Fickeisen Plains Cactus
(Pediocactus peeblesianus ssp. fickeiseniae)

Monitoring Report
Salt Trail Canyon Monitoring Site
2006-2011

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INTRODUCTION

The genus *Pediocactus* is native to the Western United States. Benson (1982) recognizes seven species, six of which are highly restricted endemics on the Colorado Plateau. There are two recognized subspecies of *P. peeblesianus*: *P.p. ssp. peeblesianus* is listed as endangered under the Endangered Species Act. *P.p. ssp. fickeisenae* is a candidate for listing under the Endangered Species Act and listed in Group 3: threatened on the Navajo Endangered Species List (USFWS 2010, Navajo Nation Division of Natural Resources 2008).

Fickeisen plains cactus is a narrow endemic restricted to Kaibab Limestone-derived soils in Coconino and Mohave Counties in northern Arizona. It occurs along canyon rims and flat terraces along washes, typically with limestone chips scattered across the surface (Mikesic and Roth 2008). Populations are known to occur between 4000 and 6000 feet in elevation. The Fickeisen plains cactus occurs on lands managed by the Bureau of Land Management, Navajo Nation, Hualapai Nation, Arizona State Land Department, and the U.S. Forest Service (Arizona Rare Plant Committee 2001, Roth 2008). It also occurs on private land (Goodwin 2008). On Navajo Nation land, known populations occur along the east rim of the Little Colorado River Canyon and in the vicinity of the town or Gray Mountain, although potential habitat is more extensive (Fig. 1)

Known threats include off road vehicles use, livestock grazing, mining, recreational activities, road construction, illegal collection, and herbivory (Roth 2008, USFWS 2010).

In 2006, NNHP staff established four monitoring plots on the east rim of the Little Colorado River Gorge, near the Salt Trail Canyon. The Fickeisen plains cactus in these plots have been monitored annually by the staff of NNHP since that year, except for the year 2010 when the program lacked a botanist. For the same reason, the most recent Fickeisen plains cactus monitoring report addressed the population status in 2008. This monitoring report will address the status of the Salt Trail Canyon population as recorded in 2009 and 2011, as well as the longer-term trends captured by the full data set beginning in 2006.

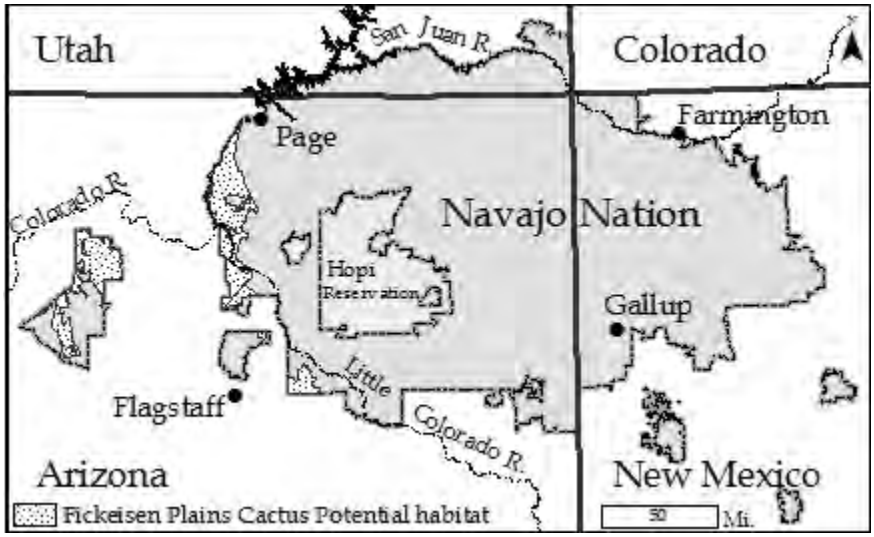

Figure 1. Potential habitat for Fickeisen Plains Cactus on the Navajo Nation.

METHODS

Four circular monitoring plots were established in the vicinity of Salt Trail Canyon on the Navajo Nation in April of 2006. The center of each plot is marked with a large nail and the plots have a radius of 4 meters measured from this nail. Each cactus is individually tagged and the location recorded as distance from and azimuth relative to the center nail . Reproductive status, number of reproductive structures, plant diameter, and plant vigor are recorded annually during the third week of April. Plots have been sampled each April beginning in 2006, except for 2010.

RESULTS

In 2011, a total of 70 cacti were located in the 4 monitoring plots. Twenty-eight tagged plants were found dead or could not be relocated. One new plant was recorded (Fig. 2).

In 2009, 101 cacti were located in the monitoring plots, including 8 new plants. Thirty-one plants were either found dead or could not be located.

Compared to previous years, mortality was high in 2009 and 2011, and fewer new plants were found.

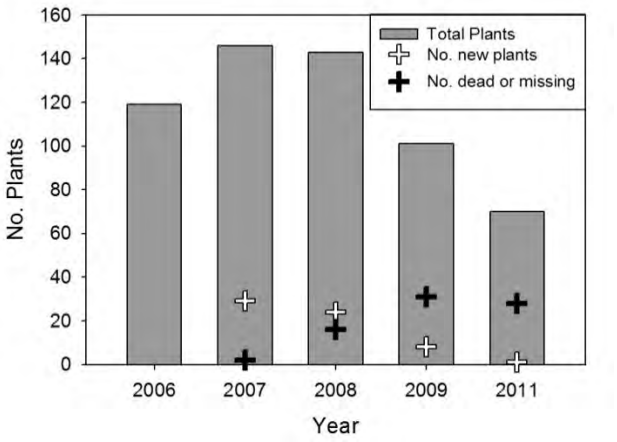

Figure 2. Total number of plants, mortality, and new plants found in four Salt Trail monitoring plots, 2006-2011.

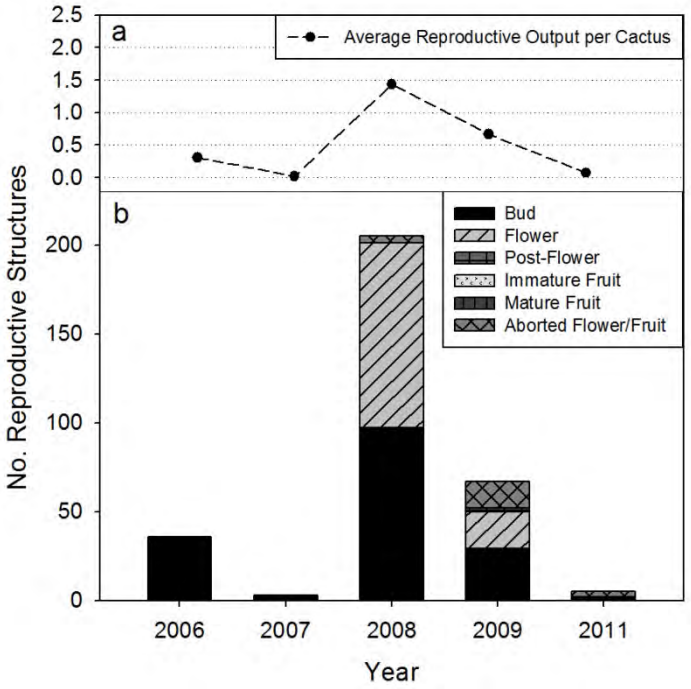

Figure 3. Reproductive output of Fickeisen plains cactus, reported as average number of reproductive structures per plant measured in the population (a), and as total number of reproductive structures, coded by phenological phase (b), in four Salt Trail monitoring plots, 2006-2011.

Reproductive effort in 2009 was moderate, while in 2011 it was extremely low. Both years' reproductive output was much lower than in 2008, when 205 reproductive structures were observed on 98 plants. (Fig. 3). In 2009, 67 reproductive structures were found on 43 plants, and in 2011, 5 reproductive structures were found on 5 plants. While reproductive output was extremely low in 2011, it was similar to 2007 levels, when only 3 reproductive structures were recorded. Even after standardizing by the total number of plants observed (including non-reproductive individuals) to control for increased survey effort, the reproductive effort in 2008 was substantially higher than in any other year (Fig. 3a).

Reproductive structures observed in 2009 and 2011 were flower buds, flowers both at and past their peak, and aborted flower buds. This is similar to phenological results in 2008, when flower buds, flowers at their peak, and aborted buds were observed. In contrast, only flower buds were found in 2006 and 2007. Fifteen aborted flower buds were found in 2009, a substantially higher number than in any other year.

Mean cactus diameter remained constant at 2.8 cm between 2008 and 2009. By 2011, however, mean cactus diameter declined by 0.5 cm to 2.3 cm (Fig. 3). This decline was driven by individual cacti shrinking, rather than mortality of larger individuals. Cacti that were dead or missing in 2011 had an average diameter of 2.7 cm when they were last measured in 2009, slightly smaller than the mean for that year. Compared to 2009, in 2011 there were more cacti in the smaller 1- 1.99cm size class and fewer cacti in the larger 2-2.99cm and 3-3.99cm size classes (Table 1).

One seedling (defined as a plant with a diameter <0.99cm) was found in 2011. Of the two plants that had diameters ≥4cm in 2009, one shrunk to 3.3cm in 2011 and the other was not relocated in 2011.

Table 1. Size class distribution for plants recorded in Salt Trail monitoring plots, 2006-2011.

Size class	2006	2007	2008	2009	2011
Multi-head	4	5	4	4	6
0 - 0.99cm	3	2	0	0	1
1 - 1.99cm	28	41	12	8	17
2 - 2.99cm	56	71	65	50	33
3 - 3.99cm	28	27	60	36	9
4 - 4.99cm	0	0	2	2	0
Total # of plants	**119**	**146**	**143**	**100**	**66**

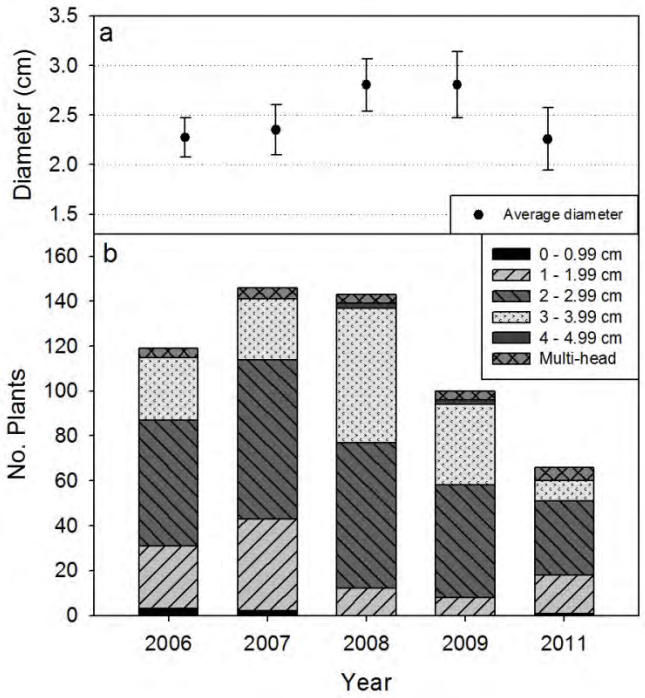

Figure 4. Mean diameter ± 1 standard error (a) and size class distribution (b) for plants recorded in four Salt Trail monitoring plots, 2006-2011.

While vigor of all plants was remarkably similar during the first three monitoring years, vigor declined in 2009 and 2011 (Fig. 5). From 2006 to 2008, the majority of cacti rated in excellent health. However, in 2009 and 2011, only 50% of plants were considered in excellent health.

The number of plants rated fair or poor increased from 4 in 2008 to 23 in 2009. Of these 23 plants, all but 2 were dead or missing in 2011. In 2011, 14 plants rated fair or poor . Of these, one was a new seedling, two were rated fair in 2009, and the remaining 11 had been rated good or excellent last time they were observed.

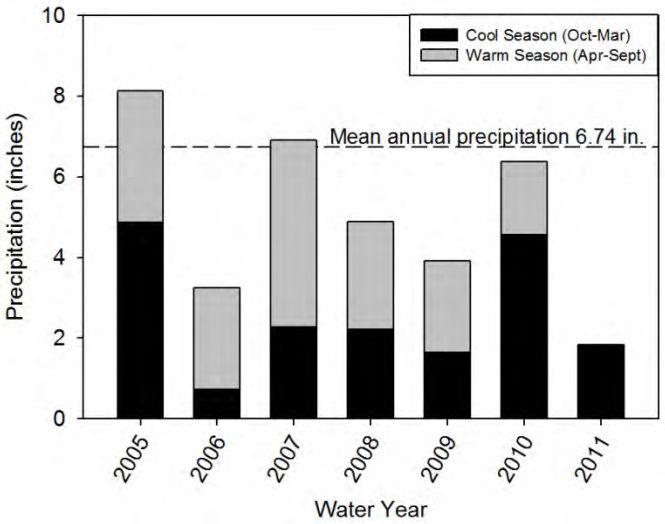

Figure 6. Total precipitation in Tuba City, coded by cool season (October to March) and warm season (April to September) for water years 2005 – 2011. Mean annual precipitation is a 30-year average, calculated from the years 1981-2010. Data from NOAA. Warm season precipitation data for 2011 is not displayed.

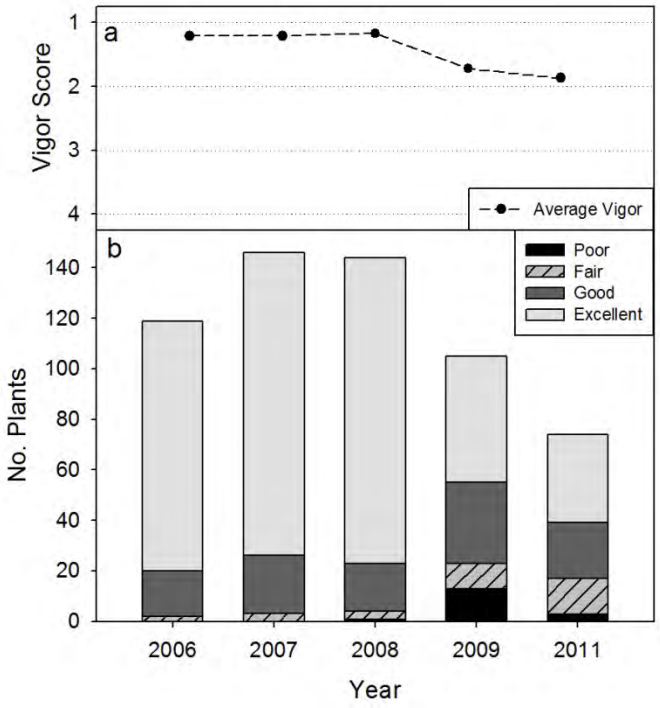

Figure 5. Mean vigor score (a) and number of plants assigned each vigor score (b) for plants recorded in four Salt Trail monitoring plots, 2006-2011. Vigor scores range from 1 (excellent), to 4 (poor).

Annual precipitation was below average for each year of the monitoring study except for 2007 (Fig. 6). Winter precipitation was uncommonly high during 2005, the year before the monitoring plots were installed, and 2010, the year that the plots were not monitored.

DISCUSSION

Of the fifteen known populations of Fickeisen plains cactus in the Navajo Nation, the Salt Trail population is considered the largest (Roth 2008). Between 2008 and 2011, a high proportion of the plants were lost. Mean vigor, diameter, and reproductive output of the remaining plants declined as well. The cause of this decline in the population is not clear. Population trends do not clearly reflect cool-season precipitation patterns, as they do for at least one other species of *Pediocactus* in the region (Hazelton *in prep*). In 2011, there was evidence that one of the plots had been disturbed by an animal. This may explain at least some of the mortality; one plant appeared to have been partly eaten (Fig. 7). However, many of the plants that were recorded as missing in 2011 had been rated with poor vigor in 2009. There was no mention of animal disturbance on the 2009 data sheets, so it is likely that the disturbance occurred sometime between the 2009 and 2011 site visits.

Figure 7. Damaged Fickeisen Plains Cactus in a monitoring plot near Salt Trail Canyon, AZ in 2011.

Cacti in the genus Pediocactus are known to have contractile roots (Benson 1982). That is, they have the ability to retract into the ground during unfavorable conditions. Spring of 2011 was a poor year for rare plants on the Navajo Nation, due to drought. Some species of perennial herbs failed to put up new growth, and others failed to flower or fruit (*pers. obsv.*). While several winter storms did come through the region, the accumulated precipitation was still below average. Many of the Fickeisen plains cacti that could not be located in 2011 were assumed dead because of vigor rated as "poor" in 2009. However, it is possible that some of those plants remained contracted into the ground this year. This is not an unlikely possibility; many of the plants found in 2011 were buried under limestone gravel at the time of the site visit. Future monitoring visits will clarify whether the statistics reported in this document reflect actual mortality, or just dormancy.

Little can be said about trends or external causes for those trends from such a short-term data set. This is particularly true for a species about which so little is known. Future monitoring is a necessity. In order to be able to assess trends for the species as a whole, it is necessary to install additional monitoring sites throughout the species' range. With data from only one location, it is not possible to determine whether this mortality event is reflective of species' status, or an isolated phenomenon affecting this one population.

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