

Pediocactus bradyi

Brady's Pincushion Cactus

STATUS REPORT

2004



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INTRODUCTION

The Brady pincushion cactus (*Pediocactus bradyi*) was first collected by Major L.F. Brady in July of 1958. It was described by Lyman Benson in 1962.

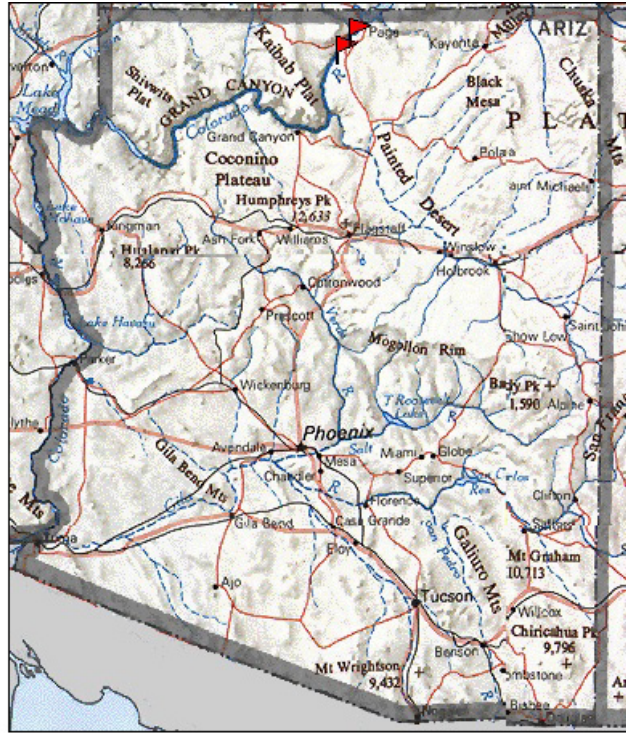
On October 26, 1979, it was federally listed as endangered (44 FR 61784). *Pediocactus bradyi* is known only from the vicinity of Marble Canyon, Coconino Co., AZ, over a stretch of ca. 25 miles. Management responsibility is shared by the Bureau of Land Management (AZ Strip District), Glen Canyon National Recreation Area and the Navajo Nation.

There are 7 species and their varieties of *Pediocactus* in the United States, six of which are rare endemics of the Colorado Plateau. Only one species of *Pediocactus* is widespread and occurs from the Columbia River Basin south to the Colorado Plateau (*Pediocactus simpsonii* (Engelm.) Britt. & Rose). All other species of *Pediocactus* are rare, occupying small, specialized habitats in northern Arizona, Utah, and northwestern New Mexico. Three other species of *Pediocactus* are listed as endangered (*Pediocactus peeblesianus* (Croizat) L. Benson var. *peeblesianus*, *P. knowltonii* L. Benson, *P. despannii* Welsh and Goodrich). Two species are listed threatened (*Pediocactus sileri* (Engelm.) L. Benson, *P. winkleri* Heil). Two species are listed as state sensitive (highly safeguarded) in Arizona (*Pediocactus peeblesianus* (Croizat) L. Benson var. *fickeiseniae* L. Benson, *P. paradinei* B.W. Benson).

Presently, monitoring studies are ongoing on BLM and Navajo Nation lands. These long-term studies indicate a decline in plant numbers (Hughes 2003, Roth 2004). This is largely attributed to low recruitment numbers and increased mortality through human caused disturbances such as off-road vehicle traffic. Insect herbivory is one of the leading natural causes of death. Ongoing long term monitoring studies on the population dynamics of *P. bradyi* are necessary to fully understand population trends. The Navajo Nation unsuccessfully surveyed for new population sites in 1991 & 1992. Inventory efforts commenced in 1998 and have continued through 2004.

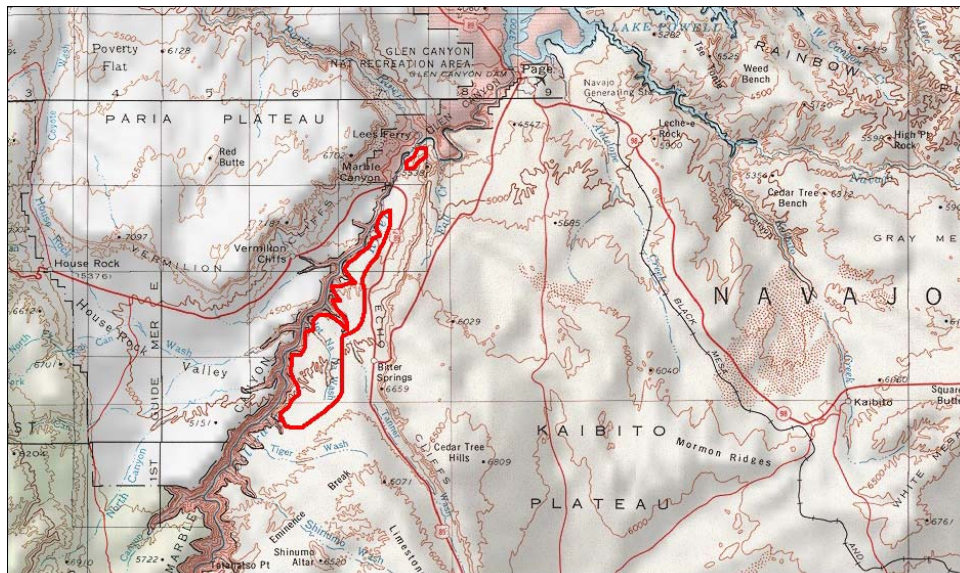
The Recovery Plan of 1985 did not establish criteria for delisting of *P. bradyi* because a complete census of plants within the known habitat had not been completed due to funding limitations (Phillips et. al. 1985). The criterion for downlisting is to permanently protect 75% of habitat following a 5-step outline.

Step 2 of this outline calls for sustaining healthy populations in their natural habitat at existing sites. One of the 3 main goals within this step is to inventory for *Pediocactus bradyi* by searching for other populations within the known area and to search for new locations. This study was proposed in an effort to contribute to the cumulative knowledge about the status and distribution of *Pediocactus bradyi* on the Navajo Nation with the goal of moving towards establishing a means of quantifying criteria for delisting and the eventual recovery of the Brady Pincushion Cactus.



TN MN
12°
0 100 200 300 miles
0 100 200 300 400 km
Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

2004 distribution of *Pediocactus bradyi* on the Navajo Nation



TN MN
12°
0 5 10 15 20 25 miles
0 5 10 15 20 25 30 35 40 km
Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

Map detail

TECHNICAL DESCRIPTION

Pediocactus bradyi L. Benson (Brady Pincushion, Brady Plains Cactus)

Family: Cactaceae

Synonyms: *Toumeyia bradyi* Earl

Plant Description:

Small semiglobose cacti, stems 3.2 – 6.2 cm tall, 2.5 – 5.0 cm in diameter, spherical, solitary or few branched. Areoles white, somewhat pectinate. Central spines absent or rarely 1-2, radial spines 14 – 15, each 3 – 5 mm long, white or yellowish-tan. Flowers are straw-yellow, 1.5 cm in diameter, produced on the apex of the stem. Plants have contractile roots, pulling themselves underground during drought periods.

Similar Species:

Can be confused with juvenile forms of *Coryphantha vivipara* (Nutt.) Britton & Rose, when not in flower. *P. bradyi* has distinct vertical elongate areoles and the radial spines tend to be shorter than those of *C. vivipara*.

Phenology:

Flowering time is from late March to mid April.

Habitat:

Kaibab limestone chips overlaying soils derived from Moenkopi shale and sandstone. It is typically found on gently sloping benches and terraces with sparse vegetation. On the Navajo Nation, population occurrences tend to be related to the abundance of limestone chips. However, some plants also occur in areas with a very sparse layer of Kaibab Limestone. Populations are known from 3400 – 5200 ft elevation. Potential habitat in the entire Marble Canyon area has been estimated at 17,000 acres. However, within that area only 10 – 20 % of that habitat appears to actually be occupied (Brady Pincushion Cactus Recovery Plan 1985). This estimate may be high for Navajo Nation lands.

Vegetation community: Great Basin Desertscrub community (Brown 1994).

Associated species: *Atriplex confertifolia*, *Ephedra torreyana*, *Bromus tectorum*, *Phacelia crenulata*, *Echinocereus fendleri*, *Gutierrezia sarothrae*, *Bouteloua gracilis*.

Associated sensitive and rare species: *Astragalus cremnophylax* var. *hevronii*, *Cryptantha atwoodii*, *Pediocactus peeblesianus* var. *fickeiseniae*, *Rosa stellata* var. *abyssa*.

Distribution:

Coconino Co, AZ, along the Colorado River on the rim of Marble Canyon. On the Navajo Nation *Pediocactus bradyi* occurs from across Cathedral Wash on the east side of the Colorado River, south to the vicinity of Sheep Springs Wash.

Responsible Agencies: Navajo Nation, ADOT, Glen Canyon NRA, BLM (AZ Strip Field Office)

STATUS

Federally Listed Endangered (Federal Register Vol. 44, No. 209). No critical habitat was designated to avoid publication of exact population locations.

This species is also protected as an endangered species by the Navajo Nation under Navajo Tribal Code Title 17, Subchapter 507 (Navajo Endangered Species List G2, Resources Committee Resolution, No. RCMA-31-01, 2001). On state lands it is protected under the Arizona Native Plant law as a Highly Safeguarded Native Plant.

GENERAL ASSESSMENT

METHODS

Surveys

In 2004, 12 days were spent in the field re-surveying Element Occurrence Records older than 6 years. In addition, appropriate habitat was surveyed just south of Lee's Backbone & N of Navajo Bridge, south along the Marble Canyon rim to just north of Tiger Wash, ca. 20 miles to the south. General habitat surveys began in the spring 2001 and lasted through the spring of 2004. The objective was to determine the distribution of *Pediocactus bradyi* on the Navajo Nation, estimate population size and parameters, biotic and abiotic habitat characteristics as well as potential threats. Survey boundaries were determined by potential habitat.

Monitoring

Seven monitoring plots were established in 1991 near Marble Canyon in northwestern Arizona to obtain information on demographic characteristics and trends of the population and to evaluate various threats and the response to possible human disturbance. The plots were monitored annually during early spring from 1991 to 1994, then again annually in the springs since 1997. Recorded are the number of plants in each plot, vigor or health of each plant, diameter (cm) to determine size classes, and phenology (buds, flowers, post-flowers, immature fruits, mature fruits, aborted flowers/fruits), to determine reproductive effort.

RESULTS

Surveys

Only a fraction of the available habitat was occupied by the cactus and only two new populations were located during the survey period. The Navajo Natural Heritage Program has currently 11 Element Occurrences on record from the Navajo Nation. Five of these contain very low population numbers with less than 25 plants per population (Table 1). Navajo Nation populations are typically found in small widely scattered groups of 2 to 15 cacti. In 2004, only one population contained over 100 plants.

All populations are potentially impacted by livestock trampling. Six populations

are in the immediate vicinity of dirt roads, within 4 of these populations off-road vehicle traffic is a noted threat. On three sites heavy impacts by livestock or off-road vehicle traffic was noted.

Despite excellent habitat and the presence of *Pediocactus bradyi* directly north and south of Navajo Bridge, no plants were found within 1 – 2 miles of the bridge. The northernmost population of *Pediocactus bradyi* is located north of Navajo Bridge, across from Cathedral Wash. Habitat for *Pediocactus bradyi* ends about 1 mile north of the Cathedral Wash confluence, at the base of Lee's Backbone. *Pediocactus bradyi* populations were traced southward along the rim of Marble Canyon and vicinity where appropriate habitat was located. The southernmost population on Navajo land was located ca. 2 miles north of Sheep Springs Wash. No other populations were found south of Sheep Springs Wash.

Monitoring

The Navajo Natural Heritage Program has been monitoring a population of Brady Pincushion Cactus since 1991. Originally the 7 monitoring plots contained 114 cacti. The site has seen a variety of disturbances, mostly human caused. The drought of 2002 had a devastating impact the *Pediocactus bradyi* population at the monitoring site. Only 81 cacti were located in the spring of 2003. Sixteen plants were found dead, apparently eaten by a cactus borer beetle. Only one seedling was found. This trend continued into 2004 when an additional 8 plants were found dead. Four plants were added in 2004, one was not located. The total number of live plants was 78 in 2004.

The overall health of the cacti as measured by appearance or vigor had been on a decline since the drought of 2002. However, by 2004, vigor of the surviving plants was rated excellent for 81% of the plants, compared to only 53% in 2003. 13% of all plants were in good condition in 2004. The remaining plants were in fair or poor condition (4 and 3% respectively). Reproductive effort was unprecedented in the 2002 and 2003 monitoring years. None of the cacti were flowering or reproducing in 2002, while in 2003 only 6 cacti were found with reproductive structures. The last successful reproductive year was in 2001 when 92 reproductive structures were counted on 97 plants, which is over twice the number found in most of the four previous monitoring years. In 2004, 17 of the 78 live plants were found reproductive, with 21 reproductive structures among them.

Analyses of size class distributions indicate a loss of large diameter plants from the population following the severe disturbance caused by a film crew and the combined effects of drought stress and insect damage. The number of plants in diameter size classes above three centimeters decreased sharply, from 45 plants in 1993 to 33 in 1997. By 2002 only 11 plants were over 3.00 cm in diameter. In 2004, 18 large diameter cacti were found in the monitoring plots. Some of this decline might be attributed to shrinkage due to drought conditions. Since the 1998 monitoring year the majority of cacti have placed in the 2 – 2.99 cm diameter category. Prior to 1998 the majority of plants were evenly distributed between the 2 – 2.99 cm and the 3 – 3.99 cm categories. Recruitment of seedlings remains low. During the past four monitoring years only one seedling was found each year. In 2004, 4 new plants were recruited into the population. Highest recruitment numbers were achieved in 1991 and 1993, with 5 and 8 seedlings respectively.

THREATS

A. Habitat Destruction or Modification:

The main threats on Navajo are a multitude of old and new access roads and associated off-road vehicle use. Ever increasing access dirt roads leads to the opening of previously undisturbed areas and subsequent habitat destruction.

B. Disease or Predation:

The past 3 years have seen declines in number in our monitoring plots as a direct result of drought and subsequent predation by insects.

C. Over utilization for commercial, sporting or scientific purposes:

Illegal collection on Navajo Nation lands has not been documented and appears to be a minor threat. *Pediocactus bradyi* is difficult to grow in situ but is now commercially available for cactus aficionados worldwide.

D. Inadequacy of existing regulatory mechanisms:

Habitat on Navajo Nation Lands is not protected.

E. Other natural or manmade threats

Natural limiting factors include droughts, predation by insects and small mammals, restricted habitat and gene pool, low reproductive success and root rot. Trampling by livestock might be significant because there is no grazing plan and livestock may remain in an area year round.

CONCLUSION & RECOMMENDATION

Despite extensive surveys throughout the habitat, *Pediocactus bradyi* remains a rare and threatened species on Navajo Nation lands. Only a fraction of existing habitat is occupied. The estimated total abundance of ca. 10,000 plants in the Recovery Plan may be a serious overestimate, certainly so for Navajo Nation lands. Considering the results of this survey, number of plants on the Navajo Nation is likely less than 1000. Low recruitment rates combined with off-road vehicle traffic, livestock trampling, insect predation and other drought related stresses may seriously impair the continued existence of this species on the Navajo Nation. Off-road vehicle use appears to be the greatest human induced threat to *Pediocactus bradyi* on the Navajo Nation.

Long term monitoring is essential to understand population trends of *Pediocactus bradyi*. A study on the relationship of the cacti and its natural predators, especially cactus borer beetles, would aid in predicting the long term viability of a population under natural conditions. In addition, understanding the role of abiotic factors such as soil chemistry, drought and temperature changes on the germination of seeds and the establishment of seedlings is essential to sustain healthy populations in their natural habitat. Pollination studies to further our insights into the low reproduction and recruitment process may lead to significant findings as to the causes of this problem. On

the Navajo Nation, increased monitoring activities would allow for a greater understanding on the effects of off-road vehicle use and livestock grazing on *Pediocactus bradyi*

Illegal collection of *Pediocactus bradyi* appears to be a minor threat on the Navajo Nation but documentation of illegal activities and law enforcement are difficult in this remote northwest corner of the reservation. Annual monitoring of population sites near the paved highway and areas with easy access might provide us with insights on whether this is a current problem.

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Table 1.

EOR #	Surveys		Status					
	First	Last	P	A	V	T	I	X
2	1986	2004	X	H	V	R, O, G	L	N
3	1963	2004	X	M	V	R, O, G	H	N
4	1994	2004	X	L	V	G	M	N
15	1997	2004	X	M	V	R, O, G	H	N
16	1998	1998	X	VL	V	R, G	L	N
17	1998	1998	X	L	V	G	L	N
18	1998	1998	X	VL	V	R, G	L	N
19	1998	1998	X	VL	V	G	L	N
20	2001	2001	X	L	V	G	L	N
21	2004	2004	X	VL	V	G	L	N
22	2004	2004	X	VL	V	R, O, G	H	N

Key:

EOR# = element occurrence record number

First = year site was first surveyed

Last = year site was last surveyed

P = presence: extant (X), absent (blank)

V = vigor: vigorous (V), not vigorous (N)

A = abundance: > 100 plants (H), 50 - 99 plants (M), 25 - 49 plants (L), 1 - 24 plants (VL)

T = Threats: R = proximity of road, O - off-road vehicle traffic, G = grazing/trampling

I = Impacts: heavy (H), medium (M), light (L)

X = invasive species noted: yes (X), no (N)

Appendix I. Examples of *Pediocactus bradyi* plants on the Navajo Nation.



Rare cluster of *Pediocactus bradyi* plants with one budding cactus.



Example of typical budding cactus among limestone chips, partially submerged.



Example of fully emerged *Pediocactus bradyi* plant in limestone chip poor site.