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and four sagebrush shrubland reference areas. The first comprehensive studies of the reclaimed vegetation were conducted in selected portions of the J-3, J-7, J-27, J-1/N-6, N-1 and N-2 mining areas. The results of these studies were reported to regulatory authorities in the first annual vegetation and wildlife resources report (Arizona Division, Peabody Coal Company, 1982).

Vegetation baseline studies were completed in the J-16 and J-28 mining areas in the spring of 1982. In the fall of 1982, baseline studies were initiated in the then unpermitted southeastern portion of the leasehold referred to as the Mine Plan Modification Area. This area included the contiguous J-19 through J-23 mining areas (Figure 1). Ongoing monitoring was continued in the reference areas and selected reclaimed portions of the J-7, J-27, J-1/N-6, N-1 and N-2 mining areas. With the exception of the data collected in the Mine Plan Modification Area, the results of these studies were reported in the Vegetation Resources 1982 Report (Arizona Division, Peabody Coal Company, 1983).

Vegetation baseline studies in the J-19 through J-23 coal resource areas were completed during the spring of 1983. The results of these and the 1982 studies were submitted as part of a mine plan modification filed with regulatory authorities in July, 1983. A major ramification of that submittal was that sufficient baseline studies were completed to adequately characterize the pre-mining vegetation on the Black Mesa leasehold.

Six reference areas were established in 1979 and 1980 for use as revegetation success standards. Two were located in the pinyon-juniper woodland adjacent to the N-7/8 and N-14 coal resource areas. Four were located in the sagebrush shrubland adjacent to the N-7/8, N-14, J-1/N-6 and J-7 coal resource areas. The reference area at the N-7/8 area included both community types. The size of the reference areas were as follows: N-7/8 (140.8 acres), N-14 pinyon-juniper (230.2 acres), N-14 sagebrush (31.7 acres), J-1/N-6 (45.4 acres) and J-7 (91.1 acres). Within each reference areas, 0.1 acre exclosures were established to monitor livestock grazing effects.

The 0.1 acre exclosures were expanded in 1982 such that each exceeded two acres in size. These expanded exclosures became the permanent reference areas and sampling was discontinued in the larger unfenced areas. This measure was taken in response to Special Stipulation #26 attached to Permit AZ-0001. At the same time, the J-1/N-6 reference area was redesignated as a back-up area and sampling was discontinued. Sampling in the two

pinyon-juniper reference areas was discontinued following the end of the 1982 field season. This measure was taken based upon negotiations with regulatory authorities regarding the suitability of the woodland as a standard for revegetation success. The net result was that revegetation success standards would be based upon the three remaining sagebrush shrubland reference areas. Each would represent the premining vegetation in a specific region of the leasehold unless further studies identified new plant communities.

Ongoing monitoring of the vegetation in the reference areas and selected reclaimed units was continued in 1983 and 1984. The results of these studies were reported in the respective annual resources reports (Arizona Division, Peabody Coal Company, 1984 and 1985). Since 1984, annual spring and fall monitoring of reclaimed areas and periodic spring and fall monitoring of reference areas has been conducted at the Black Mesa and Kayenta Mines. The results of these monitoring and sampling efforts are included in annual reports submitted to the regulatory authority.

The objective of this chapter is to provide vegetation maps, detailed descriptions of the plant communities, and all available data to better characterize and define the spatial and temporal variability of the vegetation resources within and surrounding the Black Mesa leasehold. This necessitates consolidation of vegetation information that has been collected since 1979. The information has been variously reported to regulatory authorities in mining permit applications and annual reports designed to review the results of annual monitoring activities. Detailed vegetation survey summary reports are included as Attachment 1 to this chapter. Vegetation data summaries that were presented in annual vegetation reports submitted to regulatory authorities are not presented in detail in this chapter but may be referenced. Additionally, vegetation baseline studies were conducted in the N-10 and J-28 Life of Mine (LOM) Coal Resource Area in 2003. The N9 and the N11 Extension area (former N12/N99 North/South areas)were included in studies submitted in 2005. All most current studies can be found in Attachments 4, 5 6.

The following sections present: (1) a general description of the study area and review of relevant literature; (2) a description of the vegetation sampling methods; and (3) results and discussion of the vegetation studies. Appropriate sections and attachments address the significance of the pre-disturbance vegetation, important plant species, impact analysis, recommendations for feasible mitigation and enhancement and continuing monitoring activities.

TABLE 18

Seasonal Livestock Carrying Capacity Figures for the Plant Communities Occurring on the PWCC Leasehold[1]

Vegetation Community	Season	Livestock Carrying Capacity (ac./AUM)[2]
Pinyon-Juniper Woodland	Spring	119.0 ± 95.2 (Confidence Limit: t0.05(2), 4 = 2.776)
	Fall	189.2 ± 229.4 (as above)
Sagebrush Shrubland	Spring	10.5 ± 1.7 (Confidence Limit: t0.05(2), 8 = 2.306)
	Fall	13.0 ± 7.7 (as above)
Greasewood Shrubland	Spring	9.6 (n = 1)
Saltbush Shrubland	Spring	5.7 (n = 3: s = 2.01)
	Fall	2.5 (n = 2)
Reclaimed Land[3]	Spring	4.2
	Fall	4.2

[1] Total usable forage is derived from Proper Use Factors for sheep (Attachment 2).

[2] Livestock carrying capacity is expressed as acres required to support one animal unit for one month (AUM). See attachment 2.

[3] Based on averaged historic reclaimed area monitoring data.

Impact Analysis

The scope of this analysis is limited to direct and indirect impacts on the biotic components of vegetation and wildlife. The approximate acreages of each vegetation type or other category to be disturbed by mining activities for the LOM Kayenta Complex are shown in Table 19.

Approximately 12,989 acres are included in Kayenta Complex disturbed or redisturbed LOM areas for the remaining planned LOM mining activities. The breakdown by native vegetation community type is 9221 acres of pinyon-juniper woodland, 1453 acres of sagebrush shrubland, 138 acres of saltbush shrubland, and 16 acres of greasewood shrubland. Additionally, 2164 acres disturbed prior to 2012 will be redisturbed, including an estimated 897 acres of reclaimed land in the N-10 and N-11 Extension areas. There are 11,476 acres of Interim and Permanent Program lands that are variously reclaimed and 6281 acres that are in stages of reclamation, facilities or disturbance.

The loss of wildlife habitat may have varied impacts on wildlife populations. The impacts may be direct or indirect. Removal of the vegetation will result in the direct loss of food, cover and breeding habitat. Noise and related impacts associated with concentrated industrial activities will disturb sensitive wildlife in surrounding areas. Disturbance of the land surface and subsurface creates the potential for impacting surface and ground water quality and quantity, and may affect natural physical shelters.

Mobile wildlife species will not be as severely influenced by the disturbance as less mobile small mammals, strongly territorial birds, reptiles and amphibians. The restricted species can be expected to be extirpated in the disturbance area. The larger and more mobile species will be displaced into surrounding areas, temporarily creating increased competition for the available resources. If the surrounding areas are at or near carrying capacity, populations will be stressed until a new equilibrium is reached. Displaced species which have the capacity to exploit the habitat created by reclamation activities will repopulate developing reclaimed areas, particularly those species adapted to grass/shrubland habitats.

Overall, the fauna in the lease area is relatively sparse; apparently attributable to habitat availability, quality, and condition. Areas to be disturbed exhibit less value to wildlife in their present state than that expected under more pristine conditions. There are extensive tracts of the plant communities throughout the southwestern United States, and since few, if any, vertebrates are wholly dependent upon them, the impact or manipulation of a small percentage is viewed as negligible. No unique or high quality habitats or habitats of will be disturbed.

Table 19

Estimated Affected Acreages for Native Vegetation Types and Other Categories in Remaining Life of Mine Areas (LOM) and Reclamation Status of Previously Mined Interim and Permanent Program Lands (as of 01/01/2012) in the Kayenta Complex LOM Permit Area

		Affected Vegetation Type or Category[2]							Reclamation Status[3]				
LOM/Pit Area[1]	Years	PJ	SB	SA	GR	REV	FAC/DIS	Total	FGR	TSD	REV	FAC/DIS	Total
J-1	Mining Complete								41	15	459	20	535
J-3	Mining Complete										95	12	107
J-7	Mining Complete								42		1104	50	1196
J-16	Mining Complete								79	12	1233	11	1335
J-19	2012-2013	229	165	4			28	426	296	203	1248	1956	3703
J-21	2012-2013	282	37				11	330	334	128	3053	521	4036
	2014-2018	126	14				6	146					
	Beyond 2018	1111	102	8			5	1226					
J-21 West	2014-2018	1001	156					1157					
	Beyond 2018	997	120	2				1119					
J-27											49		49
J-28	Beyond 2018	1083	533	55	16		1	1688					
N-6	Mining Complete								649	46	2175	105	2975
N-9	2012-2013	529	26				3	558	129	56		790	975
	2014-2018	243	6				3	249					
	Beyond 2018	101	10					111					
N-10[4]	Beyond 2018	707	44	69		683	70	1573[5]	60		135	26	221
N-11	Mining Complete								486	40	356	33	915
N-11 Extension	Beyond 2018	2812	240			214	1140	4406					
N-14	Mining complete								90		1569	53	1712
Total		9221	1453	138	16	897	1267	12,989	2206	500	11,476	3577	17,757

Table 19

Estimated Affected Acreages for Native Vegetation Types and Other Categories in Remaining Life of Mine Areas (LOM) and Reclamation Status of Previously Mined Interim and Permanent Program Lands (as of 01/01/2012) in the Kayenta Complex LOM Permit Area

[1] Does not include the N1, N2, N7 and N8 Termination of Jurisdiction (TOJ) release areas.

[2] Estimated acreages for vegetation types in planned LOM areas or maximum disturbance acreages remaining in the currently active mining areas of J19, J21 and N9 by type: PJ = pinyon-juniper; SB = sagebrush shrubland; SA = saltbush shrubland; GR = greasewood shrubland; and REV = revegetated areas or FAC/DIS = roads, facilities, or other currently affected lands which may be re-affected by LOM activities.

[3] Reclamation status for active mining areas and former mining areas in final or completed reclamation as of 01/31/12.

[4] N10 is currently in temporary cessation.

[5] N10 Total includes Prelaw and Interim Program reclaimed lands, access roads, ponds and scoria areas that will be affected by reinitiation of mining activity in N10.

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The additional LOM disturbance for the Kayenta Complex could result in the temporary loss of approximately 11,727 acres of native and reclaimed rangeland. On the basis of the averaged carrying capacity values presented in the previous section (type and season), a maximum potential loss of approximately 299 animal unit months (AUMs) of grazing could occur. Revegetation and release of successfully reclaimed lands will compensate for the acreage loss during the life-of-mine. As of 01/31/12, 15,889 pre- and postlaw acres have been reclaimed at the Kayenta Complex. Based on an average reclaimed land stocking rate of 4.6 ac/AUM, there are approximately 3454 AUMs of reclaimed area grazing available in a normal precipitation year.

The list of plant species resulting from comprehensive floristic surveys conducted on and adjacent to the Black Mesa leasehold is presented in Table 1. The list includes 278 species. The importance of some of these species as cultural resources of the Navajo and Hopi (medicines, food, building materials, tools, ceremonial items, etc.) has been previously discussed. Culturally significant plants are identified in plant lists that can be found in Attachment 3. Ninety-nine species, genera, or families are listed in the ethnobotanical information compiled by the Navajo Health Authority (79 listed species or genera plus an additional 20 species, genera, or families referenced in the narrative). A supplemental list, prepared by Peabody (Attachment 3), lists 19 additional species or genera that are known to have or are suspected to have ethnobotanical significance. See also Chapter 23 and Appendix B to Chapter 23 for additional discussion regarding culturally significant plants.

Appendix 3 contains 118 species, genera, or families of vascular plants that are of ethnobotanical importance. Several of these species, genera, and families need not be considered in an impact analysis for reasons given in the following paragraphs. The result is a total of 77 species or genera, or approximately 28 percent of the plants found in the floristic surveys which could potentially be impacted by surface mining activities.

It is extremely unlikely that several of the species or genera contained in Attachment 3 will be impacted by surface mining activities on the basis that their regional distribution does not encompass the disturbance areas or they were not present in the comprehensive floristic surveys. These species or genera may include:

Mirabilis oxybaphoides	Gaura coccinea	Chenopodium album
Melilotus indica	Tribulus terrestris	Senecio multicapitatus
Salix laevigata (S. bonplandiana)	Eriogonum rotundifolium	Echinocereus spp.
Lupinus kingii	Mammillaria spp.	

Attachment 6

2003 Baseline Vegetation Sampling Report
J28 and N10 Areas
Kayenta Complex
PWCC

2003 BASELINE
VEGETATION BASELINE SAMPLING REPORT
J28 and N10 Areas

Kayenta Complex, PWCC

November 2003

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INTRODUCTION

In late May and early June 2003, ESCO Associates conducted a baseline vegetation study of the J28 and N10 Life of Mine Areas (LOM) within Peabody Western Coal Company's (PWCC) Kayenta Complex. The purpose of this sampling was to describe species composition, woody plant density, and diversity in the LOM study areas prior to disturbance by mining. Both quantitative and qualitative data were collected in the LOM study areas; methods, sample areas, and sample sizes were those specified by PWCC.

The vegetation resources in the project areas were similar to those described in previous baseline studies (Peabody Coal Company 1985 and ESCO Associates 2000), consisting of a mosaic of sagebrush and pinyon-juniper vegetation communities. Sampled areas were classified as either sagebrush or pinyon-juniper using aerial photos and previous baseline vegetation maps.

METHODS

Sensitive Plant Surveys

A list of sensitive plant species was compiled from the following sources under the following definitions:

USFWS THREATENED AND ENDANGERED SPECIES (50CFR 17.11 AND 17.12, DEC. 1999)

Endangered species: any species which is in danger of extinction throughout all or a significant portion of its range (other than a species of the Class Insecta as determined by the Secretary to constitute a pest whose protection under the provisions of The Endangered Species Act of 1973 would present an overwhelming and overriding risk to man).

Threatened species: any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, as determined by the Secretary.

NAVAJO ENDANGERED SPECIES LIST (NESL)

The following definitions are taken from the Navajo Endangered Species List (NESL) issued by the Navajo Nation Department of Fish and Wildlife-NNDFWL (2001)

Group 1: Those species or subspecies that no longer occur on the Navajo Nation

Group 2 (**G2**) & Group 3 (**G3**): "Endangered" – Any species or subspecies whose prospects of survival or recruitment within the Navajo Nation are in jeopardy or are likely within the forseeable future to become so.

G2: A species or subspecies whose prospects of survival or recruitment are in jeopardy.

G3: A species or subspecies whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future.

Group 4: Any species or subspecies for which the Navajo Nation Department of Fish & Wildlife (NNDFWL) does not currently have sufficient information to support their listing as G2 or G3 but has reason to consider them. The NNDFWL will actively seek information on these species to determine if they warrant inclusion in a different group or removal from the list.

The final sensitive plant species list (Appendix 3 – *Field Guide to Potentially Occurring Rare Plants*) was organized by species growth habit and habitat preferences, and included detailed descriptions and drawings of morphological traits, mention of lookalikes and distinguishing characteristics, habitat requirements, and phenology. A literature review was conducted on those species listed in the above sources to compile this information (see Kearny and Peebles 1960, McDougall 1973, Arizona Rare Plant Committee 2000, Ecosphere 1995, Great Plains Flora Association 1986, Utah TES Plant Interagency Committee 1991, Spahr 1991, Welsh et al. 1993).

The study areas shown on Map 1 were traversed on foot to ascertain the presence of the target species. This pedestrian survey took place between May 20 and June 1,

2003. As of September 2003, the areas to be included in the baseline study increased. Inasmuch as the target species were all most reliably to be identified in the early season, the additional areas could not be inventoried for species presence. Rather, they were visited in September and early October 2003 to determine the comparability of habitats of the outer areas to those of the inner areas that were surveyed in detail in the blooming season. This knowledge of the habitats of the outer areas was used to assess the likelihood of the occurrence there of each target species.

Qualitative Data Collection

LOM study areas were surveyed on the PWCC Kayenta Complex area for threatened and endangered species. The areas were J28, and N10. The vegetation type in N10 was entirely pinyon-juniper. The J28 area was comprised of a variable mosaic of both vegetation types.

Using maps provided by PWCC and plotted over a photographic base with Universal Transverse Mercator (UTM) waypoints marking the boundaries, ESCO personnel walked throughout these areas searching for the listed species' habitat requirements. If habitat was found, a more detailed search of the area was performed. During the course of this survey, 'lookalike' species were noted as were 'cultural' species (those of significance to the Navajo and Hopi). Occasionally these specimens were entered into a handheld Global Positioning Device (GPS) for potential seed collecting or salvage purposes. If any species of concern were encountered these would also have been mapped using the GPS and located on the maps provided by PWCC.

Quantitative Vegetation Sampling

Quantitative data were collected for cover and woody plant density in the areas surveyed for threatened and endangered species (discussed above) except J21-West which had previously been quantitatively sampled (Peabody Coal Company 1985). A map with randomly generated sampling points (Map 1) overlaying a photographic base was provided by PWCC for each of the baseline areas to be sampled. This information is included on Map 1. UTM coordinates were also provided for each point which in conjunction with the use of hand-held GPS units, assisted in objective sample point location. There was no significant sagebrush shrubland and sampling of this type in N10.

COVER SAMPLING

Cover data were collected along randomly oriented 50 m transects using a point-intercept method in which data were recorded as interceptions of a point with a plant species, litter, standing dead plant material, bare soil, or rock. Plant material produced during 2003 and still standing was tallied by species. Litter was considered to be any organic material that had fallen, or begun to fall to the soil surface. Standing dead was any dead plant material that was produced in previous years but which was still standing and had not lodged or broken off to become litter. Inorganic materials greater than 1 cm in diameter were considered rock. The cover sampling points were optically projected using a Cover-Point Optical Point Projection Device developed by ESCO Associates. One hundred points were collected at each transect. The points were evenly distributed; a pair of points collected on opposite sides of every meter mark along the 50 m transect (50 X 2 = 100).

First hit interceptions were used to calculate absolute top layer foliar cover by dividing the number of interceptions for a particular species or ground cover type by the total number of points taken (100). First hit relative vegetation cover was calculated by dividing first hit absolute cover for each species by the total first hit vegetation cover. All-layer absolute cover was calculated by dividing all hits (first-hits and additional-hits) for a particular species by the total number of points taken (100). In addition, all-layer relative cover was calculated using all hits for a particular species divided by the total hits accumulated during sampling of the transect.

PLANT SPECIES FREQUENCY AND DENSITY MEASUREMENTS

During the course of cover sampling, all plant species occurring within one meter of either side of the cover sample transect were noted as present within each sample. The total number of species (within each lifeform) observed in each 100 sq.m. sample provides a measure of species density, indicating the relative species richness of different areas. Frequency for each plant species observed during sampling was calculated by dividing the number of sample transects in which the species was observed by the total number of samples.

WOODY PLANT DENSITY SAMPLING

Woody plant density sampling was undertaken in all sample areas along each transect established for cover. Trees, shrubs, subshrubs, and agavoids with root crowns located

within the boundaries of the quadrats (belt transects) were tallied according to species. In pinyon-juniper areas, woody plant density sampling was collected in 4x50 meter plots, 2 meters on either side of the cover transect. In sagebrush areas, woody plants were counted inside the 2x50 meter transects established for cover. The presence of dead individuals was not included in woody plant density calculations.

LIFEFORMS USED IN DATA PRESENTATION

All data and summary tables are organized by lifeform to facilitate data interpretation and analysis. The lifeform categories that follow reflect growth habit and provenance.

Lifeforms Present in 2003

Native Annual & Biennial Forbs	Native Subshrubs
Introduced Annual & Biennial Forbs	Native Shrubs
Native Annual Grasses	Introduced Shrubs
Introduced Annual Grasses	Native Trees
Native Perennial Forbs	Succulents
Introduced Perennial Forbs	Agavoids
Native Perennial Cool Season Grasses	Lichens
Introduced Perennial Cool Season Grasses	Fungus
Native Perennial Warm Season Grasses	Algae

Both grasses and graminoids (grass-like plants) are included in the Native Perennial Cool Season Grasses lifeform.

PLANT SPECIES LISTING

Scientific names used generally follow McDougall (1973) or Kearney and Peebles (1960) while the common names cited are found in Beetle (1970), Nickerson et al. (1976), or Soil Conservation Service (1979). Lichens and mosses were described in Hale (1969) and Conard (1956), respectively. Scientific names for vascular plants not found in the sources listed above were described by either Welsh et al (1993) or Great Plains Flora Association (1986). The table below lists these species with their sources:

Vascular plants not found in McDougall (1973) or Kearney and Peebles (1960)	Great Plains Flora Association (1986)	Welsh et al. (1993)
Arenaria hookeri	X	X

Bahia oppositifolia	X	
Cryptantha flavoculata		X
Elymus junceus	X	X
Erysimum asperum	X	X
Lygodesmia juncea	X	X
Puccinellia distans	X	X
Stephanomeria runicnata	X	X

During the course of fieldwork, a list of all encountered plant species (quantitative plus incidental observations) was compiled for each area. These lists are summarized in Appendix 2, 'Plant Species from the LOM Baseline Study', which includes current nomenclature, cross-references to older nomenclature, common name, and the area in which the species was observed.

RESULTS

Tables containing the LOM baseline sampling data are present in Appendix 1. Results of quantitative cover sampling of sagebrush shrubland are presented in Table 1, and data from pinyon-juniper woodland are found in Tables 2 and 3. Woody plant density data from sagebrush shrubland are presented in Table 4. Woody plant density data from pinyon-juniper woodland are found in Tables 5 through 6. Cover and woody plant density data are summarized in Table 7. Relative cover data organized by lifeform are presented in Table 8. Data on species density separated by lifeform are present in Table 9. A listing of all plant species encountered during quantitative sampling is provided in Table 10. Photographic documentation from representative quantitative sampling locations is available in Photographs present in Appendix 4.

DISCUSSION

Sagebrush Shrubland

Areas mapped as sagebrush shrubland in the J28 sampling areas (no sagebrush shrubland in N10) are for the most part dominated by big sagebrush (*Artemisia tridentata*) and blue grama (*Bouteloua gracilis*). Variations from this general statement were typically in the form of varying and sometimes substantial presence of other shrubs and subshrubs, especially fourwing saltbush (*Atriplex canescens*), sticky-leaved rabbitbrush (*Chrysothamnus viscidiflorus*), and Greene rabbitbrush (*C. greenei*). Along

with blue grama, the grass component of many sagebrush stands included galleta (*Hilaria jamesii*) and, more occasionally, bottlebrush squirreltail (*Sitanion jubatum* and *S. longifolium*), needle and thread (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), and western wheatgrass (*Agropyron smithii*). However, the latter five cool season grasses were almost always less abundant than the warm season grasses blue grama and galleta. A preponderance of warm season grasses is consistent with environmental conditions that are strongly characterized by low and variable precipitation concentrated in summer "monsoon" episodes.

Sagebrush cover in J28 averaged 10.2 percent total vegetation cover. These data suggest that abundance of sagebrush is an indicator of overall soil productivity and that, within the limitations imposed by low annual precipitation, highest cover within the sagebrush type is expectable on the deeper (alluvial / colluvial) substrates.

Bare soil (Table 7) is very abundant within the sagebrush shrubland vegetation type, averaging from 67 percent cover, while rock averaged approximately 2 percent cover. Rock cover was predictably highest on sites where soils are shallow and more rock is exposed. Standing dead was probably more abundant in 2003 than usual because of the widespread death of sagebrush following the 2000-2002 drought (see below). It averaged about 8 percent cover in the 2003 sampling and was primarily dead big sagebrush.

Relative vegetation cover data (Table 8) show that although shrubs and subshrubs are by far the most abundant lifeforms in the sagebrush shrubland type, warm season grasses contributed about 6 percent of total vegetation cover.

With regard to woody plant density, the total density within sampled areas for sagebrush shrubland was approximately 10,000 stems per acre (Table 7). The bulk of the shrubs present at the J28 sagebrush site was big sagebrush but included the shrubs and subshrubs Greene rabbitbrush, sticky-leaved rabbitbrush, (*Chrysothamnus viscidiflorus),* broom snakeweed (*Gutierrezia sarothrae*) and the shrubs black greasewod (*Sarcobatus vermiculatus*) and fourwing saltbush.

Among the sagebrush shrubland sites with deeper soils, invasion of pinyon pine is commonly occurring. The pines are most often found directly beneath sagebrush where shading or other protection has apparently provided critical assistance in establishment.

That big sagebrush is among the native plants sensitive to moisture deprivation was evident throughout the Black Mesa area in 2003. The effects of serious drought conditions of the previous few years were very clear. Within the baseline areas examined in 2003, it is estimated that approximately 30% of sagebrush shrubland stands had suffered heavy die-back of sagebrush (e.g. Photograph 31), while another 50 to 60% had experienced light to moderate die-back. About 10 to 20% of stands had little or no die-back (Photograph 32). See the discussion of the drought sensitivity of sagebrush in the next section.

Species density (Table 9) within the sampled sagebrush shrubland stands averaged 18.2 species per 100 sq.m.

Pinyon-Juniper Woodland

Although pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) are by far the most abundant plants on these sites in terms of ground cover and possibly biomass, their abundance is on the low end of the spectrum for this type in the Southwest (Moir and Carleton 1986). With tree canopy cover mostly in the range of 11 to 117 percent, these sites do not meet the UNESCO definition of woodland (> 40 percent tree cover, UNESCO 1973). Pinyon-juniper vegetation at similar elevation (6300 ft) with the same tree dominants in Zion National Park had 38 percent cover (by ocular estimate; Harper 2003). Inasmuch as trees are by far the most abundant lifeform, it is reasonable to continue to refer to these as woodlands.

Beyond the tree cover, shrubs are the next most abundant lifeform, being comprised of big sagebrush and either fourwing saltbush or cliffrose (*Cowania mexicana*). On the shallow soils, accompanying shrubs (or subshrubs) include Greene rabbitbrush and broom snakeweed. For the most part, herbaceous cover in all the pinyon-juniper vegetation is very sparse. Warm season grass cover is very limited, mostly considerably less than 1 percent (compared with often 2 to 4 percent cover in sagebrush of the same area). Cool season native grasses are more abundant in the pinyon-juniper vegetation type than in the sagebrush shrubland. More commonly observed species include

bottlebrush squirreltail, Indian ricegrass, and muttongrass (*Poa fendleriana*). Native perennial forbs are more frequently encountered in the pinyon-juniper than in sagebrush shrubland, but still are very minor in the quantitative sense. Some pinyon-juniper stands give the general impression of virtually bare understory (e.g. Photographs 62, 74, and 76), while others have at least moderate presence of shrub cover (e.g. Photographs 63 and 75).

Total vegetation cover (Table 7) of as high as 20.4 percent and as low as 14 percent is comparatively sparse for reported pinyon-juniper woodland. Harper (2003) for example, found an average of 62 percent live vegetation cover in his examination of pinyon-juniper woodland at Zion National Park. Rock varied from 6.8 percent cover at J28 to nearly 25 percent at N10 compared to about 2 percent in sagebrush shrubland. Standing dead of approximately 3 to 4 percent in pinyon–juniper woodland was substantially less than the sagebrush shrubland. Although some pinyon pine did perish as a result of the drought, overall the tree cover was mostly intact. Some of the mortality of pines was indirect, caused by bark beetle infestation of stressed trees.

Study of the ecophysiology of pinyon pine, Utah juniper and sagebrush has shown that the trees have assimilation (carbon-fixation) rates that are more sensitive to drought than sagebrush (DeLucia and Schlesinger 1991), but the trees have higher "water use efficiency" (assimilation rate/transpiration rate). In other words, the trees have much tighter control on transpirative loss, so even though their assimilation drops quickly with drought, they still make a little water go farther per gram of fixed carbon than sagebrush. Flanagan et al. (1992) as cited in Nowak et al. (1999) showed that pinyon pine and Utah juniper are more dependent on summer precipitation than sagebrush.

Occasional trees within the pinyon-juniper stands of the study areas have been removed presumably for firewood. The major residual evidence is the presence of stumps and litter from limbing the bole.

In the pinyon-juniper type species density (Table 9) varied from 15.7 to 19.8 species per 100 sq. m., essentially the same range observed in sagebrush shrubland. As in sagebrush shrubland, the distribution of species is fairly even among native perennial forbs, native perennial cool season grasses, native perennial warm season grasses, subshrubs, and shrubs. Native annual forb species were distinctly less numerous in the

pinyon-juniper than in the sagebrush shrubland. Compared to the range of vascular plant species density observed elsewhere in pinyon–juniper woodlands of adjacent New Mexico and Utah (Harner and Harper 1976), the LOM study areas fall somewhat below the mean of the 30 sample areas reported there which was about 22 to 23 species per 100 sq.m., and ranged from about 12 to 60 species per 100 sq.m.

Throughout the bulk of the pinyon-juniper woodland of the study area, the soil surface is trampled sufficiently frequently by livestock that "cryptobiotic" or "cryptogamic" soil crust is non-existent. In a very few sites, however, this soil crust was found intact. The cryptogams involved are predominantly blue-green algae, mosses (mostly *Polytrichum piliferum*), and lichens. Evans and Ehlehringer (1994) found that the nitrogen requirements of Utah juniper may be largely met by nitrogen fixation by the cryptobiotic crust. It may be assumed that the absence of a cryptobiotic crust in heavily trampled areas results in a diminished availability of nitrogen from atmospheric fixation.

With regard to woody plant density in the pinyon-juniper woodland type, overall woody plant densities (including subshrubs, shrubs, and trees) are far lower than in the sagebrush shrubland type, ranging from about 1720 to 3600 stems per acre (Table 7). Tree densities were only a fraction of the total woody plant densities, ranging from 158 (J28) to 340 (N10) tree stems per acre. These values are comparable to the lower to middle range of densities reported for pinyon-juniper stands of the Piceance Basin by Welden et al. (1990) and well below the range reported in 1974 (599 trees per acre) and 1984 (629 trees per acre) from permanent plots in northeastern Utah by Austin (1987).

In J28 and N10 pinyon exceeded juniper by about 2:1. In other areas of the PWCC leasehold and at lower elevations, juniper is much more prevalent and in some cases, dominant. This would appear to be related to a gradient of increasing elevation and precipitation from south to north. Pinyon pine has shown physiological evidence of having much higher potential rates of carbon fixation than junipers (Lathja and Barnes 1991), but shows less resistance to impacts of water stress on assimilation rate. Measures of the degree of soil moisture stress at which leaf turgor can no longer be maintained ("permanent wilting point") is an indication of the relative drought tolerance of a plant species. Wilkins and Klopatek (1987) determined that the "permanent wilting point" for pinyon pine was slightly higher than that for Utah juniper. Breashers et al. (1997) studied the use of soil moisture in spaces between trees in a pinyon-juniper

woodland and determined that one-seeded juniper made more effective use of shallow soil moisture between trees than pinyon pine.

In other words, pinyon pine is, in general, less accommodating of dry conditions than Utah juniper and, when competition for shallow soil moisture is intense, junipers tend to have an advantage over the pines. Lower relative abundance of pinyon pine in the southern part of the LOM study areas, where elevations and precipitation are lower and soils tend to be shallower (and with presumably less moisture-holding capacity), is consistent with what is known of the ecology of these two tree species.

Densities of subshrubs were highly variable often driven by the extremely local very dense occurrence of snakeweed. At a somewhat larger scale Douglas rabbitbrush or Greene rabbitbrush could be very dense in a general area perhaps reflecting a combination of substrate and land use history.

Occurrence of Forbs in the LOM Study Areas

Historical grazing use of these lands has been so intense and unrelenting that growth of herbaceous species in general, but especially native perennial forbs, is very restricted. Although the complete absence of native perennial forbs in a randomly sampled 100 sq.m. area was uncommon (no more than 2 of 10 such plots in any of the LOM study areas were totally devoid of any native perennial forbs), the extent of native perennial forb cover is extremely limited. In the sagebrush vegetation type, percent cover by native perennial forbs in the J28 study area averaged from 0.0 percent, while in the pinyon-juniper woodland, it averaged from 0.0 to 0.4 percent. (0.0 percent cover means less than 0.1 percent cover in most cases, i.e. cover is below the quantitative detection limit).

Most frequently comprising (in the 2003 sampling) the very small cover afforded by native perennial forbs were some few of the following: *Astragalus wingatanus*, *Calochortus nuttallii*, *Cryptantha flavoculata*, *Cymopterus purpureus*, *Eriogonum umbellatum*, *Aster arenosus* (*Leucelene ericoides*), *Mirabilis multiflora*, *Oxybaphus linearis*, *Pedicularis centrantherum*, *Penstemon linarioides*, *Phlox longifolia*, *Solidago petradoria* (*Petradoria pumila*), *Sphaeralcea coccinea*, *Stanleya pinnata*, and/or *Townsendia exscapa*. Although the spring of 2003 was comparatively favorable with regard to moisture, the extent native annual and biennial forbs was scant, averaging no

more than 0.8 percent cover in the sagebrush type and no more than 0.1 percent cover in the pinyon-juniper type. Native annual and biennial species sporadically present included: *Aster canescens*, *Chenopodium fremontii*, *Chenopodium glaucum*, *Chenopodium leptophyllum*, *Cryptantha crassicarpa*, *Descurainia pinnata*, *Descurainia richardsonii*, *Gilia pumila*, *Gilia sinuata*, and *Lappula redowskii* ssp.

Sensitive Plant Survey Results

Survey of the inner (red) areas shown on Map 1 in spring 2003 did not reveal the presence of any of the "target" species (those deemed to have even a small chance of occurrence (see *Appendix 3, Kayenta Complex Field Guide to Potentially Occurring Rare Plants).*

Notes regarding the potential for the sought for rare plants to occur and the results of the intensive survey for them are summarized below:

Amsonia peeblesii – Peebles blue star

This plant is known from grasslands and desert scrub communities at elevations from 4,000 to 5,620 ft., in the arc of the Little Colorado River drainage from central Coconino County south and east into southern Navajo County, Arizona. Even the lowest reaches of the LOM study areas are nearly 1,000 ft. higher than the uppermost occurrence of this plant. The environs of the Little Colorado River to which this plant is restricted are approximately 50 miles distant. No individuals of Peebles blue star were encountered during the 2003 surveys.

Asclepias sanjuanensis – San Juan milkweed

This plant is known from sandy benches and hills in pinyon-juniper woodland vegetation near the Chaco and San Juan Rivers in San Juan County, New Mexico at 5,000 to 6,200 feet. The type locality is on the San Juan College campus in Farmington. In terms of sandy substrate and pinyon-juniper woodland vegetation, the LOM study areas would seem to include suitable habitat. However, its nearest occurrence in areas approximately 150 mi. east and at elevations mostly below the LOM study area elevations (6,200 to 7,150 ft.) made its presence unlikely; none was found during the 2003 surveys.

Astragalus cremnophylax var. *cremnophylax* – Sentry milkvetch

This milkvetch is known from Grand Canyon National Park on Kaibab limestone, a Permian-age formation. LOM study areas do not include limestones and are far younger (Cretaceous-age). Thus no suitable habitat was found and no sentry milkvetch was encountered.

Astragalus cutleri (*A. preusii* var. *cutleri*) – Copper Canyon milkvetch

This plant is an endemic in southern San Juan County, Utah occurring on seleniferous soils derived from the Triassic-age Shinarump Conglomerate member of the Chinle formation at 3,800 ft. The lowest LOM elevations of about 6,200 ft. are substantially higher and no substrates approximating those of the known occurrences are present. No individuals of Copper Canyon milkvetch were encountered during intensive surveys.

Astragalus humillimus – Mancos milkvetch

This plant is known from San Juan County, New Mexico and adjacent Montezuma County, Colorado at elevations from about 5,000 to 6,500 ft. in cracks on "slickrock" exposures of the Cretaceous-age Point Lookout sandstone, which is also found in McKinley and Sandoval Counties, New Mexico in close association with the Satan Tongue member of Mancos Shale. In the LOM study areas, Yale Point sandstone, a facies of the Mesa Verde formation of the Black Mesa Basin, forms limited exposures of bare rock. These sandstones are older than those of the San Juan Basin, the Cretaceous sea having receded from the Black Mesa Basin before it receded from the San Juan Basin. In addition to the differences in substrates, the LOM study areas are mostly higher in elevation than the known occurrences of Mancos milkvetch. No individuals of Mancos milkvetch were found during intensive searches in 2003.

Astragalus naturitensis – Naturita milkvetch

This plant is known from sandstone mesas, ledges, crevices, and slopes from 5,000 to 7,000 ft. in McKinley Co., New Mexico, as well as in southern Utah and southwestern Colorado. Such habitats are present in the LOM study areas; those in the intensive survey areas were found not to be occupied.

Carex specuicola – Navajo sedge

This plant is known to occur in extreme northern Arizona and barely into Utah in seeps and hanging gardens below vertical cliffs of Navajo sandstone at elevations between

4,400 ft and 7,000 ft. No exposures of the lower Jurassic-age Navajo sandstone are present in the LOM study areas. The upper Cretaceous Yale Point sandstone that forms cliffs along washes in the LOM area is generally without development of seepage zones. The very few seepage zones observed during the intensive surveys had extensive crusts of evaporated salt. No individuals of Navajo sedge were observed during the intensive surveys.

Clematis hirsutissima var. *arizonica* – Arizona leather flower

Although the known range of elevational occurrence (6,800 to 9,000 ft) overlaps the elevations of many of the LOM study areas, its preferred habitat is moist portions of mountain meadows, open woods, or thickets in ponderosa pine and mixed conifer forests on soils derived from limestone. On the Navajo Nation, it is known only from the Chuska Mountains and Defiance Plateau. None of the habitat criteria are met in the LOM sites, and no Arizona leather flower was encountered in the intensive survey areas.

Cystopteris utahensis – Utah bladder-fern

Known from Arizona, Colorado, New Mexico, Texas, and Utah at elevations from 4,200 to 8,800 feet, this plant could reasonably occur in the LOM study areas on the very few sites where cracks in sandstones with calcareous cementation are at least slightly seeping. These locations were examined closely. None were found.

Echinocereus triglochidiatus var. *arizonicus* – Arizona hedgehog cactus

This rare cactus is known from central Arizona at elevations from 3,400 to 6,360 ft. on very rocky sites comprised mostly of boulders and cobbles of orthoclase-rich granite of late Cretaceous age. Other substrates on which it has been found include volcanic tuff and mid-Tertiary age dacite. Substrates of the LOM study areas are distinctly unlike these. In addition, the range of elevations within the LOM sites is 6,200 to 7,150 feet, which is, for the most part, substantially higher than the highest known occurrences of the cactus. These facts made the occurrence of this cactus unlikely in the LOM study areas, and, in fact, no individuals of Arizona hedgehog cactus were encountered during the 2003 surveys.

Errazurizia rotundata – Round dune-broom

This plant is known from an arc of sites within a comparatively narrow elevational range (4,800 to 5,200 ft) from near Tuba City in Coconnino County, Arizona swinging south and east to near Holbrook, in general following the valley of the Little Colorado River. Substrates are of various lithologies, but are apparently coarse and loose. Although the LOM study areas include some loose sands over sandstone, elevations are considerably higher and the LOM sites are about 50 miles east and north from the Little Colorado drainage. No individuals of round dune-broom were encountered during 2003 intensive surveys.

Lesquerella navajoensis – Navajo bladderpod

Navajo bladderpod is known to occur in McKinley County, New Mexico, Apache County, Arizona, and in Utah on windswept exposures of the Todlito limestone member of the Morrison formation at elevations between 7,200 and 7,600 ft. Upper elevations of the north-most LOM study areas are just below this range, but Morrison formation (Upper Jurassic age) materials are not present at the surface in the Black Mesa Basin. Furthermore the Upper Cretaceous sediments that are present in the LOM study areas do not include limestones. Navajo bladderpod was not considered a likely occurrence in the LOM study areas and none was found during 2003 surveys.

Pediocactus bradyi – Brady pincushion cactus

This narrow endemic is found in Coconino County, Arizona along the rim of Marble Canyon between elevations of 3,400 and 5,200 ft. Substrates are narrowly defined where intermixed Moenkopi and Kaibab formation debris form the soil parent material. LOM study area elevations begin at about 6,200 ft and range upward to about 7,150 ft. Furthermore none of the Upper Cretaceous-age substrates of the LOM areas approximate the Moenkopi or Kaibab formation materials (Upper Triassic to lower Jurassic age). There was almost no chance of finding this cactus, and none were found during 2003 intensive surveys of the LOM study areas.

Pediocactus peeblesianus var. *fickeiseniae* – Fickeisen plains cactus

The known occurrences of this cactus are in Coconino and Mohave Counties, Arizona on soils derived from Kaibab limestone at elevations between 4,000 and 5,600 ft. LOM study area sites are all well above the known elevational limit and limestone-derived

soils are not present. Nonetheless, it was sought during the intensive surveys but not found.

Pediocactus peeblesianus var. *peeblesianus* – Navajo plains cactus

This cactus is known from southern Navajo County at elevations from 5,100 to 5,650 ft. in the upper reaches of the Little Colorado River watershed on thin veneers of gravel that are not replicated in the LOM study areas. The elevations of the LOM study areas are well above the highest known occurrence of this cactus. No individuals of Navajo plains cactus were encountered in the intensive field surveys.

Phlox cluteana – Navajo Mountain Phlox

This plant is known from the northern Chuska Mountains, Navajo Mountain, and Black Rock Mountain on the Navajo Nation, and in adjacent New Mexico and Utah at elevations from 6,000 to 10,400 ft. on sandy soils with leaf litter under ponderosa pine, Gambel oak, and pinyon – juniper woodland. Although it seems likely that the pinyon-juniper woodland habitat in which it is found represents the opposite end of the moisture spectrum from that found in the LOM pinyon-juniper sites, it was sought in the intensive searches of spring 2003, but not found.

Platanthera zothecina – Alcove bog orchid

This plant requires the constant flow of moisture usually in hanging garden / alcove environments and is known from small populations at widely scattered locations in central and northeastern Arizona, east-central Utah, and northwestern Colorado. The northeastern Arizona locations include nearby Tsegi and Betatakin Canyons. Although nearby, these locations are in very deep canyons with overhanging cliffs of Navajo sandstone. The much younger Cretaceous-age sandstones (Yale Point member of the Mesa Verde formation) of the LOM study areas form small cliffs along some of the washes of the area, but nowhere are there deep shady well-wetted sites that would support this plant. The very few appearances of moisture on the LOM cliff sites have only enough flow to periodically bring dissolved salts to the surface where rapid evaporation produces extensive salt crusting.

Puccinellia parishii – Parish's alkaligrass

This rare annual alkaligrass is found on salt-encrusted frequently wet soils at widely disjunct sites from northern and eastern Arizona, to southwestern Colorado and western

New Mexico and as far away as San Bernadino County, California. Such microsites are found at a few seepage sites in the PWCC leasehold and along Wild Ram wash. Although alkaligrass is present, it is saltmarsh alkaligrass (*Puccinellia fasciculata*), an introduced species now found in the northeastern U.S. and in Arizona, Colorado, and New Mexico. Careful examination of the LOM alkaline/wet soils revealed only this species. Characteristics distinguishing saltmarsh alkaligrass from Parish's alkaligrass include lemmas glabrous and 2 to 2.5 mm long, panicle branches floriferous to the base, and perennial habit.

Sclerocactus mesae-verdae – Mesa Verde Cactus

This cactus is known from San Juan County, New Mexico as well as adjacent Montezuma County, Colorado at elevations from 4,900 to 5,500 ft. on very heavy soils derived from Mancos formation shales or from shaley facies of the overlying Mesa Verde formation. Exposures of Mesa Verde formation facies in the northern Black Mesa Basin and the LOM study areas in general are dominated by the Yale Point sandstone and extensive areas of heavy clay soils are absent. These rocks are age-equivalent to the upper Mancos and lower Mesa Verde rocks of the San Juan Basin but are not marine deposits (the Cretaceous sea having withdrawn from the Black Mesa Basin earlier). No individuals of Mesa Verde cactus were encountered during the 2003 intensive searches in the LOM study areas.

PLANTS FAIRLY COMMONLY SEEN THAT ARE SIMILAR TO TARGET SPECIES

Asclepias asperula – considerably larger than *A. sanjuanensis* in all dimensions of herbage and flowers, and with flowers with greenish corolla lobes with purplish hoods. *A. sanjuanensis* flowers have purplish corolla lobes with whitish hoods.

Phlox longifolia – This phlox has easily observed bulging intercostal membranes, unlike *P. cluteana*

Echinocereus triglochidiatus var. *mojavensis* — Differs from *E. t. arizonicus* in color, length and diameter of central and radial spines.

Pediocactus simpsonii – Possesses normal spines rather than the corky spines of *P. peeblesianus* var. *fickeiseniae* and *P. p.* var. *peeblesianus.* Possesses central spines, unlike *P. bradyi.*

PLANTS OCCASIONALLY ENCOUNTERED THAT ARE SIMILAR TO TARGET SPECIES

Asclepias involucrata (Photograph 87) – Differs from *A. sanjuanensis* in having cream to greenish flowers.

Puccinellia fasciculata – Differs from *P. parishii* in being perennial and having lemmas glabrous and 2 to 2.5 mm long.

Habitats of the Outer Areas

The areas within and outside of the primary study areas were examined in fall 2003 for the presence of habitats either different from those areas that were examined in detail in spring 2003 and/or the same as those in the inner areas that had the potential to support sensitive species. Habitats in the outer areas that were as potentially suitable for *Asclepias sanjuanensis*, *Astragalus humillimus*, and *Astragalus naturitensis* as those in the inner areas were found. It should be noted, of course, that those same types of potentially suitable habitats were found not to support any of these species in the adjacent inner areas in spring 2003 surveys.

No new habitats (i.e. habitats not represented in the inner areas) were found in the fall 2003 examination of the outer areas. No additional wet seepage sites were located. Drainages found in the outer areas were dry and generally heavily trampled by livestock.

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APPENDIX 1

DATA TABLES

Cover data tables: Both first and additional hit data are presented in these tables. Additional hit data are shown in parentheses.

Woody plant density data tables: Counts of dead shrubs are shown in parentheses but are not included in density totals.

Table 1. Cover Data - J28 LOM Sagebrush Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ----Sample Number---- 1	2	3	4	5
NATIVE ANNUAL & BIENNIAL FORBS										
Aster canescens	0.00	40.00	0.00	0.00	0.00				P	P
Chenopodium glaucum	0.00	20.00	0.00	0.00	0.00					P
Chenopodium hians	0.00	40.00	0.00	0.00	0.00				P	P
Chenopodium leptophyllum	0.00	60.00	0.00	0.00	0.00		P		P	P
Cryptantha crassisepala	0.00	40.00	0.00	0.00	0.00	P				P
Descurainia pinnata	0.40	80.00	2.33	0.40	2.25	2	P		P	P
Descurainia richardsonii	0.00	40.00	0.00	0.00	0.00		P		P	
Gilia pumila	0.20	40.00	1.16	0.20	1.12		1		P	
Lappula redowskii	0.20	100.00	1.16	0.20	1.12	1	P	P	P	P
TOTAL NATIVE ANN. & BIEN. FORBS	0.8	100.0	4.7	0.8	4.5	3	1	P	P	P
INTRODUCED ANNUAL & BIENNIAL FORBS										
Chenopodium album	0.00	80.00	0.00	0.00	0.00	P	P		P	P
Salsola kali	0.00	40.00	0.00	0.00	0.00	P				P
Solanum sarachoides	0.20	20.00	1.16	0.20	1.12					1
TOTAL INTRO. ANN. & BIEN. FORBS	0.2	80.0	1.2	0.2	1.1	P	P	---	P	1
NATIVE ANNUAL GRASSES										
Festuca octoflora	1.00	60.00	5.81	1.20	6.74	P	1		4(1)	
Munroa squarrosa	0.20	20.00	1.16	0.20	1.12				1	
TOTAL NATIVE ANN. GRASSES	1.2	60.0	7.0	1.4	7.9	P	1	---	5(1)	---
INTRODUCED ANNUAL GRASSES										
Bromus tectorum	0.00	60.00	0.00	0.00	0.00		P		P	P
TOTAL INTRO. ANN. GRASSES	0.0	60.0	0.0	0.0	0.0	---	P	---	P	P
NATIVE PERENNIAL FORBS										
Aster arenosus	0.00	60.00	0.00	0.00	0.00		P	P	P	
Penstemon sp.	0.00	20.00	0.00	0.00	0.00			P		

Table 1. Cover Data - J28 LOM Sagebrush Baseline, Kayenta Complex, PWCC, AZ - 2003

Phlox longifolia	0.00	20.00	0.00	0.00	0.00			P		
Sphaeralcea coccinea	0.00	60.00	0.00	0.00	0.00	P		P		P
Townsendia exscapa	0.00	20.00	0.00	0.00	0.00				P	
TOTAL NATIVE PERENNIAL FORBS	0.0	100.0	0.0	0.0	0.0	P	P	P	P	P
NATIVE PERENNIAL GRASSES (cool)										
Agropyron smithii	0.00	60.00	0.00	0.00	0.00		P	P		P
Oryzopsis hymenoides	0.00	20.00	0.00	0.00	0.00				P	
Sitanion jubatum	0.20	40.00	1.16	0.40	2.25				1(1)	P
Sitanion longifolium	0.00	80.00	0.00	0.20	1.12	P	(1)	P	P	
Stipa comata	0.00	20.00	0.00	0.00	0.00				P	
TOTAL NATIVE PERENNIAL GRASSES (c)	0.2	100.0	1.2	0.6	3.4	P	(1)	P	1(1)	P
NATIVE PERENNIAL GRASSES (warm)										
Bouteloua gracilis	1.00	80.00	5.81	1.00	5.62	P	4	P	1	
Hilaria jamesii	0.00	20.00	0.00	0.00	0.00				P	
Sporobolus cryptandrus	0.00	40.00	0.00	0.00	0.00	P				P
TOTAL NATIVE PERENNIAL GRASSES (w)	1.0	100.0	5.8	1.0	5.6	P	4	P	1	P
NATIVE SUBSHRUBS										
Chrysothamnus greenei	2.20	60.00	12.79	2.20	12.36	8	P	3		
Gutierrezia sarothrae	0.00	60.00	0.00	0.00	0.00		P		P	P
TOTAL NATIVE SUBSHRUBS	2.2	100.0	12.8	2.2	12.4	8	P	3	P	P
NATIVE SHRUBS										
Artemisia tridentata	10.20	100.00	59.30	10.20	57.30	1	22	3	14	11
Atriplex canescens	0.20	60.00	1.16	0.20	1.12		1	P		P
Chrysothamnus viscidiflorus	0.20	40.00	1.16	0.20	1.12			P		1
Sarcobatus vermiculatus	0.80	20.00	4.65	0.80	4.49					4
TOTAL NATIVE SHRUBS	11.4	100.0	66.3	11.4	64.0	1	23	3	14	16
NATIVE TREES										
Pinus edulis	0.20	40.00	1.16	0.20	1.12				1	P
TOTAL NATIVE TREES	0.2	40.0	1.2	0.2	1.1	—	—	—	1	P

Table 1. Cover Data - J28 LOM Sagebrush Baseline, Kayenta Complex, PWCC, AZ - 2003

MOSS										
Moss	0.00	40.00	0.00	0.00	0.00		P		P	
TOTAL MOSS	0.0	40.0	0.0	0.0	0.0	—	P	—	P	—
LICHEN										
Parmelia chlorochroa	0.00	40.00	0.00	0.00	0.00		P		P	
TOTAL LICHEN	0.0	40.0	0.0	0.0	0.0	—	P	—	P	—
SUCCULENT										
Opuntia macrorhiza	0.00	80.00	0.00	0.00	0.00	P	P		P	P
TOTAL SUCCULENT	0.0	80.0	0.0	0.0	0.0	P	P	—	P	P
Standing dead	8.20	100.00		8.20		3	21	4	11	2
Litter	6.60	100.00		6.60		5	4	6	5	13
Bare ground	66.60	100.00		66.60		80	46	78	62	67
Rock	1.40	40.00		1.40				6		1
TOTALS	100.0			100.6		100	100	100	100	100
TOTAL VEGETATION COVER	17.2 (s=8.9)		100.0	17.8 (s=9.5)	100.0	12	29(1)	6	22(2)	17
GROUND COVER (Litter+Rock+Veg+St.Dead)	33.4			34.0		20	54(1)	22	38(2)	33
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 18.2 Std.Dev.= 5.6)						13	19	12	25	22

*P=Present within 1 m. of either side of the cover transect, but not quantitatively encountered.

Table 2. Cover Data - J28 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ----Sample Number---- 1	2	3	4	5
NATIVE ANNUAL & BIENNIAL FORBS										
Aster canescens	0.00	20.00	0.00	0.00	0.00	P				
Chenopodium berlandieri	0.00	20.00	0.00	0.00	0.00	P				
Chenopodium fremontii	0.00	20.00	0.00	0.00	0.00				P	
Chenopodium leptophyllum	0.00	40.00	0.00	0.00	0.00				P	P
Descurainia pinnata	0.00	80.00	0.00	0.00	0.00	P		P	P	P
Descurainia richardsonii	0.00	20.00	0.00	0.00	0.00					P
Lappula redowskii	0.00	60.00	0.00	0.00	0.00	P			P	P
TOTAL NATIVE ANN. & BIEN. FORBS	0.0	80.0	0.0	0.0	0.0	P	---	P	P	P
INTRODUCED ANNUAL & BIENNIAL FORBS										
Chenopodium album	0.00	20.00	0.00	0.00	0.00					P
TOTAL INTRO. ANN. & BIEN. FORBS	0.0	20.0	0.0	0.0	0.0	---	---	---	---	P
NATIVE ANNUAL GRASSES										
Festuca octoflora	0.00	20.00	0.00	0.00	0.00					P
TOTAL NATIVE ANN. GRASSES	0.0	20.0	0.0	0.0	0.0	---	---	---	---	P
INTRODUCED ANNUAL GRASSES										
Bromus tectorum	0.00	20.00	0.00	0.00	0.00					P
TOTAL INTRO. ANN. GRASSES	0.0	20.0	0.0	0.0	0.0	---	---	---	---	P
NATIVE PERENNIAL FORBS										
Arabis lignifera	0.00	20.00	0.00	0.00	0.00					P
Aster arenosus	0.00	40.00	0.00	0.00	0.00		P		P	
Astragalus wingatanus	0.00	40.00	0.00	0.00	0.00	P			P	
Cryptantha flavoculata	0.00	40.00	0.00	0.00	0.00				P	P
Cymopterus purpurascens	0.00	20.00	0.00	0.00	0.00	P				
Euphorbia fendleri	0.00	20.00	0.00	0.00	0.00	P				
Lesquerella intermedia	0.00	20.00	0.00	0.00	0.00	P				
Mirabilis multiflora	0.00	20.00	0.00	0.00	0.00				P	
Mirabilis oxybaphoides	0.00	20.00	0.00	0.00	0.00				P	
Oxybaphus linearis	0.00	20.00	0.00	0.00	0.00		P			
Pedicularis centrantherum	0.00	40.00	0.00	0.00	0.00	P		P		
Penstemon barbatus	0.00	20.00	0.00	0.00	0.00			P		
Penstemon linarioides	0.00	20.00	0.00	0.00	0.00	P				
Phlox longifolia	0.00	20.00	0.00	0.00	0.00	P				
Solidago petradoria	0.00	20.00	0.00	0.00	0.00	P				
Sphaeralcea coccinea	0.00	60.00	0.00	0.00	0.00	P	P		P	
Sphaeralcea parvifolia	0.00	20.00	0.00	0.00	0.00		P			
Townsendia exscapa	0.00	60.00	0.00	0.00	0.00	P		P	P	
TOTAL NATIVE PERENNIAL FORBS	0.0	100.0	0.0	0.0	0.0	P	P	P	P	P

Table 2. Cover Data - J28 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ----Sample Number---- 1	2	3	4	5
NATIVE PERENNIAL GRASSES (cool)										
Agropyron smithii	0.00	20.00	0.00	0.00	0.00			P		
Oryzopsis hymenoides	0.00	100.00	0.00	0.00	0.00	P	P	P	P	P
Poa fendleriana	0.00	40.00	0.00	0.00	0.00	P		P		
Sitanion jubatum	0.00	60.00	0.00	0.00	0.00	P		P	P	
Sitanion longifolium	0.00	40.00	0.00	0.00	0.00		P			P
Stipa comata	0.00	20.00	0.00	0.00	0.00			P		
TOTAL NATIVE PERENNIAL GRASSES (c)	0.0	100.0	0.0	0.0	0.0	P	P	P	P	P
NATIVE PERENNIAL GRASSES (warm)										
Bouteloua gracilis	0.00	80.00	0.00	0.00	0.00		P	P	P	P
Hilaria jamesii	0.20	60.00	0.98	0.20	0.95	1			P	P
Sporobolus cryptandrus	0.00	20.00	0.00	0.00	0.00				P	
TOTAL NATIVE PERENNIAL GRASSES (w)	0.2	100.0	1.0	0.2	1.0	1	P	P	P	P
NATIVE SUBSHRUBS										
Chrysothamnus greenei	0.00	20.00	0.00	0.00	0.00		P			
Eriogonum aureum	0.00	40.00	0.00	0.00	0.00			P		P
Gutierrezia sarothrae	0.00	80.00	0.00	0.00	0.00	P		P	P	P
Senecio douglasii var. longilobus	0.00	20.00	0.00	0.00	0.00	P				
TOTAL NATIVE SUBSHRUBS	0.0	100.0	0.0	0.0	0.0	P	P	P	P	P
NATIVE SHRUBS										
Artemisia tridentata	2.00	100.00	9.80	2.20	10.48	1	1	1	P	7(1)
Atriplex canescens	0.40	20.00	1.96	0.40	1.90		2			
Chrysothamnus nauseosus	0.20	20.00	0.98	0.20	0.95	1				
Chrysothamnus viscidiflorus	0.00	20.00	0.00	0.20	0.95		(1)			
Cowania mexicana	0.20	20.00	0.98	0.20	0.95	1				
Haplopappus laricifolius	0.20	60.00	0.98	0.20	0.95	1	P	P		
Lycium pallidum	0.00	20.00	0.00	0.00	0.00				P	
TOTAL NATIVE SHRUBS	3.0	100.0	14.7	3.4	16.2	4	3(1)	1	P	7(1)
NATIVE TREES										
Juniperus osteosperma	6.20	100.00	30.39	6.40	30.48	7	4	9(1)	P	11
Pinus edulis	11.00	60.00	53.92	11.00	52.38		7	22	26	
TOTAL NATIVE TREES	17.2	100.0	84.3	17.4	82.9	7	11	31(1)	26	11
MOSS										
Polytrichum piliferum	0.00	40.00	0.00	0.00	0.00			P	P	
TOTAL MOSS	0.0	40.0	0.0	0.0	0.0	---	---	P	P	---

Table 2. Cover Data - J28 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ----Sample Number---- 1	2	3	4	5
SUCCULENT										
Echinocereus triglochidiatus var. mojavensis	0.00	20.00	0.00	0.00	0.00					P
Opuntia phaeacantha	0.00	20.00	0.00	0.00	0.00					P
Pediocactus simpsonii	0.00	20.00	0.00	0.00	0.00			P		
TOTAL SUCCULENT	0.0	40.0	0.0	0.0	0.0	---	---	P	---	P
AGAVOIDS										
Yucca angustissima	0.00	20.00	0.00	0.00	0.00			P		
TOTAL AGAVOIDS	0.0	20.0	0.0	0.0	0.0	---	---	P	---	---
Standing dead	2.80	60.00		2.80		5	1			8
Litter	24.20	100.00		24.20		26	17	23	36	19
Bare ground	45.80	100.00		45.80		50	57	42	28	52
Rock	6.80	100.00		6.80		7	11	3	10	3
TOTALS	100.0			100.6		100	100	100	100	100
TOTAL VEGETATION COVER	20.4 (s=8.4)		100.0	21.0 (s=8.5)	100.0	12	14(1)	32(1)	26	18(1)
GROUND COVER (Litter+Rock+Veg+St.Dead)	54.2			54.8		50	43(1)	58(1)	72	48(1)
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 19.8 Std.Dev.= 4.1)						25	14	19	22	19

*P=Present within 1 m. of either side of the cover transect, but not quantitatively encountered.

Table 3. Cover Data - N10 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ----Sample Number---- 1	2	3	4	5	6	7	8	9	10
NATIVE ANNUAL & BIENNIAL FORBS															
Chaenactis stevioides	0.00	10.00	0.00	0.00	0.00								P		
Chenopodium fremontii	0.00	70.00	0.00	0.00	0.00	P	P		P	P	P	P			P
Descurainia pinnata	0.00	20.00	0.00	0.00	0.00	P							P		
Erysimum asperum	0.00	10.00	0.00	0.00	0.00								P		
Gilia sinuata	0.10	10.00	0.71	0.10	0.69								1		
Lappula redowskii	0.00	10.00	0.00	0.00	0.00								P		
TOTAL NATIVE ANN. & BIEN. FORBS	0.1	80.0	0.7	0.1	0.7	P	P	---	P	P	P	P	1	---	P
INTRODUCED ANNUAL GRASSES															
Bromus tectorum	0.00	10.00	0.00	0.10	0.69								(1)		
TOTAL INTRO. ANN. GRASSES	0.0	10.0	0.0	0.1	0.7	---	---	---	---	---	---	---	(1)	---	---
NATIVE PERENNIAL FORBS															
Aster arenosus	0.10	40.00	0.71	0.20	1.38				P	P			1(1)		P
Astragalus calycosus var. scapiosus	0.00	10.00	0.00	0.00	0.00									P	
Astragalus wingatanus	0.10	20.00	0.71	0.10	0.69							P		1	
Calochortus nuttallii	0.00	10.00	0.00	0.00	0.00					P					
Cryptantha sp.	0.00	10.00	0.00	0.00	0.00						P				
Cymopterus purpurascens	0.00	20.00	0.00	0.00	0.00				P			P			
Eriogonum alatum	0.00	30.00	0.00	0.00	0.00			P	P				P		
Eriogonum umbellatum	0.00	10.00	0.00	0.00	0.00					P					
Haplopappus nuttallii	0.00	20.00	0.00	0.00	0.00			P					P		
Lithospermum incisum	0.00	10.00	0.00	0.00	0.00								P		
Mirabilis multiflora	0.10	40.00	0.71	0.10	0.69				P			P	1		P
Oxybaphus linearis	0.00	10.00	0.00	0.00	0.00		P								
Pedicularis centrantherum	0.00	20.00	0.00	0.00	0.00			P				P			
Penstemon barbatus	0.00	20.00	0.00	0.00	0.00			P				P			
Penstemon linarioides	0.00	40.00	0.00	0.00	0.00	P		P			P	P			
Solidago petradoria	0.10	30.00	0.71	0.10	0.69			P		1	P				

Table 3. Cover Data - N10 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* —Sample Number— 1	2	3	4	5	6	7	8	9	10
Sphaeralcea coccinea	0.00	20.00	0.00	0.00	0.00				P				P		
Stanleya pinnata	0.00	20.00	0.00	0.00	0.00			P					P		
Streptanthus cordatus	0.00	10.00	0.00	0.00	0.00			P							
TOTAL NATIVE PERENNIAL FORBS	0.4	100.0	2.9	0.5	3.4	P	P	P	P	1	P	P	2(1)	1	P
NATIVE PERENNIAL GRASSES (cool)															
Carex occidentalis	0.00	10.00	0.00	0.00	0.00			P							
Oryzopsis hymenoides	0.20	80.00	1.43	0.20	1.38		P	P	P	P		1	1	P	P
Poa fendleriana	0.00	20.00	0.00	0.00	0.00		P	P							
Sitanion longifolium	0.10	60.00	0.71	0.10	0.69			P	P		P	P	P		1
Stipa comata	0.00	10.00	0.00	0.00	0.00								P		
TOTAL NATIVE PERENNIAL GRASSES (c)	0.3	90.0	2.1	0.3	2.1	---	P	P	P	P	P	1	1	P	1
NATIVE PERENNIAL GRASSES (warm)															
Bouteloua gracilis	0.10	50.00	0.71	0.10	0.69		P		P			P	1	P	
Hilaria jamesii	0.30	30.00	2.14	0.50	3.45			P	1				2(2)		
TOTAL NATIVE PERENNIAL GRASSES (w)	0.4	60.0	2.9	0.6	4.1	---	P	P	1	---	---	P	3(2)	P	---
NATIVE SUBSHRUBS															
Chrysothamnus greenei	0.00	10.00	0.00	0.00	0.00				P						
Eriogonum microthecum	0.00	10.00	0.00	0.00	0.00							P			
Gutierrezia sarothrae	0.10	90.00	0.71	0.10	0.69		P	P	P	P	P	P	1	P	P
TOTAL NATIVE SUBSHRUBS	0.1	90.0	0.7	0.1	0.7	---	P	P	P	P	P	P	1	P	P
NATIVE SHRUBS															
Artemisia tridentata	0.80	70.00	5.71	0.90	6.21		2(1)	P	P			1	2	P	3
Atriplex canescens	0.00	40.00	0.00	0.00	0.00				P			P	P	P	
Chrysothamnus viscidiflorus	0.00	50.00	0.00	0.00	0.00			P	P		P			P	P
Cowania mexicana	1.20	60.00	8.57	1.20	8.28	7		2		P	3		P	P	
Ephedra viridis	0.00	30.00	0.00	0.00	0.00	P					P				P

Table 3. Cover Data - N10 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* —Sample Number— 1	2	3	4	5	6	7	8	9	10
Haplopappus laricifolius	0.00	10.00	0.00	0.00	0.00							P			
TOTAL NATIVE SHRUBS	2.0	100.0	14.3	2.1	14.5	7	2(1)	2	P	P	3	1	2	P	3
NATIVE TREES															
Juniperus osteosperma	6.20	100.00	44.29	6.20	42.76	8	7	3	15	1	13	3	4	8	P
Pinus edulis	3.90	100.00	27.86	3.90	26.90	3	2	8	3	4	9	4	P	4	2
Quercus gambelii	0.30	10.00	2.14	0.30	2.07									3	
TOTAL NATIVE TREES	10.4	100.0	74.3	10.4	71.7	11	9	11	18	5	22	7	4	15	2
MOSS															
Moss	0.00	30.00	0.00	0.00	0.00	P		P				P			
TOTAL MOSS	0.0	30.0	0.0	0.0	0.0	P	—	P	—	—	—	P	—	—	—
LICHEN															
Parmelia chlorochroa	0.00	40.00	0.00	0.00	0.00		P		P					P	P
TOTAL LICHEN	0.0	40.0	0.0	0.0	0.0	—	P	—	P	—	—	—	—	P	P
SUCCULENT															
Echinocereus triglochidiatus var. mojavensis	0.00	30.00	0.00	0.00	0.00				P				P		P
Opuntia polyacantha	0.20	50.00	1.43	0.20	1.38	P	1			P	1	P			
TOTAL SUCCULENT	0.2	80.0	1.4	0.2	1.4	P	1	—	P	P	1	P	P	—	P
AGAVOIDS															
Yucca angustissima	0.00	10.00	0.00	0.00	0.00					P					
Yucca baccata	0.10	40.00	0.71	0.10	0.69				P				P	P	1
TOTAL AGAVOIDS	0.1	50.0	0.7	0.1	0.7	—	—	—	P	P	—	—	P	P	1
Standing dead	3.60	90.00		3.60		2	4	2	2	2	4	3	11		6
Litter	13.10	100.00		13.10		7	10	29	8	6	16	20	7	5	23

Table 3. Cover Data - N10 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE COVER (%)	FREQUENCY (%)	RELATIVE VEGETATION COVER (%)	AVERAGE COVER-ALL (%)	RELATIVE VEGETATION COVER-ALL (%)	Percent Foliar Cover* ---Sample Number--- 1	2	3	4	5	6	7	8	9	10
Bare ground	44.60	100.00		44.60		59	38	39	39	36	35	68	20	58	54
Rock	24.70	90.00		24.70		14	36	17	32	50	19		48	21	10
TOTALS	100.0			100.5		100	100	100	100	100	100	100	100	100	100
TOTAL VEGETATION COVER	14.0 (s=6.1)		100.0	14.5 (s=6.2)	100.0	18	12(1)	13	19	6	26	9	14(4)	16	7
GROUND COVER (Litter+Rock+Veg+St.Dead)	55.4			55.9		41	62(1)	61	61	64	65	32	80(4)	42	46
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 15.7 Std.Dev.= 5.3)						9	11	20	20	12	12	19	26	14	14

Table 4. Woody Plant Density Data - J28 LOM Sagebrush Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE DENSITY (per 100 sq.m.)	DENSITY (per acre)	FREQUENCY (%)	Shrubs per 100 sq.m. ----Sample Number---- 1	2	3	4	5
NATIVE SUBSHRUBS								
Chrysothamnus greenei	105.40	4,265.5	60.00	398	5	124		
Gutierrezia sarothrae	1.00	40.5	60.00		2		1	2
TOTAL NATIVE SUBSHRUBS	106.4	4,306.0	100.0	398	7	124	1	2
NATIVE SHRUBS								
Artemisia tridentata	105.20	4,257.4	100.00	30	195	38	88	175
Atriplex canescens	2.20	89.0	60.00		2	1		8
Chrysothamnus viscidiflorus	24.00	971.3	40.00			50		70
Sarcobatus vermiculatus	9.80	396.6	20.00					49
TOTAL NATIVE SHRUBS	141.2	5,714.4	100.0	30	197	89	88	302
NATIVE TREES								
Pinus edulis	0.80	32.4	40.00		1		3	
TOTAL NATIVE TREES	0.8	32.4	40.0	---	1	---	3	---
TOTAL DENSITY	248.4	10,052.7		428	205	213	92	304
Standard Deviation	125.4	5,074.9						
SPECIES DENSITY (# of species/100 sq.m.) (AVERAGE= 3.8 Std.Dev.= 1.3)				2	5	4	3	5

Table 5. Woody Plant Density Data - J28 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE DENSITY (per 200 sq.m.)	DENSITY (per acre)	FREQUENCY (%)	Shrubs per 200 sq.m. -----Sample Number----- 1	2	3	4	5
NATIVE SUBSHRUBS								
Chrysothamnus depressus	0.20	4.05	20.00		1			
Chrysothamnus greenei	9.60	194.26	40.00		47		1	
Eriogonum aureum	2.40	48.56	40.00			3		9
Gutierrezia sarothrae	57.00	1,153.40	80.00	113		28	51	93
Senecio douglasii var. longilobus	0.20	4.05	20.00	1				
TOTAL NATIVE SUBSHRUBS	69.4	1,404.3	100.0	114	48	31	52	102
NATIVE SHRUBS								
Artemisia tridentata	58.80	1,189.82	100.00	2	31	50	14	197
Atriplex canescens	1.60	32.38	20.00		8			
Chrysothamnus nauseosus	0.20	4.05	20.00	1				
Chrysothamnus viscidiflorus	15.60	315.67	20.00		78			
Cowania mexicana	2.20	44.52	20.00	11				
Haplopappus laricifolius	4.20	84.99	60.00	16	2	3		
Lycium pallidum	18.20	368.28	20.00				91	
TOTAL NATIVE SHRUBS	100.8	2,039.7	100.0	30	119	53	105	197
NATIVE TREES								
Juniperus osteosperma	2.80	56.66	100.00	2	3	5	1	3
Pinus edulis	5.00	101.18	100.00	3	2	12	6	2
TOTAL NATIVE TREES	7.8	157.8	100.0	5	5	17	7	5
AGAVOIDS								
Yucca angustissima	0.20	4.05	20.00	1				
TOTAL AGAVOIDS	0.2	4.05	20.0	1	—	—	—	—
TOTAL DENSITY	178.2	3,605.9		150	172	101	164	304
Standard Deviation	76	1,527.7						
SPECIES DENSITY (# of species/200 sq.m.) (AVERAGE= 6.8 Std.Dev.= 1.6)				9	8	6	6	5

Table 6. Woody Plant Density Data - N10 LOM Pinyon-Juniper Baseline, Kayenta Complex, PWCC, AZ - 2003

PLANT SPECIES	AVERAGE DENSITY (per 200 sq.m.)	DENSITY (per acre)	FREQUENCY (%)	Shrubs per 200 sq.m. —Sample Number— 1	2	3	4	5	6	7	8	9	10
NATIVE SUBSHRUBS													
Chrysothamnus greenei	6.30	127.48	20.00				61			2			
Gutierrezia sarothrae	40.60	821.54	80.00	1	122		44	13		6	193	8	19
TOTAL NATIVE SUBSHRUBS	46.9	949.0	80.0	1	122	—	105	13	—	8	193	8	19
NATIVE SHRUBS													
Artemisia tridentata	8.60	174.02	70.00	1	30			5		25	6	3	16
Atriplex canescens	1.10	22.26	30.00				5				1	5	
Chrysothamnus viscidiflorus	3.70	74.87	60.00	4			16		13	1	2	1	
Cowania mexicana	5.20	105.22	60.00	7		21		1	21			1	1
Ephedra viridis	1.00	20.24	40.00			3			3		2		2
TOTAL NATIVE SHRUBS	19.6	396.6	100.0	12	30	24	21	6	37	26	11	10	19
NATIVE TREES													
Juniperus osteosperma	5.40	109.27	90.00	3	6	3	16	7	4		2	3	10
Pinus edulis	9.00	182.12	100.00	18	14	8	3	22	7	10	4	2	2
Quercus gambelii	2.40	48.56	10.00									24	
TOTAL NATIVE TREES	16.8	339.9	100.0	21	20	11	19	29	11	10	6	29	12
AGAVOIDS													
Yucca angustissima	1.10	22.26	10.00					11					
Yucca baccata	0.60	12.14	30.00								1	1	4
TOTAL AGAVOIDS	1.70	34.40	40.0	—	—	—	—	11	—	—	1	1	4
TOTAL DENSITY	85.0	1,720.0		34	172	35	145	59	48	44	211	48	54
Standard Deviation	65.2	1,319.3											
SPECIES DENSITY (# of species/200 sq.m.) (AVERAGE= 6.0 Std.Dev.= 1.6)				6	4	4	6	6	5	5	8	9	7

Table 7. Cover and Woody Plant Density Data Summary, LOM Baseline, Kayenta Complex, PWCC, AZ - 2003

AREA	TOTAL FOLIAR COVER (%)	STANDING DEAD (%)	LITTER (%)	ROCK (%)	SOIL (%)	WOODY PLANT DENSITY (shrubs/acre)
J28 SAGEBRUSH	17.2	8.2	6.6	1.4	66.6	10,052.7
J28 PINYON-JUNIPER	20.4	2.8	24.2	6.8	45.8	3,605.9
N10 PINYON-JUNIPER	14.0	3.6	13.1	24.7	44.6	1,720.0

Table 8. Relative Vegetation Cover by Lifeform Data Summary, LOM Baseline, Kayenta Complex, PWCC, AZ - 2003

RELATIVE VEGETATION COVER - ALL HITS (%)

			——INTRODUCED——						——NATIVE——								
		TOTAL	—FORBS—		—GRASSES—			TOTAL	—FORBS—		—GRASSES—			SUB-SHRUBS			
AREA	TOTAL*	INTRO. SP.	ANNUAL+	PERENN.	ANNUAL	PERENN. (C)	SUB-SHRUBS	NATIVE SP.	ANNUAL+	PERENN.	ANNUAL+	PERENN. (C)	PERENN. (W)		SHRUBS	TREES	OTHER**
J28 SAGEBRUSH	100.0	1.1	1.1	0.0	0.0	0.0	0.0	98.9	4.5	0.0	7.9	3.4	5.6	12.4	64.0	1.1	0.0
J28 PINYON-JUNIPER	100.1	0.0	0.0	0.0	0.0	0.0	0.0	100.1	0.0	0.0	0.0	0.0	1.0	0.0	16.2	82.9	0.0
N10 PINYON-JUNIPER	100.0	0.7	0.0	0.0	0.7	0.0	0.0	99.3	0.7	3.4	0.0	2.1	4.1	0.7	14.5	71.7	2.1

*May sum to 100.0 plus or minus 0.2 due to rounding errors.

** Lower plants (mosses, lichens, parasites), succulents, and agavoids.

+ANNUAL category includes biennials.

Table 9. Species Density Data Summary, LOM Baseline, Kayenta Complex, PWCC, AZ - 2003

SPECIES DENSITY (number of species / 100 sq.m.)

			——INTRODUCED——						——NATIVE——								
		TOTAL	—FORBS—		—GRASSES—			TOTAL	—FORBS—		—GRASSES—			SUB			
AREA	TOTAL*	INTRO. SP.	ANNUAL+	PERENN.	ANNUAL	PERENN. (C)	SHRUBS	NATIVE SP.	ANNUAL+	PERENN.	ANNUAL+	PERENN. (C)	PERENN. (W)	SHRUBS	SHRUBS	TREES	OTHER**
J28 SAGEBRUSH	18.2	2.0	1.4	0.0	0.6	0.0	0.0	16.2	4.6	1.8	0.8	2.2	1.4	1.2	2.2	0.4	1.6
J28 PINYON-JUNIPER	19.8	0.4	0.2	0.0	0.2	0.0	0.0	19.4	2.6	5.2	0.2	2.8	1.6	1.6	2.6	1.6	1.2
N10 PINYON-JUNIPER	15.7	0.1	0.0	0.0	0.1	0.0	0.0	15.6	1.3	3.9	0.0	1.8	0.8	1.1	2.6	2.1	2.0

* Due to rounding errors, table values may not exactly match this value.
** Lower plants (mosses, lichens, parasites), succulents, and agavoids.
+ANNUAL category includes biennials.

APPENDIX 2

PLANT SPECIES FROM THE LOM BASELINE STUDY, KAYENTA COMPLEX

Table 10. Species Presence, N10 and J28 Baseline Study Areas, Kayenta Complex, PWCC, AZ - 2003

SPECIES	COMMON NAME	SYNONYM	N10 PJUN	J28 PJUN	J28 SAGE
NATIVE ANNUAL & BIENNIAL FORBS					
Aster canescens	hoary tansyaster	Machaeranthera canescens		X	X
Chaenactis stevioides	pincushion		X		
Chenopodium berlandieri	pitseed goosefoot			X	
Chenopodium fremontii	Fremont goosefoot		X	X	
Chenopodium hians	maple-leaved goosefoot	C. hybridum			X
Chenopodium glaucum	oak-leaved goosefoot				X
Chenopodium leptophyllum	narrowleaf goosefoot			X	X
Cryptantha crassisepala	cryptantha				X
Cryptantha minima	small hiddenflower				
Descurainia pinnata	pinnate tansy-mustard		X	X	X
Descurainia richardsonii	Richardson tansy-mustard			X	X
Erysimum asperum	wallflower		X		
Gilia pumila	gilia	Ipomopsis pumila			X
Gilia sinuata	floccose gilia	G. inconspicua	X		
Lappula redowskii	bluebur stickseed		X	X	X
INTRODUCED ANNUAL & BIENNIAL FORBS					
Chenopodium album	common lambsquarter			X	X
Salsola kali	Russian thistle				X
Solanum sarachoides	South American nightshade				X
NATIVE ANNUAL GRASSES					
Festuca octoflora	six-weeks fescue			X	X
Munroa squarrosa	false buffalograss				X
INTRODUCED ANNUAL GRASSES					
Bromus tectorum	cheatgrass		X	X	X
NATIVE PERENNIAL FORBS					
Arabis lignifera	woody rockcress			X	
Aster arenosus	white aster	Leucelene ericoides	X	X	X
Astragalus calycosus var. scapiosus	Torrey milkvetch		X		
Astragalus wingatanus	Fort Wingate milkvetch		X	X	
Calochortus nuttallii	sego lily		X		
Cryptantha flavoculata	cryptantha			X	
Cryptantha sp.	cryptantha		X		
Cymopterus purpurascens	spring parsley		X	X	
Eriogonum alatum	winged eriogonum		X		
Eriogonum umbellatum	sulfur wild buckwheat		X		
Euphorbia fendleri	Fendler spurge			X	
Haplopappus nuttallii	Nuttall goldenweed		X		
Lesquerella intermedia	bladderpod			X	
Lithospermum incisum	puccoon		X		
Mirabilis multiflora	colorado four o'clock		X	X	

Table 10. Species Presence, N10 and J28 Baseline Study Areas, Kayenta Complex, PWCC, AZ - 2003

SPECIES	COMMON NAME	SYNONYM	N10 PJUN	J28 PJUN	J28 SAGE
NATIVE PERENNIAL FORBS (cont)					
Mirabilis oxybaphoides	short-calyx four o'clock			X	
Oxybaphus linearis	narrowleaf umbrellawort		X	X	
Pedicularis centrantherum	wood betony		X	X	
Penstemon barbatus	beardlip penstemon		X	X	
Penstemon linarioides	mat penstemon		X	X	
Penstemon sp.	penstemon				X
Phlox longifolia	longleaf phlox			X	X
Solidago petradoria	rock goldenrod	Petradoria pumila	X	X	
Sphaeralcea coccinea	scarlet globemallow		X	X	X
Sphaeralcea parvifolia	littleleaf globemallow			X	
Stanleya pinnata	desert plume		X		
Streptanthus cordatus	twistflower		X		
Townsendia exscapa	ground daisy			X	X
NATIVE PERENNIAL GRASSES (cool)					
Agropyron smithii	Western wheatgrass			X	X
Carex occidentalis	Western sedge		X		
Oryzopsis hymenoides	Indian ricegrass		X	X	X
Poa fendleriana	mutton grass		X	X	
Sitanion jubatum	big squirreltail			X	X
Sitanion longifolium	bottlebrush squirreltail	Sitanion hystrix	X	X	X
Stipa comata	needle-and-thread grass		X	X	X
NATIVE PERENNIAL GRASSES (warm)					
Bouteloua gracilis	blue grama		X	X	X
Hilaria jamesii	galleta		X	X	X
Sporobolus cryptandrus	sand dropseed			X	X
NATIVE SUBSHRUBS					
Chrysothamnus greenei	Greene rabbitbrush		X	X	X
Eriogonum aureum	slenderbush wild buckwheat	E. microthecum	X	X	
Gutierrezia sarothrae	broom snakeweed		X	X	X
Senecio douglasii var. longilobus	threadleaf groundsel			X	
NATIVE SHRUBS					
Artemisia tridentata	big sagebrush		X	X	X
Atriplex canescens	four-wing saltbush		X	X	X
Chrysothamnus nauseosus	rubber rabbitbrush			X	
Chrysothamnus viscidiflorus	sticky-leaved rabbitbrush		X	X	X
Cowania mexicana	cliff rose	Purshia stansburiana	X	X	
Ephedra viridis	mountain joint-fir		X		
Haplopappus laricifolius	turpentine-bush	Ericameria laricifolius	X	X	
Lycium pallidum	rabbitthorn			X	
Sarcobatus vermiculatus	black greasewood				X

Table 10. Species Presence, N10 and J28 Baseline Study Areas, Kayenta Complex, PWCC, AZ - 2003

SPECIES	COMMON NAME	SYNONYM	N10 PJUN	J28 PJUN	J28 SAGE
INTRODUCED SHRUBS					
Tamarix pentandra	saltcedar				X
NATIVE TREES					
Juniperus osteosperma	Utah juniper		X	X	
Pinus edulis	Colorado pinyon		X	X	X
Quercus gambelii	Gambel oak		X		
MOSSES					
Moss	moss		X		X
Polytrichum piliferum	moss			X	
LICHENS					
Parmelia chlorochroa	lichen	Xanthoparmelia chlorochroa	X		X
SUCCULENTS					
Echinocereus triglochidiatus var. mojavensis	Mojave claret-cup		X	X	
Opuntia macrorhiza	thickroot pricklypear				X
Opuntia phaeacantha	pricklypear			X	
Opuntia polyacantha	plains pricklypear		X		
Pediocactus simpsonii	ball cactus			X	
AGAVOIDS					
Yucca angustissima	Spanish bayonet		X	X	
Yucca baccata	banana yucca		X		

APPENDIX 3

Field Guide to Target Species in the J9 Study Area

Black Mesa Mining Complex
Rare Plant Field Guide
1999/2000

VERY UNLIKELY TO BE SEEN

***Lesquerella navajoensis* O' Kane – Navajo Bladderpod**
Family: Brassicaceae
Synonyms: none
Status: Federal, none, NN, G4

Distinguishing characteristics
Perennial, cushion forming from a thick taproot
Flowers / Fruits: May to June

Lookalikes: *L. fendleri* has a deep orange "eye", the veins of the petals near the eye are also orange, the petals much larger and the stellate trichomes are webbed for at least half the length of the rays, *L. navajoensis* has a faint orange eye and no orange veins, the flowers are much smaller and the trichomes are not webbed.

Habitat: limited to windward, windswept mesa rims and nearby habitat with little vegetative cover (**pinyon-juniper**) and high insolation. Typically only found on the nearly white Todlito limestone member of the Morrison foundation which forms local mesa rims capping the Entrada Sandstone formation. Elevations range from 7200-7600 ft

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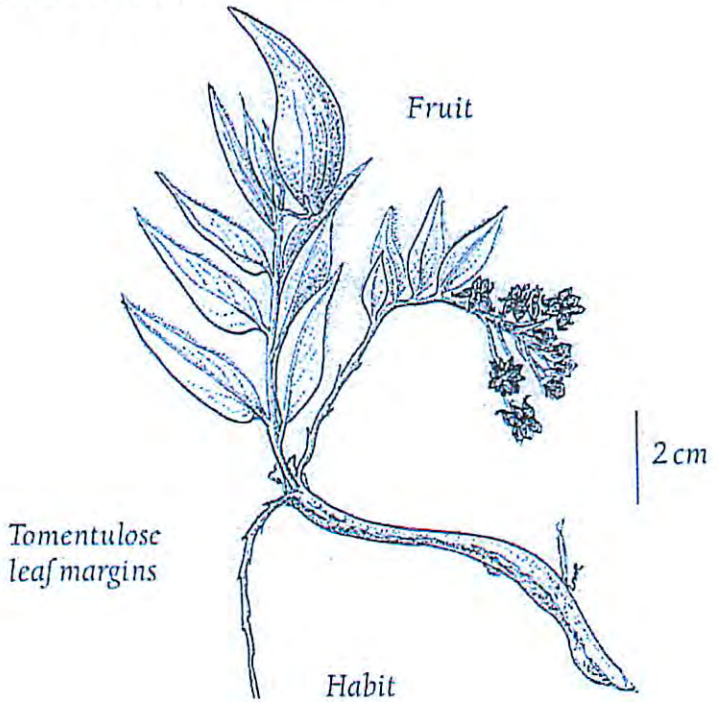
PINYON-JUNIPER WOODLAND SPECIES

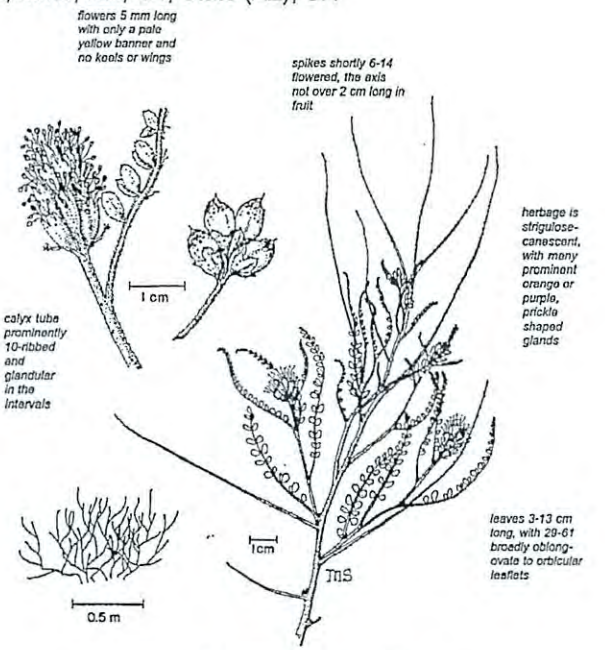
Asclepias sanjuanensis **– San Juan Milkweed**
Family: Asclepiadaceae
Synonyms: *A. unicialis* var. *ruthiae* (debated)
Status: Federal, 3B; NN, G4



Distinguishing characteristics
Milky white latex in stems and leaves; 2-7 branches, the auricles of the hood are erect, herbage pubescence is sparse, leaf shape lanceolate to broadly lanceolate.
Stems: woody taproot, 4-8 cm tall, prostrate to ascending
Leaves: 2-4 cm long, oblong-lanceolate, white tomentulose on leaf margins
Flower: inflorescence terminal; corolla reddish-violet; follicle 1/8-1/4 inch long
Blooms: Late April-early May
Lookalikes: *A. ruthiae* usu. has one branch, auricles of the hood not erect, herbage pubescence is dense, leaf shape broadly ovate to broadly lanceolate.
Habitat: grows on sandy benches and hills near the Chaco River, NM in **pinyon-juniper woodland** and Great Basin grassland communities

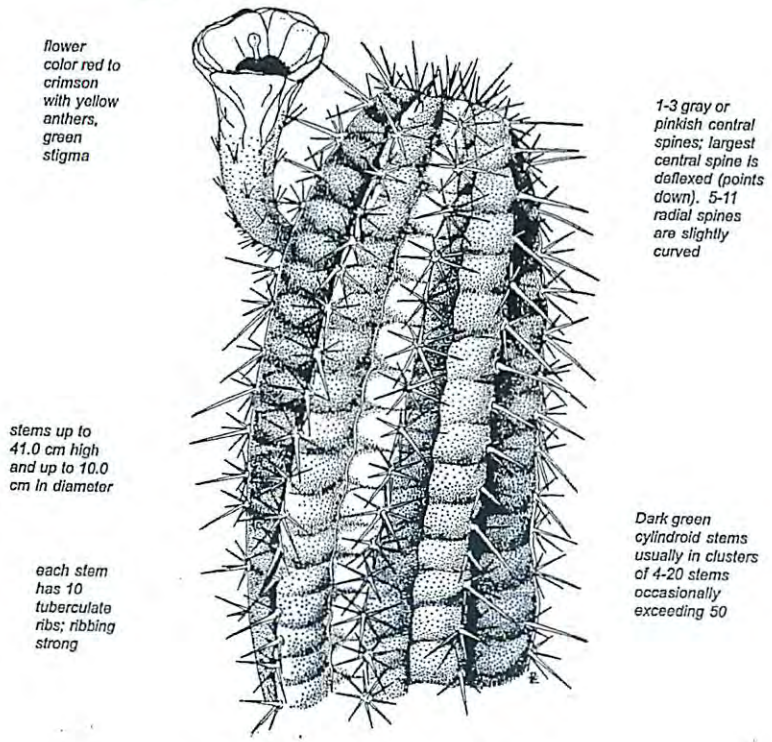
VERY UNLIKELY TO BE SEEN

Errazurizia rotundata **– Round dune-broom**
Family: Fabaceae
Synonym: *Paryella rotundata*
Status: Federal, none; NN, G4; State (AZ), SR



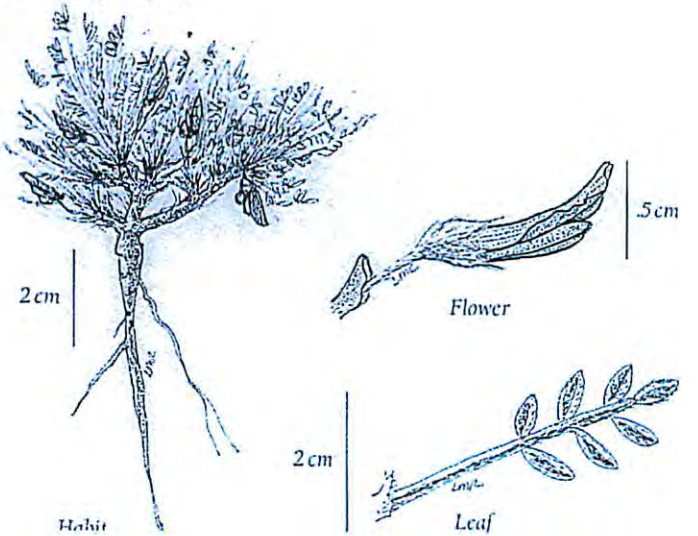
Distinguishing characteristics
Low, clonal, woody shrub, up to 30 cm tall
Flowers: 5 mm long with only a pale yellow banner and no keels or wings
Spikes: shortly 6-14 flowered, the axis not over 2 cm long in fruit
Herbage: strigulose-canescent, many prominent orange or purple, prickle shaped glands
Leaves: 3-13 cm long, with 29-61 broadly oblong-ovate to orbicular leaflets
Calyx: tube prominently 10-ribbed and glandular in the intervals
Blooms: late April to early May

Habitat: Little Colorado River drainage, exposed sites in several types of outcrops ranging from sandy soils in sandstone, gravelly soils in calcareous outcrops, to deep, alluvial cinders in sandstone breaks; **desertscrub**, 4,800-5,200 ft.



Cactaceae (Cactus Family)

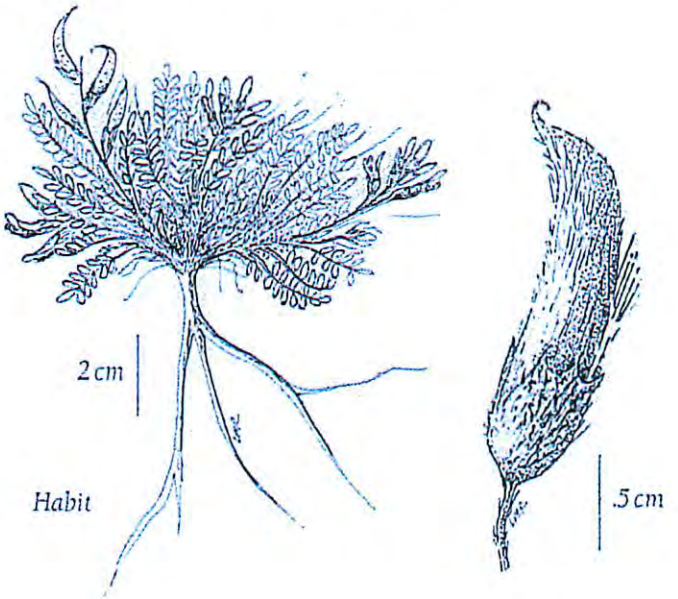
Astragalus humillimus **– Mancos milkvetch**
Family: Fabaceae
Synonyms: *Tragacantha humillima, Phaca humillima*
Status: Federal, LE; NN, G2



Distinguishing Characteristics:
Tufted perennial forming clumps up to 30 cm across
Stems: **only Astragalus in the area with persistent spiny leaf petioles**, up to 1 cm long.
Pod: spreading, egg shaped, ellipsoid, 4.5 mm long, 2 mm wide
Leaves: crowded, up to 4 cm long, 7-11 oval leaflets, 0.7-2 mm long
Flower: branches short, 1-3 flowers, petals lavender to purplish, conspicuous lighter colored spot in the throat of the corolla tube; banner 7-10 mm long; keel and banner petal 6-8 mm long; calyx, 3mm long
Phenology: flowers late april to early may, fruits june to early july.
Lookalikes: *A. deterior* and *A. calycosus* var. *scaposus* have flaccid leaf petioles and longer, oblong, or narrowly ellipsoid pods. *A. micromerius* doesn't have persistent spiny leaf stalks.
Habitat: ledges and mesa tops in slickrock communities / **pinyon-juniper** woodlands of the Mesa Verde Group, often in cracks in the sandstone substrate or in shallow pockets of sandy soil. 5,000-5,850 ft in elevation.

Astragalus naturitensis **– Naturita milkvetch**
Family: Fabaceae
Synonyms: *A. arientinus* var. *stipularis*
Status: Federal, 3C (more abundant than prev. thought); NN, G4

Distinguishing Characteristics:
Low growing, miniature spreading perennial about 10 cm tall
Stems: ascending, 2-6 cm long
Calyx: 4-8 mm, cylindrical, mixed white and black pubescent, lobes 1-1.5 mm
Pod: leathery, less than 2 cm long, more than twice as long as wide, widely spreading, covered with short, stiff, flat-lying hairs, **straight except for beak**, usually red mottled.
Leaves: basal, pinnate with 9-15 leaflets, leaves 2-7 mm, clustered, obovate to elliptic, mostly folded, often glabrate above, stipules free
Peduncles: scapose, 2-7 cm, wiith 4-9 subcapitate or briefly racemose ascending flowers
Flowers: 10-15 mm long, banner white, keel purple spotted, and wings reddish purple or purple tipped
Blooms: April to early June / Fruits: late May to June



Lookalikes: *A. deterior* has yellow-white flowers, *A. desperatus* has smaller flowers and loosely hirsute pods of broader and shorter outline, *A. monumentalis* var. *cottamii* has firm-walled, dorsiventrally shorter outline, *A. humillimus* has persistent, spiny racheses.
Habitat: Sandstone mesas, ledges, crevices and slopes in **pinyon-juniper woodlands**. 5,000-7,000 ft in elevation.

VERY UNLIKELY TO BE SEEN

Echinocereus triglochidiatus **var. *arizonicus* – Arizona hedgehog cactus**
Family: Cactaceae
Synonyms: *E. arizonicus var. arizonicus, E. coccineus var. arizonicus, Cereus polycanthus, Echinocereus polycanthus*
Status: Federal, LE; NN, none

Distinguishing characteristics
Plant caespitose, few branches or stems grow in clumps. As with all *Echinocereus* flowers burst through sides of stem, leaving scar on stem right above spine.
Stems: 22.5-40 cm long, 7.5-10 cm in diameter; dark green and cylindroid, usu. in clusters of 4-20 stems, occasionally exceeding 50.
Central Spines: 2-4, 2.5-40 cm long, grey or pinkish, deflexed
Radial spines: 8-10, appresed, 0.5-1 cm long, light yellow or pinkish tab, often slightly curved.
Stem ribs: +/- 7 cm long, 10 tuberculate ribs, ribbing strong
Areoles: (of mature parts of stems) white felt or cobwebby hairs; nearly circular
Flowers: stay open for 2-3 days, even at night; +/- 5 cm in diameter and +/- 7 cm long; red to crimson (as with all *E. t.*) with yellow anthers, green stigma; style 2mm in diameter
Fruit: Red, fleshy at maturity
Blooms / fruits: April to May/ May to June; germinates mid-summer
Other varieties: As opposed to other varieties, *E.t. arizonicus* has flowers on upper third of stem ribs. Spines are shorter and more robust than other *Echinocereus'*. Var. *melanacanthus* has much smaller stems (in height and width), each cluster has many (up to 500) stems. Var. *neomexicanus* has weaker ribbing, thinner central spines (0.5-1mm); central spines are not deflexed, smooth and are 4.5-7 cm long.
Habitat: open slopes of rugged steep-walled canyons, granite boulder-pile ridges and slopes in AZ desert grassland; shrubby vegetation, understory of shrubs, does not do well without extensive rock cover; 3,400-6,360 ft
Substrate: Normally found on Orthoclase-rich granite of late Cretaceous age; other parent materials in the are include volcanic tuft, mid-Tertiary age dacite and perhaps rhyolite. Schultze(?) granite, light in color.
Plant community: **interior Chaparral and Madrean Evergreen Woodland**; also into desert grassland. Often with the following associated species: *Quercus turbinella, Quercus emoryi, Arcostaphylos pungens, Cercocarpus montanus, Nolina microcarpa, Dasylirion wheeleri, Agave chrysantha, Muhlenbergia emersleyi, Pinus monophylla, Juniperus erythrocarpa,* and *Rhus trilobata.*

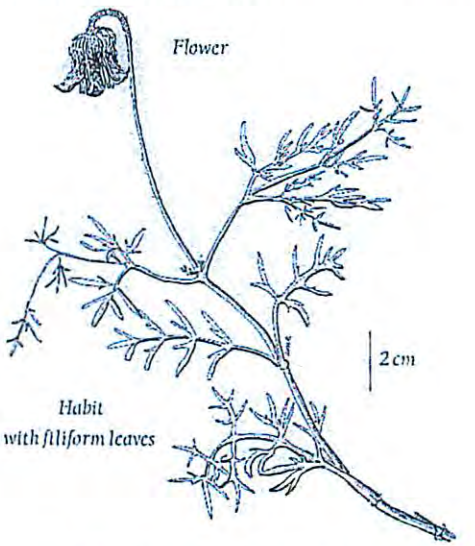
VERY UNLIKELY TO BE SEEN

***Astragalus cutleri* – Cutler's milkvetch**
Family: Fabaceae
Synonyms: *Astragalus preussii* var. *cutleri*
Status: Federal, LE; NN, G3

Distinguishing characteristics
Moderate, caulescent, short lived perennial, 10-35 mm long, from a woody caudex, pubescence affixed by its base
Flowers: 14-24 mm long; white or tinged or drying purplish; ascending peduncles, 2-15 cm long; racemes, 3 to 22 flowered, axis 1-20 cm long in fruit; bracts,1.5-4 mm long; pedicels,1-5.5 mm long; bracteoles, 2; calyx, 6.4-12.3mm long; tube, 5.1-9.7 mm long, cylindric, thinly strigose, purple; teeth, 1.3-2.6 mm long, subulate
Fruit: pods thin textured, often drying straw colored, erect to ascending, stipitate, or subsessile; stipe, 2-7 mm long, oblong-ellipsoid, inflated, 12-34 mm long, 6-13 mm thick, glabrous or puberulent , stiffly papery to leathery,uniloculular; ovules 20-44
Leaves: 3.5-13 cm long
Leaflets: 5-13, 7-12 mm wide, obovate to obchordate to oblong, narrrowly elliptic, lanceolate, or linear, emarginate to rounded, obtuse, or acute, glabrous
Stipule: 2-7 mm long, all distinct
Stems: few to several, erect or ascending, forming clumps
Blooms:
Lookalikes: *A. p.* var. *laxiflorus* and *A. p.* var. *preussii* have vivid purple flowers and more, narrower leaflets, and the pods dry brownish
Habitat: warm **desert shrub** communities on sandy, seleniferous soils with level to moderate slopes, on the Shinarump and Chinle Formations. 3,800 ft elev

***Clematis hirsutissima* var. *arizonica* – Arizona leather flower**
Family: Ranunculaceae
Synonym: *Clematis hirsutissima* var. *hirsutissima*
Status: Federal, none, NN, G4

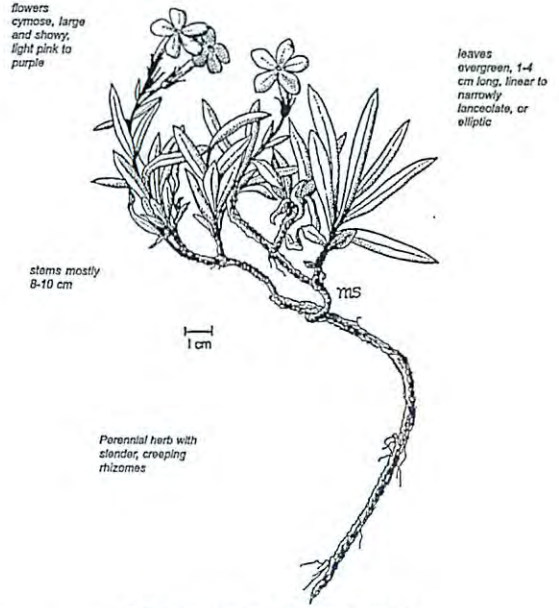
Distinguishing characteristics
Herbaceous perennial, 20-70 cm high
Fruit: head of achenes, each bearing a 4-6 cm plumose style
Flowers: nodding, solitary at the end of ea. Stem, 2-4 cm long
No petals, but w/ 4, thick purplish sepals, numerous stamens and pistils
Stems: erect from a somewhat woody base, ~5 cm to 1st branch
Leaves: pubescent to nearly glabrous, pinnately compound w/ 7-13 leaflets, these divisions narrowly linear, usually 1-2 mm, but rarely up to 12 mm
Blooms: Late April to June, Fruits July to August



CLEMATIS HIRSUTISSIMA Pursh
var. ARIZONICA (Heller) Erickson
Ann. Missouri Bot. Gard. 30: 48. 1943.

Lookalikes: other *Clematis* are vine forming
Habitat: moist mtn meadows, prairies, and open woods and thickets usually in limestone soils of **ponderosa pine and mixed conifer** forests, 6,800 to 9,000 ft

***Phlox cluteana* – Navajo Mountain Plox**
Family: Polemoniaceae (Phlox family)
Status:



Polemoniaceae (Phlox Family)

Distinguishing characteristics

Plants with stems single or more/less clumped from subterranean, many-headed, subrhizomatous caudices. 4-12 cm tall

Stems: 8-10 cmm tall, sparsely to densely glandular pubescent

Leaves: 1-4 cm long, elliptic to linear, lanceolate, or oblanceolate, glabrous or ciliate or pubescent (like the stem) 2-5 mm wide

Flowers: cymose, large and showy, on pedicels 3-15 mm long, alone or 2 to several in terminal cymes; calyx: 7-9 mm long, intercostally flat; corolla tube: 14-18 mm long; lobes 7-10 mm long and nearly as wide, pink to lavender or white; stamens included or slightly exserted; style 9-14 mm long

Rhizomes: long, slender, terminating in clusters of evergreen leaves

Lookalikes: *P. longifolia* and *P. amabilis* has taproots and deciduous leaves

Habitat: Light to heavy shade under ponderosa pine, gambel oak, or **pinyon and juniper** in sandy soils with leaf litter; 6,400-10,400 ft

VERY UNLIKELY TO BE SEEN

***Astragalus cremnophylax* var. *cremnophylax* Barneby – Sentry milkvetch**

Family: Fabaceae

Status: Federal, none; NN, G4

Distinguishing characteristics

Dwarf, evergreen, perennial, mat forming herb, 2-25 cm in diameter

Flowers: tiny, pale pinkish-lilac, white tipped keep incurved 100-120 degrees, purple veined banner; borne on a raceme of 1-3 flowers, held slightly above the mat, less than 10mm long, immersed in leaves

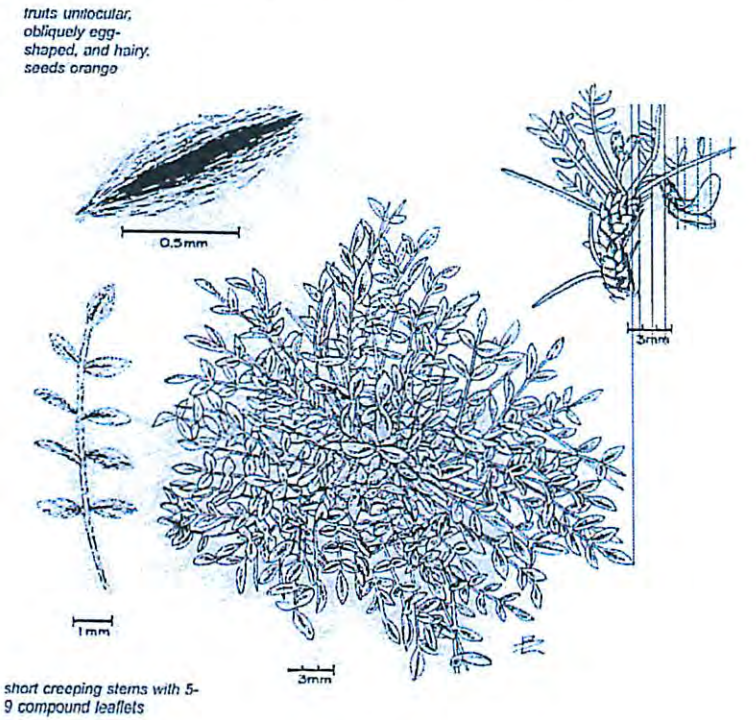
Leaves: all diminutive, leaf stalk 2-5 mm, softly tipped; leaflets 3-7, leaves 3-10mm, crowded pinnate or subpalmate

Fruit: ascending, unilocular, deciduous ovoid/obliquely egg-shaped, and hairy. Seeds orange. Ovules 4-6, fruits May to June

Blooms: late April to May, rarely a 2nd flowering in fall

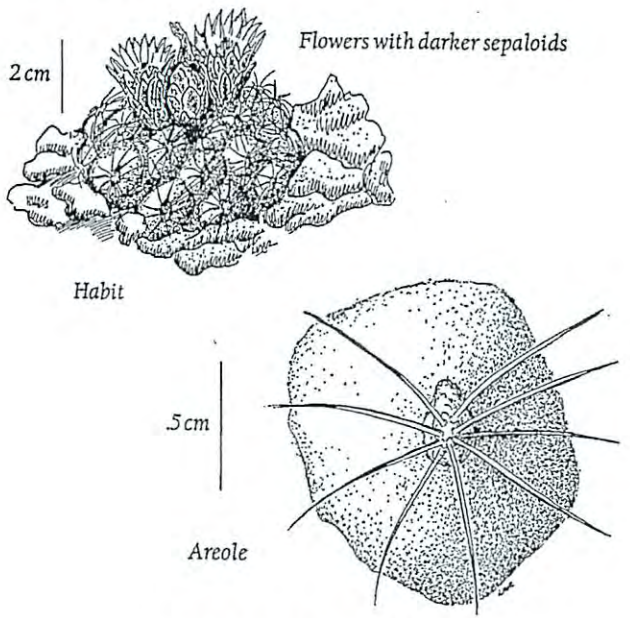
Lookalikes: var. *myriorrphaphis* has spinescent leaf bases; var. *hevronii* has larger flowers; and *A. calycosus* has larger leaflets and does not have unilocular fruits

Habitat: Grand Canyon NP in crevices and depressions w/shallow soils on Kaibab limestone on rim-rock benches at the canyon edge in **pinyon-juniper** woodland at 7,050-7,960 ft.



BOTH SHRUB AND PINYON-JUNIPER

Sclerocactus mesae-verdae – **Mesa Vede cactus**
Family: Cactaceae
Synonyms: *Coloradoa mesae-verdae, Echinocactus mesae-verdae, Pediocactus mesae-verdae*
Status: Federal, LT; NN, G3

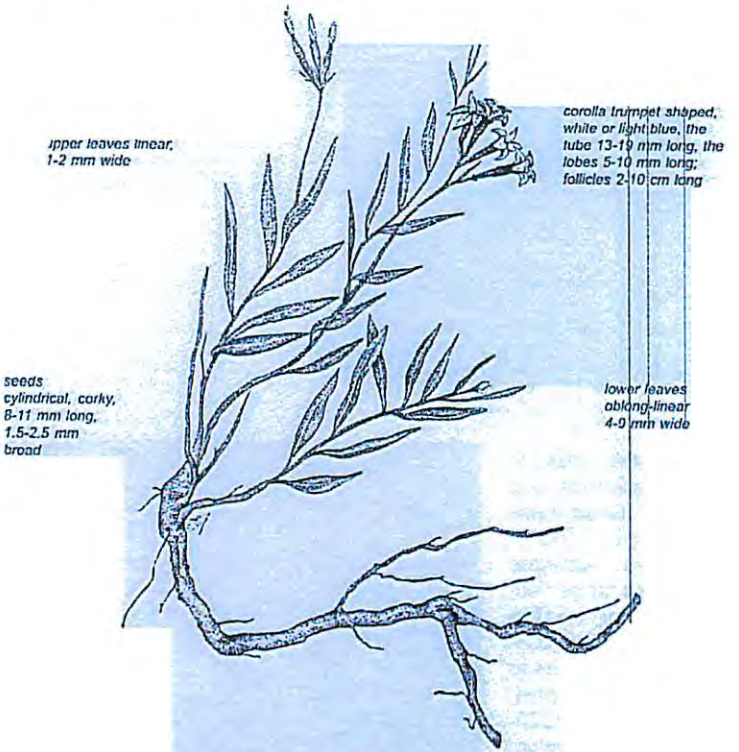


SCLEROCACTUS MESAE-VERDAE
(Boissevain *ex* Hill & Salisbury) L. Benson
Cact. and Succ. Iour. 38: 54. 1966.

Distinguishing characteristics
Sclerocactus is subglobose, depressed-hemispheric, ovoid, obovoid, or cylindroid; ribs 8-17; one or more of lower central spines usu strongly hooked. *S. mesae-verdae* is~ 2 cm tall, above ground
Areole: 0.5 cm diamter
Stems: mostly solitary, sometimes in clusters, 3-11 cm tall, oval to depressed-globose
Central spines: none or rarely 1
Radial spines: 8-10
Flowers: cream to pink, born below but adjacent to apex of the stem
Fruit: green turning tan; oblong
Blooms: late April to early May
Lookalikes: *S. parviflorus* usu. has 4 central spines, green cylindroidal to elongate cylindroidal stems. *S. whipplei* is taller (stems 10-25 cm tall), has 1-3 or more central spines, 3-5 cm long, 1-3 or more radial spines usu obscure the stem, 5000-6000 ft.
Habitat: barren clay hills of Fruitland and Mancos shale formation

Amsonia peeblesii – **Peebles blue star**
Family: Apocynaceae (Dogbane)
Status: Federal, none; NN, G4

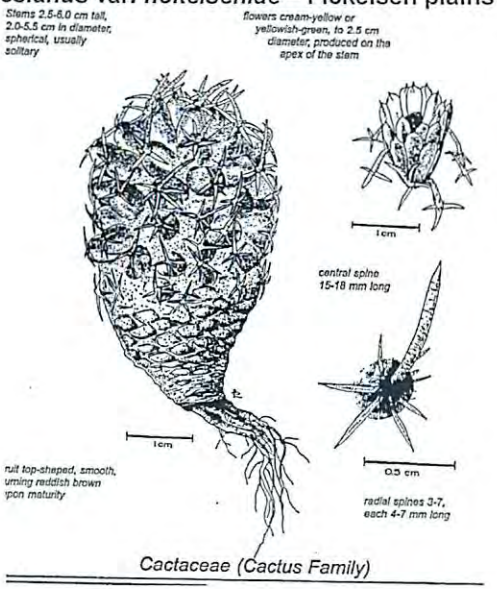
Distinguishing Characteristics
Robust, herbaceous perennial, glabrous, 40-90 cm tall
Seeds: cylindrical, corky, 8-11mm ling, 1.5-2.5 mm broad
Leaves: upper leaves linear, 1-2 mm wide
Lower leaves oblong-linear, 4-9 mm wide
Flower: corolla trumpet shaped, white or light blue
Tube 13-19 mm long
Lobes 5-10 mm long
Follicle 2-10 cm long
Blooms: May to June, leaves turn golden color in fall
Lookalikes: Glabrous form of *A. tomentosa* var. *stenophylla* has smaller flowers (7-12 mm long) and the follicles are moderately constricted between the seeds (*A. peeblesii* has smoothly cylindrical follicles)
Habitat: Little Colorado watershed; grows in **grasslands** and Great Basin **desertscrub** communities. Subtrate types range from strongly alkaline sedimentary conglomerates to volcanic cinders; 4,000-5,620 ft.



Apocynaceae (Dogbane Family)

SHRUBLAND SPECIES

Pediocactus peeblesianus var. *fickeiseniae* – Fickeisen plains cactus

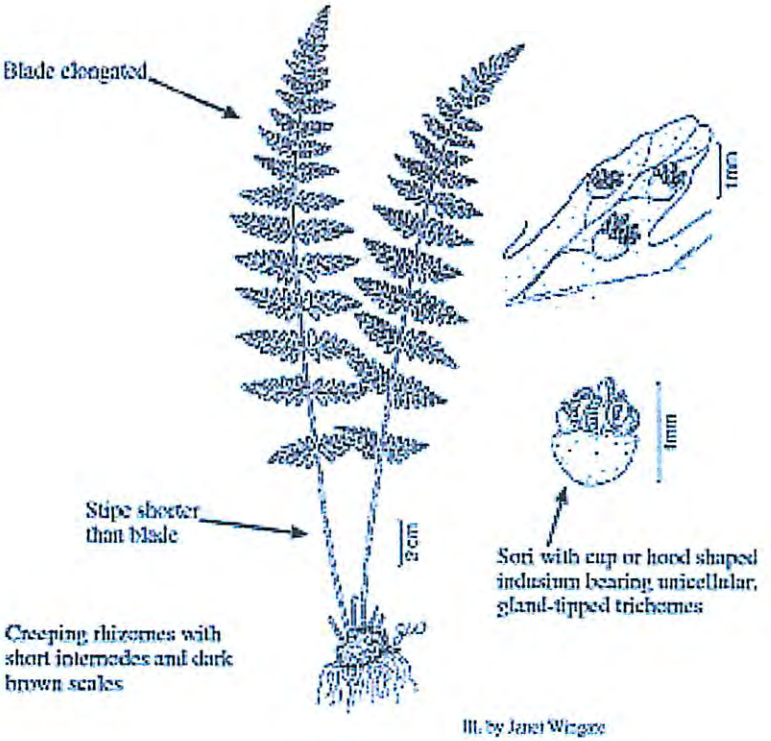


Family: Cactaceae
Synonyms: *Navajoa fickeisenii, Toumeya fickeisenii*
Status: Federal, Candidate; NN, G3

Distinguishing characteristics
Pediocactus have no ribs, cylindric to globose stems, flowers <25mm in diameter, petals white or with pink or yellow at least on the midribs; fruit, dry, green, to tan/yellow, naked or scaly. *P. p. fickeiseniae* is a solitary or clustered cactus, globose to 6 cm tall and 5.5 cm in diameter
Flowers: cream-yellow or yellowish-green, to 2.5 cm diameter, produced on the apex of the stem, petaloid perianth parts cream, yellow, or yellowish-green; outer perianth parts with pink or green midstripe; stamens yellow; stigma yellow.
Tubercles: 3-7 mm long, 4-6 mm broad
Aureoles: circular
Stems: 2.5-6 cm tall, 2-5.5 cm in diameter, spherical, usu. solitary
Central spine: **15-18 mm long, spongy,** white to pale gray, ascending, mostly 1 mm wide at base
Radial spines: 3-7, each 4-7 mm long, **spongy**, not obscuring the stem, long, white to pale gray, recurving
Fruit: top-shaped, smooth, turning reddish brown upon maturity
Blooms: April, retracts into the soil in drought
Lookalikes/Varieties: *P.p. peeblesianus* has no central spine and 4-5 radial spines. *P. simpsonii* has a smooth spine spreading at right angles to tubercles, tubercles have strait central spines, not ribbed
Habitat: gravelly limestone/gravelly loam in **desertscrub**; 4,300-5,450 ft.

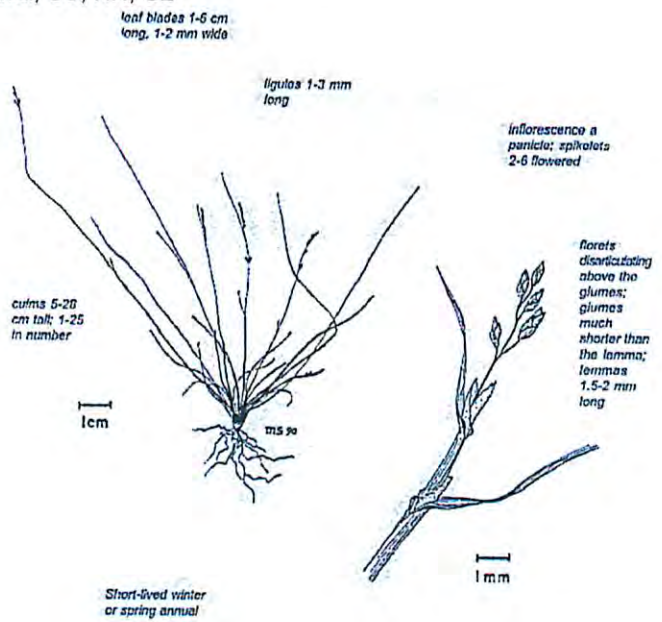
Cystopteris utahensis – Utah bladder-fern

Family: Polypodiaceae
Status: Federal, none; NN, G4



Distinguishing characteristics
Stems: creeping, not cordlike, internodes short, heavily beset with old petiole bases, hairs absent; scales lanceolate
Fronds: monomorphic, clustered at stem apex, to 45 cm, nearly all bearing sori.
Petiole: green to straw colored; blade deltate, 2 pinnate-pinnatifid, usually widest at or near the base, apex short-attenuate, rachis and costae with unicellular, gland-tipped hairs
Phenology: sporulating summer to fall
Lookalikes: *C. fragilis* does not have small glands and scaly bulblets near the tip of the frond, as wells as dark scales on the underground stem made up of cells with very thick walls
Habitat: **seepages, crack, and ledges on cliffs**; on calcareous substrates including sandstone, limestone, and dacite. On the NN, know from sandstone cracks above the streambed. 4,200-8,800 ft.

Puccinellia parishii – Parish's alkali grass
Family: Poaceae
Status: Federal, SC; NN, G2

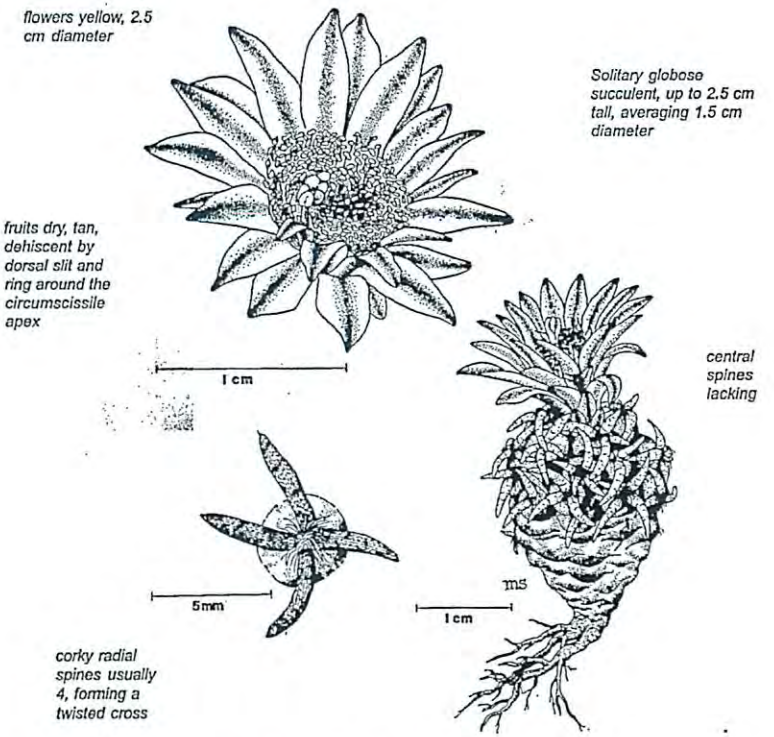


Poaceae (Grass Family)

Distinguishing characteristics
winter or spring **annual** dwarf grass, 5-28 cm tall
Leaves: blades 1-6 cm long, 1-2 mm wide; flat to slightly involute
Ligules: **1-3 mm long**
Inflorescence: narrow panicle; spikelets 2-6 flowered, 3-5 mm long
Florets: disarticulating above the glumes
Glumes: much shorter than the lemma, unequal, broad, strongly nerved, scarious margined
Lemma: 1.5-2 mm long, **pubescent on nerves only**, firm, obtuse
Culms: 5-28 cm tall; 1-25 in number
Flowers: April to May and June to September
Lookalikes: *P. fasciculata* and *P. airoides*. Both perennial; if hairy, hairs not confined to nerves of lemma; *P. fasiculata* is 20-50 cm tall (on average, taller); *P. airoides* is 15-80 cm tall (also taller, on average); *Poa annua* has boat shaped leaves
Habitat: Marhsy ground along **seeps and streams**, saline or alkaline soil forming a white crust on the ground; assoc with pinyon-juniper woodlands to desert communities, 2,950-6,070 ft.

Pediocactus peeblesianus var. ***peeblesianus*** – Navajo plains cactus
Family: Cactaceae
Status: Federal, LE; NN, none

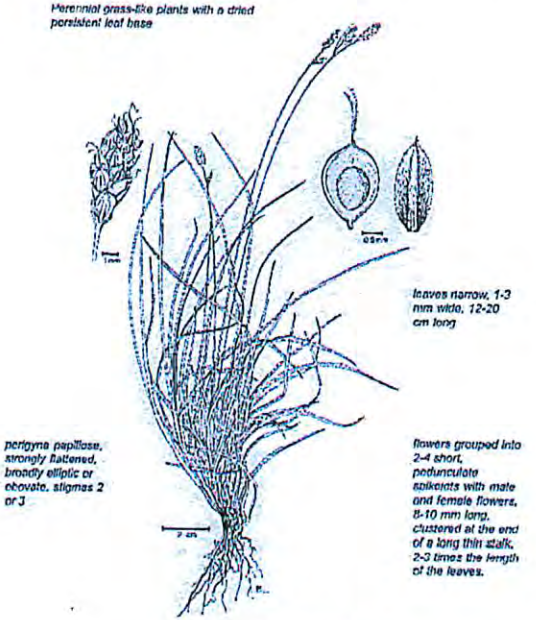
Distinguishing characteristics
Solitary globose succulent, up to 2.5 cm tall, averaging 1.5 cm diameter
Flowers: yellow, 2.5 cm in diameter
Central spines: **lacking**
Radial spines: corky, usu. 4, forming a twisted cross
Fruits: dry, tan, dehiscent by dorsal slit and ring around the circumscissile apex
Blooms: April, fruits May to June, retract during drought / dry
Lookalikes/varieties: *P. p. fickeiseniae* has a prominent central spine, more radial spiines and grows larger. See above description of *P. simpsonii*.
Habitat: low hills in **desertscrub** and grassland; 5,100-5,650 ft.



Cactaceae (Cactus Family)

***Carex specuicola* – Navajo Sedge**
Family: Cyperaceae
Status: Federal, LT; NN, G3

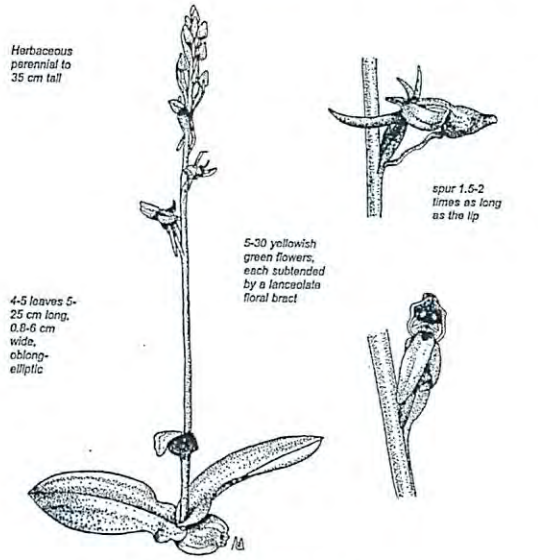
Distinguishing characteristic
Perennial grass-like plant with a dried, reddish, persistent leaf base
Styles: 2-branched with lenticular achenes and 3-branched with trigonous achenes, 2-branched style is more common
Terminal spike: usu. gynaceandrous, short peduncled or sessile
Perigynea: nerveless or finely few-nerved, strongly flattened, papillose, broadly elliptic or obovate, stigmas 2 or 3
Leaves: narrow, 1-3 mm wide, 12-20 cm long
Flowers: grouped into 2-4 short, pedunculate spikelets with male and female flowers, 8-10 mm long, clustered at the end of a long thin stalk, 2-3 times the length of the leaves. Female flowers located above male flowers
Phenology: flowering and fruit set occur from Spring to summer, most repro appears to be vegetative
Lookalikes: *C. aurea* does not have a strongly flattened perigynia or female flowers located above male flowers. *C. occidentalis* has slender, longer stems (20-70 cm); *C. geophila* has fertile stems shorter than most leaves, leaf blades 5-15 cm long (shorter)
Habitat: N. AZ, **seeps and hanging gardens**, on vertical Navajo sandstone cliffs and alcoves; 4,400-7,000 ft.



Cyperaceae (Sedge Family)

***Platanthera zothecina* – alcove bog orchid**
Family: Orchidaceae
Synonym: *Limnorchis zothecina, Habenaria zothecina*
Status: Federal, SC (species of concern); NN, G3

Distinguishing characteristics
Herbaceous perennial to 35 cm tall
Spur: 1.5-2 times as long as the lip
Inflorescence: 5-30 yellowish green flowers, each subtended by a lanceolate floral bract
Leaves: 4-5 leaves, 5-25 cm long, 0.8-6 cm wide, oblong-elliptic, appear late April to early May
Spike: develops in early June
Flowers: corolla tube, yellowish-green
Blooms: mid June-July
Capsules: mature in about one month
Lookalikes: *P. sparsiflora* has spur equal or slightly exceeding lip, less rounded basal leaves, and a less elliptic lip
Habitat: **seeps, streams, hanging gardens and wet canyon alcoves**, 5,000-9,000 ft. requires constant moisture, full to partial sun

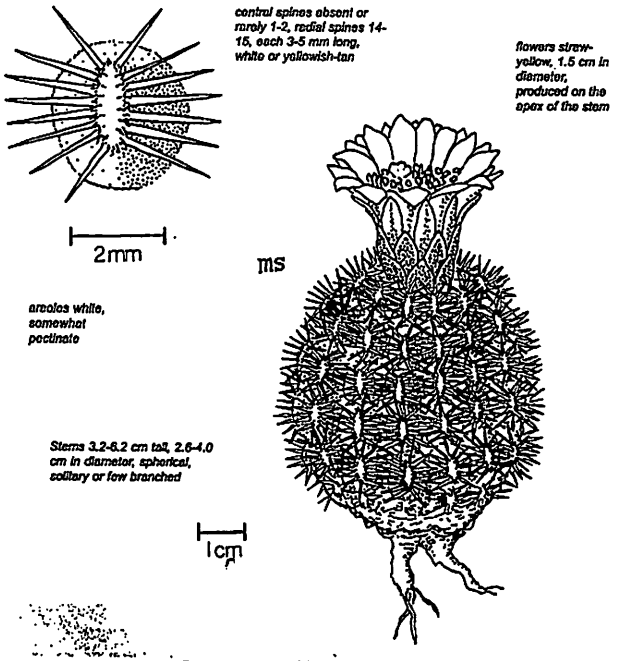


Orchidaceae (Orchid Family)

VERY UNLIKELY TO BE SEEN

***Pedicactus bradyi* – Brady pincushion cactus**
Family: Cactaceae
Synonym: *Toumeya bradyi*
Status: Federal, LE; NN, G2

Distinguishing characteristics
Pediocactus have no ribs, cylindric to globose stems, flowers <25mm in diameter, petals white or with pink or yellow at least on the midribs; fruit, dry, green, to tan/yellow, naked or scaly. *P. bradyi* is defined by unique capsule dehiscence, it is a restricted endemic to Marble Canyon
Small, semi-globose cacti, ranging from 2.5 to 5 cm in diameter
Central spines: absent or rarely 1-2
Radial spines: 14-15, each 3-5 mm long, white, yellowish-tan
Areoles: white, somewhat pectinate; vertical elongate
Stems: 3.2-6.2 cm tall, 2.6-4 cm in diameter, spherical, solitary or few-branched
Flowers: straw yellow, 1.5 cm in diameter, produced on the apex of the stem
Blooms: March to april, retracts into the soil in response to drought
Lookalikes: sim to juveniles of *Corypantha vivpara* but radial spines shorter
Habitat: Kaibab limestone chips overlaying soils derived from Moenkopi formation, 3,340-5,200 ft (very specific soil requirements). **Only grows in Marble Canyon**



Cactaceae (Cactus Family)

APPENDIX 4

Baseline Vegetation Sampling Area Photos
J28 and N10 LOM Study Areas
Kayenta Complex
2003

Photograph 29. J28 LOMCRA Sagebrush Baseline, Sample 1, Spring 2003

Photograph 30. J28 LOMCRA Sagebrush Baseline, Sample 2, Spring 2003

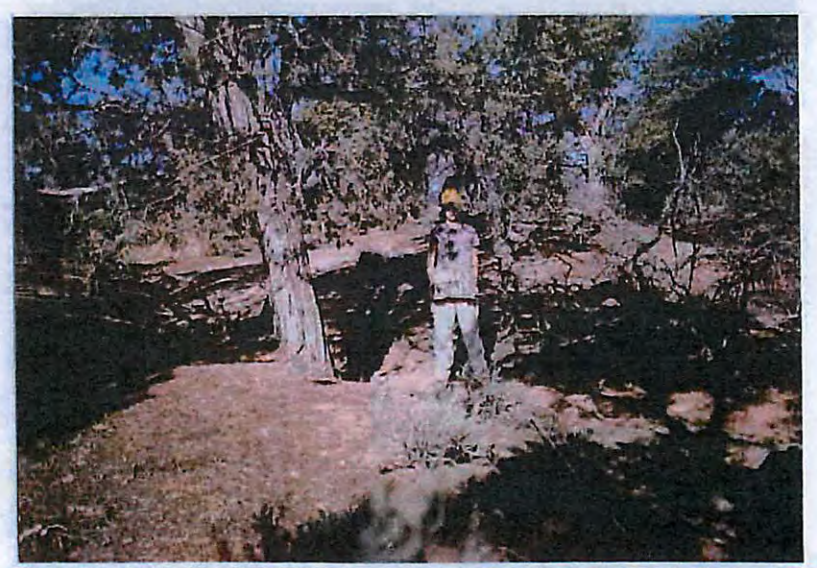
Photograph 31. J28 LOMCRA Sagebrush Baseline, Sample 3, Spring 2003

Photograph 32. J28 LOMCRA Sagebrush Baseline, Sample 5, Spring 2003

Photograph 61. J28 LOMCRA Pinyon-Juniper Baseline, Sample 1, Spring 2003

Photograph 62. J28 LOMCRA Pinyon-Juniper Baseline, Sample 2, Spring 2003

Photograph 63. J28 LOMCRA Pinyon-Juniper Baseline, Sample 4, Spring 2003



Photograph 64. J28 LOMCRA Pinyon-Juniper Baseline, Sample 5, Spring 2003

Photograph 73. N10 LOMCRA Pinyon-Juniper Baseline, Sample 1, Spring 2003

Photograph 74. N10 LOMCRA Pinyon-Juniper Baseline, Sample 2, Spring 2003

Photograph 75. N10 LOMCRA Pinyon-Juniper Baseline, Sample 3, Spring 2003

Photograph 76. N10 LOMCRA Pinyon-Juniper Baseline, Sample 4, Spring 2003

MAP 1

2003 Baseline Vegetation Sampling Map
Kayenta Complex Study Area
PWCC

Kayenta Complex - Map 1

2003 Baseline Vegetation Sampling Map
Kayenta Mine Study Area

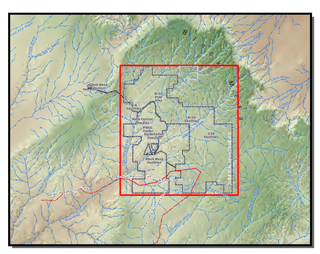
Produced by PWCC GIS

Friday, April 27, 2012

T:\Projects\Permit\Vegetation 85320\Maps\BaselineVeg LOM.mxd

1 Inch = 2000 Feet

PEABODY WESTERN COAL COMPANY
GIS
Kayenta Complex
PO Box 650
Kayenta, Arizona 86033



Pre-Vegetation Type

- Revegetated
- Mixed Conifer
- Pinyon-Juniper Woodland
- Greasewood Shrubland
- Tamarix Riparian Shrubland
- Saltbrush Shrubland
- Sagebrush Shrubland
- Disturbed

- Vegetation Sample Location
- LOM Area/Study Area
- Coal Resource Areas
- Major Drainages (mineplan version)

Administrative Boundaries

- PWCC Lease/ROW Line
- AZ-0001E Permit Line
- Navajo-Hopi Partition Line

MAP REVISIONS

CHK'D	DATE	DESCRIPTION
VP	02-24-2012	LOM Mineplan Updates

Environmental Department

Vernon Pfannenstiel
Sr. Manager - International Reclamation

Date