POPULATION TRENDS OF THE MANCOS SALTBUSH, *PROATRIPLEX PLEIANTHA* FROM 1991 TO 1995, NAVAJO MINE, NORTHWEST NEW MEXICO[1]

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Abstract: *The Mancos Saltbush, Proatriplex pleiantha* is of concern to Navajo Mine, BHP Minerals due to its potential status as a threatened plant species. The occurrence of this plant within its natural range however, is strongly influenced by climatic conditions in the Spring. Seeds may remain viable in the soil for up to 10 years, thereby avoiding unfavorable years (Foote, 1989, Knight and Parta, 1992, and personal communication, 1994). Documentation of the plants occurrence and population trends at seven permanent monitoring sites were recorded by Marron Tasheck Knight, Inc. in 1991 and 1992 and by Buchanan Consultants, Ltd. in May 1993 and 1994. Six of the sites are located just outside the Navajo Mine lease boundaries and the seventh site in the Four Corners Region of New Mexico just south of the Colorado border.

Results to date show a general decrease in *P. pleiantha* site size, number of plants at the site, plant size and plant density. There were no plants observed at any of the sites in 1994. Population data collected at sites in 1991, 1993 and 1994 show a decrease from 1992. These decreases are most likely due to unfavorable climatic conditions during the period of seed germination in 1991, 1993, and 1994. Climate during the Spring of 1993 and 1994 was dry and warm compared to wet, warm conditions in 1992 and to a lesser degree in 1991. A cool, wet spring climate appears to favor *P. pleiantha* germination.

Additional Key Words: Threatened and Endangered Species, Mancos Saltbush, San Juan Basin, New Mexico.

Introduction

The Mancos Saltbush, Proatriplex pleiantha (Weber) Stutz and Chu was discovered in 1949 by William Weber, at a location west of Mancos trading post in southwest Colorado. Weber in 1950 published the plant as a new species, *Atriplex pleiantha* Weber (MTK, 1991). In 1990, the plant was elevated to the level of a separate genus and was designated *Proatriplex pleiantha* (Weber) Stutz and Chu, based on female flower and embryo morphology (Stutz, Chu and Sanderson, 1990). *P. pleiantha* is described as a small erect annual herb with succulent leaves. Plants germinate in early spring and flowering in May and June (Foote, 1989). The plant is endemic to the Four Corners region of the Colorado Plateau and is normally found growing on badlands dominated by siltstone outcrops (MTK, 1991). Two population centers have been documented, one in San Juan County, New Mexico and another in Montezuma County, Colorado extending into San Juan County, Utah (MTK, 1991). Populations of *P. pleiantha* may be found in association with the annual *Atriplex* species *Atriplex powellii* and *A. saccarina* (Stutz, 1987). The species has no range management value and generally occupies areas of low economic value (Stutz, 1993).

The occurrence of *P. Pleiantha* within its natural range is strongly influenced by climatic conditions in late winter and spring. Seeds may remain viable in the soil for up to 10 years, thereby avoiding unfavorable conditions (Foote, 1989, Knight and Parta, 1992, and Stutz, 1993). In unfavorable years the plant is rarely observed but is abundant in favorable years.

Proatriplex pleiantha was collected on BHP Minerals, Navajo Mine in 1979. The plant was listed as a federal C2 candidate species in 1980 (MTK, 1991). Federal listing is based on the U.S. Fish and Wildlife Service definitions of rare plant species according to potential vulnerability (U.S. Fish and Wildlife Service, 1990). The definition of a threatened species is a species that is in danger of becoming endangered. In contrast, category 3C species are species that have proven

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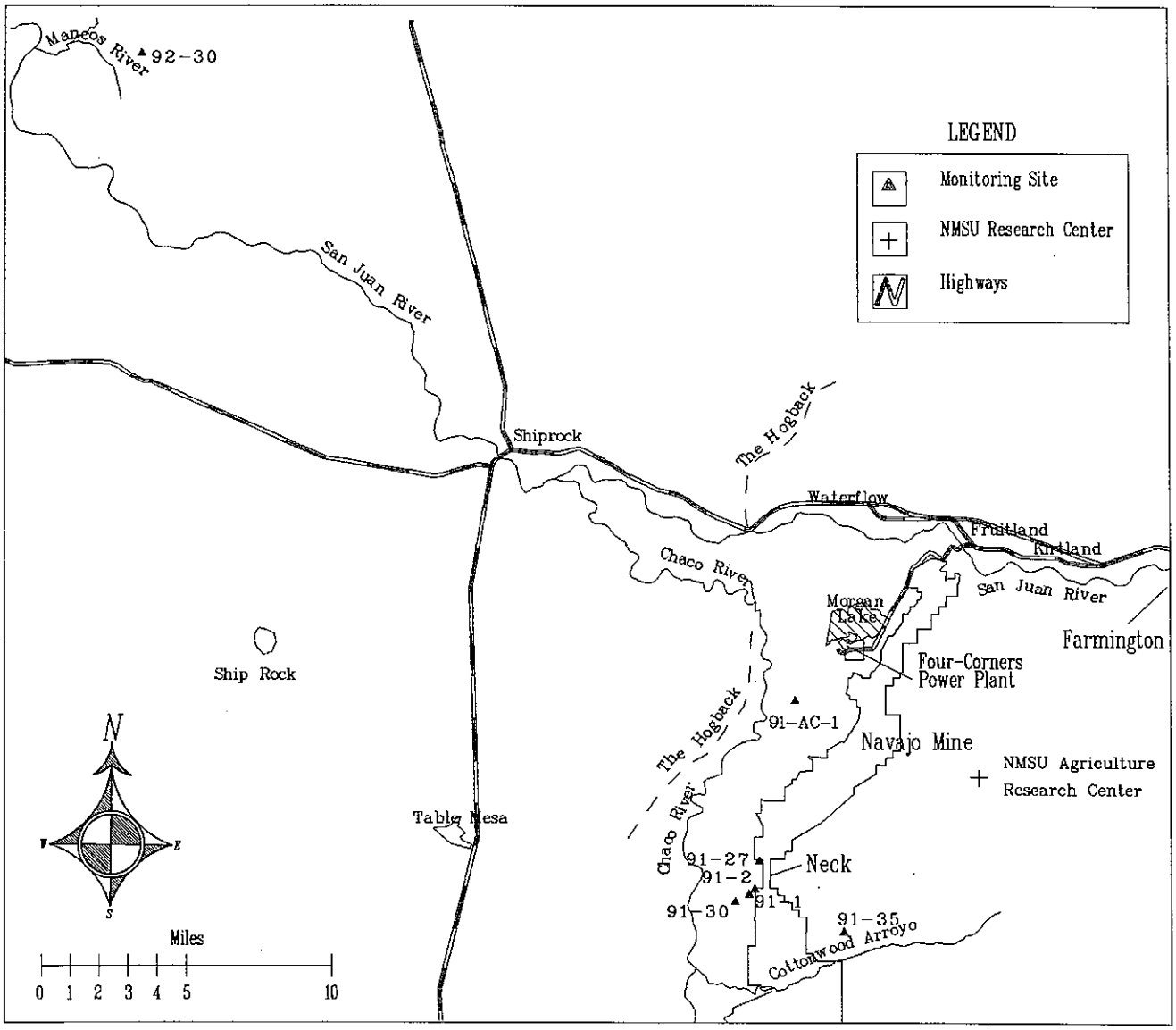
to be more abundant, widespread or are not subject to any identifiable threat than previously believed. Category 2C species are those that there is not enough information to support listing as a threatened or endangered species. Concern over the potential listing of the plant as a Federally threatened species, when in fact there was little available evidence to support this listing, prompted Navajo Mine to undertake investigations of *P. pleiantha* distribution and abundance within its natural range.

Investigations from 1984 through 1990 were under the direction of Dr. Howard Stutz of Brigham Young University (Stutz, 1987, Stutz, 1990 and MTK, 1991). Navajo Mine in 1991 retained Marron Taschek Knight Inc. (MTK) to conduct an extensive survey of *P. Pleiantha* around the Navajo Mine (MTK, 1991). The survey covered 11,000 acres and documented 57 locations for *P. pleiantha.* A variety of population data was gathered at each location. Six locations (sites) were selected to provide long term information on *P. pleiantha* population abundance, distribution and occurrence.



Map1: Location of Proatriplex pleiantha monitoring plots, San Juan County, New Mexico.

The monitoring sites were selected based on: 1) proximity to a permanent weather station 2) geological attributes, 3) physiological attributes and, 4) aspect characteristics represented within the natural range of *P. pleiantha.* These sites are outside the Navajo Mine lease boundaries near the "Neck" portion of the mine (Map 1). A seventh site is located in the Four Corners Region of New Mexico just south of the Colorado border (Map 1). This site was selected to represent *P. pleiatha* populations on the Navajo Reservation that are removed from the Navajo Mine vicinity. Monitoring of the sites was continued in 1993 through the present by Buchanan Consultants, Ltd.

This report presents the results of the *P. pleiantha* monitoring conducted in 1991 to 1994. Certain terms are used in the same manner as used in the 1991 and 1992 *P. pleiantha* reports of MTK. The terms specifically include, Neck, rock datum, population, cell and coverage. Clarification of these terms can be obtained by referring to the 1991 and 1992 reports of MTK.

Methods

Methods are those previously reported by MTK, 1992. Monitoring plots (Figure 1) consisted of: 1) a rock datum[5] marking the site location, 2) a rebar marking the center of the major *P. pleiantha* cell present in 1991, 3) four 50 meter linear transects installed outward from the cell center and positioned at the cardinal compass points and marked on the ends by rebar, and 4) a 10 x 10 meter plot geometrically positioned on the cell center. Corners of the plot are marked with rebar. The four, 50 meter transects divide the plot into four quadrants. Data was collected in the following manner. Monitoring plot figures were revised and redrawn from those of MTK 1992.

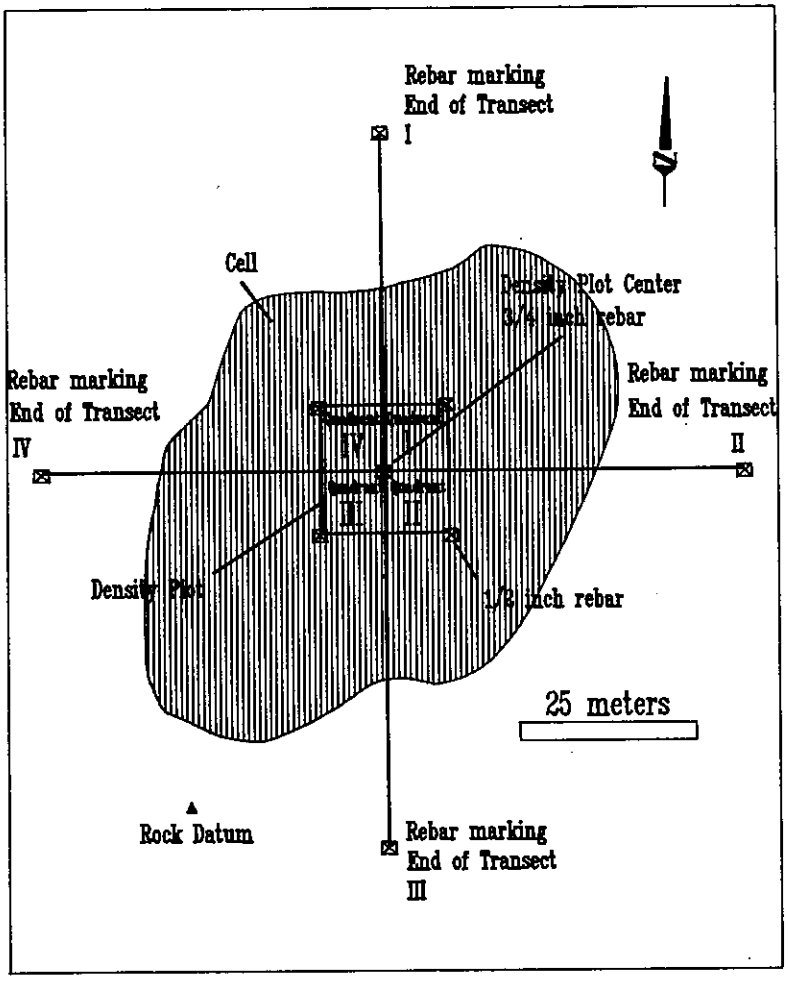


Figure 1: General Layout of density plot and vegetation transects positioned at each of seven study sites.

[5]Rock datum is a stack of rocks used to identify the location of the site.

Coverage was measured by recording the total area of *P. pleiantha* represented along a 50 m x 1 cm wide metric tape, for each of four transects (Figure 1). Coverage, expressed as percent coverage, was obtained by dividing the total area of *P. Pleiantha* covered by the tape by the total area of the tape. This can be expressed as: % coverage = Area of plants in cm/20,000 cm x 100.

Density data was obtained by counting the total number of *P. pleiantha* within the 10 x 10 meter plot and dividing this by 100 (the square meters of the plot) figure 1). Each plot was divided into four equal 5x5 meter quadrants. Total number of plants within each quadrant was recorded to provide a critical look at year to year density fluctuations within small areas.

Number of plants at each site was obtained by determining the extent of the area in which the plants were represented at each site (Figure 1). The extent of the area was determined by locating the rock datum and systematically walking the surrounding area, visually estimating the extent of plants. The extent of the area was then bisected along the long axis and along the short axis with a 100 meter tape. The number of plants touching the tape and total meters were recorded for each axis. These numbers were then projected to represent the total plants per area of each site. The following equation was used to calculate the number of plants at each site. Total plants = [(area meters^2 x 100 cm) (# of plants along transect)]/tape meters^2 x 100 cm.

Ten plants were collected at each site to estimate biomass. Above ground plant height was recorded for individual plants. From this, an average plant height was obtained. The following equations developed by MTK, 1992 were used to determine estimated total biomass from plant height: Estimated average biomass = (x height (cm) x 0.18) -0.40. Total estimated average biomass (estimated biomass) = estimated average biomass x number of plants at the site (Figure 8). If less than twenty plants were found at the site, biomass was not calculated.

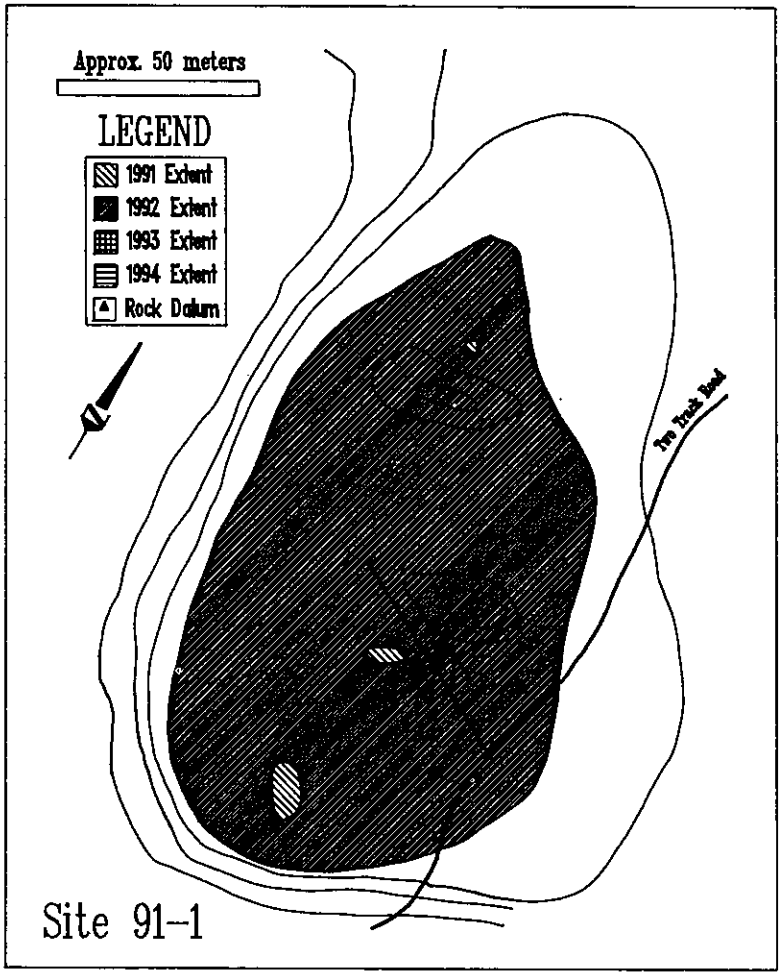


Figure 2: Monitoring site 91-1 west of the "Neck", Navajo Mine, showing population extents for 1991-1994.

Results and Discussion

Data were collected on size of site, number of plants present (abundance), density, vegetal coverage and biomass at seven *P. Pleiantha* monitoring sites in late April to early May of 1992 through 1994. Data on vegetal coverage and biomass was not collected in 1991 and are not available for comparison with data collected in 1992 through 1994. The following results are presented for each of the seven monitoring sites. Results of 1991 and 1992 monitoring are from MTK, 1992. A summary of the results is presented in Table

Monitoring Site 91-1 is located west of the "Neck" portion of the Navajo Mine (Map 1) on gentle slopes (2% to 10%) of the upper Fruitland Formation (Knight, 1992). The site is within the upper region of a drainage area running west toward Chaco Wash.

In 1991, the site (Figure 2) was composed of three small cells that covered approximately 158 square meters and 174 plants. In 1992, the site covered approximately 10,666 square meters and an estimated 12,800 plants. There were no plants observed in 1993 and 1994. Mean plant height increased from 2.37 cm in 1991 to 6.39 cm in 1992 and estimated biomass from 0.0003 kg in 1992 to 22.1 Kg in 1992.

Foliar coverage in 1992 was 0.81%. Coverage was not calculated in 1991. Number of plants per square meter within the 10 meter by 10 meter density plot increased form 0.74 in 1991 to 7.94 in 1992.

A spring annual, *Atriplex powellii* occupied the site in 1992 and 1993, but was absent in 1994. Presence of this annual in 1991 could not be ascertained from the MTK data or from observation at the site in 1993. Cattle hoofprints were observed at the site in 1994, but soil surface impact was minimal.

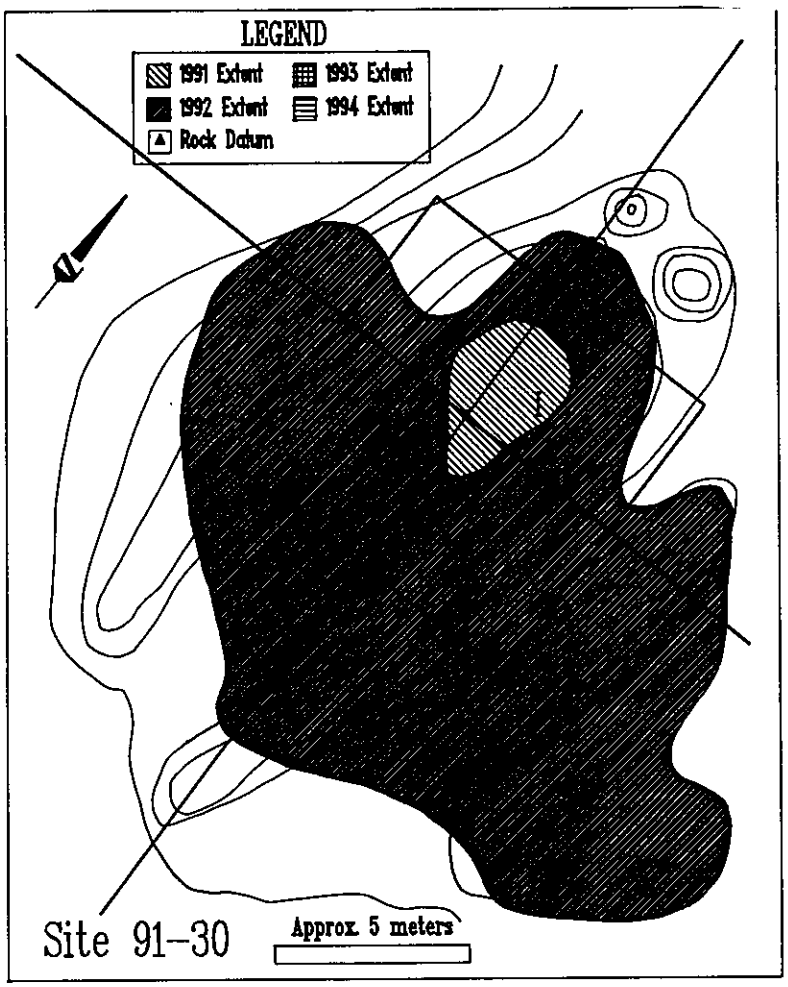


Figure 3: Monitoring site 91-30 west of the "Neck", Navajo Mine, showing population extents for 1991-1994.

Monitoring Site 91-30 is positioned approximately 1.5 miles west of the "Neck" portion of Navajo Mine (Map 1) on gentle to steep slopes (1% to 25%) of the Lower Fruitland formation (Knight, 1992). This site is located a short distance west and within the same drainage area of the 91-1 site, but is situated on steeper north facing slopes running into the drainage bottom. Site 91-30 (Figure 3) was represented in 1991 by a total of 14 plants within a single cell covering approximately 9 square meters. In 1992, the site covered approximately 270 square meters and an estimated 187 plants. There were no *P. pleiantha* observed in the 1993 or the 1994 survey. Due to the small number of plants present at the site in 1991 and 1992 biomass was not calculated. Foliar coverage in 1992 was 0.28%. Number of plants per square meter within the density plot was 1.56 plants per square meter in 1991 and 1.52 in 1992. The annual *Atriplex sacarinia* that had dominated the site in 1993 was rarely observed in 1994. Numerous cattle hoofprints were observed at the site in 1994.

Monitoring Site 91-2 is located west of the "Neck" portion of the Navajo Mine (Map 1) on gentle to steep slopes (flat to 40%) of the lower Kirtland Formation (Knight, 1992). The northwest corner of the site is marked by

Table 1. Summary of four years population and habitat data for *Proatriplex pleiantha* monitoring plots, Navajo Mine.

SITE	YEAR	PLANTS PER SQ. METER	VEGETAL COVER(%)	MEAN PLANT HEIGHT (CM)	ESTIMATED MEAN BIOMASS (g)	APPROX. SIZE OF SITE (SQ. M)
91-1	1991	0.74	-----	2.37	------	158
	1992	7.94	0.81	6.90	0.70	10666
	1993	0.00	0.00	0.00	0.00	0.00
	1994	0.00	0.00	0.00	0.00	0.00
91-2	1991	1.22	-----	1.60	------	337
	1992	15.22	1.35	5.42	0.59	520
	1993	0.04	0.00	0.00	0.00	175
	1994	0.00	0.00	0.00	0.00	0.00
91-27	1991	0.22	-----	------	------	161
	1992	5.23	0.36	7.90	1.46	6400
	1993	0.03	0.00	------	------	100
	1994	0.00	0.00	0.00	0.00	0.00
91-30	1991	1.56	-----	------	------	9
	1992	1.52	0.28	------	------	270
	1993	0.00	0.00	0.00	0.00	0.00
	1994	0.00	0.00	0.00	0.00	0.00
91-35	1991	------	-----	------	------	1100
	1992	19.34	1.27	1.27	9.96	2500
	1993	14.75	0.01	0.01	2.7	900
	1994	0.00	0.00	0.00	0.00	0.00
91-AC-1	1991	2.14	-----	------	------	3068
	1992	133.25	1.80	3.71	0.50	61000
	1993	0.38	NA	2.35	0.023	1674
	1994	0.00	0.00	0.00	0.00	0.00
92-30	1991	------	-----	------	------	------
	1992	4.12	1.95	10.05	1.74	> km sq.
	1993	3.54	0.145	8.35	1.10	33445.1
	1994	0.00	0.00	0.00	0.00	0.00

Table 1. (Continued)

SITE	YEAR	NO. OF PLANTS ALONG TRAN.	ESTIMATED NO. OF PLANT	ESTIMATED BIOMASS (kg)	ASPECT	GEOLOGY
91-1	1991	NA	174	0.0003	S-W	Fruitland
	1992	NA	12800	22.1	ALL	Fruitland
	1993	0.00	0.00	0.00	------	Fruitland
	1994	0.00	0.00	0.00	------	Fruitland
91-2	1991	NA	302	0.03	N-E-S	Kirtland
	1992	NA	3650	1.75	ALL	Kirtland
	1993	0.00	+19	------	N-E-S	Kirtland
	1994	0.00	0.00	0.00	------	Kirtland
91-27	1991	NA	+35	------	N	Kirtland/Fruitland
	1992	NA	3200	4.28	ALL	Kirtland/Fruitland
	1993	0.00	+18	------	N	Kirtland/Fruitland
	1994	0.00	0.00	0.00	------	Kirtland/Fruitland
91-30	1991	NA	+14	------	N	Fruitland
	1992	NA	187	------	N-E-W	Fruitland
	1993	0.00	0.00	0.00	------	Fruitland
	1994	0.00	0.00	0.00	------	Fruitland
91-35	1991	NA	------	------	S-W	Kirtland
	1992	NA	11600	15.6	ALL	Kirtland
	1993	20	265	0.023	S-W	Kirtland
	1994	0.00	0.00	0.00	------	Kirtland
91-AC-1	1991	NA	6576	------	NONE	Lewis
	1992	NA	96000	48	NONE	Lewis
	1993	3	59	0.0015	NONE	Lewis
	1994	0.00	0.00	0.00	------	Lewis
92-30	1991	------	------	------	------	Mancos
	1992	NA	>1000000	>17000	E	Mancos
	1993	56	512064	563.2	E-S	Mancos
	1994	0.00	0.00	0.00	------	Mancos

NA: Data not available.
----: Not collected.
•: Data from MTK, 1992.
+: Actual number of plants observed at site.

the western Navajo Mine lease boundary fence. The site is positioned a short distance northeast and within the same drainage area as the 91-1 site.

P. pleiantha was observed at the site in 1991, 1992 and 1993, but not in 1994 (Figure 4). In 1991, the site covered approximately 337 square meters, in 1992 520 square meters and in 1993 175 square meters. Estimated number of plants increased form 302 in 1991 to 3,650 in 1992. Actual number of plants occurring at the site in 1993 was 19. Mean plant height increased from 1.6 cm in 1991 to 5.42 cm in 1992 and estimated biomass from 0.03 Kg. in 1991 to 1.75 Kg in 1992. Estimated biomass was not calculated in 1993 due to the small number of plants observed at the site. Foliar coverage in 1992 was 1.35%. A total of 122 plants were counted in the 10 x 10 meter density plot in 1991, 1,522 in 1992 and 4 in 1993, resulting in number of plants per square meter of 1.22, 15.22, and 0.04, respectively.

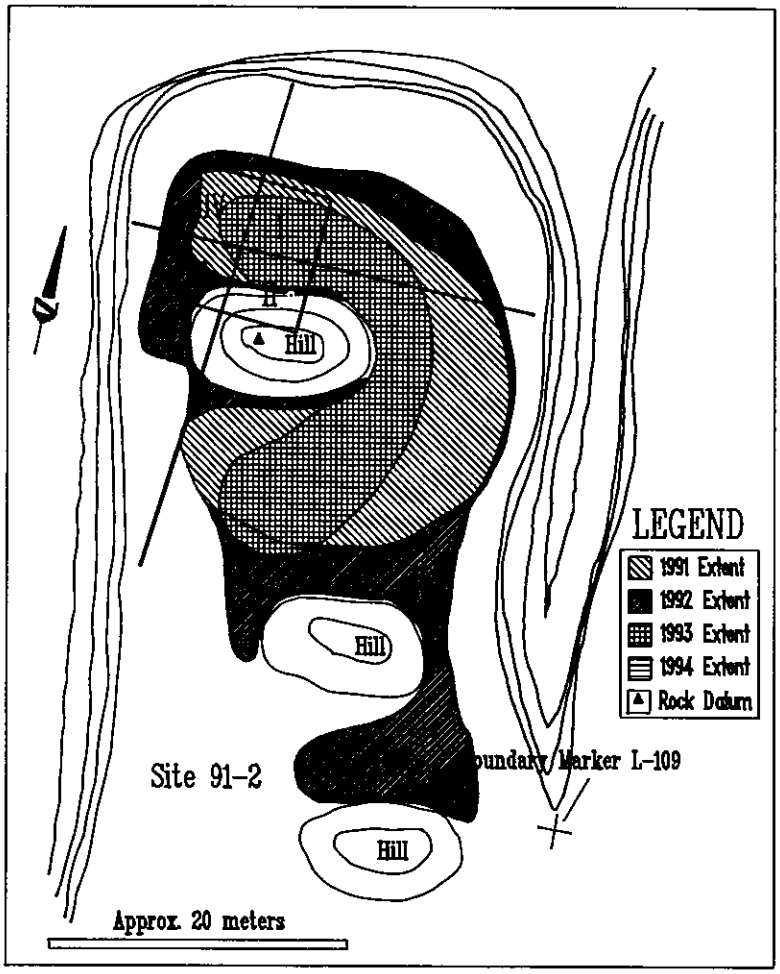


Figure 4: Monitoring site 91-2 west of the "Neck", Navajo Mine, showing population extents for 1991-1994.

Monitoring Site 91-27 is positioned approximately one mile north of site 91-2 (Map 1) and less than 1,000 feet west of the northwest corner of the "Neck" portion of the Navajo Mine lease. The site is located on gentle slopes (2% to 10%) of the Kirtland/Fruitland Contact Zone (Knight, 1992).

In 1991, the site (Figure 5) was composed of one cell that covered approximately 161 square meters and 35 plants. In 1992 an estimated 3,200 plants were present within an area covering approximately 6,400 square meters. In 1993 only 18 plants were observed in an area covering 100 square meters. Mean plant height, 7.9 cm, was used to estimate a biomass of 4.28 Kg in 1992. Foliar coverage of *P. pleiantha* in 1992 was 0.36%. Number of plants per square meter within the 10 x 10 meter density plot increased from 0.22 in 1991 to 5.23 in 1993. Only 3 plants were observed in the density plot in 1993. There were no plants observed at the site in 1994.

Monitoring Site 91-35 is located in the Cottonwood Wash drainage approximately 3/4 mile northeast of the Burnham Road (Map 1). The site is on a gentle slope of the Kirtland Formation, at the base of a steep hill in the upper area of the Wash drainage.

Site 91-35 (Figure 6) is represented in 1991 by only approximate site size. Site size in 1991 was 100 square meters and increased to 2,500 square meters in 1992. In 1993 site size was 900 square meters. Estimated number of plants in 1992 was 11,600 and in 1993, 265. Mean plant height in 1992 was 9.96 cm and estimated biomass 15.6Kg. Foliar coverage in 1992 was 1.27% and in 1993 0.01%. Plants per square meter within the 10 x 10 meter square density plot was 19.34 in 1992 and 14.75 in 1993. There were no plants observed at the site in 1994.

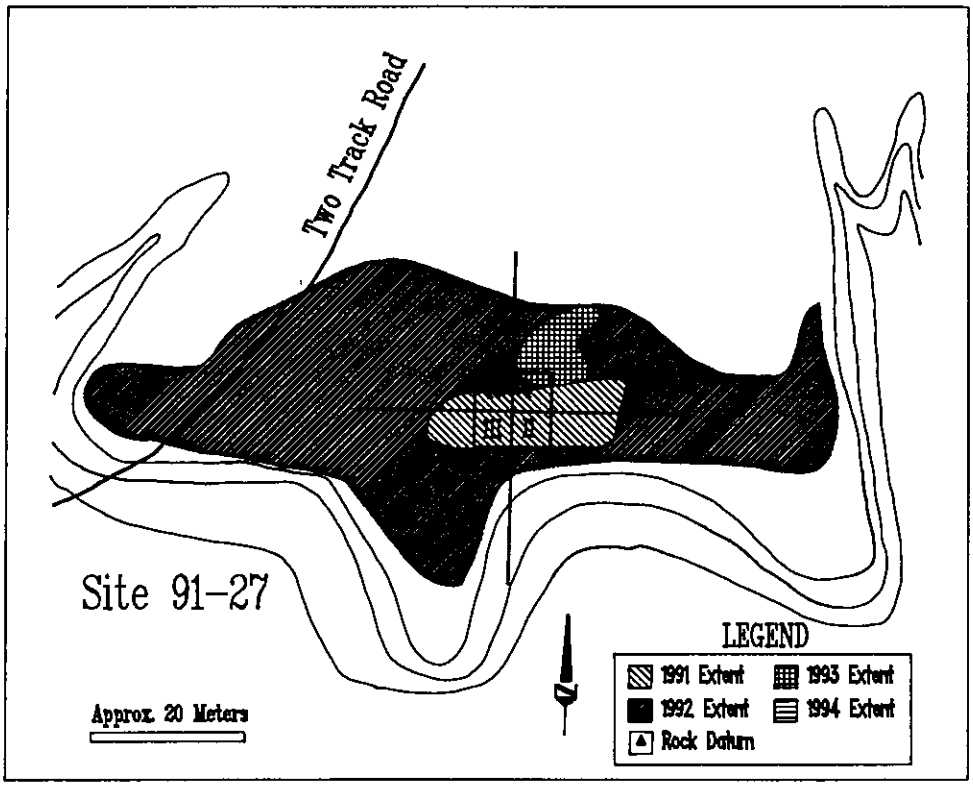


Figure 5: Monitoring site 91-27 west of the "Neck", Navajo Mine, showing population extents for 1991-1994.

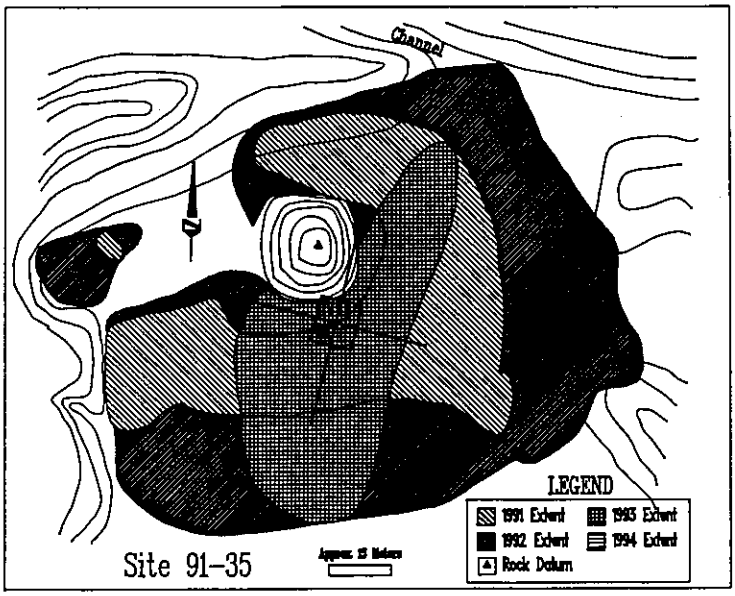


Figure 6: Monitoring site 91-35 east of the "Neck", Navajo Mine, showing population extents for 1991-1994.

Monitoring Site 91-AC-1 is located west of the Navajo Mine lease boundary, east of the Chaco River and south of the Ash Ponds associated with the Four Corners Power Plant (Map 1). The site is on nearly flat ground of the Lewis Shale Formation, directly under the power lines leaving the power plant. The site (Figure 7) in 1991 covered an area of approximately 3,068 square meters, and 6,576 *P. pleiantha* plants were estimated to be present. The area covered by the site increased in 1992 to 61,000 square meters. Coupled with this increase, was an estimated 96,000 plants. In 1993, the approximate area of the site was 1,674 square meters. Estimated number of plants was 59.

Mean plant height in 1992 was 3.71 and in 1993 2.35 cm. Estimated biomass was 48.0 Kg. i 1992 and 0.0015 Kg. in 1993. Vegetal coverage in 1992 was 1.8%. Plants per square meter within the 10 x 10 meter square density plot was 2.14 in 1991, 133.25 in 1992 and 0.38 in 1993. There were no *P. pleiantha* observed at the site in 1994.

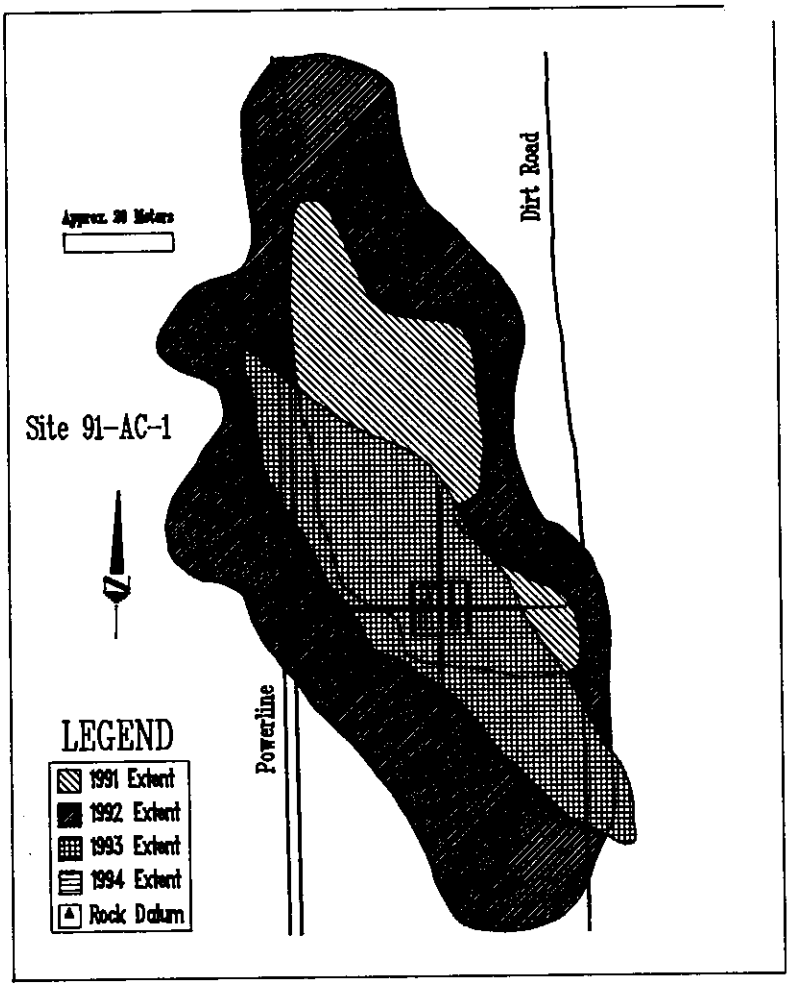


Figure 7: Monitoring site 91-AC-1, east of Chaco River, showing population extents for 1991-1994.

Monitoring Site 92-30 is located approximately 1.5 miles south of the Colorado/New Mexico border (Map 1). The site is positioned on nearly flat ground in the Lower Mancos formation. Site 92-30 was established in 1992 to represent a *P. pleiantha* site removed from Navajo Mine and representative of the Navajo Indian Reservation geology and climate. The site was not known in 1991 and there were no *P. Pleiantha* observed at the site in 1994. In 1992, the site (Figure 8) covered an area in excess of one square kilometer. Estimated number of plants was in excess of 1,000,000. The site in 1993 covered an area approximately 33445.1 square meters. Estimated number of plants was 512,064.

Mean plant height in 1992 was 10.05 cm and in 1993, 8.35 cm. Estimated biomass was greater than 17,000 Kg. in 1992, dropping to 563.2 Kg. in 1993. Vegetal coverage in 1992 was 1.95% and 0.145% in 1993. Plants per square meter within the 10 x 10 meter square density plot was 4.12 in 1992 and 3.54 in 1993. Annual forbs including *Helianthus anomalus* and *Atriplex powellii* observed at the site in 1993 were rarely observed in 1994.

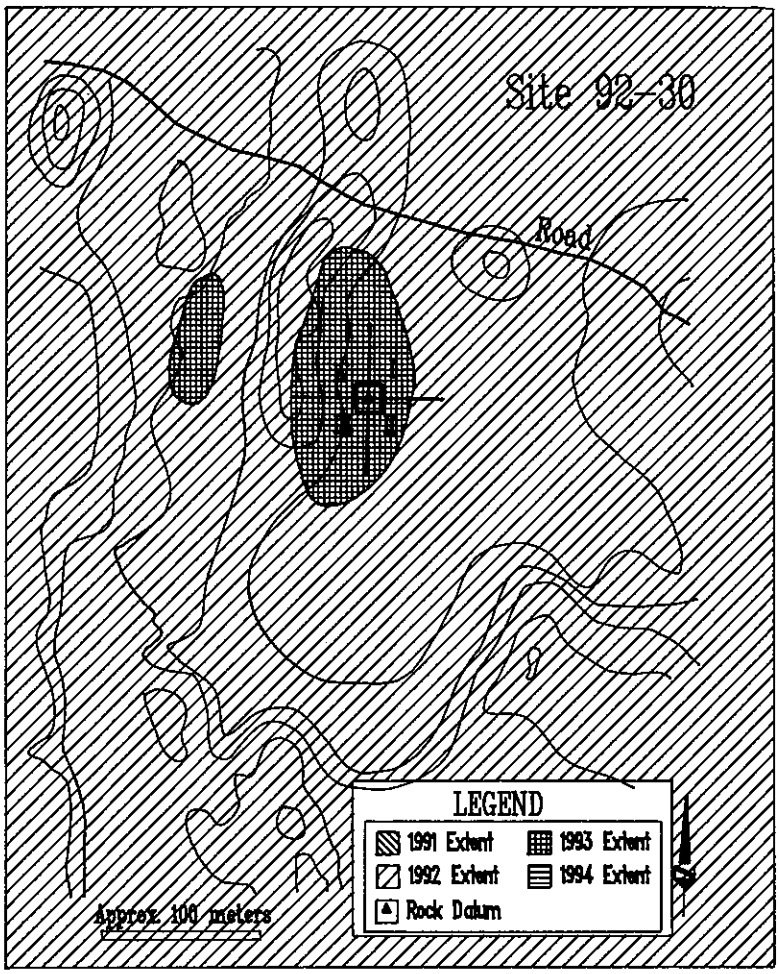


Figure 8: Monitoring site 92-30 near the Mancos River Northwestern San Juan County, New Mexico, showing population extents for 1991-1994.

Total area (square meters) representing *P. pleiantha* at all sites in 1993 was less than areas recorded in 1991 and 1992 by Knight, 1992. The extent of the 1993 areas (Figures 2-8) was observed to overlap extents recorded in 1991 and 1992 (Knight, 1992). The greatest plant density, however, tended to fall within the lesser extents recorded in 1991 and marked by the permanent density plot. Based on those results, it seems quite probable that there were localized areas within plant cells that were not as affected by prevailing climatic conditions during the germination period as other areas. In other words, certain areas could be expected to have plants most years. Due to the great number of seeds deposited in 1992, a few plants would be expected to germinate in areas less insulated from adverse climatic conditions. This would account for the 1993 extents overlapping the 1991 and 1992 extents.

Site population abundance, expressed as number of plants per total estimated area of each site, was estimated by recording the total number of plants touching transects projected across the greatest width and greatest length of the cell. This data was then used to project the total estimated number of plants within the site. This method was chosen for consistency with the method used in 1991 and 1992. A clumped distribution of plants within each cell coupled with the small size of plants in 1993 may have affected the accuracy of the method. It is suggested that in years such as 1993, plant abundance be estimated by counting the number of plants within a one meter band along the transects.

Density of *P. pleiantha* within the 100 meter square permanent density lots in 1993 was less than densities recorded in 1991 and 1992 at all locations. Plants were not observed at sites 91-1 and 91-30. The greatest decrease in density was recorded for sites 91-1, 91-2, 91-27, and 91-30, all located just west of the "Neck" portion of the Navajo Mine, and site 91-

AC-1 located just west of the APS power plant near the north area of Navajo Mine. All of these sites lie east of a natural barrier, the Hogback, which tends to shadow localized rainstorms. Site 91-35, lies to the east of the Navajo Mine and is thus less affected by the Hogback "rainshadow" effect. In 1992, site 91-35 had a density of 19.34 plants and in 1993 14.75, representing a 1.3% decrease in density (Table 1). At site 92-30, located in the Four Corners area of New Mexico, density decreased very little, 4.12% in 1992 to 3.54% in 1993 (Table 1).

Height of *P. pleiantha* at all sites in 1993 was reduced from that recorded in 1992 (Table 1). Due to the small number of plants at sites 91-2 and 91-27 and the lack of plants at sites 91-1 and 91-30, plant height was not recorded. Average plant height at site 91-35 was considerably less than in 1992; 9.96 cm in 1992 and 2.7 cm in 1993. Sites 91-AC-1 and 92-30 exhibited smaller reductions in height. These results could possibly be explained if microhabitat conditions were known for each site following seed germination time.

Biomass in 1993 could only be calculated for sites 91-35, 91-AC-1, and 92-30 due to the small number of plants at all other sites. Biomass in grams was estimated based on a correlation relationship between plant height and biomass developed by Knight, 1992. True average biomass (estimated mean biomass in grams) was determined by oven drying the plants collected for height measurement (Table 1). This was then compared to the estimated dry weight. True dry weight was slightly higher than estimated in all cases. Due to the small size of the plants, estimated biomass for the entire cell was low at sites 91-35 and 91-AC-1 and is probably not accurate for these reasons. Site 92-30 probably represents the most accurate estimate of biomass.

Variation in *P. pleiantha* cell size, number of plants, plant size and plant density at each of the seven monitoring sites from 1991 to 1994 is most likely due to climatic conditions during late winter and early spring of each year. There is little evidence to suggest that environmental impacts as cattle grazing or as the case with site 91-AC-1 the construction of a power line affected the abundance of *P. pleiantha.*

According to Knight, 1992, extremely wet and cool springs seem to encourage the growth of *P. pleiantha* while hot, dry windy springs discourage growth. A system for determining *P. pleiantha* success in a particular year was developed by Knight, 1992 and based on a broad description of climate during winter and spring. The system is shown as follows:

Quality 0 year: The winter is dry, the spring is hot and dry. *Proatriplex* is absent from at least half of the indicator sites. The plant is scarce, scattered and dwarf at sites where it does occur. **Quality 1 year:** Late winter is wet, but the spring is warm and dry. *Proatriplex* is present at most of the indicator sites, but is sparse, usually in small clusters. In general, most plants are dwarfed. **Quality 2 year:** Late winter is wet, the spring is often wet but mitigated by conditions such as extreme spring winds and early summer warming. *Proatriplex* is present at all of the indicator sites, but is scattered. The plant is locally continuous. **Quality 3 year:** Late winter and spring are wet and cool, the summer is mild. *Proatriplex* is present at all of the indicator sites. It often forms extensive stands that can cover large areas, and the plants are locally dense.

Using this system, Knight, 1992, classified 1992 as a Quality Two year. This conclusion can be partially cooberated by examining precipitation, wind speed and air temperature data, (Table 2). In 1992 the late winter was wet, the spring wet and early summer mitigated by early warming, but spring winds were low compared to 1991, 1993 and 1994. Extending this conclusion however to the 92-30 site in the four corners area may not be accurate. Climate data presented in Table 2 is from the New State University Agricultural Experiment Station, located a few miles east of Navajo Mine. To properly assign site 92-30 to a particular Quality Year would require climate data closer to the site. This was not available.

Based on the MTK system and climate data presented in Table 2, the Navajo Mine sites for 1991 and 1993 were probably Quality One years. This conclusion is based mainly on the wet winter in 1993 (26.9 millimeter precipitation in February) and the warm spring and moderate windspeeds and the strong spring winds, 8.40 mph in March, and moderate precipitation in late winter and early spring. The Navajo Mine sites in 1994 were probably affected by low precipitation in January, February and March, moderate yearly spring winds (7.28 mph in March) and late winter and early spring warming. This in general describes a Quality Zero year.

Table 2. Precipitation, air temperature and wind speed data for January through April, 1990 through 1994. Data recorded at the New Mexico State University Agricultural Experiment Station near Navajo Mine.

	Precipitation(millimeter)				Air Temperature (°F)				Wind Speed (MPH)			
Date	**1991**	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**
Jan	14.5	2.03	5.08	5.08	20.80	26.20	34.30	30.50	0.57	0.08	0.20	0.20
Feb	11.9	10.2	26.9	9.14	34.90	36.70	36.40	34.40	0.47	0.40	1.06	0.36
March	19.1	23.1	19.3	6.10	39.70	43.80	43.30	45.60	0.75	0.91	0.76	0.24
April	1.02	8.13	18.0	12.2	47.90	55.70	51.10	51.50	0.04	0.32	0.71	0.48

Even though the MTK system is not accurate for all sites and does not consider all possible climatic factor combinations, general trends are still worth considering. A greater accuracy will only be obtained by detailing climate information at each monitoring site and from this developing a more extensive Quality Year system.

Conclusion

The occurrence, abundance and vigor of *P. pleiantha* at seven monitoring sites from 1991 through 1994 was influenced by climatic conditions occurring in late winter and early spring. Lack of sufficient moisture and early warming in the late winter and early Spring of 1994 totally prevented growth of the plants at all sites. It is hoped that monitoring in the spring of 1995 will provide additional proof of the cryptic nature of the species. It does not appear from the results of this study and from those conducted prior to this study that *P. Pleiantha* is a threatened species. During the course of this study *P. pleiantha* was moved from a Federal category 2C to category 3C listing.

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