12,882	12,882	0	0	0
Palo verde-mixed cacti total	**17,713**	**17,713**	**0**	**0**	**0**
Total acres	**31,926**	**26,227**	**5,699**	**0**	**0**
Loamy swale	1 mile	1 mile	0 miles	0	0
Sandy wash	63 miles	0 miles	63 miles	0	0
Lower Vekol					
Limy fan	118*	118*	0		0
Limy upland deep	3,564	3,564	0	0	0
Creosote bush-bursage total	**3,682**	**3,682**	**0**	**0**	**0**
Limy upland	576	0	576	0	0
Granitic hills	6,262	6,262	0	0	0
Palo verde-mixed cacti total	**6,838**	**6,262**	**576**	**0**	**0**
Misc. ecological sites*	4,889	4,889	0	0	0
Total acres	**15,409**	**14,833**	**576**	**0**	**0**
Loamy swale	0.5 miles	0.5 miles	0 miles	0	0
Sandy wash	18 miles	0 miles	18 miles	2 miles (7 acres)	1%
Arnold					
Limy fan	706	0	706	0	0
Creosote bush-bursage total	**706**	**0**	**706**	**0**	**0**
Limy upland	360*	360*	0	0	0
Granitic hills	543*	543	0	0	0
Palo verde-mixed cacti total	**903**	**903**	**0**	**0**	**0**
Total acres	**1,609**	**903**	**706**	**0**	**0**
Sandy wash	2 miles	2 miles	0 miles	0	0
Total acres unavailable to grazing: 8,498**					

*Generally consists of small patchy inclusions of ecological site polygons within the allotment that do not represent larger stratum for management purposes and do not meet the key area concept or are inaccessible to livestock and were not evaluated. However, the majority of these areas were mapped for livestock use patterns.

**The sandy wash acres for the Conley allotment are included in the creosote bush-bursage vegetation community acreage and not included in the grand total acres to avoid acreage duplication.

Palo Verde-Mixed Cacti Vegetation Community, Saguaro Cactus Forests, Diversity of Plant and Animal Species, Wildlife

Studies (Abouhaidar 1992, Holden et al. 2000) have shown that saguaro cactus forest communities are strongly influenced by forces that alter density of shade-producing perennials ("nurse" plants). Evidence from the SDNM suggests that current grazing practices are compatible with the maintenance of nurse plants. Analysis of 87,366 acres of palo verde-mixed cactus and the saguaro cactus forest communities in the SDNM indicate that Standard 3 is being achieved on 65,827 acres (see **Table E-9**, Land Health Standard Status & Determination by Vegetation Community). Standard 3 is not being met on the Conley or Lower Vekol allotments (see **Table E-9**, Land Health Standard Status & Determination by Vegetation Community). Use-pattern mapping and utilization data indicate that failure to achieve Standard 3 on the Lower Vekol allotment is not attributable to grazing. However, on 511 acres (more than 1 percent) of the Conley Allotment, conditions do not meet Standard 3, a situation that likely is attributable to grazing. The BLM has determined that current grazing practices are not compatible with the protection of the palo verde-mixed cacti vegetation or saguaro cactus forest communities on 511 acres of the Conley Allotment within the SDNM.

Table E-9
Land Health Standard Status & Determination by Vegetation Community

	Bighorn	Beloat	Conley	Hazen	Lower Vekol	Arnold	Total
Creosote Bush-Bursage							
1. Acres achieving land health standards	29,856	3,581	0	8,514	3,682	0	45,633
2. Acres not achieving land health standards	29,384	17,906	52,315	5,699	0	706	106,010
a. Due to livestock grazing	2,974	0	5,006	0	0	0	7,980
b. Due to other causes*	26,410	17,906	47,309	5,699	0	706	98,030
Total acres: 151,643							
Palo Verde-Mixed Cacti & Saguaro Cactus Forest							
1. Acres achieving land health standards	28,835	12,113	0	17,713	6,262	903	65,826
2. Acres not achieving land health standards	0	0	20,963	0	576	0	21,539
a. Due to livestock grazing	0	0	511	0	0	0	511
b. Due to other causes*	0	0	20,452	0	576	0	21,028
Total acres: 87,366							
Desert Wash							
1. Miles (acres) achieving land health standards	190 (665)	1 (3.5)	1 (3.5)	0	0.5 (1.7)	2 (7)	6.2 (680.7)
2. Miles (acres) not achieving land health standards	0	63 (220.5)	154 (539)	59 (206.5)	18 (63)	0	0 (1,029)
a. Due to livestock grazing	0	0	10 (35)**	0	2 (7)	0	0 (42)

Table E-9
Land Health Standard Status & Determination by Vegetation Community

	Bighorn	Beloat	Conley	Hazen	Lower Vekol	Arnold	Total
b. Due to other causes*	0	63 (220.5)	144 (504)	59 (206.5)	16 (56)	0	0 (987)
Total miles (acres): 490.5 miles (1,716.75)							

* May include historic livestock grazing, livestock use patterns, fire, drought, OHV use, etc.

** The sandy wash acres for the Conley allotment are included in the creosote bush-bursage vegetation community acreage and not included in the total acres to avoid acreage duplication

The failure of 21,539 acres (24.7 percent) of the SDNM to meet Standard 3, is due to a small difference in canopy cover or composition from the reference state. These are important criteria for recruitment in saguaro forests and recovery in both these communities. Failure to achieve Standard 3 is likely due to plant mortality associated with recent periods of drought (in particular the 2002 drought) and local site characteristics.

The results of the PBI saguaro study indicate that recruitment of saguaros is occurring within the grazed portion of SDNM north of I-8 at appropriate rates for this community.

Based on the results summarized in **Table E-6**, Average Number of Perennial Species Per Plot (Diversity), species diversity within the palo verde-mixed cacti and saguaro cactus forest vegetation communities within the SDNM north of I-8 is not reduced from what is found in the BGR and Area A.

Scientific Analysis of Plant Species & Climates in Past Eras

Packrat middens: Current livestock grazing is compatible with the Scientific Analysis of Plant Species and Climates biological object. Use-pattern mapping indicates that livestock do not utilize areas with dry caves or rock shelters where ancient packrat middens, used for ancient climate studies, occur due to steep, rocky and rough terrain. Other indicators of scientific analysis of plant species, identified in **Table E-7**, Results of the Land Health Evaluation (LHE Objectives by Monument Object), occur south of I-8.

Creosote Bush-Bursage and Wildlife Within This Community

Elf Owl, Western Screech Owl, Mule Deer, Mountain Lion, Gray Fox, Bobcat, California Leaf-Nosed Bat, Cave Myotis Bat: Analysis of the 151,643 acres of creosote bush-bursage vegetation community in the SDNM indicates that Standard 3 is being achieved on 45,633 acres (see **Table E-9**, Land Health Standard Status & Determination by Vegetation Community. The acreage where Standard 3 is not being met (106,010) is mostly attributable to drought and subsequent plant mortality (98,030 acres). Utilization data indicate that grazing is contributing to the failure to achieve Standard 3 on 7,980 acres of the SDNM. The BLM has determined that current livestock-grazing practices are not compatible with the protection of the creosote-bursage vegetation community on 2,974 acres of the Big Horn allotment and 5,006 acres of the Conley allotment within the SDNM.

Desert Washes and Wildlife Within This Community

Elf Owl, Western Screech Owl, Mule Deer, Mountain Lion, Gray Fox, Bobcat, California Leaf-Nosed Bat, Cave Myotis Bat: Desert washes are particularly important and provide habitat for numerous wildlife species. There are 490.5 miles (approximately 1,717 acres) of desert washes within the SDNM. Of these, 294 miles (1,029 acres) (see **Table E-9**, Land Health Standard Status & Determination by Vegetation Community) are not achieving Standard 3 due to differences in vegetation canopy or composition from the reference state. Utilization data indicate that grazing management practices or levels of use are contributing to non-achievement on 12 miles (42 acres) of desert wash. Ten of these miles are on the Conley allotment and two on the Lower Vekol allotment. The BLM has determined that current livestock-grazing practices are not compatible with protection of 10 miles (35 acres) of desert washes on the Conley allotment and 2 miles (7 acres) of the Lower Vekol allotment within the SDNM.

Where livestock grazing was determined to be a significant causal factor for non-achievement of land health standards, it was determined that livestock grazing is not compatible with the protection of the Monument objects. Current livestock grazing was determined to be a significant causal factor for non-achievement of standards in areas where unacceptable patterns of livestock use (greater than 40 percent utilization levels) occurred. In addition to identifying livestock-related effects on the SDNM's biological objects, this compatibility study also evaluated livestock-related effects on archaeological and historic objects, as identified in the Monument proclamation. A class I literature search was completed in 2010 for the LHE, as per BLM manual section 8110.2.A.2. This review identified previous surveys and known archeological sites or traditional cultural places within the allotment boundaries. The results on the archaeological/historical evaluation are identified in **Table E-10**, Results of the Cultural Evaluation by Monument Object.

Table E-10
Results of the Cultural Evaluation by Monument Object

Indicator	Evaluation Results
Monument Object: Archaeological and Historic Sites	
Rock art sites	Three rock art sites are known to exist on the grazing allotments within the SDNM north of I-8. These sites are all in rocky, upland settings and are not situated in areas of concentrated livestock use. These sites do not exhibit evidence of damage from livestock, livestock-management activities, or range improvements, because the petroglyphs and associated artifacts are on large, boulder-strewn hillsides and knolls that it would be extremely unlikely for livestock to access.
Lithic quarries	All sites identified in existing information are located south of I-8 and are no longer subject to grazing activities.
Scattered artifacts	A total of 22 of the 41 sites located north of I–8 on the SDNM are listed as artifact scatters. Of these 22 artifact scatters, 19 sites have characteristics that would make them eligible for the National Register of Historic Places (NRHP). None of these known artifact scatters are located within areas of concentrated livestock use. Of the 19 artifact scatters that have the characteristics that would make them eligible for the NRHP, five sites have been documented by the recording archaeologist as having been affected by grazing. On three of these sites, the documentation merely mentions grazing generally as an effect, usually among other effects, with no further information tied to indicators of disturbance to that site. There is no documentation as to whether any artifacts or features had been disturbed by grazing. Two sites were documented with specific indicators of the type and level of disturbance. One site was documented as having "moderate trampling and denudation of vegetation." This was cited as a factor that leads to gradual erosion. However, the photographs of the site in this documentation do not show that this is the case. The photograph shows Sonoran Desert vegetation with typical densities. This photo shows that the ground surface is stable and is not subject to erosion. The other site was documented as being disturbed because of "three well-defined livestock trails that cut across a potential ancient trail near the northwest end of the site, and general grazing impacts and gradual erosion." The line of sight can follow the line of travel and the profile of the probable prehistoric trail in several places. Artifacts and features have not been disturbed by the livestock trails. The livestock trails are distinct and visible in this area due to their distance to a water development (Bosque Well). This well is roughly 0.75 mile away from the site. Livestock trails have disturbed roughly 0.4 percent of the ground surface of this site.
Vekol Wash	Located south of I-8.
Table Top Mountain bajadas	Located south of I-8.

Table E-10
Results of the Cultural Evaluation by Monument Object

Indicator	Evaluation Results
Juan Bautista de Anza NHT	While no visible physical remnants remain of this historic trail, later trails utilized the same corridor used by Anza. The historic trail corridor, as identified by the National Park Service, varies in width depending on the information found in the diaries. The historic setting of this trail is an area 3 miles wide, or up to the visual horizon, whichever is less. The livestock water developments in the area –Gap Tank, Conley Tank, North Tank, and North Tank Well – all lie within this historic setting. The line of sight for a trail user is undisturbed as one can see where the trail corridor continues ahead. This trail is 1,200 miles long – from the border with modern Mexico to the San Francisco Bay area – with roughly 17 miles within the SDNM. Of the four water developments on the SDNM where livestock usage is concentrated, the area at North Tank is the only one where effects from grazing activities disturbs the setting. The area where livestock use has reduced the vegetation is about 10 acres in size, amounting to 1,300 linear feet of the trail corridor. The Anza NHT story involves driving 1,000 head of livestock and 300 people mounted on horseback along this trail when it was originally used. Thus, livestock may be viewed as compatible with authentic Anza NHT setting.
Mormon Battalion Trail	The Mormon Battalion Trail is an historic route with well documented physical features and attributes. It has the characteristics that would make it eligible for the NRHP. This trail experiences direct disturbance from the congregation of livestock at North Tank. The area of direct impact amounts to about 800 linear feet of trail signature from trampling the trail ruts, berms, and vegetation that grows along the berms. The Mormon Battalion Trail is about 1,850 miles long, 17 miles of which are within the SDNM boundaries. The area at North Tank where direct effects from grazing activities disturbs the setting is about 10 acres in size.

E.1.9 STEP 4: ANALYSIS OF THE EFFECTS OF LIVESTOCK GRAZING ON ARCHAEOLOGICAL & HISTORIC OBJECTS

E.1.9.1 Indicators to Evaluate the Condition of Monument Cultural Objects

Based on the above discussion, indicators of grazing-related damage could include the following:

- Breakage or displacement of artifacts or features that is clearly associated with livestock-grazing use.
- Evidence of trampling that has disturbed archaeological deposits or accelerated processes of erosion at archaeological sites.
- Trampling, loss of vegetation, defecation, or other observable effects that impair qualities of setting, feeling, and other aspects of integrity.

E.1.9.2 Summary of Grazing Effects on Cultural Monument Objects

The rock art sites are all situated in rough, rocky areas it is extremely unlikely for livestock to access. None of the rock art (petroglyph) site information suggests any disturbance from livestock. Lithic quarries sites are situated south of I-8 and are not subject to grazing activities.

The artifact scatter sites are a very common site type in this region. A close look at the documentation shows that only one site out of 22 artifact scatters shows physical disturbance due to grazing activities. The amount of disturbance to the site is calculated to be approximately 0.4 percent of the surface area of this one site.

The Juan Bautista de Anza NHT setting is being affected by historically concentrated use around one livestock water source. The nature of this disturbance is trampling of the local vegetation. When one considers the length of the Anza Trail (1,200 miles long, 17 miles of which is located within the SDNM boundaries) and the area of direct impact of 10 acres, amounting to about 1,300 linear feet of trail corridor, this disturbance area is at a very small scale. Driving livestock and people along this trail historically is the action that blazed the original trail. In historic and recent times, vegetation was not permanently removed from this area. The diminishment of the volume of vegetation in one small area along the trail corridor does not affect the characteristics that make this trail important in history.

In terms of the Butterfield Overland Stage Route and the Mormon Battalion Trails, they share the same 17 miles of physical trail tread in the SDNM. Therefore, they both have experienced historic disturbances from the congregation of livestock at North Tank. The area of direct disturbance amounts to a loss of about 800 linear feet of trail signature due to livestock trampling of the historic trailruts, berms, and vegetation that grows along the berms. The area at North Tank where direct disturbance from grazing activities diminishes the setting is about 10 acres in size [Note: in total acreage calculations, these acres are included in the creosote bush-bursage figures to avoid duplications]. Trail users can see the trail continue beyond this open area. The diminishment of the volume of vegetation in one small area along the trail corridor does not affect the characteristics that make this trail important in history. The essential characteristics that make these two trails important in history are still present and visible.

E.1.10 STEP 5: COMPATIBILITY ANALYSIS FINDINGS AND DETERMINATION

The Proclamation for the Sonoran Desert National Monument requires that BLM determine the compatibility of grazing "with the paramount purpose of protecting objects identified in this proclamation." The results of this determination will be used in the Lower Sonoran and Sonoran Desert National Monument Resource Management Plan to inform a range of alternatives with respect to livestock grazing.

Methodologies employed in the compatibility analysis included a rigorous land health evaluation process, a thorough literature review, technical reports and guidance, and a comprehensive evaluation of the effects of grazing on Monument objects and their indicators within the SDNM. This analysis has been a complex undertaking due to the inherent challenges of balancing human use and the needs of interrelated desert ecosystems.

E.1.10.1 Findings

In some locations, current conditions on the six allotments within the SDNM are not achieving Standard 3 (See **Map E-2**). Monument lands not achieving Standard 3 total 127,550 acres, representing 50.5 percent of all Monument lands north of I-8. Livestock use pattern mapping and monitoring data indicate that non-achievement of Standard 3 cannot be attributed to current livestock-grazing practices on 96.6 percent of Monument lands located north of I-8. There may be several contributing factors to non-achievement of Standard 3 aside from livestock grazing.

The results of the analysis indicate that livestock grazing is a causal factor for non-achievement of Standard 3 on 8,498 acres (**Map E-2**). This represents 3.4 percent of the 252,500 acres of the Monument north of I-8, and 6.76 percent of the 127,550 acres not achieving Standard 3.

Areas where livestock grazing was determined to be the causal factor for not achieving Standard 3 include portions of the following Monument objects or indicators: palo verde-mixed cacti (1 percent of plant community), the saguaro cactus forest (1 percent of plant community), creosote bush-bursage (5 percent of plant community) or desert wash (2 percent, or 12 miles of the plant community) and its associated wildlife objects (identified in Table E-7, Results of the Land Health Evaluation [LHE Objectives by Monument Object]) and a small portion (1.4 percent, or 10-acres) of the Anza NHT.

Currently, the grazing preference for perennial forage is not supported by monitoring and inventory data. Field observations and use compliance checks indicate that operators graze the majority of their permitted AUMs during the early winter and spring months, which are periods of high levels of ephemeral forage.

Concentrated livestock use around North Tank (10 acres) is not consistent with past use during historic time periods, and it negatively affects the protection of the archaeological and historic site within the SDNM. Elsewhere, known rock art sites in the SDNM are not near areas of grazing concentration and have not been impacted by grazing. Artifact scatters have not yielded any definitive evidence of grazing impacts that would affect site setting or integrity.

E.1.10.2 Determination

A limited amount of livestock grazing is compatible with the protection of Monument objects, based on the draft SDNM LHE and this draft compatibility analysis. The evaluation, literature review and professional opinions of BLM staff identify presently undesirable interactions between current livestock-grazing practices and individual Monument objects, as well as the underlying biological/ecological processes.

Livestock-grazing practices negatively affect 3.4 percent (8,498 acres) of the Monument north of I-8. Current livestock grazing is determined to be incompatible on 3.4 percent of the Monument. Recommended livestock-grazing adjustments and technical recommendations presented in the draft SDNM LHE ensure that 49.5 percent of Monument north of I-8 will continue to meet Standard 3. Future permitted use should be changed to ensure the Monument objects are managed properly. To ensure that future management practices remain compatible with the Monument objects, perennial permitted use should be reduced.

Management Recommendations from the LHE (**Section F.16**) proposed level-of-use adjustments to primarily fall-winter-spring with reduced use levels during the summer months as follows: 65 percent of permitted use would occur from Oct. 1 to April 30 and 35 percent of permitted use from May 1 to Sept. 30. This would reduce potential competition with special status wildlife and other wildlife species during the critical summer months. Occasional ephemeral grazing does not appear to influence achievement of Land Health Standards, and thus should be considered to continue where applicable, in accordance with the Special Ephemeral Rule and the Arizona Guidelines for Grazing Administration (see **Appendix L**, Guidelines for Grazing Administration).

Current livestock grazing at one 10-acre site around North Tank along the Anza NHT and the Butterfield Overland Stage Route is not compatible with protecting these archaeological and historic Monument objects [Note: this acreage figure is included in the creosote bush-bursage biological objects calculations to avoid duplication]. Overall, however, this compatibility analysis finds that livestock-grazing activities on the SDNM are compatible with the paramount purpose of protecting archaeological and historic objects identified in the Monument proclamation.

E.1.10.3 Manager Recommendation

The foregoing compatibility analysis and determination considers the SDNM's place in the NLCS, the unique character of the Sonoran Desert, as well as the historic role and current practices of livestock grazing management in the area. This analysis concludes that current livestock-grazing practices negatively affect 3.4% (8,498 acres) of the Monument north of I-8 and grazing is therefore incompatible with protection of monument objects in that area. This 8,498 acre figure includes the one 10-acre site determined to not be compatible with protecting archeological and historic monument objects. In accordance with the proclamation's direction, those areas will be unavailable for livestock grazing. With that limited exception, I find that modified and limited livestock-grazing authorizations on the public lands of the SDNM north of I-8 is compatible with the paramount purpose of protecting the objects the objects identified in Presidential Proclamation 7397 and for which the SDNM was designated.

_____ _____

Manager, Lower Sonoran Field Office Date

E.2 REFERENCES

Abouhaidar, F. 1992. Influence of livestock grazing on saguaro seedling establishment, pp. 57-61, in: Proceedings of the Symposium on Research in Saguaro National Monument. 23-24 January 1991 Tucson, Arizona. National Park Service, Rincon Institute and Southwest Parks and Monuments Association.

Andrew, M. H. 1988. Grazing impact in relation to livestock watering points. Trends in Ecology and Evolution 3(12):336-339.

Bahre, C. J. 1991. A legacy of change: historic human impact on vegetation of the Arizona borderlands. The University of Arizona Press, Tucson. pp. 231.

Blydenstein, J. C., R. Hungerford, G. I. Day, and R. R. Humphrey. 1957. Effect of domestic livestock exclusion on vegetation in the Sonoran Desert. Ecology 38(3):522-526.

Bowers, J. E., and R. M. Turner. 2002. The influence of climatic variability on local population dynamics of Cercidium microphyllum (foothill palo verde). Oecologia 130:105-113.

Brown, P. E., and C. L. Stone. 1982. Granite Reef: A study in desert archaeology. Anthropological Research Papers No. 28, Arizona State University, Tempe.

Cooke, R. U., and R. W. Reeves. 1976. Arroyos and environmental change in the American South-west. Clarendon Press, Oxford.

Dodd, N. L., and W. W. Brady. 1986. Cattle grazing influences on vegetation of a sympatric desert big horn range in Arizona. Desert Big horn Council Transactions 30:8-13.

Fagerstone, K. A., and C. A. Ramey. 1996. Rodents and lagomorphs, pp. 83-132 in: Rangeland Wildlife, Paul R. Krausman, ed. The Society for Range Management, Denver, Colorado.

Goldberg, D. E., and R. M. Turner. 1986. Vegetation change and plant demography in permanent plots in the Sonoran Desert. Ecology 67(3):695-712.

Hall, J. A., S. Weinstein, and C. L. McIntyre. 2005. The impacts of livestock grazing in the Sonoran Desert: a literature review and synthesis for the Bureau of Land Management, Phoenix District Office. The Nature Conservancy in Arizona, Tucson.

Holden, M., P. Anning, and M. Weesner. 2000. 10-year re-survey of saguaro cactus (Carnegia gigantea) populations at Saguaro NP. Lay Report to Southwest Parks and Monuments Association, SPMA Project 00-08.

Holechek, J. L., R. D. Pieper, and C. H. Herbel. 1998. Range management: principles and practices. 3rded. Prentice Hall. Upper Saddle River, NJ.

Holechek, J. L., M. Thomas, F. Molinar, and D. Galt. 1999. Stocking desert rangelands: what we've learned. Rangelands 21(6):8-12.

Holechek, J. L., and D. Galt. 2000. Grazing intensity guidelines. Rangelands 22(3):11-14.

Holechek, J. L., T. T. "Red" Baker, and J C. Boren. 2005. Impacts of controlled grazing versus grazing exclusion on rangeland ecosystems: what we have learned. Range Improvement Task Force Report No. 57. Agricultural Experiment Station, Cooperative Extension Service, College of Agriculture and Home Economics, New Mexico State University, Las Cruces, NM.

Hovorka, M. D. 1996. The impacts of livestock grazing on Sonoran desert scrub vegetation, insect, and insectivorous bat communities. M.S. Thesis, Graduate Programme in Biology, York University, North York, Ontario.

Interagency Technical Team. 1996a (revised 1997, 1999). Sampling vegetation attributes. Interagency Technical Reference 1734-4. Cooperative Extension Service; US Department of Agriculture, Forest Service; US Department of Agriculture, Natural Resources Conservation Service, Grazing Land Technology Institute; US Department of the Interior, Bureau of Land Management. 172p.

Interagency Technical Team. 1996b (revised 1997, 1999). Utilization studies and residual measurements. Interagency Technical Reference 1734-3. Cooperative Extension Service; US Department of Agriculture, Forest Service; US Department of Agriculture, Natural Resources Conservation Service, Grazing Land Technology Institute; US Department of the Interior, Bureau of Land Management. 176p.

Jones, K. B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. The Southwestern Naturalist 26(2):107-115.

Krausman, P. R., R. Valdez, and J. A. Bissonette. 1996. Big horn sheep and livestock, pp. 237-243, in: Rangeland wildlife. Paul R. Krausman, ed. The Society for Range Management, Denver, Colorado.

Little, B., E. M. Seibert, J. Townsend, J. H. Sprinkle Jr., and J. Knoerl. 2000. National Register Bulletin: Guidelines for evaluating and registering archaeological properties. US Dept. of the Interior, National Park Service, Washington, D.C.

Martin, S. C., and R. M. Turner. 1977. Vegetation change in the Sonoran Desert region, Arizona and Sonora. Journal of the Arizona Academy of Science 12:59-69.

Milchunas, D. G. 2006. Responses of plant communities to grazing in the southwestern United States. US Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-169.

Niering, W. A, R. H. Whittaker, and C. H. Lowe. 1963. The saguaro: a population in relation to environment. Science 142(3588):15-23.

Osborn, A. J., and R. J. Hartley. 1991. Adverse effects of domestic livestock grazing on the archaeological resources of Capitol Reef National Park, Utah, p.136-153 in: Proceedings of the first biennial conference of research in Colorado Plateau National Parks. US Geological Survey, Washington, D.C.

Osborn, A. J., S. Vetter, R. J. Hartley, L. Walsh, and J. Brown. 1987. Impacts of domestic livestock grazing on archaeological resources of Capitol Reef National Park, Utah. Occasional Studies in Anthropology No. 20. US Dept. of the Interior, National Park Service, Midwest Archaeological Center.

Pellant, M., P. Shaver, D. A. Pyke, and J. E. Herrick. 2000. Interpreting indicators of rangeland health-version 3. Technical Reference 1734-6. US Department of the Interior, Bureau of EIS1079 Land Management; US Department of the Interior, US Geological Survey; US Department of Agriculture, Natural Resources Conservation Service; US Department of Agriculture, Agricultural Research Service. 130p.

Robinett, D. 1992. Drought and recovery in the upper Sonoran Desert. Rangelands 14(4):219-222.

Robinett, D. G. 1997. Rangeland, p. 97-100, in: Soil survey of Gila Bend-Ajoarea, Arizona, parts of Maricopa and Pima Counties. US Department of Agriculture, Natural Resources Conservation Service.

Roney, J. 1977. Livestock and lithics: the effects of trampling. Unpublished manuscript on file, US Department of the Interior, Bureau of Land Management, Phoenix District.

Roundy, B. A., and G. B. Ruyle. 1989. Effects of herb ivory on twig dynamics of a Sonoran Desert shrub, Simmondsia chinensis (Link) Schn. The Journal of Applied Ecology 26(2):701-710.

Shreve, F. 1929. Changes in desert vegetation. Ecology 10(4):364-373.

Shreve, F., and A. L. Hinckley. 1937. Thirty years of change in desert vegetation. Ecology 18(4):463-478.

Smith, L., G. Ruyle, J. Maynard, S. Barker, W. Meyer, D. Stewart, B. Coulloudon, S. Williams, and J. Dyess. 2007. Principles of obtaining and interpreting utilization data on rangelands. The University of Arizona, College of Agriculture and Life Sciences, Arizona Cooperative Extension, AZ1375,14p.

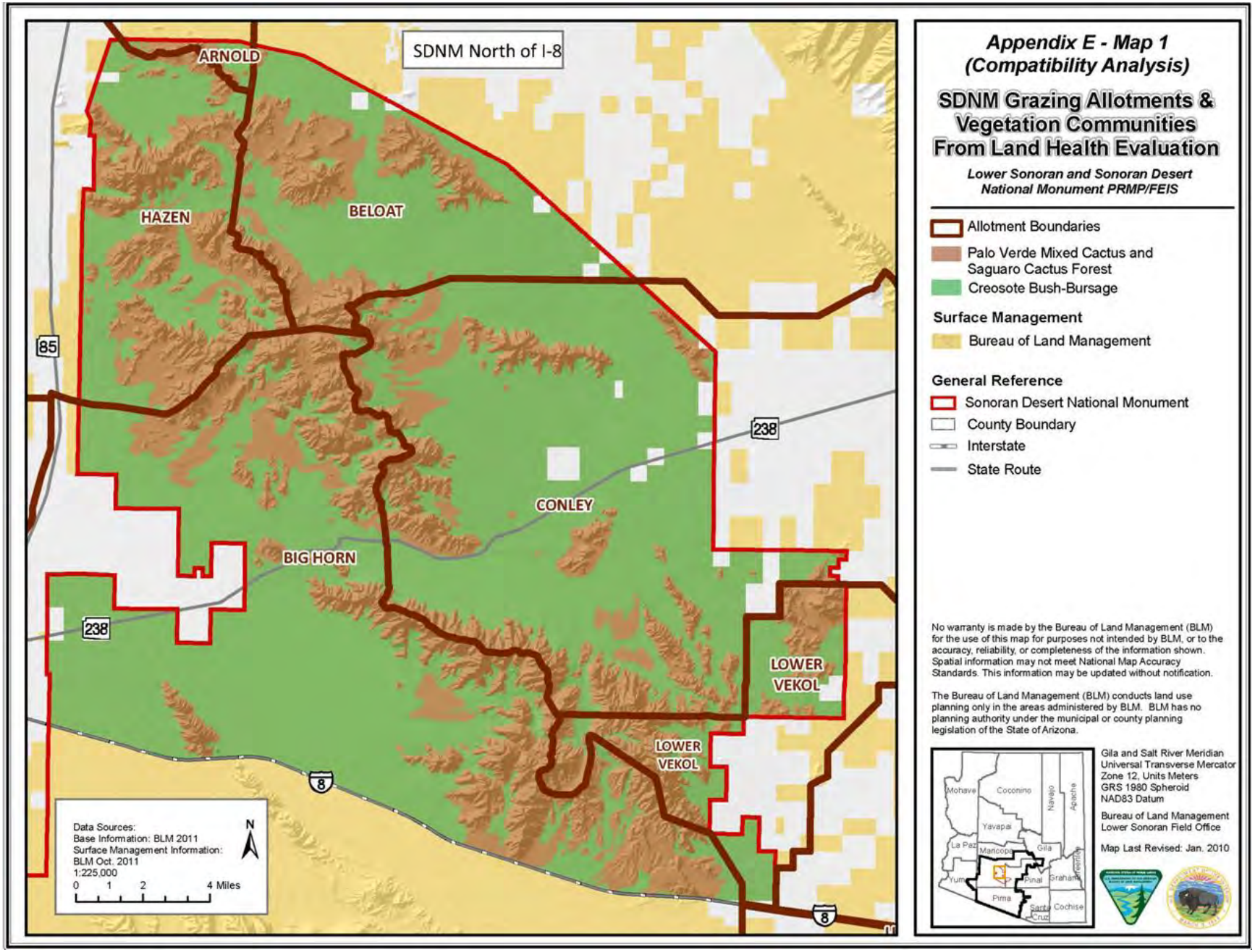
Steenbergh, W. F., and C. H. Lowe. 1977. Ecology of the saguaro: II. reproduction, germination, establishment, growth, and survival of the young plant. US Department of the Interior, National Park Service, Scientific Monograph Series, Number 8. Turner, R.M. 1990. Long-term vegetation change at a fully protected Sonoran Desert site. Ecology 71(2):464-477.

Turner, R. M., S. M. Alcorn, G. Olin, and J. A. Booth. 1966. The Influence of shade, soil, and water on saguaro seedling establishment. Botanical Gazette 127(2/3):95-102.

University of Arizona. 1982. Big Horn Allotment cattle diet study.

Van Vuren, D. 1982. Effects of feral sheep on the spatial distribution of artifacts on Santa Cruz Island. Bulletin of the Southern California Academy of Science 81(3):148-151.

Waser, N. M., and M. V. Price. 1981. Effects of grazing on diversity of annual plants in the Sonoran Desert. Oecologia 50:407-411.


SDNM North of I-8
ARNOLD
HAZEN
BELOAT
CONLEY
BIG HORN
LOWER VEKOL
LOWER VEKOL
85
238
238
8
8
Data Sources:
Base Information: BLM 2011
Surface Management Information:
BLM Oct. 2011
1:225,000
0 1 2 4 Miles
N
Appendix E - Map 1
(Compatibility Analysis)
SDNM Grazing Allotments & Vegetation Communities From Land Health Evaluation
Lower Sonoran and Sonoran Desert National Monument PRMP/FEIS
Allotment Boundaries
Palo Verde Mixed Cactus and Saguaro Cactus Forest
Creosote Bush-Bursage
Surface Management
Bureau of Land Management
General Reference
Sonoran Desert National Monument
County Boundary
Interstate
State Route
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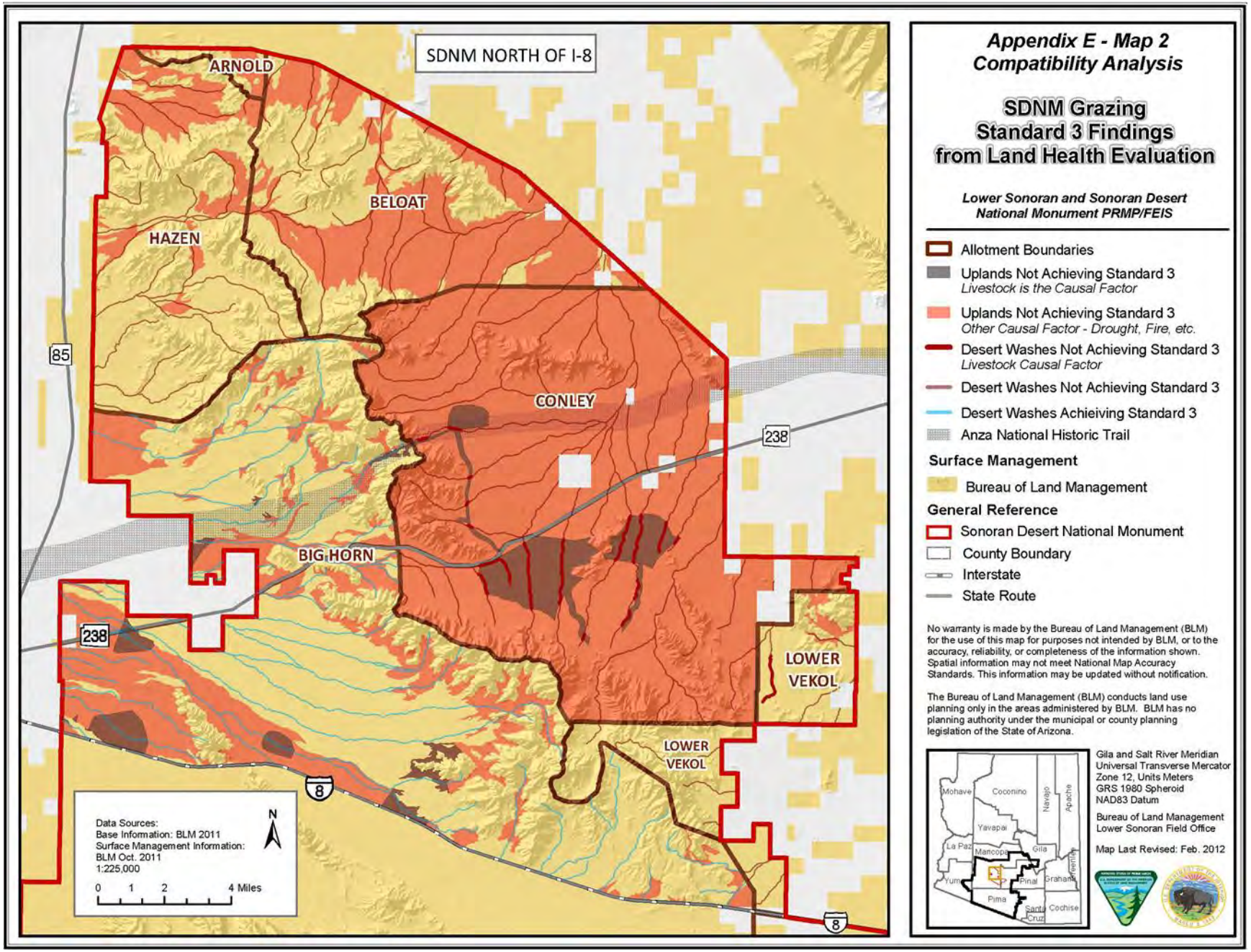
Navajo
Apache
Yavapai
La Paz
Maricopa
Gila
Greenlee
Yuma
Pinal
Graham
Pima
Santa Cruz
Cochise
Gila and Salt River Meridian
Universal Transverse Mercator
Zone 12, Units Meters
GRS 1980 Spheroid
NAD83 Datum
Bureau of Land Management
Lower Sonoran Field Office
Map Last Revised: Jan. 2010


SDNM NORTH OF I-8
ARNOLD
BELOAT
HAZEN
CONLEY
BIG HORN
LOWER VEKOL
LOWER VEKOL
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Data Sources:
Base Information: BLM 2011
Surface Management Information: BLM Oct. 2011
1:225,000
0 1 2 4 Miles
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Appendix E - Map 2
Compatibility Analysis
SDNM Grazing Standard 3 Findings from Land Health Evaluation
Lower Sonoran and Sonoran Desert National Monument PRMP/FEIS
Allotment Boundaries
Uplands Not Achieving Standard 3
Livestock is the Causal Factor
Uplands Not Achieving Standard 3
Other Causal Factor - Drought, Fire, etc.
Desert Washes Not Achieving Standard 3
Livestock Causal Factor
Desert Washes Not Achieving Standard 3
Desert Washes Achieiving Standard 3
Anza National Historic Trail
Surface Management
Bureau of Land Management
General Reference
Sonoran Desert National Monument
County Boundary
Interstate
State Route
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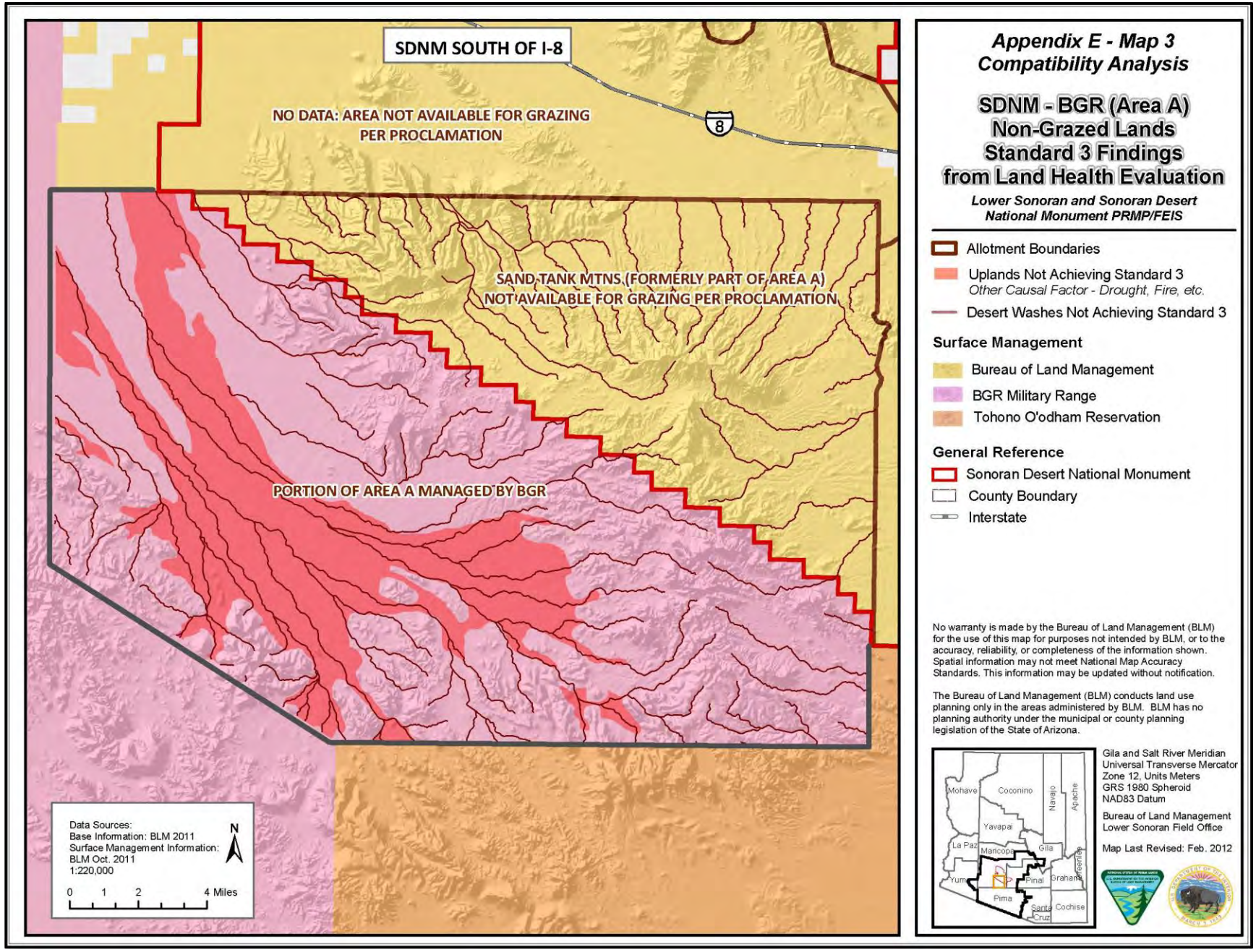
Map Last Revised: Feb. 2012


SDNM SOUTH OF I-8
NO DATA: AREA NOT AVAILABLE FOR GRAZING PER PROCLAMATION
8
SAND TANK MTNS (FORMERLY PART OF AREA A) NOT AVAILABLE FOR GRAZING PER PROCLAMATION
PORTION OF AREA A MANAGED BY BGR
Data Sources:
Base Information: BLM 2011
Surface Management Information: BLM Oct. 2011
1:220,000
N
0 1 2 4 Miles
Appendix E - Map 3
Compatibility Analysis
SDNM - BGR (Area A)
Non-Grazed Lands
Standard 3 Findings
from Land Health Evaluation
Lower Sonoran and Sonoran Desert National Monument PRMP/FEIS
Allotment Boundaries
Uplands Not Achieving Standard 3
Other Causal Factor - Drought, Fire, etc.
Desert Washes Not Achieving Standard 3
Surface Management
Bureau of Land Management
BGR Military Range
Tohono O'odham Reservation
General Reference
Sonoran Desert National Monument
County Boundary
Interstate
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Gila and Salt River Meridian
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Zone 12, Units Meters
GRS 1980 Spheroid
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Bureau of Land Management
Lower Sonoran Field Office
Map Last Revised: Feb. 2012