Brady Pincushion Cactus
(Pediocactus bradyi)
5-Year Review:
Summary and Evaluation

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U.S. Fish and Wildlife Service
Arizona Ecological Services Office
Phoenix, Arizona
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5-YEAR REVIEW
Brady Pincushion Cactus (*Pediocactus bradyi)*

1.0 GENERAL INFORMATION

1.1 Listing History

Species: Brady pincushion cactus (*Pediocactus bradyi* L. Benson)
Date listed: October 26, 1979
FR citation(s): 44 FR 61784
Classification: Endangered

1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (Service) most recently evaluated the biology and status of the Brady pincushion cactus (cactus) as part of a status review completed on July 13, 2012. We examined whether new information was available and whether that new information would alter or affect analyses and conclusions made in the previous status review. Additionally, we evaluated new available information about the cactus when we amended the recovery criteria in the Recovery Plan (USFWS 1985) on August 28, 2019. Data for this current review were solicited from interested parties through a Federal Register notice announcing the review on February 2, 2022 (87 FR 5834). We also contacted tribes and our partners to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files.

1.3 FR Notice citation announcing the species is under active review:

Endangered and Threatened Species: Initiation of 5-Year Status Reviews of 35 Species in the Southwest; February 2, 2022 (87 FR 5834 - 5838).

2.0 REVIEW ANALYSIS

Section 4 of the Endangered Species Act of 1973 as amended (16 U.S.C. 1531 et seq; Act) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of “endangered species” or “threatened species.” The Act defines an “endangered species” as a species that is “in danger of extinction throughout all or a significant portion of its range,” and a “threatened species” as a species that is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" due to any of the following five factors: 1) damage to, or destruction of, a species’ habitat; 2) overutilization of the species for commercial, recreational, scientific, or educational purposes; 3) disease or predation; 4) inadequacy of existing protection; and 5) other natural or manmade factors that affect the continued existence of the species.

The identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In assessing whether a species meets either definition, we must evaluate all identified threats by considering the expected response of the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, and then we analyze the cumulative effect of all the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Service recommends whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

2.1 Updated Information and Current Species Status

On August 28, 2019, we finalized an amendment to the 1985 Recovery Plan (USFWS 1985) that contained updates regarding implementation of recovery actions for the species, as well as updated downlisting criteria and new delisting criteria (USFWS 2019). While it would not change our assessment of the species' status, we do have some new information that we included in this 5-year review, most of which we also included in the 2019 Recovery Plan amendment.

2.1.1 Biology and Habitat:

Below we summarize new and ongoing research and conservation efforts regarding the species' distribution, long-term range-wide monitoring, and seed collection. These will improve our understanding of the cactus and guide conservation and management in the future.

Distribution

The cactus occurs only in scattered populations along the rim of Marble Canyon, near Lees Ferry, in northern Arizona on lands administered by the Bureau of Land Management (BLM) and National Park Service (NPS), and on the Navajo Nation. The Arboretum at Flagstaff (Arboretum) conducted surveys to increase understanding of the population and distribution the cactus using 200 randomly selected plots within appropriate soil types that covered the known distribution of the cactus as well as suitable habitat (Haskins and Murray 2017, p. 4). The plots were distributed across BLM and NPS-managed lands (90 plots on BLM, 5 plots on NPS), and 105 plots located on the Navajo Nation. The Arboretum-led study located cacti at 18 of the 200 plots and found 80 occurrences of cacti (724 individuals) outside of survey plots (Haskins and Murray 2017, p.5). Including cacti at the survey plots, they located over 850 individuals, but of more significance, they located new occurrences of the cactus south of its previously known range.

Long-term Range-wide Monitoring

The U.S. Geological Survey (USGS) and Arizona Strip District Office of the BLM compiled 22 years' worth of monitoring and demographic data (Shryock *et. al.* 2014, entire). They tagged and measured 1,049 cacti over the study period, with annual population size ranging from a low of 152 cacti in 1992 to a high of 311 cacti in 2002 (Shryock *et al.* 2014, p. 1947). The cactus' survivorship was lowest during the first five years of life and after 15 years, with increased survivorship of cacti in between these ages. They found that the median survival age was eight years. Thirty-one cacti survived at least 20 years and 14 cacti were present for the entire length of the study, indicating that some cactus may live longer than 22 years. The growth rate (λ) was below unity (0.961), meaning the population is declining (a stable population is equal to 1 and a growing population is greater than 1).

Within plots, the cacti generally occur in small, widely spaced clumps, surrounded by sparse vegetation dominated by low shrubs and grasses. Vegetation in these occupied areas include shadscale (*Atriplex confertifolia*), broom snakeweed (*Gutierrezia sarothrae*), and Indian ricegrass (*Achnatherum hymenoides*) (Shryock *et al.* 2014, p. 1945; Haskins and Murray 2017, p. 8). Annual non-native grasses, including invasive species of *Bromus* spp. and *Schismus* spp., are also common (Shryock *et al.* 2014, p. 1945; Haskins and Murray 2017, p. 9). Non-native grasses can reduce native plant diversity and reduce pollinator availability (Aslan 2017, p. 15). Haskins and Murray (2017, p. 5) found some overlap between the cactus and the federally endangered Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*). They observed 28 Fickeisen plains cacti within and nearby their cactus survey plots.

Seed Collection

The Arboretum collected seeds for propagation studies to determine the efficacy of growing cacti in a greenhouse to supplement wild populations, following the Center for Plant Conservation guidelines (Haskins and Murray 2017, p. 10; Murray 2022, p. 1). Haskins and Murray (2017, p. 10) collected a small number of seed; however, the amount was too small to send to the U.S. Department of Agriculture National Laboratory for Genetic Resource Preservation (NLGRP) in Fort Collins, Colorado. The remote cactus locations, uncertainty of timing, and quality and abundance of cactus fruit/seed production hampered their ability to collect viable seeds. The Arboretum made multiple attempts at collecting seed in 2015 and 2016, but with little success. In 2022, the Arboretum collected 41 seeds from 10 individuals at two locations. They dried the seeds and sent them to the NLGRP for long-term storage.

2.1.2 Threats Analysis (threats, conservation measures, and regulatory mechanisms):

We identified threats to Brady pincushion cactus in our 2012 5-year review. These threats remain similar at the time of this review; therefore, we do not repeat the entire analysis here. Below we briefly discuss recent information pertaining to some of the threats we identified in previous listing and recovery documents.

Habitat Loss

Haskins and Murray (2017, p. 10) identified potential stressors to the cactus based upon the surveys they conducted at 200 plots. They evaluated the presence or evidence of eleven potential threats on their study plots and found that invasive species (~157 plots), livestock grazing (~145 plots), livestock trampling (~127 plots), and burrows/tunnels/digging (~135 plots) were the most prevalent. They also found evidence of vehicle tracks within plots (~25 plots).

We received a report from a cactus researcher noting that recreationists were ignoring 'No Parking' and interpretive cactus signs, driving vehicles over study plots, removing boulders placed to protect the cactus and its habitat, and camping on top of known occupied areas on BLM-managed lands (T. Esque, USGS, pers. comm., 2021). In an old roadbed that a small cactus had colonized in 2019, they found fresh tire tracks but no cacti in 2021 (T. Esque, USGS, pers. comm., 2021). The researcher noted these activities in March 2021, which was during the COVID-19 pandemic when there was reduced land manager presence on the landscape.

Murray (2022) also noted heavy recreational use at cactus sites even though the roads have visible signage informing visitors not to drive or park off-road. The found many user-created pull-out and camp spots, including a campsite on a USGS cactus monitoring plot with tire tracks over tagged cacti. The BLM has designated most, if not all, of the habitat on BLM-administered lands as an Area of Critical Environmental Concern, providing extra management protections to the cactus and its habitat in perpetuity. These management protections are intended to reduce, if not eliminate the effects associated with previously identified threats of mining activity, off-highway vehicle use, and recreational activities in cactus habitat. It will be important for land managers and the Service to monitor these areas and identify how vehicular access can be further discouraged to protect cacti.

The Navajo Natural Heritage Program has a planning tool called the Biological Resource Land Use Clearance Policies and Procedures that discourages development in sensitive wildlife areas. Moenkopi shale, on which the cactus occurs, is in Area 1 ("highly sensitive"). The Heritage Program does not allow for development (including homesites) within Area 1 unless there is a reason (*e.g.*, it is a previously disturbed area, not sensitive species habitat).

Herbivory

Over the course of their 22-year study, Shryock et al. (2014, p. 1947) found that herbivory ranged from zero to a high of 85 cacti. Researchers hypothesized that during extreme drought periods, rodents used cactus for nourishment due to reduced food sources and noted that the rodent herbivory in the 1989 to 1990 census event likely accounted for differences in stochastic growth rates between plots (Shryock *et al.* 2014, p. 1952). As climate change causes more frequent and longer droughts, herbivory may become a larger stressor to cactus persistence than previously anticipated.

Collection

Large cacti present on an overlook on the Marble Plateau in 2019 disappeared in 2021 and cactus researchers think that collectors are likely responsible (T. Esque, USGS, pers. comm., 2021). A specific cactus known for its unique size and morphology was also missing when researchers conducted monitoring in 2021(T. Esque, USGS, pers. comm., 2021). They noted a large hole that someone backfilled with rock and gravel where the individual plant used to occur. This cactus occurred in a heavily used area and the researchers had a Global Positioning System (GPS) point for the cactus, allowing them to determine conclusively that it is gone. We do not know the full effect that illegal cactus collection has on the species' persistence, but it is likely a threat we need to address further with our partners.

Climate Change

Shryock *et al.* (2014, entire) used 22 years of monitoring data to study the long-term vulnerability of the cactus to climate change. Both deterministic (non-fluctuating) and stochastic (fluctuating) population growth rates indicated that cactus populations might decline in the future, depending on relationships between demographic processes, climate, and other stochastic events (Shryock *et al.* 2014, p. 1949). They found that cactus had low survival during drought years that outweighed the increase in seedling establishment in wet years. Quasi-extinction risks based on the scenario of increased drought suggested that from several hundred to a thousand cacti would be required for populations to remain viable after 75 years (Shryock *et al.* 2014, p. 1950). This finding is important because we do not have reliable estimates of the cactus' (Shryock *et al.* 2014, p. 1950). Based upon these findings, the cactus, which has a low growth rate, will likely be vulnerable to increases in the frequency and intensity of extreme weather events, particularly drought.

Researchers are documenting vulnerability of the cactus to drought. Murray (2022) noted during seed collection events from 2019 to 2022 that long-term drought, specifically below average rainfall and high late spring temperatures, was responsible for poor cactus condition, a lack of flowers, and reduced seed. These observations of drought effects are consistent with research documenting the negative effects of successive drought years and increased ambient temperatures on recruitment and persistence of the Peebles Navajo cactus (*P. peeblesianus*), a closely related species to the cactus (Phillips *et al.* 2017, pp. 38-39).

2.2 Synthesis:

After reviewing the best available scientific information, we conclude that the cactus remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in our 2012 5-year review (USFWS 2012) remains an accurate reflection of the species current status, and additional potential threats have been identified, as described above.

3.0 RESULTS

3.1 Recommended Classification:

____ **Downlist to Threatened**
____ **Uplist to Endangered**
____ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *The species is extinct*
____ *The species does not meet the definition of an endangered species or a threatened species (i.e., is recovered, or new information on status and threats indicate species does not meet definitions)*
____ *The listed entity does not meet the statutory definition of a species.*
_X__ **No change is needed**

3.2 New Recovery Priority Number: No change recommended.

Brief Rationale: At this time, we do not have information to indicate that the status the cactus or its threats have substantially changed since our 2012 5-year review.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- We recommend the Service and partners, the Navajo Nation, BLM, NPS, USGS, and Arboretum, develop a monitoring plan to detect population trends for the cactus (USFWS 2019). This action would address Delisting Recovery Criteria 1.

- We recommend land managers implement management actions to protect cacti and their habitat from dispersed recreation. This action would address Recovery Action 1.

- We recommend researchers collect cactus demographic information (*e.g.*, survival, fecundity) to understand how the cactus has responded to past climatic fluctuations and enable predictions for how future climatic changes will affect demographic processes. This action would address Recovery Action 2.

- We recommend researchers continue to bank seeds so that this material is available for propagation research and genetic analysis, especially for research of genetic variance across cactus populations. This action would address Recovery Actions 2 and 5.

- We recommend further study of the zone of overlap between Brady pincushion cactus and Fickeisen plains cactus. The known area of overlap is relatively small, but does exist, so increasing our understanding of the respective species' microhabitats may provide valuable information for management and conservation. This action would address Recovery Action 2.

- We recommend mapping and estimating the size of existing and potential suitable habitat, as well as the conservation status of these areas. This would include cooperation with the Navajo Nation Department of Fish and Wildlife, as well as federal land managers. This information would allow for better interpretation of the estimates of

stochastic growth rates and quasi-extinction risks that Shryock *et al.* (2014, p. 1950) calculated as well as for tracking habitat disturbance. This action would address Recovery Action 2 and Delisting Recovery Criteria 2.

- We recommend creating and conducting additional public outreach and education to reduce the risk of illegal collection (poaching), and public awareness, appreciation, and support for the cactus. This action would address Recovery Action 4.

5.0 REFERENCES

Aslan, C. 2017. *Pediocactus peeblesianus* var. *fickeiseniae* exhibits exceptionally low pollination rates. Section 6 Final Report (Grant #16-2015-2017-01) to the Arizona Department of Agriculture and the U.S. Fish and Wildlife Service. September 30, 2017. 35 pp.

Esque, T. 2021. Email from T. Esque, U.S. Geological Survey (USGS) regarding *Pediocactus bradyi* census trip observations. Personal communication with Shaula Hedwall, U.S. Fish and Wildlife Service. April 12, 2021.

Haskins, K.E. and S. Murray. 2017. Conservation of a rare cactus (*Pediocactus bradyi*) through surveying and seed collection. Section 6 Final Report (Grant #19-2015-2017-10) to the Arizona Department of Agriculture and the U.S. Fish and Wildlife Service. September 5, 2017. 11 pp.

Murray, S. 2022. Seed collections of rare and threatened Pediocactus for conservation. The Arboretum at Flagstaff, Section 6 interim performance report (Grant #2019-2021-03) to the Arizona Department of Agriculture and the U.S. Fish and Wildlife Service. June 6, 2022. 1 p.

Phillips, K.O., B.G. Phillips, and A. Hazleton. Population dynamics of Peebles Navajo cactus *Pediocactus peeblesianus* subsp. *peeblesianus* (Croizat) L.D. Benson: Summary of a 34-year monitoring program. Section 6 Final Report (Grant #20-2016-2018-07) to the Arizona Department of Agriculture and the U.S. Fish and Wildlife Service. September 2018. 45 pp.

Shryock, D.F., T.C. Esque, and L. Hughes. 2014. Population viability of *Pediocactus bradyi* (Cactaceae) in a changing climate. American Journal of Botany 101(11):1944-1953.

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U.S. Fish and Wildlife Service (USFWS). 2012. Brady pincushion cactus (*Pediocactus bradyi*) 5-Year Review: summary and evaluation. 37 pp.

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of Brady Pincushion Cactus *(Pediocactus bradyi)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, Arizona Ecological Services Office

Approve HEATHER WHITLAW Digitally signed by HEATHER WHITLAW Date: 2022.09.21 15:38:29 -07'00'