

Special Status Plants of the Flagstaff Area National Monuments

FINAL REPORT

by

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Table of Contents

<u>Description</u>	<u>Page</u>
List of Figures	3
List of Tables	4
Acknowledgements	5
Introduction	6
Research Questions	6
Methods	7
The Flora of Sunset Crater Volcano National Monument	8
The Flora of Walnut Canyon National Monument	9
The Flora of Wupatki National Monument	10
Map of Sunset Crater Volcano National Monument	11
Map of Walnut Canyon National Monument	12
Map of Wupatki National Monument	13
Status of special status plants	14
Status legend and definition of codes	14-15
Summary of phenologies	16
Results of 1999 surveys	17
Plants known to the Monuments	
Sunset Crater Volcano National Monument	17-18
Walnut Canyon National Monument	19-20
Wupatki National Monument	21-23
Plants not found on the Monuments	24-25
Summary of 1999 status	25
Summary of additional rare species	26
Culturally-significant plants	27
Recommendations for further research	28
Bibliography	29-30
Individual Species Accounts	
Sunset Crater Volcano National Monument	
<i>Penstemon clutei</i>	32-39
<i>Phacelia serrata</i>	40-45
Walnut Canyon National Monument	
<i>Aquilegia desertorum</i>	46-51
<i>Cimicifuga arizonica</i>	52-56
<i>Clematis hirsutissima</i> var. <i>arizonica</i>	57-61
<i>Erigeron saxatilis</i>	62-66
<i>Hedeoma diffusa</i>	67-71
Wupatki National Monument	
<i>Amsonia peeblesii</i>	72-78
<i>Astragalus lentiginosus</i> var. <i>ambiguus</i>	79-81
<i>Camissonia specuicola</i> ssp. <i>hesperia</i>	82-85
<i>Cymopterus megacephalus</i>	86-88
<i>Errazurizia rotundata</i>	89-93
<i>Pediocactus peeblesianus</i> var. <i>fickeiseniae</i>	94-98
<i>Pediocactus simpsonii</i>	99-103
<i>Phacelia welshii</i>	104-108
<i>Psoralea thompsonae</i> var. <i>whitingii</i>	109-113
<i>Puccinellia parishii</i>	114-118
Photo Appendix	119-124

List of Figures

<u>Figure Description</u>	<u>Page</u>
Front cover, Tobacco at Crack-In-Rock Ruin	
Photo, Sunset Crater Volcano National Monument	8
Photos, Walnut Canyon National Monument	9
Photo, Wupatki Ruin, Wupatki National Monument	10
Map of Sunset Crater Volcano National Monument	11
Map of Walnut Canyon National Monument	12
Map of Wupatki National Monument	13
Map of rare plant species locations, Sunset Crater Volcano National Monument	18
Map of rare plant species locations, Walnut Canyon National Monument	20
Map of rare plant species locations, Wupatki National Monument	23
Photo, <i>Amsonia peeblesii</i>	31
<i>Penstemon clutei</i> , line drawing	38
Rare plant species abundance, <i>Penstemon clutei</i> , Sunset Crater Volcano National Monument	39
Rare plant species abundance, <i>Phacelia serrata</i> , Sunset Crater Volcano National Monument	44
Rare plant species abundance, <i>Phacelia serrata</i> , Wupatki National Monument	45
<i>Aquilegia desertorum</i> , line drawing	50
Rare plant species abundance, <i>Aquilegia desertorum</i> , Walnut Canyon National Monument	51
<i>Cimicifuga arizonica</i> , line drawing	56
<i>Clematis hirsutissima</i> var. <i>arizonica</i> , line drawing	61
<i>Erigeron saxatilis</i> , line drawing	65
Rare plant species abundance, <i>Erigeron saxatilis</i> , Walnut Canyon National Monument	66
<i>Hedeoma diffusa</i> , line drawing	71
<i>Amsonia peeblesii</i> , line drawing	77
Rare plant species abundance, <i>Amsonia peeblesii</i> , Wupatki National Monument	78
<i>Camissonia specuicola</i> ssp. <i>specuicola</i> , line drawing	85
<i>Errazurizia rotundata</i> , line drawing	92
Rare plant species historic locations, <i>Errazurizia rotundata</i> , Wupatki National Monument	93
<i>Pediocactus peeblesianus</i> var. <i>fickeiseniae</i> , line drawing	98
Rare plant species historic locations, <i>Pediocactus simpsonii</i> , Wupatki National Monument	103
<i>Phacelia welshii</i> , line drawing	108
<i>Psoralea thompsoniae</i> var. <i>whitingii</i> , line drawing	112
Rare plant species abundance, <i>Psoralea thompsoniae</i> var. <i>whitingii</i> , Wupatki Nat'l Mon.	113
<i>Puccinellia parishii</i> , line drawing	118
Photo, 1999 Field team	119
Photos, Herbarium sheets of special status plants	120-124

List of Tables

<u>Table Description</u>	<u>Page</u>
Table 1. Status of special category plants of the Flagstaff Area Monuments, Arizona	14
Table 2. Status legend and definition of codes	14-15
Table 3. Summary of phenologies	16
Table 4. Summary of 1999 status	25

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Introduction

The Flagstaff Area National Monuments are comprised of three national monuments located in northern Arizona. These monuments (Wupatki, Sunset Crater Volcano, and Walnut Canyon) represent very diverse habitats including cold desert scrub, grassland, ponderosa pine forests, lava fields, and shaded Douglas fir side canyons. The monuments were combined to form a single administrative unit in 1990, with headquarters for the three areas located in the City of Flagstaff.

The Flagstaff Area National Monuments is continuing the General Management Planning process that includes the VERP (Visitor Experience and Resource Protection) process. VERP includes the identification of visitor use zones. Information concerning sensitive resources is vital for proper identification of activities allowed in these zones. Much of the information concerning sensitive natural resources is missing, incomplete or has never been collected. Furthermore, a recent act established by Congress, the National Parks Omnibus Management Act, has identified the need for inventory and monitoring of resources within National Parks.

Although special status plants occur within the boundaries of National Monuments, threats to their populations still exist. One of the biggest concerns regarding the special status plants is harvesting of them within monument boundaries. Often the only remaining populations of significant size are found in protected areas. Other significant threats to rare plants are habitat displacement, whether by human interference, animal disturbance, construction of new buildings, roads, and trails, or non-native plant invasions.

Research questions and concerns

Surveying and mapping of special category plant species is difficult and sensitive. They can have sparse distributions making them difficult to locate and they often live in extremely sensitive habitats that are best left undisturbed (Travis and Sutter, 1986). Most rare plant studies have been observational, describing the distribution, abundance and status of plants. However, some species have been studied experimentally (Kolb & Maschinski, 1996).

Most of the 17 special category plant species that were investigated in the scope of this study are known by observational studies. During 1999, experimental data was not collected on the special status plants. Instead, several previously-known and newly-recorded populations were noted and mapped by the field crew. Although in need of more study, special status plants that are culturally-significant were investigated as well.

The objective of this research was to complete the special status plant survey at the Flagstaff Area National Monuments to provide baseline data on their occurrence and abundance. These data will be used in the future to shape management of the sensitive plant resources within the monuments. During the course of this study, many questions were considered regarding the approach for surveying the special category plants of Flagstaff's National Monuments. The results of these questions are discussed briefly in this introductory chapter and in detail in the individual species accounts.

Questions that were addressed include:

1. Where are the major populations of these plants?
2. What plants are the most threatened and rare on the monuments?
3. Which species should be monitored in the future? Should high use areas be the priority areas for monitoring?
4. Where have the plants been found historically?
5. What plants on the search list do not occur in the monuments?
6. What is the ethnobotanical significance of the special category plants?

Methods

The first segment of this botanical survey was a complete literature review that consolidated all research on the 17 special category plant species. Historical plant locality information was gathered in 1997 by Hogan and Huisinga from various sources including the National Park Service, United States Forest Service, Arizona Game & Fish Heritage Database Management System and the herbaria at state universities, the Museum of Northern Arizona, and Walnut Canyon and Wupatki National Monuments. All information is contained in a report that was submitted to the National Park Service Flagstaff Area Headquarters (Hogan & Huisinga, 1997).

Secondly, a research plan for the field survey was designed using information from the literature and herbaria searches. Known locations of the plants were revisited in 1999 from April to October to determine if the plants still existed. Relocating previously-known populations of the special status plant species was the most efficient method of assessing and mapping their present populations. Each site was characterized by its abundance and population size, habitat, slope, substrate type, health, potential threats, dominant species and associated species. A search around each historic plant locality was made (approx. 1/4 mile) to estimate the population size at each site. At each site, a Global Positional System (GPS) was used to record accurate locations. The GPS data was downloaded onto the National Park Service Headquarters computer and coordinates were differentially corrected. These data were then imported into ArcView and maps showing plant populations were designed and included in the final report. All plant information was incorporated into the Flagstaff Area Geographical Information System (GIS) database.



The Flora of Sunset Crater Volcano National Monument

In 1930, President Herbert Hoover established Sunset Crater Volcano National Monument to preserve and protect the geological formations, features, and resources for scientific interests and research, and for public interest including scenic, educational, and recreational pursuits. Sunset Crater Volcano is one of the most recent volcanic eruptions known in historic time, erupting last from 1064-1071 A.D. The vegetation that has colonized subsequently includes four dominant tree species, ponderosa pine, limber pine, juniper and piñon pine. Many other shrubs and grasses dominate the understory including gooseberry, Apache plume, stickleaf, skyrocket gilia, rice grass, grama grass and little bluestem (Eggler, 1966). Elevations within the monument range from 7200-7500 feet (McDougall, 1962). The climate and microhabitats of Sunset Crater Volcano allow for an unusual mix of organisms ranging from lichens and molds to highly endemic species such as Sunset Crater beardtongue. This exemplifies the succession and adaptation that has occurred at Sunset Crater since its eruption (Eggler, 1966).



The Flora of Walnut Canyon National Monument

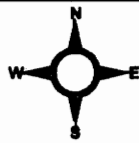
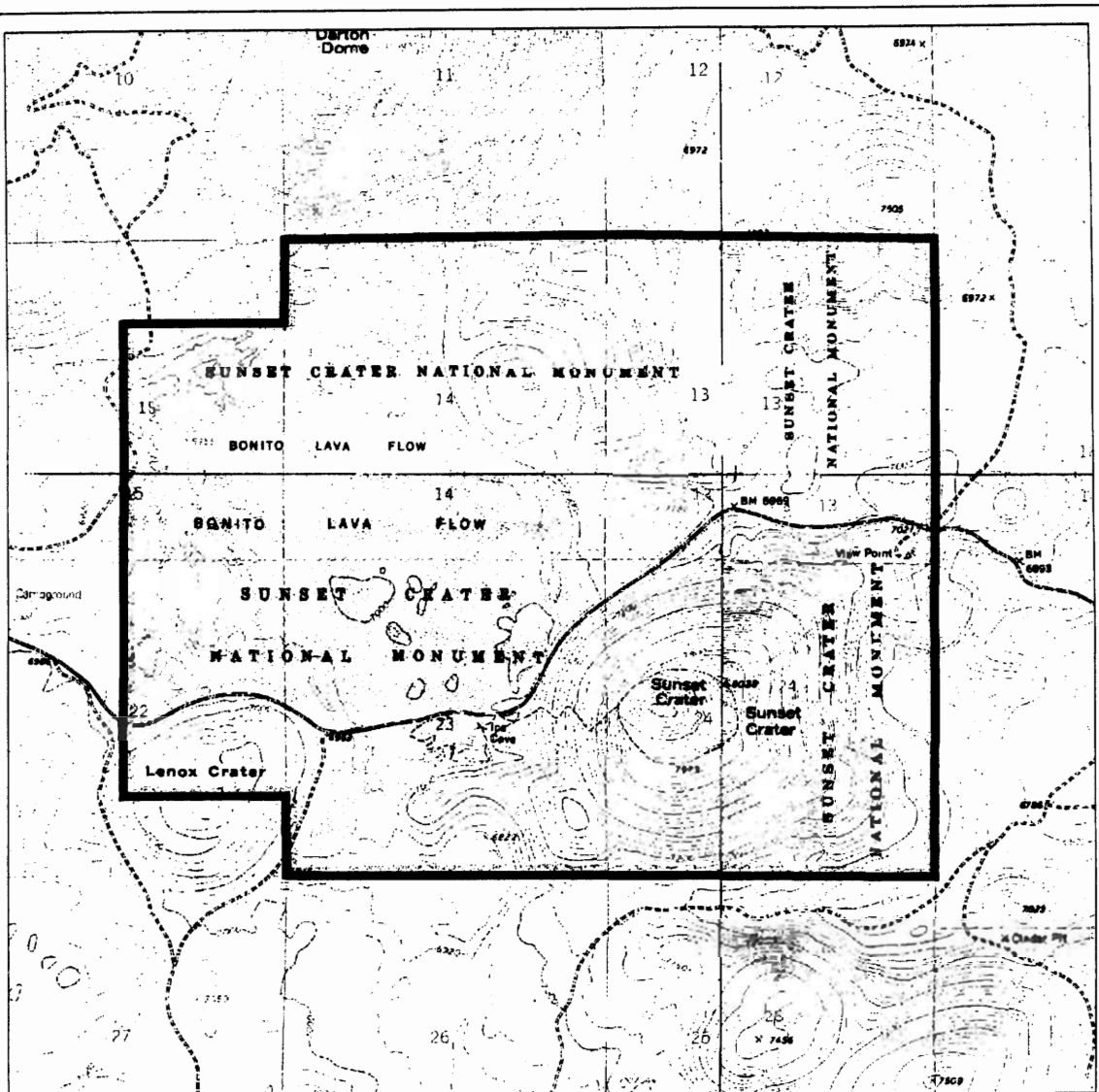
In 1915, Walnut Canyon National Monument was established to preserve and protect several Sinagua archaeological sites. Its vegetation communities include ponderosa pine and piñon-juniper forests on the rim with moist mixed conifer forests and riparian areas on the canyon slopes and bottom. Joyce (1976) notes that the transition between vegetation types is abrupt and sharp leaving very few zones of transition. In addition, north- and south-facing slopes are drastically different in their botanical composition. South-facing slopes support species that are adapted to dry, sunny conditions such as piñon pine, juniper, saltbush, sagebrush and cacti. North-facing slopes support species that require moist, shady conditions including douglas fir, ferns, and elderberry. A wide variety of microclimates are found in Walnut Canyon that are conducive to the growth of rare and unusual species such as desert columbine. By compiling previous checklists for the Monument, Jenkins et al. (1991) reported over 285 species of native plants and 21 species of exotic plants existing within Walnut Canyon National Monument.



The Flora of Wupatki National Monument

In 1924, President Calvin Coolidge established Wupatki National Monument which lies on the south side of the lower western region of the Little Colorado River (LCR). The LCR valley is a fascinating region that is not only botanically and geologically astonishing, but once was part of a prehistoric trade route from Mexico. Within the protected boundaries of the Monument exist more than 2668 prehistoric sites and historic Navajo sites. Growing in direct association to many of the dominant sites are rare and endangered species that have cultural significance to the Hopi and Navajo. Some of these may even be remnant plants that were important prehistorically.

The vegetation found at Wupatki National Monument is a mix of piñon-juniper woodland, desert grassland and riparian habitats. The woodlands are not dominant but a few individual piñon and juniper trees are found scattered in cooler areas such as canyons and north-facing slopes. Shrubs such as four-wing saltbush, Mormon tea, blackbrush, cliffrose, and Apache plume are common in the higher open areas. Lower in elevation, grasses dominate the landscape. Common grass species at the Monument include gramma grass, three awn, galleta grass, rice grass, dropseed and needle and thread. The riparian area along the Little Colorado River is dominated by tamarisk but a variety of herbs and shrubs can be found. Elevations within the Monument range from 4000-5700 feet (McDougall, 1962). Rominger documented 240 species of plants at Wupatki National Monument and at least 122 of these may have cultural significance.



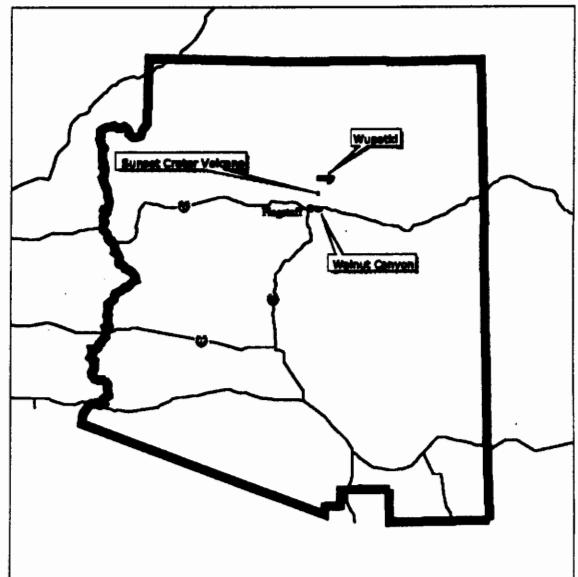
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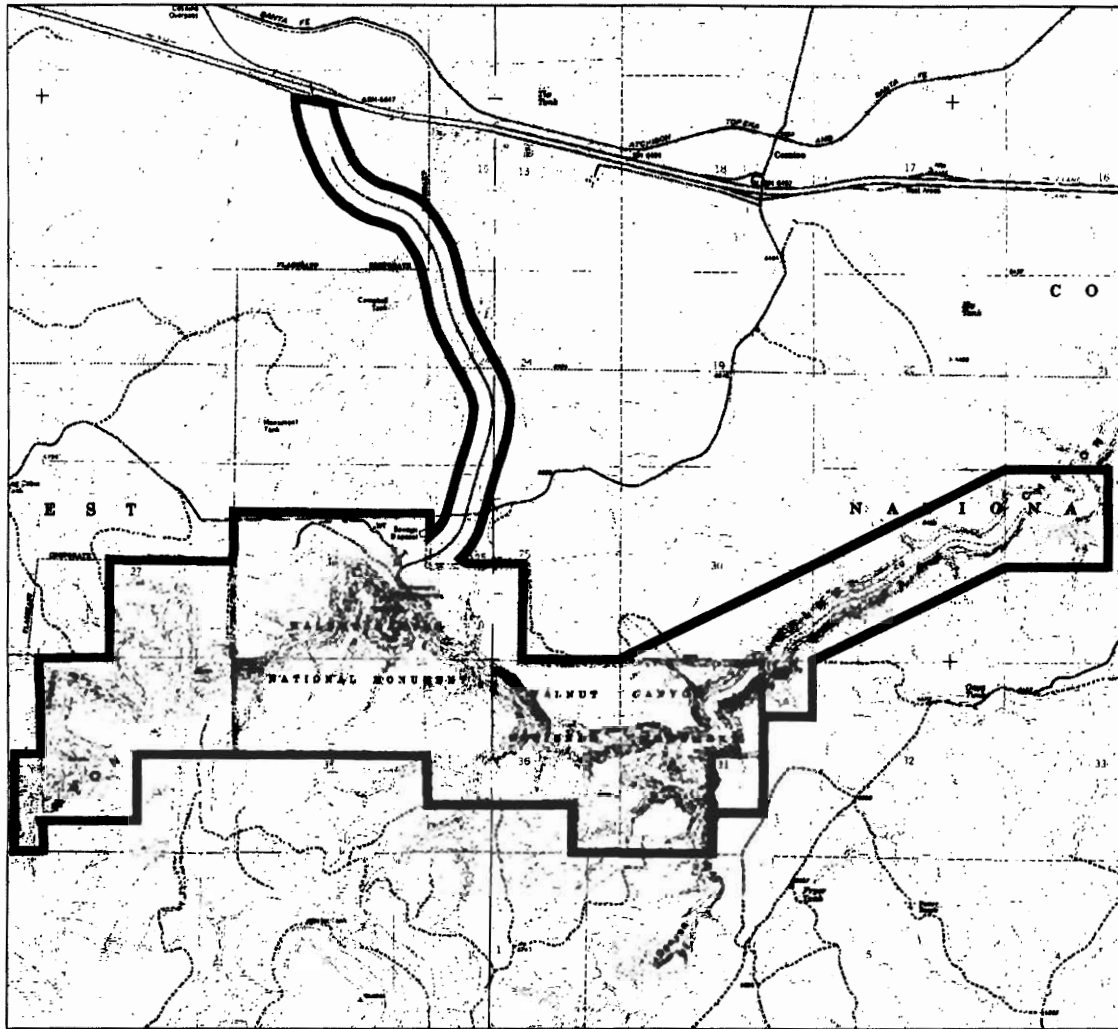


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Sunset Crater Volcano National Monument





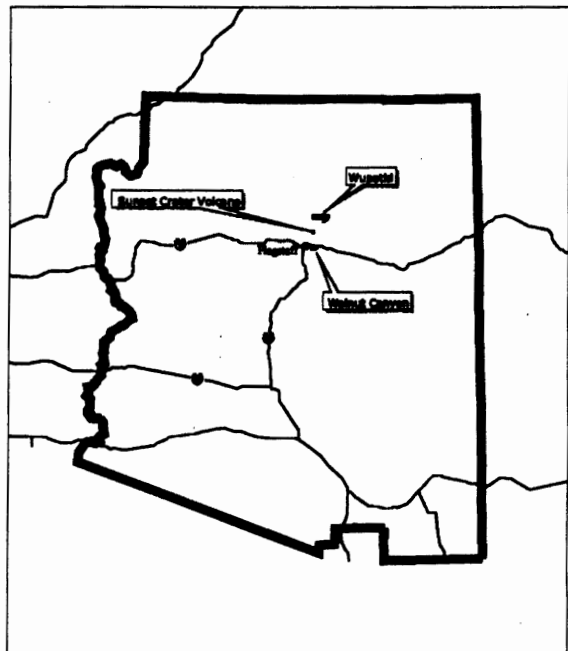
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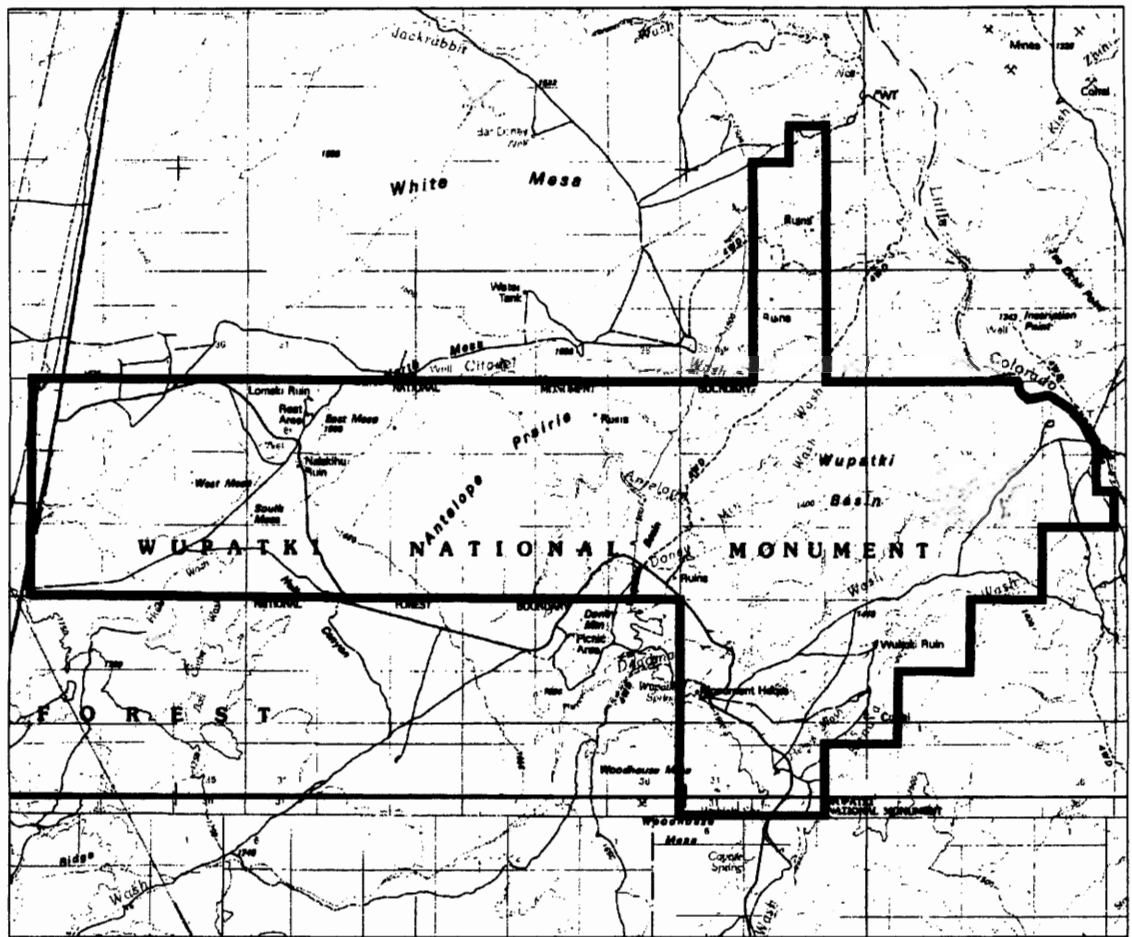


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Walnut Canyon National Monument





2 0 2 4 Kilometers

2 0 2 4 Miles

Wupatki National Monument

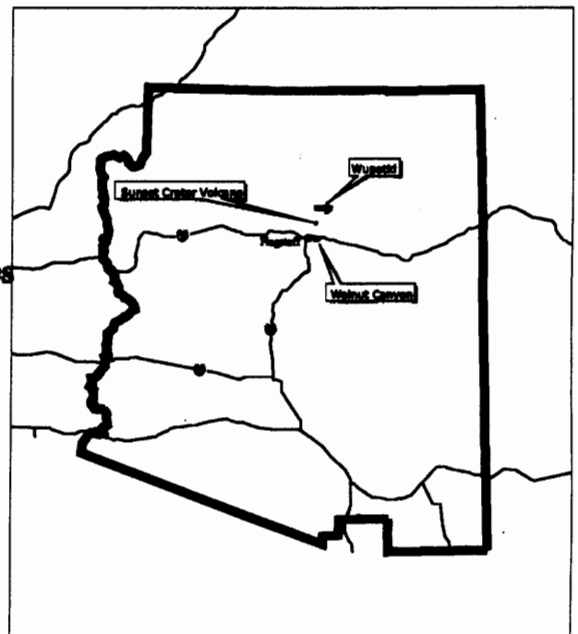


**Table 1. Status of special category plants of the Flagstaff Monuments, Arizona
(from AGFD, 1998)**

Sensitive plant species	ESA¹	USFS²	NESL³	ANPL⁴	GRank⁵	SRank⁶
<i>Amsonia peeblesii</i>	None	None	None	None	G3	S3
<i>Aquilegia desertorum</i>	None	S	4	SR	G4	S4
<i>Astragalus lentiginosus</i> var. <i>ambiguus</i>	SC	None	None	None	G5T1	S1
<i>Camissonia specuicola</i> ssp. <i>hesperia</i>	SC	None	None	None	G2T1	S1
<i>Cimicifuga arizonica</i>	C	S	None	HS	G2	S2
<i>Clematis hirsutissima</i> var. <i>arizonica</i>	C	S	4	HS	G4T2Q	S1
<i>Cymopterus megacephalus</i>	SC	None	None	None	G2G3	S2S3
<i>Erigeron saxatilis</i>	None	S	None	None	G2	S2
<i>Errazurizia rotundata</i>	None	None	4	SR	G4	S3
<i>Hedeoma diffusa</i>	None	S	4	SR	G3	S3
<i>Pediocactus peeblesianus</i> var. <i>fickeiseniae</i>	C	S	3	HS	G2T2	S2
<i>Pediocactus simpsonii</i>	None	None	None	SR	G4	S1
<i>Penstemon clutei</i>	SC	S	None	SR	G2	S2
<i>Phacelia serrata</i>	SC	None	None	None	G2?	S2
<i>Phacelia welshii</i>	SC	S	4	None	G3	S2
<i>Psoralea thompsoniae</i> var. <i>whitingi</i>	C2	S	None	?	?	?
<i>Puccinellia parishii</i>	PE	None	2	HS	G2	S1

Table 2. Status Legend and Definition of Codes

1 = Endangered Species Act (ESA), 1973 as amended

- LE: Listed Endangered: imminent jeopardy of extinction
- LT: Listed Threatened: imminent jeopardy of becoming Endangered
- C: Candidate
- SC: Species of Concern (or Species at Risk)
- PE: Proposed Endangered
- PT: Proposed Threatened

2 = US Forest Service, Region 3 (USFS), 1990

- S: Sensitive

3 = Navajo Endangered Species List (NESL), 1994

- 1: Species of subspecies that no longer occur on the Navajo Nation
- 2: Any species of subspecies which is in danger of being eliminated from all or a significant portion of its range on the Navajo Nation
- 3: Any species or subspecies which is likely to become an endangered species, within the foreseeable future, throughout all or a significant portion of its range on the Navajo Nation.
- 4: Any species or subspecies for which the Navajo Fish and Wildlife Department (NF&WD) does not currently have sufficient information to support their being listed in Group 2 or Group 3 but has reason to consider them.

4 = Arizona Native Plant Law (ANPL), 1993, Arizona Department of Agriculture

- HS Highly Safeguarded: no collection allowed.
- SR Salvage Restricted: collection only with permit
- ER: Export Restricted: transport out of State prohibited
- SA: Salvage Assessed: permits required to remove live trees
- HR: Harvest Restricted: permits required to remove plant by-products

5=Global Ranking (GRank)

- G1: Very rare: 1-5 occurrences or very few individuals or acres; critically imperiled globally because of rarity or because of some factor of its biology making it especially vulnerable to extinction
- G2: Rare: 6-20 occurrences or few individuals or acres; imperiled globally because of rarity or because of other factors making it very vulnerable to extinction throughout its range
- G3: Uncommon or restricted: 21-100 occurrences, either very rare and local throughout its range or found locally in a restricted range, or because of other factors making it vulnerable to extinction throughout its range
- G4: Apparently secure: more than 100 occurrences, though it could be quite rare in some parts of its range;
- G5: Demonstrably secure: more than 100 occurrences; though it may be quite rare in parts of its range, especially at the periphery
- G#T#: Subspecies: numeric designations based on same criteria as those for global ranks
- G#?: Uncertain: insufficient information to give a definitive ranking. Confidence of numeric rank is plus or minus one rank
- G#Q: Taxonomic question: taxonomic status is questionable & numeric rank may change with taxonomy

6=State Ranking (SRank)

- S1: Very rare: 1-5 occurrences or very few individuals or acres; critically imperiled within the state because of rarity or because of some factor of its biology making it especially vulnerable to extinction
- S2: Rare: 6-20 occurrences or few individuals or acres; imperiled within the state because of rarity or because of other factors making it very vulnerable to extinction throughout its range
- S3: Uncommon or restricted: 21-100 occurrences, either very rare and local throughout its range or found locally in a restricted range, or because of other factors making it vulnerable to extinction throughout its range
- S4: Apparently secure: more than 100 occurrences, though it could be quite rare in some parts of its range;
- S5: Demonstrably secure: more than 100 occurrences; though it may be quite rare in parts of its range, especially at the periphery
- S#T#: Subspecies: numeric designations based on same criteria as those for state ranks
- S#?: Uncertain: insufficient information to give a definitive ranking. Confidence of numeric rank is plus or minus one rank
- S#Q: Taxonomic question: taxonomic status is questionable & numeric rank may change with taxonomy

Table 3. Summary of Phenologies

Latin Name	Flowers	Fruits
<i>Amsonia peeblesii</i>	Apr-Jun	May-Jun
<i>Aquilegia desertorum</i>	Jul	Jul-Sep
<i>Astragalus lentiginosus</i> var. <i>ambiguus</i>	Apr-May	Jun
<i>Camissonia specuicola</i> ssp. <i>hesperia</i>	Apr-May	May
<i>Cimicifuga arizonica</i>	Jul-Aug	Aug-Sep
<i>Clematis hirsutissima</i> var. <i>arizonica</i>	Apr-Jun	Jul-Sep
<i>Cymopterus megacephalus</i>	Apr-Jun	Jun
<i>Erigeron saxatilis</i>	Apr-Jul	Sep-Oct
<i>Errazurizia rotundata</i>	Apr-May	May
<i>Hedeoma diffusa</i>	May-Aug	Aug
<i>Pedlocactus peeblesianus</i> var. <i>fickeiseniae</i>	Apr-May	May-Jun
<i>Pediocactus simpsonii</i>	Apr-May	May-Jul
<i>Penstemon clutei</i>	Jun-Aug	Aug-Sep
<i>Phacelia serrata</i>	Jun-Sep	Sep
<i>Phacelia welshii</i>	May-Jun	Jun
<i>Psoralea thompsoniae</i> var. <i>whitingi</i>	May-Aug	Aug
<i>Puccinellia parishii</i>	Apr-May	May

Results of the 1999 Surveys

The results of the 1999 special category plant survey are briefly discussed here. Additional information can be found in the individual species accounts that are included in this document. In addition to the species that were on the search list, a few species that are culturally-significant and the species that are rare to the monuments are included. All plants are discussed in greater detail in the individual species accounts.

Maps of the three monuments show all of the plants that occur within the boundaries. Note that a distinction was made between the localities that were recorded in 1999 and those that were localities from the AZ Game & Fish Heritage Database. Some of the species were not found in 1999 and are mapped by historical localities (*Errazurizia rotundata*, *Pediocactus simpsonii*.)

Species that are known to occur in Flagstaff's National Monuments

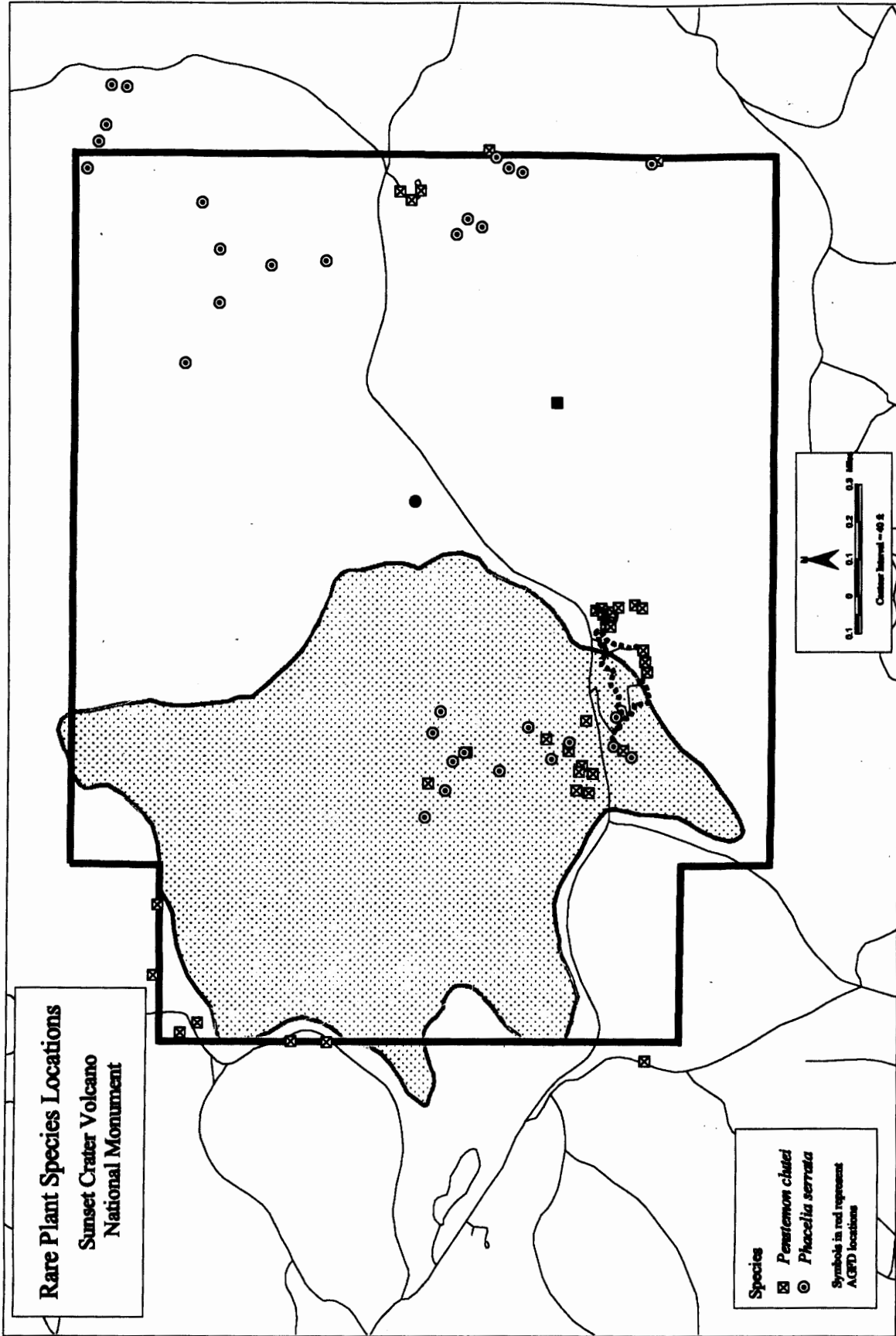
A. Sunset Crater Volcano National Monument

Penstemon clutei

Several localities of this species were mapped within Sunset Crater Volcano National Monument in 1999. Although it was previously known in this area (from Bateman, 1980), many of the populations were not previously recorded using a GPS. Most of the area at the monument was surveyed and numerous localities are represented on the map as point localities.

Phacelia serrata

Several localities of this species were recorded within Sunset Crater Volcano National Monument in 1999. Although it was previously known in this area (from Bateman, 1980), many of the populations were not previously recorded using a GPS.



B. Walnut Canyon National Monument

Aquilegia desertorum

Five distinct localities of this species were recorded and mapped within Walnut Canyon National Monument. According to Park records, it had not been previously recorded as occurring here although it occurs in Walnut Canyon in locations outside of the monument boundaries.

Anthericum torreyi

This species was first recorded by our field team in Walnut Canyon National Monument in 1999. It has not been previously collected there and it does not appear on any of Walnut Canyon National Monument's checklists of plants. It was observed in the ponderosa pine forest and is probably abundant within the monument.

Erigeron saxatilis

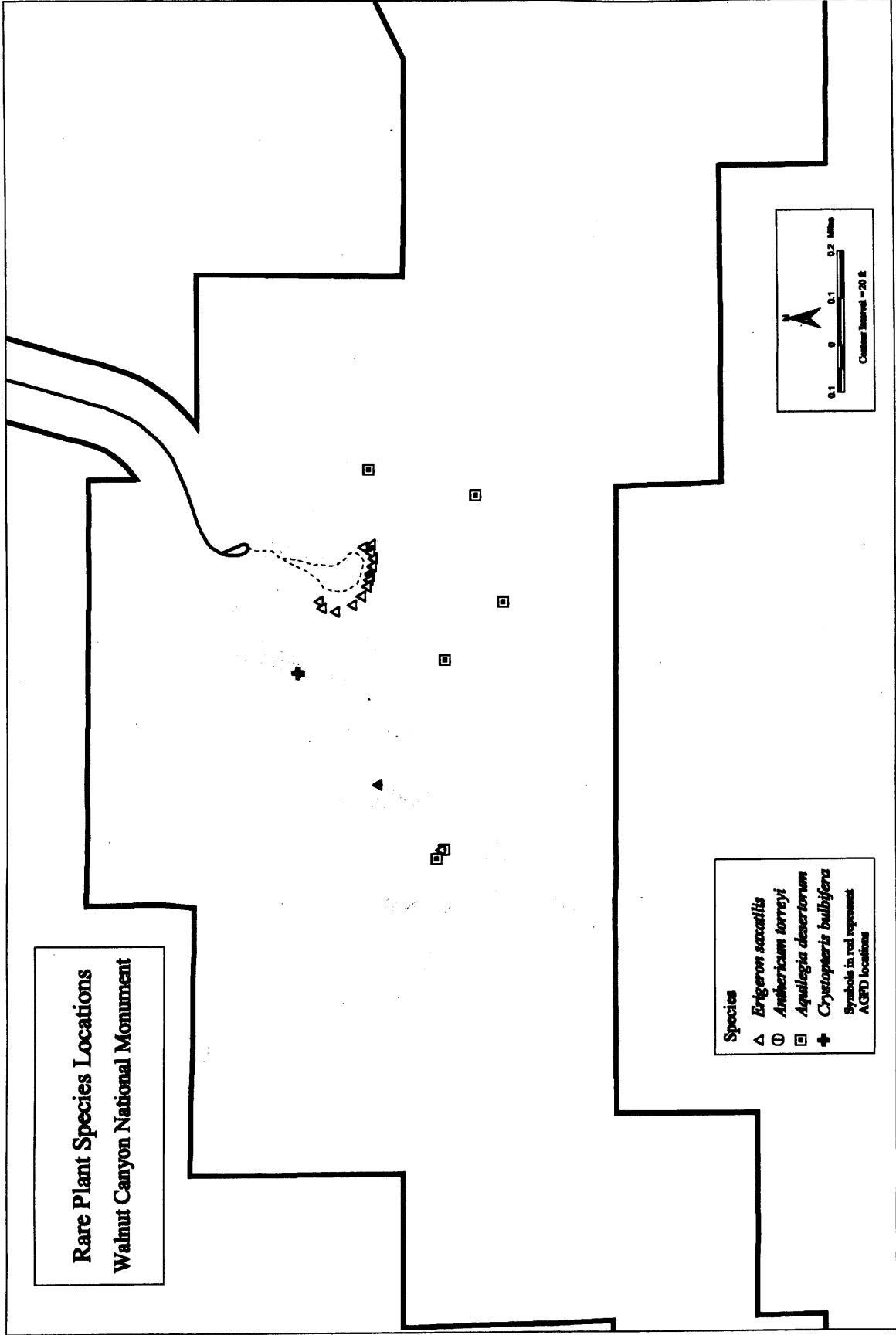
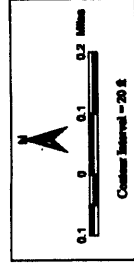
Several localities of this species were relocated within the Walnut Canyon National Monument. Approximately 50 individuals were found below the heavily-traveled Island Trail in Walnut Canyon. One other locality near the western boundary of the monument was found with over 15 individuals. Both localities are remote and appear to be safe from disturbance.

Hieracium fendleri

This species was first recorded by our field team in Walnut Canyon National Monument in 1999. It has not been previously collected there and it does not appear on any of Walnut Canyon National Monument's checklists of plants. It was observed in the ponderosa pine forest and is probably abundant within the monument. It was not mapped in 1999 because of its probable abundance.

Rare Plant Species Locations Walnut Canyon National Monument

- Species**
- △ *Erigeron saxatilis*
 - ⊙ *Anthericum torreyi*
 - *Aquilegia desertorum*
 - ⊕ *Cryptantha bulbifera*
- Symbols in red represent
AGFD locations



C. Wupatki National Monument

Amsonia peeblesii

This species is found abundantly in localized, scattered populations throughout Wupatki National Monument. Extensive progress was made in mapping this species and many new localities were found by our field team. They are shown on the map.

Localities that were first recorded in 1999 include:

Crack-In-Rock Ruin area between Horseshoe and Middle Mesas
Along the road to Crack-In-Rock Ruin (3 individual locations)

Chilopsis linearis

This species does not occur on the monument but it is rare to this area. It is found only 1/4 mile south of the southern boundary of Wupatki National Monument. The occurrence of this species in this area is puzzling because it is usually found near waterways and in clumps. There is only one tree growing in the middle of a dry, open area. Its presence may be an indication of an historic spring. According to Hogan, this could be an historic Cohonina site because they were known to use *Chilopsis* and *Yucca* for baskets.

Echinocactus polycephalus

This cactus is found abundantly along the Colorado River and has been sited in scattered areas of Wupatki National Monument. It appears to be rare to the monument and surveys to map its abundance and distribution should be conducted in future field seasons. It was not mapped in 1999 but was observed at Crack-In-Rock Ruin.

Juglans major

This species is rare to Wupatki National Monument. Only one tree is known to occur within the Monument near archaeological site #S747 in Deadman Wash. Other interesting culturally-utilized species that occur nearby this locality are *Brickellia* sp. (medicine and ceremony), *Oryzopsis hymenoides* (food), *Atriplex canescens* (food), and *Datura meteloides* (ceremony and medicine).

Phacelia serrata

In 1999, this species was mapped at Wupatki National Monument near its historic locality and at several localities within Sunset Crater Volcano National Monument including the ones near Doney Mountain.

Phacelia welshii

The 1999 field crew did not find this species at Wupatki National Monument before it had flowered and died.

Phragmites communis

This species is rare to Wupatki National Monument and was mapped at Heiser Spring. It is typically found in wet areas and is very abundant along the Colorado River in the Grand Canyon. This is a very important symbolic and ceremonial plant to the Hopi. There is evidence that it has been recently collected at this site.

Poliomintha incana

This species is rare at Wupatki National Monument and was mapped at Heiser Spring. It is abundant in a local area in several places throughout the monument although it was not mapped extensively in 1999. This is an important plant to the Navajo medicinally, ceremonially and for food.

Psoralea thompsoniae* var. *whitingii

One large population on the west side of the road leading to the Little Colorado River was recorded on the Monument using GPS. Over 300 plants were located on dry ridgetops and sandy slopes in this area. An area of similar habitat on the east side of the road to the river was searched but no plants were found. Another area where this species is abundant is across the Little Colorado River on the Navajo Nation just north of its locality in the Monument. This plant is important to the Hopi ceremonially and for food.

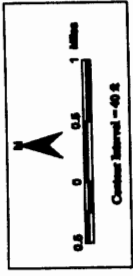
Rare Plant Species Locations Wupatki National Monument

Historic Location
Pediocactus simpsonii

Historic Location
Pediocactus simpsonii

Historic Location
Eriogonum reticulatum

- Species**
- *Anemone peeblesii*
 - ◆ *Chilopsis linearis*
 - ★ *Juglans major*
 - ⊠ *Pediocactus simpsonii*
 - ⊙ *Phacelia serrata*
 - ▲ *Phacelia communis*
 - ✱ *Pollinidra incana*
 - ⊖ *Psoralea thompsoniae*
 - ⊙ *var. whitneyi*
 - *Astragalus lanceolatus*
- Symbols in red represent
AGFD locations



Species that are not known to occur in Flagstaff's National Monuments

Species that were suspected to occur within Flagstaff's National Monuments were investigated during this study. Although they were not located, some of them may be found on or adjacent to the monuments in future surveys. Additional notes are included regarding their potential occurrence within the monuments.

Walnut Canyon National Monument

Cimicifuga arizonica

This species probably does not occur in Walnut Canyon National Monument although it is found abundantly in other canyons in the Mogollon Rim area.

Clematis hirsutissima* var. *arizonica

It is likely that this species occurs within Walnut Canyon National Monument although it has not been observed there. The abundance of shady habitat on limestone substrate is ideal for the colonization of this species.

Cryptopteris bulbifera

This species was not found in the monument although the AZ Game & Fish Heritage Database has a record of its occurrence here.

Hedeoma diffusa

It is likely that this species occurs within Walnut Canyon National Monument although it has not been observed there. It is found at nearby locations in the ponderosa pine forest.

Wupatki National Monument

Camissonia specuicola* ssp. *hesperia

This species was not found within Wupatki National Monument. It is unlikely that it occurs here because of it is currently known only from the Grand Canyon at lower elevations than occur at the monument.

Cymopterus megacephalus

Cymopterus megacephalus was not observed in Wupatki National Monument. It is likely that this species grows on the monument because of its nearby locality at Spiderweb Ranch. In addition, it is found in gravelly places of which there are an abundance along the Little Colorado River.

Errazurizia rotundata

This plant was not relocated in 1999. An historic collection by L.T. Green III in 1977 was documented in Section 8 within Wupatki National Monument. A return visit to this exact locality with L.T. Green III in 1997 revealed that the plant had disappeared since it was first seen there in 1977.

Pediocactus peeblesianus* var. *fickeiseniae

This variety of *Pediocactus* was not found at Wupatki National Monument during the 1999 field season. However, it is likely that this species occurs in the high desert of the Monument because other localities of this variety occur in this vicinity along the Little Colorado River near Cameron.

Pediocactus simpsonii

This species of *Pediocactus* was not found at Wupatki National Monument during the 1999 field season. One plant was located in Antelope Prairie at Wupatki National Monument in 1976 by L.T. Green, III. This site and one near Lomaki Ruin were revisited in 1999 with L.T. Green, III but the plants were not relocated. They may have already retracted into the soil or stolen from the sites. It is recommended that no collection of this species be allowed.

Puccinellia parishii

This species was not found within Wupatki National Monument. It seems likely that it may be found in this area because of its nearby populations in Tuba City. This species is extremely inconspicuous and short-lived. Searches should be concentrated in the appropriate season by experienced botanists.

Table 4. Summary of 1999 status

There were 17 species on the search list for the 1999 field season. Six of the 17 species were located within Flagstaff's National Monuments.

<u>Correct species names with authorities</u>	<u>Monument</u>	<u>Found in 1999?</u>
<i>Amsonia peeblesii</i>	WUPA	Yes
<i>Aquilegia desertorum</i>	WACA	Yes
<i>Astragalus lentiginosus</i> var. <i>ambiguus</i>	WUPA	No
<i>Camissonia speculicola</i> ssp. <i>hesperia</i>	WUPA	No
<i>Cimicifuga arizonica</i>	WACA	No
<i>Clematis hirsutissima</i> var. <i>arizonica</i>	WACA	No
<i>Cymopterus megacephalus</i>	WUPA	No
<i>Erigeron saxatilis</i>	WACA	Yes
<i>Errazurizia rotundata</i>	WUPA	No
<i>Hedeoma diffusa</i>	WACA	No
<i>Pediocactus peeblesianus</i> var. <i>fickeiseniae</i>	WUPA	No
<i>Pediocactus simpsonii</i>	WUPA	No
<i>Penstemon clutei</i>	SUCR	Yes
<i>Phacelia serrata</i>	SUCR, WACA	Yes
<i>Phacelia welshii</i>	SUCR	No
<i>Psoralea thompsoniae</i> var. <i>whitingii</i>	WUPA	Yes
<i>Puccinellia parishii</i>	WUPA	No

Summary of additional rare species

Other plants that were not investigated in depth may also be of concern. Some of these plants have been of concern historically and may have been removed from State or Federal lists. Other plants have been noted as rare to the monuments by the Arizona Ethnobotanical Research Association. However, it is recommended that these "at risk" species be part of future surveys for special status plants. Monitoring programs should be established as soon as possible in order to manage these plants within the monuments.

Walnut Canyon National Monument

Anthericum torreyi
Cystopteris bulbifera
Rumex orthoneurus
Talinum validulum

Wupatki National Monument

Astragalus episcopus var. *lancearius*
Chilopsis linearis (near boundary)
Chrysothamnus molestus
Echinocactus polycephalus
Juglans major
Oenothera boothii
Parryella filifolia
Phragmites communis
Poliomintha incana

Culturally-significant plants

The National Park Service Natural Resource Coordinator for the Flagstaff Area's National Parks, Steve Mitchelson, requested additional information regarding the culturally-significant plants that are found at Wupatki, Sunset Crater Volcano, and Walnut Canyon National Monuments. Although this type of study should not be included in the scope of the existing study, some of the plants were given special attention. These plants included *Lycium pallidum*, *Nicotiana attenuata*, *Nicotiana trigonophylla*, *Datura meteloides*, *Poliomintha incana*, *Physalis* sp., and *Aloysia wrightii*. Further investigation of the distribution and association of these plants with archaeological sites could prove to be significant.

There are two classes of ethnobotanically significant plants that should be differentiated. First, some culturally-significant plants are found in abundance and have a widespread distribution elsewhere but are extremely rare at the monuments. Other culturally-significant plants are found abundantly on the monuments and are widespread throughout northern Arizona. Some of the monuments' culturally-significant plants are listed below.

Culturally-significant plants that are rare to the Monuments

Sunset Crater Volcano National Monument

Ageratina herbacea
Lesquerella cinerea
Monarda pectinata

Walnut Canyon National Monument

Aquilegia desertorum
Petrophytum caespitosum

Wupatki National Monument

Chilopsis linearis (adjacent to the monument)
Errazurizia rotundata
Juglans major
Phragmites communis
Yucca angustissima

Culturally-significant plants that are widespread and abundant

Wupatki National Monument

Datura meteloides
Hilaria jamesii
Lycium pallidum
Nicotiana trigonophylla
Parryella filifolia
Poliomintha incana

Recommendations for further research

* In 1998, the Congress passed the National Parks Omnibus Management Act which mandated that scientific data be collected for better management of National Park resources. Long term monitoring of the special status plants fits well with this mandate. However, more baseline information must be gathered in order to design suitable monitoring guidelines for each species. Eventually, a permanent monitoring team should be hired to assess impacts, abundance and status of these plants on a yearly basis.

* Survey and mapping of the special status plants should be the highest priority. Efforts should be concentrated on those species that may have additional unmapped localities within the Monuments. Little focus should be directed towards those species that are unlikely to occur within the monuments (noted above in results).

* Historic *Phacelia welshii* locations from Atwood (1972) should be investigated.

* A continued search for *Psoralea thompsoniae* var. *whitingii* and *Errazuruzia rotundata* should be conducted on similar topographical features such as mesas and rocky hills.

* Surveys for *Pediocactus* spp. should be done when they are in flower (April to May). Two experts should be taken into the field to do additional searches for *Pediocactus simpsonii* at their historic locations.

* Until further information regarding the abundance, status, phenology, biology, and ecology of the special status plants is compiled, collection of these plants within the monuments is NOT advised. It is recommended that a moratorium be placed on all collection of these plants because of the serious risk of overcollection and extirpation.

* Furthermore, over-collection of *Amsonia peeblesii* is a significant concern and any collection of it should not be allowed at Wupatki National Monument. It is highly regarded by the Western Navajo, was extensively used by the Wupatki Navajo, and is difficult to find outside of Wupatki National Monument. Due to the fact that the whole plant is collected including the roots, this plant could easily be eradicated if over-collected.

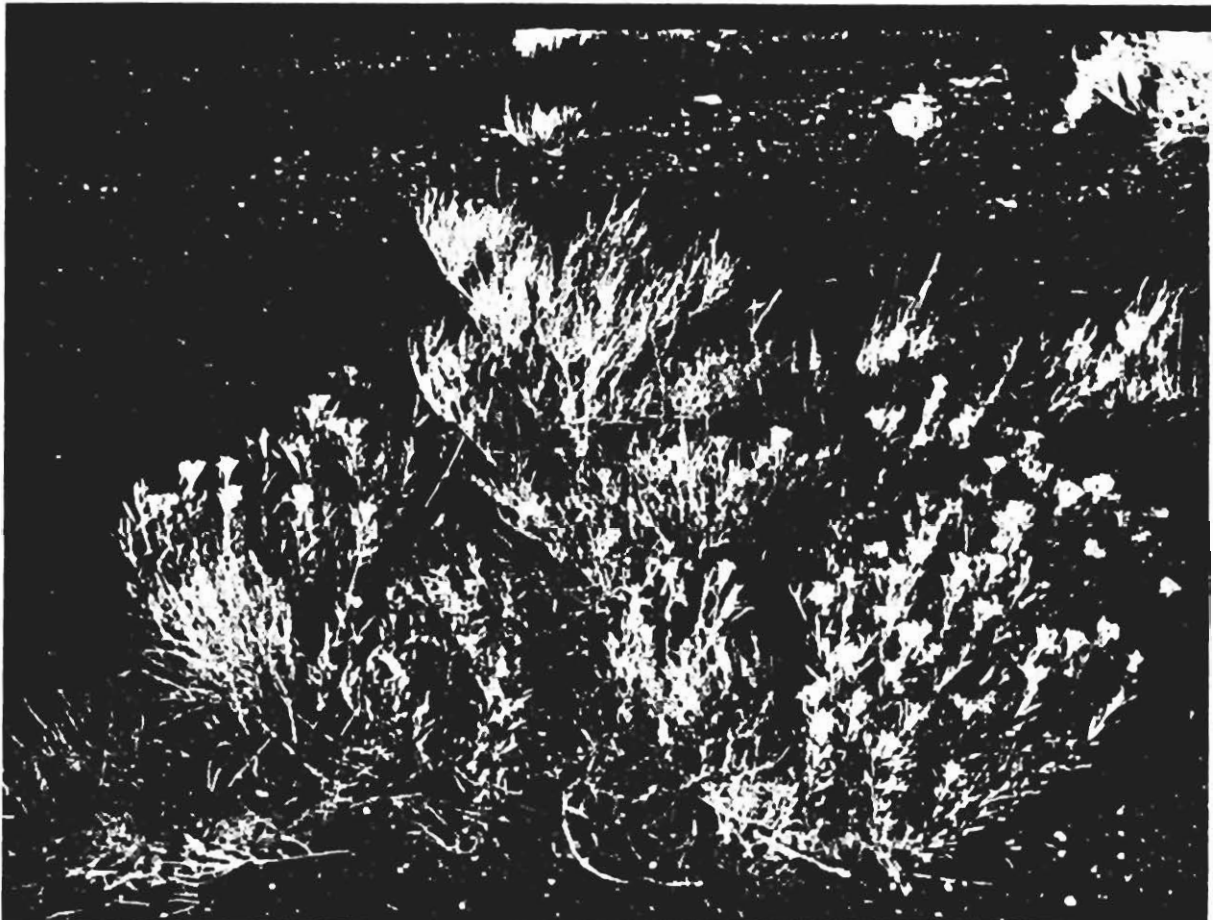
* High priority species that should be monitored include: *Amsonia peeblesii*, *Aquilegia desertorum*, *Erigeron saxatilis*, *Penstemon clutei*, *Phacelia serrata*, *Phacelia welshii*, *Psoralea thompsoniae* var. *whitingii*, and *Phragmites communis*.

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Individual Species Accounts



Latin Name: *Penstemon clutei*
Latin Name w/ authority: *Penstemon clutei* A. Nels.
Synonyms: *Penstemon pseudospectabilis* ssp. *clutei*
Family: Scrophulariaceae
Common Name: Sunset Crater beardtongue, Pink beardtongue

Original Description:

Aven Nelson. 1927. A New *Penstemon* from Arizona. American Botanist 33: 109-110.

Type Specimen:

Willard N. Clute. Painted Desert, north of San Francisco Peaks, Arizona, July 12, 1923.

Taxon History:

In 1923, Willard N. Clute first collected *Penstemon clutei* near Sunset Crater in Coconino County, Arizona. He grew specimens in his garden in Illinois and sent some to Aven Nelson at the University of Colorado. Nelson (1927) published the original description of the new species, naming it after Clute. Keck (1937) reduced it to a subspecies of *Penstemon pseudospectabilis*, but later re-elevated it to species rank based on the narrow ecological niche that *Penstemon clutei* occupies (Clokey and Keck, 1939; Phillips et al., 1992; Crisp, 1996).

Research regarding the speciation of *P. clutei* (Bateman, 1980) indicates that *Penstemon pseudospectabilis*, the presumed parental species, may have inhabited Sunset Crater before it erupted. The warmer, more humid environment at that time was better suited to *Penstemon pseudospectabilis* which occurs today in the upper regions of Oak Creek Canyon and on Schnebly Hill. This species has not been seen above Oak Creek or anywhere near Sunset Crater. Therefore, it is hypothesized that geographic isolation of *P. clutei* from a parental population of *P. pseudospectabilis* ssp. *connatifolius* could have occurred (Bateman, 1980).

Although they are preliminary results, additional evidence from flavonoid chromatography shows many similarities for the two species. Chromosome counts also suggest that *P. clutei* is a segregate of the *P. pseudospectabilis* ssp. *connatifolius* population that may have been present near the time of eruption of Sunset Crater. In theory, the climate change may have created this separate population and caused speciation. Pollinator mechanisms probably changed as well and can be seen in the inflated corolla of *Penstemon clutei* (Bateman, 1980).

Description

Perennial herbaceous forb, to 30.0 to 80.0 cm tall. STEMS one to several, semi-woody, glabrous and glaucous except in the inflorescence. LEAF blades lanceolate to broadly ovate, finely and sharply serrate-dentate, lower ones petioled, cauline (stem) ones sessile, uppermost leaf appearing to surround the stem, forming disks up to 8.0 cm long and 4.0 cm wide. INFLORESCENCE glabrous, open, the lower part usually leafy, often interrupted by long internodes, peduncles and pedicels erect or nearly so, more or less glandular-pubescent. FLOWER sepals 3.0 to 5.0 mm long, sparsely puberulent; corolla is deep pink, the tube yellowish on the ventral side, sparsely puberulent externally, 15.0 to 25.0 mm long, nearly regular, throat definitely swollen on one side, 9.0 to 12.0 mm wide; sterile filament bearded with long yellow hairs from the tip for 1/3 of its length; the base of the lower lip sparsely bearded with similar hairs. FRUIT capsule, broadly ovoid, 7.0 to 10.0 mm long (Nelson 1927; Kearney & Peebles, 1960; McDougall, 1973).

P. pseudospectabilis differs by its moderately inflated corolla that is 6-9 mm wide (Fletcher, 1979). *Penstemon clutei* can be distinguished from this presumed parental species by its swollen corolla that appears like a "bellylike protuberance" and the width of the corolla (9.0-12.0 mm).

Penstemon clutei is distinguished from other species of *Penstemon* found in northern Arizona by its sharply toothed leaves that clasp the lower stem, bright pink flowers, and its tall stature (up to 3 feet) (Kearney & Peebles, 1960; McDougall, 1973; Crisp, 1994).

Biology

Penstemon clutei flowers in early June through August. Bateman (1980) has distinguished flowering times between areas of low and high plant density. In areas of low plant density, the plants bloom mostly in June. In areas of higher plant densities, flowers have been observed as late as the August or September, especially in years of late monsoon rains. Later blooming plants are probably more common at higher

elevation sites like O'Leary Peak (7300 feet). Typically, *P. clutei* is fruiting by mid-August (Kearney & Peebles, 1960; McDougall, 1973; Bateman, 1980).

Several species of pollinators were observed including two hummingbirds (broad-tailed and rufous), the white-lined sphingid moth (*Hyles lineata*), and three species of the family Apidae (bees). Two of these bee species were of the genus *Anthophora* (digger bees) and one was of the genus *Bombus* (bumblebee). Digger bees were the most frequent visitors. Leaf-cutter bees (*Megachilidae*) were observed entering the flower by chewing an entry hold through the corolla tube (Bateman, 1980).

P. clutei is a short-lived perennial and the oldest plants are probably around 5-10 years old. Maintenance of a good seed bank in the soil, to permit populations to revive after a succession of years unfavorable for the establishment of new individuals, is of critical importance to the survival of such short-lived species (Phillips et al., 1992).

Ethnobotany

Penstemon clutei flowers have been utilized in the summer katsina ceremonies by the Hopi at Shungopavi. The plant is also used by the Navajo for Lifeway and other healing ceremonies (Hogan, 1982).

Habitat

Penstemon clutei is found in cinder soils on gentle slopes of relatively open areas in ponderosa pine and pinyon juniper communities. These soils are well-defined, silty below, and covered with 2-10 inches of fresh black and red volcanic cinders (Patton & Meurisse, 1972; Goodwin, 1979; Phillips et al., 1992; Crisp, 1996). Other herbaceous vegetation is usually sparse. It also occurs in openings, around the base of large trees (especially snags), or in areas of previous disturbance. It is found at elevations between 6500-8500 feet (McDougall, 1973; Goodwin, 1979; Phillips et al., 1992; Crisp, 1994; AGFD, 1997).

P. clutei usually occurs as a cluster of 10-50 individuals that are widely spread and have unoccupied habitat between them. Large clusters may contain several hundreds of individuals. Isolated individuals of one to a few plants also occur nearby larger clusters (Phillips et al., 1992; AGFD, 1997).

The silty/cindery soil has an important function in water retention following rain. The lower layer of silty material retains moisture for significantly longer periods than the overlying cinder layers. This enables the plant to utilize moisture deep below the surface in extended periods of summer drought conditions. "Areas of deep cinders without the soil layer, areas on the slopes of cinder cones where soil is unstable, and areas of dense vegetative cover by other vegetation such as blue grama do not provide the required microhabitat for this plant" (Crisp, 1994, 1996).

According to Phillips et al. (1992), only ponderosa pine is consistently associated with *Penstemon clutei*. No other species appear to be reliable indicators for the occurrence of the species. Other species that have been observed at *Penstemon* sites include *Fallugia paradoxa*, *Chrysothamnus nauseosus*, *Penstemon barbatus*, *Verbascum thapsus*, *Bouteloua gracilis*, *Pinus edulis*, and *Juniperus osteosperma* (AGFD, 1997).

Distribution

Penstemon clutei is endemic to northern Arizona and is found only in Coconino County. It is found predominantly at Sunset Crater and at nearby cinder cones. Small populations have been located on a red cinder hill southwest of Indian Flat (Wirtanen, 1991), the east side of O'Leary Peak, south of Haywire Crater (Goodwin, 1979), and White Horse Hills, north of San Francisco Mountains (AGFD, 1997). Its range is extremely narrow and does not extend beyond the limits of its specialized habitat (Phillips et al., 1992).

Herbarium specimens

Several specimens documenting the presence of *P. clutei* at Sunset Crater Volcano National Monument were located (Hogan & Huisinga, 1997). Three specimens were found at the Sunset Crater Volcano National Monument herbarium (WUPA). Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	T24N, R7E, NW ¼, Sec. 9, Coconino National Forest, volcanic cinder hill just west of Indian Flats off of F.S. Road 548
NAU	NE side of O'Leary Peak, Sec. 1, T23N, R8E
NAU	O'Leary Peak, south side, Sec. 3 T23N R8E
NAU	Sec. 22 T23N R8E, north of Bonita Forest Camp, near Sunset Crater N. Mon., Coconino N.F., Coconino Co, AZ
NAU	Vicinity of Sunset Crater
NAU	Face of O'Leary Peak on primitive Rd. 545A, near Sunset Crater
NAU	Near Sunset Peak, south slope
NAU	1/2 mile SE of Cinder Lake, Sec. 7 T22N R9E
NAU	Haywire Crater, Sec. 22 T23N R9E
NAU	O'Leary Peak on FS Rd. 545A on mixed Sunset and O'Leary cinder next to road
NAU	In an area cleared for the high tension electric line leading from Leupp Highway to Sunset Crater
NAU	5 km SSE of Sunset Crater, FS Rd. 498 near Pinnacle Crater at intersection with FS Rd. to Little Cinder Basin, growing on Sunset Cinder
NAU	West of Lenox Crater, Sunset Crater National Monument
NAU	Bonito Forest Camp, Sunset Crater
NAU	Road leading to Sunset Crater
MNA	Cone 48, Sunset Crater
MNA	Just west of Indian Flats off F.S. Rd 548, T24N R7E NW1/4 Sec. 9
MNA	Sunset Crater summit
MNA	North side of cone
ASU	Near Sunset Crater, Sec. 22 T23N R8E
ASU	Sunset Crater, 1 mile west of crater
ASU	Near Sunset Crater, Sec. 22 T23N R8E
ASU	Sunset Crater, Bonito campground in campground
WUPA	Base of Sunset Crater, Sunset Crater shelf road
WUPA	Sunset Crater Shelf Road, west exposure
WUPA	Base of Sunset Crater

Listing Status (AGFD, 1997)

ESA:	SC
USFS:	S
NESL:	None
NPL:	SR
GRank:	G2
SRank:	S2

This species is recognized as a "species of concern" by the Endangered Species Act (ESA). The U.S. Forest Service (USFS) recognizes it as a "sensitive" species. The Navajo Nation (NESL) does not recognize this species because it does not occur on the Reservation. The Arizona Native Plant Law (NPL) designates this species as "salvage restricted" and allows collection only with a permit. The Global (G) and State (S) Ranking indicate that this species is very rare in its range and is vulnerable to extinction globally and at the state level. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

In 1999, several localities of *Penstemon clutei* were recorded in the National Park Service GIS database. They are indicated on the map. All of these localities were previously known as occurring in the limited range of this species but did not exist as part of a comprehensive GIS database. A species status report is currently underway by a private consultant in Flagstaff, Susie Smith.

Management

Healthy populations of *Penstemon clutei* have been observed throughout its habitat. There is some evidence that the plant can tolerate disturbances such as fire, minor soil disturbance, and logging. Exposure of the underlying silty soil and redistribution of seeds may enhance germination in new areas (Crisp, 1994, 1996). However, the plant merits the "sensitive" status from the U.S. Forest Service because of its very limited habitat and distribution.

Two commercial disturbances in *Penstemon clutei* habitat, construction of an underground powerline and a proposed landfill expansion, are being monitored by the U.S. Forest Service (Crisp, 1994, 1996). Visitor impact is significant at the Bonita Lava Flow trail and Sunset Crater picnic site. Picking of the flowers is tempting to visitors because of the plant's very conspicuous flowers (Bateman, 1976). Activities involving the use of heavy machinery and off-road vehicles are a concern because they churn the soil and have the potential to destroy the seed bank (Phillips et al., 1992; Crisp, 1996). Further expansion of trails and roads within Sunset Crater Volcano National Monument is discouraged.

Penstemon clutei can also respond to logging pressures – high concentrations of reproducing adults and seedlings were found growing around stumps or near the edges of decaying logs (Phillips et al., 1992). Normal traffic such as driving over the plants a few times with a pickup truck does not seem to damage the plants severely (Crisp, 1994, 1996). *P. clutei* has been observed growing in ATV tracks, possibly as the depressions filled with pine needles and other duff and thereby increased nutrient and moisture availability (Smith, 1999).

After a wildfire in November 1973, this plant was found to be one of the pioneering species, being the largest population with very vigorous individual plants and abundant reproduction (Goodwin, 1979). Accordingly, the U.S. Forest Service conducted a prescribed burn study in October 1990. Observations in 1993 and 1994 showed substantially higher numbers of seedlings in the burned plots, but there was exceptional precipitation in 1992 and 1993, and no control or replicate sites were established, so these results were inconclusive (Fule, 1999). An alternative hypothesis presented by Fule (1999) indicates that fire decreases competition from overstory trees (ponderosa pine) and may promote the growth and reproduction of *Penstemon clutei*. Experimental trenches were dug around plots and once ponderosa pine competition was eliminated the plants flourished and produced many seeds and seedlings (Springer, 1999).

Past observations have indicated that *P. clutei* responds positively to disturbance. In 1991-2, a Transwestern Natural Gas pipeline was laid through four miles of *P. clutei* habitat. After construction, seeds were deposited in plots in the disturbed and undisturbed areas. While these studies gave inconclusive results, observations show vigorous growth of the plant along the area of pipeline disturbance (Fule, 1999).

In November 1992, searches for *P. clutei* were conducted and photopoints were established shortly after a tornado passed through an area near O'Leary Peak. The populations were monitored throughout the resultant sale of downed and damaged timber. Mitigating procedures restricted the sale operations and the operation of heavy machinery to the winter months when the soil was frozen and disturbance to the seed bank would be minimized. In addition, the slash was scattered because the top layer of soil can be disturbed when slash is pushed into piles by tractors (Crisp, 1994, 1996).

When the photopoints were revisited in August 1994, populations of *P. clutei* had increased substantially, perhaps due to several factors: (1) the storm uprooted large trees, resulting in a ponderosa pine stand of smaller trees with less canopy closure; (2) the skidding of logs and other activities on the project could have helped disperse the seeds of *P. clutei* to parts of the area unoccupied by the species before the activities; (3) since the sale occurred during the winter months, no deep disturbance of the beneficial soil layering resulted; (4) the storm destroyed competing ground vegetation; (5) the 1992 survey was done in late fall when the plants were dormant, while the 1994 survey was done in August during the growing season (Crisp, 1994, 1996; Fule, 1999).

Annotated Bibliography

Arizona Game and Fish Department. 1997. *Penstemon clutei*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Includes a location map and detailed listing of locality, quad name, dates of observations and descriptions of abundance and flowering/fruit condition in each locale.

Bateman, Gary C., project director. 1980. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report (Phase III). Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

Second draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments, including: *Amsonia peeblesii*, *Phacelia serrata*, and *Penstemon clutei*.

_____. 1976. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report. Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

First draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments, including: *Amsonia peeblesii*, *Phacelia serrata*, and *Penstemon clutei*.

Clokey, I.W. and Keck, D.D. 1939. Reconsideration of certain members of *Penstemon* Subsection Spectabiles. Bull. S. Calif. Acad. Sci. 38: 8-13.

Crisp, Debra. 1996. Monitoring of *Penstemon clutei* on Tornado Salvage, Coconino National Forest. Pp. 243-246. In Maschinski, Joyce, H.D. Hammond, L. Holter. Southwestern Rare and Endangered Plants: Proceedings of the Second Conference.

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Fule, Peter. 1999. NAU College of Ecosystem Science and Management. Personal communication.

Has conducted burn studies with *P. clutei*; unpublished "Studying Rare Plants: Examples with *Penstemon clutei*", May 1993.

Goodwin, Greg. 1979. Observations on *Penstemon clutei* on the Coconino National Forest. Unpublished report for the Coconino National Forest, Flagstaff, AZ.

A field survey of the cinder hills area northeast of Flagstaff for *Penstemon clutei*.

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Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Huffman, Dave. 1999. NAU College of Ecosystem Science and Management. Personal communication.

Performed seed germination studies in 1996 on *P. clutei*.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Key to *Penstemon* sp. (contributed by David D. Keck) and brief description of *P. clutei*.

Keck, D.D. 1937. Studies in *Penstemon* V. The Section Peltanthera. Amer. Midl. Nat. 18: 790-829.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Brief description of genus *Penstemon*

_____. 1962. Seed Plants of Wupatki and Sunset Crater National Monuments. Northern Arizona Society of Science and Arts, Inc.

Descriptions of families, keys and descriptions of species found within the monuments.

Moore, R.B. and E. W. Wolfe. 1976. Geologic Map of the Eastern San Francisco Volcanic Field, Arizona. USGS Map 1-953, Misc. Inves. Series.

Nagiller, Sandra J. 1999. U.S. Forest Service, Coconino National Forest, Peaks Ranger Station.. Personal communication.

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Nelson, Aven. 1927. A New *Penstemon* from Arizona. American Botanist 33: 109-110.

Original description of *Penstemon clutei*.

Patton, W.W. and R.T. Meurisse. 1972. Soils Report, Cinder Hills Area, Elden Ranger District, Coconino National Forest.

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A survey of 307 points in 17,485 acres on the Peaks Ranger District of the Coconino National Forest

Smith, Susan. 1999. Northland Research, Inc., Flagstaff, AZ. Personal communication.

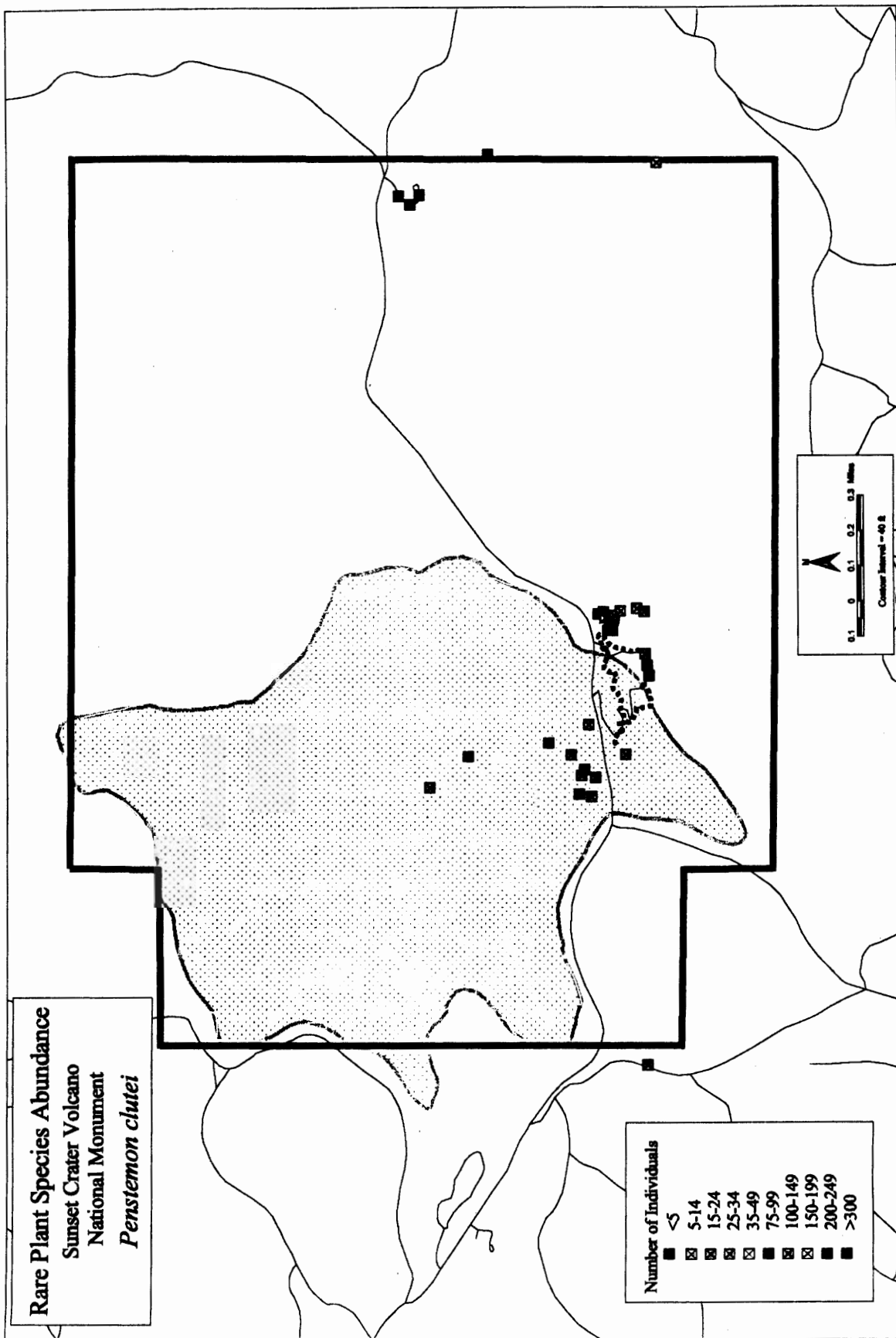
Springer, Judy. 1999. NAU College of Ecosystem Science and Management. Personal communication.

United States Fish and Wildlife Service, line drawing of plant in flower.

Wirtanen, Mark. 1991. Unpublished communication to District Wildlife Staff, Peaks Ranger District, Flagstaff, AZ.

Report of a new population of *Penstemon clutei* growing on a red cinder hill southwest of Indian Flat in the pinyon-juniper habitat.





Latin Name: *Phacelia serrata*
Latin Name w/ authority: *Phacelia serrata* J. Voss
Synonyms: None
Family: Hydrophyllaceae
Common Name: Cinder phacelia, Saw scorpionweed, Saw phacelia

Original Description

J.W. Voss. 1937. Bulletin of the Torrey Botanical Club 64: 83-89.

Type Specimen

Type: C.A. Purpus, POM! 8064 (Pomona College Herbarium). 1900, San Francisco Mountains, Arizona.

Isotype: University of California.

Taxon History

This is a distinct species in a polymorphic genus of about 200 species that are mostly found in the western United States and Mexico. Thirty-five species and 7 varieties of the *Phacelia crenulatae* group occur in North America. In 1937, John W. Voss revised the *Phacelia crenulata* group in North America. N. Duane Atwood revised this group in 1975 discussing taxonomic relationships between the 35 species and 7 varieties of *Phacelia* in this group (Phillips et al., 1982; AZGD, 1998).

Description

Herbaceous annual, 10-34 cm tall. STEMS erect, simple or branched at base, with glandular hairs (like other *Phacelia*). LEAVES lanceolate, serrate or dentate to shallow lobed, 1-5 cm, 0.5-2 cm wide. INFLORESCENCE scorpioid raceme, compact in both fruit and flower. FLOWERS many; corolla blue, tubular. FRUIT capsule. SEEDS oval, 3 x 2 mm diameter, pitted with thickened edge of lighter color on dorsal side, ridge prominent and somewhat corrugated on one side (Voss, 1937; McDougall, 1973).

Biology

This species blooms from late June to September (Kearney & Peebles, 1951; AGFD, 1997). It will sometimes flower a second time with the monsoon rains and seeds can be found into September.

P. serrata is adapted to precipitation cycles of arid southwest. Its populations vary greatly from rare to abundant depending upon the amount of winter and spring precipitation. In wet years, the plants are very dense due to the germination of the dormant seed crop within the soil. In drought years, the plants are sparse to rare (AGFD, 1997).

A notable difference between the populations of *Phacelia serrata* at Sunset Crater Volcano and Wupatki National Monuments is that the plant at Sunset Crater are smaller (30 cm tall) than those at Wupatki (40-50 cm tall). These differences may be due to the length of the growing season and the availability of water, especially near roadsides (Bateman, 1980).

Ethnobotany

Some species of *Phacelia* were used historically by the Hopi and Navajo but are not used currently (Hogan, 1995).

Habitat

This endemic species is found on coarse to fine black cinders, usually in open flats with little shading (Bateman, 1980; Smith, 1995). It occurs in pinyon-juniper woodlands and ponderosa forests at elevations between 5000-7200 (AGFD, 1997).

Phacelia serrata thrives in recently disturbed areas and has been observed in recently burned areas (Bateman, 1980; AGFD, 1997).

Distribution

This species is known only from Coconino County in northern Arizona, specifically in an around Sunset Crater Volcano National Monument, the San Francisco Mountains north of Flagstaff, and west of Flagstaff (Kearney & Peebles, 1951; McDougall, 1973; AGFD, 1997).

According to Bateman (1980), one locality was located on cinders within Wupatki National Monument: "Wupatki Basin: Doney Mountain, s of Antelope Wash" (AGFD, 1997). Specific localities near Sunset Crater National Monument are "Black Bill park, vicinity of Sunset Crater"; "Cinder Lake area" and "1/2 mile east of Sunset Crater Visitor Center, south of paved road" (Bateman, 1980).

Herbarium Specimens

Herbarium specimens documenting this species at Sunset Crater Volcano and Wupatki National Monuments were found at the local herbaria and are listed below (Hogan & Huisinga, 1997). Three voucher specimens are currently at Wupatki and Sunset Crater Volcano herbarium. Other collections that were made by the U.S. Forest Service are referenced in Crisp (1994) and are not listed here. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Sunset Crater National Monument, Coconino Co.
NAU	Sec. 22, 26N 8E, 8.5 miles S of Gray Mountain, in black cinders near roadside
NAU	I-40, N edge of west bound lane, opposite Navajo Army Depot (identification questionable)
NAU	Oak Creek Canyon (identification questionable)
MNA	Cinder area, Flagstaff
WUPA	Visitor center
WUPA	Sunset Crater National Monument
WUPA	0.2 miles south of road 545, 1.8 miles east of viewpoint turnoff

Listing Status (AGFD, 1997)

ESA:	SC
USFS:	None
NESL:	None
NPL:	None
GRank:	G2?
SRank:	S2

The Endangered Species Act (ESA) lists this variety as a "species of concern." The U.S. Forest Service (USFS), the Navajo Nation (NESL), the Arizona Native Plant Law (NPL) do not list this species. The Global Ranking (G) lists this variety as one that is imperiled globally because of rarity making it very vulnerable to extinction throughout its range. The State Ranking (S) states that this variety is vulnerable to extinction throughout its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

In 1999, *Phacelia serrata* was located and GPS coordinates were recorded at three localities near Sunset Crater: "viewpoint approximately 1 mile northeast of Sunset Crater, Sunset Crater Lava Trail long loop"; "Doney Mountain from picnic area up south ridge across summit ridge and down northwest side to Road 545" and "Doney Mountain, along west flank at mid elevation." Approximately 300 individuals exist on the slopes of Doney Mountain although it is more concentrated its top. Only 1/3 of the population is officially protected by the National Park Service. The other 2/3 of the population occurs on U.S. Forest Service land and it is not protected under a "sensitive" species designation. This area lies in the midst of a dense residential area which probably results in great disturbance due to recreationists.

Other plants were recorded using GPS at Wupatki National Monument. These plants occur near the historic locality at Doney Mountain that was noted by Bateman (1980).

Management

This plant is restricted in range but is locally common (AGFD, 1997). Bateman (1980) noted that this species appeared to be increasing in the area of Sunset Crater. It is often described as locally abundant but due to drought, its abundance will vary from year to year depending upon the amount of precipitation (Nagiller, 1995).

Threats to certain populations of *Phacelia serrata* include land trades, road realignment and maintenance, and increased use of the area around Flagstaff and Sunset Crater. Specifically, recreation and off-road vehicle use is increasing due to an expanding Flagstaff population. It is also found near the Flagstaff city dump (Nagiller, 1995; AGFD, 1997).

Annotated Bibliography

Arizona Game and Fish Department. 1997. *Phacelia serrata*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Includes classification, description, biology, conservation. Also from the same source, element status designations and specific location occurrences with plant condition, flower and fruit detail where possible.

Atwood, N.D. 1975. A Revision of the *Phacelia crenulatae* group (Hydrophyllaceae) for North America. *The Great Basin Naturalist* 35: 127-190.

Discusses the relationships between species of *Phacelia* and gives a new taxonomic key to species

Bateman, Gary C., project director. 1980. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report (Phase III). Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

Second draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments, including: *Amsonia peeblesii*, *Phacelia serrata*, and *Penstemon clutei*.

_____. 1976. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report. Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

First draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments, including: *Amsonia peeblesii*, *Phacelia serrata*, and *Penstemon clutei*.

Crisp, Debra. 1994. Status of *Phacelia serrata* on the Peaks Ranger District, Coconino National Forest. Unpublished report in U.S. Fish and Wildlife Office, Flagstaff, AZ.

Summary of all known locations of this plant on the Peaks Ranger District in response to increased management activities in potential habitat.

Hogan, Phyllis. 1995. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Description of genus *Phacelia*, keys to species, location and habitat.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Description of genus, keys to species, brief description of *P. serrata*.

Nagiller, Sandra J. 1995. Wildlife review of special use permit application. Unpublished report, U.S. Forest Service, Wildlife Biologist.

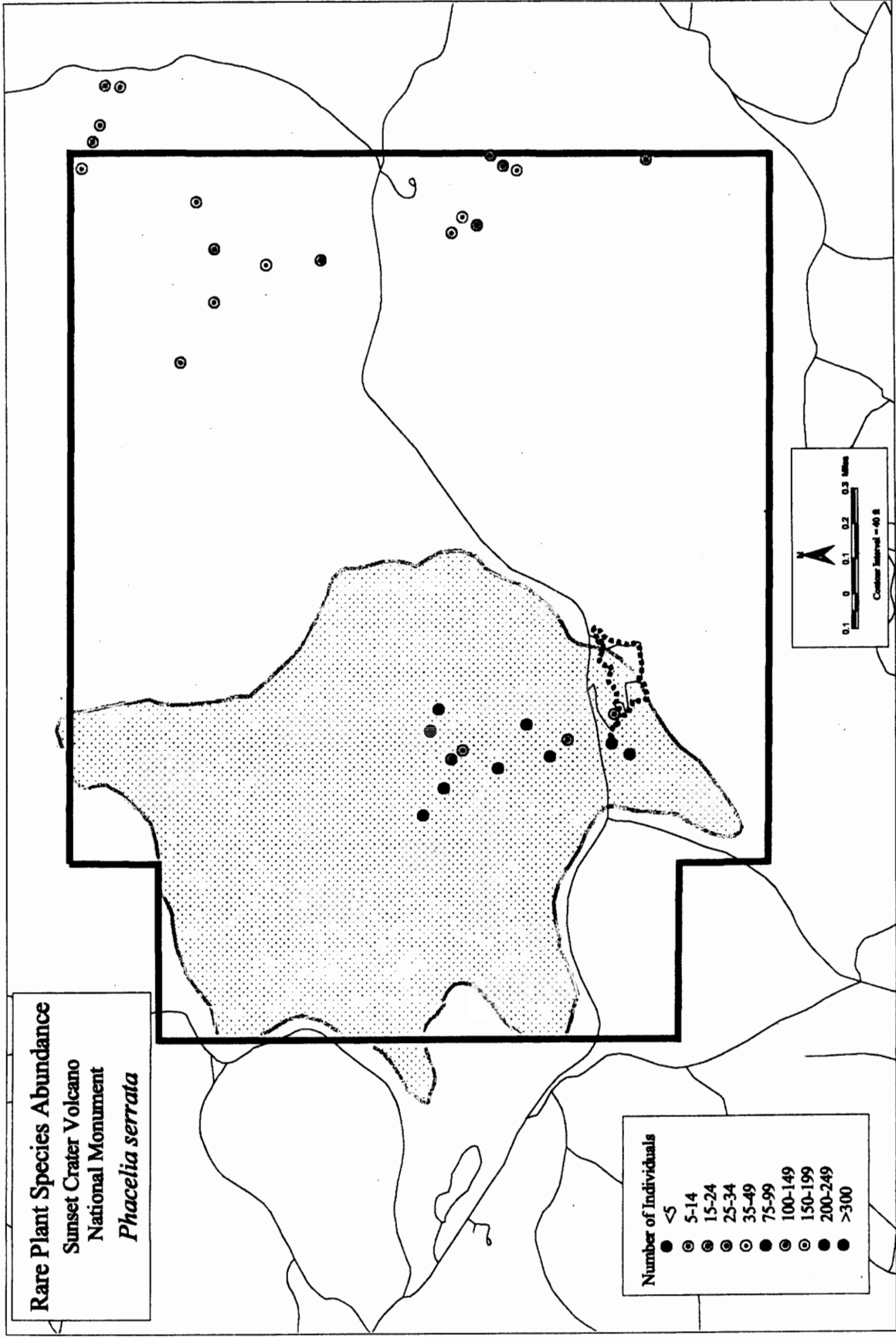
This short report discusses possible impacts on two sensitive plants, including *Phacelia serrata*

Smith, Susan. 1995. Biological Assessment for sensitive plant species City of Flagstaff Landfill Transfer and Expansion Peaks Ranger District, Coconino National Forest, Coconino County, Arizona. Unpublished report .

Field study and habitat evaluations for *Penstemon clutei* and *Phacelia serrata* regarding proposed expansion of Cinder Lake landfill by City of Flagstaff.

Voss, John W. 1937. A revision of the *Phacelia crenulata* group for North America. Bulletin of the Torrey Botanical Club 64 (2): 83-9.

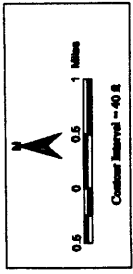
Original description in English and Latin and type locality of this new species with key to all species.



Rare Plant Species Abundance
Wupatki National Monument
Phacelia serrata

Number of Individuals

- <5
- 5-14
- 15-24
- 25-34
- 35-49
- 75-99
- 100-149
- 150-199
- 200-249
- >300



Latin Name: *Aquilegia desertorum*
Latin Name w/ authority: *Aquilegia desertorum* (M.E. Jones) Cockerell ex Heller
Synonyms: *Aquilegia formosa* var. *desertorum*
Family: Ranunculaceae
Common Name: Desert Columbine, Mogollon Columbine

Original Description

A. Heller. 1901. Muhlenbergia 1: 27.

Type Specimen

Aquilegia formosa Fischer ex de Candolle var. *desertorum* M.E. Jones. 1898. Contr. W. Bot. 8: 2.

Taxon History

Marcus E. Jones first collected this species near Flagstaff on August 29, 1884. D.T. MacDougal also collected it in Walnut Canyon in 1898. In 1898, Heller named it as *Aquilegia formosa* var. *desertorum*. Later, in 1900 T.D.A. Cockerell designated it as a distinct species and called it *Aquilegia desertorum*; although Munz (1946) notes that Cockerell actually referred to a specimen of *A. elegantula* when naming the species.

The genus name may have been derived from the Latin *aqua*, water, and *legere*, to draw or collect, because of the wet habitat of some species and because of the quantity of liquid nectar borne in spurs. Another possible derivation is from the Latin *aquila*, eagle, because of similarity in shape of curved spurs of some European *Aquilegia* species to an eagle's talons.

Description

Perennial herbaceous forb, from slender woody rhizomes. STEMS 15-60 cm. LEAVES basal and cauline; *proximal leaves* petiolate; *distal leaves* sessile; *cauline leaves* alternate; *basal leaves* 2-3x-ternately compound, 7-30 cm., much shorter than stems; *leaflets* to 9-26(-32) mm, not viscid, either green towards the axis or glaucous on both sides; *primary petiolules* 15-57 mm (leaflets not crowded), glabrous or pilose, sometimes somewhat viscid. INFLORESCENCES terminal, 1-10-flowered cymes or solitary flowers, to 30 cm; bracts leaflike, not forming involucre. FLOWERS bisexual, radially symmetric, nodding; *sepals* 5, not persistent in fruit, divergent from floral axis, red or apex yellow-green, elliptic-ovate to ovate or lanceolate, 7-20 x 3-8 mm, apex obtuse to acuminate; *petals* 5, spurs red, straight, +/- parallel, 16-32 mm, stout proximally, slender distally, abruptly narrowed near middle, blades yellow or red and yellow, oblong or rounded, 4-12 x 3-8 mm; *stamens* many, 14-19 mm; *filaments* filiform; *staminodes* usually present between stamens and pistils, scalelike; *pistils* 5-10, simple; *ovules* many per pistil; *beak* present. FRUITS follicles, 15-30 mm, aggregate, sessile, cylindric, sides prominently veined; beak 8-12 mm, terminal, straight. SEEDS black, obovoid, smooth (Whittemore, 1997).

Aquilegia desertorum is very similar to *A. canadensis* and they may not be distinct at the species level. Plants at the eastern and southern parts of the range of *A. desertorum* have been labeled as a distinct species, *A. triternata*, based on the longer sepals and petal blades (Whittemore, 1997). However, these sepal and petal types overlap throughout central Arizona and other diagnostic characters for *A. triternata* (leaves not glaucous, 3X-ternately compound) are not often seen with the noted flower characteristics (Munz, 1946; Whittemore, 1997). According to Kearney and Peebles (1951), the ranges of *A. desertorum* (Navajo & Coconino Counties) and *A. triternata* (Apache, Cochise, Santa Cruz, and Pima Counties) do not overlap in Arizona.

Biology

Aquilegia desertorum flowers in summer (July) and fruits can be seen until November in some years.

Whittemore (1997) notes that small, isolated populations of *Aquilegia* species are found in arid areas. This results in increased variability due to the fixation of genes in a localized area. "This is perhaps an excellent example of phenotypic plasticity" (Whittemore, 1997).

Ethnobotany

The Western Navajo used *Aquilegia triternata* historically as a ceremonial fumigant for headaches or other severe pain. Certain varieties of a synonymous species, *Aquilegia formosa*, have been used by several Native American groups including the Gosiute, Paiute, and Shoshone for various ailments (D.E. Moerman, 1986).

Habitat

Aquilegia desertorum is found in open rocky places, in crevices of rocks, and in small pockets of soil on and around limestone boulders. The plant grows at higher elevations from 6800-8000 feet in the ponderosa pine belt in northern Arizona and New Mexico. (Tidestrom, 1941; McDougall, 1973; Whittemore, 1997).

Distribution

In Arizona, this plant is known only from northern Navajo County and Coconino County (Kearney & Peebles, 1951; McDougall, 1973). There are other isolated populations in southwestern New Mexico and southwestern Utah (Whittemore, 1997).

Other *Aquilegia* species found in Coconino County are: *A. caerulea* (8000-11,000 feet, June and July), *A. chrysantha* (3000 to 11,000 feet, April to September), *A. micrantha* (6500-7000 feet, June to September), and *A. triternata* (4000-10,000 feet, May to October) (McDougall, 1973).

Herbarium Specimens

Although *Aquilegia desertorum* has been extensively collected, no historical collections were found from Walnut Canyon National Monument. During 1999, the plant was collected in the Monument and was deposited in the AERA herbarium (not listed here). Two historical collections were made in Walnut Canyon outside of the Monument. All Walnut Canyon specimens are listed first (Hogan & Huisinga, 1997). Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Walnut Canyon, Coconino Co.
NAU	Fisher Point, Walnut Canyon, Sec. 31 T21N R8E
NAU	Lake Mary, Coconino Co., AZ
NAU	NE1/4 Sec. 4 T20N R5E, Coconino Co., Volunteer Canyon
NAU	1/2 mile E. Coconino Country Club
NAU	Marshall Lake, Coconino County
NAU	2 mi W. of Lower Lake Mary
NAU	1 mi. SE of I-40 in rocky ravine at mile post 200
MNA	Long Valley, South of Flagstaff
MNA	Pumphouse Wash
MNA	Kachina Village
MNA	Big Sowats Canyon, Coconino County

Listing Status (AGFD, 1998)

ESA:	None
USFS:	S
NESL:	4
NPL:	SR
GRank:	G4
SRank:	S4

This species is not recognized under the Endangered Species Act (ESA). The U.S. Forest Service (USFS) recognizes it as a "sensitive" species. The Navajo Nation (NESL) holds this species under consideration for possible threats although information on its status and distribution on the Navajo Reservation is lacking and incomplete. The Arizona Native Plant Law (NPL) designates this species as "salvage restricted" and allows collection only with a permit. The Global (G) and State (S) Ranking

indicate that this species is secure although it is rare in parts of its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

In 1999, six populations of *Aquilegia desertorum* were located within the boundaries of Walnut Canyon National Monument. These populations varied in size from less than 5 plants to one population of over 300 plants.

The largest population of approximately 300 plants was found in a moist, shady area in and around several large limestone outcrops. This area had previously been approved for a prescribed fire, therefore a fire line was established around the columbine population in order to protect it. Post-fire investigation of this population by Ariel Leonard revealed that the fire did not reach this population and the plants were undisturbed.

Management

Its Global and State rankings (G4 and S4) indicate that this species is abundant and secure in its range. However, rapid development in northern Arizona potentially threatens many populations of this species that are outside of protected areas such as Walnut Canyon National Monument. Its habitat in rocky areas and on limestone boulders is limited and threatened. The assumption that this species is not sensitive in its range and habitat is dangerous.

Annotated Bibliography

Arizona Game and Fish Department. 1999. *Aquilegia desertorum*. Status Designations, Biological Elements of Arizona. Unpublished data, Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Key to the genus *Aquilegia* and locations of *A. desertorum*.

Moerman, Daniel E. 1986. Medicinal Plants of Native America. University of Michigan Museum of Anthropology, Technical Reports, Number 19. Ann Arbor, MI.

Arranged by genera, then species; various Indian tribes listed under each species with uses and preparation of each plant.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, Arizona.

Key to the genus *Aquilegia* and technical description of *A. desertorum*.

Munz, Philip A. 1946. Gentes Herbarium: Occasional papers on the kinds of plants. Vol. VII, Fasc. I. The Bailey Hortorium, Ithaca, NY.

Key to several species of *Aquilegia* including wild and cultivated columbines

Standley, Paul C. 1917. Contributions from the United States National Herbarium, Vol. 20, Part 1. Government Printing Office, Washington.

Brief description and key of *Aquilegia desertorum*.

Tidestrom, Ivar. 1941. Flora of Arizona and New Mexico. Catholic University of America Press, Washington, DC.

Brief description and habitat of *Aquilegia desertorum*, *Cimicifuga arizonica*, *Cymopterus megacephalus*, *Hedeoma diffusa*.

United States Fish and Wildlife Service, line drawing of plant in flower and seed.

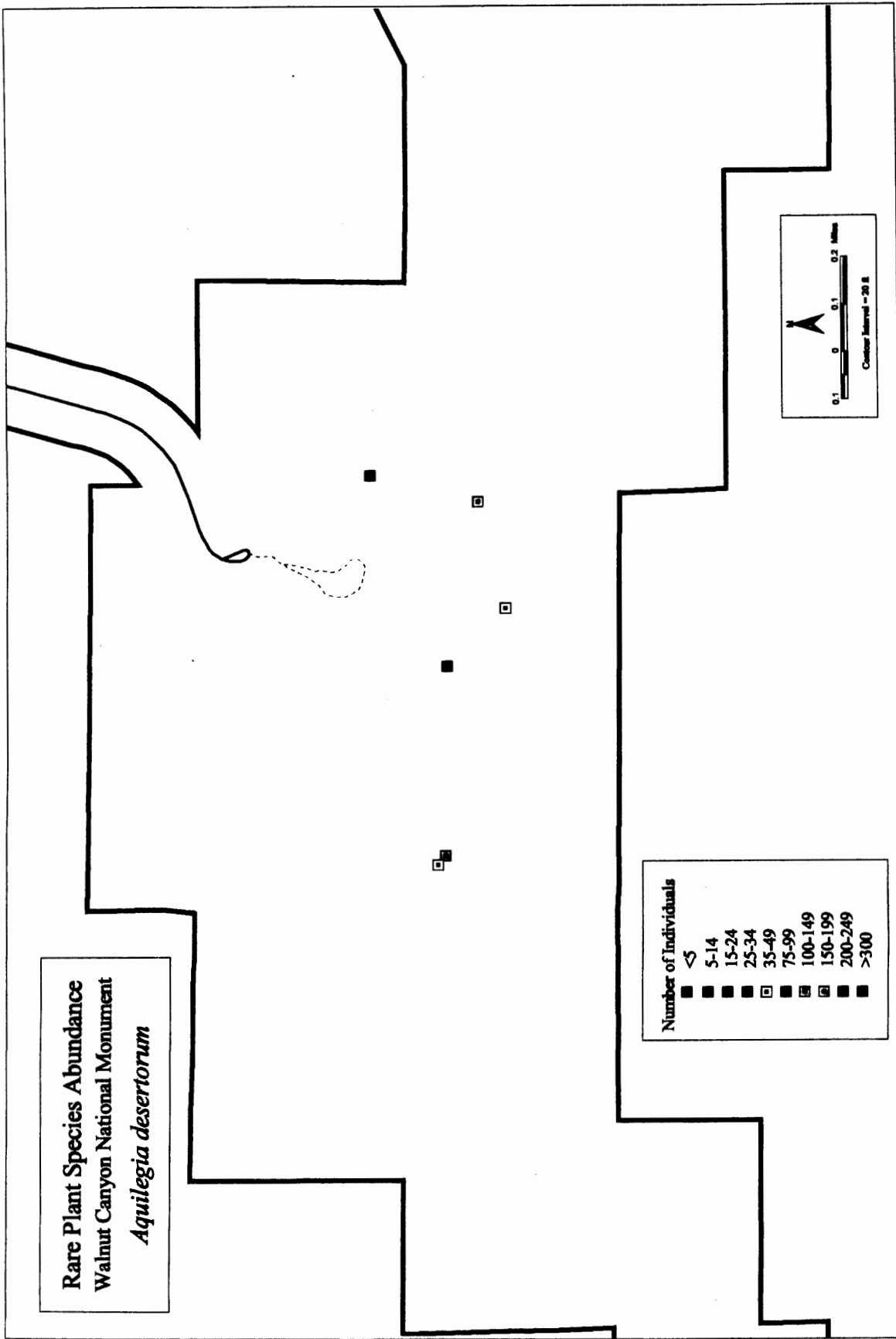
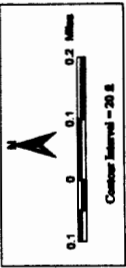
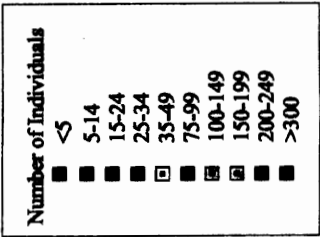
Whittemore, Alan T. 1997. Flora of North America, North of Mexico, vol. 3. Oxford University Press.

Key to genera in the Ranunculaceae, technical description of each genus and keys to species; taxon information, location maps, and descriptions of species.



Aquilegia desertorum

Rare Plant Species Abundance
Walnut Canyon National Monument
Aquilegia desertorum



Latin Name: *Cimicifuga arizonica*
Latin Name w/ authority: *Cimicifuga arizonica* S.Wats.
Synonyms: *Actaea arizonica*
Family: Ranunculaceae
Common Name: Arizona bugbane, Black cohosh

Original Description

Sereno Watson. 1885. Descriptions of some new species of plants, chiefly from our Western Territories. Proceedings of the American Academy of Arts and Sciences 20: 352-353.

Type Specimen

Lectotype: J. G. Lemmon and Mrs. J. G. Lemmon 3275 (Gray Card Index). Aug. 25, 1884.
 Isotype: J.G. Lemmon, ARIZ 11737. 1884, Bill Williams Mountain, Coconino County, AZ.

Taxon History

In 1883, H.H. Rusby first collected *Cimicifuga arizonica* at Bill Williams Mountain (Coconino County, Arizona). Mr and Mrs. J. G. Lemmon also collected it on August 25, 1884 in a ravine on the northwest slope of the same mountain. It was described by Sereno Watson in 1885 (Phillips et al., 1996).

In the Deaver Herbarium, NAU campus, and at the Museum of Northern Arizona herbarium, this plant is filed under *Actaea arizonica*. Analysis by Compton et al. (1998) shows that the genus *Actaea* is closely related to *Cimicifuga*. These authors have combined them into one genus, *Actaea*.

There are 15 species of *Cimicifuga* worldwide, with 6 in North America. Four of these species are local or regional endemics (Kaye and Kirkland, 1994).

The name is derived from the Latin *cimex*, bug, and *fugare*, to drive away.

Description

Herbaceous perennial, vigorous, from hard, knotted, long-lived rhizomes. STEMS 70-150 cm tall, glabrous. LEAVES dimorphic, maple-like appearance; *lower leaves* have long petioles; *upper leaves* sessile, the blades are divided by three, and each segment is divided with ultimate segments toothed and tipped with glands, jagged, and 2-5 lobed. INFLORESCENCE long, with slender racemes positioned above the large leaves. FLOWERS small, white, petal-less, clustered on the flower stalk, making the plant very conspicuous when in flower. FRUIT follicles, sessile, compressed laterally. SEEDS pale brown, loosely covered with membranous scales (AGFD, 1997; Ramsey, 1997; Phillips, 1998).

Cimicifuga arizonica can be easily confused with *Actaea rubra* var. *arguta*, another Ranunculaceae member. Both are vegetatively very similar and grow in similar habitats. The primary difference is in the inflorescence and fruits. *Actaea rubra* var. *arguta* has a short, open panicle with red or white berries that are arranged perpendicular to the stalk. *C. arizonica* has a long, narrow spike with follicles (Phillips et al., 1982; AGFD, 1997). In early spring, sprouting *C. arizonica* can also be confused vegetatively with the Apiaceae member, *Osmorhiza* spp. (Phillips et al., 1996).

Cimicifuga arizonica may be most closely allied to *C. elata*, which grows in Oregon, Washington, and British Columbia (Phillips et al., 1996; AGFD, 1997).

Biology

This species flowers from July to August and after summer rains. It sets fruit between August and September and loses its leaves in late fall (Phillips et al., 1996). The seedlings develop rhizomes early on and extend further into the soil as they mature. The mature plants sprout from rhizomatous buds making it difficult to distinguish individuals (Phillips et al., 1996).

DeWald and Phillips (1995) saw very little phenotypic plasticity between the four distinct population areas of *Cimicifuga arizonica*. They hypothesized that this was due to the presence of extremely similar habitats. Further research is underway in order to investigate genetic differences between populations (DeWald and Phillips, 1995).

The pollination biology of *Cimicifuga arizonica* was investigated by Olle Pellmyr in 1983, who found that workers of three bumblebee species were pollinators: *Bombus occidentalis*, *Separatobombus morrisoni*, and *Probombus huntii*. Under normal conditions these flowers receive a very limited number of visits, while pollinators are also visiting several simultaneously flowering species: *Phacelia magellanica*, *Asclepias speciosa*, *Aquilegia chrysantha*, *Geranium richardsonii*, among others (Pellmyr 1985).

Therefore, it is essential to maintain a diversity of plant species pollinated by these bees in order to attract them so that the bees will be in the area when *Cimicifuga* is flowering (Phillips et al., 1996). Some small insect and larvae damage has been noted in some populations. Self-pollination also occurs. Flowers abort if adverse pollination conditions (rain, no pollinators) exist.

The plants senesce in late fall. Since above-ground parts die back each winter, making it difficult to find, surveys for this plant should be conducted during the flowering/fruiting season (AGFD, 1997). More extensive information regarding the biology of this species can be found in Phillips et al. (1996).

Ethnobotany

The common name "snakeroot" is sometimes given to the genus *Cimicifuga*. The underground parts of *Cimicifuga racemosa* found in eastern North America contain a drug, cimicifugin, which has been used to treat uterine disorders and rheumatism. Other Eastern species were also used for snake bites. The common name "bugbane" suggests that the plant may have been used as an insecticide (Kearney & Peebles, 1960).

Habitat

Cimicifuga arizonica grows in moist, loamy soil of ecotones between coniferous forest and riparian habitat. Most of the known populations are located between 4800-8600 feet along canyon bottoms and lower canyon slopes (at times under overhangs) in association with Douglas fir, Rocky Mountain maple, and sometimes aspen. Some populations are found on mountains at seeps and springs, in drainages and on shaded north slopes. It appears to require deep shade from forest or riparian overstory, high relative humidity and cold air drainage. Canyon direction and aspect do not appear to be a big factor as long as the canyons are deep and narrow enough to provide shade for a large part of the day (Phillips et al., 1996; AGFD, 1997).

Associated species include *Acer grandidentatum*, *Abies concolor*, *Alnus oblongifolia*, *Cornus stolonifera*, and *Pseudotsuga menziesii*.

Distribution

This species is found only in Arizona in the Mogollon Rim area of central Arizona. All of the known populations and sites are found in four main population areas: (1) Bill Williams Mountain (Kaibab National Forest), (2) tributaries to Oak Creek (Coconino National Forest), (3) West Clear Creek (Coconino National Forest), and (4) Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains (Tonto National Forest) (Phillips et al., 1996; AGFD, 1997).

Cimicifuga arizonica is the only species of *Cimicifuga* occurring in Arizona (Phillips et al., 1996)

Herbarium Specimens

No herbarium specimens were found at local herbaria documenting the presence of *Cimicifuga arizonica* in Walnut Canyon National Monument (Hogan & Huisinga, 1997). However, several herbarium specimens exist that document the localities of this species in creeks along the Mogollon Rim. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Oak Creek Canyon, above rearing pond
NAU	Pumphouse wash
NAU	Clear Creek, 65 mi. S.E. of Flagstaff
NAU	60 mi. SE of Flagstaff, Coconino Co., Arizona
NAU	Maple Spring, T19N R6E S30, Coconino County
MNA	Workman Creek Falls, Sierra Ancha Mountains, Tonto National Forest, Gila County
MNA	Bill Williams Mountain, south of Williams, Kaibab National Forest, T21N R2E S8, along the trail and west of stream along trail, Coconino County
MNA	Junction Bugbane Canyon and West Buzzard Draw, T19N R6E S14/23
MNA	West Clear Creek, Tramway Trail
MNA	Secret Canyon, Sedona
MNA	1 1/2 mile downstream SE of Casner Tank in draw, T19N R5E NE 1/4
MNA	Fry Canyon, Coconino County

Listing Status (AGFD, 1997)

ESA:	C
USFS:	S
NESL:	None
ANPL:	HS
GRank:	G2
SRank:	S2

Cimicifuga arizonica is listed as a "candidate" species by the Endangered Species Act (ESA). The U.S. Forest Service recognizes it as a "sensitive" species. The Navajo Nation (NESL) does not recognize this species. The Arizona Native Plant Law (ANPL) does not allow collection of this species at all ("highly safeguarded"). The Global (G) and State (S) Rankings indicate the this species is imperiled because of its rarity and is in danger of extinction throughout its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

This species was not located within Walnut Canyon National Monument during the 1999 field season. It has never been observed there although it was on the search list because it occurs in many of the waterways along the Mogollon Rim. It seems unlikely that it will be found at Walnut Canyon because of the lack of perennial water.

This species has been extensively studied and surveyed. It has been located in several areas along the Mogollon Rim and is monitored regularly. Comprehensive reports are referenced in the annotated bibliography.

Management

Monitoring of this species shows that all populations appear to be stable or increasing. However, populations of this species can be easily threatened by general disturbance (AGFD, 1997). Some losses have occurred from incidental trampling by hikers accessing the falls at Workman Creek, scouring by heavy rains in Oak Creek Canyon, and disease in West Clear Creek. There is little use by insects and wildlife. Ninety-five percent of the observed populations are protected in part by the Wilderness Area designation (AGFD, 1997). Many populations are not easily accessible and are therefore less disturbed.

Annotated Bibliography

Arizona Game and Fish Department. 1997. *Cimicifuga arizonica*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Comprehensive review of species including description, biology, habitat, distribution, management factors, sources of further information, map, and occurrence reports. Element Status Designations also included.

Compton, J.A., A. Culham, and S.L. Jury. 1998. Reclassification of *Actaea* to include *Cimicifuga* and *Souliea* (Ranunculaceae): Phylogeny inferred from morphology, nrDNA ITS, and cpDNA *trnL-F* sequence variation. *Taxon* 47: 593-634.

Discusses the relationships between *Actaea*, *Cimicifuga*, and *Souliea* which affects the naming of the species

DeWald, Laura E. and B.G. Phillips. 1996. Morphological Variation Within and Among Four *Cimicifuga arizonica* Populations. Pp. 53-58. In Maschinski, Joyce, H.D. Hammond, L. Holter. *Southwestern Rare and Endangered Plants: Proceedings of the Second Conference*. September 11-14, 1995, Flagstaff, Arizona.

Research on the genetic diversity of four populations of this species.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kaye, T. and M. Kirkland. 1994. *Cimicifuga elata*: Status, habitat analysis, monitoring, inventory, and effects of timber management, 1993 report. Plant Conservation Biology Program. Oregon Department of Agriculture, OR.

Referenced in Phillips 1996.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Keys and brief description of *Cimicifuga* and discussion of medicinal uses of the plant.

Pellmyr, O. 1985. Pollination Ecology of *Cimicifuga arizonica* (Ranunculaceae). Botanical Gazette 146 (3): 404-412.

Referenced in Phillips 1996.

Phillips, Barbara G., et al. 1982. Status report: *Cimicifuga arizonica* Wats. Museum of Northern Arizona, Flagstaff. Submitted to USDI Fish and Wildlife Service, Albuquerque, NM.

Referenced in Phillips 1996.

Phillips, Barbara G., R. Popowski, C. Franz, and P. Warren. 1996. Conservation Assessment and Strategy for *Cimicifuga arizonica* Watson (Arizona Bugbane) on the Coconino and Kaibab National Forests. Pp. 213-218. In Maschinski, Joyce, H.D. Hammond, L. Holter. Southwestern Rare and Endangered Plants: Proceedings of the Second Conference. September 11-14, 1995, Flagstaff, Arizona.

Overview of the species, including background history, biology, ecology, distribution, habitat; five localities were selected for long-term Level 1 and Level 2 monitoring.

Ramsey, Gwynn W. 1997. Flora of North America, North of Mexico, vol. 3. Oxford University Press.

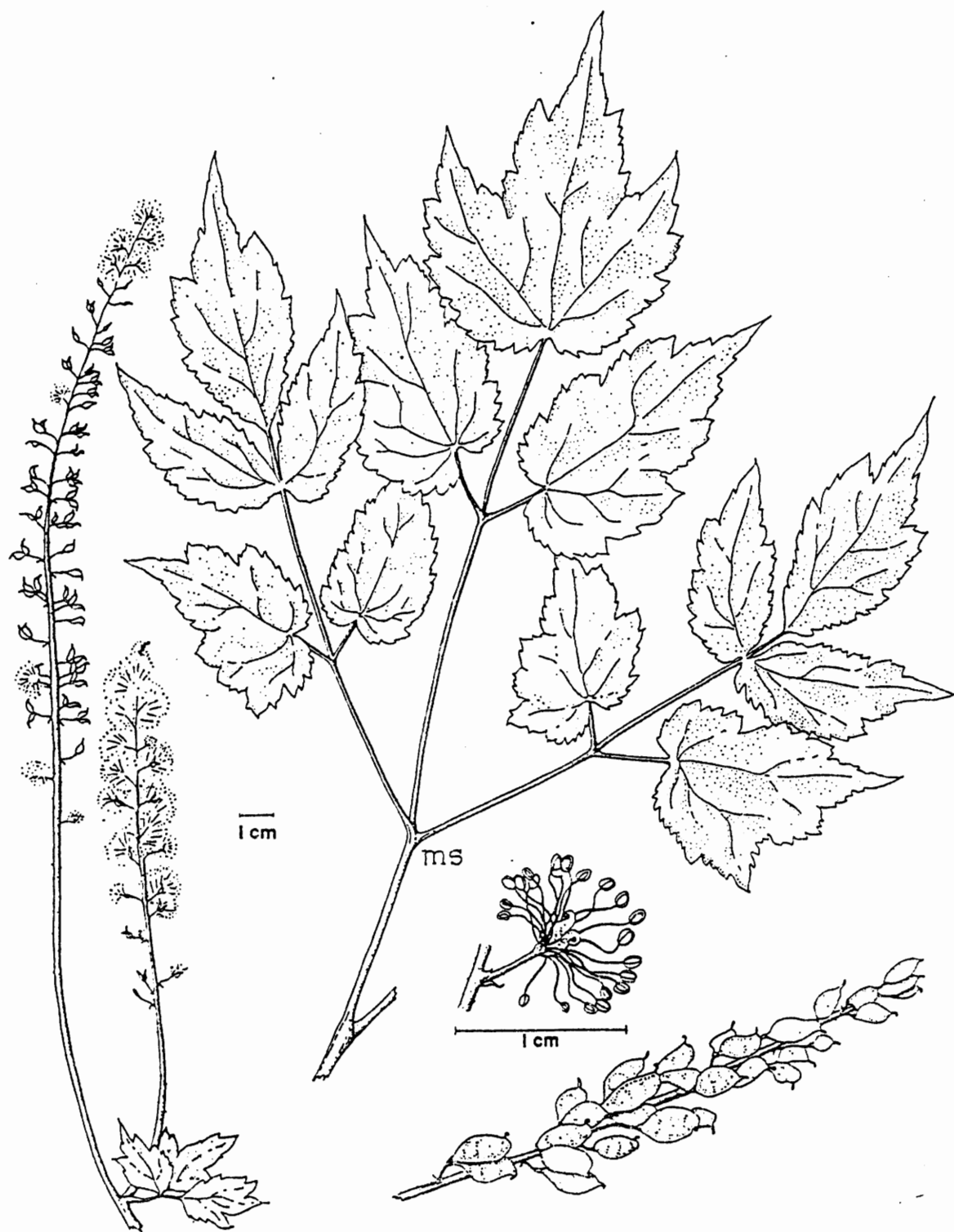
Description of genus, keys to six species, technical description, habitat, biology.

Rutman, Sue. 1990. Handbook of Federally endangered, threatened, and candidate plants of Arizona. U.S. Fish and Wildlife Service, Phoenix, AZ.

Brief description of habitat of this Category 1 species.

United States Fish and Wildlife Service, line drawing of plant in flower and seed.

Watson, Sereno. 1885. Descriptions of some new species of plants, chiefly from our Western Territories. Proceedings of the American Academy of Arts and Sciences 20: 352-353.



Cimicifuga arizonica

Latin Name: *Clematis hirsutissima* var. *arizonica*
Latin Name w/ authority: *Clematis hirsutissima* Pursh var. *arizonica* (Heller) Erickson
Synonyms: *Clematis arizonica*
Family: Ranunculaceae
Common Name: Arizona clematis, Arizona leatherflower

Original Description

1943. Annals of the Missouri Botanical Garden 3: 48.

Type Specimen

MacDougal 343. Walnut Canyon.

Taxon History

Although Erickson treats *C. hirsutissima* var. *arizonica* as a variety of *C. hirsutissima*, Kearney and Peebles (1960) suggest that it may be a distinct species. A more recent treatment by Pringle (1997) suggests that *C. hirsutissima* var. *arizonica* should not be recognized as distinct. Some plants of *C. hirsutissima* var. *hirsutissima* from Washington, Oregon, Colorado, and elsewhere have leaflets quite as narrowly-lobed, and other plants in the Flagstaff area have more widely lobed leaflets. The widely-spreading leaves of *C. hirsutissima* var. *arizonica* occur in other parts of the range of the species (Pringle, 1997).

Nonetheless, the Arizona clematis is still rare in Arizona. The typical phase of *Clematis hirsutissima* (var. *hirsutissima*) is confined to the North Rim of the Grand Canyon and the Kaibab Plateau in Arizona. *C. hirsutissima* var. *arizonica* occurs near Flagstaff, on the South Rim of the Grand Canyon, and some in New Mexico (Pringle, 1997).

Description

Herbaceous perennial shrub. STEMS singular or clustered, erect, weak or trailing, up to 70 cm long, woody below, usually climbing by means of tendril-like petioles, dying back in the fall after seeds are shed. LEAVES opposite, scattered along the stem, pinnately compound; *fine leaflets* 7-13, threadlike. FLOWERS bell-shaped, always found nodding, perfect or unisexual; *petals* rudimentary; *sepals* four, thick, deep purple; *stamens* and *pistils* numerous, solitary. FRUIT achenes, in globose heads with long, persistent, plumose styles (Kearney and Peebles, 1960; Ecosphere, 1995; Pringle, 1997; Galeano-Popp, n.d.).

The Arizona clematis differs from *C. hirsutissima* var. *hirsutissima* by its filiform leaflets and smaller flower size. *C. hirsutissima* var. *arizonica* has more spreading petioles, narrower, filiform leaflets, and smaller flowers and sepals (less than 2.5 cm. long) (Kearney & Peebles, 1960). The young leaves depart from the stem at approximately 45 degree angles, but when mature the leaf bases are set rigidly at 90 degrees from the stem axis. This may be the most consistent feature that distinguishes *C. hirsutissima* var. *arizonica* from the typical form of *C. hirsutissima* (Galeano-Popp, n.d.).

The Arizona clematis in the Zuni and Chuska Mountains approaches *C. hirsutissima* var. *arizonica* although it varies in flower size and leaflet form. The status of these plants is relatively uncertain (Ecosphere, 1995).

Biology

This variety flowers in the early spring from May to early June before the summer rains. It sets seeds in July and retains these seeds until August or early September depending on the year.

This variety appears to be dependent on sexual reproduction. During a study by Galeano-Popp (n.d.), a variety of insects were observed visiting the flowers, including butterflies and bees. However, many plants failed to set seed, especially when growing in small colonies. The plants are most often found in aggregated colonies and appear to successfully reproduce more often in this arrangement (Galeano-Popp, n.d.).

A study of shade effects (Kolb & Maschinski, 1996) showed that shading from the *Pinus ponderosa* canopy ameliorates daytime water stress in adult *Clematis*. Since shading lowers net photosynthetic rate, it is suggested that environments with intermediate levels of canopy cover characterized by frequent sunflecks may offer the best combination of exposure. "*Clematis* faces a trade-off between the costs of

water loss, bud death, and higher competitive conditions in open environments versus costs of reduced net photosynthesis, growth, and reproduction in the most shaded environments" (Maschinski, 1995).

More detailed accounts of the experimental biology and ecology of the variety can be found in Galeano-Popp (n.d.), Maschinski et al. (1997) and Maschinski (1995).

Ethnobotany

Closely related species are used for medicinal purposes such as migraine headaches. The roots of *C. hirsutissima* var. *arizonica* may have been used historically and should be studied for potential medicinal constituents. The Arizona Ethnobotanical Research Association (AERA) is currently conducting a formal ethnobotanical investigation on this plant (Hogan, 1999).

Habitat

This variety grows in upper pinyon-juniper woodland and ponderosa pine forests at elevations of 5000-6900 feet (Kearney & Peebles, 1960; McDougall, 1973; Ecosphere, 1995; Galeano-Popp, n.d.). *C. hirsutissima* var. *arizonica* usually grows on soils derived from Kaibab limestone in colonies consisting of between 1-200 plants covering only fractions of an acre (Rutman, 1990).

Galeano-Popp (n.d.) suggests that *Clematis* plants require specific conditions for growth and survival. The most important variables are substantial soil development in substrates, variable ground cover, 12-15% slope, and north-northeastern aspect. In addition, most plants grow in shady areas. Where *Clematis* plants were found in the open, the herbage had more purple-brown pigment and the leaves tended to be more narrow and inrolled, an adaptive response to prevent water loss (Galeano-Popp, n.d.).

Associated species are *Pinus edulis*, *Juniperus scopulorum*, *Festuca arizonica*, *Thalictrum fendleri*, *Solidago* sp., *Zygadenus elegans*, *Pseudocymopterus montanus*, and *Vicia americana*.

Distribution

This variety is found only in Coconino and Apache Counties in northern Arizona and in adjacent New Mexico.

Other *Clematis* species that also occur in Coconino County include: *C. bigelovii*, *C. ligusticifolia*, and *C. pseudoalpina* (Kearney and Peebles, 1960; McDougall, 1973; Pringle, 1997).

Herbarium Specimens

Several specimens of this variety were found in the local herbaria. However, this species has not been collected within Walnut Canyon National Monument. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Rio de Flag
NAU	1 ½ miles NE of Railroad Tank, Volunteer Canyon, SE ¼ S27 T21N R5E, on top of a grassy bank in an open area of the canyon
NAU	Fisher Point, 5 mi SE of Flagstaff, AZ, T21N R7E S36
NAU	SW side of Lower Lake Mary, NW1/4 NE1/4 S19 T20N R8E
NAU	Off forest road 296 near the lower lake Mary Dam
NAU	Camp Navajo, 0.5 km E of Atherton Marsh, Coconino County
MNA	Rio de Flag
MNA	Just west of lower end of lower Lake Mary, FS Route 296, near well housing, Lake Mary Meadows, SE1/4 Sec18 T20N R8E

Listing Status (AGFD, 1998)

ESA:	C
USFS:	S
NESL:	4
NPL:	HS
GRank:	G4T2Q
SRank:	S1

The Endangered Species Act (ESA) lists this variety as a "candidate" for listing. The U.S. Forest Service (USFS) lists this variety as a "sensitive". The Navajo Nation (NESL) indicates that this species is not currently listed as a species of concern due to the lack of information regarding its status on reservation lands. The Arizona Native Plant Law (NPL) considers this variety of *Clematis* a "highly safeguarded" plant and no collection is allowed. The Global Ranking (G) lists this variety as one that appears to be secure on a global scale though it is rare in parts of its range, especially at the periphery. The State Ranking (S) states that this variety is critically endangered in its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

About 1600 plants are known on the Coconino National Forest mostly in the Lake Mary vicinity (Galeano-Popp, n.d.). Most of the populations along the Rio de Flag have declined significantly but a few spotted localities still exist (Hogan & Huisinga, unpub. data). This variety has been reported from the Zuni Mountains and the Navajo Nation but the taxonomic status of these populations is not understood (Rutman, 1990).

No new locations of *C. hirsutissima* var. *arizonica* were found after extensive searches in Walnut Canyon National Monument during the 1999 field season. It is highly likely that this species occurs within the Monument and searches should continue into future field seasons. The abundance of shaded forests and limestone substrate would be ideal for the colonization of this species. In addition, many populations are found along the Lake Mary drainage system which includes Walnut Canyon (in flood years).

Management

Logging and thinning activities may negatively affect *Clematis*. Heavily logged sites appear to have different leaf morphology, higher incidences of flowering failures in the form of dried and shrivelled buds, and lower seed germination rates due to increased light penetration (Galeano-Popp, n.d.). However, thinning that maintains intermediate levels of shading (>50% canopy cover) is probably not detrimental (Kolb & Maschinski, 1996).

Other activities may not affect the status of *Clematis*. This variety may be fire-adapted and may benefit from the inhibition of grass establishment and reduction of accumulated litter. However, this is based on assumption. Grazing pressure by ungulates appears to be minor. Impact from recreational activities such as camping and off-road vehicle travel is minor because *Clematis* is found in rocky, inaccessible areas (Galeano-Popp, n.d.).

Some protection is provided for the populations that are found within the National Forests, the Grand Canyon National Park and the Navajo Army Depot. More extensive information regarding the management concerns of this variety can be found in Galeano-Popp (n.d.).

Annotated Bibliography

Arizona Game and Fish Department. 1998. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Ecosphere Environmental Services, Inc. 1995. The Farmington District. Endangered, Threatened and Sensitive Plant Field Guide. Farmington District, Farmington, New Mexico.

Brief description, line drawing and photographs.

Galeano-Popp, Renee. n.d. *Clematis hirsutissima* Pursh. var. *arizonica* (Heller) Erickson: Preliminary study and survey in the Lake Mary Timber Sale Area. Prepared for Coconino National Forest, Contract #40-8167-8-276.

Comprehensive survey of study plots with comments regarding the distribution, habitat, biology, and effect of management activities on this sensitive species. Approximately 100 locations of *C. hirsutissima* var. *arizonica* were documented and an estimated 1500 plants were observed.

Hogan, Phyllis. 1999. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Key to genus and five species; description of *C. hirsutissima* includes a note regarding var. *arizonica*.

Kolb, T. and J. Maschinski. 1996. An Ecophysiological Analysis of Shade Effects on *Clematis hirsutissima* var. *arizonica*. Pp. 206-212. In Maschinski, Joyce, H.D. Hammond, L. Holter. Southwestern Rare and Endangered Plants: Proceedings of the Second Conference. September 11-14, 1995, Flagstaff, Arizona.

Report of research on net photosynthetic rates and water potentials of adult *Clematis hirsutissima* var. *arizonica* in four canopy density environments.

Maschinski, Joyce. 1995. Report on 1994 Challenge Cost-share proposal for research on *Clematis hirsutissima* var. *arizonica*. Unpublished report in files of Peaks Ranger District office, Coconino National Forest.

Report of research to determine the effect of shading on reproduction of the species and tracking of the population dynamics in a long-term demographic study.

Maschinski, Joyce, et al. 1997. Potential impacts of timber harvesting on a rare plant species, *Clematis hirsutissima* var. *arizonica*. Biological Conservation 80: 49-61.

Published report of shading studies.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Key to the genus and six species; description of *C. hirsutissima* includes a note regarding var. *arizonica*.

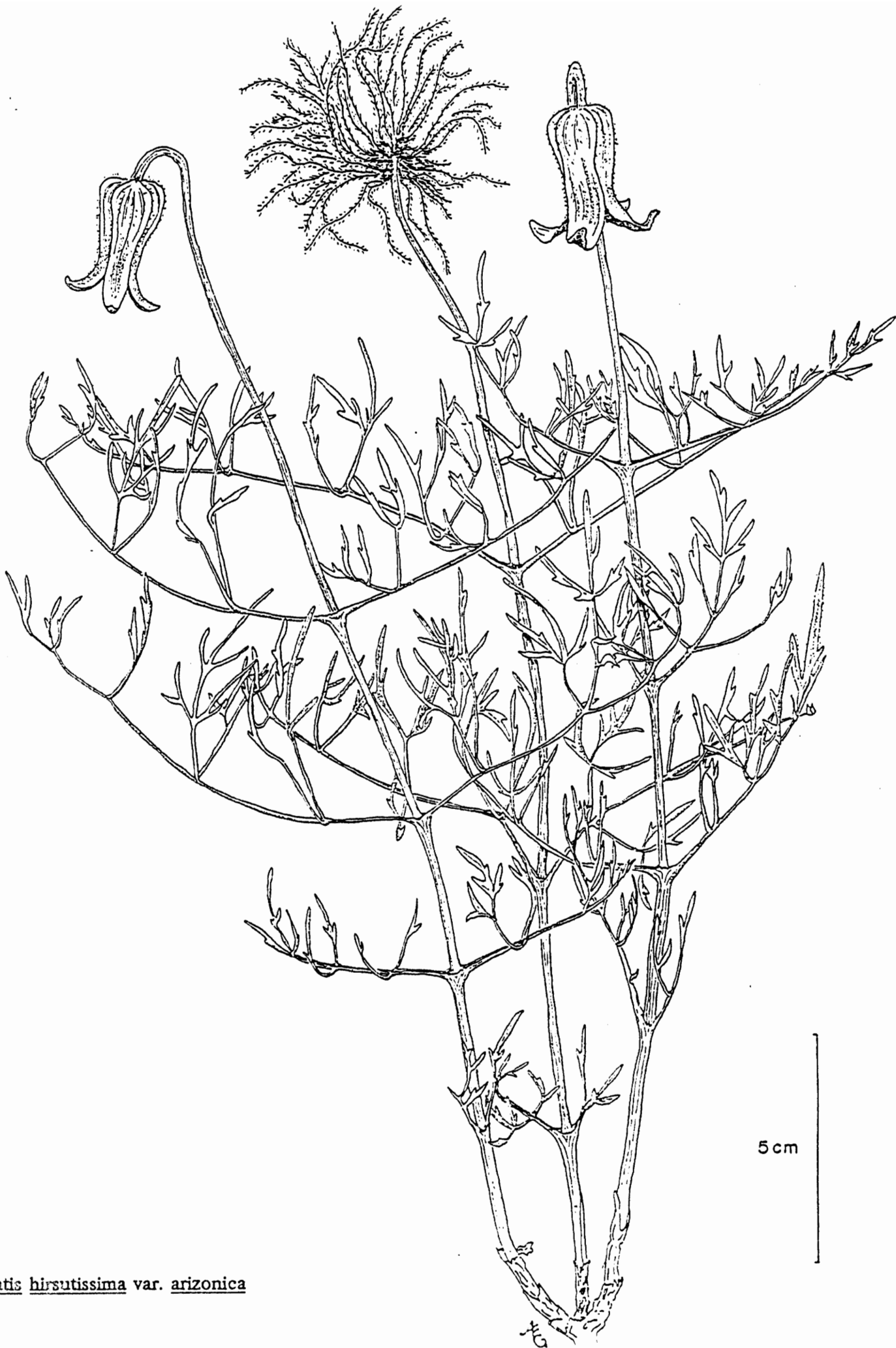
Pringle, James S. 1997. Flora of North America, North of Mexico. Oxford University Press, New York. Vol 3.

Keys to Ranunculaceae, key to *C. hirsutissima* var. *hirsutissima* and var. *scottii* with description of var. *arizonica*.

Rutman, Sue. 1990. Handbook of Arizona's rare plants. U.S. Fish and Wildlife Service, Phoenix, AZ.

A brief description of habitat and distribution.

United States Fish and Wildlife Service, line drawing of plant in flower.



Clematis hirsutissima var. arizonica

Latin Name: *Erigeron saxatilis*
Latin Name w/ authority: *Erigeron saxatilis* Nesom
Synonyms: *Erigeron pringlei* A. Gray
Family: Asteraceae
Common Name: Rock fleabane

Original Description

G.L. Nesom. 1990. Phytologia 69 (3): 227-235.

Type Specimen

Type locality: Oak Creek Canyon, Arizona

Holotype: Ripley and Barneby 3109, NY! (New York Botanical Garden). May 24, 1940.

Isotype: NY!

Taxon History

Cyrus Pringle first collected plants of this species on Mt. Wrightson in the Santa Rita Mountains on June 6, 1881. The original description was done by Asa Gray in 1882. Other collections were made in the 1930's and 1940's in areas near the Sierra Ancha and Mazatzal Mountains to West Fork of Oak Creek Canyon. Several new localities have been found in recent years including ones in Walnut Canyon (Phillips, 1991).

In 1990, Guy Nesom revised the species and split *Erigeron pringlei* into four taxa: *E. pringlei*, *E. heliographis*, *E. anchana* and *E. saxatilis*. *E. pringlei* includes the type specimen and other plants from the Santa Rita Mountains and other mountain localities (Phillips, 1991).

According to Nesom (1990), the geographic range of *Erigeron saxatilis* is contiguous with that of *E. anchana*. However, *E. saxatilis* is restricted to the Colorado Plateau above the Mogollon Rim. *Erigeron anchana* has only been collected south of the rim. Furthermore, the two species are morphologically distinct and *E. saxatilis* flowers earlier than *E. anchana* (Phillips, 1991).

Description

Perennial herbs, small, growing in dense tufts from a thick taproot, plants comparatively slender, small leaved and small-headed. STEMS 3-5 cm long, erect and unbranched. LEAVES basal and cauline; basal leaves linear-spatulate to obovate, some of them usually 3-toothed to pinnatifid, 1-3 cm long, 0.5-2.0 mm wide at the widest point, petioles about as long as the blade when distinct; stem leaves entire, much narrower. FLOWER heads 6-7 mm wide; peduncles 8-15 mm long, with bracts; phyllaries glabrous, purplish, strongly graduated in 3-4 series; ray flowers 20-29 in a single series, with corollas 5.5-7.0 mm long, white, the ligules 1.0-1.5 mm wide; disc corollas 2.1-3.0 mm long, narrowly funnelform. FRUIT achenes, with sparse, stiff hairs, 1.3-1.6 mm long; pappus of 9-13 bristles, the longest 2.5-2.6 mm long (Nesom, 1990; Phillips, 1991).

This species can be distinguished in the field from other species of *Erigeron* within its range by its persistent stout, woody, leaf bases of previous years' growth and by its glabrous phyllaries (Phillips, 1991).

E. saxatilis can be distinguished from *E. heliographis* by its apically broadened leaf blades, shorter disc corollas, and fewer and shorter pappus bristles (Nesom, 1990).

Biology

This species flowers mostly from April to July and sometimes into September. Plants of all size classes from seedling to adult (with many flowers and fruit evident) are present in populations varying in number from a few plants to over 300. In field studies from 1985 to 1989, no pollinators were observed at twelve individual sites although plants were flowering profusely in season (Phillips, 1991).

Ethnobotany

Several species of *Erigeron* were used historically by the Navajo for ceremonial and medicinal purposes (Hogan, 1988).

Habitat

Erigeron saxatilis is found in riparian, deciduous forests of the western mountains at elevations between 4400-8350 feet. It most commonly grows on shaded cliff-faces and in streambeds of shady canyons. Although Coconino sandstones seem to be preferred, the Mt. Elden locality substrate is dacite (Phillips, 1991).

Distribution

Erigeron saxatilis is an endemic found only above the Mogollon Rim in the mountains of central Arizona. Specific localities are listed below. Other taxa in this group (*E. pringlei*, *E. heliographis*, *E. anchana*) are found in southern Arizona in the Pinaleno Mountains and the Santa Rita Mountains.

Herbarium Specimens

Several herbarium specimens were found at the local herbaria documenting the presence of *Erigeron saxatilis* within Walnut Canyon National Monument (Hogan & Huisinga, 1997). Other localities along the Mogollon Rim are listed below as well but the Walnut Canyon localities are listed first. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Walnut Canyon, Sec. 26 T21N R8E, canyon bottom between Monument west boundary and narrows
NAU	Entrance to Walnut Canyon, Sec. 6 T20N R8E
NAU	Walnut Canyon, below Fisher Point
NAU	Mogollon Rim, Barbershop Canyon, S10 T13N R111/2 E, running N into Clear Creek
NAU	Red Hill, 15 miles northeast of Blue Ridge, Sec. 19 T15N R13E
NAU	West Fork, Oak Creek
NAU	0.5 mile S of Little Elden Spring
NAU	East side of East Clear Creek

Listing Status (AGFD, 1997)

ESA:	None
USFS:	S
NESL:	None
NPL:	None
GRank:	G2
SRank:	S2

This species is listed as an U.S. Forest Service (USFS) "sensitive" species. The Endangered Species Act (ESA), the Navajo Nation (NESL), and the Arizona Native Plant Law (NPL) do not list this species. The Global Ranking indicates that this species is imperiled globally because of rarity. The State Ranking lists this species as vulnerable to extinction at the state level. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the 1999 field season, several populations of *Erigeron saxatilis* were relocated within Walnut Canyon National Monument. Approximately 50 individuals were found below the heavily traveled Island Trail in Walnut Canyon. One other locality near the western boundary of the Monument was found with over 15 individuals. Both localities are remote and appear to be safe from disturbance.

Management

Most of the populations of the four *Erigeron* species occur in remote or inaccessible areas with few threats (Phillips, 1991). However, some populations are at risk due to development and heavy use of riparian areas, flooding, and sensitive habitat. The plants that occur along the trails in Walnut Canyon National Monument and near Fisher Point are probably the most at-risk populations because of the impact from recreational use.

Annotated Bibliography

Arizona Game and Fish Department. 1997. *Erigeron saxatilis*. Unpublished Plant Abstract, Heritage Data Management System, Arizona Game & Fish Department, Phoenix, AZ.

Includes classification, description, biology, conservation. Also from the same source, element status designations and specific location occurrences with plant condition, flower and fruit detail where possible.

Hogan, Phyllis. 1988. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Nesom, G.L. 1990. Taxonomy of the *Erigeron pringlei* group. *Phytologia* 69 (3): 227-235.

Phillips, Barbara G. 1991. Status Report *Erigeron* sp. Unpublished report submitted to U.S. Fish and Wildlife Service. Museum of Northern Arizona, Flagstaff, AZ.

Thorough review of four *Erigeron* species, including *E. saxatilis* classification, technical description, locations, management concerns; report of field studies by the author and assistants in twelve sites from 1985 to 1989.

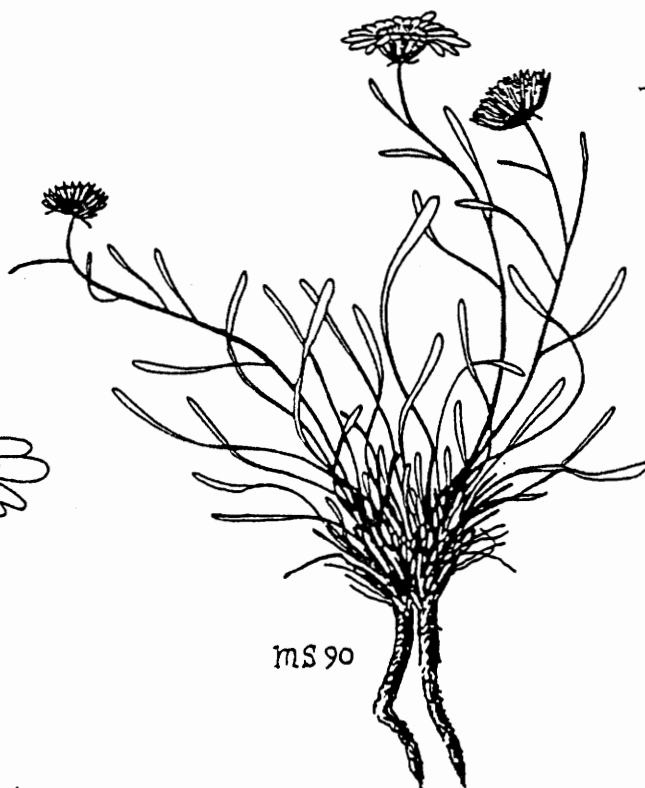
United States Fish and Wildlife Service, line drawing of plant in flower.



5mm



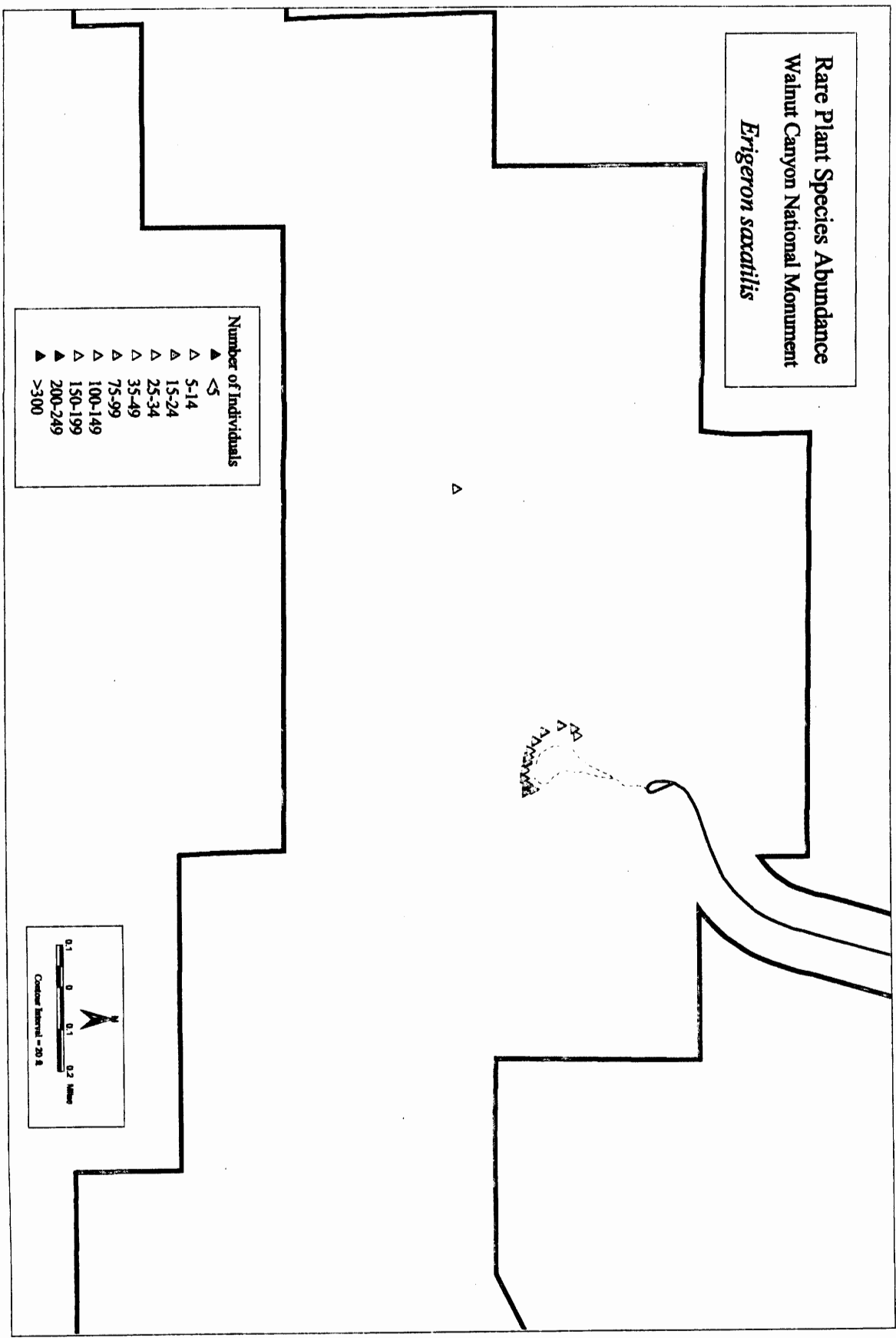
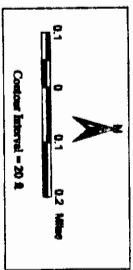
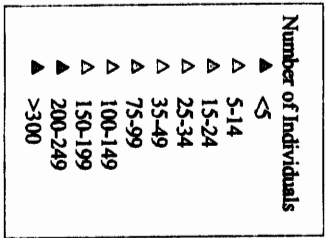
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1cm

Erigeron saxatilis

Rare Plant Species Abundance
Walnut Canyon National Monument
Erigeron saxatilis



Latin Name: *Hedeoma diffusa*
Latin Name w/ authoriy: *Hedeoma diffusa* Greene
Synonyms: *Hedeoma blepharodontum*, *Hedeoma diffusum* (difference only in ending)
Family: Lamiaceae
Common Name: Flagstaff pennyroyal, Mock pennyroyal, Spreading false pennyroyal

Original Description

Hedeoma diffusum. Pittonia, iii, 338.

Type Specimen

Jones, 1884. *Hedeoma diffusum*.

Rusby, 1883. *Hedeoma blepharodontum*.

Taxon History

Two collections served as the type specimens for *H. diffusum* and *H. blepharodontum*, which were described by Edward L. Greene in 1898. Both now fall under the same name, *Hedeoma diffusum*. Dr. Rusby made the first collection (then called *Hedeoma blepharodontum*) in 1883. In 1884, M.E. Jones collected it again although it was named differently as *Hedeoma diffusum* (Irving, 1980; Boucher, 1984; Phillips, 1984).

Description

STEMS 5-20 cm long, wiry and prostrate or nearly so, forming dense mats 30-40 cm diameter. LEAVES mostly oblong to oval, 4-6 mm long. FLOWERS 1 to 3 in the leaf axils, often borne nearly the full length of the stem; *calyx* tube about 5 mm long, not strongly 2-lipped but the upper teeth sometimes as much as twice as long as the lower; *corolla* about twice as long as the calyx. FRUIT nutlet, smooth (McDougall, 1973).

Biology

This species blooms from May to August.

Ethnobotany

The aerial parts of this plant can be used medicinally as a tea for fever and painful menstruation. *Hedeoma* was used historically by the Western Navajo as a ceremonial lotion in the Lifeway ceremony (Hogan, 1994).

Habitat

H. diffusa occurs only in specific habitats within the ponderosa pine forest: rock pavement, cliffs, and limestone breaks. It is found on south to east exposures on outcrops of dolomitic upper Kaibab limestone Counties at elevations between 5000-7000 feet. It prefers cliffy outcrops of white to pink substrate and appears to avoid cherty layers of high quartz content. It grows well in deeper soil (about 4-6") but will colonize in vertical cracks as well. Occasionally this species will colonize downslope from limestone outcrops but in only distinct soils (Phillips, 1984).

Associated species are *Pinus ponderosa*, *Quercus gambellii*, *Geranium* sp., *Potentilla* spp., *Lotus wrightii*, *Festuca arizonica*, *Solidago sparsiflora*, *Astragalus* sp., and *Elymus elymoides* (Goodwin, 1983; Phillips, 1984).

Distribution

This species is known only from northern Arizona in Navajo, Coconino, and Yavapai Counties (Kearney & Peebles, 1951; McDougall, 1973). The majority of plants are located in Oak Creek, West Fork of Oak Creek, and Secret Mountain although it is found further north in Flagstaff (Boucher, 1987).

Phillips (1984) estimated that about 100 locations of this species exist, over 50 of which have at least 100 plants, and 5 of which have over 1000 plants. In 1989, a survey of the Fisher-Campbell Timber Sale area showed that the species occurred in drainages running into Walnut Canyon mostly those with a north or northwest direction (Olwine, 1989).

Other species of *Hedeoma* that occur in Coconino County include: *H. drummondii* (3500-7500 feet, April to September), *H. hyssopifolium* (5000-9500 feet, May to October), *H. nanum* (1000-5500 feet, March to October), and *H. oblongifolium* (2000-8000 feet, April to September).

Herbarium Specimens

Several herbarium specimens documenting this species were located at local herbaria. It has been found in areas of Walnut Canyon but has not been documented within Walnut Canyon National Monument. Many duplicated specimens were found at the NAU and MNA herbaria although only one of each locality was noted here. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
MNA	Fisher Point, Sec. 31 T21W R8E
NAU	2 miles north of Lower Lake Mary, SE1/4 SE ¼ Sec5 T20N R8E
NAU	3 miles SW of Lower Lake Mary, SE1/4 SE ¼ Sec35 T20N R7E
NAU	1 1/2 miles NE of Lower Lake Mary, SE1/4 SE ¼ Sec9 T20N R8E
NAU	1/4 mile N of Lower Lake Mary, SW1/4 SE ¼ Sec17 T20N R8E
NAU	2.5 miles N of Lower Lake Mary, SW1/4 SE ¼ Sec4 T20N R8E
NAU	2 miles NE of Lower Lake Mary, Sec 8 T20N R8E
NAU	Oak Creek Canyon
NAU	Secret Mountain
NAU	Fisher Point, Walnut Canyon, Sec. 31 T21N R8E
NAU	Sycamore Canyon

Listing Status (AGFD, 1998)

ESA:	None
USFS:	S
NESL:	4
NPL:	SR
GRank:	G3
SRank:	S3

The Endangered Species Act (ESA) does not list this species. The U.S. Forest Service (USFS) lists it as a "sensitive" species. The Navajo Nation (NESL) indicates that this species is not currently listed as a species of concern due to the lack of information regarding its status on reservation lands. The Arizona Native Plant Law (NPL) considers this species as "salvage restricted" and allows collection with a permit. The Global (G) and State (S) Rankings indicate that this species is very rare in its habitat and is vulnerable to extinction. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

The survey crew did not find *Hedeoma diffusum* within Walnut Canyon National Monument in 1999. An extremely limited area was covered while searching for other rare species that do not necessarily occur in the same habitat. Other species of *Hedeoma* were found within the Monument. It is likely that *Hedeoma diffusa* does occur within the Monument because it is found in nearby areas like Fisher Point and at Lake Mary.

Management

Many factors contribute to the limited distribution of *Hedeoma diffusum*. It appears to be sensitive to competition from other species, especially grasses (Phillips, 1984). Goodwin (1983) noted that many plants show decreasing vigor and density in areas with heavy pine needle accumulation due to the increased soil acidity. *H. diffusum* requires soil stability on slopes and intensive soil erosion can destroy established plants (Phillips, 1984).

Fire suppression could be preventing its establishment in some areas. A year after the Fisher Prescribed Burn in October 1988, five vigorous colonies were found in the burned area. The plants seemed more vigorous than those observed in unburned areas having long stems and abundant flowers (Olwine, 1989). Post-fire monitoring of a prescribed burn showed a modest increase in plant abundance in the burn

plots versus the control plots. Due to a small sample size, no direct association between plants and ground cover, grass cover, litter depth, tree canopy and precipitation on the individual plots of *H. diffusum* was observed (Crisp, 1997).

This species does not appear to be sensitive to common disturbances such as trampling and road travel. Healthy populations were found in an ungraded infrequently used roadway (Phillips, 1984). The plants are not heavily impacted by cattle because of their prostrate and matted habit. Fletcher (1980), after visiting the Fisher Point population, observed that *Hedeoma diffusum* plants were repeatedly covered up and trampled by livestock and vehicles. It was noted that the species was recovering well even after severe and regular impacts. Healthy populations have also been observed in old skidding areas where light to moderate timber activities have taken place (Crisp, 1997).

Phillips (1984) suggests that known populations and habitats of *Hedeoma diffusum* should be protected from road construction, herbicide application, slash piles, trail construction, conifer plantations, recreational developments, heavy cattle grazing and stock water development (Phillips, 1984).

Additional literature regarding previous management and study of this species is noted in the bibliography.

Annotated Bibliography

Boucher, Paul F. 1987. A continuing survey for *Hedeoma diffusum* Greene. Prepared for the USDA Forest Service Coconino National Forest.

Report of field surveys in difficult terrain in Red Rock Secret Wilderness and Oak Creek Canyon area. Populations found to be widespread, with visible plants in the thousands.

Crisp, Debra. 1997. Prescribed Fire Effects on Flagstaff Pennyroyal *Hedeoma diffusum* Greene. Unpublished report in US Fish and Wildlife Service office, Peaks Ranger District, Flagstaff, AZ.

Results of an independent study project for NAU begun with monitoring and prescribed fires in 1989 and monitoring of the study plots each year through 1995.

Fletcher, R. 1980. Provisional status report: *Hedeoma diffusum*. USDA Forest Service Report, Albuquerque, New Mexico.

Referenced in Goodwin 1983.

Goodwin, Greg. 1983. Proposed Thomas and Walnut Timber Sales Mormon Lake District, Coconino National Forest: Survey results and interim management guidelines for *Hedeoma diffusum* Greene. Unpublished report in office of US Fish and Wildlife Service, Peaks Ranger District, Flagstaff AZ.

Report includes location maps of known populations in the Thomas and Walnut Timber Sale area, and a small population in Sycamore Canyon area.

Hogan, Phyllis. 1994. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Description of genus, key and descriptions of seven species.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

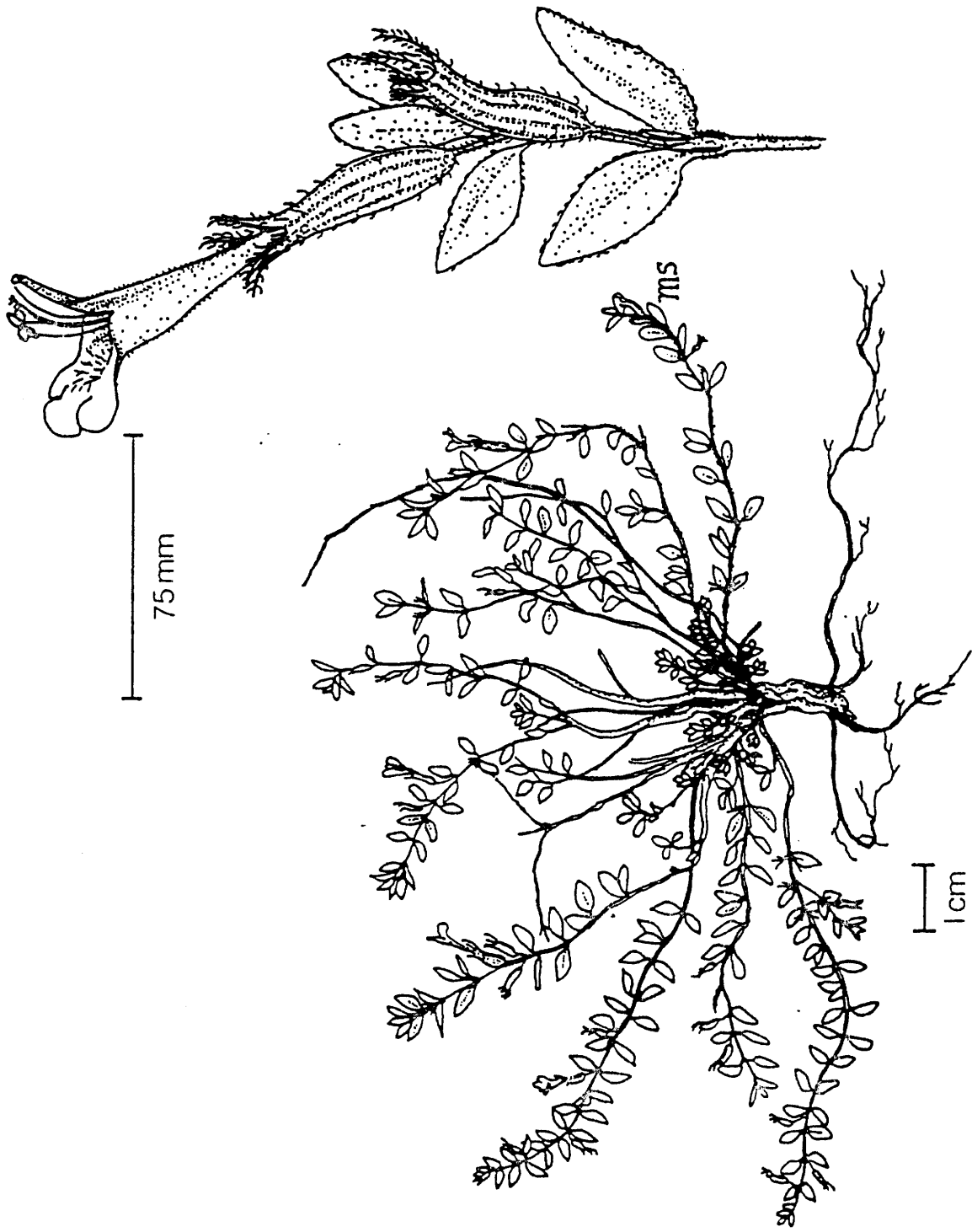
Brief description, key and descriptions of five species, all found in Coconino county.

Olwine, John. 1989. Field Survey for *Hedeoma diffusum* on the Elden Ranger District, Coconino National Forest. Unpublished report in office of USFWS, Peaks Ranger District, Flagstaff, AZ.

Report of field work in the Fisher-Campbell Timber Sale area September 25 through September 29, 1989 by driving roads or hiking through areas of suitable habitat; populations recorded on field data sheets and topo maps.

Phillips, Barbara G. 1984. Field Survey for *Hedeoma diffusum* Greene Coconino National Forest. Unpublished report in USFWS office, Peaks Ranger District, Flagstaff, AZ.

Survey of populations in Oak Creek Canyon and west of Lower Lake Mary with much information about the biology of the plant and management recommendations.



Hedeoma diffusum

Latin Name: *Amsonia peeblesii*
Latin Name w/ authority: *Amsonia peeblesii* Woods.
Synonyms: none
Family: Apocynaceae
Common Name: Peebles' bluestar

Original Description

Robert E. Woodson, Jr. 1936. Additions to the genus *Amsonia*. Bulletin Torrey Botanical Club, Volume 63: 35-36.

Type Specimen

T.H. Kearney & R.H. Peebles 9568, Missouri Botanical Garden. May 27, 1934. Near Leupp, Coconino County, AZ.

Taxon History

A specimen of *A. peeblesii* was first collected in 1890 near Lee's Ferry although it was originally mislabelled as *A. palmeri*. Another specimen collected by Thomas H. Kearney and Robert H. Peebles near Leupp, Arizona in 1934 was the basis of Robert E. Woodson's (1936) description of the species. *A. peeblesii* was collected several more times in the Cameron area and in two places at Wupatki National Monument. Since 1939, it has been collected in many scattered localities from St. John's (Apache Co.) northwest to Cameron (Coconino Co.), a distance of about 150 miles. Bureau of Land Management surveys in the 1970s and 80s documented other localities in this vicinity (Reichenbacher, 1986).

McLaughlin (1982) found numerous *A. peeblesii* specimens labelled as *A. tomentosa* var. *stenophylla* and *A. eastwoodiana* on the basis of two specimens, one from Utah in fruit and one from a specimen from Arizona. One of the specimens was clearly *A. eastwoodiana* but the other turned out to be what Woodson later described as *A. peeblesii*. This has caused great confusion because incorrect flower and fruit dimensions for *A. eastwoodiana* were given in the keys by Woodson (1928 & 1938) and Kearney and Peebles (1960).

Amsonia peeblesii is placed in subgenus *Sphinctosiphon* by both Woodson (1936) and McLaughlin (1993) who both conclude that it is most closely related to *A. palmeri*.

Description

Herbaceous perennial. PLANTS 40-90 cm tall, glabrous. STEMS one to several, branched above. LEAVES numerous and alternate, oblong-linear to linear, the lower ones 3-7 cm long, 4-9 mm wide, the upper ones 3-7 cm long, 1-2 mm wide. FLOWERS small, in terminal panicles; *calyx* lobes 5-parted, ovate to linear, 2-7 mm long; *corolla* tube 13-19 mm long, trumpet-shaped, the white or light blue narrow tube flaring abruptly at the open end and slightly swollen just below the flared oblong lobes which are 5-10 mm long. FRUIT terete, 2-10 cm long. SEEDS cylindrical, corky, 8-11 mm long, 1.5-2.5 mm broad (McLaughlin, 1993).

Amsonia peeblesii is easily confused with the glabrous form of *A. tomentosa* var. *stenophylla*. However, *A. peeblesii* has much larger flowers (13-19 mm long) and smoothly cylindrical follicles while *A. tomentosa* var. *stenophylla* has smaller flowers (7-12 mm long) and moderately constricted follicles (Reichenbacher, 1986).

Amsonia peeblesii is also very close to *A. eastwoodiana*. The two are nearly indistinguishable without flowers and fruits. However, *A. peeblesii* has a larger corolla tube (16-18 mm long) than *A. eastwoodiana* (10-15 mm long) and the corolla lobes of *A. peeblesii* are 7-12 mm long (vs. 4-6 mm long in *A. eastwoodiana*) (McDougall, 1973).

While a very close relative of *Amsonia palmeri*, the two species do not occur together. *A. palmeri* is found at lower elevations (2500-5000 feet) and along watercourses in southwestern Arizona (Cochise, Graham, Maricopa, Mohave, Pinal, Yavapai counties). *A. peeblesii* is found only in northern Arizona (Apache, Coconino, Navajo counties) from 4000-6000 feet (McDougall, 1973).

Biology

This species buds in early April, flowers mid-April through early June, and sets fruit in late May through mid-June depending on the year.

The pollinators of *A. peeblesii* are unknown. McLaughlin (1993) speculates that the white color and tubular shape of the corolla indicates pollination by hawkmoths (Sphingidae). There is a possibility that the plants are self-pollinated because the flowers are not protandrous (anthers releasing pollen before the stigma is receptive) (Reichenbacher, 1986).

Amsonia peeblesii is a relatively distinctive species in a genus which is characterized by imperfect reproductive barriers between taxa and/or extreme variability between sites. Although no evidence of hybridization has been seen in the field, *Amsonia* species sometimes have overlapping morphological characters (Reichenbacher, 1986).

Ethnobotany

The Western Navajo give the plant *Amsonia peeblesii* a descriptive name, "Turkey corn". The entire plant and roots are used in the Lifeway Medicine. The roots are also used to assist circulation. A decoction of the entire plant is used for skin irritation caused by chicken pox or measles. The Navajos distinguish this species from a closely related species, *Amsonia jonesii*, which they call "Blue root medicine". The root of *A. jonesii* is used as an eyewash but is otherwise used like *Amsonia peeblesii* (Hogan, 1982; Hogan & Huisinga, 2000).

Habitat

This species is found principally in shrubland and shrubland-grassland with a few populations in the grasslands at Wupatki National Monument. Substrate types range from strongly alkaline sedimentary conglomerates to volcanic cinders. The plant's elevational range is from 4000-6000 feet.

Some associated species are *Gutierrezia sarothrae*, *Atriplex confertifolia*, *Fallugia paradoxa*, *Lycium andersonii*, *Forestiera neomexicana*, *Ephedra torreyana*, *Chrysothamnus nauseosus*, *Yucca angustissima*, *Bouteloua gracilis*, *Hilaria jamesii*, and *Sporobolus airoides*.

Other *Amsonia* species also found in Coconino County are *A. jonesii* (4000-5200 feet, April to May) and *A. tomentosa* var. *stenophylla* (1500-4500 feet, April to June) (McDougall, 1973; McLaughlin, 1993).

Distribution

Amsonia peeblesii is found only in Arizona in Apache, Coconino, Navajo Counties. Except for the Lee's Ferry collection, the plant occurs entirely within the Little Colorado Valley from Winslow to Cameron (Reichenbacher, 1986). Although *Amsonia peeblesii* and other *Amsonia* species are found in Coconino County, none of these species are common. They may be abundant in a local area but their populations are very scattered and rare.

In 1980 (Bateman), *Amsonia peeblesii* was discovered at four locations at Wupatki National Monument. In Section 7 approximately 0.4 miles south of Citadel Sink and halfway between the base of South Mesa and the road, 116 individual clusters were counted. At the merging of two jeep trails in Section 13 of Wupatki National Monument, 42 clusters were counted at the base of a rocky ledge. Approximately 100 m northwest of this location, 106 additional clusters were counted in a small unnamed wash. Finally, 324 clusters of *Amsonia peeblesii* were found in Sections 1 and 6 at the base of Cedar Canyon near the Borrow Pit, in the grass-*Atriplex-Fallugia* association adjacent to the Juniper-Grassland, but none were found in association with junipers. The soil (sandy base with a light cinder cover) in all locations was bare except for a few four-winged saltbushes and some grasses (Bateman, 1980).

Herbarium Specimens

Several herbarium specimens documenting the presence of *A. peeblesii* at Wupatki National Monument were found in local herbaria (Hogan & Huisinga, 1997). All Wupatki locations are listed first. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
MNA	Wupatki National Monument
MNA	3 miles south of visitors center, Wupatki National Monument
NAU	Wupatki National Monument, in middle of Cedar Canyon, 3/4 way across from borrow pit going west, SE1/4 NW1/4 NE1/4 SE1/4 Sec. 7 T25N R9E
NAU	Small, dry, sandy wash, Wupatki National Monument
NAU	Wupatki, NW corner Sec. 13
WUPA	1/2 mi. from Wukoki Ruin
WUPA	Wukoki Ruin
NAU	Coconino County, 9.3 miles S of junction US 89 and US89A, ca .25 miles W of US89, 36 degrees 30'N 111 degrees 35'W
NAU	10 miles S of Winslow on Chevron Butte Rd.
NAU	Montezuma Castle National Monument, Yavapai Co., S boundary fence, ca 1/2 mile from SE corner of fence, 34 degrees 37' N 111 degrees 50' W (This specimen was probably misidentified and is probably <i>A. eastwoodiana</i>)
NAU	Coconino Co., 2 miles W of Red Point Hills, 36 degrees 12'N 111 degrees 34'W
NAU	Spiderweb Ranch, north of Wupatki National Monument, in Jackrabbit Wash, 1/4 mile SW of Cement Dam Tank, T26N R9E Sec. 10 SE1/4
MNA	Road to Cameron, AZ
MNA	Junction of Platt Wash with Little Colorado River
MNA	Old road to Grand Canyon
MNA	Polacca-Winslow Rd., Navajo County, AZ
MNA	27N 8E-1, 2 mi NE of Gray Mountain

Listing Status (AGFD, 1999)

ESA:	None
USFS:	None
NESL:	None
ANPL:	None
GRank:	G3
SRank:	S3

The Endangered Species Act (ESA), the U.S. Forest Service (USFS), the Navajo Nation (NESL), and the Arizona Native Plant Law (ANPL) do not recognize this species. The Global (G) and State (S) Rankings indicate that this species is uncommon or restricted and is rather rare throughout a fairly wide range but may be common in a restricted range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

In 1986, Reichenbacher noted that no systematic, broad-scale searches for the species had been done and he believed that there were many undiscovered populations. However, during the 1999 field season, systematic surveys for this species were conducted and several new populations within Wupatki National Monument were discovered. New locations were documented at Crack-In-Rock ruin and along the southern end of the dirt road that leads from the Monument north to this ruin. The localities in Citadel Wash, South Mesa Wash, Wukoki Ruin, and "Peshlakai Wash" (a small wash north of Deadman Wash) were confirmed in 1999. All of these plants were mapped using GPS and GIS. The plant was not relocated at the south end of Doney Mountain Wash though it may occur further north in the wash. The original collection at this locality stated only that it grew in Doney Mountain Wash and did not give its exact location. After the 1999 fieldwork, it is estimated that approximately 1500 individuals of *Amsonia peeblesii* in 7 distinct areas are growing at Wupatki National Monument. Refer to the map for exact localities.

Management

Most of the 52 known extant *Amsonia peeblesii* localities occur at Wupatki National Monument. The Monument has acknowledged the presence of an *A. peeblesii* population adjacent to the paved parking area at Wukoki Ruin but otherwise has not developed an active management plan for the species.

Outright habitat destruction (clearing of vegetation, trampling by cattle) is the only known threat to *Amsonia peeblesii*. It is extremely unpalatable to cattle. Most of its range lies in remote or sparsely settled regions where such destruction is not likely to occur very often (Reichenbacher, 1986). However, Bateman (1976) recommends prohibiting entrance of livestock from the adjacent Navajo Reservation to the east and private lands to the north of Cedar Canyon to protect *A. peeblesii* from elimination through livestock overgrazing or habitat alteration.

Over-collection of this species is a significant concern. It is highly regarded by the Western Navajo and is difficult to find outside of Wupatki National Monument. It was extensively used by the Wupatki Navajo especially when they inhabited the Monument. Due to the fact that the whole plant is collected including the roots, this plant could easily be eradicated if over-collected.

The realignment and conversion of the crude oil pipeline to a natural gas pipeline from Cameron, Arizona to Farmington, New Mexico is a threat to certain populations of this plant. Navajo Nation scientists have advised that the work sites be thoroughly surveyed for any potential impact to this species (Meyer, 1999).

Annotated Bibliography

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Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Bateman, Gary C., project director. 1980. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report (Phase III). Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

Second draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments, including: *Amsonia peeblesii*, *Phacelia serrata*, and *Penstemon clutei*.

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Describes the history of plant collection on the Monuments and lists all voucher specimens

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Lists herbarium specimen locations for sensitive plant species.

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Key to genus, 8 species, and brief description of *A. peeblesii*.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Brief description of genus *Amsonia*, keys to 5 species, and brief description of *A. peeblesii*.

_____. 1962. Seed Plants of Wupatki and Sunset Crater National Monuments. Northern Arizona Society of Science and Arts, Inc., Flagstaff, AZ.

Descriptions of families, keys and descriptions of species found within the Monuments.

McLaughlin, Steven P. 1993. Apocynaceae A.L. Juss. Dogbane Family. Journal of the Arizona-Nevada Academy of Science 27: 164-166.

Keys and technical descriptions of *A. palmeri*, *A. peeblesii*, *A. tomentosa* var. *stenophylla*.

Meyer, John R. 1999. Unpublished correspondence regarding the realignment and conversion of crude oil pipeline to natural gas pipeline from Cameron, Arizona to Farmington, New Mexico. The Navajo Nation, AZ.

Reichenbacher, F.W. 1986. Unpublished status report on *Amsonia peeblesii* for US Forest Service.

Comprehensive report on taxon history, description, biology, geographic distribution, habitat, management.

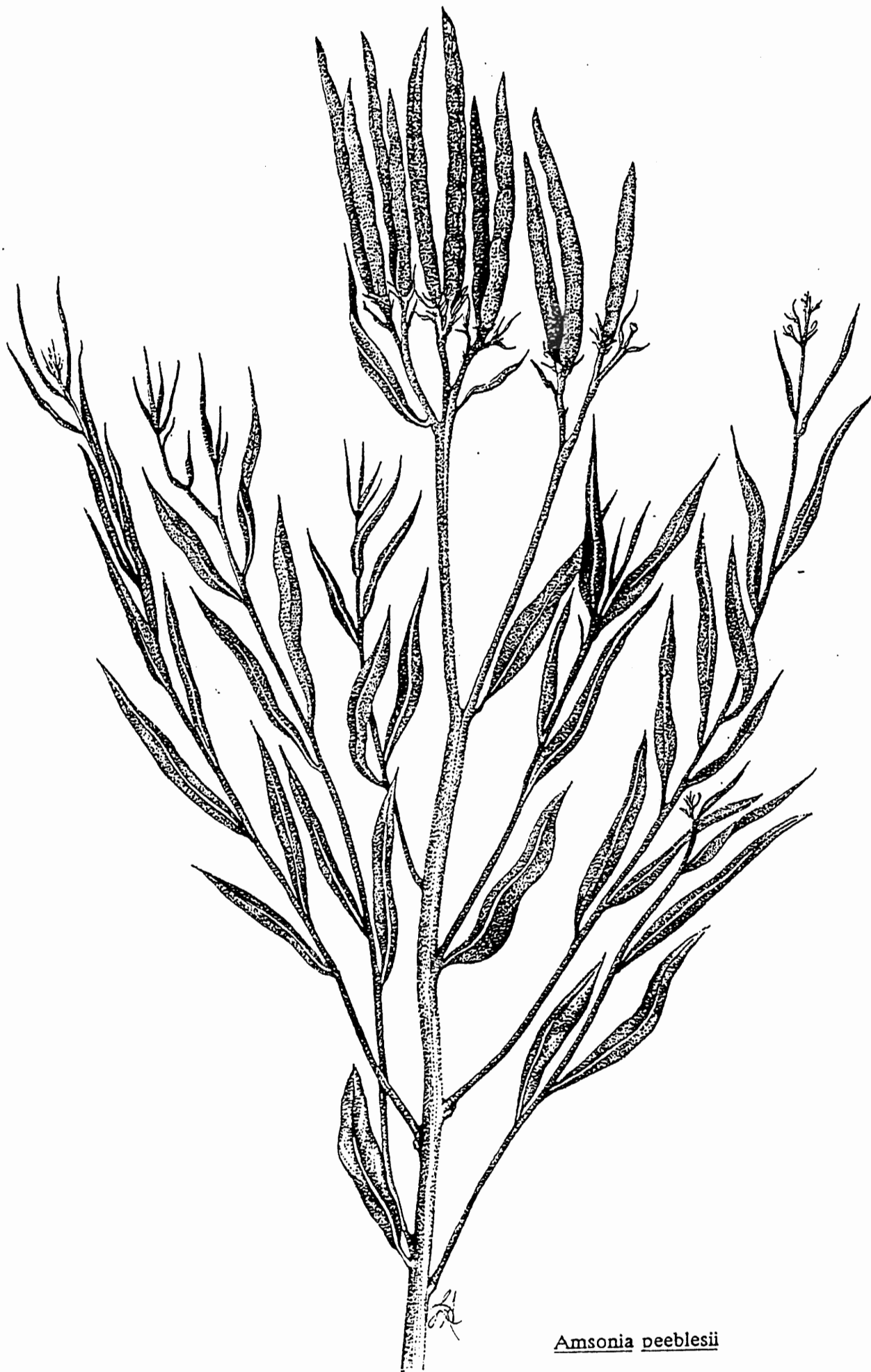
United States Fish and Wildlife Service, line drawings of plant in flower and seed.

Woodson, Robert E., Jr. 1938. *Amsonia*. North American Flora 29: 126-131.

_____. 1936. Additions to the genus *Amsonia*. Bulletin of the Torrey Club 63: 35-36.

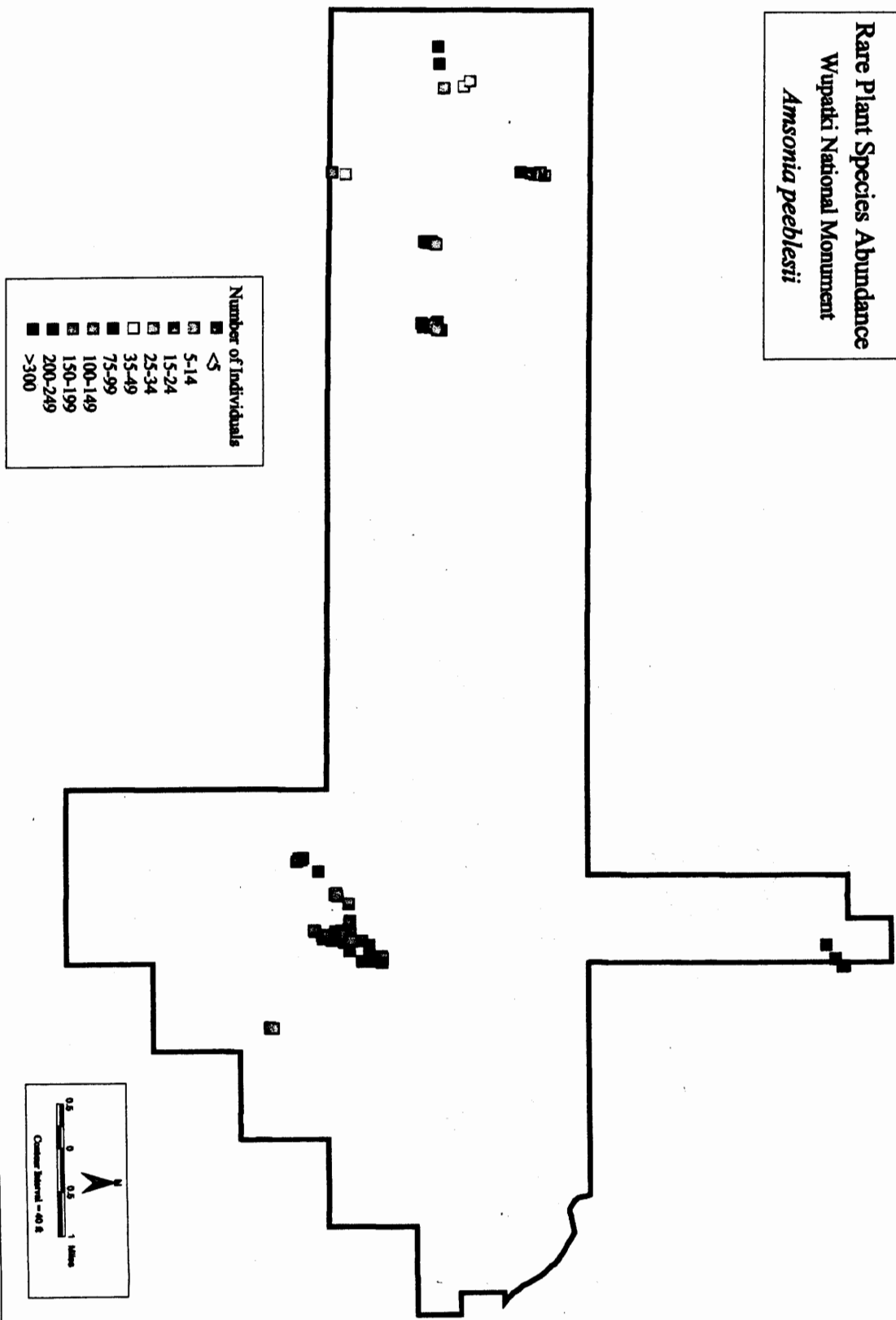
Description, in Latin, of *A. peeblesii* with comment by Mr. Peebles, distinguishing between *A. peeblesii* and *A. palmeri*.

_____. 1928. Studies in the Apocynaceae. III. A monograph of the genus *Amsonia*. Annals of the Missouri Botanical Garden 15: 379-434.



Amsonia peeblesii

Rare Plant Species Abundance
Wupatki National Monument
Amsonia peeblesii



Latin Name: *Astragalus lentiginosus* var. *ambiguus*
Latin Name w/ authority: *Astragalus lentiginosus* Dougl. ex Hook. var. *ambiguus* Barneby
Synonyms: None
Family: Fabaceae
Common Name: Freckled milkvetch

Original Description

Rupert C. Barneby. 1964. Atlas of North American Astragalus, Part II. Memoirs of the New York Botanical Garden 13(2): 945.

Type Specimen

Ripley and Barneby 3403. May 11, 1941, Peach Springs, Mohave County.
Holotype: RSA!

Taxon History

The identification of this species from early collections (Jones, 1903) from Chloride and Peach Springs (Mohave County) is doubtful. These specimens may actually be *A. lentiginosus* var. *mokiensis*, *A. lentiginosus* var. *vitreus* or *A. lentiginosus* var. *diphysus* (Barneby, 1964). A more detailed discussion of this species complex can be found in Barneby (1964).

McDougall (1973) calls this species a polymorphic complex. It is so variable that 38 varieties have been recognized in various parts of its range. Eight varieties have been recognized in northern Arizona and its various forms are represented in all of Arizona's counties (McDougall, 1973).

Description

Herbaceous perennial, coarse. STEMS stout, 3-5 dm long, spurred below, few to numerous from the crown of a taproot, prostrate, ascending or erect. LEAVES 7-14 cm long; *leaflets* 7-27, oblong-obovate or oblanceolate, shallowly notched in the rounded apex, 7.5-15 mm long. INFLORESCENCE raceme, with 15-20 flowers. FLOWERS appear near or below the middle; *calyx* 6.7-8 mm long, white or black, with stiff appressed hairs, tube 5-5.7 mm., teeth 1.6-2.3 mm long; *petals* purple, drying violet, the auricles of the wings often fleshy-thickened; *banner* (13) 15-16.7 mm long; *wings* 11-14 mm long, the claws 5.1-6 mm, the blades 6.5-8.8 mm long; *keel* 11.3-12.2 mm long, with claws 5.6-5.8 mm, with blades 6.1-7.3 mm long; *ovules* 22-34. FRUIT pod, 1.5-2.2 cm long, inflated but firm, +/- 9-13 mm in diameter, the body plumply ovoid, the beak 2-5 mm long, broadly deltoid, the valves stiffly papery or almost leathery, glabrous, green, becoming straw-like (Barneby, 1964; McDougall, 1973).

Biology

Astragalus lentiginosus var. *ambiguus* blooms during April and May and sets fruit in June.

Ethnobotany

A. lentiginosus is part of the Lifeway Medicine used by the Western Navajo. It does, however, contain alkaloids that may be carcinogenic and should be used with extreme caution. *A. mollissimus* and *A. sesquiflorus* are also utilized by the Navajo (Hogan, 1982).

Habitat

This variety grows in colonies on open hillsides in limestone or granite substrates. Its elevational range is between 4000-4800 feet (Barneby, 1964).

Distribution

This variety is endemic to Arizona and is found only in Mohave County, south of the Colorado River. Eight varieties have been recognized in northern Arizona and *A. lentiginosus* is found in its various forms in all of Arizona's counties (McDougall, 1973).

Herbarium specimens

Barneby (1964) notes that four collections have been made in previous years. However, none of these voucher specimens were found at the local herbaria and Barneby does not specify where they are located. Specimens of other varieties of *A. lentiginosus* are found in the local herbaria but are not listed here.

Listing Status (AGFD, 1994)

ESA: SC
USFS: None
NESL: None
NPL: None
GRank: G5T1
SRank: S1

The Endangered Species Act (ESA) lists this variety as a "species of concern" and considers it a species that is potentially at risk. The U.S. Forest Service (USFS), the Navajo Nation (NESL), and the Arizona Native Plant Law (NPL) do not recognize this variety. The Global Ranking (G) indicates that this variety is secure globally although the State Ranking (S) indicates that it is critically imperiled on a state level and is vulnerable to extinction. It is likely that the State of Arizona has it listed as state rare because this particular variety is found very locally. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the course of the 1999 field season, *Astragalus lentiginosus* var. *ambiguus* was not located within Wupatki National Monument. It has never been observed within the Monument but it was on the search list because the habitat is similar to that of Peach Springs (Mohave County) where it has been previously collected. It is unlikely that this particular variety occurs within Wupatki National Monument because it is found in very local areas in Mohave County. However, var. *palans* and var. *diphysus* have been found within Wupatki National Monument (Hogan & Huisinga, 2000).

Management

The highly-localized distribution of *Astragalus lentiginosus* var. *ambiguus* indicates that it is a high risk species. If disturbance to its habitat occurs, it may become an extinct species. No known threats to the specific localities of this plant are known, although grazing is always a potential threat.

Annotated Bibliography

Arizona Game and Fish Department. 1994. *Astragalus lentiginosus* var. *ambiguus*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Barneby, Rupert C. 1964. Atlas of North American *Astragalus*. Vol 13, part II. Memoirs of the New York Botanical Garden.

Description and taxon history of *A. lentiginosus* var. *ambiguus*.

Hogan, Phyllis. 1982. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, Arizona.

Technical description of *Astragalus lentiginosus* presenting a range of characters in several varieties.

Rutman, Sue. 1992. Handbook of Arizona's rare plants. United States Fish and Wildlife Service, Phoenix, Arizona.

A brief description of habitat and distribution.

Latin Name: *Camissonia specuicola* ssp. *hesperia*
Latin Name w/ authority: *Camissonia specuicola* (Raven) Raven ssp. *hesperia* (Raven) Raven
Synonyms: *Oenothera specuicola* ssp. *hesperia*
Family: Onagraceae
Common Name: Ditch evening primrose, Grand Canyon evening primrose, Kaibab suncup

Original Description

Peter H. Raven. 1962. University of California Publications in Botany 34: 88.

Peter H. Raven. 1964. Brittonia 16: 281.

Type Specimen

J.T. Howell 26486, CAS! (California Academy of Sciences), 359,774. May 23, 1950.

Taxon History

There are 15 species of *Camissonia* in Arizona, 61 species in North America, and 1 in South America (Raven, 1964; Lehr, 1978; Hickman, 1993).

Description

Tufted perennial, 10-50 cm tall with numerous divergent branches from base, stems and leaves glabrous or sparsely villous below. LEAVES sparsely pubescent, oblong, 3-20 cm long, pinnate or often bipinnate, mostly in a basal rosette, lateral leaflets well developed to 15 mm long and 7 mm wide. OIL CELLS beneath, dark brown. INFLORESCENCE erect, elongating in flower and fruit; *mature buds* individually drooping, 3-7 mm long; *petals* 2-6 mm long, bright yellow, fading to light purplish, red-dotted near the base; *anthers* 1-2 mm long, glabrous; *style* 5-7 mm long, pubescent at base. FRUIT capsule, straight to slightly curved, spreading to ascending, 0.8-2 cm long, 1-1.5 mm thick, glandular-pubescent or glabrous. SEEDS 0.6-1.0 mm long, to 0.6 mm thick (Cronquist et al., 1997; AGFD, 1998).

In Grand Canyon National Park, *C. specuicola* ssp. *specuicola* grows in crevices of the Redwall Limestone and on stable limestone debris, and is distinguished morphologically by its glabrous leaves and style. *C. specuicola* ssp. *hesperia* has pubescent leaves and style, is less densely tufted, and is not woody (AGFD, 1998).

According to Brian (2000), this species is similar to *C. multijuga* and *C. walkeri* but is distinguished by its non-woody habit, its pubescent leaves and style and because it is not as densely tufted as the others.

Biology

This subspecies flowers in April and May (Cronquist et al., 1997).

Ethnobotany

No ethnobotanical data has been collected regarding this species.

Habitat

This subspecies is found in washes and dry stream beds at elevations between 1600-3750 feet. It is often found on limestone substrates.

Associated species include *Salvia davidsonii*, *Euphorbia fendleri*, *Oxybaphus pumilus*, *Elymus elymoides*, and *Solidago sparsiflora* (AGFD, 1998).

Distribution

This species is known only from two disjunct populations along the Colorado River in Arizona: from Havasu and Hualapai Canyons, Coconino County and from Separation Canyon to Spencer Canyon, Mohave County (Rutman, 1990). It is not known to reach the North Rim of the Grand Canyon (Cronquist et al., 1997).

Herbarium Specimens

One herbarium specimen documenting this subspecies in Arizona was found at the local herbaria and is listed below. No specimens of this species are currently documented from Wupatki National Monument. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Above Mooney Falls, Havasu [Topotype]

Listing Status (AGFD, 1998)

ESA:	SC
USFS:	None
NESL:	None
NPL:	None
GRank:	G2T1
SRank:	S1

The Endangered Species Act (ESA) lists this subspecies as a "species of concern" and considers it a species that is potentially at risk. The U.S. Forest Service (USFS), the Navajo Nation (NESL), and the Arizona Native Plant Law (NPL) do not recognize this subspecies. The Global Ranking (G) indicates that it is imperiled globally and is vulnerable to extinction. The State Ranking (S) indicates that it is extremely rare and it is especially vulnerable to extinction at the state level. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the course of the 1999 field season, *Camissonia specuicola* ssp. *hesperia* was not located within Wupatki National Monument. It has never been observed within the Monument but it was on the search list because some plants along the Colorado River in the Grand Canyon move up into the Little Colorado River Valley. It is unlikely that this particular variety occurs within Wupatki National Monument because it is found in specific areas of the Grand Canyon and because of its elevational range (1600-3750 ft.) The lowest point in Wupatki National Monument is 4000 ft. However, there may be other subspecies of *Camissonia specuicola* that occur at Wupatki National Monument.

Management

This subspecies is protected within Grand Canyon National Park and its collection is regulated. No grazing is allowed within the park (AGFD, 1998). The Hualapai and Havasupai Tribes also limit the collection of this plant.

Annotated Bibliography

Arizona Game and Fish Department. 1998. *Camissonia specuicola* ssp. *hesperia*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Comprehensive review, including description, range, biology, management, sources of information, distribution map, and occurrence report.

_____. 1998. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Brian, Nancy J. 2000. A field guide to the Special Status Plants of Grand Canyon National Park. Science Center, Grand Canyon, Arizona.

Cronquist, Arthur, N.H. Holmgren, and P.K. Holmgren. 1997. Intermountain Flora: Vascular Plants of the Intermountain West. Vol. 3, Part A. The New York Botanical Garden, Bronx, NY.

Description of genus *Camissonia*, key to sections and species; no description of *C. specuicola* ssp. *hesperia*.

Hickman, J.C. 1993. The Jepson Manual. University of California Press, Berkeley, CA.

Description of *Camissonia*.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

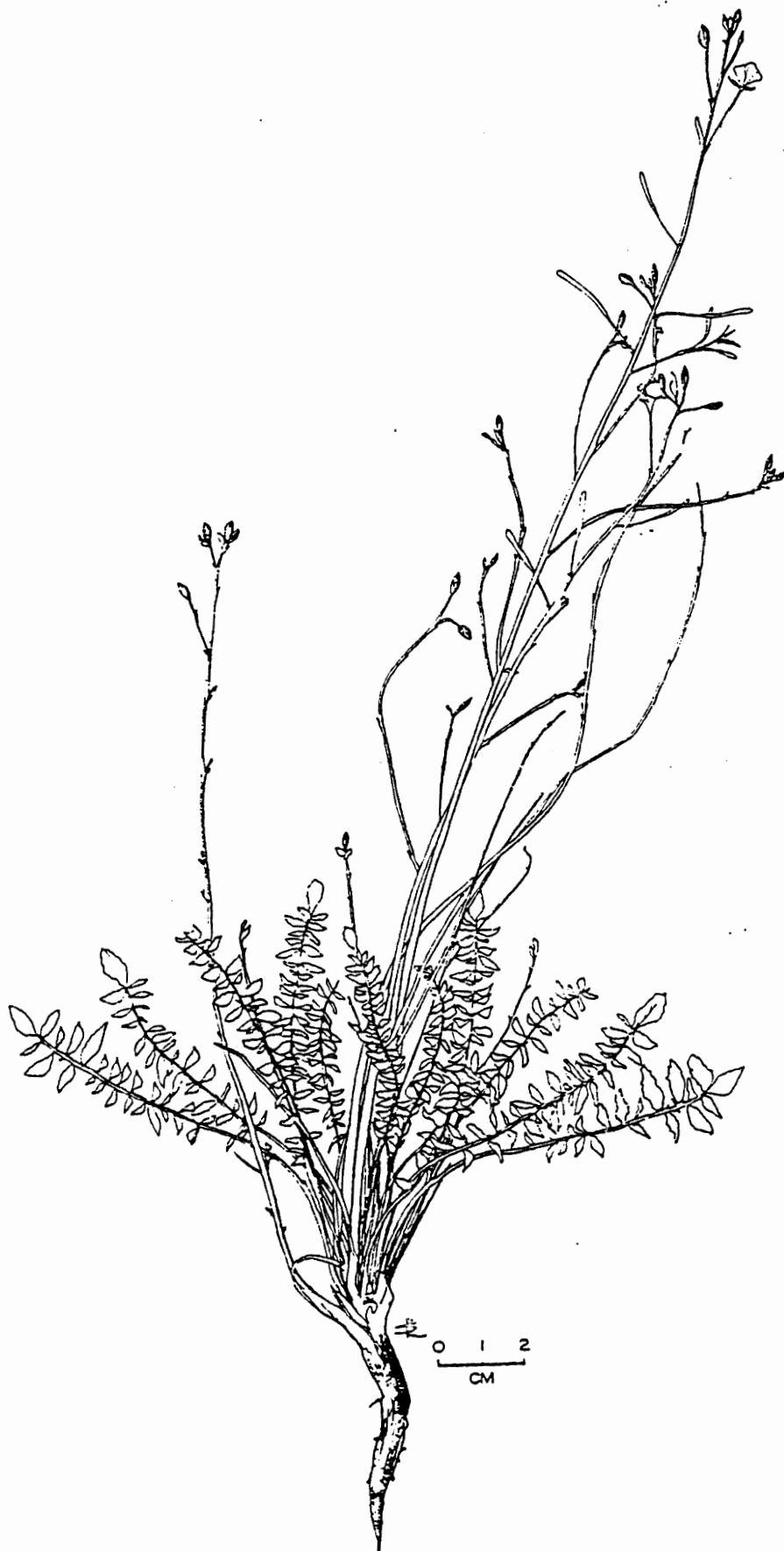
Lists herbarium specimen locations for sensitive plant species.

Raven, Peter H. 1964. The Generic Subdivision of Onagraceae, Tribe Onagreae. Brittonia 16: 276-281.

Review of the Onagraceae, a family of 640 species, with justifications for divisions into six tribes, and division of *Camissonia* into 10 sections.

Rutman, Sue. 1990. Handbook of federally endangered, threatened, and candidate plants of Arizona. U.S. Fish and Wildlife Service, Phoenix, Arizona.

United States Fish and Wildlife Service, line drawing of plant in flower.



Camissonia specuicola spp. specuicola

Latin Name: *Cymopterus megacephalus*
Latin Name w/ authority: *Cymopterus megacephalus* M.E. Jones
Synonyms: None
Family: Apiaceae
Common Name: Big-head spring-parsley, Cameron water-parsley, Largeleaf springparsley

Original Description

Marcus E. Jones. 1891. New Plants from Arizona, Utah and Nevada. Zoe 2: 14-15.

Type Specimen

M.E. Jones. June 10, 1890, mesas just south of the Little Colorado River, northern AZ.
Holotype. POM! (Pomona State College).

Taxon History

This genus is represented by 45 species that occur in western and central North America. Marcus E. Jones (1891) states that this species is closely related to *C. globosus* and *C. corrugatus* but it is different in leaves, fruit, and size.

This species name was derived from the Greek *kyma*, wave, and *pteron*, wing, which refers to the fruits.

Description

Perennial herb, with a taproot and subterranean crown from which the leaves and scapes (a leafless flower stalk) arise individually. SCAPES up to 15 cm long, lax or prostrate. LEAVES petiolate, largely underground, firm and shorter than or equal to the petiole, pinnately 2-3 times dissected, with 3-5 pairs of pinnae in the same plane, the primary and secondary pinnae have a broad midstrip. INFLORESCENCE globose compound head, without bracts. FLOWERS whitish; *petals* yellow; *peduncles* (flower stalks) one to few, up to 15 cm long, lax or prostrate, expanded at the top into a disk from which numerous short pedicels arise. FRUIT woolly when young, almost glabrous at maturity, 7-11 mm long, with conspicuously corky lateral wings 1.5-2 mm wide; *oil-tubes* dark reddish, readily visible (Cronquist et al., 1997).

C. megacephalus is separated from the other species by its globose head inflorescence, its small involucre bracts, its non-mat-forming habit, its lack of stem pubescence, its simple surficial or subterranean crown on the taproot, and its fruit without a carpophore (a slender prolongation of the receptacle between the carpels as a central axis) (Cronquist, 1997).

Biology

This species flowers from April to June and its seeds mature shortly after flowering. It is one of the first plants to emerge in the early spring.

Ethnobotany

The roots of several closely related species of *Cymopterus* were eaten by Navajo and Hopi and were called "wild carrot." The Navajos also use the entire plant in ceremonial chant lotions. Other tribes on the Colorado Plateau, including Havasupai and Hualapai, also eat the roots (Hogan, 1984).

Habitat

Cymopterus megacephalus is found in gravelly or shaly soil and very commonly on Moenkopi shales near Cameron or the Little Colorado River (Rutman, 1992).

Distribution

This species is found only in northern Arizona (Kearney & Peebles, 1951). In Arizona, it occurs in Apache, Navajo and eastern Coconino counties at elevations between 4500 to 7000 feet (McDougall, 1973). It should be noted that McDougall (1973) mistakenly noted that this species was also found in Utah, Colorado, and New Mexico.

Other *Cymopterus* species also found in Coconino County include: *C. bulbosus* (3500-6000 feet, April to June), *C. multinervatus* (3000-7000 feet, March to May), *C. fendleri* (5000-6000 feet, May and June), *C. newberryi* (4500-7000 feet, April to June (very rare)), *C. purpurascens* (3500-7000 feet, March to May), and *C. purpureus* (4000-7000 feet, May and June) (Kearney & Peebles, 1960; McDougall, 1973).

Herbarium Specimens

Herbarium specimens were located from areas that are nearby Wupatki National Monument (Spiderweb Ranch). However, it has never been documented within the Monument. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Spiderweb Ranch, low sandy ridges and bottoms, Cameron, Coconino Co.
NAU	Coconino Co., approx. 1.3 miles N of Red Butte, N of the LCR, between US Hwy 89 and the river, on flat expanse of red Moenkopi, Lat: 35 degrees 58'N Long: 111 degrees 36' W
NAU	Coconino Co., ca. .5 miles due N. of Shadow Mountain
NAU	Coconino Co., S of Red Point Hills, N of Big Canyon, between US Hwy 89 & LCR, bottom of small arroyo in Moenkopi formation, Lat: 36degrees 09'N Long: 111 degrees 33 ' W
NAU	Coconino Co., ca. 1 mi. E of Bodaway Mesa, W of US 89, low, rounded Moenkopi hill, Lat: 36 degrees 19' N Long: 111 degrees 32' W
NAU	Coconino Co., N of LCR, between US Hwy 89 and the LCR on brown, tan, and purple Shinarump Formation, Lat: 35 degrees 59' N Long: 111 degrees 31' W
NAU	Coconino Co., W off US 89, at Cedar Ridge onto BIA 6110, at mi. 1.5, turn N onto two-track dirt road, stop mi. .2, Moenkopi Formation
MNA	North of Gray Mountain, US Highway 89, west side of road, Coconino County

Listing Status (AGFD, 1998)

ESA:	SC
USFS:	None
NESL:	None
NPL:	None
GRank:	G2G3
SRank:	S2S3

The Endangered Species Act (ESA) lists this species as a "species of concern" noting that its habitat and limited populations may be at risk. It is not recognized by the U.S. Forest Service (USFS), the Navajo Nation (NESL), nor the Arizona Native Plant Law (NPL). The Global (G) and State (S) Rankings indicate that this species is rare or local throughout its range and is vulnerable to extinction globally and statewide. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the course of the 1999 field season, no localities of *Cymopterus megacephalus* were observed in Wupatki National Monument. It seems highly likely that this species grows on the Monument because of its nearby locality at Spiderweb Ranch. In addition, it is found in gravelly places of which there are an abundance along the Little Colorado River. The key to finding this species is the timing of searches because it could be easily confused with other species of *Cymopterus*. Cronquist et al. (1997) note that this species is rarely collected.

Management

Some protection is provided by the Navajo Nation and the Bureau of Land Management (Rutman, 1992). However, the realignment and conversion of the crude oil pipeline to a natural gas pipeline from Cameron, Arizona to Farmington, New Mexico is a threat to certain populations of this plant. Navajo Nation scientists have advised that the work sites be thoroughly surveyed for any potential impact to this species (Meyer, 1999).

Annotated Bibliography

Arizona Game and Fish Department. 1998. *Cymopterus megacephalus*. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status
Cronquist, Arthur, N.H. Holmgren, and P.K. Holmgren. 1997. Intermountain Flora: Vascular plants of the Intermountain West, U.S.A. Vol 3, Part A, Subclass Rosidae. The New York Botanical Garden, Bronx, NY.

Description of genus and key to species.

Hogan, Phyllis. 1984. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Jones, Marcus E. 1891. New Plants from Arizona, Utah and Nevada. Zoe 2: 12-17.

Original description of *Cymopterus megacephalus*

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Description of genus *Cymopterus*, key to seven species, location and habitat.

McDougall, W. B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Description of genus *Cymopterus*, key to seven species, brief description of *C. megacephalus* including distribution, habitat, and months in flower.

Meyer, John R. 1999. Unpublished correspondence regarding the realignment and conversion of crude oil pipeline to natural gas pipeline from Cameron, Arizona to Farmington, New Mexico. The Navajo Nation, AZ.

Rutman, Sue. 1992. Handbook of Arizona's rare plants. United States Fish and Wildlife Service, Phoenix, AZ.

A brief description of habitat, distribution and land management/ownership.

Latin Name: *Errazurizia rotundata*
Latin Name w/ authority: *Errazurizia rotundata* (Woot.) Barneby
Synonyms: *Parryella rotundata*
Family: Fabaceae
Common Name: Roundleaf dunebroom, Roundleaf Errazurizia

Original Description

1898. *Parryella rotundata*. Bulletin of the Torrey Botanical Club 25: 457.

Type Specimen

Wooten. 1892, Winslow, Navajo County.

Taxon History

In 1892, Elmer O. Wooten first observed a single shrub of *E. rotundata* on the sandstone desert north of Winslow, Arizona. He named the species *Parryella* based on the fact that the flowers were all apetalous (Barneby, 1962). Based upon more recent collections of the plant near Moenave in both flowering and fruiting condition, Barneby (1962) has assigned the earlier specimens to *Errazurizia rotundata*. In addition, Marcus E. Jones incorrectly named this species as *Dalea nummularia* when he found it near Cameron on June 11, 1890 (Kearney & Peebles, 1951; Barneby, 1962).

Three other species in the genus *Errazurizia* have been named, two of them native to Baja California and coastal Sonora, and one to the desert fog belt of northern Chile. Although both North American species were first described in the genus *Dalea*, their flowers are distinctly different than other *Dalea* species (Barneby, 1962).

Description

Perennial shrub, low, much-branched, up to 30 cm tall, spreads clonally and forms rings, presumably by rhizomes or suckers. STEMS with many prominent orange or purple prickly-shaped glands (leaf-rachis and lower surface of the leaflets also). LEAVES 3-13 cm long, subsessile, with persistent, recurving rachis; leaflets many, oblong, 1-8 mm long, gradually diminishing upward along the rachis. INFLORESCENCE spicate, 6-14 flowered, the axis not over 2 cm long in fruit. FLOWERS many; calyx 5-6.5 mm long, the tube prominently 10-ribbed and glandular in the intervals, with broadly obovate teeth 1.5-2.3 mm. long, obtuse, silky-pubescent within; banner, when present, oblanceolate, flat or nearly so, openly notched at apex, about 5.5 mm long and 2 mm wide, thinly pubescent dorsally toward the tip; wings and keel 0; filaments greenish-yellow, (7) 8-12 mm long when fully grown; anthers bright yellow. FRUIT pod, obovoid, 9-11 mm long, cuneately narrowed at base, prominently glandular. SEEDS fusiform, chestnut-brown, about 6 mm long (Barneby, 1962).

Biology

This species flowers in April to early May and sets fruit from mid-May onward. Its foliage is extremely aromatic.

Ethnobotany

The Navajo and Hopi utilize the roots and leaves of this plant for ceremonial and ritual purposes (Hogan, 1994).

Habitat

Errazurizia rotundata is found on hilltops and rock-ledges in red or white sandstone at elevations between 4850-5000 feet. A commonly confused species, *Parryella filifolia*, is found in nearby areas but in sandy dunes or washes.

Associated species are *Ephedra torreyana*, *Ephedra viridis*, *Fallugia paradoxa*, *Atriplex canescens*, *Hilaria jamesii* and *Sporobolus flexuosus*.

Distribution

This species is known only from northern Arizona in Navajo and Coconino Counties (Kearney & Peebles, 1951; Barneby 1962). Specific localities are listed below.

Herbarium Specimens

Several herbarium specimens documenting the presence of *E. rotundata* at Wupatki National Monument were found at local herbaria (Hogan & Huisinga, 1997). All Wupatki locations are listed first. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Above Moenave, 4 or 5 miles west of Tuba City, Coconino Co. AZ
NAU	Overlooking Moenave, 4-5 mi. W of Tuba City
MNA	Moenave
MNA	1 mile east of Moenave, Navajo Indian Reservation, T32N R10E NE 1/4 SW1/4 of Sec 22, Coconino County
MNA	4.25 miles north of Winslow and I-40, T20N R15E S31, Navajo County
MNA	Overlooking Moenave, 4-5 miles west of Tuba City

Listing Status (AGFD, 1998)

ESA:	None
USFS:	None
NESL:	4
NPL:	SR
GRank:	G4
SRank:	S3

The Endangered Species Act (ESA) and the U.S. Forest Service (USFS) do not list this species. The Navajo Nation (NESL) indicates that this species is not currently listed as a species of concern due to the lack of information regarding its status on reservation lands. The Arizona Native Plant Law (NPL) considers this species as "salvage restricted" and allows collection with a permit. The Global Ranking (G) indicates that this species is secure globally although it is rare in parts of its range. The State Ranking (S) indicates that this species is very rare in its range and is vulnerable to extinction. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

This plant was not relocated in 1999. An historic collection by L.T. Green III in 1977 was documented in Section 8 within Wupatki National Monument. A return visit to this exact locality with L.T. Green III in 1997 revealed that the plant had disappeared since it was first seen there in 1977. Other populations of this plant were visited in 1999 including the ones near Winslow, Arizona. This population consists of over 500 individuals and appears to be stable.

Management

Potential threats to this plant are flooding and grazing. It is believed that the historic locality found at Wupatki may have been washed out by flooding along the Little Colorado River.

Annotated Bibliography

Arizona Game and Fish Department. 1998. *Errazurizia rotundata*. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations of *Errazurizia rotundata*.

Barneby, R.C. 1962. A Synopsis of *Errazurizia*. Leaflets of Western Botany, Vol IX (13-14): 209-214.

Thorough discussion of taxon history, a key to the four species of *Errazurizia* and a brief description of *E. rotundata*.

Hogan, Phyllis. 1994. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

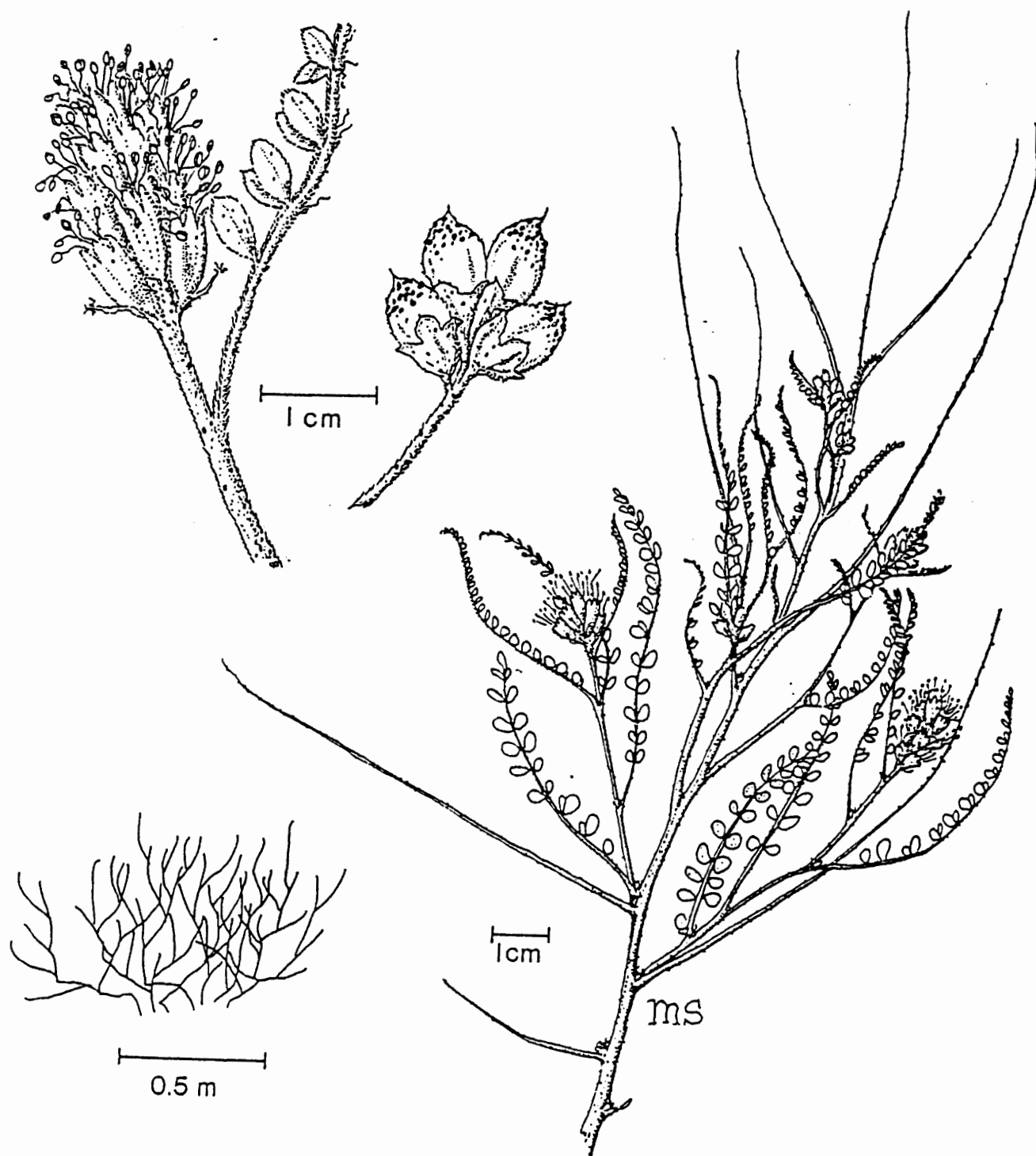
_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

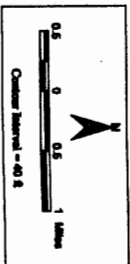
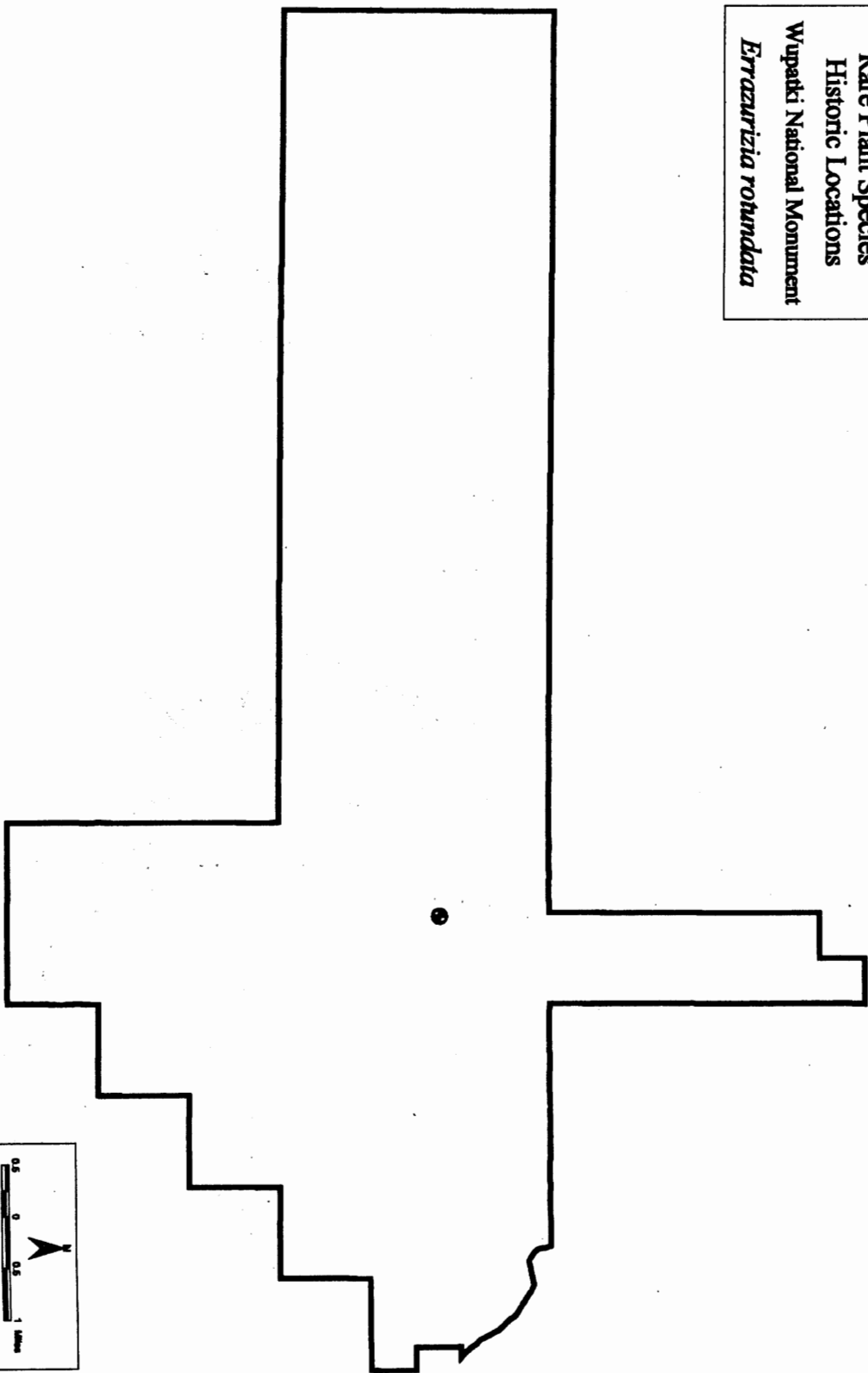
Description of genus *Parryella*, key to two species, with descriptions of each.

United States Fish and Wildlife Service, line drawing of plant in flower and seed.



Errazurizia rotundata

Rare Plant Species
Historic Locations
Wupatki National Monument
Eryazurzia rotundata



Latin Name:	<i>Pediocactus peeblesianus</i> var. <i>fickeiseniae</i>
Latin Name w/ authority:	<i>Pediocactus peeblesianus</i> (Croizat) L. Benson var. <i>fickeiseniae</i> L. Benson
Synonyms:	<i>Navajoa fickeisenii</i> , <i>Pediocactus peeblesianus</i> var. <i>fickeisenii</i> , <i>Toumeyia fickeisenii</i> , <i>Pediocactus fickeisenii</i>
Family:	Cactaceae
Common Name:	Fickeisen Navajo cactus, Fickeisen plains cactus, Fickeisen pincushion cactus, Navajo pincushion cactus

Original Description

L. Benson. 1969. *Pediocactus peeblesianus* (Croizat) L. Benson var. *fickeiseniae* L. Benson. The Cacti of Arizona, Third Edition.

Type Specimen

L. and R.L. Benson (15,745), POM! (Pomona College Herbarium), 285,856. June 29, 1957, watershed of the Little Colorado River west of Cameron, Coconino County, AZ.
From the originally designated type these two specimens were designated:
Lectotype (fruiting) Lyman & Robert L. Benson 15,745, POM! 285,856. June 28, 1957.
Paratype (flowering) Lyman & Evelyn L. Benson 16,086, POM! 299,969. April 21, 1961.

Taxon History

Miss Maia Cowper first discovered this species. Specimens were later shown to Mr. W. Taylor Marshall, Director of the Desert Botanical Garden at Phoenix, Arizona, which led to a published note in *Saguaro* (Vol. 10, p. 76) in 1956 (Benson, 1969). The species was officially named by Benson in 1969.

There are two recognized varieties of *P. peeblesianus*. The other variety of *Pediocactus peeblesianus*, variety *peeblesianus*, occurs in Navajo County. Seven species of *Pediocactus* occur from the Columbia River Basin, Great Basin, Rocky Mountains and Colorado Plateau. Six of these species, including *P. peeblesianus*, are restricted endemics.

Britton and Rose (in Britton & Brown, 1913) proposed the genus *Pediocactus* to encompass a single species, *Echinocactus simpsonii*. When originally proposed, the area of discovery was one of very few cacti, eastern North America. This plant was supposedly found in the Great Plains and was given a Greek name denoting a habitat on a plain. However, this species is more characteristic of mountainous and sagebrush desert areas (Britton & Brown, 1913).

Benson (1982) suggests that the extant species of *Pediocactus* are relics of a group of plants that once had a more widespread distribution. One indicator that the genus has had a long evolutionary period is the physiological limitation of each species to a specific habitat. This *Pediocactus* is found in specific rock or soil type in the deserts of the west (Benson, 1982).

Description

Perennial, very small, globose succulent, unbranched cactus that shrinks into the gravelly soils after flowering and fruiting. STEMS of mature plants are 2.5-3.8 cm long and the same in diameter, majority of the stem is underground, occasionally with 2-4 branches, have tubercles that form a spiral pattern around the plant. SPINES corky; *central spine* 3/8-inch long, ashy white, and pointed upwards; *radial spines* usually 6, spreading irregularly, variable in size, 3-6 mm long, 0.25-0.5 mm diameter. FLOWERS 1.5-2.5 cm in diameter; *petals* cream, yellow or yellowish-green; *outer perianth parts* with pink or green midstripe; *stamens* yellow; *style* cream-colored; *stigmas* yellow, 6-8. FRUIT often 4-5 per plant, top-shaped, green, and turn reddish-brown as it dries, becoming dehiscent by a vertical slit along the ovary wall. SEEDS are dark brown to black (McDougall, 1973; Benson, 1982; Hughes, 1996; AGFD, 1998).

The populations near the Grand Canyon and Cameron are difficult to distinguish from var. *peeblesianus*. "The white spines of var. *fickeiseniae* arise from the plant like tiny horns pointing in a variety of directions. In contrast to the prim, precise arrangement of spines in *P. peeblesianus* var. *peeblesianus*, the disposition of spines in this variety yields a ragged appearance" (Benson, 1982). Other characteristic differences are the presence of a central spine and the presence of six or seven radial spines in var. *fickeiseniae* instead of four (rarely three or five) in var. *peeblesianus*. Benson (1982) also notes that the Cameron collections have variable spines though most of the plants from Mohave County have stout, slender spines.

A useful table detailing the morphological and geographical differences between the two varieties of *Pediocactus peeblesianus* can be found in Benson (1982).

Biology

This species flowers in late April and sets fruit from May to June. The plants will sometimes retract into the soil during drought and after flowering and fruiting (Hughes, 1996; Roth, 1999).

The plant seems to have low seed production although good winter precipitation may increase plant population sizes and reproduction efforts (Hughes, 1996).

Ethnobotany

To this date, the AERA has found no culturally significant use of this plant by any of the Native American tribes on the Colorado Plateau.

Habitat

P. peeblesianus var. *fickeiseniae* grows on flat ridge-tops and benches with slight to moderate slope in shallow, gravelly limestone soils derived from Kaibab limestone (Hughes, 1996). It can also be found at the margins of canyons or in well-drained hills in the Great Basin Grassland between elevations of 4000-5500 feet. Dominant vegetation types in its habitat are desert grassland, sagebrush, and shadscale shrubland.

The closely related variety, *Pediocactus peeblesianus* var. *peeblesianus*, is found in sandy soils of desert hills at elevations of 5000 feet in the deserts of northeastern Arizona in Navajo County from near Joseph City to Marcou Mesa region northwest of Holbrook (Benson, 1982).

Associated species are *Bouteloua gracilis*, *Bouteloua eriopoda*, *Hilaria jamesii*, *Atriplex canescens*, *Gutierrezia sarothrae*, *Artemisia tridentata* and *Pediocactus bradyi* (Hughes, 1996).

Distribution

This subspecies is endemic to northern Arizona occurring only in Coconino and Mohave Counties. In Coconino County, the populations are widely scattered from House Rock Valley, Cameron, and Gray Mountain along the canyon rims of the Little Colorado and Colorado Rivers. In Mohave County, it is found in Hurricane Valley and Mainstreet Valley, and near Clayhole Ridge and Sunshine Ridge, as far west as Dutchman Draw and Grandstand (Benson, 1982; Roth, 1999). The known range is about 125 airline miles (Benson, 1982).

Other species of *Pediocactus* that are found in Coconino County are: *P. paradinei* (5000-6000), *P. sileri* (no range given), *P. simpsonii* (6000-9500, April-September) and *P. bradyi* (4000 ft, April) (McDougall, 1973).

Herbarium Specimens

No specimens have been located in local herbaria that document the presence of this species at Wupatki National Monument. Two specimens documenting the plant in Mohave and Coconino Counties are listed below (Hogan & Huisinga, 1997). Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Mohave Co., AZ, Main Str. Valley, T38N R11W S22
NAU	Coconino Co., Tiger Wash, N of Shinumo Alter, on limestone ridge, Lat: 36 32 N Long: 111 43 W

Listing Status (AGFD, 1998)

ESA:	C
USFS:	S
NESL:	3
NPL:	HS
GRank:	G2T2
SRank:	S2

The Endangered Species Act (ESA) lists this variety as a "candidate" for listing. The U.S. Forest Service (USFS) lists this variety as a "sensitive". The Navajo Nation (NESL) indicates that this variety is not currently listed as a species of concern due to the lack of information regarding its status on reservation lands. The Arizona Native Plant Law (NPL) considers this variety of *Pediocactus* a "highly safeguarded" plant and no collection is allowed. The Global Ranking (G) lists this variety as one that is imperiled globally because of rarity making it very vulnerable to extinction throughout its range. The State Ranking (S) states that this variety is vulnerable to extinction throughout its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

The field crew did not find this variety of *Pediocactus* during the 1999 field season. However, it is likely that this species occurs in the high desert of Wupatki National Monument because other localities of this variety occur in this vicinity along the Little Colorado River near Cameron.

It should be noted that most species of *Pediocactus* are found very rarely because of their narrow geographical ranges and small size. "At maturity some species are of no greater diameter than a medium-sized coin, standing above ground no higher than the thickness of the coin. Even when their approximate location is known, days of searching may be consumed in finding the plants. Most species grow hidden in particular kinds of rocks, and during the dry season they retract into the substrate" (Benson, 1982).

Management

Due to its rare status, *P. peeblesianus* var. *fickeiseniae* is vulnerable to damage by grazing, trampling, rodent depredation, and off-road vehicles. This plant is likely to remain rare because of its small population sizes, low reproductive potential, and specialized environment (Hughes, 1996).

Some action has been taken to protect the few known populations of *P. peeblesianus* var. *fickeiseniae*. In 1992, a management plan restricted vehicle activity to existing roads and trails near the known populations that reduced threats of off-road (USDI, 1992).

Annotated Bibliography

Arizona Game and Fish Department. 1998. *Pediocactus peeblesianus* var. *fickeiseniae*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Includes classification, description, biology, conservation. Also from the same source, element status designations and specific location occurrences with plant condition, flower and fruit detail where possible.

Benson, Lyman. 1982. *The Cacti of the United States and Canada*. Stanford University Press, Stanford, CA.

General discussion of the genus and this species with keys to seven species, distribution map, line drawings and photographs of live and herbarium specimens.

_____. 1969. *The Cacti of Arizona*, Third edition. The University of Arizona Press, Tucson, AZ.

Long discussion of genus, key to six species, description of *Pediocactus peeblesianus* and three varieties: var. *peeblesianus*, var. *fickeiseniae*, var. *maianus*, with a useful comparative table of these three varieties.

Hogan, Phyllis and Kristin Huisinga. 2000. *The Wupatki and Sunset Crater Herbaria: A guide to the plant collections*. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

Hogan, Phyllis and Kristin Huisinga. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Hughes, Lee E. 1996. Demographic Monitoring of *Pediocactus peeblesianus* var. *fickeiseniae* on the Arizona Strip. Pp. 47-52. In Maschinski, Joyce, H.D. Hammond, L. Holter. Southwestern Rare and Endangered Plants: Proceedings of the Second Conference. September 11-14, 1995, Flagstaff, Arizona.

Report of a monitoring study begun in 1986 by the BLM at four places across the Arizona Strip to measure size, mortality, fruiting, recruitment, and to map the cacti in plots.

Hughes, Lee. 1996. History, observations and monitoring of *Pediocactus peeblesianus* var. *fickeiseniae* on the Arizona Strip. Desert Plants.

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Brief description of the genus, key and descriptions of six species.

Roth, Daniella. 1999. Unpublished abstract on *Pediocactus peeblesianus* var. *fickeiseniae*. Navajo Nation Botanist report.

Brief description of habitat and distribution and of this species.

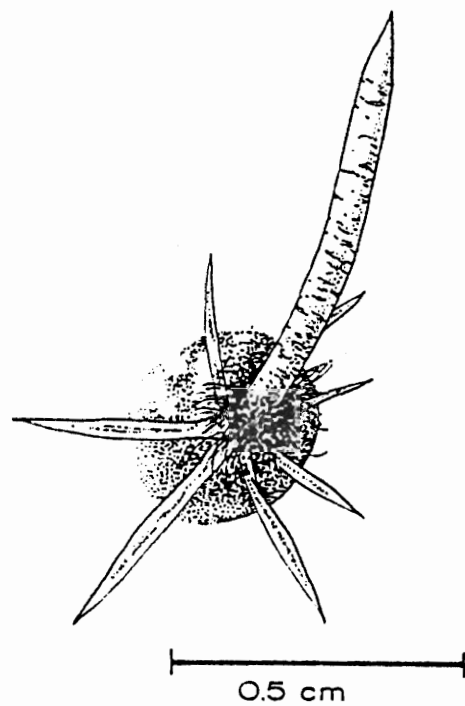
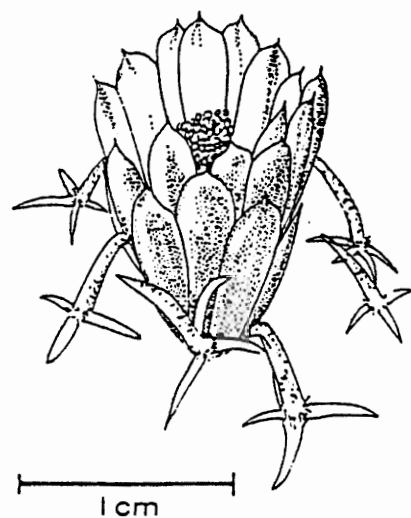
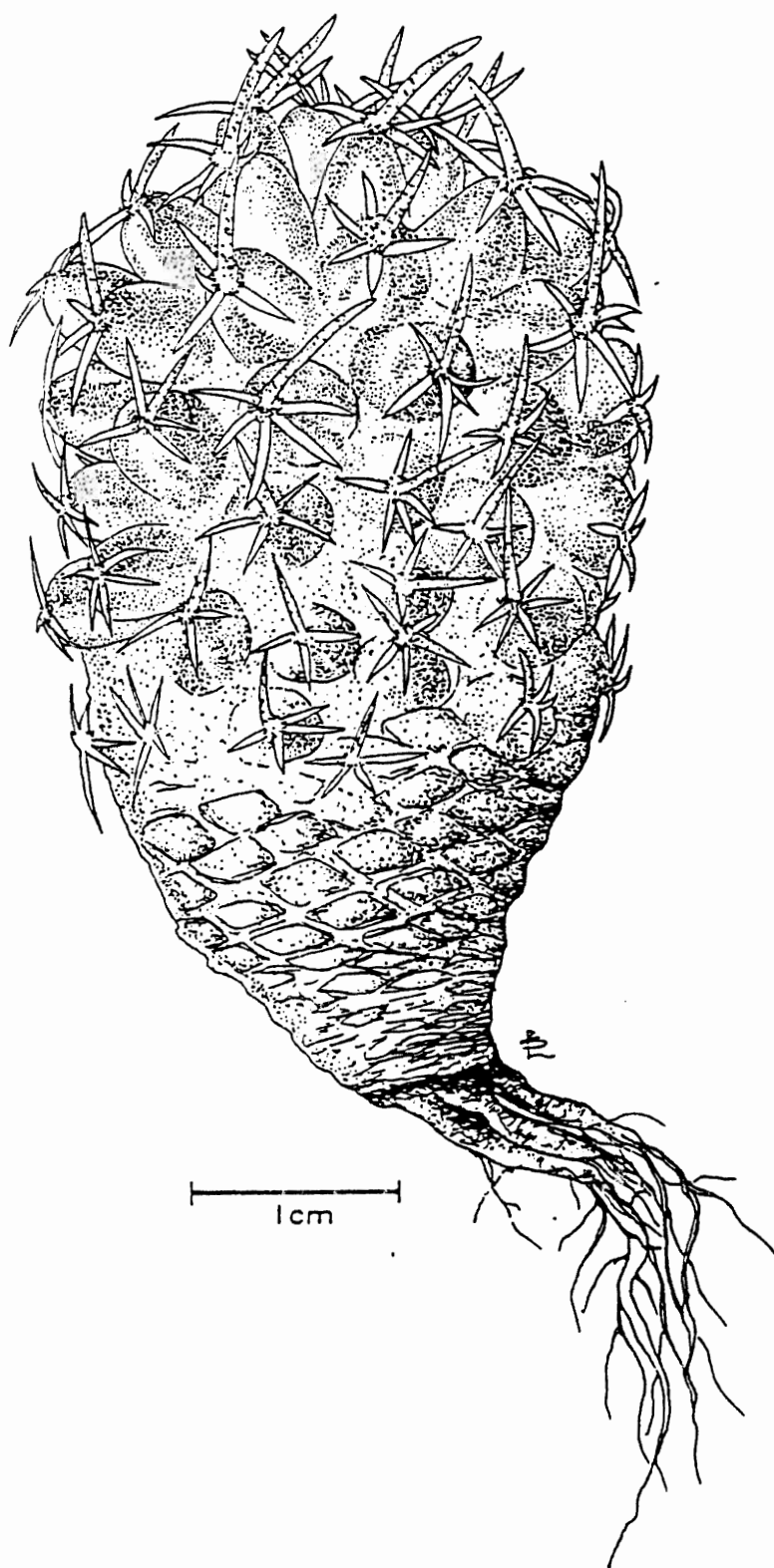
Rutman, Sue. 1990. Handbook of Federally endangered, threatened, and candidate plants of Arizona. U.S. Fish and Wildlife Service, Phoenix, AZ.

Brief description of habitat and distribution of the plant.

USDI, Bureau of Land Management. 1992. Vermillion Resource Area Implementation Plan for the Arizona Strip District, Approved Resource Management Plan.

Referenced in Hughes 1996.

United States Fish and Wildlife Service. Line drawings of plant in flower.



Pediocactus peeblesianus var. fickeiseniae

Latin Name: *Pediocactus simpsonii*
Latin Name w/ authority: *Pediocactus simpsonii* (Engelm.) Britt. & Rose
Synonyms: *Echinocactus simpsonii*, *Echinocactus simpsonii* var. *minor*, *Mammillaria simpsonii*, *Mammillaria purpusii*, *Echinocactus simpsonii* var. *robustior*
Family: Cactaceae
Common Name: Simpson plains cactus, Hedgehog-thistle, Mountain ball cactus, Simpson hedgehog cactus

Original Description

George Engelmann, M.D. 1863. *Echinocactus simpsonii*. Trans. of the Acad. of Science 2: 197.

Type Specimen

Type localities both used in the description by Engelmann: Kobe Valley, Nevada and Butte Valley, Utah.

Lectotype: *Pediocactus simpsonii* var. *minor*, presumably by Parry, Hall & Harbour, Mt. Vernon.

Taxon History

Britton and Rose (in Britton & Brown, 1913) proposed the genus *Pediocactus* to encompass a single species, *Echinocactus simpsonii*. When originally proposed, the area of discovery was one of very few cacti, in eastern North America. This plant was supposedly found in the Great Plains and was given a Greek name denoting a habitat on a plain. However, this species is more characteristic of mountainous and sagebrush desert areas (Britton & Brown, 1913).

Benson (1982) suggests that the extant species of *Pediocactus* are relics of a group of plants that once had a more widespread distribution. One indicator that the genus has had a long evolutionary period is the physiological limitation of each species to a specific habitat. In the genus *Pediocactus*, the habitat is a specific rock or soil type in the deserts of the west (Benson, 1982).

Description

STEMS solitary or a few in a cluster, globular, dark green, flattened to the ground when young, later arising a few inches tall, often covered with debris; *central spines* 8-12, stouter and longer than the radials, 1-3 cm long, white to yellowish at the base, reddish brown to nearly black toward the tips. FLOWERS 2-3.5 cm long, usually pink, crowded in the center of the plant, surrounded by white to brownish wool. FRUIT 6-8 mm in diameter, greenish, dry, splitting along side to release seed. SEEDS 3 mm long, asymmetrically obovate, gray or nearly black (Abrams, 1951; Earle, 1963; Benson, 1969; Weber, 1976).

Biology

This species flowers from April to May and sets fruit from June to August depending on the area. The pink flowers have a heavy rose fragrance.

Ethnobotany

To this date, the AERA has found no culturally significant use of this plant by any of the Native American tribes on the Colorado Plateau.

Habitat

This species is found in dry interior mountain valleys and on rocky ridges in fine, powdery soils. It sometimes occurs in grassy openings in pine forests (Weber, 1976). It is most often seen between elevations of 6000-9500 feet in pinyon-juniper woodlands, sagebrush deserts, or Upper Sonoran deserts (Abrams, 1951; Benson, 1969).

Distribution

This species is found in Coconino County at Marble Canyon and occurring throughout the western states from eastern Oregon and Washington, southern Idaho, southern Wyoming, west central Nevada, Colorado, Utah, northern New Mexico, westernmost South Dakota, and reportedly in Montana and western Kansas (Benson, 1969; McDougall, 1973).

Benson (1982) calls the distribution of *P. simpsonii* widespread and variable because it occupies a range in the Columbia River Basin, the Great Basin, and the middle portions of the Rocky Mountain system. Even though it occurs over a large geographic range, it is nonetheless rare and scattered in Arizona. Other species of *Pediocactus* are mostly restricted to smaller areas and more specialized habitats in the arid areas of northern Arizona and northwestern New Mexico.

Seven species of *Pediocactus* occur from the Columbia River Basin, Great Basin, Rocky Mountains and Colorado Plateau. Six of these species are restricted endemics.

Other species of *Pediocactus* that are found in Coconino County are: *P. paradingi* (5000-6000), *P. sileri* (no range given), *Pediocactus peeblesianus* var. *fickeiseniae* (4000-5500, April-June) and *P. bradyi* (4000 ft, April) (McDougall, 1973).

Herbarium Specimens

No specimens have been located in local herbaria that document the presence of this species at Wupatki National Monument.

Listing Status (AGFD, 1998)

ESA:	None
USFS:	None
NESL:	None
NPL:	SR
GRank:	G4
SRank:	S1

The Endangered Species Act (ESA), the U.S. Forest Service (USFS), and the Navajo Nation (NESL) do not list this species. The Arizona Native Plant Law (NPL) considers this species "salvage restricted" and collection is allowed only with a permit. The Global Ranking (G) lists this species as one that is secure globally although it may be rare in certain parts of its range. The State Ranking (S) states that this species is critically imperiled because of its extreme rarity in the state. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

The field crew did not find this species of *Pediocactus* during the 1999 field season. However, it is possible that this species occurs in the high desert of Wupatki National Monument. Other localities of this species occur along the Colorado River and it may be able to colonize along the Little Colorado River.

One plant was located in Antelope Prairie at Wupatki National Monument in 1976 by L.T. Green, III. One locality near Lomaki Ruin was revisited in 1999 with L.T. Green, III but the plant was not relocated. The plant may have already retracted into the soil or it may have been stolen from the site. It is recommended that no collection of this species be allowed.

It should be noted that most species of *Pediocactus* are found very rarely because of their narrow geographical ranges and small size. "At maturity some species are of no greater diameter than a medium-sized coin, standing above ground no higher than the thickness of the coin. Even when their approximate location is known, days of searching may be consumed in finding the plants. Most species grow hidden in particular kinds of rocks, and during the dry season they retract into the substrate" (Benson, 1982).

Management

The Bureau of Land Management (BLM) currently protects this species at Marble Canyon on the North Rim of the Grand Canyon. The National Park Service is also involved in the monitoring of this species along the Arizona Strip in northern Arizona (AGFD, 1998).

Due to its rare status in Arizona, *P. simpsonii* is vulnerable to damage by grazing, trampling, rodent depredation, and off-road vehicles. This plant is likely to remain rare because of its small population sizes, low reproductive potential, and specialized environment.

Annotated Bibliography

Abrams, Leroy. 1951. Illustrated Flora of the Pacific States: Washington, Oregon, and California, Vol. III. Stanford University Press, Stanford, CA.

Volume three covers geraniums to figworts; descriptions are given of genera; only one species, *P. simpsonii*, is described; a clear line drawing is included.

Arizona Game and Fish Department. 1998. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

Arp and Rogers. 1970. Use of the computer in correlation of data concerning the varieties of *Pediocactus simpsonii*.

Referenced in Benson 1982.

Bateman, Gary C., project director. 1980. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report (Phase III). Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

Second draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments

_____. 1976. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report. Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

First draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments

Benson, Lyman. 1982. The Cacti of the United States and Canada. Stanford University Press, Stanford, CA.

General discussion of the genus and this species with keys to seven species, distribution map, line drawings and photographs of live and herbarium specimens.

_____. 1969. The Cacti of Arizona, Third edition. The University of Arizona Press, Tucson, AZ.

Long discussion of the genus, key to six species, *P. peeblesianus* with 3 varieties, description of *P. simpsonii* with distribution and synonymy.

Earle, W. Hubert. 1963. Cacti of the Southwest. Science Bulletin No. 4, Arizona Cactus & Native Flora Society, Inc, Phoenix, AZ.

Clear description of the genus, synonyms, distribution, and photograph.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

Hogan, Phyllis and Kristin Huisinga. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Phillips, Barbara G. 1999. Personal communication, U.S. Forest Service Supervisor's office, Flagstaff, AZ

Weber, William A. 1976. Rocky Mountain Flora. Colorado Associated University Press, Boulder, CO.

Brief description of Cactus Family and key to *Opuntia* sp, *Echinocereus*, *Coryphantha*, and *Pediocactus simpsonii*.

Rare Plant Species
Historic Locations
Wupatki National Monument
Pediocactus simpsonii



Latin Name: *Phacelia welshii*
Latin Name w/ authority: *Phacelia welshii* Atwood
Synonyms: None
Family: Hydrophyllaceae
Common Name: Welsh's phacelia, Welsh caterpillar weed

Original Description

N.D. Atwood. 1972. New species in the *Phacelia crenulata* Group (Hydrophyllaceae). *Rhodora* 74 (800): 451-468.

Type Specimen

N.D. Atwood, BRY! 2608. May 19, 1970, along Highway 89 north of Gray Mountain, on red shale (also common south of town on red shale), Coconino County, AZ.

Taxon History

This is a distinct species in a polymorphic genus of about 200 species, mostly of the western United States and Mexico. Thirty-five species and 7 varieties of the *Phacelia crenulata* group occur in North America. In 1937, John W. Voss revised the *Phacelia crenulata* group in North America although *Phacelia welshii* was not named until 1972. At this time N. Duane Atwood named this new species in honor of Dr. Stanley L. Welsh from Brigham Young University. His 1975 revision of the *Phacelia crenulata* group discussed taxonomic relationships between the 35 species and 7 varieties of *Phacelia* in this group (Phillips et al., 1982; AZGD, 1998).

Description

Herbaceous annual to 10-50 cm tall. STEMS more or less yellowish to green, densely covered with many-celled stalked glands. LEAVES oblanceolate to lanceolate, covered with glands, with margins rolled, wavy, toothed; *basal leaves* clustered. FLOWERS purplish to blue; *stamens* exerted, bluish filaments, yellow anthers. SEEDS four per flower, brown ventrally to reddish dorsally, with ridge corrugated on one side, margins corrugated and often rolled (Atwood, 1972; AZGD, 1998).

According to Atwood (1972), *P. welshii* is closely related to *P. corrugata* and *P. utahensis*. Distinguishing characteristics of *P. welshii* are its broader, dark brown seeds, long (up to 1.3 mm long), flattened, multicellular, stipitate glands and distinct leaves. *P. welshii* differs from *P. utahensis* by its broad, shorter, glandular leaves, corrugated seeds, more open inflorescence, and distinct geographic range. *P. utahensis* is endemic to the Arapien Shale Formation in Utah.

The ranges of *P. welshii* and *P. corrugata* overlap although *P. corrugata* is typically found further north and is not uncommon in Coconino County (Atwood, 1972; Phillips et al., 1982).

Biology

This species flowers from May to June and sets fruit shortly after flowering before it withers away like other annuals. It will sometimes flower a second time with the monsoon rains and seeds can be found into September. Reproduction is typically very high (95-100%) and seeds are very abundant.

P. welshii is adapted to precipitation cycles of Great Basin Grassland and Shrubland communities. Its populations vary greatly from rare to abundant depending upon the amount of winter and spring precipitation. In wet years, the plants are very dense due to the germination of the dormant seed crop within the soil. In drought years, the plants are sparse to rare (Phillips et al., 1982; AZGD, 1998).

Ethnobotany

Some species of *Phacelia* were used historically by the Hopi and Navajo but are not used currently (Hogan, 1995).

Habitat

P. welshii is found in scattered populations along roadside edges and in gravelly washes. It can also be found on red shale outcrops of the Moenkopi Formation and black, sandy volcanic ash in Great Basin Shrubland vegetation. Its elevational range is between 4250 and 5100 feet (Phillips et al., 1982; AZGD, 1998; Roth, 1999).

Associated species are: *Atriplex canescens*, *Atriplex confertifolia*, *Fallugia paradoxa*, *Amsonia peblesii*, *Senecio douglasii* var. *longilobus*, *Lycium andersonii*, *Echinocactus polycephalus*, *Eriogonum deflexum*, *Mentelazia pumila*, *Brickellia californica*, *Stanleya pinnata*, *Rhus trilobata*, *Chrysothamnus nauseosus*, *Hilaria jamesii*, *Opuntia erinacea* (Phillips et al., 1982; AZGD, 1998).

Distribution

This *Phacelia* is endemic to Coconino County, Arizona ranging from Wupatki National Monument to north of Tuba City on the Navajo Indian Reservation.

Although not represented by herbarium specimens at local herbaria, specific localities of *Phacelia welshii* within Wupatki National Monument are: "red shale hills along road ca. 0.5 mi. n. of headquarters of Wupatki National Monument" and "ca. 1.5 mi. n.w. of Headquarters of Wupatki National Monument along highway on red shale" (Atwood, 1972).

Herbarium Specimens

Herbarium specimens documenting this species at Wupatki National Monument were found at the local herbaria and are listed below. No specimens of this species are currently at Wupatki National Monument herbarium. Some specimens were collected more than once from the same locality but the localities are listed only once here. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Rim of a small canyon, Wupatki National Monument
NAU	Sandy wash, Wupatki National Monument
MNA	10 miles north of Wupatki turnoff on AZ Highway 89, T27N R8E Sec. 24
MNA	Near Cameron, Coconino County
MNA	2.4 miles N of Gray Mountain, roadside along AZ Highway 89, T28N R9E Sec. 29, Coconino County
MNA	Wash to east of Highway 89, 2.4 mile north of Gray Mountain, T28N R9E Sec. 29, Coconino County
MNA	Navajo Route 6133, 1/2 mile east of US89 and 3/4 miles SW School, 6.5 mile north of junction with US160, Coconino Count.

Listing Status (AGFD, 1998)

ESA:	SC
USFS:	S
NESL:	4
NPL:	None
GRank:	G3
SRank:	S2

The Endangered Species Act (ESA) lists this species as a "species of concern." The U.S. Forest Service (USFS) lists this species as a "sensitive". The Navajo Nation (NESL) indicates that this species is not currently listed as a species of concern due to the lack of information regarding its status on reservation lands. The Arizona Native Plant Law (NPL) does not list this species. The Global Ranking (G) lists this species as one that is imperiled globally because of rarity making it very vulnerable to extinction throughout its range. The State Ranking (S) states that this species is vulnerable to extinction throughout its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

The 1999 field crew did not find this species at Wupatki National Monument before it had flowered and died. However, two precise localities are described in Atwood (1972). These localities should be visited in the spring of 2000 to assess the population health and vigor.

Management

Destruction of the apical meristem by grazing cattle does not appear to harm these plants because the lower side branches quickly grow to replace main apical stem. The realignment and conversion of the crude oil pipeline to a natural gas pipeline from Cameron, Arizona to Farmington, New Mexico is a threat to certain populations of this plant. Navajo Nation scientists have advised that the work sites be thoroughly surveyed for any potential impact to this species (Meyer, 1999). No other serious threats to this species are known (Phillips et al., 1982; AZGD, 1998).

Annotated Bibliography

Arizona Game and Fish Department. 1998. *Phacelia welshii*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Comprehensive review of species including description, biology, habitat, distribution, management factors, sources of further information, map, and occurrence reports. Element Status Designations also included.

Atwood, N.D. 1975. A Revision of the *Phacelia crenulatae* group (Hydrophyllaceae) for North America. *The Great Basin Naturalist* 35: 127-190.

Discusses the relationships between species of *Phacelia* and gives a new taxonomic key to species

_____. 1972. New Species in the *Phacelia crenulata* Group (Hydrophyllaceae). *Rhodora, Journal of the New England Botanical Club* 74 (800): 465-468.

Bateman, Gary C., project director. 1980. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report (Phase III). Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

Second draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments

_____. 1976. Natural Resources Survey and analysis of Sunset Crater and Wupatki National Monuments: Final Report. Prepared for the Office of Natural Resources Management, Southwest Region, National Park Service.

First draft including descriptions, locations, and management recommendations for several threatened and endangered plants within the two monuments

Hogan, Phyllis. 1995. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. *The Wupatki and Sunset Crater Herbaria: A guide to the plant collections*. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species

Meyer, John R. 1999. Unpublished correspondence regarding the realignment and conversion of crude oil pipeline to natural gas pipeline from Cameron, Arizona to Farmington, New Mexico. The Navajo Nation, AZ.

Phillips, Arthur M, B.G. Phillips and N. Brian. 1982. Status report *Phacelia welshii* Atwood.
Unpublished report prepared for U.S. Fish and Wildlife Service, Albuquerque, NM.

Referenced in Arizona Game and Fish Department Heritage Data Management System, 1998.

Roth, Daniella. 1999. Unpublished abstract on *Phacelia welshii*. Navajo Nation Botanist report.

Description of the plant, its habitat and location.

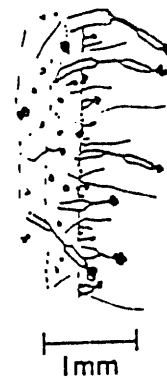
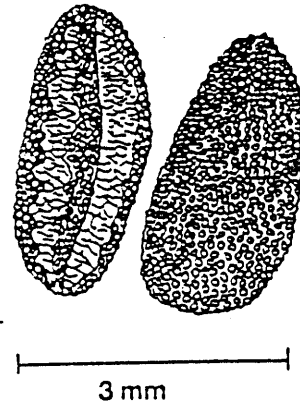
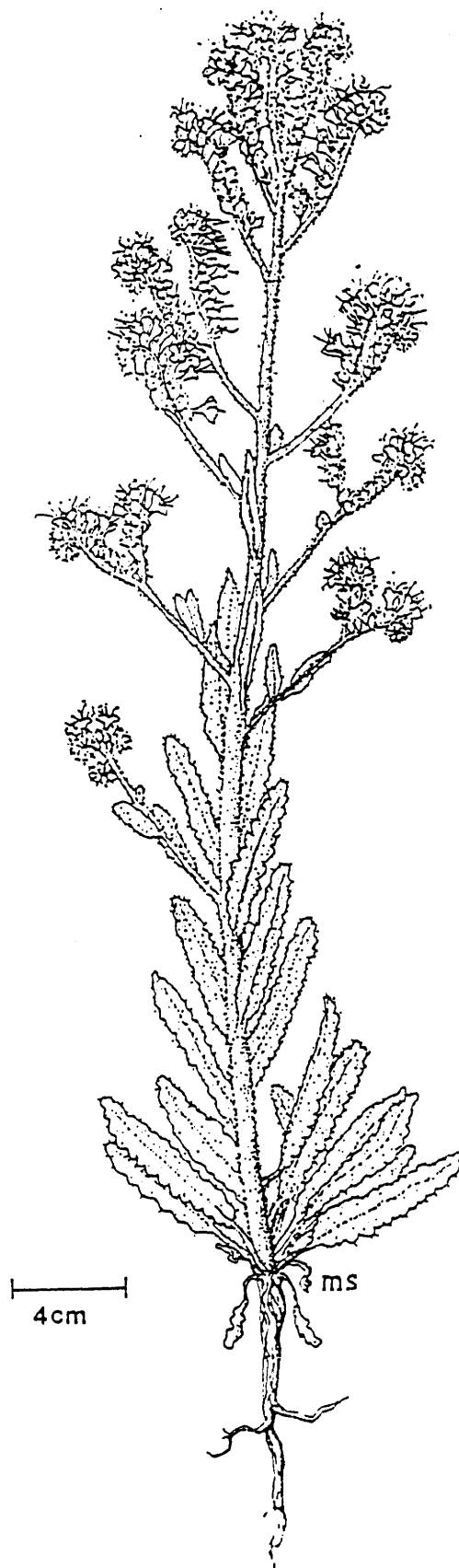
Rutman, Sue. 1992. Handbook of Federally endangered, threatened, and candidate plants of Arizona.
U.S. Fish and Wildlife Service, Phoenix, Arizona.

Brief description of habitat of this species.

Voss, John W. 1937. A revision of the *Phacelia crenulata* group for North America. Bulletin of the
Torrey Botanical Club 64 (2): 83-9.

Original description in English and Latin and type locality of this new species with key to all
species.

United States Fish and Wildlife Service, line drawing of plant in flower and seed.



Phacelia welshii

Latin Name: *Psorothamnus thompsoniae* var. *whitingii*
Latin Name w/ authority: *Psorothamnus thompsoniae* (Vail) Welsh & Atwood var. *whitingii* (Kearney & Peebles) Barneby
Synonyms: *Dalea whitingii*
Family: Fabaceae
Common Name: Whiting's dalea, Whiting's indigo-bush

Original Description

R.C. Barneby. 1977. *Memoirs of the New York Botanical Garden* 27: 52-54.

Type Specimen

Type: Whiting and Jones (916/3277), US 1732120. 1938, Wupatki National Monument, Little Colorado River, Coconino County, AZ.

Holotype: US! (U.S. National Herbarium)

Taxon History

This species was first documented in Arizona by a renowned southwest ethnobotanist, Alfred Whiting, who wrote *Ethnobotany of the Hopi* in 1948. It was originally named as *Dalea whitingii* after him. The other variety of *Psorothamnus thompsoniae* is variety *thompsoniae* which occurs only in Utah. It was previously known as *Dalea thompsoniae*. It differs from variety *whitingii* by its leaf shape and size and its calyx pubescence (Cronquist et al., 1989).

Psorothamnus is a genus of nine species that occur in the Sonoran, Mojavean, and Chihuahuan deserts and in desert basins in the Intermountain U.S. Five species enter or are endemic to our region. This genus was formerly referred to as *Dalea* but is now distinguished by the fact that all of its petals are inserted on the hypanthium rim (Cronquist, et al., 1989).

The name was derived from the Greek *psoros* and *thamnós*, meaning scurfy shrub (Cronquist et al., 1989).

Description

Perennial shrub, small, rounded, 40-90 cm tall, with branchlets often spinescent. STEMS covered with dense silky hairs and orange resinous glands. LEAVES short-petioled, 1.4-3.0 cm long; leaflets 7-17 pairs, emarginate, linear, 2-7 mm long. INFLORESCENCE a loose raceme. CALYX bears large red-orange glands and is shaggy, with spreading hairs 0.3-0.5 mm long; calyx lobes ovate to oval, obtuse to rounded, or the lowermost ovate-acute. FLOWERS bright pink or violet-purple; banner petal 6-8.4 mm long, 4-6 mm wide. FRUIT pod 4-4.5 mm long, flattened, short-hairy and dotted with large glands (McDougall, 1973; Cronquist et al., 1989; AGFD, 1993).

In Arizona, *P. thompsoniae* var. *whitingii* is distinguished from *P. scoparius* by its pink-purple flowers, nonrush-like habit, and evenly pinnate leaves. *P. scoparius* has a rush-like habit, odd-pinnate leaves and vivid blue or blue-violet (rarely white) flowers. *P. arborescens* is distinguished by its pedicels without orange glands, pods greatly exserted and indigo blue or violet blue flowers (Roth, 1999).

Biology

This variety flowers from May to August and sets fruit in the fall. It is a clonal plant and its distribution remains very local.

Ethnobotany

The roots of *Psorothamnus* were historically eaten by the Hopi as a sweet treat for children. It is believed that the Navajo also ate the roots. The Hopi utilize the aerial parts of the plant for ceremony and healing (Hogan, 1995).

Habitat

This variety is found on sandy, gravelly soils. It grows from 3700-5100 feet on slopes of low hills and ridgetops sometimes moving into arroyos and floodplains. It occurs in mixed desert shrub communities and is often associated with saltbush, sand sagebrush, and Mormon tea (AGFD, 1993; Roth, 1999).

Other species of *Psorothamnus* that are found in Coconino County are: *Psorothamnus fremontii* (3000 ft., April-June) and *Psorothamnus arborescens* var. *pubescens* (no range) (McDougall, 1973).

Distribution

This variety is known only from the Monument Valley region in southwestern San Juan County, Utah (Copper Canyon, Paiute Canyon) southwest to Navajo Mountain and Wupatki National Monument along the Little Colorado River drainage (Coconino County, Arizona). It was reported from Grand Canyon National Park at Kanab Creek although this locality is questionable (Kearney & Peebles, 1951; McDougall, 1973; AGFD, 1993).

Specific localities within Wupatki National Monument are listed below.

Herbarium Specimens

Several herbarium specimens documenting presence of *P. thompsoniae* var. *whitingii* at Wupatki National Monument were found at local herbaria (Hogan & Huisinga, 1997). Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

Herbarium	Location of Collections
NAU	Wupatki National Monument, banks of LCR below Black Falls
NAU	Spiderweb Ranch, N of Wupatki National Monument, in a sandy arroyo
NAU	Wupatki National Monument, on steep sides of low hills about 2 miles downstream from Black Falls, approx. 1000 feet west of LCR
WUPA	Near Black Falls in the Little Colorado River
WUPA	Sandy slope about 1/4 mile from type locality on the banks of the Little Colorado River

Listing Status (AGFD, 1993)

ESA:	C2
USFS:	S
NESL:	None
NPL:	None
GRank:	?
SRank:	?

The Endangered Species Act (ESA) recognizes this variety as a "species of concern." The U.S. Forest Service (USFS) indicates that this is a "sensitive" species. The Navajo Nation (NESL) and the Arizona Native Plant Law (NPL) do not recognize this variety. The Global and State Rankings indicate the status of this variety is unknown. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the 1999 field season, *Psorothamnus thompsoniae* var. *whitingii* was located both on and off of Wupatki National Monument. The population on the Navajo Reservation just to the north of the Little Colorado River was investigated but was not inputted into the GIS system. This population occurs on a rocky ridgetop and is of approximately 100-200 individuals. Another population just south of the Little Colorado River on Wupatki National Monument is represented on the GIS maps. This population is extensive with over 1500 plants occurring on the slopes and tops of rocky ridges. However, it is abundant in a very specific, local area and is not generally abundant at all.

Management

According to Rutman (1990), the populations of this species appear to be stable. The plants are palatable and browsed by livestock. Otherwise, very little is known about this species. This plant may have been more widespread in the past and its abundance may have decreased due to heavy use of this plant historically by indigenous people. The Navajo Natural Heritage Program is preparing (1992) a status report under contract with the U.S. Fish and Wildlife Service (AZGD, 1998).

Annotated Bibliography

Arizona Game and Fish Department. 1993. *Psorothamnus thompsoniae* var. *whitingii*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Includes classification, description, biology, management concerns

Cronquist, Arthur, N.H. Holmgren, and P.K. Holmgren. 1989. Intermountain Flora: Vascular Plants of the Intermountain West. Vol. 3, Part B. The New York Botanical Garden, Bronx, NY.

Description of genus *Psorothamnus*

Hogan, Phyllis. 1995. Unpublished ethnobotanical field notes.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species

McDougall, W.B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

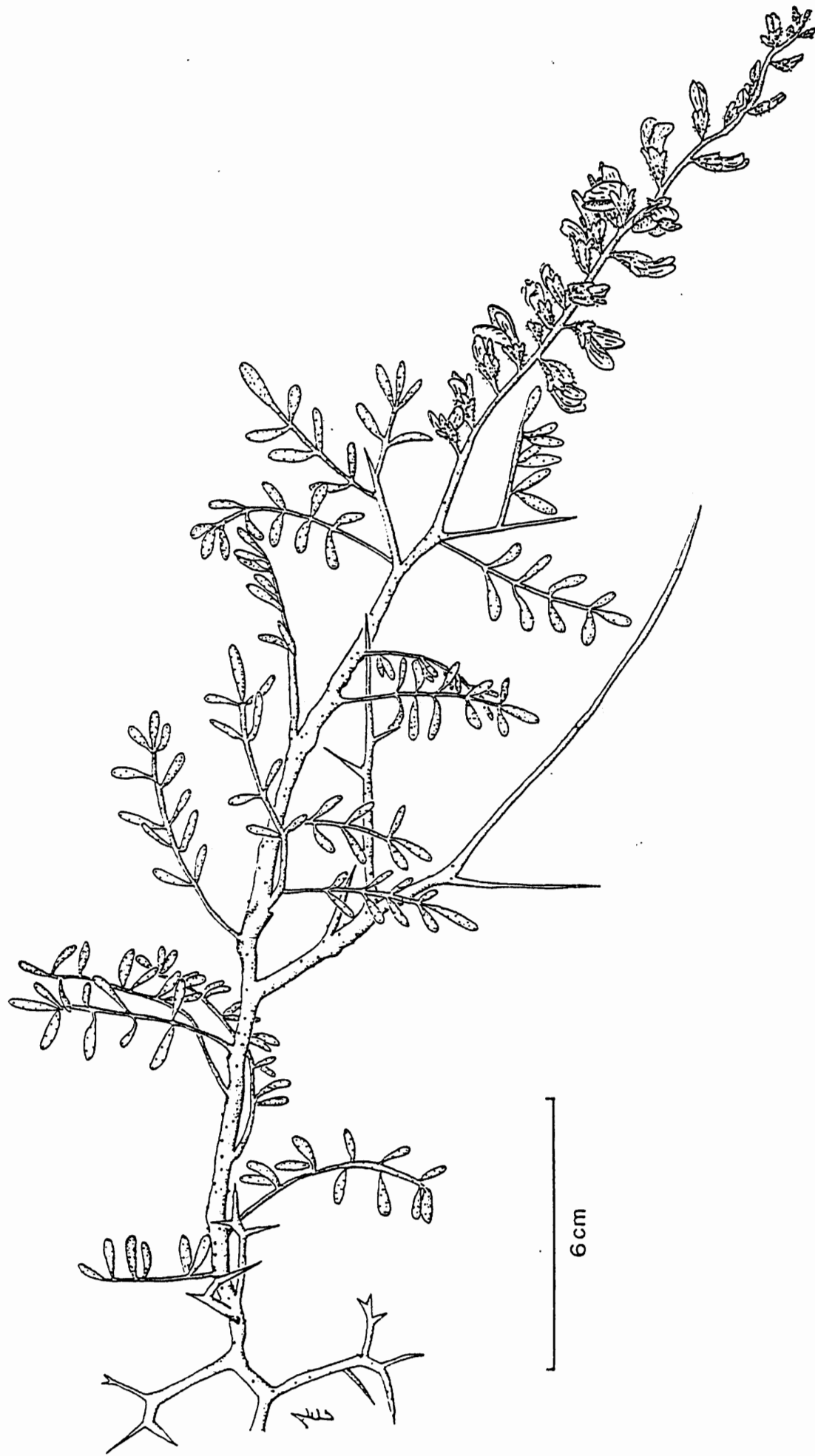
Description of genus and species

Roth, Daniella. 1999. Unpublished abstract on *Psorothamnus thompsoniae* var. *whitingii*. Navajo Nation Botanist report.

Abstract and location of plant on Navajo lands.

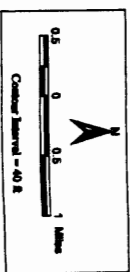
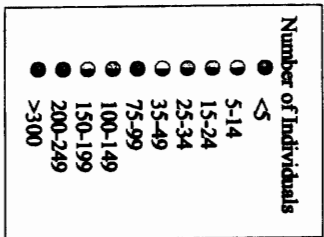
Rutman, Sue. 1992. Handbook of Arizona's rare plants, U.S. Fish and Wildlife Service, Phoenix, AZ.

Brief description of habitat and distribution of the plant.



Psoralea thomsoniae var. *whitingii*

Rare Plant Species Abundance
Wupatki National Monument
Psoralea thompsoniae
var. *whitingii*



Latin Name: *Puccinellia parishii*
Latin Name w/ authority: *Puccinellia parishii* A.S. Hitchc.
Synonyms: None
Family: Poaceae
Common Name: Bog alkaligrass, Parish's alkaligrass

Original Description

A.S. Hitchcock. 1928. Proc. Biol. Soc. Wash., xli, 157.

Type Specimen

S.B. Parish 99799, US! (U.S. National Herbarium), 906,851. April 24, 1915, Rabbit Springs, San Bernardino County, CA.

Taxon History

This genus consists of approximately 25 species that are either perennial or annual. It occurs in arctic and cool temperate regions of the Northern Hemisphere (Gould, 1951). It is presumed to be a relict species from the Holocene, persisting only along the saline edges of drying lake beds (AGFD, 1998).

Description

Annual dwarf grass, 7.5-20 cm tall, bluish-green in color. CULMS 1-25, 2-20 cm long, strictly ascending at 20 to 60 degrees, sheaths open to the base. LIGULES 1-3 mm long, membranous, acute, entire. LEAF blades 1-3 cm long, 1 mm broad, contracted, branches appressed. INFLORESCENCE paniculate, stalked, narrow, few-flowered; *spikelets* 2-6 flowered; *florets* disarticulating above the glumes; *glumes* much shorter than the lemmas, sharply acute, strongly nerved, scarious margined; *lemmas* 1.5-2 mm long, rounded across the back, finely pubescent on the nerves, scarious at the broad tip. FLOWERS perfect; *anthers* 0.25-0.75 mm long (Gould, 1951; Soreng, 1986).

This species is separated from other *Puccinellia* species found in Coconino County by its size (less than 20 cm tall), annual growth habit and pubescent lemma (versus taller, mostly perennial species, with glabrous lemma nerves) (McDougall, 1973).

Biology

Puccinellia parishii is a short-lived winter or spring annual that flowers in April and May. It rapidly sets seed drying up during the late spring (drought period). The numbers of plants can vary from a few to a thousand depending on the amount of precipitation. Its seeds may survive for an undetermined number of years in the seedbed if dry conditions prevail (AGFD, 1998).

Ethnobotany

To this date, the AERA has found no culturally significant use of this plant by any of the Native American tribes on the Colorado Plateau.

Habitat

This plant is a wetland species that grows in marshy ground in open, flat or gently sloping areas. It is found in pinyon-juniper and desert communities between the elevations of 5000-6000 feet. In Arizona, it is found salt beds where water seeps between sandstone and leaves moist salty deposits (Phillips, 1999). Otherwise it is found in the moist, open, saline areas that are created when perennially flowing streams go underground, re-emerge to the surface and evaporate, leaving a very saline microhabitat (AGFD, 1998).

In Coconino and Apache Counties, this species is associated with *Juncus balticus*, *Scirpus* sp., *Oxytenia acerosa*, *Tamarix* sp., *Sporobolus airoides*, *Eleocharis* sp., *Sarcobatus vermiculatus*, *Juniperus* sp., *Phragmites communis*, *Pinus edulis* and *Purshia* sp.. In Yavapai County, it is associated with upland Sonoran desertscrub where many Mohave desert and desert grassland species occur.

Distribution

Several small, widely disjunct sites are known from southern California, Nevada, northern and eastern Arizona, southwestern Colorado and western New Mexico. Within Arizona, there are populations in Yavapai, Coconino and Apache Counties. It occurs on the Navajo Nation near Shonto (considered extirpated by AGFD) and Tuba City (very disturbed, possibly extirpated) (AGFD, 1998). There are at least

5 extant locations on the Navajo Nation including localities near Echo Cliffs and north of the Carrizo Mountains. One population occurs in Yavapai County near Prescott in a tributary to Little Shipp Wash (Correll & Correll, 1975; AZGD, 1998; Roth, 1999).

Other species of *Puccinellia* that occur in Coconino County are: *P. airoides* (4000-7500 feet), *P. fasciculata* (no range), and *P. pauciflora* (7000-9000 feet) (McDougall, 1973).

Herbarium Specimens

Several herbarium specimens documenting presence of *Puccinellia parishii* in northern Arizona were found at local herbaria. It has not been recorded within Wupatki National Monument. Due to an active loan policy at the Arizona herbaria, this list of specimens may represent only a partial list of documented plant localities.

One herbarium specimen that is not listed here from Arizona State University documents *Puccinellia parishii* in Pinal County along Aravaipa Creek. It is likely that this identification is a mistake because of the limited range of the species and this specimen requires re-identification before included in the range of this species (AGFD, 1998).

Herbarium	Location of Collections
NAU	Coconino Co., Arizona, in Pasture Canyon NE of Tuba City ca 1.1 miles north of Pasture Canyon Reservoir, growing on moist, sandy soil with salty crust, site is bounded by farm plots on north and south
NAU	Apache Co., Arizona, 5.1 miles W of Hwy 160 junction at Tec Nos Pos on Hwy 64, on wet alkaline soil of large cienega
NAU	Coconino Co., Rose Well, at W base of Echo Cliffs, On 89, 10.3 mi N of Jct. with US 160, E in ravine behind corral, Lat: 36 degrees 13' N Long: 110 degrees 23' W

Listing Status (AGFD, 1998)

ESA:	PE
USFS:	None
NESL:	2
NPL:	HS
GRank:	G2
SRank:	S1

The Endangered Species Act (ESA) lists this species as a "proposed endangered." The U.S. Forest Service (USFS) does not list this species. The Navajo Nation (NESL) indicates that this species is endangered on reservation lands. The Arizona Native Plant Law (NPL) indicates that this species is "highly safeguarded" and collection is not allowed. The Global Ranking (G) lists this species as one that is imperiled globally because of rarity making it very vulnerable to extinction throughout its range. The State Ranking (S) states that this species is extremely rare and is extremely vulnerable to extinction throughout its range. Refer to the introduction for a more complete explanation of these definitions and codes.

1999 Status

During the 1999 field season, *Puccinellia parishii* was not found within Wupatki National Monument. It seems likely that it may be found in this area because of its nearby populations in Tuba City. It is recommended that search efforts be continued into the next field season, concentrating efforts along the Little Colorado River where perennial water flows, evaporates and leaves saline flats. However, the species is short-lived and extremely inconspicuous. Search efforts should be concentrated in the appropriate season and conducted by experienced botanists.

Management

P. parishii is very rare, restricted, and unusual. Its saline spring/seep habitat is uncommon and vulnerable as well. Its abundance has declined greatly over the last 40 years due to encroachment on its habitat and drying climates (AGFD, 1998). One location that has not experienced serious habitat alteration or disturbance is located at Faywood Hot Springs, New Mexico. Its status remains uncertain at other historic localities including one in Clark County, Nevada (AGFD, 1998).

It is possible that the species is not especially vulnerable to certain kinds of habitat disturbance. It appears to survive trampling due to cattle. As an annual, it can apparently survive drought periods as a dormant seed for an unknown length of time, which possibly buffers it from ephemeral drying out of its habitat. Its small size and the short duration of its active life cycle make it less likely to be discovered at new sites than larger, showier, or longer-lived species (AZGD, 1998; Roth, 1999).

P. parishii is an opportunistic species and is capable of invading newly created habitats such as newly plowed fields. Where the plant occurs in New Mexico on private land, the landowner is aware of the existence of the plant and sensitivity of the site and he restricts access to the site. Biologists working at wetland sites should be alerted to the possibility of discovering new sites in the course of their investigations (AZGF, 1998).

The realignment and conversion of the crude oil pipeline to a natural gas pipeline from Cameron, Arizona to Farmington, New Mexico is a threat to certain populations of this plant. Navajo Nation scientists have advised that the work sites be thoroughly surveyed for any potential impact to this species (Meyer, 1999).

Annotated Bibliography

Arizona Game and Fish Department. 1998. Status Designations, Biological Elements of Arizona. Unpublished notebook, Heritage Data Management System, Phoenix, AZ.

Complete listing of Arizona plant and animal taxa with Arizona and U.S. status designations, as well as other designations where appropriate.

_____. 1998. *Puccinellia parishii*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ.

Comprehensive review, including description, range, biology, management concerns, sources of information, distribution map, and occurrence reports.

Correll, Donovan S. and H.B. Correll. 1975. Aquatic and Wetland Plants of Southwestern United States. Vol I. Stanford University Press, Stanford, CA.

Description of genus *Puccinellia*, keys to three species and brief description of *P. parishii*.

Gould, Frank W. 1951. Grasses of Southwestern United States. University of Arizona Press, Tucson, AZ.

Description of *Puccinellia*, key to two species, with descriptions.

Hitchcock, A.S. 1950. Manual of the Grasses of the United States. Second edition. U.S. Government Printing Office, Washington DC.

Description of genus *Puccinellia*, keys to 10 species, brief description of *P. parishii* with small drawing of panicle and floret of *P. parishii*.

Hogan, Phyllis and Kristin Huisinga. 2000. The Wupatki and Sunset Crater Herbaria: A guide to the plant collections. Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Describes the history of plant collection on the Monuments and lists all voucher specimens

_____. 1997. Herbarium search for specimens documenting sensitive plant species occurring within Flagstaff's National Monuments. Unpublished report, Arizona Ethnobotanical Research Association, Flagstaff, AZ.

Lists herbarium specimen locations for sensitive plant species.

Kearney, Thomas H. and R.H. Peebles and collaborators. 1960. Arizona Flora with supplement. University of California Press, Berkeley, CA.

Key to the genus *Puccinellia*.

McDougall, W. B. 1973. Seed Plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff, AZ.

Key and technical description of *P. parishii*.

Meyer, John R. 1999. Unpublished correspondence regarding the realignment and conversion of crude oil pipeline to natural gas pipeline from Cameron, Arizona to Farmington, New Mexico. The Navajo Nation, AZ.

Phillips, Barbara. 1999. Personal communication, U.S. Forest Service, Flagstaff, AZ.

Discussion of *Puccinellia parishii* habitat.

Roth, Daniella. 1999. Unpublished abstract on *Psoralea thompsoniae* var. *whitingii*. Navajo Nation Botanist report.

Abstract and location of plant on Navajo lands.

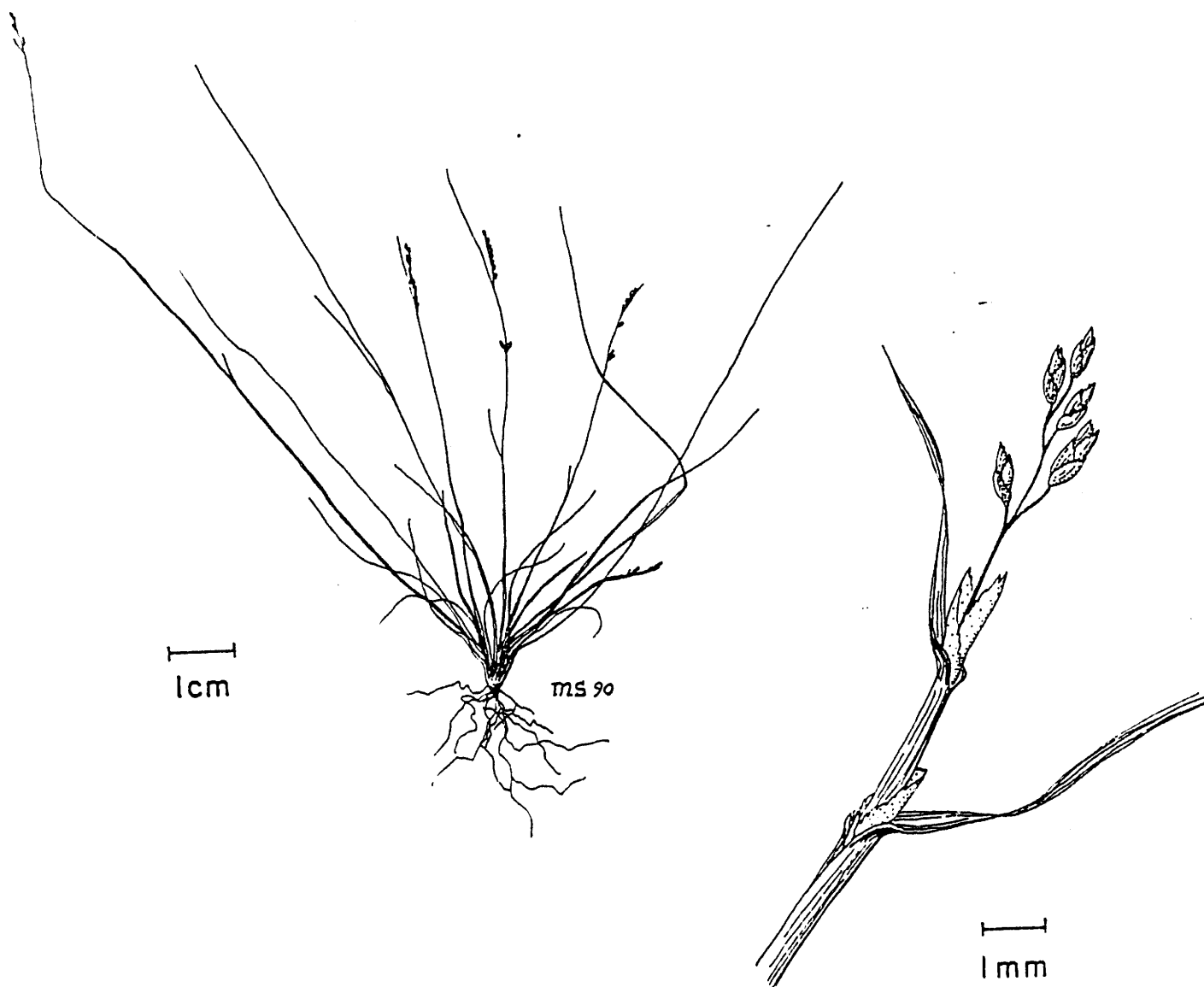
Rutman, Sue. 1990. Handbook of Federally endangered, threatened, and candidate plants of Arizona. Unpublished report. U.S. Fish and Wildlife Service, Phoenix, AZ.

Brief listing of range and land management/ownership.

Soreng, R.J. 1986. Vegetative analysis and addendum to the *Puccinellia parishii* preserve. Prepared for The Nature Conservancy, NM.

Referenced in AGFD 1998.

United States Fish and Wildlife Service, line drawing of plant in flower.



Puccinellia parishii





Clematis hirsutissima



Camissonia specuicola



Cimicifuga arizonica



Cymopterus megacephalus

41500
 1957 FROM
 MOUNTAIN, ARIZONA
 PUEBLO, ARIZONA



Phacelia welshii

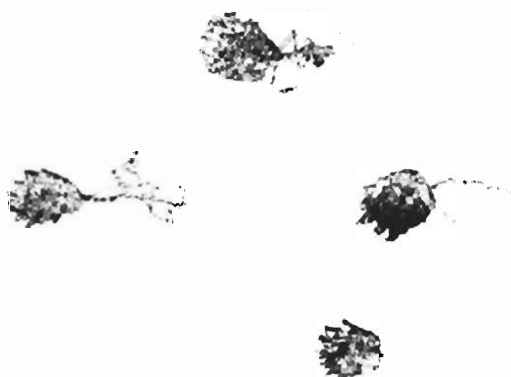
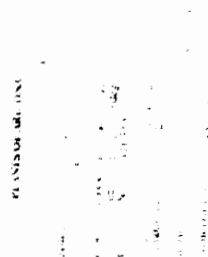
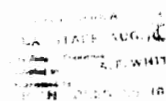


Penstemon thymepifolius var. whitinae



Puccinellia parshii

SHOULDER, THE TACAT, 1957
 1957 FROM
 MOUNTAIN, ARIZONA
 PUEBLO, ARIZONA



Pedro F. V. V.

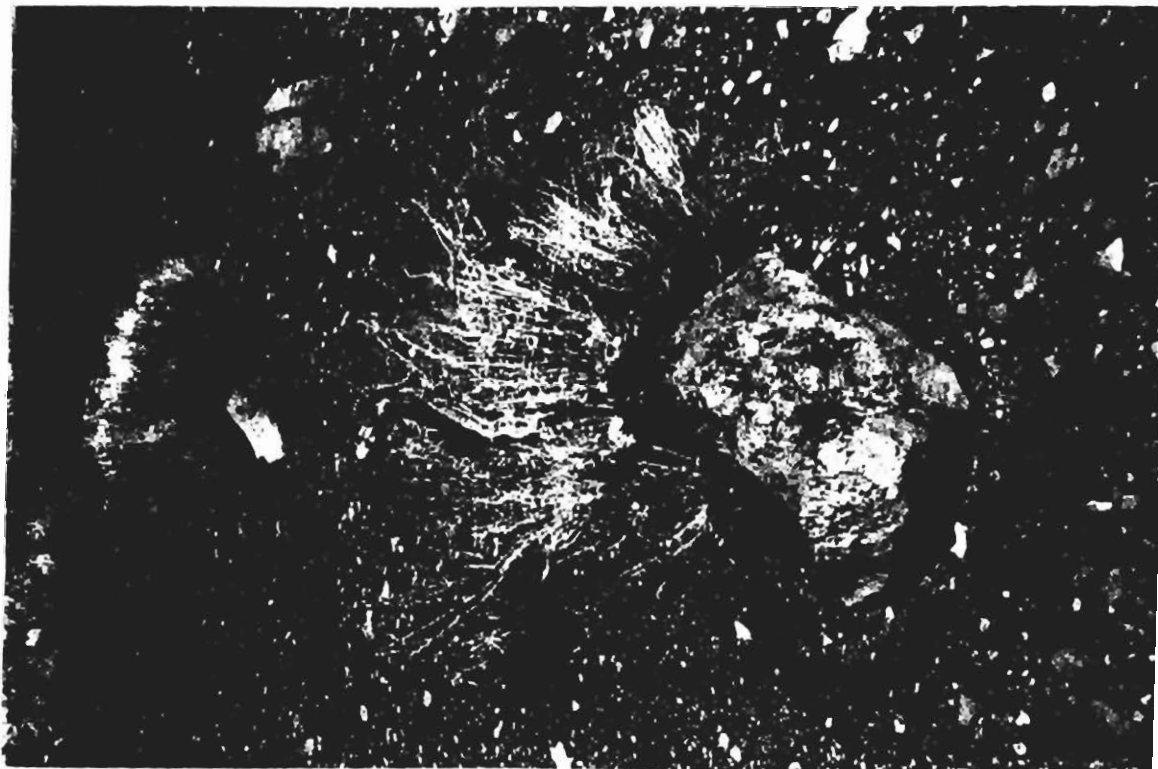
Pediocactus peeblesianus var. *firkeiseniae*



Amsonia peeblesii



Aquilegia desertorum



Amsonia peeblesii



Erigeron saxatilis



Hedecoma d. H. son

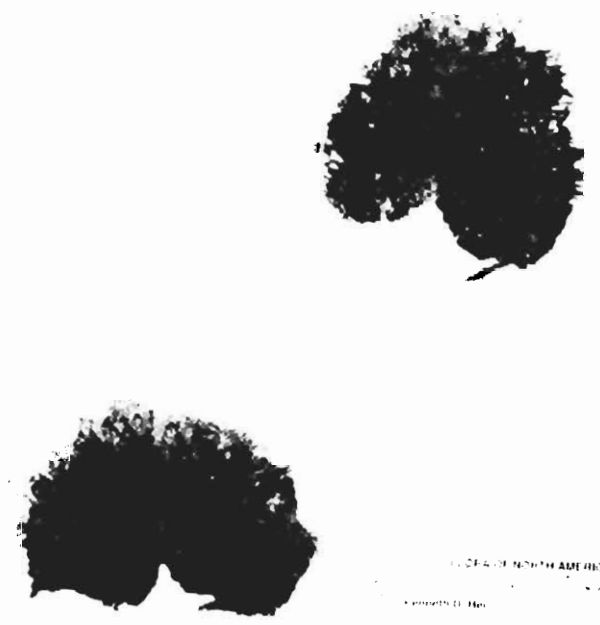
Erigeron rotundata



Erigeron rotundata

P. simpsonii

Hedecoma diffusa



Pedicularis simpsonii

PLANTS OF NAVAJO AND HOPI INDIAN RESERVES

PLANTS OF NORTH AMERICA

PLANTS OF NORTH AMERICA

