

# SANTA FE CHOLLA

*(Cylindropuntia viridiflora)*

A Community Conservation Effort

2015 – 2021

Santa Fe, NM



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# INTRODUCTION

Santa Fe cholla (*Cylindropuntia viridiflora* (Britton & Rose) Knuth) is a rare cactus found between Santa Fe and Espanola, NM. It is a hybrid derived from the tree cholla (*C. imbricata* (Haw.) F.M. Knuth) and Whipple cholla (*C. whipplei* (Engelm. & Bigelow) F.M. Knuth) (NMRPTC 1999, FNA Vol. 4, 2004). However, because plants that produce fertile seed which when germinated produce plants well within the norm for *C. viridiflora*, the New Mexico Rare Plant Technical Council considers these populations stable hybrids (NMRPTC 1999). These are only recognized from 4 natural locations between Santa Fe and Espanola in New Mexico, over a distance of approximately 27 miles. Similar plants of *C. imbricata/C. whipplei* hybrid origin are known from other areas in the greater 4 Corners region, including La Plata, Colorado; Grants, New Mexico; along the San Juan River, Utah; and Petrified Forest National Monument and Canyon de Chelly National Monument in Arizona. However, studied populations show considerable variation and are not considered stable hybrids by the New Mexico Rare Plant Technical Council. A genetics study in 1994 was inconclusive (Reed 1994). Further genetic studies are needed to verify the validity of the taxon. Various hybrid populations are often associated with ancient ruin sites and some believe the species is a recent human created hybrid, traded among the ancestral 4 Corners' pueblo tribes. The populations found near ruin sites are often just composed of a few individuals. Populations considered wild and true Santa Fe cholla have once been estimated in the thousands. Association with ancient ruins may or may not be true for New Mexico populations, although most populations are located near active human developments in the Espanola Basin, which has been occupied by humans for hundreds or even thousands of years. Given the narrow range of the species, it is possible that the natural habitat of Santa Fe cholla only coincides with human occupied areas.



Santa Fe cholla is a much-branched shrub to about 0.8 m in height and about 2 meters across. Its flowers are 2-2.5 cm in diameter, brownish-orange in the center with greenish peripheral tepals (varying to a purplish-brownish-red); fruits are tuberculate, firm and leathery, not juicy, yellow when ripe, persistent, and 1.5-2.5 cm in diameter (NMRPTC 1999). It flowers in late June, into July. Santa Fe cholla occurs on gravelly rolling hills in open pinion-juniper woodlands at elevations ranging from 5,800 to 7,200 ft (Figure 1). Northern New Mexico populations occur on geological formations associated with the Santa Fe Group, members of which are only exposed in the Espanola Basin.

Davis' cholla (*Cylindropuntia davisii*) differs from Santa Fe cholla by being lower growing, having softer stems, yellow spine sheaths, tuberous roots, and green sterile flowers (NMRPTC 1999). Whipple cholla is typically lower growing, joints are rigidly attached, spine sheaths vary but are most often yellow or white, and flowers are yellow to yellow-green. Tree cholla is larger, stems are thicker, joints are rigidly attached, and flowers are normally lavender-pink to rich magenta (rarely white). Santa Fe cholla is often seen growing in the vicinity of tree chollas, but hybrids are rarely observed (Figure 1). No Whipple cholla is known to naturally occur within 45 air miles of the northern New Mexico populations.



**Figure 1.** Santa Fe cholla in habitat at the type locality in Santa Fe, NM, growing with tree cholla.

Santa Fe cholla is state listed endangered and is a BLM sensitive species. It is therefore protected by law and by policy. The New Mexico Rare Plant Conservation Strategy considers Santa Fe cholla ‘under conserved’ due to small population size, limited distribution and documented threats (EMNRD-Forestry Division 2017). Only one of the known natural populations of Santa Fe cholla occurs on federal lands where it is protected from development. Other populations occur along roadsides, private and tribal property, and a city park.

Although in the late 1980s thousands of plants were reported from the Fort Macy population, which is the type locality, currently known natural populations of Santa Fe cholla in northern New Mexico are very small and population size ranges from a few plants to approximately 100 individuals (Ferguson and Brack 1986, D. Roth pers. observations). Documented threats include urban development, collection, and a fungal disease believed to be *Gleosporium lunatum* (NMRPTC 1999; Figures 2 & 4).



**Figure 2.** Santa Fe cholla impacted by fungal disease at the type locality in Santa Fe.

Due to the apparent decline in known populations and their vulnerability to ongoing significant development, observed impacts from fungal infections and rodent predation, and an extremely limited distribution, the Cactus Rescue Project was formed in 2002 with the aim of educating people about this endangered species and saving it through propagation and distribution. With the engagement of the Endangered Plant Program (NM Energy, Minerals and Natural Resources Department - Forestry Division), the Cactus Rescue Project started identifying sites suitable for establishing protected colonies of Santa Fe cholla at sites between Espanola and Eldorado in 2015.



## METHODS

Since 2015 the Cactus Rescue Project and the EMNRD – Forestry Division have established multiple introduction sites between Espanola and Eldorado in areas that are perpetually protected. These include the Wildlife Center in Espanola, the Eldorado Community Preserve, and the Santa Fe Institute (Tesuque and Santa Fe campus areas). Plants were grown by the Cactus Rescue Project from cuttings (clones), originally collected from the type locality in Santa Fe. Volunteers from various groups, including the New Mexico Native Plant Society, the Cactus Rescue Project, the Master Gardeners, and the Santa Fe Institute, planted the cuttings at the 5 sites and contributed to the annual monitoring efforts. Plantations are assessed annually for success, with the ultimate goal of determining optimum conditions for plant establishment and plant numbers needed to ensure long-term self-sufficient populations. Some plants were experimentally caged to improve establishment by excluding predators. Recorded annually are survival, the number of dead plants, new recruits from rooting of stem joints or seed bank, reproductive status, vigor, and in some cases plant growth. Other, smaller plantations have been established by the Cactus Rescue Project throughout Santa Fe. However, these are planted in urban landscaped settings and are not monitored annually.

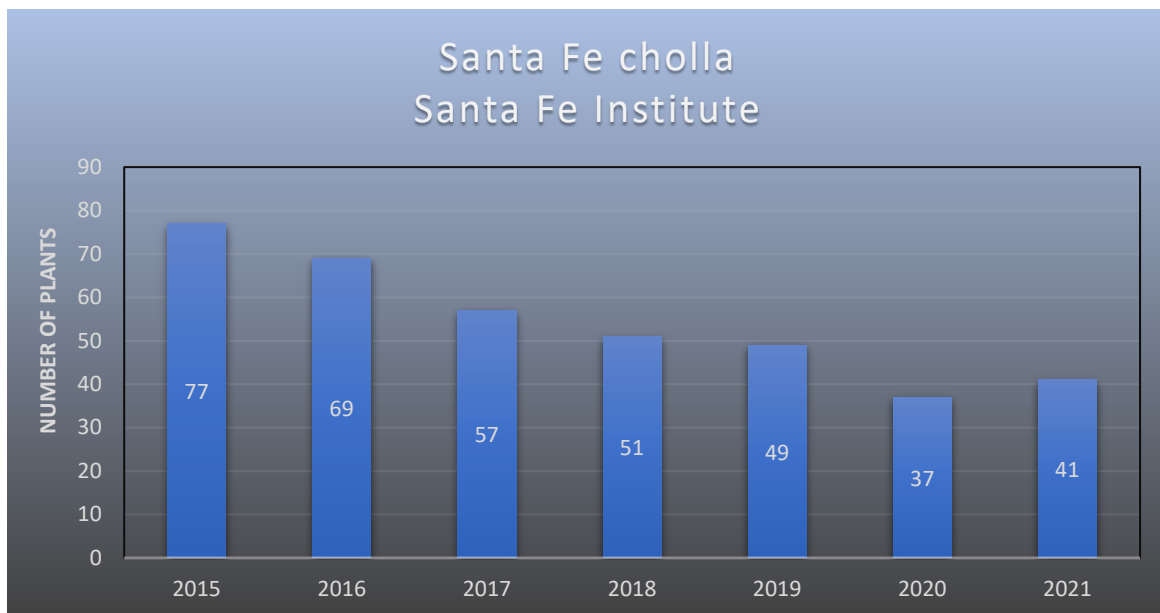
# RESULTS

## 1. Santa Fe Institute – Santa Fe Campus - 2015



The Santa Fe Institute Santa Fe Campus was the first introduction site for this project. On August 1, 2015 volunteers of the Native Plant Society, the Santa Fe Master’s Gardeners, the Santa Fe Botanical Garden, the Santa Fe Institute, and the Cactus Rescue Project planted 77 rooted cuttings of Santa Fe cholla in 7 monitoring plots marked by a rebar in the plot center. Plots were 15 ft in diameter. Plants were assessed annually during June to determine survival and reproductive status. 69 plants survived through the

first year and were rated in good or fair condition (Figure 3). Many of the smaller plants were found to have died back or were eaten by rodents or rabbits. However, many plants were resprouting from the base. Only 7 plants were found reproductive. These were among the medium or larger sized plants. By 2017 most plants were found in poor condition, exhibiting a failure to thrive, even though the habitat, slope, aspect, and exposure are similar to those of nearby natural populations along Gonzalez Road and the nearby type locality. None of the plants were reproductive. Plants gradually continued to decrease through 2020 and very few plants were reproductive. Although there was an apparent increase in the number of plants in 2021, no new plants were found. Hence the increase was considered an artifact of detection in 2020 when center posts were missing for 2 monitoring plots and location had to be approximated. Overall, this site has experienced a 53 % survival rate since 2015 with no recruitment observed. The failure to thrive at the Santa Fe Institute Santa Fe campus is attributed to the same fungal infection that has been decimating Santa Fe populations for decades (Figure 4).



**Figure 3.** Population trend at the Santa Fe Institute Santa Fe campus from 2015 through 2021.



**Figure 4.** Santa Fe cholla with fungal infection at the Santa Fe Institute.

## 2. Santa Fe Institute – Tesuque Campus – 2020

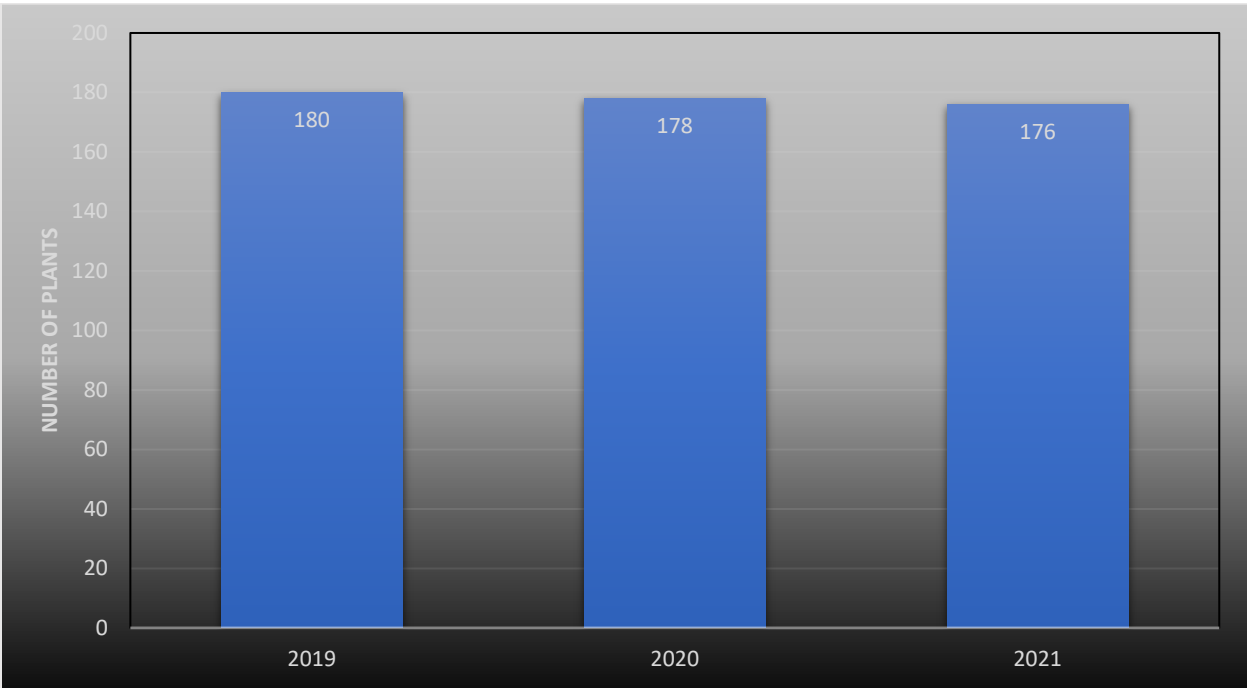


The Tesuque Campus site of the Santa Fe Institute was planted on September 23, 2019. Plants were planted along steep north and east facing slopes among pinion and juniper at about 6,900 ft (Figure 5). A total of 180 plant clones donated by the Cactus Rescue Project were planted by the Cactus Rescue Project in 12 20 ft diameter monitoring plots marked with a center rebar. In each plot half of the plants were caged and half of them were uncaged. In addition, 4 plots were planted with bareroot plants and the remaining plants were potted and had their root balls in soil at the time of planting. The majority of plants survived into 2020 (99%)(Figure 6). Only one plant was found dead on July 1, 2020. The majority of plants were rated in excellent condition. Fifteen percent of plants were reproductive. 176 plants were found alive on June 30, 2021, although many were looking sickly. Plants in the monitoring plots were rated in either good or fair condition. Approximately 12% of the plants were reproducing. The four plants that had died since 2019 were all caged plants.

Whether mortality was caused by the caging is unknown, albeit unlikely. Cages were removed in 2021 to allow plants to expand beyond the cage limits. No difference was noted between the survival of bare rooted vs. potted plants.



**Figure 5.** Caged and uncaged Santa Fe cholla plants at the Santa Fe Institute Tesuque campus.



**Figure 6.** Number of Santa Fe cholla plants in 12 monitoring plots at the Santa Fe Institute Tesuque Campus.



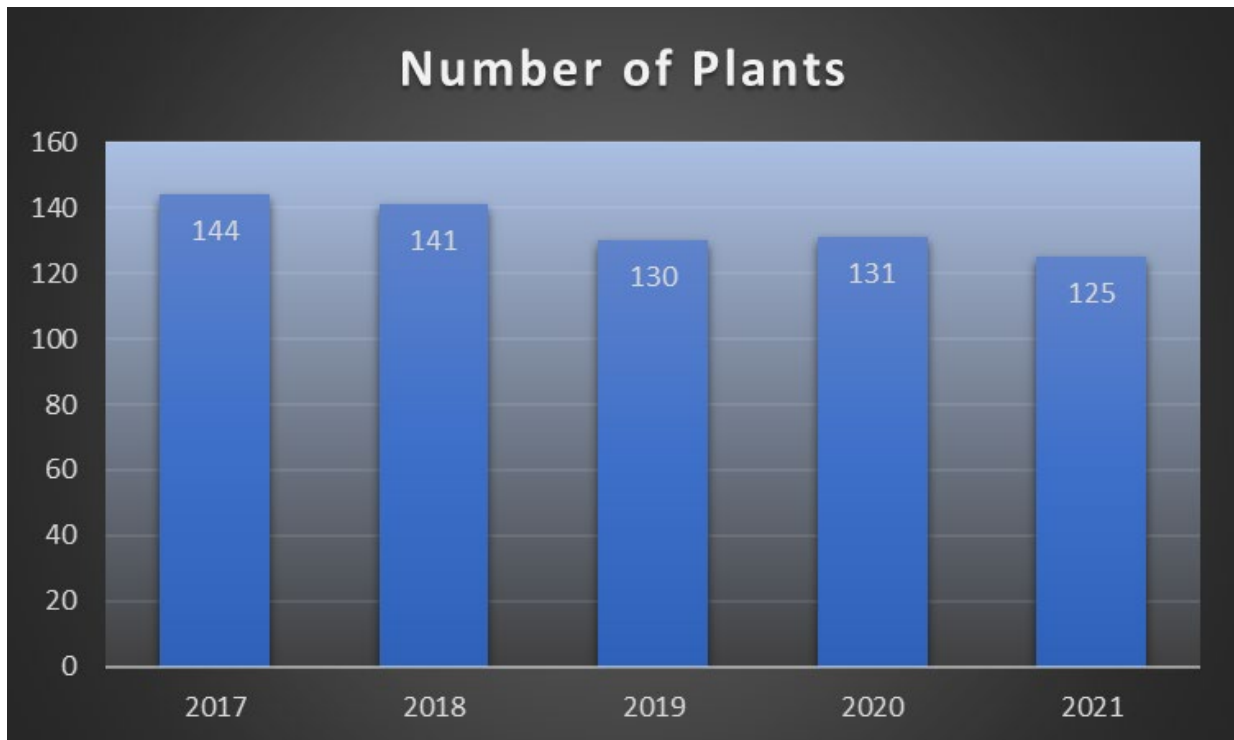
### 3. Espanola Wildlife Center - 2017

The Espanola Wildlife Center received a donation of 144 Santa Fe cholla plant clones from the Cactus Rescue Project in the summer of 2017. These were planted by volunteers from the Cactus Rescue Project, the NM Native Plant Society, and the Santa Fe Master Gardeners on July 29, 2017. Plants were distributed in 6 30 ft diameter monitoring plots (Figure 7). 24 plants were planted in each plot, half of which were caged. In addition, the plots received the following treatments: 1 plot was cleared of all vegetation and watered regularly, 2 plots were cleared from vegetation but not watered, 1 plot was left natural but was watered, 2 plot were left natural and were not watered.

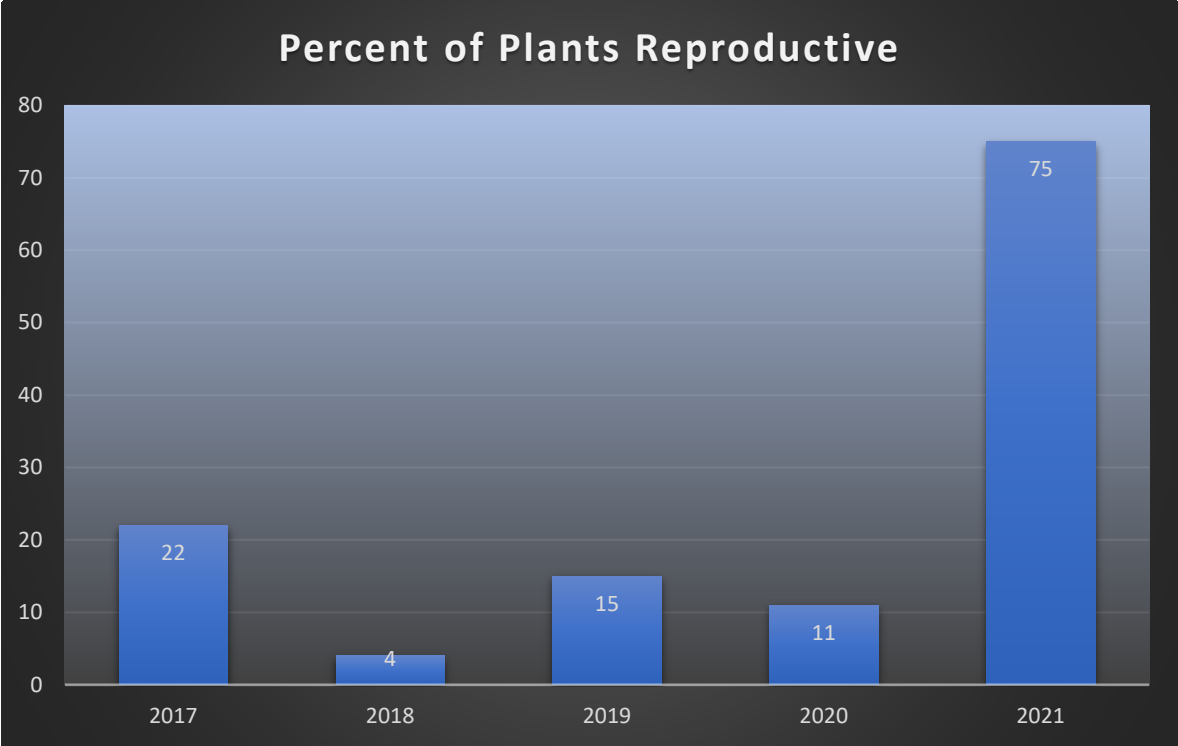


**Figure 7.** Volunteers planting Santa Fe cholla at the Espanola Wildlife Center in 2017.

There was a 98% overall survival rate among all plots over the first year (Figure 8). Two plants were missing from uncaged areas, likely eaten by rodents. One plant was unaccounted for. Plants were rated in good to excellent condition. Many of the rooted clones provided by the Cactus Rescue Project were larger than previous planted cacti. Hence 32 of the 144 plants were reproductive at the time they were planted (22%) (Figure 9). However, only 5 of the 141 remaining plants were flowering in 2018. There was no apparent differences between the different treatments or whether plants were watered or not. Cages were removed in 2019 to allow for plants to grow and expand. In 2019 130 plants were found in the six monitoring plots, plus 7 new plants from rooted joints that had fallen off established plants. Nineteen of the 130 plants were found reproductive. Two of the plots where vegetation was cleared in 2017 were dominated by the invasive annual Kochia. The highest number of plants was found in plots that were left natural. However, differences were not significant. There was no obvious difference between watered and unwatered plants. Plants were mostly rated in excellent condition. Five plants were found dead. In 2020 131 plants were found in the monitoring plots, none were recent recruits from rooted joints. Fourteen plants were reproductive, and all plants were considered in excellent condition. 2021 was an excellent year for the Wildlife Center population. Even though the population declined to 125 plants, most plants were found in excellent and very vigorous condition and 94 of the 125 plants were found reproductive (Figure 10). Overall, the Espanola Wildlife Center has an 87% survival since the monitoring plots were established in 2017, making this site the most successful among the 5 planted conservation sites.



**Figure 8.** Number of Santa Fe cholla plants in 6 monitoring plots at the Espanola Wildlife Center, from 2017 through 2021.



**Figure 9.** Percent of Santa Fe cholla plants reproductive at the Espanola Wildlife Center, 2017 – 2021.



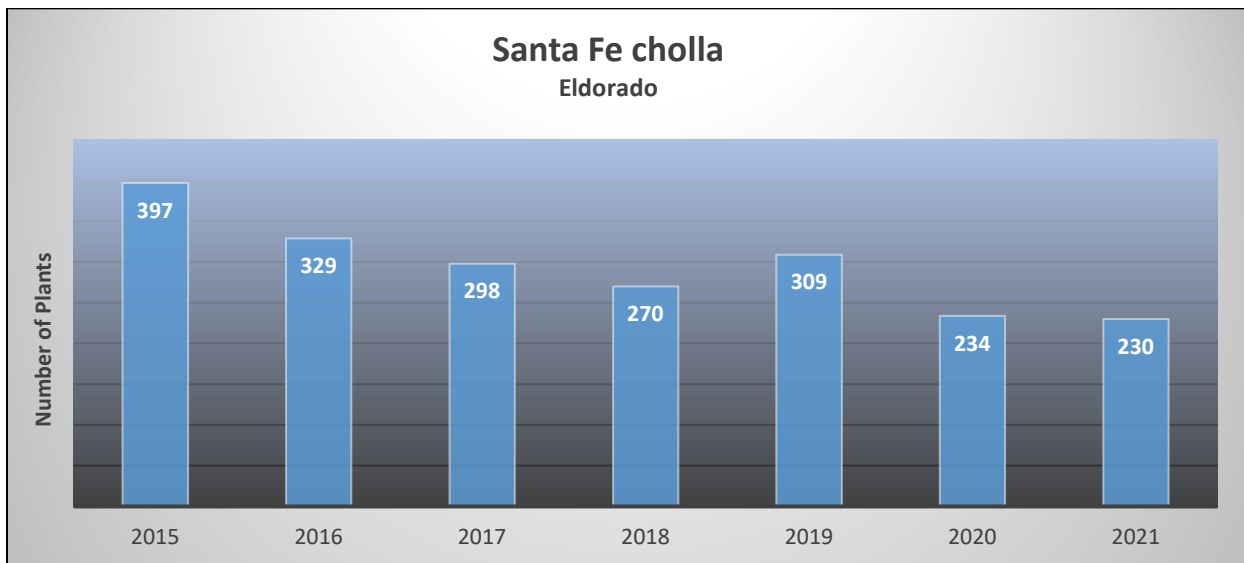
**Figure 10.** Extremely vigorous Santa Fe cholla plants in a monitoring plot at the Espanola Wildlife Center, 4 years after planting.

## 4. Eldorado – Initial Site 2015

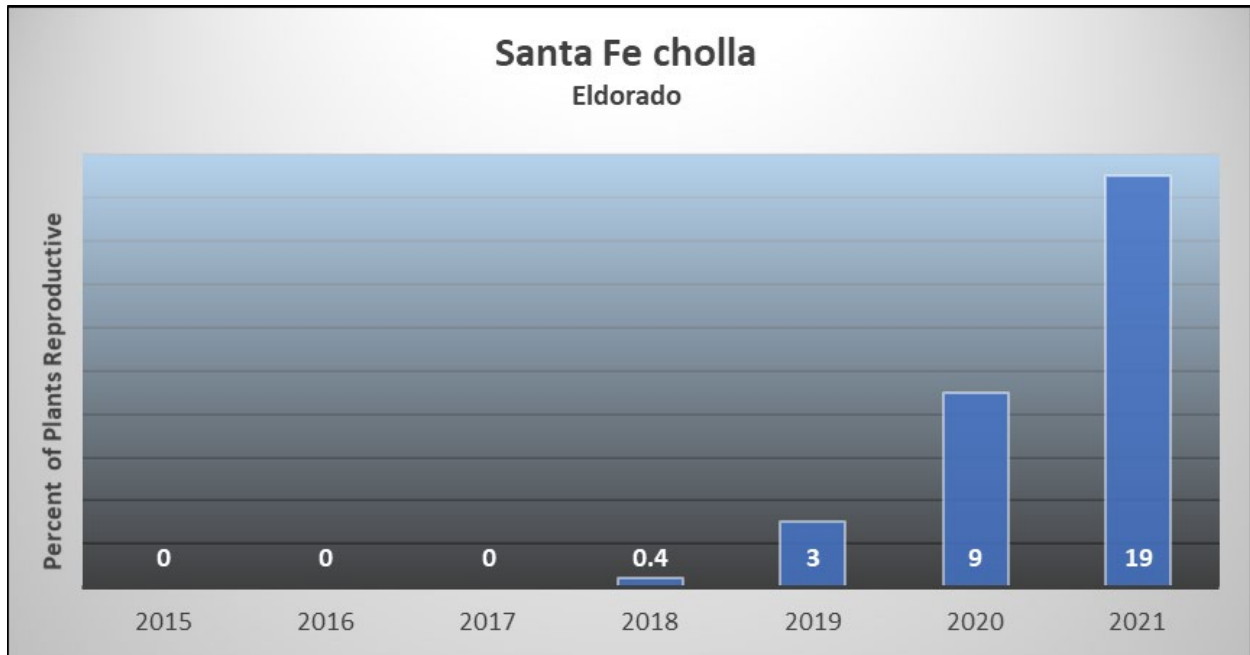


The Santa Fe cholla colony at the Eldorado Community Preserve is the largest site planted to date and also situated in the most natural habitat, well away from most human influence. The Cactus Rescue Project provided 397 rooted clones which were planted by volunteers on July 11<sup>th</sup>, 2015, in 20 40ft diameter monitoring plots. Approximately 83% of these plants survived through the first year (Figure 11). However, none of the plants were found reproductive (Figure 12). Only 298 plants remained by 2017, none of the plants were reproductive and the majority of plants were ranked in good to fair condition. Significant rodent activity was noted in several plots. The first reproductive plant was found in 2018. Reproducing plants have continued to increase in the plots through 2021. In 2018 a significant number of joint rooted plants were found inside the monitoring plots (81) in addition to the planted cacti (270). This likely contributed to an increase in plants found in 2019 (309), when 33 joint rooted plants were found in the plots. Joint rooted plants are plants that successfully rooted after falling off the parent plants. No

seedlings were observed during any of the monitoring years. Despite some recruitment from joint rooted plants, the overall survival between 2015 and 2021 was only 58%. Mortalities were attributed to predation, drought, and erosion associated with plants that were mound planted. In addition, some plots were vandalized in 2020 and 2021 when several plot center stakes had been removed and carried off. It is unknown whether plants were damaged in the process.



**Figure 11.** Number of Santa Fe cholla plants in 20 monitoring plots at the Eldorado Community Preserve from 2015 through 2021.



**Figure 12.** Percent of plants reproductive at the Eldorado Community Preserve, 2015 – 2021.



## 5. Eldorado – Caged Site 2018

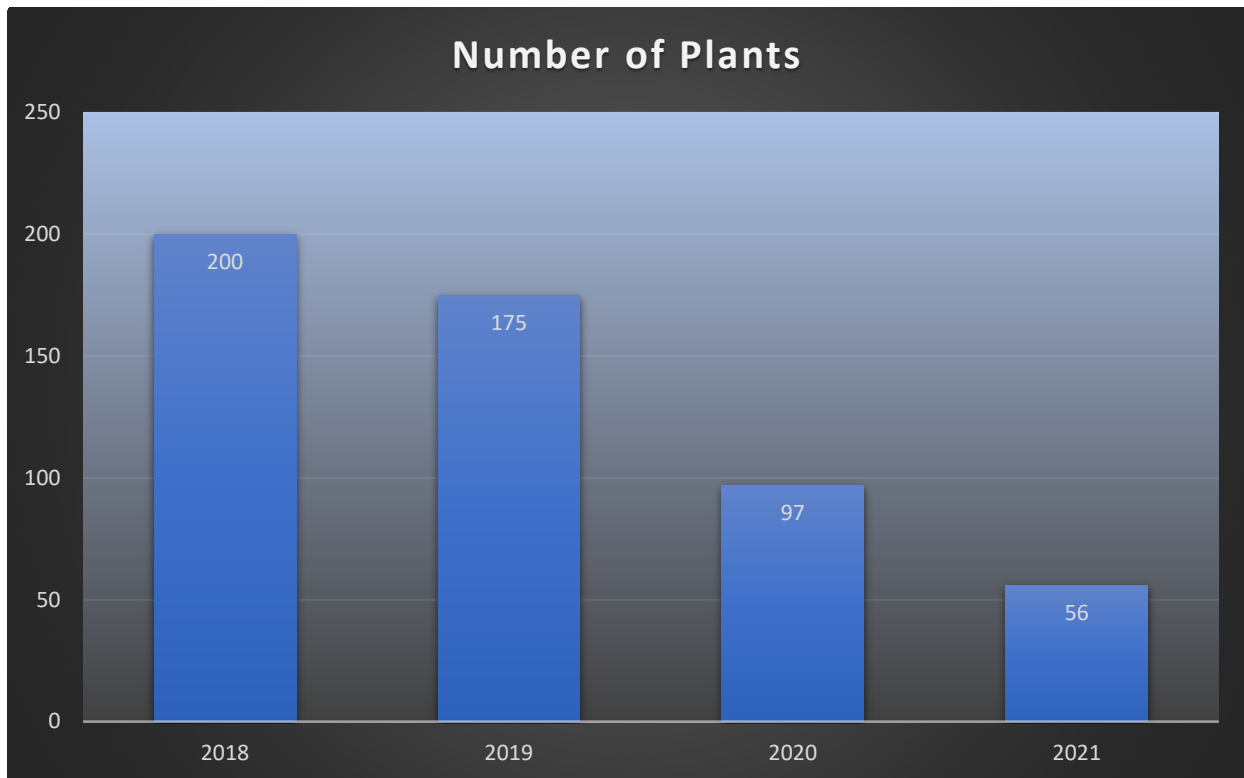
An additional 200 Santa Fe cholla clones provided by the Cactus Rescue Project were planted by volunteers near the initial site at the Eldorado Community Preserve in 2018 (Figure 13). All plants were caged to protect newly planted cacti from rodent predation. Twenty plants were planted in each of the 10 40ft diameter monitoring plots. In addition to determining survival and reproduction, each plant was tagged and maximum height was measured to assess growth through the years.

First year survival of plants was high; 88% of the 200 plants survived (Figure 14). Mortalities were largely attributed to gopher activity, especially in Plots 1 & 2. Surviving plants were largely rated in good or

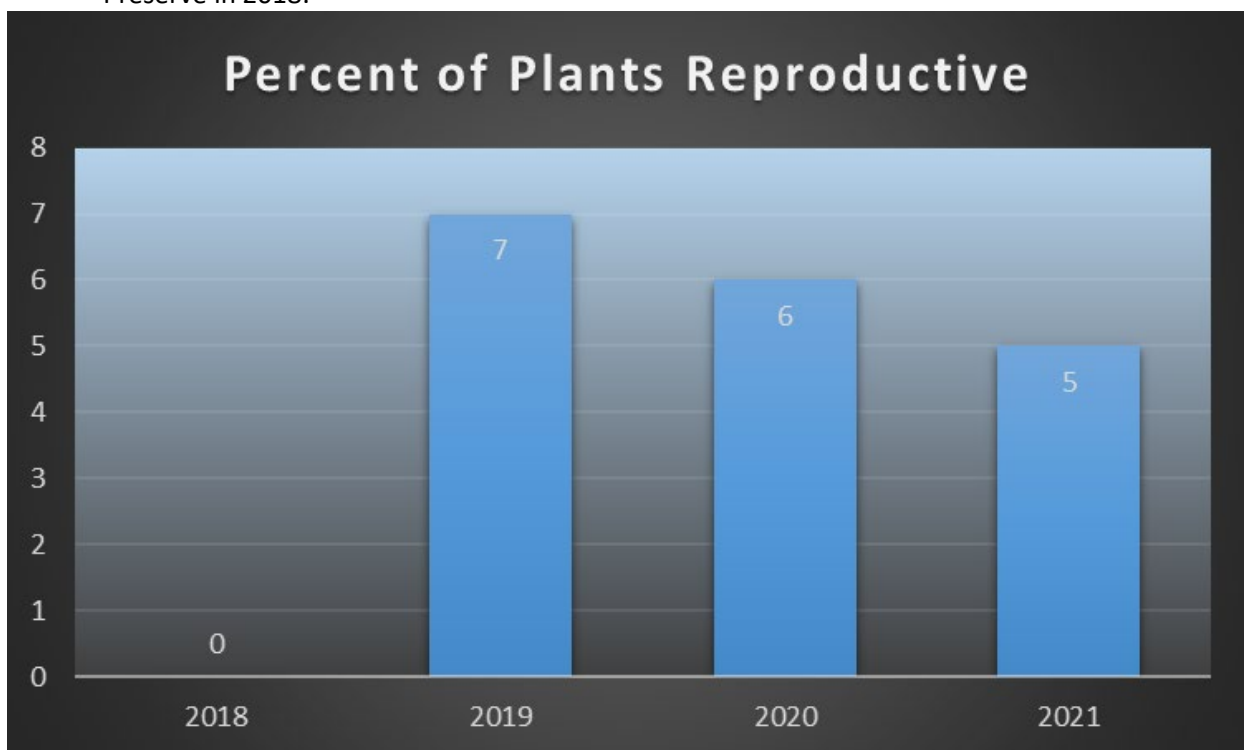
excellent condition. Only 13 of the plants were flowering (Figure 15). Cages were removed after the first year to allow for plant growth and expansion. In 2020 only 97 plants were found in the 10 monitoring plots. 43 plants were reported missing and 35 plants were found dead. Losses were attributed to gopher activity in the area and inside the plots. Only 3 plots had 15 or more plants. By 2021 only 56 plants remained. Forty-three dead plants were found and 16 were reported missing. Again, mortality and missing plants were attributed to gopher activity. In addition, at no point joint rooted plants were observed in the monitoring plots and the percent of reproductive plants in the population remained low, ranging from 0 to 7% of plants. No seedlings were observed during any of the monitoring years. Growth as measured in maximum height was minimal in the years after planting. The average height of all plants increased by only 2.1 inches in 3 years. As of 2021 the overall survival rate at this site is only 28%. This site is not likely to persist without significant intervention and augmentation.



**Figure 13.** Volunteers planting and caging Santa Fe cholla plants into monitoring plots, Eldorado Community Preserve 2018.



**Figure 14.** Number of Santa Fe cholla plants in 10 monitoring plots planted at the Eldorado Community Preserve in 2018.



**Figure 15.** Percent of Santa Fe cholla plants reproductive at the second monitoring site at the Eldorado Community Preserve, 2018 – 2021.



## DISCUSSION

After 6 years of monitoring Santa Fe cholla introduction sites we still cannot say that we successfully established a self-sustaining population of the species. For a population to be self-sustaining recruitment has to offset mortality. Even though some sites have great overall survival, recruitment has not offset mortality at any of our sites, which will ultimately lead to the demise of the populations. At this point populations will need continuous augmentation from additional plant clones to be successful, until enough plants remain on a site that can be considered self-sustaining. This could take decades of tedious augmentation and monitoring efforts.

Based on the information gathered through the years from different plantation sites and experiments with various planting techniques we have learned the following lessons about establishing new colonies for Santa Fe cholla:

- Hundreds of plants are needed for successful establishment of a population, or continuous augmentation of a plantation by adding new plants regularly.
- Larger plants have a higher chance for survival than smaller plants
- Cages will not protect plants from gopher damage but will help with other rodents and rabbits, especially during the first year of establishment
- Supplemental watering does not make a difference in the survival of a colony (unless we are in an unusual and prolonged drought)
- The species does not appear to be negatively impacted by associated species, although potential recruitment from seeds may be impacted by significant stands of Kochia or other invasive plants.
- The fungus impacting plants in the Santa Fe area is detrimental to the species leading to a slow death and significantly impacting reproduction.

# RECOMMENDATIONS

## Introduction Sites

Successful self-sustaining populations are difficult to achieve and require consistent monitoring and research to determine what constitutes a successful introduction and at which point they can be considered self-sustaining. Based on current knowledge we can make the following recommendations for future introduction efforts or augmentations:

- The more plants, the better, likely hundreds of plants to start with, augmented by additional plantings until recruitment equals or exceeds mortalities for a number of years
- Caging during the first year is beneficial, but not necessary
- Annual monitoring to track success is important until self-sustaining population status is confirmed
- Larger, well rooted plants do better than smaller cuttings.
- Initial evaluation of rodent and rabbit activity, especially gophers, at a potential introduction site is key to establishment success
- Additional colonies should not be planted in the Santa Fe area within several miles of the known population at Fort Marcy, due to the potential presence of the infectious fungus.

## Natural Populations

The state of the New Mexico populations was described as 'grim' in the 1986 status report (Ferguson and Brack 1986). Conservation recommendations were provided, but not followed, likely due to the uncertain taxonomic status of the species. The current status of the species in its natural habitat can easily be described as critically imperiled. The following recommendations are essential to provide for the continuous existence of the species in its natural habitat into the future:

- A genetics study to determine the validity of the taxon as a species is needed to clarify rarity and to guide conservation efforts
- All known populations in the 4 Corners region need to be properly documented and sampled with ecological notes to support genetic sampling and to determine the cultural heritage of the species, if any
- A status report on the current status of known populations is needed
- The impacts of the fungus on the natural population needs further study
- Seeds should be collected to provide ex-situ conservation opportunities and long term storage for possible future augmentation projects.
- Surveys on BLM lands are needed to determine the status of the species on federal lands, providing protection from development for natural populations.

# ACKNOWLEDGEMENTS

All of these projects came into being solely through the dedication of a great number of outstanding individuals that have worked tirelessly in promoting the conservation of this rare cholla, including several institutions that allowed us to plant an endangered species on their property (Santa Fe Institute, Eldorado Community Preserve, Espanola Wildlife Center). All aspects of these projects from site donation, growing out plants, planting, and monitoring were accomplished by community volunteers largely organized by the Cactus Rescue Project, including Obie Oberhausen, Nancy Lehrhaupt, Joe Newman, Barbara Fix, Bob Sivinski, Phil Musser, Kris Palek, Don Mengay, CJ House, and Catherine Williamson. Special thanks go to Obie Oberhausen, Nancy Lehrhaupt, and Joe Newman for growing hundreds of plants from cuttings, rallying the troupes, and providing endless entertainment through education about the benefits of xeriscaping with cacti. Joe Newman documented all the plantings and monitoring activities in hundreds of photographs, many of which are featured in this report. Obie was also primarily responsible for securing the Eldorado Community Preserve site. Rebecca Bradshaw was instrumental in getting permission to establish 2 colonies at both campuses of the Santa Fe Institute, where it all began. She also participated annually in gathering the data and brainstorm possible causes of the demise of plants at the Santa Fe Campus. Sandy Powell with the Santa Fe Master Gardeners secured the Espanola Wildlife Center site and organized volunteers for the establishment of the monitoring plots and the annual monitoring.

Volunteers are too numerous to list separately but all these lovely people were largely recruited through the Cactus Rescue Project, the NM Native Plant Society, the Santa Fe Botanical Garden, and the Santa Fe Master Gardeners. We thank them all. Volunteer partnerships are rarely this successful and prosperous.

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