

**30 YEAR
Monitoring Report**

MESA VERDE CACTUS
(Sclerocactus mesae-verdae)

1986 – 2016



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INTRODUCTION

Mesa Verde cactus (*Sclerocactus mesae-verdae*) was listed as a threatened species under the Federal Endangered Species Act in 1979 (44 FR 62471). The primary reasons for listing included illegal collection, highway construction, and off-road vehicle use.

Mesa Verde cactus is endemic to the Four-Corners Region of northwestern New Mexico and southwestern Colorado. The total range of this species is an area of approximately 75 x 30 miles, stretching from near Naschitti in southern San Juan County, New Mexico to about 10 miles north of the New Mexico border in Montezuma County, Colorado. Distribution within this range is sporadic and widely scattered. At least 95% of the total Mesa Verde cacti occur on tribal lands, primarily on Navajo Nation lands in New Mexico. North of Waterflow, New Mexico, Mesa Verde cactus occurs on small blocks of BLM and State Trust lands. Small numbers of cacti also occur on Public Service Company of New Mexico lands and private lands.

Mesa Verde cactus habitat occurs within the Colorado Plateau ecoregion, one of seven ecoregions represented in the state of New Mexico (Griffith et al. 2006, Level III). The ecoregion is characterized by low variable annual rainfalls, averaging 7 inches in Shiprock, NM (WRCC 2017). The topography is eroded badlands of numerous small dry drainages between low hills and ridges at elevations between 4,800 and 6,560 ft. The majority of the occupied habitat consists of Mancos Shale which is a silty sediment of marine origin that is highly alkaline and saline. A relatively small portion of the total habitat occurs on the east side of the Farmington Hogback near Waterflow, New Mexico, on Fruitland Shale which is fluvial in origin. This shale is highly sodic and also contains obvious quantities of selenite gypsum.

Vegetation cover in Mesa Verde cactus habitat is sparse and has the appearance of a nearly barren badland. It is most frequently associated with low-growing species of saltbush (*Atriplex cuneata*, *A. corrugata*, *A. confertifolia*). Other woody associates are *Artemisia spinescens* and *Frankenia jamesii*. Grass cover is typically sparse, but can include *Hilaria jamesii*, *Sporobolus cryptandrus* and *Oryzopsis hymenoides*. Herbaceous annuals, including invasives, such as *Halogeton glomeratus*, *Salsola kali*, *Descurainia pinnata*, *Chorispora tenella*, *Bromus tectorum*, and *Eremopyrum triticeum*, can be common during wet years and entirely absent during periods of drought.

Mesa Verde cactus can reach an age of 20 years or more. Individual cacti reach reproductive maturity at 2 - 3 years of age, although some seedlings becoming established in difficult microhabitats may take longer. Flower buds begin to swell in early April and bloom during late April and early May. Fruits mature in late May and through June. Number of flowers and success in fruit-set are strongly correlated to size and condition of the individual plant. Long term demographic monitoring has variously occurred on BLM lands, Navajo Nation and Ute tribal lands (Coles et al. 2012, Cully et al. 1993, Hazelton 2011, 2013; Kendall 2010; Roth 2004, 2008, 2014; Sivinski 1999, 2003, 2007).

STUDY AREA AND METHODS

The Waterflow monitoring plot was established on BLM land north of Waterflow, New Mexico, in 1986. This plot was monitored every spring for 10 years (1986-1995). Thereafter infrequent monitoring was accomplished in 1999, 2003, 2007, 2014, and 2016 by the New Mexico Forestry Division, BLM staff, and a variety of volunteers.

The monitoring plot is located on silty shale of the Fruitland Formation which is a sparsely vegetated, almost barren badland of low ridges and dry drainages. The perennial vegetation provides only 6% ground cover and is mostly composed of low-growing species of saltbush (*Atriplex cuneata*, *Atriplex corrugata*, *Atriplex confertifolia*). Within the past decade halogeton (*Halogeton glomeratus*) has invaded the monitoring site, covering the majority of the occupied habitat inside the monitoring plot and throughout the area north of Waterflow.

The plot is a 100 x 200 meter rectangle with a grid of steel rebar stakes along the plot boundaries. In 2016 the plot was monitored on May 12. In previous monitoring years, individual cacti were located by triangulating surveyor tapes from two assigned stakes marking the plot boundaries. Individual cacti were tagged with rectangular numbered aluminum tags. After a 7 year monitoring gap the majority of these tags was either gone or no longer readable in 2014, which made relocating previously documented cacti challenging. In 2014 surveyors walked evenly spaced transects throughout the plots and flagged each cactus found. Individual plants were then mapped with a GPS and tagged with a round, individually numbered metal tags.

In an effort to further simplify the sampling design, ensure maximum detection of tagged cacti, and to better capture recruitment of small individuals and seedlings, we established 41 sub-monitoring plots in 2016 inside the 100 x 200-meter study plot. Each plot has a 1m radius from the plot center and originally contained at least one tagged, live cactus. Each plot center is marked by a rebar or wooden stake with a numbered aluminum tag and its location is mapped with a Garmin Monterra GPS.

Data collected for each cactus included stem diameter, reproductive status (number of flowers and/or fruits), number of stems, and condition. Condition was evaluated by assigning a vigor rank (1 = excellent, 2 = good, 3 = fair, 4 = poor, 5 = dead). In addition, percent cover of *Halogeton glomeratus* was visually estimated inside each sub-monitoring plot in 2016.

RESULTS

The total number of Mesa Verde cactus in the Waterflow plot has fluctuated since 1986 (Figure 1). It was relatively low in 1986 when the plot was established. The plot population began to trend upward (except 1990) and was fairly large during the early years of the 1990s until it reached another low point in 1995. The highest number of plants was recorded in 1999 (235 plants). This was likely due to the very favorable rainfall year of 1997, which received 11.45 inches of precipitation, followed by another above average rainfall year in 1998 (from weather station at adjacent San Juan Coal Mine). Most of the cacti in the 1999 plot population were juvenile, non-flowering individuals (Figure 2). A similar favorable precipitation year occurred in 1990 followed by several years of normal rainfall, which correlates positively with an increase in

cactus density within the plot after 1990. The low density year of 1990 followed an especially dry period in 1989, which was a year receiving only 3.82 inches of precipitation. The very low density year of 1995 cannot be explained by the precipitation data. Many dead cacti were found in the plot that year and are assumed to have been killed by the longhorn cactus beetle (*Moneilema semipunctatum*), a frequent native predator of cacti.

The population crash observed in 2003 also followed an extremely dry period with only 2 inches of precipitation from September 1, 2001 to August 31, 2002. Only 26 of the 235 individual cacti found in May 1999 were still alive in April 2003 and the total population had decreased from 235 cacti in 1999 to 74 in 2003 (Figure 1). The dead cacti were hollowed-out and most of the surviving cacti had damaged, chewed-up stems, presumably by longhorn cactus beetle or army cutworm (Lepidoptera) predation in 2002. The population appeared to be recovering in 2007, when 113 cacti were found in the monitoring plot. However, only 48 cacti were located in 2014, with only somewhat of an increase in 2016 (62 plants).

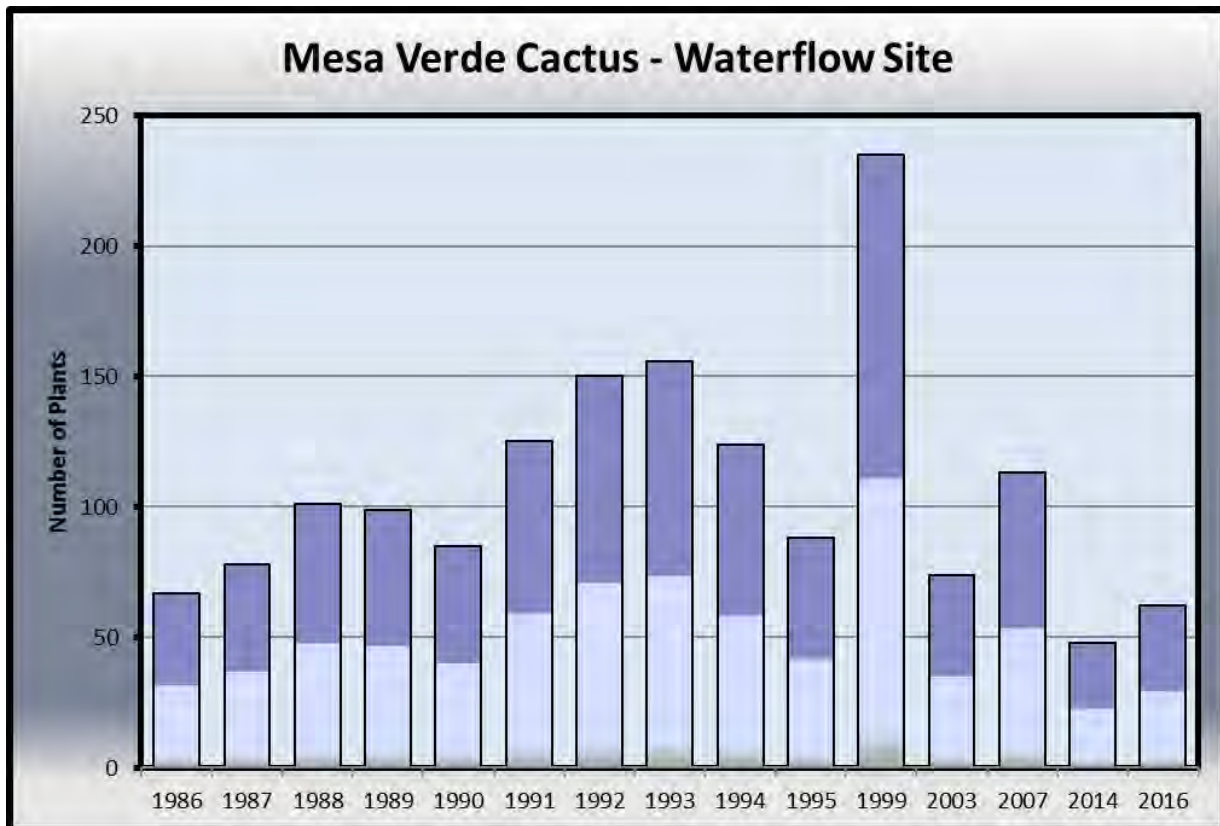


Figure 1. Number of Mesa Verde cacti located in the Waterflow monitoring plot between 1986 and 2016.

Density within size classes also varied greatly over the study period (Figure 2). Mesa Verde cactus size is often indicative of relative age. Cacti that are 2 cm or less in diameter are considered juveniles or seedlings. They can (but seldom do) begin to produce flowers at a young age when the stems reach about 2.0 cm in diameter. They begin to regularly produce 1- few

flowers at the 4-6 cm stage, but the large cacti (>6 cm or multistemmed) produce the greatest per-plant number of flowers (up to 27/plant). Reproductive effort varies greatly from year to year and is associated with rainfall. The lowest reproductive effort was recorded in 2003, when only 9 % of the plants inside the monitoring plot were flowering or fruiting (Table 1). The largest reproductive effort was recorded in 2014 when 94% of the population was flowering or fruiting. Reproductive effort was also high in 2016, when 87% of the population was reproductive.

Table 1. Reproduction efforts of *Sclerocactus mesae-verdae* at the Waterflow, New Mexico monitoring plot.

Year	Number of Cacti Reproductive	Percent of Population Reproductive
1986	42	64%
1987	54	73%
1988	51	67%
1989	66	67%
1990	48	58%
1991	102	82%
1992	116	83%
1993	108	76%
1994	92	76%
1995	81	88%
1999	51	22%
2003	7	9%
2007	54	48%
2014	45	94%
2016	54	87%

The numbers of seedlings detected in this plot can vary greatly depending on precipitation or the keenness of the observers, or both (Figure 2). Unfortunately, the monitoring plot is very large, making it difficult to detect the small cryptic cacti, especially seedlings, juveniles, and small non-flowering plants. Since monitoring resumed in 2014 the pervasive annual halogeton (*Halogeton glomeratus*) has invaded the area, including the study plot, making it even more difficult to detect small non-flowering individuals. In 2016, smaller sub-plots were established within the large monitoring plot to address this issue and better capture recruitment in the future.

Adult cactus density was generally more stable until 2003 when nearly all large cacti were killed by insects. The majority of the plot population is usually medium-sized plants (2.1-6.0 cm)(Figure 2). Only the years 1993 and 1999 had the seedling class at greater densities than the next larger size class. Only one seedling/juvenile plant was documented in 2014 (0.2 – 2.0 cm in diameter). Despite favorable rainfall in 2015 and 2016, and the establishment of smaller sub-plots, no juveniles or seedlings were recorded in 2016.

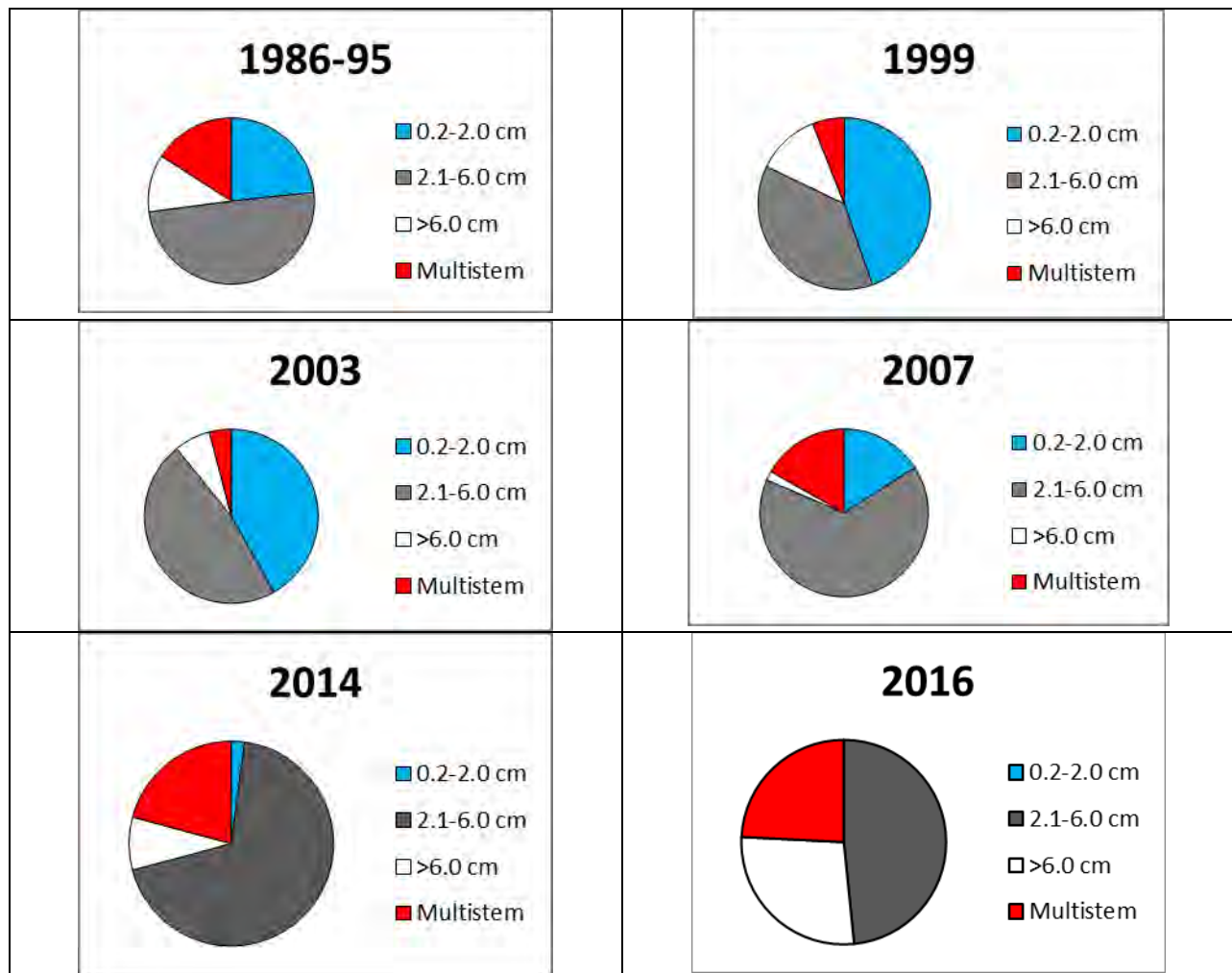


Figure 2. Size class distribution of Mesa Verde cactus between 1986 and 2016 at the Waterflow monitoring site.

In 2003 all data sheets were reexamined for causes of mortality in this population (Sivinski 2003). Usually the cause could not be determined. From 1986 to 1999, the dead remains of the monitored cacti could only be found 35% of the time. Usually no remains were located. Only three instances (1987, 1994 and 1995) when holes in the ground or crumpled tags were found suggested that one or a few cacti had been removed by cactus poachers. The 2003 monitoring year was different. The dead remains of 76% of the cacti that had died since 1999 were still visible and assumed to be victims of insect predation during the summer of 2002. Since 2014 vigor of individual plants is recorded. The majority of plants were found in good to excellent condition in 2014 and 2016 (Figure 3). In 2016 two plants were in poor condition and five plants were found dead. Four previously tagged individuals could not be relocated. Twenty-one new plants were found in the monitoring plot. None of the new plants were in the seedling/juvenile size class (0.2 – 2.0 cm in diameter). These were likely overlooked during the 2014 monitoring year.

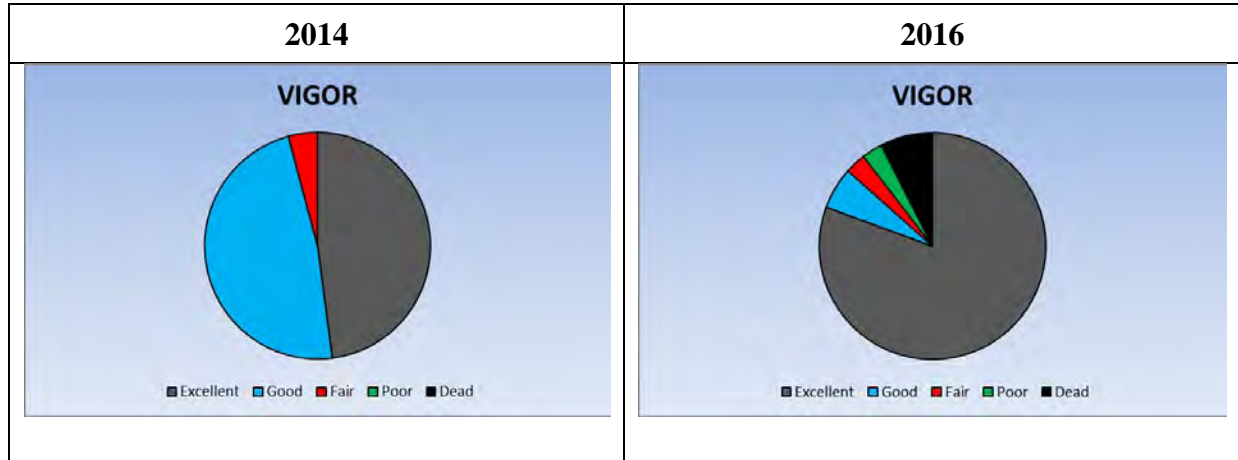


Figure 3. Vigor of Mesa Verde Cactus at the Waterflow monitoring plot in San Juan County, NM.

The longhorn cactus beetle (*Moneilema semipunctatum*) is a native predator of cacti, typically on species of *Cylindropuntia* and *Opuntia*. However, more recently this beetle has been observed to use various species of *Sclerocactus* as an alternate host (Woodruff 2010). The larvae of these beetles burrow into the stem of the cactus and pupate in the cactus and emerge as adults in the summer. The caudex of a beetle-damaged Mesa Verde cactus can survive for period of months and even initiate new stems, but the majority eventually dies from desiccation or secondary infections. Army worms (moth larvae) were also found in the dead stems of Mesa Verde cactus in 2003 (Barney Wagener, BLM-Farmington District, pers. comm. 2003).

The 2002-2003 insect kill of Mesa Verde cactus has been the most extreme during the 30 years this plant's populations have been monitored. Monitoring plots on BLM lands near Waterflow, New Mexico had mortality rates of 68.5% (this study) and 97.1% on another BLM plot (Barney Wegener and John Kendall, BLM-Farmington District, 2003). Similar declines were noted in 2003 on the Navajo Nation in New Mexico and the Ute Mountain Ute Reservation in Colorado (Ladyman 2004; Roth 2004, 2008; Coles 2012).

In 2016, the average cover of halogeton was 9% within the 41 sub-monitoring plots, ranging from 0 to 30%. Plants were generally found in depauperate condition and of small stature, likely in response to limited rainfall in March and April of 2016 (WRCC 2017).

CONCLUSIONS AND RECOMMENDATIONS

Although the Mesa Verde cactus population at the Waterflow plot has been shown to fluctuate, the population has not recovered since the 2002 extreme die-off was documented in this and other monitoring sites. Recruitment is episodic and related to periods of favorable precipitation. The greatest mortality event at the Waterflow population and other monitoring sites was documented in 2003 and was the result of insect predation during 2002. No dead plants were found in 2014, indicating that plants died several years prior, possibly during the drought years of 2009 and or 2012. It is possible that some smaller, non-flowering plants were missed in 2014 because the majority of tags were missing or no longer associated with plants (pulled out of the ground). Indeed, more plants were found during the 2016 monitoring year, some of which were likely present in 2014, but were not found. However, it is also possible that the population is in decline as a result of prolonged drought conditions and a diminishing seed bank as reproductive adults have declined over the past 15 – 20 years. In addition, halogeton has invaded the study site. This annual invasive weed is known to produce mineral salts which may inhibit or depress plant growth in associated species. The impacts of changes in soil chemistry on the germination and establishment of Mesa Verde Cactus is unknown. Population fluctuations maybe be natural for Mesa Verde cactus, but may also indicate a slow decline in response to global climate change and associated changes in vegetation community, increases in invasive species and unprecedented and prolonged droughts.

To better understand the decline of this population and gain a better understanding of overall population trends on BLM lands, monitoring of this plot needs to be more frequent and take place at a minimum of every 1-2 years. Once a better understanding of the cause of decline is gained, management actions and conservation measures can be developed to address and hopefully halt a continued decline. Management actions may include additional protection measures, population augmentation, reintroductions, ex-situ conservation through seed storage, additional studies to research causes of decline (pollinator availability, pollination success, seed banking, inbreeding depression, predation, impacts of invasive species on germination and establishment), and rangewide surveys to document the current abundance and distribution of the species.

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LITERATURE CITED

- Coles J. J., K.L. Decker, and T.S. Naumann. 2012. Ecology and population dynamics of *Sclerocactus mesae-verdae* (Boissev. & C. Davidson) L.D. Benson. *Western North American Naturalist* 72(3): 311-322.
- Cully, A., P. Knight, R. Sivinski, M. Olwell, D. E. House, and K. Lightfoot. 1993. Preliminary results from a long-term study of Mesa Verde cactus (*S. mesae-verdae*). In: Proceedings of the Southwestern Rare and Endangered Plants Conference – 1992. R. Sivinski and K. Lightfoot (eds.), pp. 108-120, Misc. Publ. No. 2, New Mexico Forestry and Resources Conservation Division, Santa Fe.
- Griffith, G.E., J.M. Omernik, M.M. McGraw, G.Z. Jacobi, C.M. Canavan, T.S. Schrader, D. Mercer, R. Hill, & B.C. Moran. 2006. Level III Ecoregions of New Mexico (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000). http://ecologicalregions.info/htm/nm_eco.htm
- Hazelton A. F. 2011. Mesa Verde Cactus (*Sclerocactus mesae-verdae*) 10 Year Transplant Monitoring Report -Shiprock Fairgrounds 2001-2011. Unpublished report prepared for the Navajo Natural Heritage Program, Department of Fish & Wildlife, Window Rock AZ, 86515
- Hazelton A. F. 2013. Mesa Verde Cactus (*Sclerocactus mesae-verdae*) Monitoring Report -El Malpais Monitoring Site 2008 - 2013. Unpublished report prepared for the Navajo Natural Heritage Program, Department of Fish & Wildlife, Window Rock AZ, 86515.
- Kendall, J. 2010. Bureau of Land Management Hogback ACEC Mesa Verde cactus plot data and status updates. Excel database received by the USFWS, May 3, 2010. Bureau of Land Management, Farmington, New Mexico.
- Ladyman, J. 2004. Status Assessment Report for *Sclerocactus mesae-verdae* (Mesa Verde Cactus). Prepared for: The Navajo Natural Heritage Program, Window Rock, AZ.
- Roth, D. 2004. Monitoring Report: Mesa Verde cactus transplantation for BIA Route N57 – Cudei Rd, San Juan County, NM. Navajo Natural Heritage Program.
- Roth, D. 2008. Monitoring Report: *Sclerocactus mesae-verdae* transplant project - Northern Navajo Fairgrounds, Shiprock, San Juan County, NM. Navajo Natural Heritage Program.
- Roth, D. 2014. Monitoring Report: Mesa Verde cactus (*Sclerocactus mesae-verdae*). 1986 – 2014. New Mexico Forestry Division - Energy, Minerals and Natural Resources Department, Santa Fe. Unpublished report prepared for the U.S. Fish and Wildlife Service, R2, Albuquerque, NM.

- Sivinski, R. 1999. Mesa Verde cactus: A fourteen-year demographic summary of the Waterflow, New Mexico study plot. New Mexico Forestry Division - Energy, Minerals and Natural Resources Department, Santa Fe. Unpublished report prepared for the U.S. Fish and Wildlife Service, R2, Albuquerque, NM
- Sivinski, R. 2003. Mesa Verde cactus: An eighteen-year demographic summary of the Waterflow, New Mexico study plot. New Mexico Forestry Division - Energy, Minerals and Natural Resources Department, Santa Fe. Unpublished report prepared for the U.S. Fish and Wildlife Service.
- Sivinski, R. 2007. Mesa Verde cactus: a twenty-one-year demographic summary of a Waterflow, New Mexico study plot. New Mexico Energy, Minerals, and Natural Resources Department, Santa Fe, New Mexico. Unpublished report prepared for the U.S. Fish and Wildlife Service.
- USDI-Fish & Wildlife Service. 1984. Mesa Verde cactus (*Sclerocactus mesae-verdae*) Recovery Plan. Region 2, Albuquerque, NM.
- USDI-Fish & Wildlife Service. 2010. Mesa Verde Cactus *Sclerocactus mesae-verdae* (Bossevain & C. Davidson) L. Benson. 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Albuquerque, New Mexico
- Western Regional Climate Center. 2017. Monthly total precipitation (inches) at the Pecos Ranger Station, Pecos, NM. Accessed online on 2/21/2017 at <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm8284>
- Woodruff, D. 2010. The cactus and the beetle. Utah Native Plant Society, Salt Lake City, UT. Sejo Lily Vol. 33: 3.