

ROUND-LEAF FOUR-O'CLOCK

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS



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Front cover photos: Round leaf four-o'clock and chalk barrens habitat. Photos by Susan Spackman Panjabi, Colorado Natural Heritage Program.

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FORT CARSON AND PIÑON CANYON MANEUVER SITE
COLORADO

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1. EXECUTIVE SUMMARY

1.1 Species Information

Scientific name:	<i>Oxybaphus rotundifolius</i> (Greene) Standley
Synonym:	<i>Mirabilis rotundifolia</i> (Greene) Standley
Common name:	Round-leaf four-o'clock
Family:	Nyctaginaceae (Four-o'clock family)
DOD Installations:	Fort Carson Military Reservation, Colorado U.S. Army Piñon Canyon Maneuver Site (PCMS), Colorado

Round-leaf four-o'clock (*Oxybaphus rotundifolius*) is a rare species due to narrow substrate specificity, weak competitive ability, and limited extent of its habitat. The species is ranked G2 (globally imperiled) by NatureServe and S2 (state imperiled) by the Colorado Natural Heritage Program (CNHP). It is considered a “species at risk” by the U.S. Fish and Wildlife Service (USFWS), but it has no formal federal status.

This perennial plant has thick woody roots that allow it to grow on dry rocky ridges where few other plants survive. The plants are low growing, leathery leaved, covered with hairs that conserve water, and remain dormant beneath the surface during drought years. Plants have magenta flowers, produce seeds and also grow new shoots from outlying roots. Three other associated plant species at risk are similarly adapted to the same habitat: golden blazing star, Arkansas River feverfew, and Pueblo goldenweed.

1.2 Habitat

The species and its cohorts are endemic to eroded outcrops of the Niobrara Formation called chalk barrens. The chalk barrens habitat is characterized by erodable terrain, shallow soils, little water and low nutrients; a unique environment in which few plants can thrive. The plant community is open piñon/juniper woodland which generally covers less than 25% of the chalk barrens. The four endemic species comprise 7.3% of the barrens flora (The Nature Conservancy 2001).

1.3 Distribution

Surveys for round-leaf four-o'clock have documented approximately 7,300 individuals. The 29 known populations occupy about 3,436 acres of chalk barrens habitat scattered across Pueblo and Fremont Counties in the central Arkansas River Valley of south-central Colorado. There is one disjunct population on 253 acres at Piñon Canyon Maneuver Site in Las Animas County, Colorado. All are within the Central Shortgrass Prairie Ecoregion.

1.4 Land Ownership

The Department of Defense (DOD) manages at least 1,015 acres of occupied habitat on Fort Carson and 253 acres on Piñon Canyon Maneuver Site (PCMS). Altogether the habitat for plant species at risk comprises about 0.05 percent of the 373,721 acres of military lands managed by Fort Carson.

Private owners control more than 2,111 acres of occupied habitat on residential commercial, industrial and agricultural lands. The State of Colorado manages about 57 acres of occupied habitat in recreation areas and along highways.

1.5 Threats Assessment

Protection for this rare plant and its cohorts depends on preventing the destruction of the chalk barrens habitat. Residential and commercial development with its attendant gravel extraction, water reservoirs, and infrastructure is increasing dramatically in the valley. Demolition of chalk barrens to make way for development on private lands is far outpacing conservation efforts. On habitat managed by Fort Carson, the ongoing threat to the plants is repetitive ground disturbance and compaction in the training areas. Intensity and frequency of impacts from training activities have increased since an armored cavalry unit moved to Fort Carson and training of National Guard and Reserve units has escalated. There is no scientific documentation of the effects of this disturbance regime on the plant species endemic to the chalk barrens.

Information on round-leaf four-o'clock population locations, sizes and trends is maintained by the Colorado Natural Heritage Program. Botanists at CNHP report that there is unsurveyed habitat on private land, unknown numbers of plants on military land, and known populations that are being extirpated faster than the database can be updated.

1.6 Conservation Actions and Recommendations

Fort Carson is currently working with The Nature Conservancy (TNC) and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk. The Colorado Department of Transportation is also supporting the establishment of this easement as a possible mitigation for conflict areas on highway right-of-ways.

TNC is promoting awareness of the chalk barrens plants among county and regional planners. Best management practices have been developed for maintenance crews on state lands. A new conservation-planning Legacy project is expected to enhance collaboration between Fort Carson, PCMS, TNC and CNHP that will benefit species at risk.

The Colorado Natural Heritage Program recommends management efforts focused on the eleven largest populations (about 5,000 plants) of round-leaf four-o'clock that are in good to excellent condition on 48 percent (1,639 acres) of known occupied habitat. Five of these populations, including about 1,226 acres, are on DOD land.

1.7 Monitoring and Adaptive Management

A two-phased implementation of monitoring is proposed by CNHP. Rapid assessments of the eleven high quality populations would document size, condition and landscape context for each site annually. Detailed assessments would consist of establishing a sufficient number of permanent plots to evaluate the impact of disturbance regime variables on population viability. Monitoring results will be integrated into existing programs to facilitate adaptive management of the habitat for long term survival of the rare plants.

1.8 Feasibility

Fort Carson plans to collaborate with CNHP to establish an assessment and monitoring program in 2005 to document the response of the plant species at risk to military and maintenance activities on the training areas. Assessment can be accomplished with two to four weeks of field work each year. Monitoring will begin with a pilot project to design the best protocol.

The collaborative efforts of DOD, private owners, TNC, CNHP, the State of Colorado, USFWS and others can, with continued support, provide long-term management and protection for the chalk barrens habitat of round-leaf four-o'clock and associated species at risk, and preclude the need to list these species as threatened or endangered.

2 INTRODUCTION

Management for a plant species at risk involves management for a unique habitat and vegetation community within an ecoregion. This management guidance template outlines protection strategies for the round-leaf four-o'clock (*Oxybaphus rotundifolius*), a species endemic to chalk barrens of the Niobrara Formation. The Nature Conservancy (TNC) has identified the chalk barrens as an ecologically important system within the Arkansas Valley Barrens (AVB) conservation site in Fremont and Pueblo Counties and on scattered outcrops in Otero and Las Animas Counties in Colorado. The AVB are mostly in the Central Shortgrass Prairie Ecoregion (TNC 2001).

The round-leaf four-o'clock is endemic to the chalk barrens. Golden blazing star is also endemic to the same habitat, although it is not always found on the same sites with the four-o'clock. A third species at risk, Arkansas River feverfew is almost always found growing with the four-o'clock on the chalk barrens sites, and also occurs on other rocky substrates in the area. These three species at risk will all benefit from proactive multi-species habitat protection and adaptive management.

3 HABITAT

3.1 Substrate

The Niobrara Formation covers more than 50 percent of the Arkansas Valley Barrens. In most areas, the Niobrara consists solely of resistant layers of shale and limestone called the shale/limestone barrens. In some areas, however, the limestone and shale are covered by more finely-grained chalk hills known as the chalk barrens (TNC 2001, Figure 1). The chalk outcrops are often found on moderately steep slopes, but also occur on flat mesa tops.



Figure 1. Chalk Barrens Habitat. Photo by S. Spackman, CNHP, 1999.

The chalk barrens occur on the Middle Chalk and Upper Chalk units of the Smoky Hills Member. They have highly weathered bedrock on the surface, consisting of small platy pieces less than four centimeters long that form a thin surface layer with shallow mineral soil underneath. These soils are fine-grained, with about 60 percent of the particles composed of silts and clays. Soil pH ranges from moderately to strongly alkaline (7.4 to 8.3 pH) (Kelso et al. 2003).

3.2 Plant Community

Shale barrens often support populations of narrowly endemic species. Recent research by Kelso (2003) indicates that plant endemism on the chalk barrens is not caused by requirements for unique geochemical conditions, i.e. round-leaf four-o'clock is not a gypsophilus plant. The chalk barrens habitat is characterized by erodable terrain, shallow soils, little water and low nutrients; a unique environment in which few plants can thrive. Vegetation generally covers less than 25% of the chalk barrens; the four endemic species comprise 7.3% of the barrens flora (TNC 2001). The round-leaf four-o'clock and many of the other barrens species have woody rhizomes or roots penetrating the thin, moisture-retentive chalk strata. They can exploit a habitat that excludes other locally abundant species that are intolerant of the physical conditions (Kelso et al. 2003).

3.2.1 Associated Species (Heckmann 1997)

Woody Species

Piñon pine	<i>Pinus edulis</i>
One-seed juniper	<i>Juniperus monosperma</i>
Bigelow's sagebrush	<i>Artemisia bigelovii</i>
Shadscale	<i>Atriplex confertifolia</i>
Gardner's saltbush	<i>Atriplex gardneri</i>
Four-wing saltbush	<i>Atriplex canescens</i>
James frankenia	<i>Frankenia jamesii</i>

Herbaceous Species

Pueblo goldenweed*	<i>Oonopsis puebloensis</i>
Golden blazing star **	<i>Mentzelia chrysantha</i>
Sidebells beardtongue	<i>Penstemon versicolor</i>
Arkansas River feverfew*	<i>Bolophyta tetraeuris</i>
Limestone bladderpod*	<i>Lesquerella calcicola</i>
Oval-leaf bladderpod	<i>Lesquerella ovalifolia</i>
Indian ricegrass	<i>Oryzopsis hymenoides</i>
New Mexico feathergrass	<i>Stipa neomexicana</i>
Fendler wild buckwheat	<i>Eriogonum fendlerianum</i>
James hidden-flower	<i>Cryptantha jamesii</i>
Rocky Mountain zinnia	<i>Zinnia grandiflora</i>
Plains blackfoot	<i>Melampodium leucanthum</i>
Snakeweed	<i>Gutierrezia sarothrae</i>
Sicklepod rushpea	<i>Hoffmanseggia drepanocarpa</i>

- ** sensitive and endemic to chalk barrens
- * sensitive and frequently found on chalk barrens

4 SPECIES INFORMATION

4.1 Protection Status

4.1.1 Federal Status

Round-leaf four-o'clock (*Oxybaphus rotundifolius*) is considered a “species at risk” (SAR) by the USFWS. Recovery actions are recommended to preclude the need for listing. The species was published as a category 2 candidate for listing in 1983. The category 2 list was eliminated in 1995 and the species currently has no formal federal status.

4.1.2 NatureServe and the Colorado Natural Heritage Program

The species is ranked G2 (globally imperiled) by NatureServe and S2 (state imperiled) by the Colorado Natural Heritage Program (CNHP). Globally and in Colorado the species is imperiled because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or (as in this case) because other factors demonstrably make it very vulnerable to extinction throughout its range.

4.1.3 State of Colorado

There are no state laws protecting sensitive plants in Colorado.

4.2 Description and Life History

4.2.1 Species Description

Round-leaf four-o'clock plants are about 12 inches high, dying back to ground level in winter; roots are thick, woody, and a meter or more long. One population may have some individuals with one or two stems and others nearly hemispheric with many branches. Stem hairs are white, long and stiff. Leaves are leathery and exhibit a wide range of hairiness. Lower leaves are round in outline, 7 cm. long and 5 cm. wide or less, upper leaves are smaller and more pointed. Flowers are bright magenta and flared to about 2 cm. in diameter (Figure 2). The flowers are only open between dawn and about midmorning; they do not reopen in the afternoon as in other four-o'clocks. Plants are pollinated by a variety of common insects, and are also self-pollinating. Small oval fruits develop in a papery, inverted umbrella-shaped structure which breaks off and rolls or blows away when the fruits are mature. Flowering starts in early June and fruits usually develop in July.

Lateral stems originate and branch out from the rhizome, to emerge at distances up to several meters from the main stem. These outlying shoots are difficult to distinguish from separate plants. Another characteristic of the species that complicates monitoring is the ability to remain dormant underground for one or more years. The individuals emerging from dormancy are difficult to distinguish from new seedling recruits

(Heckmann 1997). Available moisture has the greatest effect on plant size and reproduction, with plants remaining virtually dormant during drought.

4.2.2 Pollination Studies

Insect visitation has been observed in the field. Documented pollinators are one species of hoverfly (*Syrphus* sp.) and four species of bees: a bumble bee (*Bombus nevadensis*), a white-banded bee (Halictinae sp.), a sweat bee (*Dialictus* sp.), and a species of *Anthophora*. Western harvester ants serve as seed dispersers and seed predators. Flowering and seed set were equally abundant with and without insect pollination (Kelso et al. 2003), but the plants probably benefit from cross-pollination facilitated by insects because cross-pollination contributes to genetic variation within the species (S.C. Spackman Panjabi 2004.)



Figure 2. Round-leaf four-o'clock. Photo by S. Spackman, CNHP, 1999.

4.3 Associated Species at Risk

The golden blazing star and Pueblo goldenweed are frequently associated with the round-leaf four-o'clock on the chalk barrens; both are endemic to Pueblo and Fremont Counties. Arkansas River feverfew is strongly associated with the chalk barrens, and also occurs in three other counties of Colorado. All three species are known to occur on Fort Carson.

4.3.1 Golden blazing star (*Mentzelia chrysantha* Engelmann ex Brandegee)

Synonym: *Nuttallia chrysantha*

Family: Loasaceae

Golden blazing star is a species at risk. Recovery actions are recommended to preclude the need for listing. CNHP ranks the species G2/S2. This is a perennial herb with thick, erect,

mostly unbranched stems, 20-60 cm tall. Flowers are lemon yellow with 10 petals (Figure 3). Flowering occurs in July-September, fruits are produced in August and September.

Figure 3. Golden blazing star

Photo by S. Spackman, CNHP, 1999



4.3.2 Pueblo goldenweed (*Oenopsis* sp.)

Family: Asteraceae

This species is newly recognized (G. Brown, unpublished); its scientific name has not yet been formally published. Pueblo goldenweed is a species at risk. Recovery actions are recommended to preclude the need for listing. CNHP ranks the species G2/S2. Plants have persistent woody stalks and yellow ray and disk flowers, strongly pubescent and reflexed phyllaries. Flowers appear in July (Figure 4).

Figure 4. Pueblo goldenweed

Photo by S. Spackman, CNHP, 1999



4.3.3 Arkansas River feverfew (*Bolophyta tetraeuris* (Barneby) WA Weber)

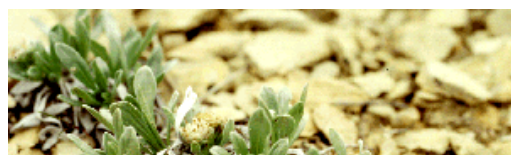
Synonym: *Parthenium tetraeuris*

Family: Asteraceae

Arkansas River feverfew is a sensitive species endemic to chalk and shale barrens habitats. CNHP ranks the species G3/S3 (threatened throughout its range). Plants are low and mat forming. White to pale cream disk flowers on very short stems bloom in April and May (Figure 5).

Figure 5. Arkansas River feverfew

Photo by S. Spackman, CNHP, 1999



5 DISTRIBUTION

5.1 Range-Wide

The chalk barrens are currently exposed only in the Pueblo to Cañon City area, although minor remnants exist to the southeast along the Arkansas River tributaries and into Otero and Las Animas Counties in Colorado (Figure 6). Elevation range for the round-leaf four-o'clock is 4,800 to 5,905 feet. The barrens appear as scattered outcrops ranging in length from 10 meters to a few kilometers.

The Colorado Natural Heritage Program has documented 3,436 acres of habitat occupied by the round-leaf four-o'clock. The total number of plants reported is 7,313. Both totals are based on field surveys. Surveys have not been completed for the chalk barrens habitat on all private or military lands, and counts of individual plants are inconsistent and incomplete.

5.2 DOD Lands

The chalk barrens extend onto the southern portion of Fort Carson. There is one isolated exposure of the formation on Piñon Canyon Maneuver Site.

5.2.1 Fort Carson

The extent of chalk barrens habitat known to be occupied by round-leaf four-o'clock on Fort Carson covers approximately 1,015 acres (CNHP 2004, DECAM 2004) which are used regularly for military training exercises, mechanized and otherwise, and for hunting and other recreational activities. The downrange maneuver areas where the barrens occur include about 82,000 acres.

DOD surveys for presence/absence of the species in 1995 and 1996 produced positive results at all of the 28 sites surveyed on 784 acres of training land. Additional surveys by non-military researchers in 1995 resulted in records for 231 additional acres of occupied habitat. Individual plants were not counted during DOD surveys. Plants were counted by other researchers using a variety of methods. The nine element occurrence records (locations) reported for DOD lands in Table 1 represents a consolidation of these survey sites into population sites.

5.2.2 Piñon Canyon Maneuver Site

“Gilligan’s Island” is a discrete outcrop of the chalk barrens that is easily distinguished from the surrounding plains. This ridge occupies about 253 acres, or 0.1 percent of the 225,000 acres of “trainable” land area within PCMS. The barrens here are composed of Greenhorn limestone instead of the Smoky Hills chalk member. The area is posted off limits to mechanized training maneuvers but there is evidence of occasional tank activity. This population represents the southeastern limit of known distribution for the round-leaf four-o'clock.

DOD surveys for presence/absence of the plants in 1995 and 1997 produced positive results only on the 253 acres of Gilligan's Island. Surveys were conducted on an additional 3,688 acres of PCMS with negative results (CNHP 2004, DECAM 2004).

5.3 Private Lands (known and estimated)

Sixty-two percent of the known populations occur on private lands that are used for residential and commercial development, surface mining and grazing (Figure 7). Suitable chalk barrens habitat where the round-leaf four-o'clock has been found covers about 2,111 acres of private land in Pueblo and Fremont Counties (CNHP 2004). CNHP records indicate that there is unsurveyed potential habitat on private lands.

5.4 Pueblo Reservoir and Pueblo State Wildlife Area

One of the largest and most robust populations of round-leaf four-o'clock grows along the edge of Pueblo Reservoir (CNHP 2004). Proposals to raise the water level in the reservoir and construct a water pipeline from there northward are currently being evaluated. Impacts to the plants in the state areas also include hiking, camping, hunting, and outdoor theater events.

5.5 Colorado Department of Transportation

Suitable chalk barrens habitat on Colorado Department of Transportation (CDOT) right of ways is estimated to be no more than 117 acres (Grunau et al. 2003), 17 acres of which have recorded populations of round-leaf four-o'clock.

5.6 Bureau of Land Management

BLM is not included in management assessments for the round-leaf four-o'clock, because only one small population covering less than an acre has been located on BLM land (CNHP 2004).

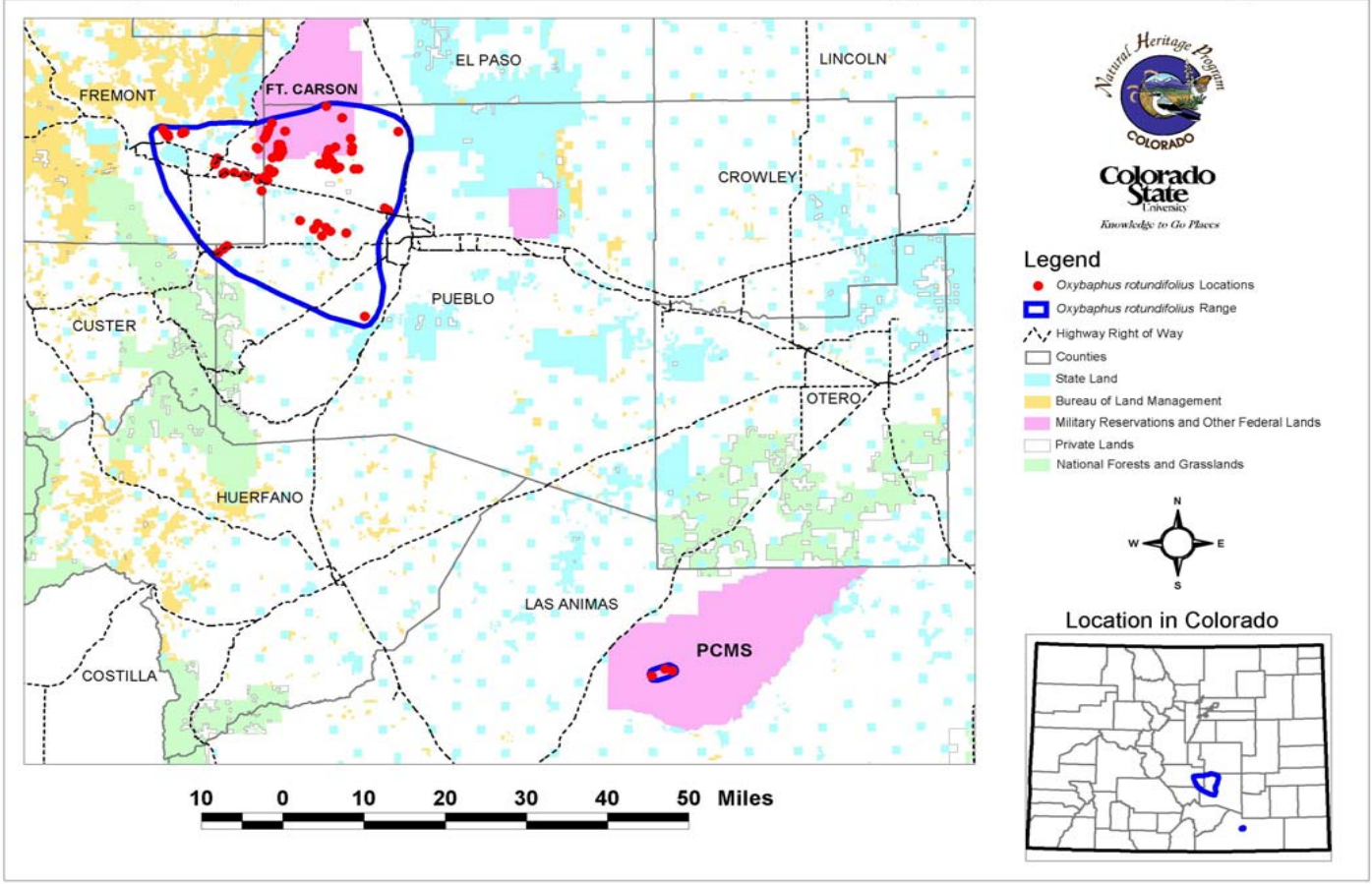
5.7 Comanche National Grasslands

Potential habitat has been identified on the Grasslands, but no occupied habitat has been reported to date. Surveys of the scattered chalk barrens are planned for 2004.

5.8 Pueblo Chemical Depot (U.S. Army)

No habitat for round-leaf four-o'clock has been found on the Pueblo Chemical Depot during inventories conducted by CNHP (2004).

Oxybaphus rotundifolius Geographic Range



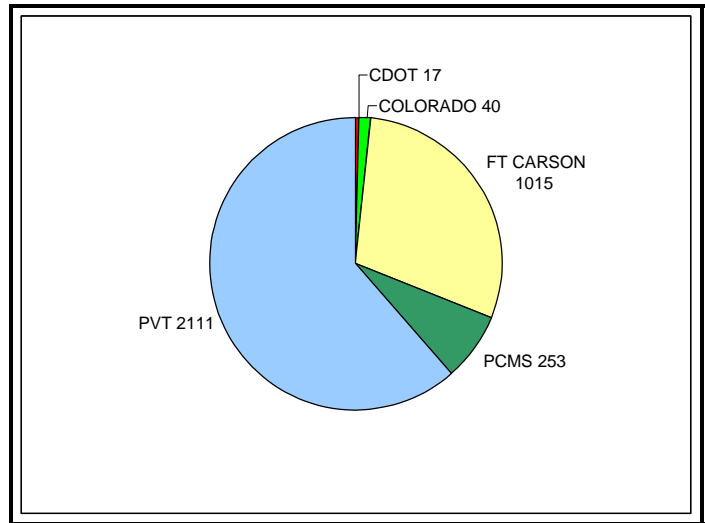
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Figure 6. Distribution and Ownership of round-leaf four-o'clock Habitat. (CNHP 2004)

Locations are generalized to protect the interests of military and private land owners. See disclaimer in section 13.2.

Figure 7. Land management (in acres) of known populations of round-leaf four-o'clock

Land Status derived from Colorado Gap Analysis Land Status, 1998 (CNHP 2004).



6 MAJOR THREATS IN ORDER OF SIGNIFICANCE

6.1 Development, Commercial and Residential

An estimated 62 percent of the occupied chalk barrens habitat is privately owned. Residential development in Colorado in the Arkansas River Valley and especially Pueblo County has been increasing at a rate comparable to that of the Colorado Springs to Fort Collins corridor.

6.2 Mining Practices on Private Lands

Mining of the underlying Fort Hays limestone for cement production has destroyed some habitat, especially at the Portland limestone mine.

6.3 Development of Roads or Utilities

The Colorado Department of Transportation (CDOT) controls right of ways that comprise about 0.5 percent of known habitat for round-leaf four-o'clock. Roads, utilities and expressways are expected to keep pace with the high rate of development in the Arkansas Valley. All three of the barrens species at risk are known to occur on roadsides. The primary concerns for potential impacts to barrens species are road widening, utilities maintenance, mowing, and herbicide application (Grunau and Lavender 2002).

Raising the level of water storage and construction of a water pipeline present an imminent threat to a large population of round-leaf four-o'clock on state land. Expanded camping and recreation facilities have encouraged heavier disturbance on round-leaf four-o'clock populations.

6.4 Repeated Recreational Vehicle Use

The chalk barrens are frequently used for off-road vehicle (ORV) recreation because of their challenging slopes and the lack of interference from vegetation. Once an area shows signs of ORV tracks it encourages others to visit the site, and usage may escalate rapidly. Repeated recreational use by ORVs can destroy plants and pose a threat to round-leaf four-o'clock populations (Anderson 2003).

6.5 Military Activities

The chalk barrens seem to be preferred for military training maneuvers due to their unique combination of open ground and piñon/juniper “cover.” Occasional surface disturbance may be beneficial to the plants (Kelso 2001), but as with ORVs, repetitive disturbance destroys plants and alters the habitat. Some slopes may be too steep or otherwise unsuitable for vehicles, and thus provide havens for the plants. The result may be a fragmented habitat for the round-leaf four-o’clock and its cohorts.

6.6 Invasive/Alien Species

Invasive species are considered to be only a low threat on most chalk barren sites because the substrate is not easily inhabitable by native or exotic species.

6.7 Grazing

Moderate grazing does not appear to have a negative effect on this plant. At appropriate stocking rates, animals tend not to enter the barrens because these areas have very low forage value (Anderson 2003).

Table 1. Population viability ranks for surveyed populations.

Rank	#DOD Sites	# Pvt. Sites	#State Sites	Total Sites	# Plants
Excellent	1	1	1	3	1100
Good	3	4	0	7	1614
Fair	1	6	3	10	425
Poor	3	0	0	3	29
TOTALS	8	11	4	23	3168

Based on Element occurrence ranks assigned by CNHP. Five populations are not included because data, such as number of plants, was incomplete.

6.8 Threats on DOD Lands

6.8.1 Fort Carson

The chalk barrens with their scattered piñon and juniper trees provide the cover that is desirable for military training, so the round-leaf four-o’clock and the training areas use the same habitat (Figure 8). A light to moderate level of disturbance to the plants and soil is considered tolerable for the barrens species, possibly beneficial for the round-leaf four-o’clock and other deeply rooted species adapted to shifting substrates. Beyond an unspecified tolerance threshold, frequent and repetitive disturbance destroys above-ground biomass faster than the plants can respond with new growth or new seedlings, or it can destroy the same new growth that it stimulates. Soil compaction may inhibit seedling and root sucker establishment and damage underground rhizomes. Heavy dust may reduce the photosynthetic process in the plants (Gibson et al. 1998). The impacts of these physical disturbances on the plants depend on the disturbance regime: timing, size, frequency and intensity. A monitoring program is needed to document the response of barrens endemics to various disturbance regimes. There may be steep slopes and other buffer areas of undisturbed occupied habitat that would serve as control sites.

Figure 8. Round-leaf four-o'clock habitat on Fort Carson

Photo by E. Mayo, USFWS



6.8.2 Piñon Canyon Maneuver Site

The population on PCMS is designated as an area off limits to maneuvers, but there is evidence of occasional tank activity on the site (Figure 9). There is no grazing of cattle on the site.

Figure 9. Round-leaf four-o'clock habitat on Piñon Canyon Maneuver Site

Photo by E. Mayo, USFWS



7 REGIONAL CONSERVATION ACTIONS

7.1 Ecoregional Planning

The Nature Conservancy produced an Arkansas Valley Barrens Site Conservation Plan in 2001. Four conservation strategy priorities were identified for the chalk barrens:

1. Incorporate ecological goals into county plans. A “Survey of Critical Biological Resources of Pueblo County, Colorado” (Spackman-Panjabi et al. 2003) was commissioned by the Pueblo Planning Department. This report presents all potential conservation areas identified in Pueblo County that support rare and imperiled plants, animals and significant plant communities. Pueblo County has yet to establish an open space program.
2. Build the capacity of local land trusts to protect priority areas.
3. Influence developers to avoid or minimize impacts.
4. Obtain conservation easements on high-priority tracts.

7.2 Conservation Easements

The Nature Conservancy is currently working with Fort Carson and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk. CDOT is also supporting the establishment of this easement as a possible mitigation for conflict areas on highway right-of-ways.

7.3 Species Assessments

The U.S. Forest Service is publishing a detailed species assessment for the golden blazing star that was prepared by CNHP (Anderson 2003).

7.4 Colorado Department of Transportation Conservation Strategy

The Colorado Department of Transportation has developed a conservation plan for sensitive species that may be impacted by routine maintenance and construction activities on existing state and federal highways within the Central Shortgrass Prairie ecoregion (Grunau et al. 2003). The goal of this plan is to: 1) minimize the temporary impact of routine maintenance activities by using best management practices (BMP), and 2) mitigate for construction projects that result in permanent habitat loss.

7.4.1 Best Management practices

Right of way (ROW) maintenance mowing will be scheduled after July 31 to allow round-leaf four-o'clock to produce seed. This schedule conflicts with BMP for the golden blazing star, which sets seed in late August to September. The golden blazing star occurs primarily on ROWs. To protect this species, CDOT avoidance measures will include delayed mowing until late September to protect the seed source.

7.4.2 Mitigation

Off site mitigation is the strategy proposed by CDOT for protection of habitat for round-leaf four-o'clock and Pueblo goldenweed. Under their Memorandum of Understanding (MOA) with the Colorado Division of Wildlife (CDOW), The Nature Conservancy (TNC), The Colorado Department of Natural Resources (DNR), U.S. Fish and Wildlife Service, and the Federal Highway Administration (FHWA), CDOT has identified a large potential conservation easement on private land that would include chalk barrens habitat for round-leaf four-o'clock as well as Pueblo goldenweed and Arkansas River feverfew plus the Arkansas Valley evening primrose.

7.5 Pueblo State Wildlife Area and Pueblo Reservoir State Recreation Area

Colorado Natural Areas Program planned (in 1990) to help the Division of Parks and Outdoor Recreation develop a monitoring and management plan for populations at Juniper Breaks and the west end of Pueblo Reservoir (Naumann 1990). These populations are still extant, but the monitoring plan needs to be implemented.

7.6 Colorado Natural Areas Program (CNAP)

CNAP recommended in its 1990 status report that the largest known population of round-leaf four-o'clock at Fourmile Creek be acquired and protected by TNC (Naumann 1990). The land was still for sale in 1995. Current status of this occurrence as a high quality site to be included in rapid assessment monitoring is based on the 1995 data.

7.7 Comanche National Grasslands (CNG)

CNG has identified scattered outcrops of the Smoky Hill Unit that may be potential habitat for the species. The Forest Service plans to conduct surveys of the potential habitat on CNG in 2004. If the species is found on the Grasslands, it will be considered as a species of management concern, with a management objective to maintain a viable population.

7.8 Denver Botanic Garden

The Denver Botanic Garden has been very successful at propagating round-leaf four-o'clock plants from seed and growing them in the native plant garden. The garden plants are not suitable for reintroduction to the chalk barrens, but they have been a source of information on the morphology and physiology of the species. Researchers from the gardens have also monitored round-leaf four-o'clock on a mining site for several years.

8 DOD CONSERVATION ACTIONS

8.1 Conservation Easements

Fort Carson is currently working with The Nature Conservancy and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk.

8.2 Piñon Canyon Maneuver Site

The "Gilligan's Island" population on PCMS is designated as an area off limits to maneuvers. There is no grazing of domestic livestock on PCMS. There is evidence of occasional tank activity on the round-leaf four-o'clock habitat. The area is inspected for damage to the habitat by USFWS staff after it is used for training exercises. The conservation objective for Gilligan's Island is to maintain the existing high quality habitat.

8.2.1 Recommended Management on PCMS

- a. Continue the policy of excluding mechanized maneuvers on this site.
- b. Monitor the habitat and demography of the round-leaf four-o'clock population as a control site for comparison with more disturbed populations elsewhere.
- c. Apply adaptive management to achieve the best management practices for the species, for example, allowing moderate disturbance.

8.3 Fort Carson Natural Resources Management

Fort Carson has a well established system for managing its range lands. They have an updated Integrated Resource Management Plan (INRMP) and an Integrated Training Area Management program (ITAM) that address management of vegetation, soils, wildlife and endangered species. The Directorate of Environmental Compliance and Management (DECAM) has professional U. S. Fish and Wildlife Service (USFWS) Biologists on staff. Habitat for seven rare plant species has been surveyed and mapped as part of the Land Condition Trend Analysis (LCTA) program. They have sophisticated systems for photographing and geographic information systems for mapping species and habitat locations on the range. Their range conservation program includes mitigation and remediation for maneuver damage control. ITAM's Limited Use Program employs a land block rest-rotation method to allow training areas to recover after heavy use by armored vehicles.

8.4 Fort Carson Training Areas

Much of the chalk barrens habitat on Fort Carson is used for training in mechanized maneuvers. Some of it has steep slopes that are not used by vehicles. Other barrens sites are only used for recreation and/or grazing. Field research to date indicates that round-leaf four-o'clock, Pueblo goldenweed and golden blazing star are adapted to conditions that are unfavorable to most species. These barrens-adapted plants exhibit opportunistic growth patterns under conditions of moderate ground disturbance and nutrient-poor soils. They can be destroyed by frequently repeated impacts such as motor vehicle traffic.

8.4.1 Recommended Management on Training Areas

- a. Conduct a complete inventory and assessment of chalk barrens habitat and round-leaf four-o'clock populations on Fort Carson. Share the data with CNHP for range-wide analysis.
- b. Integrate species at risk management into the existing programs for protecting natural resources.
- c. Ensure that range remediation methods are consistent with species at risk management
- d. Maintain existing management of high quality round-leaf four-o'clock populations on the range.
- e. Monitor the round-leaf four-o'clock population on disturbed sites for comparison with less disturbed populations elsewhere on the range.
- f. Note non-native species in any monitoring visits. Develop and implement integrated weed management plans if non-natives become invasive.
- g. Use the results of monitoring to apply adaptive management to achieve the best management practices for the species, e.g., prescribing moderate disturbance, or avoiding heavy disturbance during the flowering and seed production season in the months of June and July.

9 MEASURING EFFECTIVENESS OF CONSERVATION ACTIONS

9.1 Habitat Protection Goals, Objectives and Criteria Range-Wide

The goal for round-leaf four-o'clock is sufficient protection and viability of populations to preclude the need to list the species. The objective is to protect viable populations throughout a significant portion of the species' historic range.

Protection requires long-term conservation easements or management plans that designate specific enforceable actions. Each site will be managed to maintain the piñon/juniper chalk barrens habitat. Scientific monitoring data must indicate stable or increasing populations and provide the basis for sustainable management practices.

9.2 Colorado Natural Heritage Program Conservation Strategy

CNHP is Colorado's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. Concentrating on site-specific data for each "element", such as a plant species, enables CNHP to evaluate the biological significance of each location where it is found. Priorities can then be established to guide conservation action. A continually updated locational database and priority-setting system such as that maintained by CNHP provides an effective, proactive land planning tool.

The habitat conservation strategy recommended by the CNHP is to maintain or enhance the current status of the eleven highest ranked populations of round-leaf four-o'clock, based on CNHP ranking criteria. The following sections describe the CNHP methods for prioritizing populations and protection status. Section 11 presents the monitoring program recommended for round-leaf four-o'clock by the CNHP.

9.3 Recovery Goals

The following recovery goals rely heavily on the information from CNHP's biological conservation database that includes information from published and unpublished sources (CNHP 2004). These data have at least three attributes that have an impact on the recovery goals. First, the entire potential habitat has not been surveyed; secondly, many of the known occurrences have not been thoroughly surveyed; and thirdly, the last observation date for 16 (55%) of the occurrences is 1995 or earlier.

Although the entire potential habitat has not been surveyed, it is important to note that much of the unsurveyed habitat for round-leaf four-o'clock is on private lands and subject to development pressures. For example, the Penrose area has numerous acres of potential habitat, but a high rate of development is present and for the most part, the habitat has been destroyed.

Geological maps combined with aerial photographs have been used to determine potential habitat, thus targeting surveys towards the most suitable habitat. Surveys have been conducted by numerous entities and most of this information has been synthesized by CNHP and placed into their conservation database. These surveys have documented approximately 7,300 individuals on 3,436 acres (CNHP 2004).

*Note: The term individuals is extremely hard to apply to *Oxybaphus rotundifolius*, in that it is highly rhizomatous and thus clumps or stems that appear to be separate from another clump, may in fact be connected by an underground rhizome. In general, the term "individuals" refers to the identification of distinct "clumps."*

9.4 Element Occurrence Ranking (CNHP 2004)

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. In order to prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the estimated viability or probability of persistence (whenever sufficient information is available). This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful.

9.4.1 EO Ranking Criteria

The EO-Rank is based on 3 factors:

1. Size: a quantitative measure of the area and/or abundance of an occurrence such as area of occupancy, population abundance, population density, or population fluctuation.
2. Condition: an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued

existence of the occurrence. Components may include reproduction and health, development/maturity for communities, ecological processes, species composition and structure, and abiotic physical or chemical factors.

3. Landscape Context: an integrated measure of the quality of biotic and abiotic factors, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include landscape structure and extent, genetic connectivity, and condition of the surrounding landscape.

9.4.2 EO Ranking descriptions

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then considered to determine an appropriate EO-Rank for the occurrence. If there is insufficient information available to rank an element occurrence, an EO-Rank is not assigned. Possible EO-Ranks and their appropriate definitions are as follows:

- A Excellent estimated viability.
- B Good estimated viability.
- C Fair estimated viability.
- D Poor estimated viability.
- E Viability has not been assessed.
- H Historically known, but not verified for an extended period of time
- X Extirpated

Table 2. CNHP ranks for 29 Occurrences of round-leaf four-o'clock

Occurrence Rank and (number of occurrences)	Acres	Percentage of total acres
A (4)	797	23%
B (7)	841	25%
C (10)	184	5%
D (3)	6	<1%
E (4)	1,077	32%
H (1)	500	15%

Generally speaking, occurrences that have been ranked excellent to good are considered the most likely to survive with the least amount of restoration input. Four occurrences were ranked extant (E). Determining the viability of the extant occurrences may help with the overall assessment of round-leaf four-o'clock.

CNHP has 29 occurrences of round-leaf four-o'clock documented in their biological conservation database. Of these 29 occurrences, 11 occurrences have been ranked Excellent (A) to Good (B), representing approximately 48% of the occupied acres (Tables 2 and 3).

9.4.3 EO Ranking Specifications

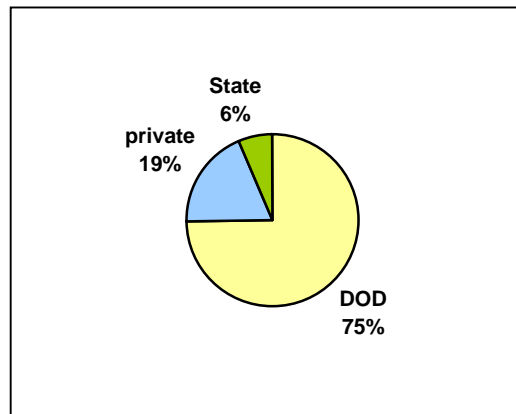
CNHP's specifications for an "A" ranked occurrence of round-leaf four-o'clock are:
Size: 500 or more individuals.

Condition: the occurrence has an excellent likelihood of long-term viability as evidenced by the presence of multiple age classes and evidence of flowering and fruiting, indicating that the reproductive mechanisms are intact. This occurrence should be in a high-quality site with less than 1% cover exotic plant species and/or no significant anthropogenic disturbance.

Landscape Context: the occurrence is surrounded by an area that is unfragmented and includes the ecological processes needed to sustain this species. Justification: Large populations in high quality sites are presumed to contain a high degree of genetic variability, have a low susceptibility to the effects of inbreeding depression, and to be relatively resilient.

For rare species, such as round-leaf four-o'clock, it is especially important to concentrate *primary* conservation efforts on A-B ranked occurrences. CNHP has documented that most of these occurrences are on Department of Defense properties (Figure 10).

Figure 10. Ownership status of 11 highest ranked (A and B) occurrences of round-leaf four-o'clock (CNHP 2004).



Most of these A-B ranked occurrences on DOD lands were documented in 1995 and the current status is unknown, although believed to be similar. The need to update these occurrence ranks is high.

Nineteen percent (310 acres), of all known occupied acres for the high quality occurrences occur on private lands. Although a conservation easement is very likely for one of these occurrences and would include approximately 150 acres of occupied habitat, the other private land occurrences are not afforded any protection and have a high potential for development of some kind due to the proximity to a large urban growth area.

Table 3. Occurrences ranked A and B in CNHP’s biological conservation database.

The occurrence number refers to the CNHP’s database reference number. Although there are six occurrences on private lands, most of the acres are on Department of Defense property. Occurrence No. 23 was found on both private and Department of Defense Lands.

Occurrence Number	Last Observed	Ownership	Acres	EORANK	Estimated No. of individuals
20	1995	DOD	365	B	>500
32	1995	DOD	203	B	250
31	1996	DOD	127	B	>84
24	1995	DOD	253	A	NA
23	2001	DOD	278	A	>500
23	2001	private	152	A	NA
8	1995	private	12	A	1000's
2	1998	private	63	B	300
10	1995	private	72	B	300
9	1995	private	5	B	500
6	2003	private	6	B	300
19	2003	State	103	A	1000

9.5 Protected Areas

Approximately 38% of the known occupied habitat is on federal or state lands (Figure 7), yet protection of the occurrences are not a given. For example, two of the largest occurrences are at Pueblo Reservoir State Recreation Area and Pueblo Reservoir State Wildlife Area, yet these occurrences are threatened by potential enlargement of the reservoir and expansion of the campground. The DOD occurrences are afforded some protection from direct development, however there is not an official adaptive management plan in place.

Round-leaf four-o'clock is included in The Nature Conservancy’s ecoregional conservation plans for the Central Shortgrass Prairie and Southern Rocky Mountains ecoregion. TNC’s goals for G1 and G2 elements are to include all occurrences within the conservation blueprint plan, thus noting the importance of managing the entire population. With round-leaf four-o'clock, it is highly unlikely that all known occurrences will be managed, as many occurrences are subject to road widening, housing development, mining, motocross courses, and potential flooding. For example one occurrence is already under the Pueblo West development and although the species is still present within the subdivision, the occurrence has been greatly altered.

One of the most reasonable assumptions for a conservation plan for round-leaf four-o'clock is the inclusion of all of the best and most viable occurrences (A and B-ranked). If this could be adequately completed, 48% of the known occupied acres would be protected and managed. It seems highly unlikely that all A-ranked occurrences could be protected given

that several are on private land and subject to development pressures. Thus one potential plan that could maintain this species would be to manage all of the public land (federal and state) acreage as well as acquire conservation easements or acquisition of the best populations known from private land.

“Protection” of round-leaf four-o’clock does not imply “no-use” for any given occurrence, but rather that adequate monitoring plans are in place to ensure an adaptive management approach. Kelso et al. (2003) found that round-leaf four-o’clock is a disturbance-tolerant species and its presence may be enhanced when disturbance inhibits the presence of other species that compete for limited water resources. Floristic comparisons of plots with low and high levels of disturbance showed that disturbance does not significantly decrease the presence of round-leaf four-o’clock, which occurred in 9 of 13 low-disturbance plots and 12 of 16 high-disturbance plots. Round-leaf four-o’clock stems were typically abundant on the disturbed plots (Kelso et al. 2003). An adaptive management plan will help to ensure the persistence of this species and provide important information on the impacts of different management scenarios that may differ by their disturbance regimes.

10 ADAPTIVE MANAGEMENT AND MONITORING

10.1 Monitoring Recommendations

An essential purpose of monitoring is to measure management success as well as raise an early warning flag that the trends may warrant a change in management (Elzinga et al. 1998). Good monitoring can demonstrate that the current management approach is working and provide evidence supporting the continuation of current management.

Elzinga states that monitoring is driven by objectives. Objectives form the foundation of the entire monitoring project and monitoring is only initiated if opportunities for management change exist. Monitoring also can measure overall trends for a given species that may help determine the rare and imperilment status.

If the primary objective/goal for round-leaf four-o’clock is to maintain all A-B ranked occurrences, a monitoring plan should be developed that can adequately assess these occurrences and document trends over a given time period. There are currently 11 known occurrences that could benefit from monitoring (Table 3).

Heckmann (1997) makes recommendations for methods of tracking individual round-leaf four-o’clock plants during monitoring: establish a minimum distance between plants that are counted as distinct individuals, mark and monitor the same individuals throughout the season and in subsequent years to document dormancy, and establish a consistent method for recording reproductive structures.

10.2 Monitoring Design

Monitoring can be an expensive endeavor but it is also possible to develop a monitoring plan that is efficient, meets objectives, and is cost-effective. A two-phased approach to monitoring round-leaf four-o’clock is presented, with the first phase providing the most cost-efficient method but less detailed, while the second phase provides a detailed approach, but may be more costly. The two types of monitoring are: 1) Rapid occurrence assessment, and 2) Detailed occurrence assessment. These are outlined below.

10.2.1 Rapid Occurrence Assessment

This type of monitoring is a “quick” assessment of an occurrence that requires applying element occurrence rank specifications. The primary criteria for assessments are size, condition, and landscape context. The current specifications that CNHP have developed would need slight modifications to ensure a consistent way of counting plants. The time needed to assess an occurrence will depend on the size of the occurrence, but in general, most occurrences could be adequately assessed in a one to two day site visit. All of the existing highest quality occurrences could be visited in approximately two to four weeks. Thus the objective of maintaining all A-B ranked occurrences could easily be assessed in a timely manner.

For all monitoring plans, it is important to recognize life history strategies that may impact the results of monitoring. Round-leaf four-o’clock individuals and occurrences are subject to periodic droughts and often respond by going dormant for the season, thus the above ground parts are not visible (Heckman 1997). Surveys and monitoring during drought years will inevitably miss the dormant plants and underestimate the population. We recommend that the rapid occurrence assessments be conducted only in non-drought years to ensure a more consistent assessment.

10.2.2 Detailed Occurrence Assessment

This type of monitoring should include a more detailed monitoring plan for several of the occurrences. Ideally, these sites would include permanent monitoring plots, thus it would be best to pick sites that are likely to remain intact. Kelso et al. (2003) observed that round-leaf four-o’clock is tolerant of disturbance and that some occurrences have done well in sites disturbed by military training and grazing. However, other occurrences have been extirpated due to an excessive amount of disturbance. Since the DOD properties include an important part of round-leaf four-o’clock occurrences and also include the full range of potential disturbance regimes, there is strong potential for an effective monitoring design.

Measuring plant performance under differing disturbance regimes is most likely to generate data that can support appropriate management decisions for this species. One approach would be to address management needs by monitoring several sites with varying disturbance regimes. Ideally, plots would be selected that include examples of the spectrum of anthropogenic and natural disturbance regimes that can affect round-leaf four-o’clock. Measuring readily observable variables such as density of ramets and vigor (by measuring ramet height, leaf size, number of leaves, or other attributes) at the permanent plots could provide insight into the tolerance threshold of round-leaf four-o’clock to different disturbance regimes. Measuring other biotic variables such as plant cover, and abiotic variables such as soil porosity and compaction could provide insight into ecological reasons behind any observed changes.

The design and implementation of a detailed occurrence assessment will largely depend on developing management and sampling objectives, which must be determined a priori.

10.3 Monitoring Schedule

It will be very important to develop an adequate monitoring plan that is statistically valid. Monitoring rhizomatous perennials such as round-leaf four-o'clock that exhibit prolonged dormancy presents special challenges, and obtaining meaningful data may require large sample sizes and several years.

Normally, the first year of a monitoring plan would be considered a pilot project that will allow the botanist to work out the best protocol and estimate the correct sample size for the following years. In subsequent years return visits would be conducted during phenologically appropriate times to resample plots. At first, monitoring should be conducted annually, and this should continue unless it is determined that responses to disturbance and other variables can be measured with less frequent plot resampling. Results would be reported and analyzed annually.

11 FEASIBILITY AND TIMETABLE

11.1 Monitoring

CNHP estimates that a rapid assessment of the eleven existing highest quality occurrences could be completed in approximately two to four weeks. Thus the objective of maintaining all A-B ranked occurrences could easily be assessed in a timely manner.

The approximate budget for CNHP professional staff to conduct the 11 field assessments, enter results into their conservation data system and write an annual report would be \$18,800. Planning for the project could start in 2004. Monitoring could start in 2005, assuming it is not a drought year.

Planning for the first year of detailed monitoring could follow a similar schedule. Funding would depend on the plan and the researchers available.

11.2 Conservation Easements

Arrangements to secure a potential conservation easement adjacent to Fort Carson are continuing at this time.

12 INFORMATION MANAGEMENT

12.1 Colorado Natural Heritage Program Data Synthesis and Analysis

“Information on species and ecological communities is first compiled from existing sources, such as scientific literature, field guides, and museum collections. Natural heritage biologists conduct extensive field inventories to locate and verify species populations and to assess their current conservation condition. Each program maintains and continuously updates a sophisticated computer database that tracks the relative rarity of each species or community and the precise location and status of each known population. Representing more than 25 years of continuous ecological inventory and database development, these are the most complete and up-to-date conservation databases available.” (CNHP 2004)

12.2 Disclaimer (CNHP 2004)

The following disclaimer applies to the map on page 15 and all other data in this document that are credited to the CNHP Biodiversity Tracking and Conservation System.

Care should be taken in interpreting these data. The information provided should not replace field studies necessary for more localized planning efforts. Please note that the absence of any data does not mean that other resources of special concern do not occur, but rather our files do not currently contain information to document this presence. Data are provided on an as-is, as-available basis without warranties of any kind, expressed or implied, including (but not limited to) warranties of merchantability, fitness for a particular purpose, and non-infringement. CNHP, Colorado State University and the State of Colorado further expressly disclaim any warranty that the data are error-free or current as of the date supplied.

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