

STATUS REPORT
MESA VERDE CACTUS
(Sclerocactus mesae-verdae)
BLM HOGBACK ACEC
Waterflow, NM
2020



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INTRODUCTION



Mesa Verde cactus (*Sclerocactus mesae-verdae*) was listed Threatened under the Federal Endangered Species Act in 1979 (44 FR 62471). The primary reasons for federal listing included illegal collection, highway construction, and off-road vehicle use. It is also listed Endangered in the State of New Mexico (19 NMAC 21.2). NatureServe considers Mesa Verde cactus a globally and State imperiled species (G2/S2). The species occurs primarily on Navajo Nation lands, where it is listed Endangered (Group 2) on the Navajo Endangered Species List. Mesa Verde cactus is assigned an overall conservation rank of ‘under conserved’ by the New Mexico Rare Plant Conservation Strategy Rare Plant Scorecard due to moderate to high levels of documented threats, documented population declines and limited distribution (EMNRD – Forestry Division 2017).

Distribution

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. Up to 95% of Mesa Verde cacti occur on tribal lands, primarily on Navajo Nation lands in New Mexico. In Colorado Mesa Verde Cactus occurs exclusively on Ute Mountain Ute tribal lands. In New Mexico, Mesa Verde cactus also occurs on small blocks of BLM, private, and State Trust lands, north of Waterflow.

Habitat

Mesa Verde cactus habitat occurs within the Colorado Plateau and Arizona/NM Plateau ecoregions, two of eight ecoregions represented in the state of New Mexico (Griffith et al. 2006, Level III). The ecoregion is characterized by low variable annual rainfalls, averaging 8.21 inches in Farmington, NM (WRCC 2021). The topography is eroded badlands of numerous small dry drainages between low hills and ridges at elevations between 4,800 and 6,560 ft (Figure 1). 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.



Figure 1. Intact habitat of Mesa Verde cactus inside the BLM Hogback ACEC.

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*, *A. gardneri*). Other woody associates are *Artemisia spinescens*, *Tetradymia spinescens*, *Zuckia brandegei*, and *Frankenia jamesii*. Grass cover is typically sparse, but can include *Hilaria jamesii*, *Sporobolus cryptandrus* and *Oryzopsis hymenoides*. Common associate forbs include *Sphaeralcea coccinea*, *Phacelia splendens*, *Eriogonum salsuginosum*, *Eriastrum diffusum*, *Stanleya pinnata*, and *Cryptantha* species. Invasive annual species can be common during wet years and entirely absent during periods of drought. These include *Halogeton glomeratus*, *Salsola kali*, *Descurainia pinnata*, *Chorisporea tenella*, *Bromus tectorum*, and *Eremopyrum triticeum*,

Life History

Mesa Verde cactus can reach an age of 50 years or more (Coles et al. 2012). 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 into early May. Fruits mature in late May and through June. Germination of seedlings is thought to occur with the summer monsoons, establishing into early fall. The

number of flowers and success in fruit-set are strongly correlated to size and condition of the individual plant. Large plants can be up to 19 cm in diameter (Cully *et al.* 1992).

Population Trends



Long term demographic monitoring has variously occurred on BLM lands, Navajo Nation, and Ute Mountain Ute lands (Coles *et al.* 2012; Cully *et al.* 1992; Hazelton 2011, 2013; Kendall 2010; Roth 2004, 2008, 2020; Sivinski 2007).

From the time of federal listing to around 2002/2003 new populations were regularly documented and monitored populations on the Navajo Nation, the BLM, and the Ute Mountain Ute reservation indicated stable or increasing populations. Starting in 2003, mortality observed at all monitoring sites was significantly higher than ever observed during previous monitoring years and some sites were a complete loss (Roth 2004, BLM 2003, Sivinski 2003, Kendall 2010, Hazelton 2011). Higher mortality rates were attributed to the combination of an extreme dry year with an outbreak of cactus borer beetles and army cutworms.

In 2004 more than 56 previously occupied sites were surveyed on the Navajo Nation, covering approximately 4,723 acres (Ladyman 2004). Several of these sites were reported to have had 1,500 or more individuals prior to 2002. In 2004 few sites supported more than 20

individuals. The total number of live plants documented at all sites surveyed was 948. This represented a severe decline in plant numbers and was consistent with population trend monitoring data from Navajo Nation monitoring sites as well as those monitored on Ute Mountain Ute land in Colorado and BLM lands in New Mexico. Some monitoring sites were abandoned due to the lack of cacti (Roth 2004; Kendall 2010). Recovery has been slow, at best, or non-existent (USFWS 2010, Roth 2020a, Hazelton 2011). In 2018 only 7 live cacti were found at the BLM Waterflow monitoring site, representing an 89% reduction in population size over a period of 2 years (Roth 2020a). This monitoring site is located within the BLM Hogback Area of Critical Environmental Concern (ACEC). All Mesa Verde cactus habitat on BLM lands is included within this 10,000-acre ACEC. The loss of the majority of monitored cacti at the Waterflow monitoring site prompted concern for the overall status of Mesa Verde cacti inside the ACEC, the majority of which had not been visited since the mid-1980s, prior to the establishment of the ACEC (BLM 2020b).

BLM Hogback Area of Critical Environmental Concern (ACEC)

The Farmington BLM designated the Hogback ACEC in their 1988 Resource Management Plan for the purpose of conserving two federally listed plant species, Mesa Verde cactus (*Sclerocactus mesae-verdae*) and Mancos milkvetch (*Astragalus humillimus*), and several other rare or endemic plant species (BLM 1988). It is considered an important area of both regional and national significance for conservation and the study of rare plants. Although some populations may occur within the appropriate habitat on Public Service Company of New Mexico lands and private lands, all but one of the known populations of Mesa Verde cactus outside tribal lands are located within the ACEC boundaries, on BLM and State Trust lands. The ACEC is divided into 2 parcels, with the larger primary parcel located just north of Waterflow, NM, and a smaller disjunct section approximately 1.5 miles north of the primary parcel (Figure 2). Mesa Verde cactus habitat is strictly found within the larger parcel.

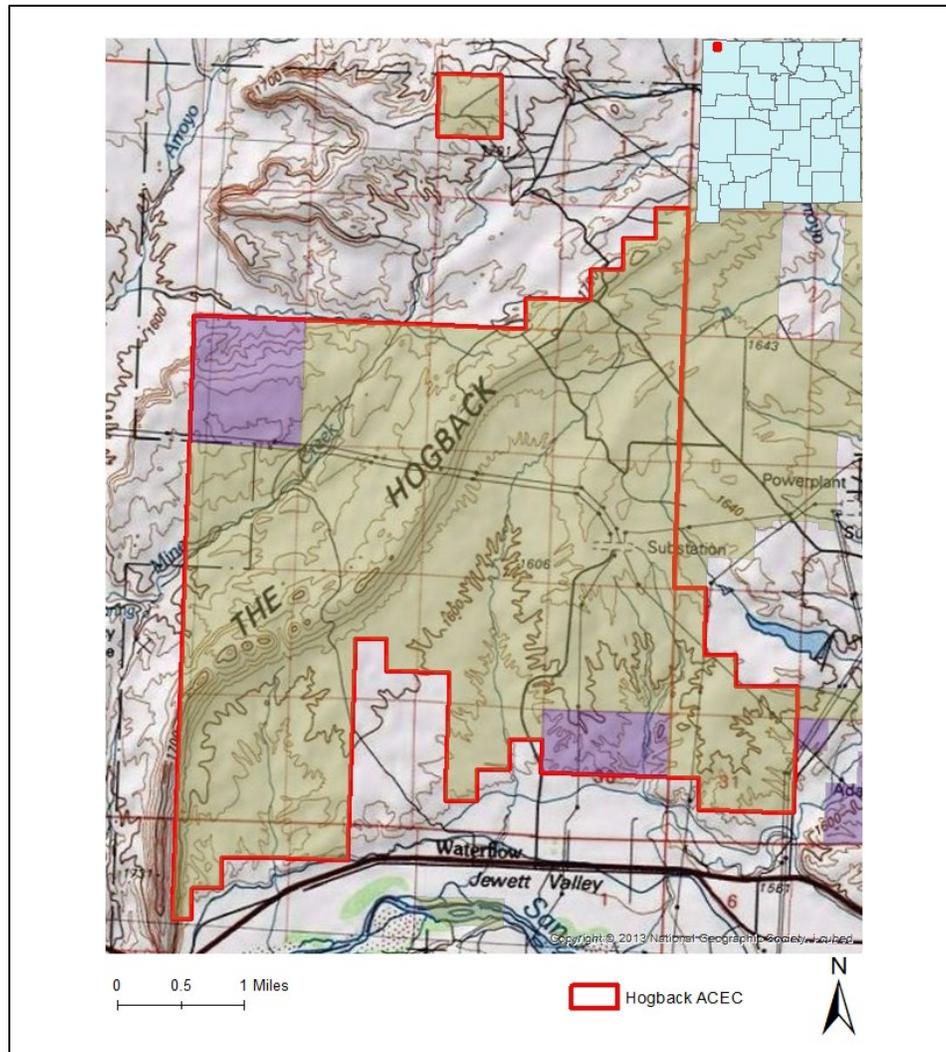


Figure 2. BLM Hogback ACEC boundaries. Purple colored sections are State Trust lands.

ACEC designation was carried forward in the updated 2003 Farmington Resource Management Plan, with some changes to management prescriptions (BLM 2003a). The 2020 draft amendment to the Resource Management Plan does not propose any changes to the ACEC (BLM 2020a). The current ACEC boundary contains 10,367 acres, including 960 acres of State Trust lands managed by the State Lands Office. The main management objective of the special management area is to meet BLM responsibilities under the Endangered Species Act to protect the habitat of threatened, endangered, proposed, or other sensitive species.

Current management prescriptions are

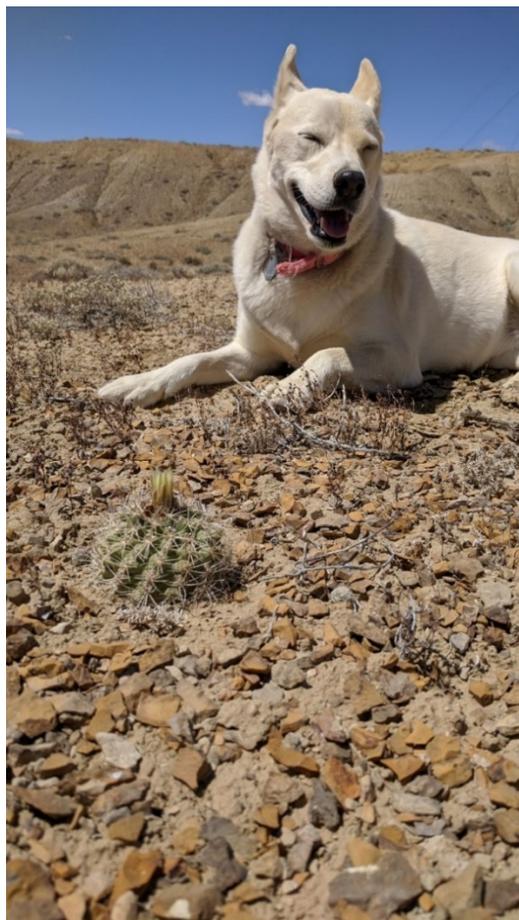
1. Manage existing oil and gas leases under Controlled Surface Use constraint.
2. Discretionary closure on new oil and gas leasing.
3. Close to all other forms of mineral entry.
4. Acquire non-federal minerals.
5. Acquire non-federal inholdings and acquire easements.
6. Land ownership not available for disposal.
7. ROWs permitted on a case-by-case basis with special management constraints and mitigations.
8. OHV limited to existing roads and trails.
9. Designate as Class II, III VRM Area.
10. Close to wood cutting and gathering except for administrative purposes with approval of wildlife staff.
11. Apply limited fire suppression and include invasive weed management.
12. Open to grazing permits.
13. Continue monitoring on regular basis. Develop activity plan as part of area-wide rare plant Habitat Management Plan
14. Apply limited fire suppression

METHODS

Outside regular monitoring and occasional clearance surveys for proposed powerline alignments, no status surveys had been conducted for Mesa Verde cactus populations inside the ACEC since it was established. Hence the 2020 surveys focused on surveying any suitable habitat within the ACEC and specifically targeting 37 previously documented areas of known occupation, with an estimated population of thousands of individuals. Surveys were performed by one person during the last 2 weeks of April 2020, during flowering season for the cactus to optimize detection. Target survey areas were in the vicinity and at historic mapped points and other areas providing suitable habitat within the ACEC boundaries. Survey routes were documented using the tracking function of a Garmin Monterra GPS. Waypoints and associated data were collected with a Samsung Galaxy S2 tablet using the Collector App. At each waypoint the number of live plants, including seedlings, were counted. The number of dead plants was also noted. Additional information was collected on the vigor, reproductive status and observed disturbances associated with the general area of occupation. A photo was taken of each live plant. If plants occurred in a cluster, each head was counted as an individual.

Very limited information on abundance of plants was available for the historic locations outside the active monitoring plots (Table 1). Locational information in the shape of maps and GIS files, and associated data were provided by the BLM, largely derived from data files obtained from the NM Natural Heritage Program. Outside the regular annual or biennial monitoring observations, the majority of prior observations date back to the mid-1980s, with a few dating as far back as the 1960s. Prior to the advent of GPS units, the actual location of an occurrence was often unknown, or occurrences were mapped on general descriptions provided on herbarium vouchers. In order to address this locational uncertainty a measure of uncertainty was incorporated by Heritage program botanists, approximating the extent of the area within which the actual location of the observation is most likely to be contained. On the Hogback ACEC assigned uncertainty distances ranged from 35m to 2,400m. The majority of locations were assigned an uncertainty distance of 100m (73%). Plants found within 100 m of an original mapped point were considered part of the original observation. Plants outside 100m of the point mapped were considered new.

RESULTS



In 2020 live plants were found at or near 13 of the 37 previously documented sites scattered throughout the ACEC, including 2 current and 6 abandoned monitoring sites (Table 1). A total of 182 live plants, including 15 seedlings, were documented from 55 waypoints throughout the ACEC. Only one dead plant was observed. A total of 129 plants were found outside the 2 current existing monitoring sites (Waterflow and BLM monitoring sites). 53 individuals were documented from the 2 monitoring sites.

No plants were found at or near 24 of the 37 target locations. Although available historic location data was approximate at best, plants were noticeably absent from the entire westside of the ACEC in suitable, previously occupied habitat on BLM and State Trust lands. Previously undocumented populations were documented at 5 waypoints, totaling 17 individuals.

The majority of plants were rated in vigorous or normal condition (34% and 59% respectively), only a few were found stressed (7%). Just over half of waypoints reported plants in various stages of reproduction (budding, flowering/fruitlet), and the other half was found vegetative, or non-reproductive.

Table 1. Historic and current number of Mesa Verde cactus inside the BLM Hogback ACEC.

NHNM Source Feature ID	2020 Waypoint Name	Number of plants Prior	Number of Plants 2020	Notes
8346	N/A	N/A	0	None found. Location uncertainty 1,500m
8347	N/A	5	0	None found. Location uncertainty 1,500m
8348	N/A	N/A	0	None found
8349	N/A	N/A	0	None found
8351	N/A	4	0	None found. Uncertainty distance 1500m
8352	N/A	150	0	None found. Uncertainty distance 1500m
8353	Scmeve-sl-9, scme-sl-1, scmeve-sl-2, scmeve-sl-7, scmeve-sl-8, scmeve-sl-4	56	21	Uncertainty distance 800m
8354	N/A	1	0	None found
8355	N/A	9	0	None found
8356	N/A	4	0	None found
8357	N/A	25	0	None found
8364	Scmeve-sl-20-20, scmeve-sl-21-20, monitoring site, scmeve-sl-22-20, scmeve-sl-46-20	N/A	10	Outside of ACEC, State Trust lands, some plants inside abandoned monitoring plot.
8365	Scmeve-50-20	10	21	
8367	N/A	12	0	None found
8368	N/A	3	0	None found
8369	Scmeve-40-20	39	1	Within 100 m of 8368
8370	N/A	3	0	None found
8371	Scmeve-34-20	40	1	Within 100m of 8371
8372	N/A	11	0	None found
8373	N/A	4	0	None found
8375	N/A	43	0	None found
8376	Scmeve-blm-21-20	11	1	Within 100 m of 8376
8377	N/A	4	0	None found
8378	Scmeve-53-20	59	5	
8379	N/A	9	0	None found

NHNM Source Feature ID	2020 Waypoint Name	Number of plants Prior	Number of Plants 2020	Notes
8380	N/A	12	0	None found
8381	N/A	17	0	None found
8382	N/A	17	0	None found
8383	Scmeve-blm-23-20	21	1	
8384	N/A	5	0	None found
17477	Tags 31, 66, 50, 55, plus scmeve-4-20	4 (36 at time of establishment in 1987. Max 61 in 2002)	8	BLM Monitoring Plot #1. 4 plants at time of abandonment in 2008
17478	Tags 72,73,74, 114, 75, 67, 68, 59, 461, 407, 69, 70, 110, 82, 355, 449, 435, 108, 417, 71, 424, 353,84,109,446,328; scmeve-43-20, scmeve-41-20	52 (2019) (81 at time of establishment in 1987. Max 189 in 1992)	40 counted 57 (actual)	Active BLM monitoring site, Plot 2
17479	Scmeve-blm-20-20	0 (8 at time of establishment in 1987. Max 61 in 2000)	1	BLM Monitoring Plot #3B. 0 plants at time of abandonment in 2008
17480	N/A	0 (13 at time of establishment in 1987. Max 246 in 1996)	0	BLM Monitoring Plot #3A. 0 plants at time of abandonment in 2008
17481	N/A	8 (38 at time of establishment in 1987. Max 166 in 2002)	0	BLM Monitoring Plot #4. 8 plants at time of abandonment in 2008
61023	Tag Nos 258, 176, 105, 145, 107, 111, 973,254, 140, 134, 229, scmeve-30-20, scme-31-20, scmeve-33-20, scmeve-32-20, outside Plot 6, west	62 (Based on last full plot count in 2016) (67 at time of establishment in 1986. Max 235 in 1999)	38	Waterflow Monitoring Site. Plants inside and outside of existing sub-plots.

NHNM Source Feature ID	2020 Waypoint Name	Number of plants Prior	Number of Plants 2020	Notes
	of plot 6, near plot 8, outside plot 27			
63801	Scmeve-1-20, scmeve-2-20, scmeve-3-20	9	15	Within 100m of 63801
N/A	Scmeve-5-20	N/A	2	New in 2020
N/A	Scmeve-51-20	N/A	4	New in 2020? Old, unmapped monitoring site.
N/A	Scmeve-44-20	N/A	1	New in 2020
N/A	Scmeve-45-20	N/A	1	New in 2020
N/A	Scmeve-46-20	N/A	9	New in 2020

Off-road vehicle use and was documented throughout the ACEC and was the primary observed direct threat. It was particularly prevalent in the unfenced Section 36, T30N R16W, which is State Trust lands, but also the southwest corner of the ACEC (Figures 3, 4, 5, 6). Other observed disturbances included horse trampling, trash dumping, target shooting, illegal collection, oil & gas development, and invasive species, primarily halogeton (*Halogeton glomeratus*) and Russian thistle (*Salsola kali*)(Figures 7, 8).



Figure 3. Off-road vehicle damage on BLM lands inside the Hogback ACEC.



Figure 4. Off-road vehicle damage to the habitat of Mesa Verde cactus on State Trust lands inside the Hogback ACEC.



Figure 5. Abandoned Mesa Verde cactus monitoring site with off-road damage on BLM lands inside the ACEC.



Figure 6. Mesa Verde cactus damaged by off-road vehicle inside the Hogback ACEC.



Figure 7. Halogeton invasion in the immediate vicinity of the Waterflow monitoring site inside the BLM Hogback ACEC



Figure 8. Mature flowering Mesa Verde cactus with an identifier cairn likely placed by collectors.

DISCUSSION

There are historically at least 6 BLM monitoring sites inside the ACEC. An additional 2 sites were found with rebar and tags, likely associated with the alternative alignments survey for the Navajo Transmission Line Project in 1995 (Ecosphere 1995). All known monitoring sites were surveyed for the presence of cacti in 2020. Two of the sites are still regularly monitored, although one had very few cacti in 2018 and 2020 (Roth 2020a). The one site continuously monitored by the BLM has shown some recruitment (Plot 2), but numbers are still not anywhere near to when the plot was established in 1987. All other monitoring plots had very few or no cacti left, indicating very little recruitment has occurred since the plots were abandoned due to the lack of cacti. The paucity of cacti in the monitoring plots is reflected in the overall lack of cacti found during the 2-week survey period. Only 129 cacti were found outside the 2 active monitoring sites after over 20 miles of suitable and previously occupied habitat were surveyed. By comparison, a clearance survey for alternative alignments for the Navajo Transmission Project inside the ACEC in 1995 yielded 1,231 cacti within a 600ft corridor (Ecosphere 1995). A clearance survey for a transmission line can be viewed as random transects through suitable habitat. The 2020 surveys were targeting known sites of occupation and therefore should have yielded significantly more cacti, by 1995 standards. Unfortunately, locational information for these clearance surveys was not available in 2020 and the historically proposed transmission lines were therefore not targeted.

In 2020, existing plants were found largely in vigorous or normal condition and a significant percentage of the population was reproductive, initially indicating a good year for the cacti, likely associated with the relatively wet winter prior to the surveys. However, a follow up study by the BLM to establish additional monitoring sites in late June of 2020 found only 25% of the

36 tagged plants attempted reproduction and only 8% had successful fruit development, 19% had at least one aborted reproductive structure (Bansbach et al. 2020). This may be attributed to the extremely dry months following the initial study in April; 1.44 inches of rain were recorded between January and March in 2002, and only 0.19 between April and June (WRCC 2021).

Although the Hogback ACEC is theoretically protected and managed for the protection of endangered plants, limited on-the-ground protection is actually provided. The ACEC is open for grazing (although currently not in use), existing oil & gas leases, and OHV traffic is permitted on existing roads and trails. However, enforcement of land use restriction has clearly been spotty, at best. Fences are regularly cut and the southside of the ACEC is not fenced along the State Trust lands boundary on the south side of Section 36, providing open access for horseback riding, trash dumping, target shooting and an off-road vehicle playground to the immediate community and others. In addition, multiple access roads for powerline maintenance provide open access for OHV traffic throughout the ACEC. Off-road vehicle users branch off from these access roads at will. Only one sign alerts the public to the sensitivity of the ACEC, other access points are open and not signed. The primary direct threat to Mesa Verde cactus inside the ACEC is OHV traffic, on BLM and SLO lands. This was identified as a primary threat back in the 80s when the ACEC was established. It remains a primary threat to this day, 30 – 40 years later. The cumulative impacts of ongoing OHV traffic throughout the ACEC cannot be overemphasized and clearly has contributed to the overall decline of the species inside the ACEC, not only through direct impacts, but also by aiding the distribution of invasives, especially halogeton, habitat destruction, soil compaction, pollination success, pollinator availability, the ongoing disturbances to the seedbank and reducing recruitment potential for decades. Clearly the current management directive of ‘OHV limited to existing roads and trails’ has not worked. This primary threat needs to be addressed through immediate action. This is a threat that can be easily controlled and abated.

However, plants were also missing from many previously occupied areas with seemingly limited OHV damage or other obvious disturbances.

The Southwest is the hottest and driest region in the United States. Climate change poses significant challenges for an already dry area that is expected to get even hotter and drier, which will increase stress on the region’s rich diversity of plants. The decade of 2001-2010 was the warmest in the 110-year recorded history, with temperatures almost 2°F higher than historic averages and are expected to rise even more (NCA 2014). A 2012 report exploring vulnerability trends in response to climate change relating to geography, conservation status, and taxonomic affiliation on western BLM lands revealed that the greatest concentrations of taxa vulnerable to climate change are found in arid to semi-arid regions of the southwestern states (Treher et al. 2012). Statistical analyses of conservation status and vulnerability to climate change showed that taxa of conservation concern tend to show greater vulnerability to climate change than other native plant species. Examination of taxonomic groups found that species of the Cactaceae showed higher overall vulnerability compared to most other groups; 93% of taxa assessed in the Cactaceae appeared especially sensitive to changes in precipitation regimes. This assessment is supported by existing population trend data on rare and endangered cacti elsewhere in the Southwest (Clark and Clark 2008; Clark et al. 2015; Hazelton 2011; Ladyman 2004; Roth 2008 a

& b; Roth 2020 a & b). Although the Southwest has seen many droughts in the past, future droughts are projected to be substantially hotter and are projected to become more frequent, intense, and longer lasting than in the historical record. Perhaps historically Mesa Verde cactus was able to recover from the seedbank after periods of drought. However, it appears that extended periods of drought brought on by climate change may limit the ability of the species to recover. We do not know about the longevity of seeds in the seedbank, but it is possible that the seedbank cannot be recharged sufficiently after multiple mortality events and ongoing hostile growing conditions, resulting in insufficient recruitment. The average annual rainfall at the nearby Farmington AG Science Center was 8.81 inches between 1979 and 1999 (WRCC 2021). The average annual rainfall since 2000 was 7.64 inches. Therefore, the average annual rainfall appears to have decreased by more than an inch, which is significant in a desert environment. Climate change may be the largest threat to Mesa Verde cactus rangewide.

Apparent population declines may be a result of prolonged drought conditions and a diminishing seed bank as reproductive adults have declined over the past 15 – 20 years (Roth 2020a). In addition, invasive plant species have spread throughout much of the ACEC's suitable habitat for the cactus. Resource competition between cactus seedlings and invasive plants may be significant, especially during good rainfall years. This may be exasperated by the invasive annual weed halogeton, which is known to produce mineral salts which may inhibit or depress plant growth in associated species. The impacts of potential changes in soil chemistry on the germination and establishment of Mesa Verde Cactus is unknown.

Two coal-fired power plants are located in close proximity of the Hogback ACEC. The San Juan Generating Station is bordering the NE side of the ACEC and has been in operation since the 1970s. The Four Corners Generating Station is located just south of the San Juan River has been in operation since the early 1960s. They are the largest source of air pollution in the state of New Mexico and sources for acid rain. Mesa Verde cactus is restricted to growing in sparsely vegetated areas of Mancos or Fruitland shale. This high degree of specificity suggests that the species may be highly susceptible to alterations in soil chemistry, possibly rendering the microhabitat unsuitable for sufficient recruitment to offset mortality over time. Long term emissions from coal fired power plant may alter the soils physical properties and concentrations of available nutrients and trace elements. Soil acidification could be contributing to low recruitment levels. Acid rain caused by coal fired power plants was identified as a potential future threat to the species in the 1984 recovery plan. Potential impacts to soil chemistry in the habitat of Mesa Verde cactus need further study.

Currently Mesa Verde cactus plants are found in small clusters or as single individuals widely scattered throughout the ACEC. The largest grouping of plants was found in the BLM monitoring plot No 2, which had 40 individuals. This plot has relatively high recruitment levels, which may be due to pollination success in response to plant density. Mesa Verde cactus is thought to be only partly self-compatible and might require cross-pollination (Tepedino 2002). If flowering plants are far and few in between, pollination success may be limited. Low seed/ovule ratios due to embryo abortion may be the result of inbreeding depression and needs further study. Studies need to examine pollination success and inbreeding depression, which can contribute to the slow decline to this species.

Illegal collection continues to be a threat to the species as evidenced by the presence of a cairn next to a large reproducing cactus. Collectors find the cacti during the flowering season when plants are most visible, returning later in the season to collect seeds. While the majority of cacti are located on mostly inaccessible tribal lands, the ACEC is likely the best-known site for collectors to find cacti and collect them without being observed.

The species has been monitored since the 1980s and monitored populations were documented stable or increasing until the early 2000s, despite annual population fluctuations. However, declining populations marked by increased mortality and low recruitment have been documented for this species rangewide for nearly 20 years now (Ladyman 2004, Roth 2020a, 2004, 2008a; Sivinski 2007; Coles *et al.* 2012; Hazelton 2011, 2013; Kendall 2010). Populations have not sufficiently recovered from the rangewide crash of 2002/2003. This is clearly not a natural population fluctuation but a slow decline trending towards extinction. Multiple significant threats are facing Mesa Verde cactus and contribute to a lack of recruitment resulting in the slow decline of the species. The Navajo Nation has ongoing population trend studies and will conduct a status survey on their Mesa Verde cactus populations in 2021. If similar results are found on Navajo Nation lands, the species should be considered for uplisting to endangered status under the federal Endangered Species Act, based on documented significant declines and low levels of recovery over the past 20 years, current knowledge on the abundance and distribution of the species, limited protection, multitudes of active documented threats and long-term population trends.

Urgent action is needed to halt the decline and ensure the continued existence of the species. The recovery plan is a historic document and needs to be updated to address new and emerging threats to guide recovery efforts, including climate change. Management actions and conservation measures need to be developed to address and halt the apparent decline. Management actions may include additional protection measures for the ACEC, such as fencing, locking gates, signing, prohibition of off-road vehicle traffic, and frequent patrols by law enforcement. These are easy enough to accomplish. Furthermore, federally listed species receive only limited protection on non-federal lands, if any. Therefore, the BLM should consider acquiring State Trust lands inside the ACEC through a land exchange to ensure proper management and protection of this highly endangered species throughout the ACEC, as required under current management prescriptions. A management plan to guide these efforts may be needed to implement and maintain management actions. A variety of solar projects have recently been proposed at or near the ACEC. Ground disturbing projects and the associated development of infrastructure should not be permitted inside the ACEC.

The Albuquerque BioPark collected seeds in 2019 from Navajo Nation populations for ex-situ seed banking and conservation purposes. The BioPark and the Desert Botanical Garden in Phoenix are now developing propagation protocols and grow plants ex-situ to produce more seeds for future augmentation and reintroduction projects. However, without a good understanding of what caused the decline and lack of recruitment, reintroduction and augmentation efforts are not likely going to succeed. Studies to research causes of decline are needed (pollinator availability, pollination success, seed bank viability and longevity, inbreeding

depression, insect and rodent predation, impacts of invasive species on germination and establishment, soil chemistry changes and acidification). In addition, more thorough surveys inside the ACEC to get a more accurate inventory of the current abundance and distribution of the species would be helpful in the evaluation of endangerment.

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