30-YEAR MONITORING REPORT

MANCOS MILKVETCH
(*ASTRAGALUS HUMILLIMUS*: FABACEAE)

BLM Hogback Area of Critical Environmental Concern,
San Juan County, New Mexico

1990 – 2020

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INTRODUCTION

Mancos milkvetch (*Astragalus humillimus* A. Gray ex Brand) is only known from the Four Corners region of New Mexico and Colorado. The species is a member of the Colorado Plateau ecoregion, one of seven ecoregions represented in the state of New Mexico (Griffith et al. 2006, Level III). It occurs primarily on Navajo Nation lands, with small populations on the Bureau of Land Management Hogback Area of Critical Environmental Concern (ACEC) on BLM and State Trust lands in New Mexico, and Ute Mountain Ute lands in southwestern Colorado.

Mancos milkvetch grows only on rimrock outcrops of the Point Lookout member of the Mesa Verde series of sandstone with flat or gently sloping surfaces at elevations between 5,200 and 6,000 feet. Within this range the species is confined to large sloping sheets of exfoliating whitish-tan colored sandstone. In San Juan County, New Mexico, this habitat extends southward from the Colorado border to the end of the Hogback, about 23 miles south of the San Juan River. The total range of the species is approximately 30 miles x 15 miles.

In all, sixteen population sites are known to occur in New Mexico, and four populations in adjacent Colorado. The majority of populations are located on Navajo Nation lands (Roth 2008, Talkington 2019, USFWS 2011). Within its restricted range Mancos milkvetch forms highly localized populations; occupied habitat ranges from 1.5 to 7.6 hectares in size, where plants could historically be concentrated in densities as high as 40 plants per square meter (Sivinski 2008). The largest and best known site is Slickrock Flats on the Navajo Nation (and partial BLM). Mancos milkvetch is usually found on large nearly flat sheets of sandstone in small depressions (tinajas) on bedrock, in cracks or fissures in sandstone, or at the base of gentle slickrock inclines (Figures 1 & 2). The density within populations can vary dramatically, depending on rainfall and habitat suitability (Sivinski 2008). The majority of plants within a population tend to be seedlings and juvenile plants, indicating a high level of reproductive effort within populations (Sivinski 2008).

Mancos milkvetch was listed endangered under the federal Endangered Species Act on June 27, 1985 (50 FR 26568-26572). Primary reasons for listing included a very limited distribution combined with low disturbance tolerance, and close proximity to powerline corridors, roads, and oil wells (energy development). A recovery plan to guide recovery efforts was completed in 1989 (USFWS 1989). Monitoring populations and their habitat to document trends and threat impacts was identified as an action that must be taken to prevent a significant decline in species population and habitat quality. It is one of the primary actions needed to remove the species from the list of threatened and endangered species. Two long term monitoring sites were established inside the BLM Hogback ACEC in 1990, one located on NM State Trust lands (Sleeping Rocks) and one located on Bureau of Land Management lands (Slickrock Flats). 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, and several other rare or endemic plant species (BLM 1988). A 30-year summary of the results from 1990 to 2020 is presented here.

METHODS

In 1990 five monitoring plots were established on State Trust land at Sleeping Rocks and five plots were established at Slickrock Flats on the northwest BLM boundary with the Navajo Reservation. The 10 study plots are monitored during the first 2 weeks of June, annually between 1990 and 1999, in 2002 and 2008, and biennially since 2014.

Each of the 10 monitoring plots represents a specific piece of Mancos milkvetch habitat, such as a single tinaja or crack segment with its own small individual watershed (Figures 1 & 2). Each is a different size island habitat separated from other island habitats by an interval of unoccupied sandstone surface. The plots are read by bisecting them with a measuring tape and locating all Mancos milkvetch plants growing between 2 permanently placed rebar stakes, and tracing individuals on a mm graph paper within a sketch of the habitat feature. This method allows for the documentation of changes in foliar cover over time and is therefore a reflection of overall health and population trend. Documenting changes in live plant cover is considered more indicative of the overall vigor of a population than reporting plant density fluctuations. Determining population trend by counting individual plants is difficult for Mancos milkvetch and can be misleading because plants coalesce into one large, pulvinate mass as they mature and can no longer be recognized as individuals (Sivinski 2008, Figure 3). However, to ensure better consistency and ease of data collection through time, cover is estimated since 2016 by taking one measurement along the widest axis and one measurement along the narrowest live part of adult plants (cm). In addition to plant cover, the number of seedlings within each monitoring plot is recorded. Any plant smaller than 2 cm in diameter is considered a seedling.

Figure 1. Tinaja habitat of Mancos milkvetch	**Figure 2.** Crack habitat of Mancos milkvetch


Figure 3. Adult live plant of Mancos milkvetch next to a dead adult and multiple seedlings.

RESULTS

When plots were established in 1990, it was apparent that each population had suffered significant mortality during the previous drought year. Recently dead plants could readily be distinguished from old remains by their color and lack of decay. By counting the living and the remains of recently dead plants in each sample plot it was determined that the loss of mature plants was 60 percent of the total. This loss varied greatly between habitats which have different water holding capacities. It is thought that habitats consisting of deep cracks in the bedrock generally fare better than the tinajas or narrow cracks with only a shallow reservoir of soil and limited water holding capacity. Some tinaja habitats experienced 100 percent mortality during the drought of 1989 and continue to be the most drought impacted habitats. In 2020 4 of the 5 unoccupied monitoring plots were tinajas. Therefore, it is thought that the more permanent habitats for mature plants are those that occur on deep cracks in the sandstone. This may also be true for the germination and establishment of seedlings. The majority of seedlings have been found in cracks. Historically the Sleeping Rocks site has produced significantly more seedlings than the Slickrock Flats site. Four of the five monitoring plots at the Sleeping Rocks site are located in cracks, and four of the five monitoring plots at the Slickrock Flats site are located in tinajas. However, in 2020 the number of seedlings at both sites was the lowest ever recorded. Only 3 seedlings were found in all 10 monitoring plots (Figure 4). All 3 seedlings were found at the Slickrock Flats monitoring site, two in a tinaja and one in a crack. The number of seedlings has been relatively low since 1999, with only one recorded germination event occurring at the Sleeping Rocks site in 2014, when 141 seedlings were found in the 5 monitoring plots. Seedling numbers have been extremely low since 2014, at both sites.

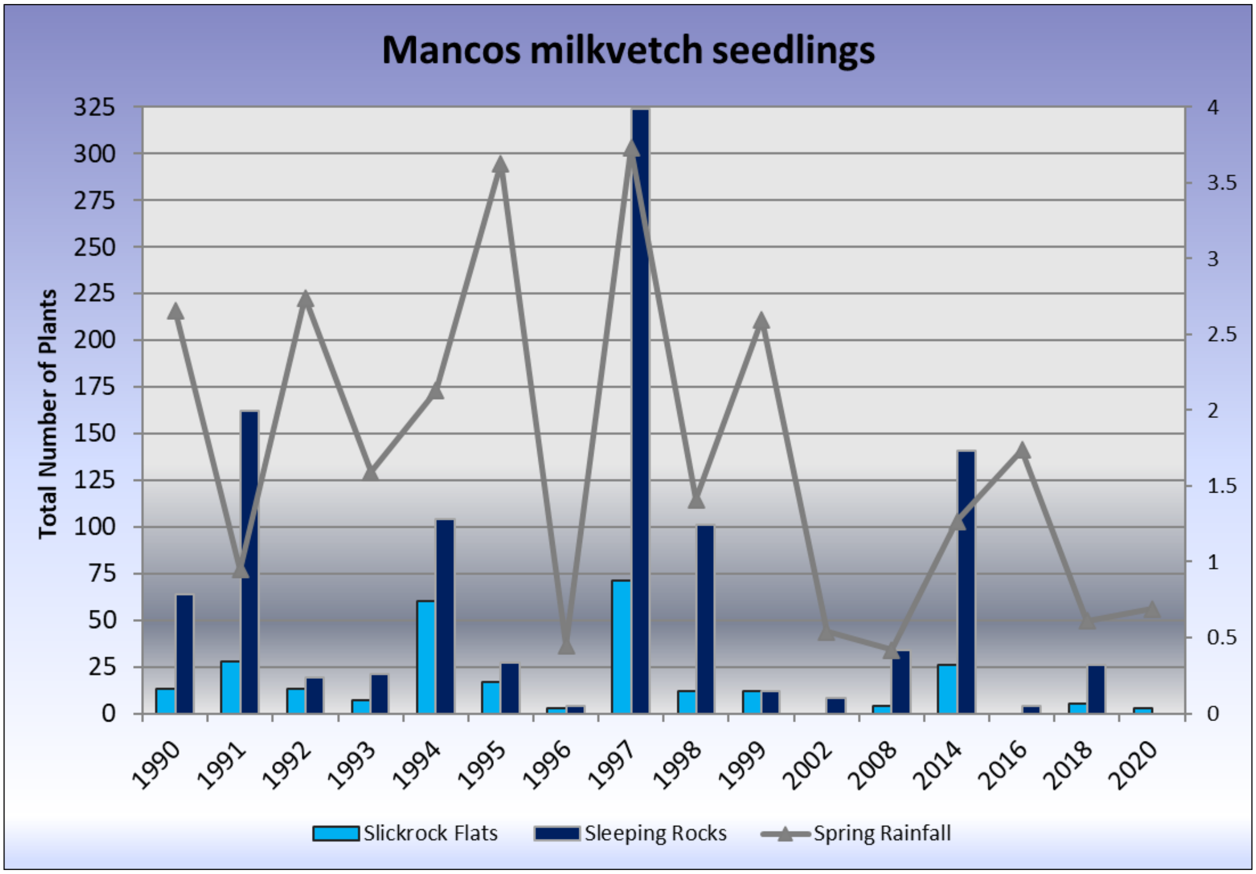

Figure 4. Number of Mancos milkvetch seedlings at Sleeping Rocks and the Slickrock Flats monitoring sites near Waterflow, NM. Spring rainfall, March through May, from the Farmington AG Science Center (WRCC 2020).

Establishment and maturation of Mancos milkvetch is slow compared to other perennial species of *Astragalus.* The establishment period is usually two full growing seasons, with maturation and flowering occurring during the third or fourth spring. Spring rainfall is key to germination and establishment. Seedlings likely germinate in March at which point enough rainfall needs to fall to support the establishment of seedlings until monsoons arrive in July. A high rate of mortality has been documented in young plants during germination and establishment. This is demonstrated by plots NM1 and NM2 which were established in May of 1990 (Sivinski 2008). The other eight plots were established in July of 1990 and plots NM1 and NM2 were reread to document any mortality during the intervening dry period. Of the 205 seedlings found in these two plots in May, only 62 (30%) had survived through the dry early summer month of June. Spring rainfall amounts have decreased significantly over the 30-year monitoring period, from an average 2.189 inches between 1990 to 1999 to an average of 0.878 inches for the 6 monitoring periods since 2002

(WRCC 2020). The average number of seedlings during the 10 monitoring periods between 1990 and 1999 was 107, in all 10 monitoring plots, and 25 for the 6 monitoring periods since 2002. Overall, the average annual rainfall amount was 8.978 inches between 1990 and 1999 at the Farmington AG Science Center and 7.641 inches between 2000 and 2019 (Figure 5).

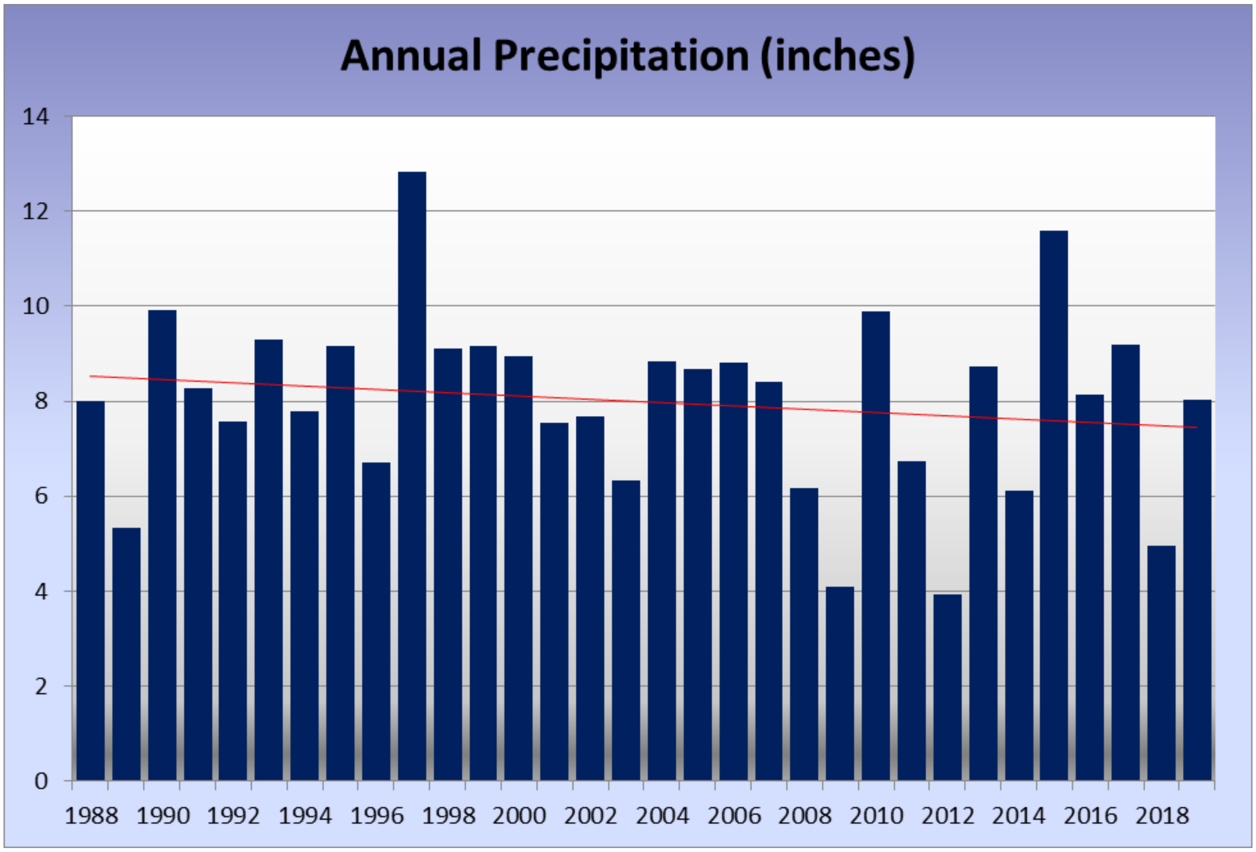

Figure 5. Annual precipitation at the AG Science Center near Farmington, NM, from 1988 to 2019 (WRRC 2020).

Some adult plants are very large (>15 cm in diameter) and appear to be many years old (Figure 3). Mortality of old plants and seedlings increases during drought years. In addition, plants weakened by dry conditions are often infested by spider mites which hastens the demise of older individuals. A drought caused significant observed mortalities 1989 (Sivinski 2008). This prompted the establishment of the 10 monitoring plots at the Slickrock Flats and Sleeping Rocks sites. However, plants reestablished from the seedbank and the populations recovered at both sites between 1990 to 1994 (Figure 6). Both monitoring sites began to decline thereafter. In response to the highest rainfall year within the study period, Mancos milkvetch cover increased significantly between 1997 and 1998, and seedling density was highest in 1997 for the entire study period, especially at the Sleeping Rocks site (Figures 4, 5 & 6). The wet year of 1997 caused the total foliar cover of Mancos milkvetch to increase by 1998, continuing into 1999, after which seedling counts and cover values declined (Figures 4, 5 & 6). No monitoring occurred after 2008, until 2014. Although more seedlings were found in the monitoring plots in 2014 over the previous years since 1997, the overall cover of plants decreased significantly over previous recorded values

(Figures 4 & 6). In 2014 only 11 adult plants were found in the 10 monitoring plots, 9 in the Sleeping Rocks plots, and only 2 adults in the 5 Slickrock Flats plots. However, a total of 167 seedlings were found at the two sites. The majority of seedlings (141) were found in the Sleeping Rocks plots. Four monitoring plots (40%) had no plants whatsoever (2 plots at Sleeping Rocks, 2 plots at Slickrock Flats). Although dead plants can persist for several years, few dead plants were documented in the monitoring plots. Therefore, mortality of large adult plants likely occurred several years prior to 2014, possibly during the drought years of 2009 and 2012 (Figure 5). Despite an excellent rainfall year in 2015 and a good rainfall year in 2016, only 4 seedlings were documented in all 10 monitoring plots in 2016, all of which were in 2 plots at the Sleeping Rocks site (Figures 4 & 5). However, some of the 2014 seedlings had made it into adulthood. In 2016, cover of adult plants had increased significantly at both sites. Fifty-four adults were documented in the 10 monitoring plots, 18 at the Sleeping Rocks site, and 36 at the Slickrock Flats site. By 2018 the number of adult plants had declined to 21 plants, the majority of which were located at the Sleeping Rocks site (18 plants). Thirty-two seedlings were documented, also primarily from Sleeping Rocks (26 plants). Cover values once again declined significantly, especially at Slickrock Flats, which had the lowest cover values recorded. In 2020 only 18 adults were recorded in the 10 monitoring plots, the majority of which occurred in the Sleeping Rocks plots (14 individuals). In addition, 3 seedlings were documented at the Slickrock Flats site. Although there were 3 fewer plants than in 2018, total cover of adult plants had increased from 2018 values (Figure 6). Overall, the Sleeping Rocks site has had higher cover values and larger numbers of seedlings than the Slickrock Flats site throughout the 30-year monitoring period (Figures 4 & 6).

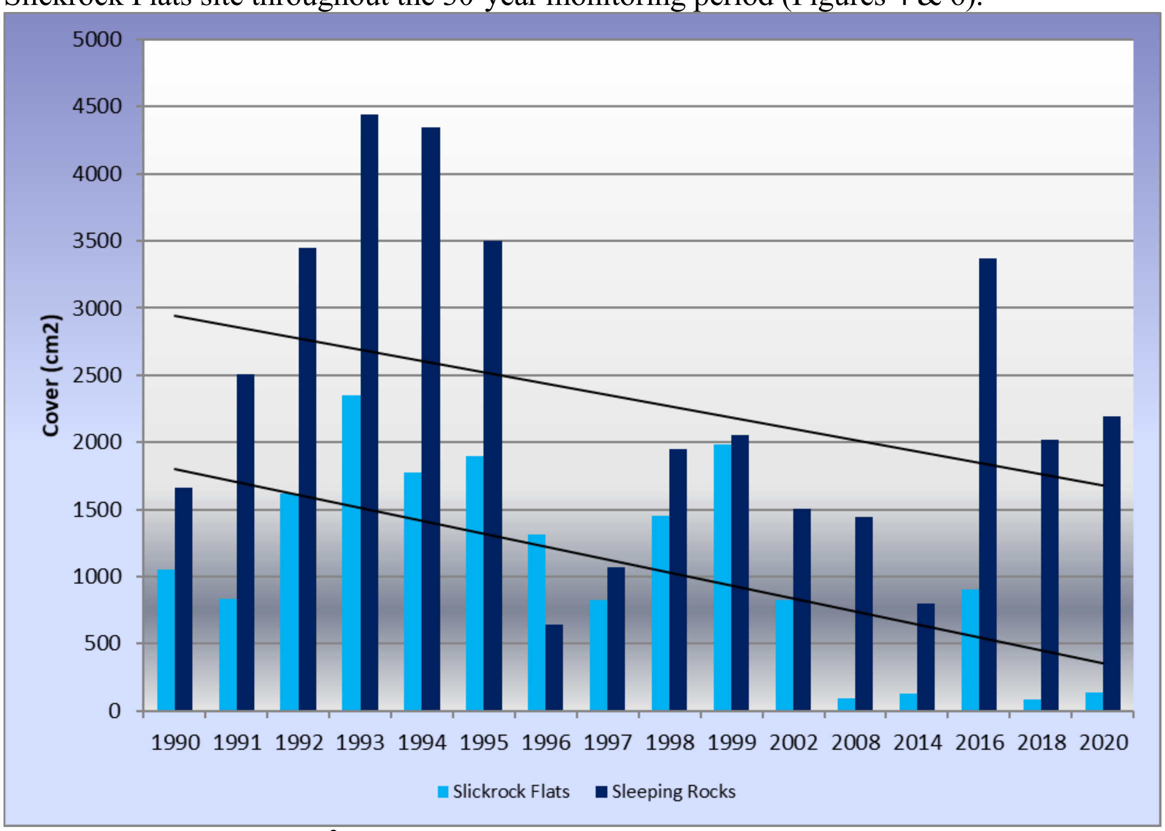

Figure 6. Total cover (cm^2) of Mancos milkvetch plants at the Sleeping Rocks and the Slickrock Flats monitoring sites near Waterflow, NM.

DISCUSSION

After 30 years of monitoring population trends at the 2 study sites at the BLM Hogback ACEC near Waterflow, the overall trend is a long-term slow decline, despite significant documented population fluctuations. Recruitment does not sufficiently outpace mortality. Seedlings were at an all-time low in 2016 and 2020. Low seedling counts in 2016 may be due to seedbank depletion following a germination event in 2014, which recorded the highest number of seedlings since 1997. Other contributing factors may include increased resource competition from adult plants and low precipitation levels in March 2016. Low seedling counts in 2020 were likely due to spring drought conditions. Five of the 10 monitoring plots had no plants whatsoever in 2020. Four of these monitoring plots did not have plants in 2018 either.

Declining populations have also been reported from status reports of the Navajo Nation sites in 2008 and 2019 and for all BLM locations in 2020 (Roth 2008, 2020; Talkington 2019). Although it is likely that this species experiences normal boom and bust years with variable climatic conditions, severe and prolonged drought conditions brought on by climate change may impact the persistence of Mancos milkvetch more than previously thought. Three of the 4 worst drought years on record since 1978 occurred after 2000 (2009, 2012, 2018) likely causing further decline of plants recovering from a drought in 1989. Although there were more seedlings documented in 2014 than during the past 4 monitoring years, seedling survival and establishment are crucial to maintaining persistent and viable populations. It is thought that germination and initial survival of seedlings is positively related to the death of older plants and the subsequent increase of precipitation (Sivinski 2008). Above average rainfall was recorded in 2010, 2013, 2015, and 2016, likely resulting in increased germination of seedlings, documented in 2014, but not in 2016. Any seedlings germinating following the above average rainfall year of 2010 apparently did not get established in significant numbers, or did not survive the drought year of 2012. Very few adult plants were recorded in 2014. Although some of the surviving 2014 seedlings were able to establish a new cohort of adult reproductive plants, very few seedlings were documented in 2016, which may be the result of low March rainfall amounts, resource competition with adult plants and a possible depletion of the seedbank in 2014. Overall plants in the Sleeping Rocks monitoring site are faring better than those at the Slickrock Flats site. This is likely due to the fact the 4 of the 5 transects at Sleeping Rocks are in cracks, while 4 of 5 monitoring transects are in tinajas at the Slickrock Flats site. This is supporting the concept that cracks provide a more stable and supportive habitat for Mancos milkvetch during drought conditions. The 1989 recovery plan lists Slickrock Flats as one of largest populations of Mancos milkvetch, containing nearly 8,000 plants. A survey of the BLM portion of the Slickrock Flats population documented a couple hundred plants at best (Roth 2020). The better-defined Sleeping Rocks site had 482 individuals in 1986 and only 94 plants in 2020.

Despite the reprieve in rainfall amounts between 2013 and 2016, predicted ongoing drought conditions may limit establishment and therefore the reproduction and seed banking of the species, leading to the observed slow decline. Half of the 10 monitoring plots had no plants in 2020. Six of the 10 plots had no adult plants in 2014 and half of the 10 plots had no adults in 2018. As there are fewer adult reproducing plants at each plot, fewer seeds are stored in the seedbank. If seedlings cannot establish themselves as reproductive adults, the population will slowly decline and eventually go extinct locally.

In addition to the long-term impacts of prolonged drought and climate change, pollination success, pollinator availability, inbreeding depression, and soil acidification may also contribute to observed declines and should be studied further.

Considering the current trend at the monitoring sites and the apparent rangewide decline, it is recommended that monitoring of the 2 sites occurs more frequently than previously, preferably annually. Additional monitoring sites should be considered based on the findings of the 2020 status report. The Navajo Nation established monitoring plots across the range of the species on Navajo lands, using the same monitoring protocol to ensure data collection consistency across the range of the species. Establishing additional monitoring plots over the entire range of the species will help to determine whether the observed declines impact the entire species. Additional management activities would improve current habitat conditions inside the BLM Hogback ACEC and increase our understanding of the possible causes of the observed declines. Recommendations include:

- Sign ACEC boundaries to make wood cutters aware of this prohibition
- Actively control or prohibit OHV traffic
- Retire existing oil & gas leases
- Consider fencing the remaining populations of ASHU in the vicinity of the transmission lines and tower, or otherwise block access to habitat
- Exchange State Trust lands or develop a management agreement
- Sample soils to determine current soil chemistry and pH
- Maintain fences and lock access gates
- Determine pollination success and study the potential of inbreeding depression
- Develop a propagation protocol from seed collections for potential population augmentation in the future
- Expand monitoring sites by increasing the number of monitoring plots at each site
- Monitor and control invasive species
- Increase monitoring frequency and document reproductive effort in the data gathering

ACKNOWLEDGEMENTS

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