Mesa Verde Cactus
Sclerocactus mesae-verdae

5-Year Review
Summary and Evaluation

Photo: Robert Sivinski

U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
Albuquerque, New Mexico

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5-YEAR REVIEW
Sclerocactus mesae-verdae (Mesa Verde cactus)

1.0 GENERAL INFORMATION

1.1 Reviewers

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1.2 Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act, as amended (Act)(16 U.S.C.1531 *et seq.*). We provided notice of this status review via the Federal Register (70 FR 5460) which requested information on the status of *Sclerocactus mesae-verdae* (Mesa Verde cactus). This review was a collaborative effort comprised of biologists from the Service's Region 2 Regional Office; New Mexico Ecological Services Field Office; Service's Region 6 Western Colorado Field Office; New Mexico Energy, Minerals, and Natural Resources Department; University of New Mexico, Biology Department; Colorado State Forestry Division, Colorado State Parks, Colorado Natural Areas Program; Navajo Nation Department of Fish and Wildlife, Navajo Natural Heritage Program; Ute Mountain Ute Tribe; and Bureau of Land Management, Farmington Field Office. Robert Sivinski, Botanist for New Mexico State Forestry Division, was contracted through a section 6 grant to gather the relevant information and prepare a draft of the review. The final review and recommended classification was prepared by the New Mexico Ecological Services Field Office.

1.3 Background

The purpose of this 5-year review is to ensure that *Sclerocactus mesae-verdae* has the appropriate level of protection under the Act. The review documents a determination by the Service whether the status of the species has changed since the time of its listing. The review also provides updated information on the current threats, ongoing conservation efforts, and the priority needs for future conservation actions.

1.3.1 FR Notice Citation Announcing Initiation of This Review:

70 FR 5460; February 2, 2005

1.3.2 Listing History

Original Listing
FR Notice: 44 FR 62471
Date listed: October 30, 1979
Entity listed: Species, *Sclerocactus mesae-verdae*
Classification: Threatened, without critical habitat

1.3.3 Associated Rulemakings: None

1.3.4 Review History:

A 5-year review was initiated on November 6, 1991 (56 FR 56882) for all species listed before 1991, but no document was prepared for this species.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 8C

The recovery priority number of 8C indicates a moderate degree of threat, a high recovery potential, the listed entity is a species, and the species' recovery conflicts with construction or other development projects or other forms of economic activity.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Mesa Verde Cactus (*Sclerocactus mesae-verdae*) Recovery Plan
Date issued: March 30, 1984
Dates of previous revisions: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy:

The Distinct Population Segment policy does not apply to *Sclerocactus mesae-verdae* because it is not a vertebrate animal.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes.

Although there is a final recovery plan, it does not reflect the most up-to-date information on the species' biology, nor does it address all five listing factors that are relevant to the species. When the recovery plan was finalized in 1984, limited data made it difficult to quantify habitat requirements with enough precision to establish detailed and measureable recovery criteria. A Recovery Plan with updated, measurable, and objective criteria is needed.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No.

The recovery plan contains one main objective which is to remove *Sclerocactus mesae-verdae* from the Federal list of endangered and threatened species. The benchmark provided is to secure the five presently known populations which were believed to be self-sustaining at the time the recovery plan was written. The goals of the existing recovery plan are to: (1) protect existing populations from present and future human threats; and (2) ensure the maintenance of vigorous, self-sustaining populations in the species' natural habitat (Service 1984).
The two recovery criteria in the recovery plan are to:

(1) establish at least two restricted use areas for selected portions of *S. mesae-verdae* habitat on the Navajo Indian Reservation and on Bureau of Land Management (BLM) administered lands, and
(2) provide *S. mesae-verdae* stock to trade outlets to help relieve the black market demand through the addition of 10,000 plants per year to commercial nurseries for 5 years.

Major actions listed in the recovery plan include species monitoring, management, and protection of the five known populations; establishment of at least two (additional) areas of restricted use; surveys of all potential species' habitat; development of a commercial artificial propagation program; and research into the distribution, population biology, and ecology of this species.

The first criterion has been partially met by the designation of one Area of Critical Environmental Concern (ACEC) within BLM lands containing a population of *S. mesae-verdae.* This ACEC was formally established in 2003 through the Resource Management Plan and covers 3,812 ha (9,480 ac). The main objective of this special management area is to protect the habitat for threatened, endangered, proposed, or other sensitive plant species. Although the cactus occurs within this ACEC, recreational uses, travel on authorized roads by off-highway vehicles (OHVs) and other vehicles, livestock grazing, and oil and gas

activities continue to be permitted and are considered allowable uses (Bureau of Land Management 2003a and b).

On Navajo Nation lands, Conservation Areas (CAs) were officially designated to protect *S. mesae-verdae* and potential habitat including Malpais, Many Devils Wash, Rattlesnake, and Monument Rocks Conservation Areas (Roth 2008, pers. comm.). Biological Resource Land Use Clearance Policies and Procedures (RCPs) were signed in September 2008 that provided the guidance for CAs (http://www.nndfw.org/clup.htm). Broad management prescriptions in place for these conservation areas include the activities listed below.

(1) Manage existing oil and gas leases.
(2) Closed to new oil and gas leasing.
(3) Closed to homesite leases.
(4) Closed to infrastructure development.
(5) Closed to all other forms of mineral entry.
(6) Permit right-of-ways on a case-by-case basis with special management constraints and mitigations.
(7) Limit vehicle access to existing roads and trails.
(8) Apply limited fire suppression and weed management.
(9) Open to grazing permits.
(10) Monitor on a regular basis.

Oil and gas and split estate issues were not addressed in these policies, so many existing wells are located inside Monument Rocks Conservation Area.

Thus, despite the designation of the ACEC on BLM land and the CAs on Navajo Nation lands, their interpretation of restricted use may not be what was envisioned for meeting the first recovery criterion. *Sclerocactus mesae-verdae* growing within the ACEC and the CAs continue to be exposed to OHV traffic, livestock grazing, and energy and mineral development, which can and does negatively impact the species. Based on this progress, the first recovery criterion has not yet been fully met.

To accomplish a portion of the second recovery criterion, a cactus grower in Belen, New Mexico, was contacted in 2008 to attempt to cultivate *S. mesae-verdae* from seed. Germination was successful, however very specific soil, water, and temperature regimes are required for seedlings to progress beyond the seedling stage due to a fungal disease that causes seedlings to wilt and die. Conditions of low humidity are necessary to prevent stem rot, which occurs in up to 90 percent of cacti within the first year. While it is physically possible for the species to be germinated and grown in captivity, commercial production using current techniques will not reach 10,000 cacti as specified in the second recovery criterion.

At this time, the motive for the second criterion, to address black market demand for the cactus, may be no longer relevant to this species. There is no information currently available that clearly substantiates whether or not cacti are still being poached, and although there has been evidence of cactus removal over the past

two decades, the threat of collection does not seem to be predominant at this time. Nevertheless, the germination and propagation of *S. mesae-verdae* remain important areas of research to build the number of individuals in the population overall. The valuable information obtained from these captive propagation experiments will be applied toward the recovery of the cactus, even if for the more current goals of supplementing diminished populations, establishing cactus individuals in historical or suitable habitat, or mitigating for development projects in occupied cactus habitat. Thus, the second recovery criterion has not been met for this cactus, but the criterion is likely outdated and in need of revision.

Although these goals, recovery criteria, and major actions provide some guidance for recovery, they do not specifically address additional and more current threats, and the second criterion needs to be revised to reflect updated approaches of responding to current threats and recovering *S. mesae-verdae*. Captive propagation of the cactus may still be useful to the species' recovery, and can be redirected to provide stock for supplementation purposes more applicable to the cactus today (see 2.3.2.1). Though the original listing factors remain relevant to this species, atypical insect predation events and climate change (specifically severe drought) are recognized as additional threats to this species' recovery.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history

Sclerocactus mesae-verdae is a perennial desert plant that grows slowly and has a lifespan of approximately 20 years (Colorado Natural Areas Program 2005). It is distinguished within the *Sclerocactus* genus by an almost total lack of central spines (0 - 1), but also a sporadic occurrence of a single hooked central spine per areole (Heil and Porter 1994). Stems are mostly pale gray-green, 3.2 to 11 centimeters (cm) long (1.3 - 4.3 inches [in]), and 3.8 to 8 cm in diameter (1.5 - 3.1 in), with 13 to 17 ribs with spines from 6 to 13 mm (0.2 - 0.5 in) long, in clusters of 8 to 11 (Heil and Porter 1994). Flowers are 1 to 3 cm (0.4 - 1.2 in) wide and 1 to 3.5 cm (0.4 - 1.4 in) long with purple mid-stripes and golden to cream-colored margins on the outer tepals (Heil and Porter 1994). Flowers in the southern end of its range tend to have smaller, pinkish flowers (Cully et al. 1993). Fruits are green becoming tan at maturity, and seeds are dull black 2.5 to 3 millimeters (mm) (~0.1 in) long (Heil and Porter 1994). Average stem length for a mature plant is 9 cm (3.5 in) (Heil and Porter 1994).

This low growing, globe-shaped cactus is often single-stemmed with a branched taproot (Heil and Porter 1994). Multi-stemmed plants (vegetative reproduction or sprouting) also occur resulting from meristem damage triggered by insect or mammal herbivory, and by natural or human-caused disturbances (Cully et al. 1993; Colorado Natural Areas Program 2005). In years of normal precipitation,

average annual increase in stem diameter is 2.6 mm (0.1 in) with the largest stem diameter found to be 11.2 cm (4.4 in) (Colorado Natural Areas Program 2005). Stem diameter was positively correlated with number of buds, flowers, and fruits (Coles and Naumann 2003). Larger cacti of greater than 6 cm (2.4 in) averaged 27 flowers per plant (New Mexico State Forestry Division 2007).

Stems begin producing flowers when they are about 2 cm (0.8 in) in diameter or about 8 years old and begin to flower each year after reaching 4 cm (1.6 in) in diameter (New Mexico State Forestry Division 2007). Flowers are diurnal, bloom from late April into early May, and open daily for up to five days (Heil and Porter 1994). Flowers possess both male and female organs (hermaphroditic) indicating self-compatibility, yet Heil and Porter (1994) suggest that self-fertilization rarely is found in the genus *Sclerocactus.* Tepedino (1998) found that a single plant can self-fertilize (selfing) using pollen from another flower on the same plant (geitonogamy) and produce viable seed, but not pollen from the same flower (autogamy). However, 50 percent less seed is produced from self-compatible fertilization when compared to the pollen donor coming from a flower on a nearby plant (xenogamy or outcrossing) (Tepedino 1998).

Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Tepedino (1998) documented 22 insect visitors on this cactus with 18 species being native. Other common visitors included pleasing fungus beetles (*Tritoma sp.*) and blister beetles (*Epicauta sp.*), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993).

Cactus seeds often are quiescent or metabolically inactive in the mature, dry state to withstand extremes of drought and cold (Rojas-Arechiga and Vasquez-Yanes 2000). This dormancy ends once the environmental limitation (temperature, precipitation, or light) is removed (Rojas-Arechiga and Vasquez-Yanes 2000). Little is known about cactus seed longevity in the field, but Bowers (2005) found a persistent seed bank up to 6 years on Sonoran cacti under protective cages. Seeds ripen in late May to early June following scarification of the seed coat (Navajo Natural Heritage Program 2005; Brack 2008, pers. comm.). Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). Seed scarification often occurs after passing through avian or mammalian digestive tracts (Traveset et al. 2001), but the mechanism of scarification is presently unknown for this species.

Harvester ants (*Pogonomyrmex sp.*) and erosional processes (rain) are the most effective short-range seed dispersers; whereas, wind may be more important to long-range dispersal (Cully et al. 1993; Rojas-Arechiga and Vasquez-Yanes 2000). Seed predation is well known in desert areas with frugivores (fruit eaters)

being another type of important dispersal agent. Mainly rodents, but also birds, lizards, and some mammals prey on fruits and seeds (Rojas-Arechiga and Vasquez-Yanes 2000). No long-range dispersal was observed by rodents or birds for this species (Cully et al. 1993; Colorado Natural Areas Program 2005; Navajo Natural Heritage Program 2005). Seed dispersal distance and seed bank sampling found a total seed load around mature plants averaging 200 seeds within a 1 meter (m) (3.3 feet [ft]) radius with 80 percent of the seeds 0 - 3 cm (0 - 1 in) deep in the soil (Cully et al. 1993).

2.3.1.2 Abundance, population trends, demographic features, or demographic trends

The 1984 recovery plan estimated the rangewide population to be approximately 5,000 to 10,000 *S. mesae-verdae* within an estimated 120 x 48 kilometers (km) (75 x 30 miles [mi]) rectangular area (Sivinski 2000). We are uncertain of the accuracy or the methodology used to determine these earlier numbers, but additional cactus populations and locations were discovered on Navajo Nation lands after the plan was finalized in 1984 (Sivinski 2000). Distribution within this range is not continuous and is sporadic and widely scattered (Sivinski 2000). Density greatly varies within populations with as many as 20 cacti in 50 m^2 (538 ft^2) or as few as a single cactus located several hundred meters from any others (Sivinski 2000). The highest known concentration is a 40 km (25 mi) swath around Shiprock, New Mexico, which may be an artifact of numerous botanical surveys conducted due to increased development pressures (Sivinski 2000). Of the known populations of *S. mesae-verdae*, at least 80 percent of these occur on Navajo Nation lands, 15 percent on Ute Mountain Ute lands, and 5 percent on small blocks of BLM and New Mexico State lands (Sivinski 2000). There are no discoveries known on lands outside of these four landowners (Navajo Nation, Ute Mountain Ute, BLM, and State of New Mexico) at the time of this report, but not all habitat potentially suitable for *S. mesae-verdae* has been surveyed.

In addition to population size discrepancies and discontinuous distribution, delineation of individual cactus plants is difficult because branching is common above and below the soil surface (Cully et al. 1993). Measurements are generally taken on individual aboveground stems in the absence of a clear means of identifying individual plants (Coles and Naumann 2003). Surveying for this species is also difficult due to the cryptic nature of the plant. Seedlings less than eight years old are often overlooked because the cactus is similar to the soil color and often resides in soil fissures, making seedlings and juvenile (nonblooming) plants difficult to observe (Heil and Porter 1994; Navajo Natural Heritage Program 2004). Difficulty in identifying individual plants from year to year needs to be considered when evaluating short and long-term population trends for this species.

Sclerocactus mesae-verdae demography in terms of distinct recruitment and mortality events appears to occur at infrequent (greater than 10 year) intervals

(Colorado Natural Areas Program 2005). Recruitment events are defined as significant single year population increases (more than 25 percent greater than the long-term average) due to recruitment of new seedlings and sprouts into the population (Colorado Natural Areas Program 2005). These recruitment events are not temporally or spatially continuous and appear to be an episodic response to favorable precipitation (Cully et al. 1993; Colorado Natural Areas Program 2005; New Mexico State Forestry Division 2007). Starting in 2003, decreased recruitment and increased mortality were observed at all sites (Colorado Natural Areas Program 1986-2005; New Mexico State Forestry Division 2007; Navajo Natural Heritage Program 2004). Since 2003, germination and recruitment have been documented in some populations, but it has occurred at relatively low levels (Navajo Natural Heritage Program 2004; Colorado Natural Areas Program 2003-2005; New Mexico State Forestry Division 2003, 2007).

Known cactus populations appeared relatively stable from 1986 until the 2002-2003 growing season (Cully et al. 1993; Navajo Natural Heritage Program 2004; Colorado Natural Areas Program 2005; New Mexico State Forestry Division 2007). Starting in 2003, the recruitment and mortality observed was outside of the normal range of population fluctuations for all study areas (Colorado Natural Areas Program 2003-2005; New Mexico State Forestry Division 2003, 2007; Navajo Natural Heritage Program 2004). The 2002 growing season was drier than the years before and after, even though all years were part of a 10-year drought in the southwest region of the United States (Breshears et al. 2005; Live Science 2007). In Colorado, drought severity was even more evident when researchers noted a 70 percent reduction in cover of *Atriplex corrugata* which is considered to be a nurse plant for *S. mesae-verdae* (Colorado Natural Areas Program 2004). Lack of cactus recruitment and severe mortality were believed to be the result of a combination of severe drought and a higher-than-typical incidence of insect predation (Navajo Natural Heritage Program 2004; Colorado Natural Areas Program 2005; New Mexico State Forestry Division 2007). Additional small but consistent sources of mortality are desiccation of stems less than 1.0 cm (0.4 in) and mechanical damage by livestock trampling, burial by ground squirrels, and inadvertent crushing by researchers (Navajo Natural Heritage Program 2004; Colorado Natural Areas Program 2005; New Mexico State Forestry Division 2007).

In Colorado, three instances of an atypical population explosion of the native longhorn cactus beetle (*Moneilema semipunctatum*) occurred prior to the drought of 2002 and resulted in significant predation and loss of *S. mesae-verdae* (Coles and Naumann 2003). The longhorn cactus beetle is typically a specialist on cacti of the *Opuntia* genus, but may expand its range to other species when the beetle population overwhelms the available *Opuntia* cacti (Kass 2001; Smith 2001). However, in New Mexico, heavy mortality due to nonnative army cutworms (*Euxoa spp*.) was found on several BLM study plots in 2003 without any evidence of longhorn cactus beetles (Kendall and Wegener 2003). Army cutworms generally infect crops such as corn, and this outbreak may have been precipitated

by transport of corn cobs from the surrounding agricultural fields. Distinguishing between predation by the native longhorn cactus beetle and the nonnative army cutworm could provide additional insight into extreme mortality events versus natural cyclic population declines.

SPECIFIC STUDY AREA STATUS AND TRENDS

COLORADO - In Colorado, the cactus is found only on Ute Mountain Ute land.

Ute Mountain Ute: This population of *S. mesae-verdae* is located on Ute Mountain Ute tribal lands and was monitored annually by staff from the Colorado Natural Areas Program, Grand Junction, Colorado, from 1986 to 2005 with the exception of 1993 (Cully et al. 1993; Coles and Naumann 2003; Colorado Natural Areas Program 1986-2005). There were 3 permanent monitoring plots installed, 100 m x 200 m (4.9 acres [ac]) in a north-south line approximately 11.3 km (7 mi) long, with a grid of eight 50 m x 50 m (0.6 ac) subplots superimposed on each plot. Stem diameter, relative vigor, reproductive phenology, new recruitment, and mortality were recorded annually. The vegetative community was defined using line-intercepts on each plot.

In Colorado from 1986 to 2002, annual individual cacti recruitment grew substantially from 160 new plants in 1986 to a maximum of 360 in 2002 (Colorado Natural Areas Program 1986-2005). From 2002 to early 2004, there was virtually no seed production or new seedling establishment. Recruitment was stable or declining over the remaining years up to the end of the study where only 50 new seedlings established in 2005. These numbers reflect true recruitment into the population, not older stems found later during the study. The proportion of seedlings surviving from germination to the end of the study was 37 percent which is considered high. Survivorship among sprouts was 69 percent over the same period which was considered normal since sprouts have an established root system to draw upon. Average mortality rates varied from 5 to 10 percent in most years. Between 2002 and 2003, there was a 20 percent decline in the stem population, the largest observed since 1986. This decline was most likely due to the combination of severe drought and an atypical longhorn cactus beetle outbreak.

In 2005, a total of 687 living cacti was found which was a 3 percent increase over the 2004 total of 666 plants, and close to the average level of change in a normal year (Table 1). The late winter and early spring of 2004-2005 was above normal in precipitation which resulted in 355 of the 687 living stems producing 1,427 flowers or fruits (4 per stem) equaling the long-term average. Additionally, for the first time, the major cause of mortality (only 29 plants) was related to mechanical (horse and truck) damage, not longhorn cactus beetle kill.

Overall, there were four major instances of beetle-caused mortality in the Colorado plots: 1987-1988, 1993-1994, 1999-2000, and 2002-2004. Researchers

believe that this revealed a typical bust-boom cycle, thus the longhorn cactus beetle probably does not represent a new threat to the cactus. It was more likely the combination of the historic drought period from April 2001 through July 2003, which created conditions for increased animal and insect predation on this specific cactus.

Recovery from the 2003 population drop is apparent based on the final numbers reported from 2005 field surveys. Even though it is still below the peak number from 2000 of 701 plants, the population trend reveals an increase from 2003 to 2005 (Table 1). However, there is no information from 2006 to 2010 from the Ute Mountain Ute lands or the Colorado Natural Areas Program to verify a more long-term population recovery.

Table 1. *Sclerocactus mesae-verdae* data from 1986-2005 on Ute Mountain Ute lands surveyed by Colorado Natural Areas Program (1986-2005).

	Total # of Live Cacti	**Recruitment =** new seedlings established	**Mortality** = # of dead cacti
1986	160	-	-
1987	223	7	14
1988	313	76	33
1989	278	17	58
1990	278	13	21
1991	296	26	20
1992	314	24	14
1993-1994	405	131	80
1995	373	20	87
1996	378	18	25
1997	405	12	20
1998	542	85	27
1999	626	110	91
2000	701	369	-
2001	619	334	-
2002	622	30	28
2003	535	7	127
2004	666	7	40
2005	687	50	29
Averages	**443**	**74**	**45**

NEW MEXICO – In New Mexico, the cactus is found on lands administered by the State, the BLM, and the Navajo Nation, as described below.

State of New Mexico, Waterflow: This population of *S. mesae-verdae* is located on State of New Mexico lands just south of Waterflow, New Mexico. These plants were monitored annually for 10 years (1986-1995), then every 4 years until 2007 by staff from the New Mexico State Forestry Division (Ecosphere

Environmental Services 1985; Cully et al. 1993; New Mexico State Forestry Division 1999, 2003, 2007). One permanent monitoring plot, 100 m x 200 m (4.9 ac), was installed in 1986. Stem diameter, relative vigor, reproductive phenology, new recruitment, and mortality were recorded. Between 1986 and 1995, the mean number of plants counted in the monitoring plot was 107.

Cully et al. (1993) found substantial differences between cacti found on the New Mexico (Waterflow) site versus the Colorado (Ute Mountain Ute) site based on data from 1986 to 1992:

(1) New Mexico populations had more multi-stemmed plants than Colorado populations; possibly an indication of increased disturbance triggering sprouting.
(2) New Mexico cacti had fewer flowers and fruits per plant as compared to Colorado cacti; possibly an indication of warmer and dryer conditions overall.
(3) New Mexico populations had a higher percentage of individuals in the smaller size classes than Colorado; possibly another indication of climatic differences.

Initially 65 cacti were found in 1986, but some plants were not detected and more were found up to 1988, thus recruitment numbers were better defined after 1988. Populations fluctuated throughout the study, but most significantly from a high of 235 plants in 1999 to 72 plants in 2003 (Figure 1). This significant decline in population size (68 percent) was attributed to the combination of severe drought and longhorn cactus beetle infestation. However, unlike Colorado, no longhorn larvae were collected to positively identify the predator. There is a possibility that the army cutworm may have been the predator instead because their larvae were found in 2003.

Reproductive effort declined from 1995 to 1999 and was lowest in 2003 (Figure 2). The 2003 decline was consistent with the drought event that affected all study areas, but the 1999 lack of flowering may have been due to the change in the age class distribution where younger (and smaller) plants dominated the population (Figure 3). Typically, these cacti begin to regularly produce one flower at the 4-6 cm (1.6-2.4 in) stage, but the large cacti (greater than 6 cm or multi-stemmed) produce the greatest per plant number of flowers.

A trend toward recovery from the 2003 population drop is apparent based on the most recent final report (New Mexico State Forestry Division 2007). Even though the population in 2007 was still below the peak numbers from 1999, it appears to be a significant increase (New Mexico State Forestry Division 1999, 2003, 2007). However, as monitoring by the State is expected to occur in 2011, there is no information yet from 2008 to present (2010) from the New Mexico State Forestry Division to verify a more long-term population recovery.

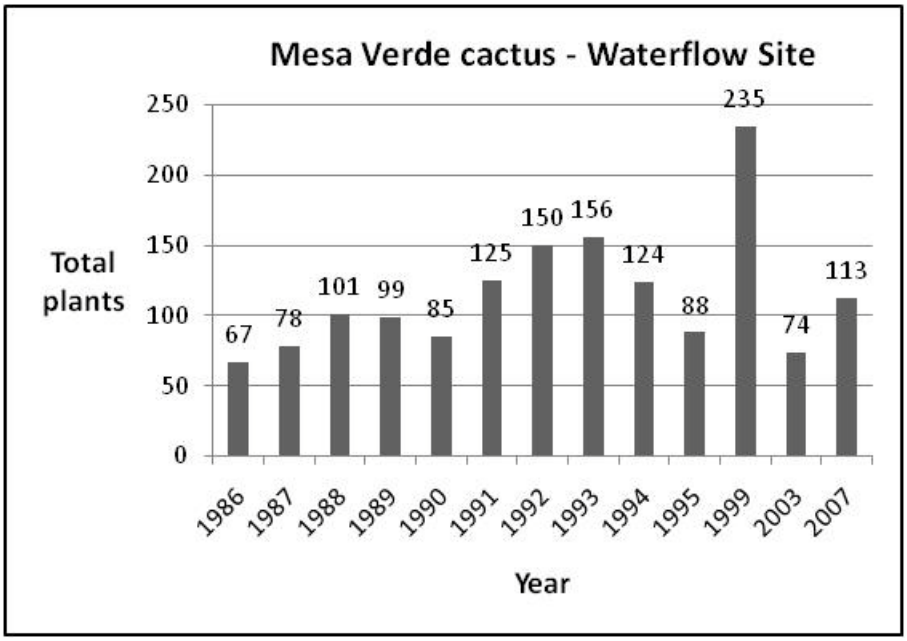

Figure 1. *Sclerocactus mesae-verdae* density (total plants per year) at the Waterflow, New Mexico study site. Data provided by New Mexico State Forestry (2007) and figure developed by Service (2010).

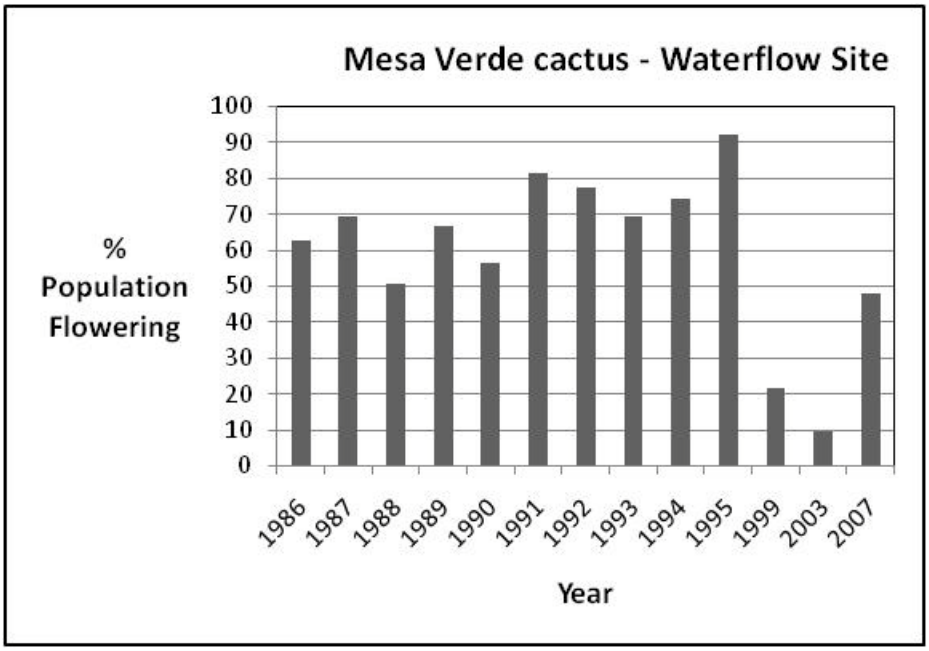

Figure 2. *Sclerocactus mesae-verdae* flowering (percent of population per year) at the Waterflow, New Mexico study site. Data provided by New Mexico State Forestry (2007) and figure developed by Service (2010).

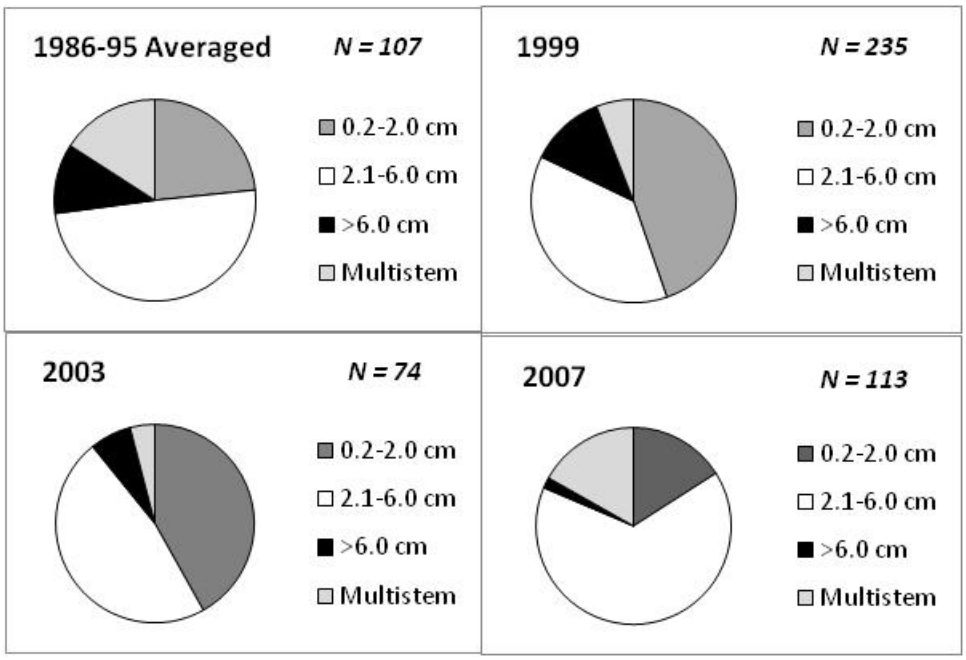

Figure 3. *Sclerocactus mesae-verdae* age class distribution (stem diameters are indicative of relative age) at the Waterflow, New Mexico study site. Years 1986-1995 were averaged and compared to 1999, 2003, and 2007. Data provided by New Mexico State Forestry (2007) and figure developed by the Service (2010).

Bureau of Land Management, Hogback: This population of *S. mesae-verdae* is located east of the distinct geologic Hogback formation on the BLM New Mexico District Field Office in Farmington. The population is entirely within the Hogback Area of Critical Environmental Concern (ACEC). This ACEC was formally established in 2003 through the Resource Management Plan and covers 3,812 ha (9,480 ac). The main objective of this special management area is to protect the habitat for threatened, endangered, proposed, or other sensitive plant species. Although the cactus occurs within this ACEC, recreational uses, travel on authorized roads by off-highway vehicles (OHVs) and other vehicles, livestock grazing, and oil and gas activities continue to be permitted and are considered allowable uses (Bureau of Land Management 2003a and b).

Sclerocactus mesae-verdae growing in the Hogback ACEC has been monitored annually by BLM staff and contractors since 1987, excluding 1988 (Ecosphere Environmental Services 1985; Dunmire 1992; Bureau of Land Management 2003a and b; Kendall 2010). Bureau of Land Management staff have recorded the number of plants (presence only), reproductive phenology, recruitment, and mortality on six plots. Four plots were 100 m x 50 m (1.2 ac) with two plots measuring 54 m x 50 m (0.67 ac). In 1997, plants and clusters were tagged for ease of relocation. Stem diameter was added as a variable to measure, while two plots were combined into one for a total of five plots.

The population was at its highest in 2000 (470 cacti), but decreased dramatically in 2003 to 48 cacti with a low of 20 plants in 2004 (Figure 4). The extreme drought combined with an army cutworm invasion from 2002-2003 appears to have devastated this population (Kendall and Wegener 2003). In addition, field notes reveal "missing" plants as early as 2001 with intermittent horse and cattle trampling onsite. Recovery has been very limited thus far with only 21 plants found in 2009 (Kendall 2010). Bureau of Land Management staff will continue to monitor the area annually, but believe that the remaining population is very vulnerable to any disturbance, from natural sources or from other factors.

Bureau of Land Management, other *S. mesae-verdae* surveys: In 2009 and 2010, Ecosphere Environmental Services was contracted by Tri-State Generation and Transmission Association to perform presence/absence surveys along two proposed corridors. The surveys included approximately 263 ha (651 ac) with 88 percent within the BLM designated Hogback ACEC. In 2009, a total of 64 living (15 pups, 45 juveniles, and 4 mature) and 34 dead cacti were found. In this context, pups are vegetative offshoots from the main cactus stem, and juveniles are individual cacti in the pre-flowering stage. Mature cacti are larger with evidence of flowering.

In 2010, approximately 178 ha (439 ac) were surveyed, excluding one 2009 area that was being extensively mined, and a total of 164 living (49 pups, 31 juveniles, and 103 mature) and 167 dead cacti were found. Surveyors explained the positive increase in pups and `mature adults was due to the amount and timing of winter/spring precipitation which was much higher into the growing season for 2010 than in previous years (Ecosphere Environmental Services 2010a).

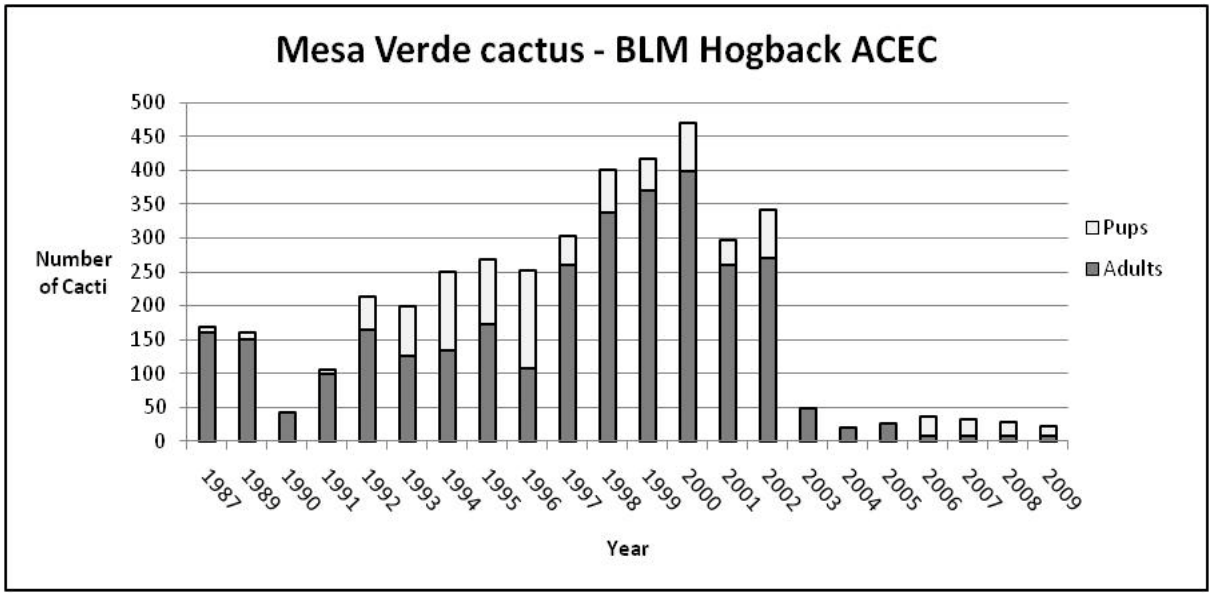

Figure 4. *Sclerocactus mesae-verdae* density at the BLM Hogback ACEC study site near Farmington, New Mexico. Data provided by Kendall (2010) and figure developed by Service (2010).

Navajo Nation, Sheep Springs: Navajo Natural Heritage Program staff began monitoring Sheep Springs in 1986; approximately 50 cacti were found that year (Ecosphere Environmental Services 1985; Cully et al. 1993; Navajo Natural Heritage Program 1994, 2003-2005). In 1990, the estimated number was 122 cacti. Although some of the increase was attributed to the growth of juvenile plants, most was the result of locating mature cacti that were previously missed. Following the severe drought of 2002-2003, combined with atypical longhorn cactus beetle predation and unrestricted livestock grazing in the immediate area of the cactus population, there was a significant loss of plants. In 2004, botanists were unable to locate any *S. mesae-verdae* in the area, and the Navajo Nation botanist believes this population was likely extirpated (Roth 2008, pers. comm.).

Navajo Nation, Shiprock: This population is a combination of disjunct, naturally occurring and transplanted *S. mesae-verdae* within a 24 km (15 mi) radius of the urban community of Shiprock, New Mexico, on Navajo Nation lands. Established in 1986, numerous cacti from a variety of undisclosed project locations on Navajo Nation lands have been transplanted to this area and monitored by Navajo Natural Heritage Program staff and contractors (Ecosphere Environmental Services 1985; Navajo Natural Heritage Program 2003, 2004b, 2005, and 2008a). Since transplants and natural populations are distinctly different in terms of baseline and monitoring, results specific to transplants will be discussed separately (see Section 2.3.1.7 Other, Propagation and Transplants).

In 2004, 56 known population sites of *S. mesae-verdae* were found and resurveyed over approximately 1911 ha (4,723 ac) within Navajo Nation lands (Navajo Natural Heritage Program 2004). The majority of plants are found within a 12 km (20 mi) radius around the town of Shiprock (Navajo Natural Heritage Program 2004). Surveys were expanded to cover larger areas around the town of Shiprock, including Malpais Arroyo, the Fairgrounds, Many Devils Wash, and an area southwest of the town of Cudie. In addition, seven "new" sites of suitable habitat were surveyed. At 18 of the sites, 100 m (328 ft) long transect lines were laid out while using a 1 m x 0.5 m (0.001 ac) rectangular quadrat frame to survey along this line for cacti.

Past survey data that was available from Navajo Natural Heritage Program to the contractor (2004) found approximate population totals of 6,700 cacti on 37 of the 45 sites prior to 2002 with many sites with only 1 cactus and a few others as high as 1,500 individuals (Navajo Natural Heritage Program 2004). Following the significant mortality caused by a severe drought and insect predation during the 2002-2003 growing season, only a few sites supported 20 or more cacti (Navajo Natural Heritage Program 2004). In 2004, the total number of plants counted at the 56 surveyed sites was 948 live cacti, 428 dead cacti, and 20 damaged cacti (Navajo Natural Heritage Program 2004). Within this total, the 7 newly surveyed sites totaled 175 cacti (125 live, 50 dead). It appears that 14 site populations were extirpated by the 2004 survey (Navajo Natural Heritage Program 2004). One example of a precipitous decline in cacti numbers was near Many Devils Wash, a

portion of the Sheep Springs population. The survey team found 27 plants; 23 dead and 4 alive, a 99 percent decrease from the 1,500 or more individuals reported at the site in 1989 (Navajo Natural Heritage Program 2004). Surveys beyond the original Many Devils Wash population found 194 more cacti with 122 dead. This significant decline by 2004 was consistent with similar observations across the species' range. According to the Navajo Nation botanist (Roth 2008, pers. comm.), recovery has been very limited in many of the areas originally surveyed in 2004.

Navajo Nation, other *S. mesae-verdae* surveys: Additional information on distribution, abundance, and threats has also been generated by numerous field surveys on Navajo Nation lands, usually in response to land use proposals or in preparation for habitat management decisions by the Navajo Nation Tribe. Ecosphere Environmental Services (2006 and 2007) have *S. mesae-verdae* data that provide more information on populations not specifically monitored by the Navajo Nation. Along the Navajo Transmission Project right-of-way and through the Malpais Conservation Area, a total of 1,377 live and 475 dead cacti were found along 25.7 km (16 mi) of suitable habitat (Ecosphere Environmental Services 2006). For the existing Lost Canyon and Kayenta – Shiprock Transmission Line, 45 km (28 mi) of suitable habitat was surveyed; 436 live and 148 dead cacti were found (Ecosphere Environmental Services 2007).

For 2009 through 2011, Bureau of Reclamation (BOR) contracted Ecosphere Environmental Services to inventory for *S. mesae-verdae* on Navajo Nation lands within potential cacti habitat along Navajo Route N-36 and U.S. Highway 491 for the Navajo-Gallup Water Supply Project. This area had not been formally surveyed prior to 2009. Preliminary results from 2009 and 2010, which covered the same survey area each year, indicated an increase in mature and juvenile cacti as well as increased mortality with a slight reduction in pups (Table 2). Surveyors explained the increase in juveniles and mature adults as possibly due to the amount and timing of winter/spring precipitation, which was much higher for 2010 than in previous years (Ecosphere Environmental Services 2010b). They were uncertain as to the reasons for increased mortality also experienced at the same time.

Table 2. Comparison of 2009 and 2010 *Sclerocactus mesae-verdae* presence/absence survey results completed by Ecosphere Environmental Services (2010b).

Age Class	2009	2010	Percent Change
Dead	152	197	+29.6
Pups (offshoot from main cactus stem)	90	86	- 4.4
Juveniles (0-8 year, pre-flowering)	80	107	+33.7
Adults	69	265	+284.1

In summary, different areas were surveyed using a variety of methods over different time frames, making the task of reasonably assessing population patterns over *S. mesae-verdae*'s range very challenging. Some populations were monitored solely for absence and presence; not all populations were monitored; and not all populations were monitored annually. Moreover, data was not always collected every year at every site, and observer experience may also affect the number of cacti found. Persistence and experience in searching for the tiny, cryptic, juvenile form of this species is necessary for ensuring a thorough search. From our understanding of information available, cactus numbers in each known population declined dramatically following an atypical insect predation event combined with the severe drought of 2002-2003.

According to the data we reviewed of the five originally monitored populations (in bolded print in two following paragraphs), only the **Ute Mountain Ute** population (as of 2005, but no data since that time) has exhibited significant increases toward pre-2002 to 2003 numbers and regained its population of live cacti, even if the level of recruitment remains low. In New Mexico, the **Waterflow** population has increased and remains within the long-term average number of individuals below pre-2002 to 2003 levels, the **Hogback** and **Shiprock** populations remain stable at substantially reduced numbers of cacti, with the **Hogback** population in danger of extirpation, and the **Sheep Springs** population has been extirpated. However, from a biological standpoint with regard to a desert plant species, we would not expect full recovery to occur quickly in their normal climate regime, much less after a catastrophic event such as the one that occurred in 2002-2003. Length of recovery for this species is unknown at this time. The cactus may be responding to many cumulative impacts including disturbance, insect predation, and climate trends that could be compounding for each plant over time. Only systematic, long-term monitoring can provide data toward understanding mortality and the length of recovery cycles for this species.

Overall, the status of *S. mesae-verdae* in Colorado and New Mexico has notably declined compared to the total estimated population size of greater than 10,000 individuals (Service 1984, 2000; Cully et al. 1993; Navajo Natural Heritage Program 2004; Colorado Natural Areas Program 2005; New Mexico State Forestry Division 2007). When the most recent data from each known site mentioned above is tallied, 4,204 cacti represent the species at the latest count based on: *Colorado* – **Ute Mountain Ute**, 2005, 687 individuals; *New Mexico* – **Waterflow** (State land), 2007, 113 individuals; **Hogback** (BLM land), 2009, 21 individuals; other BLM land (transmission corridor project), 2010, 164 individuals; **Sheep Springs** (Navajo Nation land), 2004, 0 individuals (extirpated); **Shiprock** area (Navajo Nation land), 2004, 948 individuals; and 3 other projects on Navajo Nation lands (transmission line right-of-way), 2006, 1,377 individuals; (Lost Canyon and Kayenta – Shiprock Transmission Line), 2007, 436 individuals, and (Gallup-Navajo water supply project, BOR), 2010, 458 living individuals.

Recent surveys in response to construction projects have found additional populations of the cactus at 4 new sites since 2006, totaling 2,435 living cacti (included in the 4,204 total number of cacti known). The number of dead cacti recorded at 3 of these sites is notable, adding up to 790 individuals, perhaps revealing a recent history of die-off and slow recovery. Because the number of new cacti located in the past four years represents over half of the entire known population of *S. mesae-verdae*, the current total of cacti may not capture the actual number of cactus individuals within the habitat of the species. In addition, transmission and waterline *S. mesae-verdae* surveys (Ecosphere Environmental Services 2006-2010) indicate that substantial populations exist in other locations not yet surveyed that could add to the overall numbers and distribution of this species.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation

There are no genetic disagreements among experts or genetic studies proposed for *S. mesae-verdae*.

2.3.1.4 Taxonomic classification or changes in nomenclature

Taxonomic classification of *S. mesae-verdae* has not changed since the recovery plan was finalized in 1984.

2.3.1.5 Spatial distribution, trends in spatial distribution or historic range

The distributional range of *S. mesae-verdae* has not changed since the recovery plan was finalized in 1984, although there are large tracts of suitable habitat that have not been surveyed within difficult-to-access lands including Ute Mountain Ute and much of the Navajo Nation lands.

2.3.1.6 Habitat or ecosystem conditions

Substrate

Sclerocactus mesae-verdae are restricted to sparsely vegetated badlands of clay loam soils derived from upper Cretaceous Mancos shale in Colorado, and Mancos and Fruitland shale in New Mexico (Service 1984). Populations are located in a narrow strip of land between Cortez, Colorado, and Sheep Springs, New Mexico, at elevations ranging from 1,400 to 2,000 m (4,600 - 6,560 ft) (Heil and Porter 1994; Coles and Naumann 2003). These formations erode easily, forming low, rolling hills where plants are found on hilltops and benches, but less so in basins or swales (Cully et al. 1993; Coles and Naumann 2003).

The soils are sodic (high alkalinity; pH 7.5 to 8), gypsiferous (poor permeability), and have shrink-swell tendencies which make harsh sites for plant growth (Potter et al. 1985). However, during severe hot or cold dry periods, individual plants

shrink and retract back into soils which can minimize dessication or dehydration (Heil and Porter 1994). Colorado State University soil lab results on Colorado Natural Areas Program plots (2001) revealed clay and silty clay loams in texture, with low water permeability. Sodium, calcium, selenium and iron levels are elevated, while organic matter, phosphate and nitrate levels are low. Surface cracking presents problems for any plant growing in this substrate, as well as preventing the accumulation of organic matter. Shrink-swell churning of the surface layer is shown by the fact that seven-inch-long nails are often pushed completely out of the soil over the course of a year (Colorado Natural Areas Program 2001).

Vegetative community

Principle vegetation types associated with *S. mesae-verdae* are those of the Great Basin Desert Scrub (Saltbush Series) and Desert Grassland Ecotone communities (Dick-Peddie 1993). The Southwest Regional Gap Analysis Mapping Project identified this community type as the Inter-mountain Basins Mat Saltbush Shrubland (Lowry et al. 2005). The Nature Conservancy and Bailey's both classify this ecoregion as the Colorado Plateau Semidesert Province (Lowry et al. 2005). Vegetative associates, though low in total percent ground cover (5 to 18 percent), include *Atriplex cuneata* (valley saltbush) and *A. corrugata* (mat saltbush) in New Mexico, and *A. corrugata, A. confertifolia* (shadscale saltbush), *A. gardneri* (Gardner's saltbush), and *Artemisia spinescens* (bud sagebrush) in Colorado (Cully et al. 1993; Coles and Naumann 2003). In both states, *A. corrugata* was consistently found to be the dominant shrub. The most common perennial grasses (less than 1 percent cover) are *Achnatherum hymenoides* (Indian ricegrass) and *Pleuraphis jamesii* (galleta grass) (Cully et al. 1993; Coles and Naumann 2003). Other associates in common were *A. spinescens* and *Phlox longifolia* (longleaf phlox) (Cully et al. 1993; Coles and Naumann 2003). Two nonnative associates *Bromus tectorum* (cheatgrass) and *Salsola kali* (Russian thistle) were found in New Mexico (Navajo Natural Heritage Program 2004).

Climate

As a relatively long-lived, desert specialist of small size, *S. mesae-verdae* appears to be sensitive to ecosystem conditions affected by changes in climate. The recent drought (2002-2003) spanning southwestern North America was anomalously dry, but was different from the 1950s drought in having unusually high temperatures (higher annual maximum and minimum temperatures as well as higher average summer temperatures) (Breshears et al. 2005). The combination of higher temperatures and lower precipitation levels is likely linked with reduced *S. mesae*-verdae numbers and recruitment, based on data presented above.

In the southwest region of the United States, the average annual temperature in is predicted to rise by about 2.5 to 3.9 º C (4.5 to 7 º F) during this century (IPCC 2007). This increasing rate of 0.56 º C (1.0 º F) every 14 years has already been

surpassed in Arizona since the 1970s, and New Mexico is just slightly below this rising temperature rate (Lenart et al. 2007). Hydrologic trends are less clear except when considering snow; less snowpack and earlier spring melt and runoff in the Intermountain West states is substantiated (Parmesan and Galbraith 2004; Udall and Bates 2007), yet the southwestern states show a long-term trend of increased precipitation since the 1970s (Parmesan and Galbraith 2004; Udall and Bates 2007; Enquist and Gori 2008). New Mexico precipitation changes show more variation than temperature changes, with about 54 percent of the state trending toward wetter conditions, 41 percent toward drier, and 5 percent with no discernable change between 1991 and 2005 (Enquist and Gori 2008).

The spatial heterogeneity of drought, as defined by temperature, and particularly precipitation, is extremely variable in the state of New Mexico (Enquist and Gori 2008). To look at precipitation more locally can reveal site-specific trends particular to a narrow endemic such as *S. mesae-verdae*. Average annual precipitation in Shiprock, New Mexico has been 157 mm (6.2 in) from 1926 to 2000 (Western Regional Climate Center 2010). In 2002, no precipitation was recorded, and by 2004, 33 mm (1.3 in) was recorded, which is the third lowest level measured since 1926 (Figure 5). Mean annual precipitation since the drought (2003 to 2007) was 97 mm (3.8 in), well below the long-term average (Western Regional Climate Center 2010).

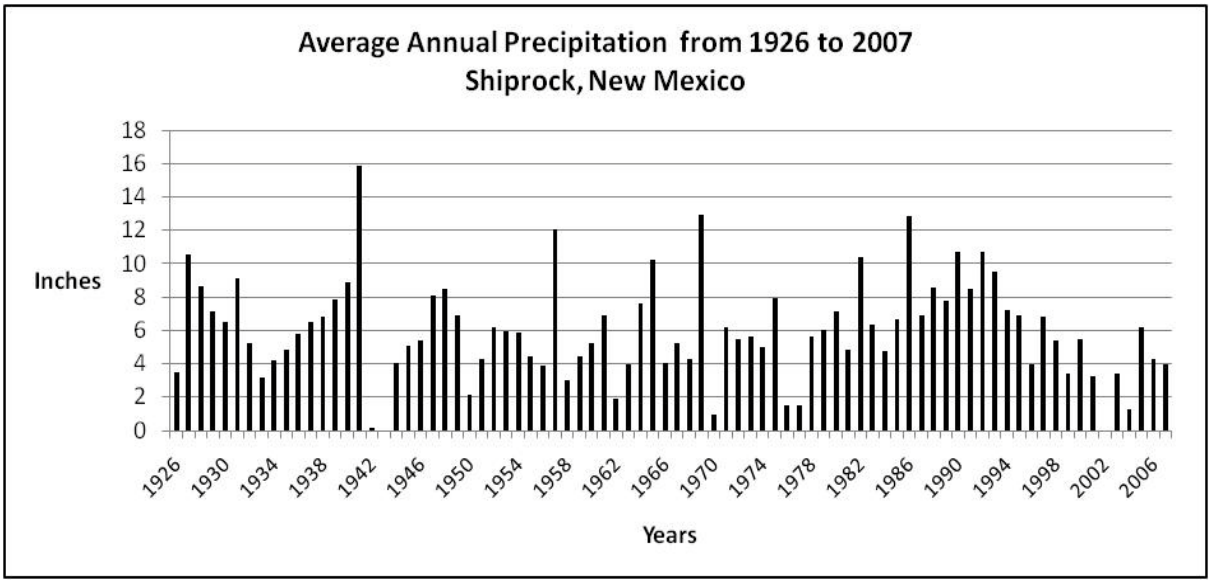

Figure 5. Average annual precipitation totals (inches) from 1931 to 2007. Data retrieved from the Western Regional Climate Center (2010) and figure developed by Service (2010).

Increases in predatory insects, both native and nonnative, were documented for *S. mesae-verdae* during the drought of 2002-2003, with the unusual and extensive invasion of the longhorn cactus beetle (native) and the army cutworm (nonnative).

Narrow endemics, like *S. mesae-verdae*, often have very specific habitat requirements and correspondingly limited distributions. Because plants are unable to move, a change in climate that causes mortality that exceeds reproduction and recruitment, could lead to the extirpation of *S. mesae-verdae*. We believe the mortality during 2002-2003 was likely caused in part by changes in climate, but because of slow growth rates and cryptic habits of seedlings, the long-term effects on their populations may not be entirely evident for many years until after drought conditions cease. Some recovery, particularly in mature cacti numbers, was found by the spring/summer of 2010 in several surveys on Navajo Nation and BLM lands reaffirming the connection between climate change (spring/summer moisture) and *S. mesae-verdae* population size (Ecosphere Environmental Services 2010a, b).

2.3.1.7 Other

Propagation

The 1984 recovery plan recommended developing a program for artificial propagation of *S. mesae-verdae* (Service 1984). Additional recommendations included providing stock to garden centers or greenhouses for commercial use and implementing a program for salvage of individual plants unavoidably threatened with destruction from permitted activities. Commercially grown cacti could also conceivably be used to supplement populations experiencing poor growth or replace stolen cacti.

In December 2008, we contacted the federally-permitted cactus grower, Steve Brack, owner of Mesa Garden, located in Belen, New Mexico. He found that *S. mesae-verdae* germination can be successful, but is typically followed by significant mortality through "damping off" which refers to a fungal disease that causes seedlings to wilt and die. Unless very specific soil, water, and air temperature regimes are followed, getting past the germination stage is difficult. This species is especially difficult to cultivate in areas of high humidity because the stem rots very easily; up to 90 percent of cacti may rot and die within the first year. While it is physically possible for the species to be germinated and grown in captivity, commercial production using current techniques likely will not reach 10,000 cacti as is recommended in the 1984 recovery plan.

Transplanting

S. mesae-verdae has been transplanted on several occasions to avoid ground disturbing construction projects, and although not highly successful, transplanting appears to be a viable stragegy for salvaging cacti in areas slated for development. In 1989, Navajo Natural Heritage Program staff arranged for the transplanting of 35 cacti within the Shiprock-Gallup oil field. After a few months, only a few individual plants survived and the transplant project was considered by the

Navajo Nation botanist to be unsuccessful, as no live cacti were found during subsequent years of monitoring (Navajo Natural Heritage Program 2004).

In the spring of 1995, staff transplanted and tagged 29 cacti from a road right-of-way into 4 monitoring plots near the plant's original location along the BIA Route N57, Cudei, NM project (Navajo Natural Heritage Program 1995, 1996, 1998, 1999, 2004a). Twenty-two naturally occurring cacti were also tagged in the plots as control plants so survival could be compared. Between 1995 and 2002, 69 and 55 percent of the transplanted and naturally occurring cacti survived, respectively. The number of transplanted cacti decreased to four plants by 2004 and the number of naturally occurring cacti decreased to two plants. Similar to other *S. mesae-verdae* populations monitored at the time, the severe drought and atypical insect predation event appeared largely responsible for the mortality (Navajo Natural Heritage Program 2004; Roth 2008, pers. comm.).

In 2001, another transplant monitoring study was initiated in the Northern Navajo Fairground Conservation Area within the larger Shiprock *S. mesae-verdae* population. Five monitoring plots were established within a designated nondevelopment zone south of Shiprock. Fifty-four cacti were excavated from the south-central portion of the proposed Northern Navajo Fairgrounds site and transplanted into the monitoring plots (Navajo Natural Heritage Program 2008a). Forty-nine cacti that naturally occurred within the plots served as controls. Seventy-six percent and 65 percent of the naturally occurring and transplanted cacti died between 2001 and 2004, respectively. In 2008, 17 of the 49 naturally occurring and 19 of the 54 transplanted cacti were alive indicating that transplanted cacti can survive approximately 35 percent of the time.

Although mortality rates have decreased since 2004 and some recruitment has been observed, population numbers remain low due to the time it takes for a small seedling to reproductively mature (8 years). We note that in 2007 and 2008, *S. mesae-verdae* vigor was rated as excellent for all naturally occurring plants and for a majority of the transplants, which was likely due to increased rainfall, and indicates that the species may be more responsive to changes in precipitation than temperature (Navajo Natural Heritage Program 2008a; Roth 2008, pers. comm.).

In summary, it is difficult to accurately assess the long-term success of *S. mesae-verdae* transplantation because the period of severe drought and atypical insect predation event confounded the results. Extensive mortality occurred rangewide in 2002-2003 and these events were equally devastating for naturally occurring cacti and transplants. Despite the extreme years of mortality, it appears that salvaging and transplanting cacti can have a potential survival rate of approximately 35 percent, and that transplanting is likely still a viable option for plants that might otherwise be destroyed during ground disturbing construction activities.

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range – Factor A

Threats when *S. mesae-verdae* was listed in 1979 included:

(1) collection by commercial suppliers and private citizens,
(2) highway construction and right-of-way development for overhead transmission lines, and
(3) off-highway vehicle activity.

In 1984, the Recovery Plan presented additional threats including:

(4) coal mining,
(5) oil and gas exploration and production,
(6) commercial and residential development,
(7) livestock utilization and trampling,
(8) pesticide use, and
(9) natural causes such as erosion.

In 2000, a preliminary internal draft revised recovery plan for Mesa Verde cactus was submitted to the Service by R. Sivinski. The draft, prepared under a Section 6 grant to the New Mexico Energy, Minerals, and Natural Resources Department, was not finalized for public review, however, much of the information on threats below was summarized from that document (Sivinski 2000). Since 2000, use of off-highway vehicles (OHVs) in areas of occupied or suitable cactus habitat has become a serious threat to the plant and the quality of its habitat. Cactus collection, pesticide use, and natural causes will be covered later in the other five-factor analysis sections.

<u>Highway Construction and Right-of-Ways for Transmission Lines</u>

The Navajo Nation and BLM have consulted with the Service for various projects that have taken place or are planned to occur in areas with occupied or suitable habitat for *S. mesae-verdae.* We provide a list of consultations in order to convey the number and diversity of projects and to acknowledge the continuing compliance of the Navajo Nation and BLM with accounting for rare species. In each case, however, after the Service provided non-jeopardy opinions, we did not receive any further information regarding implementation of conservation measures, including post-construction surveys or progress reports. To ensure that the conservation measures are implemented and effective, and to apply adaptive management, if needed, to modify measures to assist the cactus, providing documentation of the outcome of these projects and other monitoring data would be very beneficial to the Service. By sharing information about the effects of projects, all parties managing *S. mesae-verdae* can be informed of what conditions are most favorable for this cactus and what conservation measures are the most worthwhile for promoting this species' recovery and moving toward

delisting. There is a need for a *S. mesae-verdae* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery.

Each biological opinion contains different detailed conservation measures; the 10 listed below appear to be consistent activities.

(1) Pre-construction inventories in the spring one year prior to project initiation.
(2) Development of a detailed *S. mesae-verdae* construction plan to avoid and minimize disturbance; unavoidable cacti will be transplanted and monitored for 5 years.
(3) Use of pre-existing roads, staging areas, etc. to the extent practicable; no new access disturbance within 50 feet of cacti; no blading for new access roads.
(4) Flag and/or fence all known populations; 200 feet out from access roads.
(5) Worker education and awareness training on this cacti.
(6) Daily compliance monitoring during construction activities;
(7) Cleaning of all construction equipment for weeds prior to entry;
(8) Post-construction reclamation (raking) of temporary roads, staging areas, etc.
(9) Surveys required prior to any ground disturbing maintenance activities post-construction; surveys valid for 3 years.
(10) Noxious weeds will be continually controlled within disturbed areas.

The Service requires, as part of the Terms and Conditions (of most of the BOs), that documentation and reporting on the implementation of the conservation measures will occur within six months after completion of the project.

Below is a summary of previous and ongoing projects involving known and potential *S. mesae-verdae* habitat on Navajo Nation and BLM lands. At this time, this history of consultations remains the Service's primary information on habitat development and potential impacts to the cactus.

In 1980, the Federal Water and Power Resources Service proposed the Gallup-Navajo Indian Water Supply Project to deliver domestic water in a buried pipeline from the San Juan River to several communities in northwestern New Mexico. This action had the potential to impact about 200 cacti. A non-jeopardy biological opinion with conservation recommendations resulted (Service 1980).

In 1985, surveys were conducted by Ecosphere Environmental Services for the BLM on all areas of potential habitat in the Hogback-Waterflow area (Ecosphere Environmental Services 1985). Their report noted that the San Juan Generating Plant had been built on *S. mesae-verdae* habitat and the associated power transmission lines had been built through the Waterflow population.

In 1985, the Bureau of Indian Affairs (BIA) proposed to improve Navajo Route 36 from Shiprock to Fruitland that would negatively affect 40 plants. A non-jeopardy biological opinion recommended that the plants be transplanted to a safe locality and that success after one year be reported to the Service (Service 1985).

In 1997, the BLM revised their Farmington District Resource Management Plan (RMP). A non-jeopardy biological opinion concluded that management provisions and protective measures in the RMP were sufficient to prevent adverse effects to the cactus; no conservation recommendations were included (Service 1997).

In 2000, the BIA proposed that Shiprock Northern Navajo Fairgrounds be located on the Navajo Nation, San Juan County, New Mexico, and concluded with a non-jeopardy biological opinion with conservation recommendations (Service 2000b). In 2007, the BIA proposed to develop the Navajo Transmission Project, an alignment containing 927 acres of *S. mesae-verdae* habitat, which is almost 20 percent of the total acreage (4,723 acres) where Mesa Verde cactus has been documented on the Navajo Nation. A non-jeopardy biological opinion found that the effects of the action would not result in significant changes to population numbers or *S. mesae-verdae* habitat (Service 2007).

In 2008, a biological assessment from the BIA proposed Desert Rock Energy Project (DREP) found that *S. mesae-verdae* appears to be at risk from exposure to baseline and deposition metals (Ecosphere Environmental Services 2008). Currently, the significance of the direct, indirect, and cumulative impacts to *S. mesae-verdae* from DREP and the two existing power plants is unknown and consultation has not been completed.

In 2009, the Bureau of Reclamation proposed the Navajo-Gallup Water Supply Project. A non-jeopardy biological opinion resulted based on implementation of conservation measures. We found that the number of cacti lost would be very small and not pose a significant population loss (Service 2009).

The Malpais Conservation Area was established in 2008 on Navajo Nation lands (Roth 2008, pers. comm.). This area is located within a larger Navajo Nation *S. mesae-verdae* population area and was established as a mitigation bank for the Western Administrative Power Authority (WAPA). The mitigation bank was an attempt to offset impacts related to the loss of *S. mesae-verdae* from the prior construction of a right-of-way power line corridor (including a maintenance road) installed in 1997. Although the area was proposed to be monitored annually since 1997, this has not occurred and we have no information on the population at this time.

Several projects within *S. mesae-verdae* habitat are being proposed in the near future including the Bureau of Reclamation Navajo Municipal Waterline, the Tri-State Powerline, and reinitiation of the Desert Rock Energy Project. These

projects will involve complete scraping of the soil surface over large swaths of known and potential *S. mesae-verdae* habitat. The size and extent of all of these proposed projects in conjunction with the proposed maintenance of older transmission lines has to potential to devastate Navajo Nation populations where 70 percent of the known populations exist. Thus the nature and area of disturbance of these projects highlights the need to survey for and transplant cactus individuals prior to scraping to a protected location.

Highway construction and right-of-way transmission lines have negatively affected *S. mesae-verdae* populations in the past (Roth 2008, pers. comm.). If implemented, conservation measures such as avoidance, transplanting, and long-term monitoring should minimize impacts within the construction footprint of these Navajo Nation projects. Although we had been receiving project updates on the status of transplanted cacti until 2008, we have not received any other reviews or monitoring results specific to each project. As we have no additional information on the number of individual cacti, populations, or amount of habitat that has been impacted by these large scale projects on the ground, we lack the ability to quantify the threat of land development to *S. mesae-verdae*.

Large scale projects involving ground disturbance and heavy machinery such as these, threaten the species both directly (to the cacti) and indirectly (to suitable habitat, nurse plants, and pollinators). For all threats listed in section 2.3.2.1 relating to construction and development projects, if basic mitigation measures are implemented including avoiding the cactus, transplanting cactus, and controlling vehicle access, threats related to the destruction of *S. mesae-verdae* and its habitat could be reduced and not remain as severe into the foreseeable future.

Off-Highway Vehicles (OHV)

The 1984 recovery plan correctly anticipated that OHV use would be one of the greatest human-caused threats to *S. mesae-verdae*. The use of OHVs appears to have increased within the Navajo Nation (Roth 2009, pers. comm.) and on BLM lands ((Jamison 2009, pers. comm.).This increase is most likely due to the recent energy boom and the resultant population boom within San Juan County; a 55 percent increase in population from 1980 to 2006 (http://wrdc.usu.edu/htm/publications/). National all-terrain and off-highway vehicles retail sales from 1993-2003 show a dramatic increase from 2,920 total vehicles sold in 1993 to a total of 8,010 vehicles sold by 2003 (Cordell et al. 2005). However, the perception of increased OHV traffic may be more of an issue of unmanaged/unregulated use where one vehicle could cause extensive and severe habitat damage with one trip through closed areas.

When a vehicle runs over a cactus, the growing tip is often damaged resulting in a failure to flower and set seed as well as an increased vulnerability to dessication, herbivory, and pathogens. Cacti can also be directly uprooted or irreversibly

damaged from OHVs or any other form of forceful contact. In addition to these direct impacts to the cactus, indirect effects from OHV riding also occur such as damage or destruction of annual and perennial plants, destruction of fragile soil crusts, soil erosion and compaction, alteration of drainage patterns, formation of dust, and proliferation of weeds (Brooks 2009; Lei 2009).

Erosion and denuding of plants on dry soils from unauthorized OHV use changes soil properties and alters the hydrological dynamics of an area, with impacts spanning from the microhabitat to the landscape scale. These factors increase run-off and decrease the infiltration of precipitation into soils, further diminishing water storage and accessibility to plant roots. For example, Bury and Luckenbach (2002) compared habitat features of one unused, natural area and a nearby area used heavily by OHVs in the Mojave Desert. The unused, natural area had 1.7 times the number of live plants and 3.9 times the plant cover than the area used by OHVs. The areas furthest from concentrated OHV activity reflected the least amount of habitat impact (Bury and Lukenbach 2002). As *S. mesae-verdae* appears to respond negatively to reduced soil moisture availability, and to be dependent on other plants to provide shaded conditions for germination and establishment, these indirect impacts of OHV traffic could degrade habitat quality for *S. mesae-verdae* in both occupied and unoccupied suitable areas.

Off-highway vehicle activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold-desert ecosystems similar to those occupied by *S. mesae-verdae*. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco et al. 2001). Once the soil crusts are disturbed, non-native plants may colonize, become established, and outcompete native perennial and annual plant species (DeFalco et al. 2001).

Surface disturbance from OHV activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies addressing surface dust impacts on gas exchanges of desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Wijayratne et al. 2005; Sharifi et al. 1997). Sharifi et al. (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. These effects may impact desert plants including *S. mesae-verdae*.

Impacts from constant OHV use, causing soil, vegetation, and hydrological disturbances, have the capacity to compound over time, particularly if the source of OHV impacts is located high in a drainage (Brooks and Lair 2005). Repeated OHV trail use leads to new routes that are not included in road databases (Brooks and Lair 2009). As a result, continual unauthorized OHV use, especially off-trail

riding, can create conditions less and less supportive for a habitat specialist such as this cactus species. Furthermore, reduced moisture availability and ground cover from OHV use can interact with other variables such as climate change or grazing, exacerbating drying conditions an already arid system.

Despite efforts to designate areas for OHV use, unauthorized use continues to be of concern across the range of *S. mesae-verdae*. Unauthorized roads and trails, denuded hillsides, and eroded arroyos have been observed throughout the range of the species. Initially, the Shiprock (Navajo Nation lands) and Waterflow (New Mexico State land) cactus populations were experiencing the most significant impacts. However, even within BLM's special management areas (ACECs), signs clearly restricting OHV use did not deter unauthorized traffic in the area. Habitat damage has increased especially around transmission line corridor roads that were originally developed for oil and gas extraction (Jamison 2009, pers. comm.). Lack of law enforcement continues to be problematic for both BLM and the Navajo Nation. We believe that unauthorized use of OHVs and other vehicles is a serious local and landscape level threat to the species and will likely increase in the foreseeable future.

Coal Mining

About 90 percent of known *S. mesae-verdae* habitat occurs in areas that lack coal reserves (Parker et al. 1977). The 1984 recovery plan reported that no coal mining was being actively pursued within occupied habitat, although several strip mining operations were within a few miles of the Waterflow cactus population (Service 1984). This cactus population was the only one known growing on the coal-bearing Fruitland formation (Service 1984). We are not aware of any effects resulting from coal mining on this species (Sivinski 2000). Thus, we believe that coal mining is not currently a threat and is not likely to threaten the species in the foreseeable future.

Oil and Gas Exploration and Production

About 70 percent of the known occupied *S. mesae-verdae* habitat is located on Navajo Nation lands. Navajo Nation lands contain significant deposits of coal, oil, and natural gas. Development of energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). The Fruitland Coal formation of the San Juan Basin is the largest coal bed methane producer in the United States (Energy, Minerals, and Natural Resources Department 2008). These resources occur subsurface in ancient marine shale layers, primarily Fruitland and Mancos layers, which coincide with *S. mesae-verdae* habitat. Nearly all known cactus habitat has the potential to be affected by natural gas or oil exploration and development.

Another mineral, a decomposed type of coal (humate), is also found under much of *S. mesae-verdae* habitat (Colorado Natural Areas Program 2004). Humate is

used as a soil conditioner and additive to drilling mud which increases the potential for development. About 12.1 billion tons of humate occur within the San Juan Basin (McLemore et al. 2002).

Ground disturbing impacts from these activities include the construction and maintenance of pipelines, power lines, and associated roads; the total clearing of all vegetation on an average of three acres for every oil or gas well pad and associated facilities; and associated commercial and residential development. These activities lead to long-term degradation, fragmentation, or loss of habitat, with impacts to *S. mesae-verdae* similar to those described above in the OHV section. Most *S. mesae-verdae* habitat occurs on the Mancos Formation, with the Rattlesnake, Shiprock-Gallup, Horseshoe-Gallup, and Hogback oil fields located within high quality habitat. Destruction of cactus habitat from these oil fields appears to be extensive (Roth 2008, pers. comm.); however, data quantifying the size of each oil field, number of cactus mortalities, and leasing of other areas for associated activities are not available.

Since listing, we have observed and documented negative effects to numerous populations of *S. mesae-verdae* including their inadvertent crushing from vehicles and equipment, direct removal and destruction from energy-related activities, and indirect effects of unauthorized OHV disturbance using roads constructed by oil and gas companies. Oil and gas well and mine site construction has resulted in a variety of unauthorized roads; random turn-outs and turnarounds; multiple pipelines; and small but enduring piles of waste, all of which further degrade cactus habitat over large areas (Navajo Natural Heritage Program 2004). These negative effects continue to be a source of cactus mortality. Thus, we believe oil and gas development remains a severe threat to the species and will likely increase in the foreseeable future.

Commercial and Residential Development

Commercial and residential development threatens *S. mesae-verdae* on private and Tribal lands (Service 2009). Since the species was listed, cactus habitat has been increasingly impacted from urban development on Navajo Nation lands (Navajo Natural Heritage Program 2004). Urban development is not allowed within a BLM ACEC or on New Mexico State trust lands. The status of urban development on Ute Mountain Ute lands regarding this cactus is unknown at this time. Impacts from urban development include habitat loss, fragmentation, and degradation, along with other factors relating to soil, vegetation, and hydrologic disturbances described in more detail in the off-highway vehicles section above. These impacts not only directly damage cacti, but also can make occupied and potentially usable habitat inhospitable to *S. mesae-verdae* and result in the decline of individuals and populations.

Urban development, including homes, roads, power lines, pipelines, and waterlines; increased recreational activities, including use of OHVs; and

commercial facilities have expanded in the proximity of Shiprock. In an effort to off-set the Navajo fairground project interfacing with the cactus, the Northern Navajo Fairground Conservation Area was established in 2001 to use for transplanting cacti that otherwise would be destroyed by the construction of the fairground. However, it is unknown at this time if signs and fences are in place to protect this area.

Daniela Roth, Navajo botanist (2008, pers. comm.) and Robert Sivinski, New Mexico State botanist (Sivinski 2000) believe cacti losses from individual development projects are becoming cumulatively significant and the resulting habitat fragmentation may lead to genetic isolation and increased mortality. Thus, we believe that commercial and residential development has become a moderate threat to the species and will likely increase in the foreseeable future.

Livestock Grazing and Trampling

The 1984 Recovery Plan (Service) stated that livestock grazing was not believed to be a significant threat. Since that time, nearly all monitoring has documented disturbance of *S. mesae-verdae* by livestock. Livestock grazing occurs throughout the range of the cactus, and impacts from trampling, such as uprooted cacti, partially or entirely crushed cacti, and soil disturbance immediately adjacent to cactus individuals are regularly observed (Ecosphere Environmental Services 1985). Cattle have also been observed eating *S. mesae-verdae* (Service 1984; Ecosphere Environmental Services 1985).

Livestock grazing continues to be permitted by the BLM within the Hogback ACEC (Bureau of Land Management 2003b). Navajo Nation staff noted heavy sheep and cattle grazing at the Sheep Springs population that historically supported *S. mesae-verdae* prior to 2004 (Navajo Natural Heritage Program 2004), but now appears to be extirpated (Roth 2008, pers. comm.). Three additional occupied areas on Tribal land were observed to have extensive livestock damage (Navajo Natural Heritage Program 2004). In Colorado, livestock trampling was also documented and believed to be the primary source of cactus mortality in 2005 (Colorado Natural Areas Program 2005).

The 1984 Recovery Plan reported that when livestock are fenced in cactus habitat, trampling of the species could occur. High intensity grazing associated with fenced private or Tribal residences is likely to result in the permanent loss of cacti through trampling and soil compaction (Service 2009). On larger fenced acres, ranchers drive their trucks and OHVs off-road, tracking or herding their livestock (Jamison 2009, pers. comm.). Likewise, during capture of feral horse herds on the Navajo Nation, soils have become compacted within *S. mesae-verdae* habitat (Service 2009). Based on the increase in habitat degradation due to livestock trampling, whether it be compacted soils or vegetation displacement resulting in increased soil erosion and dust formation, we believe that livestock grazing and trampling has become a moderate threat to this species for the foreseeable future.

In summary, OHV use and oil and gas activities are considered to be the most severe threats to *S. mesae-verdae* populations and are expected to increase in the near future; whereas, urban development and livestock grazing are considered moderate threats for the foreseeable future. At this point in time, coal mining is not considered a threat, but highway and transmission line construction could be considered a severe threat if protective conservation measures are not implemented (see above on Highway Construction and Right-of-Ways for Transmission Lines).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes – Factor B

Cacti are desirable plants whose wild populations in the U.S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare cacti. Many of these collectors have illegally obtained certain species for their private collections (Robbins 2003).

In 1981, species expert and surveyor Paul Knight discovered a *S. mesae-verdae* population of about 75 cacti north of Waterflow, New Mexico. In late April of 1982 (blooming period), Knight returned and could not locate a single plant. Due to the large number of plants taken, it is suspected that a commercial dealer illegally collected the cacti (Ecosphere Environmental Services 1985; NatureServe 2006).

In 1985, Dr. Richard Spellenberg of New Mexico State University monitored *S. mesae-verdae* occurrence at an unrevealed site. He revisited the site later and found very few plants with many shoveled holes left in the clay. He attributed the loss to illegal collectors (Ecosphere Environmental Services 1985).

In 1987, Colorado surveyors noted five *S. mesae-verdae* apparently removed from their beds. Three cacti were blemished and likely not desirable for resale (they were left behind) with two cacti missing (NatureServe 2006). While more formal documentation of stolen cacti since 1978 is not readily available, the Navajo Nation botanist stated to Service staff that she strongly believes theft continues and remains a threat to the species (Roth 2008, pers. comm.).

The Service received a possible cacti theft notification from a New Mexico State Land Office employee. He stated that he had previously counted 130 *S. mesae-verdae* cacti on this BLM site in 1993; there were only 4 cacti found during his site visit in 1994 (Service 1994). To counter potential theft in the BLM Hogback ACEC population, populations are not fenced or signed in an attempt to deflect attention from their general location, so that collection does not occur.

Several instances of illegal take by collectors during the early 1980s were documented in the Recovery Plan (Service 1984). Since that time, the

unauthorized collection of this cactus appears to have diminished (Sivinski 2000) with positive steps taken to educate the public about *S. mesae-verdae*.

To raise public awareness of native plants, the New Mexico Rare Plants web site was established in 1998 by the New Mexico Rare Plant Technical Council to provide information on rare, threatened, and endangered plant species. Descriptive information and photographs of *S. mesae-verdae* are prominently displayed on this web site. A poster of federally threatened and endangered plants of New Mexico, including *S. mesae-verdae,* was completed in 2006 for distribution to schools, universities, and the general public.

In summary, illegal collection leads to the direct loss of plants and has threatened some *S. mesae-verdae* populations. Cactus collecting will probably continue at some level into the foreseeable future, but such activities are difficult to document and we have not discovered any new information to suggest that cactus theft is increasing (CITES 2000; Robbins 2003; Martin 2009). Although illegal collection of *S. mesae-verdae* was considered a significant threat at the time of listing and during the development of the Recovery Plan, as evidenced by the second recovery criterion which directly addresses this threat, collecting appears to have decreased since the publishing of the Recovery Plan and is now considered a minor threat to the species for the foreseeable future.

2.3.2.3 Disease or predation – Factor C

All *Sclerocactus* are susceptible to disease and predation, but only predation has been observed in this species. The longhorn cactus beetle (*Moneilema semipunctatum*) normally feeds upon *Opuntia* spp. However, during the 2002-2003 period of severe drought, the longhorn cactus beetle fed upon *S. mesae-verdae* and substantially reduced all of the monitored populations. Although the longhorn cactus beetle is a native species and *S. mesae-verdae* has likely evolved with it, this beetle has the potential to cause serious mortality in the foreseeable future with periodic atypical population eruptions.

Native to the Great Plains and Intermountain West, a migratory, noctuid moth, the army cutworm (*Euxoa* spp), destroyed many *S. mesae-verdae* in the BLM Hogback ACEC study area during the drought of 2002-2003 (Bureau of Land Management 2003b). Numerous cacti also were reported killed by the army cutworm on Navajo Nation land (Roth 2008, pers. comm.). Since this insect is generally associated with agricultural crops which are found nearby BLM and Navajo Nation lands, but will also consume native plants, particularly grasses, the threat is still substantial.

In 2003, a third type of cactus predator was observed in the Colorado (Navajo Natural Heritage Program 2004). Unfortunately, the identity of the predator was not determined, but the effects to the plant appear to be similar to those from the longhorn cactus beetle (Navajo Natural Heritage Program 2004). We believe that

insect predators can be an ongoing, yet minor threat to *S. mesae-verdae*. However, during atypical drought episodes, the threat from these predators can be severe into the foreseeable future.

2.3.2.4 Inadequacy of existing regulatory mechanisms – Factor D

Sclerocactus mesae-verdae (Mesa Verde cactus) was listed as threatened without critical habitat in October 1979 (44 FR 62471). The Endangered Species Act is the primary Federal law providing protection for the species. Beyond the listing of the species, these protections are afforded particularly through sections 7 and 9 of the Act. Section 7 of the Act requires Federal agencies to ensure that any action authorized, funded, or implemented by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat, although there is no critical habitat designated for this species. Section 7 also encourages Federal agencies to use their authorities to carry out programs for the conservation and recovery of listed species. Section 9 of the Act prohibits the removal, damage, or destruction of listed plants on Federal lands and on other areas in knowing violation of any State law or regulation or State criminal trespass law. The Service has addressed numerous projects within potential *S. mesae-verdae* habitat through formal section 7 consultations with BLM, BIA, and BOR.

The National Environmental Policy Act (NEPA) may provide some protection for *S. mesae-verdae* for projects with a Federal nexus (i.e., funding, authorization, or permitting). NEPA requires that the planning process for Federal actions be analyzed to ensure that effects on the environment are considered. The NEPA process is intended to help public officials make better decisions based on an understanding of the environmental consequences of their actions and to take actions to protect, restore, and enhance the environment (40 CFR 1500.1). Carrying out the NEPA process ensures that agency decision makers have information about the environmental effects of Federal actions and information on a range of alternatives that will accomplish the project purpose and need.

Federally listed plants occurring on private lands have very limited protection under the Act unless they are also protected by State laws. *S. mesae-verdae* is listed as endangered by the State of New Mexico under the New Mexico Endangered Plant Species Act, Section 75-6-1 NMSA 1978, which protects it from unauthorized collection, transport, and sale, but provides no protection from land use impacts. This species is not state listed as threatened or endangered in Colorado. There are no regulatory protections for federally listed threatened and endangered plant species from surface disturbing land uses on private or state owned lands in New Mexico, unless they are authorized, funded, or carried out by a Federal agency and subject to section 7 consultation of the Act. Prohibitions for this species under State law would not be sufficient for its conservation if *S. mesae-verdae* was delisted.

All native cacti, including *S. mesae-verdae*, are on Appendix II of Convention on International Trade of Endangered Species (CITES). Trade of *S. mesae-verdae* seeds and plants (import and export) is regulated under CITES, but there are no protections for internal trade or habitat destruction under this convention. While State and Federal laws against cactus collecting can be substantial and effective deterrents, illegal collecting of *S. mesae-verdae* may regularly occur and likely goes undetected. Most of these populations are located in remote areas with some road access, but are rarely patrolled by law enforcement agents.

The Lacey Act, as amended in 1981, prevents the import, export, sale, acquisition, purchase or interstate commerce or foreign commerce of any plant and/or animal taken, possessed, or sold in violation of any law, treaty, or regulation of the United States, any Indian tribal law, or any regulation of any State. If transported or exchanged for currency, the cactus could be protected under the Lacey Act.

Bureau of Land Management Manual 6840 establishes Special Status Species (SSS) policy for plant and animal species and the habitat on which they depend. This SSS policy refers not only to species protected under the Act, but also to those designated by the State Director as Sensitive. The BLM maintains the *S. mesae-verdae* as a SSS. The intent of the sensitive species designation is to ensure that actions on BLM administered lands consider the welfare of these species and do not contribute to the need to list any SSS under the provisions of the Act.

The Hogback ACEC, located on BLM administered lands, was established after the cactus was listed in 1987. This ACEC designation is intended to ensure that proposed projects in this area receive the highest environmental scrutiny before being implemented. Projects are not prevented from occurring in the ACEC, but recommendations may be made to modify them to protect certain critical resources including *S. mesae-verdae* habitat.

Navajo Tribal Code 17 Section 500(8) defines and protects species in three Groups based on a species' conservation status. Group 1 species or subspecies that are no longer found on the Navajo Nation. Group 2 applies to species or subspecies whose prospects of survival or recruitment are in jeopardy, and Group 3 incorporates species or subspecies whose prospects of survival or recruitment are in jeopardy in the foreseeable future. *S. mesae-verdae* is listed as a G2 Endangered species on Navajo Nation lands, which means that the species' prospects of survival or recruitment are or are likely to be in jeopardy (Navajo Natural Heritage Program 2008b).

Title 17 § 507 of the Navajo Tribal Code makes it unlawful for any person to "take, possess, transport, export, process, sell or offer for sale or ship any species or subspecies" on the Navajo Endangered Species List.

Existing regulatory mechanisms, secured through the ESA, have reduced some threats on Federal lands. In the absence of the ESA's protective regulatory mechanism, we believe the situation would be considerably worse. After considering the regulations other than the ESA designed to protect this cactus, we believe other Federal, Tribal, and State legal protections provided for this species are not sufficient for its conservation in the foreseeable future.

2.3.2.5 Other natural or manmade factors affecting its continued existence – Factor E

Pesticide Use

Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of *S. mesae-verdae* or their host plants (Service 1984). Herbicides are commonly used for noxious weed control, but no documentation has been provided on herbicide application occurring, and whether any *S. mesae-verdae* populations have been directly or indirectly affected. On the other hand, agricultural use of pesticides has been reported on nearby BLM lands.

Pesticides, particularly insecticides, are linked to bee declines (Kearns et al 1998; Kremen et al. 2002; National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008; Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (*Apis mellifera*) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975; Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007; Tuell and Isaacs 2010).

Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests, including army cutworms (*Euxoa* spp). Most of the *S. mesae-verdae* populations are miles away and would not be impacted by drift (Sivinski 2000). However, a few cactus populations are situated near agricultural areas, such as the Waterflow population, which is close to an apple orchard and alfalfa field, yet it has been successfully setting fruit until the severe drought of 2002-2003. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of *S. mesae-verdae*. Thus, we do not consider pesticides to be a threat to this species in the foreseeable future.

Climate Change

Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 º C (1.3 º F) during the 20th century (IPCC 2007). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change.

The IPCC (2007) projects that there will be an increase in the frequency of extreme weather events that are temporally and spatially more variable as a result of climate change. The most recent drought (2002-2003) spanning southwestern North America was anomalously dry with unusually high temperatures (Breshears et al. 2005). In Shiprock, NM, within *S. mesae-verdae* habitat, no precipitation was recorded in 2002, and by 2004, 33 mm (1.3 in) was recorded which is the third lowest level measured since 1926 (Western Regional Climate Center 2010). Mean annual precipitation since the drought (2003-2007) has been 97 mm (3.8 in), well below the long-term average (Western Regional Climate Center 2010).

Climate change also involves an increase in atmospheric carbon dioxide which is commonly associated with increased temperatures and the greenhouse effect. This increased carbon dioxide directly affects plant photosynthesis (Huxman and Scott 2007). At the plant level, adapting to drought involves the ability to balance carbon sequestration (the uptake and storage of carbon), carbon respiration (efflux back into the atmosphere), and maintain sustainable evapotranspiration rates (Huxman and Scott 2007). Adaptation would also require a plant to change its phenology (timing of life cycle events) to coincide successfully with extreme shifts in temperature, precipitation, and soil moisture (Walther et al. 2002) which are all part of the evapotranspiration equation. The potential for rapid climate change, which is predicted for the future, could pose significant challenges for plants because they may not be able to adjust their phenology or photosynthetic mechanisms quickly enough.

Cacti have a unique photosynthetic pathway referred to as Crassulacean acid metabolism (CAM) which is most effective in low soil moisture, intense sunlight, and high daytime temperature conditions, and is considered to be a desert adaptation (Barbour et al. 1999). If atypical cacti mortality occurs, as documented with *S. mesae-verdae* during the drought of 2002-2003, this could be evidence that a climatic severity threshold may have been crossed even for this well-adapted CAM species.

At the population level, *S. mesae-verdae* is a spring flowering species (Heil and Porter 1994). Growing seasons are becoming longer and warmer in many regions

(Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend.

Increases in predatory insects are also predicted with climate change (Enquist and Gori 2008). This was documented for *S. mesae-verdae* during the drought of 2002-2003 with the unusual and extensive invasion of the longhorn cactus beetle and the army cutworm. The drought combined with concurrent insect infestations significantly reduced *S. mesae-verdae* populations and recovery has been extremely slow.

Sclerocactus mesae-verdae is likely to have experienced and rebounded from periods of drought and cycles of insect predation in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Since the documented decline of *S. mesae-verdae* was concurrent with the drought of the early 2000s, we believe that climate change is a severe threat to this species in the foreseeable future.

2.4 Synthesis

Prior to anthropogenic threats and anomalous climate extremes, *S. mesae-verdae* populations likely adapted to more cyclic disturbance regimes with high mortality balanced by successful regeneration and reproduction. Fluctuations in the monitored natural populations appeared to be normal and relatively stable until 2002-2003 when a significant die-off of mature cacti occurred. The current known number of 4,204 cacti represents a 58 percent loss of individual cacti since the early 2000s. Furthermore, from the early 2000s until present, natural threats including drought and increased longhorn cactus beetle predation have negatively impacted this species. Since the development of the Recovery Plan in 1984, human caused threats pertaining to highway and transmission line construction, oil and gas exploration and production, OHV use, and commercial and residential development are increasing in intensity rangewide. Although some level of regulatory protection exists for all known populations, current regulatory protections do not adequately protect the species, mostly due to lack of enforcement. Recent survey results on Navajo Nation and BLM lands have shown mature plant increases in some populations, indicative of the possible capacity of this species to gradually recover. However, other *S. mesae-verdae* population numbers have not returned to pre-drought levels, supporting possible evidence of a low potential for recovery if conditions are not favorable. Cumulatively, threats in the species' range have reduced the numbers of this cactus in a relatively short period of time in the populations that have been monitored since 1986.

Overall population numbers have not returned to pre-drought levels, and in one case, extirpation of a single monitored population occurred (Navajo Nation, Sheep Springs site). Several other populations are still considered tenuous (BLM, Hogback site and New Mexico State, Waterflow site) even seven years after the drought appears to have subsided. It is unknown if these

populations have been permanently diminished or if some individuals rebound from drought stress more slowly than others. The frequently reported loss of the larger, most reproductive, adult-size classes is of concern for the species' resiliency to future impacts and the ability to recruit new individuals. A commitment to *S. mesae-verdae* surveys, site revisits, and regular monitoring is needed to increase our understanding of the species' status and management needs. Long-term management of OHV use in areas of sensitive habitat will be necessary to balance between species' protection and recreation. To identify best management practices for this cactus, the implementation of conservation measures for highway construction, transmission line installation, oil and gas activities, and urban development projects needs to be completed. Long-term effects of implemented conservation measures, documented and quantified by land managers in accessible reports, should be a focus in the continued management of *S. mesae-verdae* to understand how best to mitigate for *S. mesae-verdae* in light of increased threats of development.

As of 2010, there is indication that some *S. mesae-verdae* populations are recovering from the 2002-2003 drought, although others remain stable at reduced numbers. Recent surveys for proposed projects have found new populations of *S. mesae-verdae* in areas previously unknown to be occupied, suggesting that the species may be more widespread or numerous, and that thorough surveys are crucial to accurately assess the status of this cactus and its resiliency to threats. For instance, after a survey within previously unsurveyed, potential habitat on Navajo Nation lands in 2009, the same area surveyed in 2010 yielded a 280 percent increase in adult cacti in one year, indicating a dramatic recovery at least 8 years post-drought that would have been missed if continued surveys were not completed. It also reveals an interesting survival mechanism for adult plants that we are just beginning to understand - possibly a form of dormancy underneath the soils during difficult ecological conditions, adding difficulty to survey accuracy and comparison from year to year.

Although the 1984 recovery criteria have not been entirely met nor do we anticipate that they will be met in the foreseeable future, progress has been made by the establishment of several conservation areas (Recovery Criterion 1), and the species has been found to successfully germinate, and especially transplant, under specific conditions (Recovery Criterion 2). With further implementation and enforcement of conservation in the established ACEC area on BLM land, and in CAs on Navajo Nation land, recovery of the cactus would be further supported.

Upon reviewing the combined significance of current threats, we recommend that the status of federally threatened remain unchanged at this time. However, we also recommend that the cactus be closely monitored for future population trends, new population discoveries, and the level of cumulative threats. We note that all previously identified threats are still continuing including: (1) highway construction and transmission line installations; (2) oil and gas development and associated activities; and (3) commercial and residential development. We also note that there is an increased level of threat from: (1) OHV activity; (2) predicted increase in frequency and severity of drought; (3) an eroded population baseline that has not recovered to pre-drought levels; and (4) a restricted distributional range. If these threats notably increase in the near future, or if population trends decline and there is no evidence of recovery, consideration of reclassification of the species to endangered may be necessary.

3.0 RESULTS

3.1 Recommended Classification: No change; remain as threatened.

At this time we lack a clear understanding of the number of *S. mesae-verdae* individuals and populations within its range, and of how multiple threats could affect the cactus if conservation measures are better enforced. If mitigation actions, such as avoiding the cactus, transplanting the cactus, controlling vehicle access, and monitoring pre- and post-project, are implemented in areas slated for future projects, the cactus has a chance of stabilizing and improving its population status based on recent survey data. Although human caused threats are still ongoing, and predicted severity of drought will likely affect future demographic trends, suitable habitat in the vicinity of *S. mesae-verdae* has been only partially surveyed and the cactus potentially occurs in greater numbers than what have been previously known to exist.

3.2 New Recovery Priority Number: 11C

Brief Rationale: We recommend the recovery priority number be changed from 8C, a species with a moderate degree of threat and high recovery potential, to 11C, a species with a moderate degree of threat and low recovery potential. Moderate threats indicate the species will not face extinction if recovery is temporarily held off, although population declines or threats to its habitat are still present. According to our guidance, a species receives a C when it is in conflict with construction, other development projects, or other forms of economic activity (48 FR 43104). Monitoring indicates some negative effects to *S. mesae-verdae* populations from human impacts and various forms of construction, yet the cactus appears to respond positively to protective measures. In combination with natural impacts such as drought and predation, threats due to current land use practices and the slow rate at which the species reaches its reproductive peak and replaces losses in the population, indicate a low recovery potential. The cactus' life history characteristics in conjunction with its apparent slow recovery from the 2002-2003 drought support the change from a high to a low recovery potential for this species.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Revise the recovery plan for this species to incorporate new information on biology, ecology, threats, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which addresses all listing factors relevant to this species.

- Recommend more stringent off-highway vehicle use restrictions and stronger enforcement of OHV laws in known and potential cacti habitat.

- Develop a *S. mesae-verdae* multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery.

- Develop standardized survey and monitoring protocols for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis.

- Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects).

- Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs.

- Provide legally grown seeds and plants of *S. mesae-verdae* to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range.

- Provide viable *S. mesae-verdae* seeds to a seed bank operating under the Center for Plant Conservation guidelines.

- Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of this species.

- Determine microhabitat needs of this species (“nurse” plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site.

- Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Mesa Verde cactus (*Scerlocactus mesae-verdae*)

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: Not applicable

Review Conducted By: Laura Hudson, Vegetation Ecologist, New Mexico Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 9/27/10

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve _____ Date 10/22/10

Cooperating Regional Director, U.S. Fish and Wildlife Service, Region 6

Concur ✓ Do Not Concur _____

Signature _____ Date 11·10·10