

Brady Pincushion Cactus

Lee Hughes

Ecologist, Bureau of Land Management
Arizona Strip Field Office

Introduction

Brady Pincushion Cactus (*Pediocactus bradyi* Benson) occurs along the Marble Canyon Rim of the Colorado River in northwest Arizona on the Navajo Nation, Glen Canyon National Recreation Area (NRA) and on Bureau of Land Management (BLM) administered public lands operated out of the Arizona Strip Field Office. The Brady Pincushion Cactus was listed as endangered in 1979 by the US Fish and Wildlife Service (USFWS, 1979). As a result of that, a recovery plan was done in 1985 followed by a BLM habitat management plan in 1986. In 1992, a BLM Area of Critical Environmental Concern (ACEC) was established and in 1994 an ACEC plan was completed, which had management prescription for the Brady Pincushion Cactus on BLM lands. In 2001, a biological opinion on the Kane Ranch Allotment Management Plan was issued by the USFWS, which set into place additional actions to the management plans for the BLM (USFWS, 2001). The management plans and biological opinion detailed such actions as moving livestock waters, closing areas to vehicles, describing demographic monitoring and other monitoring to determine livestock trampling effects on the cactus.

The Navajo Nation and the National Park Service at Lee's Ferry also have monitoring studies on this cactus.

Some History of the Cactus

The Brady Pincushion Cactus was brought to human attention in 1958 by Major L.F. Brady who first collected it in July 1958. He gave two living specimens to the Museum of Northern Arizona and to W.H. Earle, at the Desert Botanical Garden.

W. H. Earle showed the specimen to Lyman Benson, and Benson followed up with a 1961 visit to the type locality in the Marble Canyon Rim country. From the specimens gathered from that visit, Lyman Benson described the cactus in 1962 (USFWS, 1985) (Benson, 1962c). After 1962, the record falls silent until the 1970s. From 1962 to 1976, no field notes show up in the Arizona Strip files.

In 1976, Ralph Gierisch, a retired U.S. Forest Service ecologist/botanist, signed on with the Arizona Strip BLM. He began to collect voucher specimens to develop a herbarium and search for rare and endangered plants. Ralph

began to inventory the geographic range of the cactus in 1976. In 1980, Ralph Gierisch and David Anderson set up the first demographic transects next to Soap Creek and Badger Creek Canyon rims.

After field searches and a records search, Arthur Phillips (a botanical consultant from Flagstaff, Arizona) wrote a status report in 1979 for the USFWS, which recommended listing *Pediocactus bradyi* as endangered (USFWS, 1979). In 1984, I (Lee Hughes) set up four additional plots at Badger, Soap and North Canyon rims to do demographics of the cactus. Inventory of the rims from Marble Canyon Lodge to South Canyon was done by me from 1984 to 1986. John Spence of the National Park Service set up demographic plots on the Lee's Ferry Brady Pincushion Cactus population on the NRA in 1992. The study was done in 1992 and 1993. John conducted later studies in the 2000s, but the data has not been analyzed as yet.

Donna House and later Bill Hevron set up plots by 1991 on the Navajo Nation populations on the rim of Jackass Canyon. Daniela Roth has since been the major player in Navajo Nation's monitoring. The seven plots on the Navajo Nation's Jackass Canyon have been read from 1991 to 2004, excepting 1995 and 1996.

Taxonomy

The Brady Pincushion is a small, semiglobose cactus with one or more stems up to 6 cm tall and up to 5 cm in diameter. Its areoles are elliptic and densely white or yellow-villous. There are usually no central spines, but each areole has 14-15 whitish radial spines, each 6 mm long and spreading nearly pectinate. The straw-yellow flowers are about 2.5 cm in diameter. This plant flowers the end of March and first part of April. The green top-shaped fruit turns brown at maturity. During the dry season, the plants largely retract into the soil (USFWS, 1985).

The *Coryphantha vivipara* (Nutt) Britton and Rose, is commonly known as a beehive cactus. When small and prior to central spine development it is similar in appearance to the Brady Pincushion. The *Coryphantha*, however, has very dense radials 20-30 compared to 14-15 on the Brady Pincushion. The radials are shorter on the Brady compared to the *Coryphantha*.

Distribution and Geography

The Brady Pincushion Cactus occurs along both rims of Marble Canyon and its side canyon rims. The cactus grows on three different soils. The soils are on Pennell sandy loam, gravelly loam Kinan Pennell complex and Disterheff/Houserock complex. The one soil character that seems to indicate the possible presence of this cactus is the white rock chips that overlay the soil. These indicator chips have an abundance of clear crystalline coatings and a whitish color that appears to be the distinct property on which the Brady

Pincushion Cactus occurs, as compared to the adjacent brown limestones where few or no Brady Pincushion Cactus occur. The populations of the Brady Pincushion Cactus on BLM land occur just south of Lee's Ferry, on the rims of Badger Creek Canyon, along the Marble Canyon rim down to Soap Creek Canyon and on the rims of Ryder and North Canyon. South of North Canyon they play out and the *Pediocactus peeblesianus* (Croizat) var *fickeiseniae* L. Benson is the dominant pediocactus. On the Navajo Nation Brady Pincushion Cactus has been found from the Lee's Ferry area across from Cathedral Wash to two miles north of Sheep Springs Wash. The Brady Pincushion Cactus does not consistently occur along these rims. It occurs sporadically along the canyon rims. Dense populations alternate with areas of no Brady Pincushion Cactus.

The Plant Community

The dominant vegetation types along the canyon rims are saltbush and Desert Grasslands. The Desert Grasslands are dominated by galleta (*Hilaria jamesii*), black grama (*Bouteloua eriopoda*), blue grama (*Bouteloua gracilis*), sand dropseed (*Sporobolus cryptandrus*), and Indian ricegrass (*Oryzopsis hymenoides*). The saltbush type is dominated by shadscale (*Atriplex confertifolia*), four-wing saltbush (*Atriplex canescens*), ephedras, with grasses being quite frequent in places.

The Monitoring Studies

My monitoring study plots were established in 1984 on the BLM administered lands. The four plots are square or rectangular, depending on the location. The two North Canyon plots are 32 by 30 meters each, the Badger Plot is 28 by 30 meters and the Soap Creek plot is 10 by 120 meters. All Brady Pincushion Cactus found in the plot are tagged, measured for width, and mapped. When a cactus is found dead, the ascertained cause is listed. Every year an intense search is made for new cactus recruits. As a result of the Kane Ranch Allotment Management Plan Biological Opinion in 2001, distance transects were set up to determine the number of cactus stepped on by livestock and to determine the mortality by livestock in a year. These transects were run in 2001, 2002 and 2003. None have been run since 2003, as cattle have not been turned out on this allotment due to the six year drought (BLM, 1994).

The Navajo Nation has seven plots wherein the number of plants in each plot, vigor or health of each cactus, diameter of each cactus, and phenology of the measured plant, are all noted at monitoring to determine reproductive effort (Roth, 2004b).

The NRA administers the Lee's Ferry area studies. Their chosen design of the study consists of a fixed circular plot with a radius of 10 meters. A permanent stake was placed at the center, the distance and bearing to the plants or clumps was measured from the stake. The following items were

measured or noted at each plant or clump of plants: plant long axis diameter at the ground level in millimeters; number of flower/fruits per plant; estimated seed set per plant; substrate slope; nearest flowering Brady Pincushion Cactus; distance to nearest flowering individual in centimeters; distance to perennial or large annual species other than Brady Pincushion Cactus; distance to nearest perennial species; signs of herbivory; general health and evidence of damage to plant from other kinds of disturbance. Four plots were established in dense patches of Brady Pincushion Cactus. The plant community was also characterized and pollinators were identified. This study also looked at other parameters of the plant community. The study was carried out in 1992 and 1993 and an abbreviated study in 1997 (Spence, 1993, 2000).

What Have the Studies Revealed

Size Structure (See Size Structure Tables 1-4)

The four BLM plots, the seven Navajo plots and the four National Recreation Area (NRA) plots all had their plot populations dominated by the 20-30 millimeter (mm) width cactus from 1985 to 2004. The small/young cactus in the 0-15 mm were generally in the minority, except at the Badger Creek plot on the BLM which was dominated by the 0-15 mm size class from 1994 through 1999 (BLM, 2005). The Navajo Nation plots were dominated by the 30-40 mm size class in 1992 and 1993. The 20-30mm size class dominated the 1991 and 1997 through 2004 structure readings. The NRA plots, for the two years they were read, was dominated by the 20-30 mm in 1992 and the 30-40 mm size class in 1993. Most plots had a steady stream of small/young cactus recruited into the plot population. This cactus is a long-lived cactus, so steady recruitment maintains the population. There are episodic occurrences of small to young cactus like that which the Badger Creek plot population experienced in the 1994-1999 period (BLM, 2005). Most plots have shown a small but steady recruitment.

The Marble Canyon ACEC Management plan has an objective (for BLM populations only) for the size structure of the cactus population. It states: "...manage toward a population size structure that reflects about 70% (60-80) juveniles, 0-15mm width class, and about 30% (20-30) adults, 15-40+mm, in the life of ACEC plan and after a favorable moisture period." This cactus, it was observed over the years, starts flowering around the 16 mm diameter size class; and any cactus above that size is considered adult.

Only the Badger Creek plot has met the above objective. It has had no livestock on it since 1980. However, the episodic increase in the small cactus probably happened independent of the livestock factor. The Fickeisen Plain Cactus had an episodic increase of 0-15 mm size class for three years in the presence of livestock a quarter mile from water (Hughes, 1996). The rationale for focusing on a steady stream of young/small cactus is that as long as young cactus are present in some viable number, the population will be sustained.

Probably, the goal of 70% 0-15 mm size cactus after wet periods in the Brady Pincushion cactus population, as a management objective, is too high. A goal of 30% 0-15mm size class appears a more feasible goal for sustaining and increasing a population. (BLM,2005).

Mortality

The Brady Pincushion Cactus recovery plan (USFWS,1985) listed the following causes of impacts or threats: collection, off road vehicle activity, uranium mining, and livestock grazing. It also stated that the Brady Pincushion Cactus was restricted to narrow soil-types along the canyon rims that made it very vulnerable to impacts. Frost heaving was also listed as a natural threat (USFWS,1985).

There are two types of mortality – man caused and natural, as found in the trend studies. Man-caused mortality is caused by off-road-vehicles and livestock trampling. Natural deaths are caused by old age, disease, rodents, larva and drought. Death is attributed to rodents and insects when the cactus is dug up and eaten or hollowed out. Another natural cause is drought. These natural types of mortality are by far the biggest killer of the cactus. Three hundred and fifty six were noted as dead as a result of the natural mortality (BLM,2005). In comparison man-caused types of mortality such as livestock tramping and all terrain vehicles have occurred but have been very small in number – a total of nine. The 1985 Brady Pincushion Cactus recovery plan listed collecting as one of the big causes of death of this cactus. However, little evidence has been found of any scale of collecting.

It is difficult to determine whether cactus has been collected. In my Badger Creek rim plot a possible collection occurred but it was difficult to differentiate it from a rodent dig. There was one collection that occurred on Soap Creek Rim (outside the plot); the shovel sized indentation in the ground left no doubt that a collection had been made. However, collection is infrequent.

The Badger Creek demographic plot was vandalized in 1992. Mostly, the vandalism consisted of kicking the metal tags over the nearby cliff or pulling and throwing the tags. In one kick, the three cactus clump, tagged with the # 2 tag, were sheared off by the kick. They died, but the following year, 1993 was wet and 21 small (4-8mm) sized cactus appeared in the foot-print wide trough in the dirt. The plot had to have new tags put in. My plot map indicated most cactus got the same number back. There has been no vandalism there since (BLM, 2005).

The Navajo Nation reports mortality occurring from the cactus borer beetle and vehicle traffic into the Jackass Canyon area. Collecting has not been detected and is considered a minor threat. The Navajo Nation built a fence in 1995 to reduce human activity on the canyon rims, but the gate and fence were continually vandalized until the gate was left unlocked and educational signing was put in place.

The unlocked gate and an educational sign explaining the fence appear to have brought about a better attitude toward the presence of the fence (Roth, 2004a).

Recruitment

Recruitment of the Brady Pincushion Cactus in the BLM plots totaled about 200 more than mortalities from 1986-2004. Total recruitment was 561 as opposed to 365 mortalities. Recruitment, of course has been higher during wet periods with very small annual increases during dry periods (BLM, 2005).

Retraction

Retraction is a factor to consider with mortality and recruitment. In dry years, when monitoring was done, many of the tagged cactus had retracted underground and out of sight. They are not counted as dead, but as retracted. If a wetter season leads up to the monitoring date, most retracted plants were up and observable. There are cases where the opposite has been true. If a retracted cactus fails to resurrect for five years it is counted as dead. However, I have been foiled occasionally and once found a big cactus next to a tag, after 7 years of not seeing it at monitoring, and the cactus was supposedly dead. Retraction makes accounting for the cactus less conclusive (BLM, 2005).

How Much of That Good Recruitment Mortality Ratio Is Due to Management

Of course, the BLM would like to take credit for Brady Pincushion Cactus acting very much like non-endangered species (all those recruits). The ACEC plan and subsequent management designated some roads (1.5 miles of overlook roads) and areas closed to vehicles along the rims of Marble Canyon. A little fencing was done to an overlook where vehicles were driving over the cactus. Educational signing has been added describing the reason for closing roads and leaving some roads open to the Marble Canyon rim and trail heads to the Colorado River. Hence, there has been little or no driving on the rims of the canyons where the Brady Pincushion Cactus grows, since 1980. At that time many exploration surveys for uranium were taking place. Driving along the rim occurred where the North Canyon plots now occur. The tracks are still visible twenty-five years later. The demographics might be showing some improvement there, as a result of no-off road vehicles (there is an occasional violation near overlooks). In 1988, an errant off highway vehicle (OHV) killed two tagged cactus in the North Canyon plot. In 1987, OHV killed three tagged cactus at the Badger Creek plot. The public living in the Marble Canyon area have been helpful and cooperative with the closures, which were done by an interdisciplinary team, composed in part, of community representatives. Some local residents have become guardians for the Brady Pincushion Cactus at their favorite locations. This guardianship is indicated by a circle of rock around the cactus (BLM, 2005).



Pediocactus bradyi range near Navajo Bridge



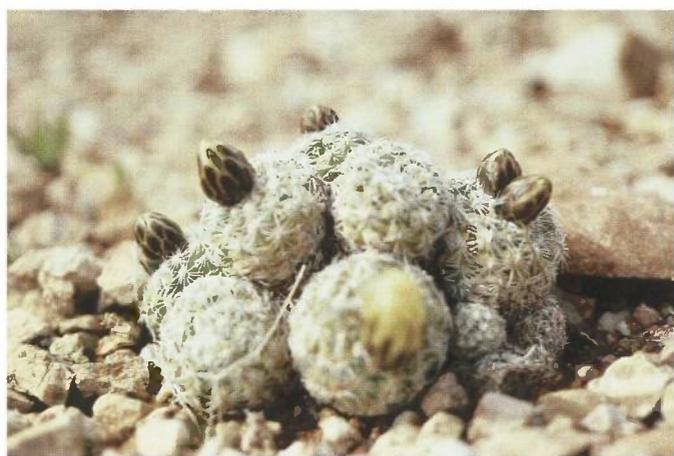
Pediocactus bradyi with slight rodent damage (D. Anderson)



Pediocactus bradyi in flower



Pediocactus bradyi in fruit



Pediocactus bradyi unusual cluster



Pediocactus bradyi frost heaved

Livestock trampling has had an affect also. The livestock waters along the rim in the ACEC have not been improved to hold water, as they all lose their water quickly due to porosity. However, four new waters were placed along a new pipeline in the mid 1990s outside the ACEC boundary. This was done to keep cattle out of the rim country in a concentrated manner. In the North Canyon plots, two cacti were found killed by trampling since 1986. That is the only plot where livestock have had that affect. The livestock trampling transects, started as a conservation measure in the Kane Ranch Allotment Management Plan BO, were done in 2001, 2002, and 2003. The total transect miles were five at their maximum per year. In those three years a total of 15 cactus were found to be stepped on, but 14 of those were not injured. One cactus was killed by livestock trampling and it was found in the North Canyon transect near the North Canyon plots. The soil was wet and hoof prints were deep in the soil. Livestock did not graze the Marble Canyon Rims in 2004 and 2005 (BLM, 2005).

The effect of closing the roads at some over-look points has allowed cactus to appear in old tracks of the two track roads. A closed road to an overlook on Soap Creek Canyon has a cactus growing in an old track and an overlook on the Marble Canyon rim that was fenced also, now, has three cactus growing in the old turn-around. Old roads and overlooks, now closed for 10 years, need to be inventoried for cactus recovery.

The Navajo Nation Population

"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. Considering the results of this survey, (the) 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 (Roth, 2004)."

Conclusion

To conclude, on the BLM administered land, the Brady Pincushion Cactus, an endangered cactus, seems to have some positive population dynamics occurring. There is more recruitment than mortality. There is steady size class structure being maintained. The public in the Marble Canyon area (west of the canyon) is supportive of recovery actions by the BLM, and off-road-vehicle activity is occurring at barely detectable levels. Livestock trampling is occurring less and less on the rims and collecting has not been detected.

Unfortunately, the results from the Navajo Nation are not as optimistic. Like many things involved with land management, there is a mixed picture and plenty of reason to maintain

monitoring and to make management changes at opportune times to promote the survival of this endangered species.

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North Canyon Plot Table 3

After 1990 the plot was reduced to two 30x32 meter plots-east and west.

| Size Class Width mm | 85 | 86 | 87 | Size Class | 88 | 89 | 90 | 91 | 92 | 93 | Size* Class | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 02 | 03 | 04 |
|---------------------|----|----|----|------------|-----|-----|----|-----------|----|----|-------------|----|----|----|----|----|----|----|----|----|----|
| 0-4.9 | 0 | 0 | 0 | 0-4.9 | 1 | 0 | 0 | | 0 | 0 | 0-15 | 14 | 9 | 19 | 15 | 17 | 99 | 12 | 5 | 2 | 3 |
| 5-19.9 | 4 | 8 | 12 | 5-10.9 | 10 | 13 | 13 | | 3 | 1 | 16-30mm | 12 | 15 | 12 | 33 | 41 | 34 | 37 | 40 | 52 | 52 |
| 20-30.9 | 15 | 38 | 85 | 11-20.9 | 54 | 35 | 16 | | 13 | 12 | 31+ | 4 | 4 | 0 | 1 | 1 | 1 | 2 | 1 | 7 | 5 |
| 31+ | 8 | 8 | 17 | 21-30.9 | 190 | 146 | 31 | | 4 | 7 | | | | | | | | | | | |
| | | | | 31+ | 51 | 46 | 21 | | 2 | 6 | | | | | | | | | | | |
| | | | | | | | | West Plot | | | | | | | | | | | | | |
| | | | | | | | | 0-4.9 | 0 | 0 | | | | | | | | | | | |
| | | | | | | | | 5-10.9 | 2 | 3 | 0-15mm | 13 | 19 | 21 | 24 | 19 | 26 | 15 | 4 | 1 | 2 |
| | | | | | | | | 11-20.9 | 5 | 21 | 16-30 | 26 | 14 | 13 | 23 | 29 | 23 | 47 | 37 | 49 | 49 |
| | | | | | | | | | | | 31+ | 5 | 3 | 0 | 1 | 1 | 0 | 1 | 2 | 8 | 10 |
| | | | | | | | | 21-30.9 | 4 | 23 | | | | | | | | | | | |
| | | | | | | | | 31+ | 3 | 7 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

The Navajo Nation Plots(Roth, 2004) Table 4

| Size Class | 91 | 92 | 93 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 |
|------------|-----|-----|-----|-----|-----|----|----|----|----|----|----|
| Multihead | 12 | 12 | 10 | 13 | 11 | 13 | 13 | 12 | 12 | 10 | 10 |
| 0-.99cm | 5 | 3 | 3 | 3 | 2 | 4 | 1 | 1 | 2 | 1 | 3 |
| 1-1.99 | 19 | 15 | 17 | 21 | 23 | 23 | 23 | 25 | 25 | 17 | 14 |
| 2-2.99 | 36 | 34 | 34 | 35 | 49 | 42 | 47 | 41 | 43 | 38 | 33 |
| 3-3.99 | 31 | 38 | 38 | 29 | 15 | 13 | 14 | 17 | 11 | 14 | 18 |
| 4-4.99 | 3 | 29 | 6 | 4 | 2 | 1 | 1 | 1 | 0 | 1 | 0 |
| 5-5.99 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 106 | 108 | 114 | 101 | 100 | 96 | 99 | 97 | 93 | 81 | 78 |

Mortality(Arizona Strip) Table 5
1986-2004

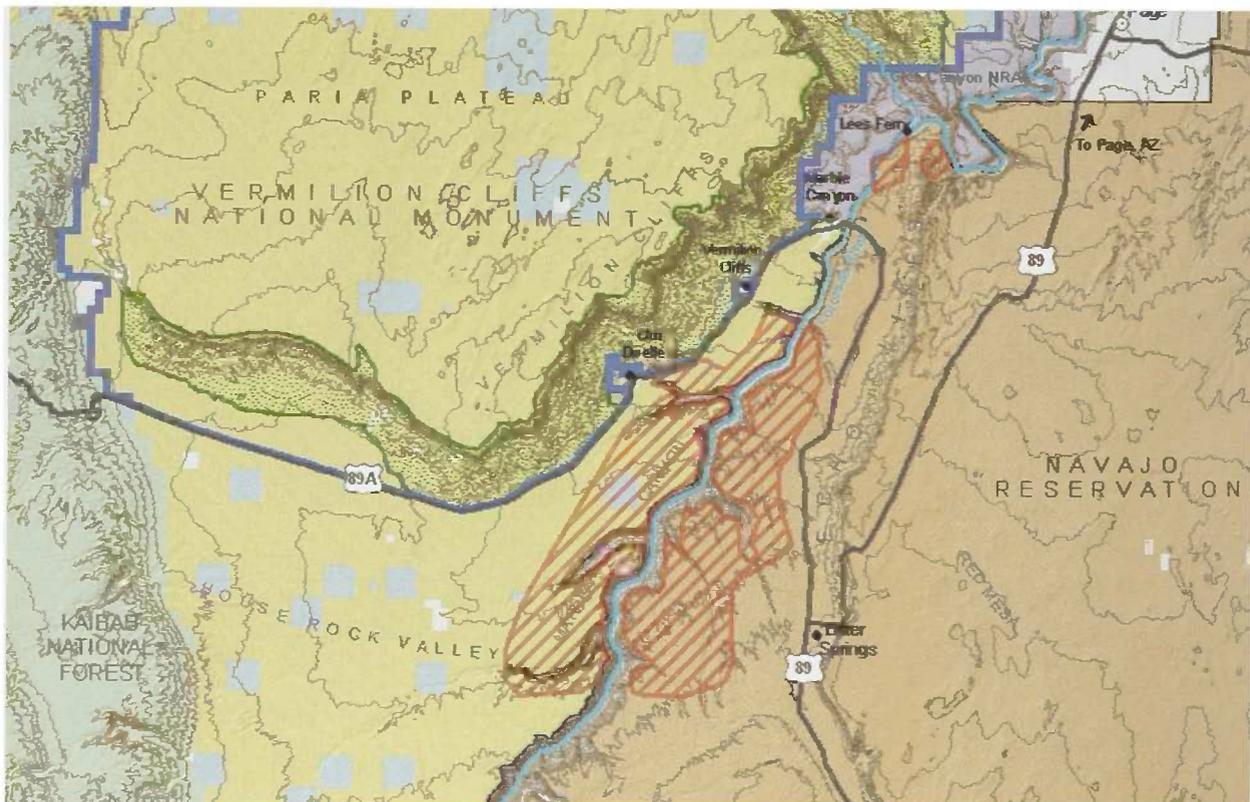
| Cause | Badger Creek | Soap Creek | North Canyon 2 Plots |
|-------------------|--------------|------------|----------------------|
| Off Road Vehicles | 3 | 0 | 2 |
| Trampling | 0 | 0 | 2 |
| Eaten | 11 | 0 | 162 |
| Natural | 93 | 68 | 24 |

Total Mortalities:365

Recruitment Table (Arizona Strip) Table 6
1988-2004

| Recruitment | Badger Creek | Soap Creek | North Canyon 2 Plots |
|-------------|--------------|------------|----------------------|
| Number | 239 | 106 | 216 |

Total Recruitment: 561



Geographical distribution of Brady Pincushion Cactus