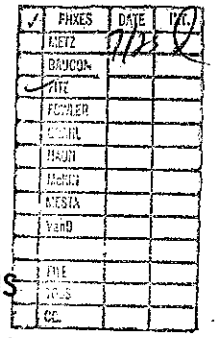
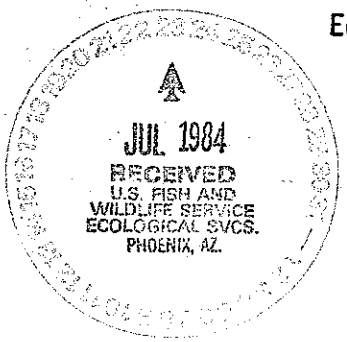


RECOVERY PLAN FOR THE ARIZONA HEDGEHOG CACTUS

Echinocerus triglochidiatus Engelmann var. arizonicus
(Rose ex Orcutt) L. Benson



AGENCY REVIEW DRAFT

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for

Region 2 of the U.S. Fish and Wildlife Service

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PART I

INTRODUCTION

The Arizona hedgehog cactus, Echinocereus triglochidiatus Engelmann. var. arizonicus (Rose ex Orcutt) L. Benson, was officially given Endangered status by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973 on October 25, 1979 (44 FR 61556). The taxon as considered here is known from only a few locations near the boundary between Gila and Pinal counties, Arizona. The range lies between the towns of Miami and Superior.

The taking of plants and potential loss of habitat through mining activities are cited as threats to the continued existence of this taxon in its native habitat (44 FR 61556).

Part one of the plan provides background information on the status, history and characteristics of E. triglochidiatus var. arizonicus. Part two is an enumeration of items determined to be necessary for recovery. The narrative following the outline provides more detailed information on the measures or actions recommended.

Taxonomy

Echinocereus triglochidiatus var. arizonicus was first collected by Charles Russell Orcutt in the vicinity of the highway between the Arizona towns of Miami and Superior in July, 1922. The plant was first named as Echinocereus arizonicus by J. N. Rose in 1926. In his first edition of The Cacti of Arizona in 1940, Lyman Benson placed E. arizonicus in synonymy with Echinocereus polycanthus which he treated as a variety of E. triglochidiatus in the book's 1950 second edition. In his third edition of The Cacti of Arizona published in 1969, Benson resurrected the taxon

as E. triglochidiatus var. arizonicus (Phillips et. al., 1979).

The taxonomic status of this entitity has not been completely resolved. Numerous of the thinner spined individuals of var. arizonicus are similar in appearance to more robust var. neomexicanus. Comparison by Fletcher of flowers and styles of var. neomexicanus from the Sierra Ancha Mts. of Arizona with those of var. arizonicus failed to conform to the differences listed by Benson (1969, 1982) (See Table one, page 4). Further, Benson (1982) indicates the two varieties intergrade. In an attempt to prevent confusion only the populations considered "classical" var. arizonicus, those between Miami and Superior, were listed as Endangered.

The relationship of this entity to other morphological forms of var. neomexicanus scattered and geographically isolated in the various mountains of Arizona and New Mexico is in need of further study.

Echinocereus triglochidiatus var. arizonicus may also intergrade with var. melanacanthus. A plant resembling var. melanacanthus was found together with one somewhat intermediate to the two varieties a short distance west of the expected distribution of var. arizonicus in April, 1982.

Difficulties in interpreting the taxon lie at the extremes of character variation where plants more closely resemble vars. neomexicanus or melanacanthus. The typical plant of variety arizonicus is distinctive. However, sufficient plants, primarily along the fringes of its distribution are intermediate between vars. melanacanthus and neomexicanus causing considerable confusion. This confusion would only be source of evening conversation between taxonomists were it not for legal requirements stemming from E. triglochidiatus var. arizonicus being listed under the Endangered Species Act. Morphological studies are needed to more distinctly define the character limits to receive protection

as var. arizonicus.

It is expected these studies will lead to naming of other geographically isolated and distinctive populations of E. triglochidiatus.

Morphology

The most distinguishing feature of this taxon comparing it to the other varieties of E. triglochidiatus in its robustness. The stems are wider and generally taller. The spines of the average plant are thicker than in vars. melanacanthus and neomexicanus.

Stems are few in number but as many as 60 in one clump have been reported. Average stem length is 21.6 cm and average stem diameter ranges from 14.4 to 24 cm. Stem ribs number about 10 and are tuberculate. Spines are dark gray, up to 3.6 cm long, straight to slightly curved, not angled.

There are 1 to 3 central spines, the largest deflexed, up to 1.8 mm in diameter at the base. Radial spines number 5 to 11. They are often slightly curved, are pinkish-tan and shorter than the centrals. The flowers are bright red, broad, about 4.8 cm in diameter and 6 cm long (Benson 1969).

Table one page 4 compares selected characters of the varieties of E. triglochidiatus found in Arizona according to Benson (Benson 1969).

Distribution

At the present time, the distribution of this taxon has been artificially delineated due to identification problems presented by apparent hybridization and similarly appearing closely related entities. Only those cacti conforming to

TABLE 1

CHARACTERS OF THE ARIZONA VARIETIES OF ECHINOCEREUS TRIGLOCHIDIATUS ACCORDING TO LYMAN BENSON (1969)

	A. Var. melanacanthus	B. Var. mojavensis	C. Var. neomexicanus	D. Var. arizonicus	E. Var. gonacanthus	F. Var. triglochidiatus
Stem number	Ultimately numerous, up to 500.	Ultimately numerous, up to 500.	Mostly 5 to 45.	Few.	Few.	Few.
Stem length	1½ to 3 or 6 inches.	1½ to 3 or 6 inches.	8 to 12 inches.	9 inches.	3 to 5 inches.	6 to 12 inches.
Stem diameter	1 to 2 or 2½ inches.	1 to 2 or 2½ inches.	3 to 4 inches.	6 to 10 inches.	2 to 3 inches.	Mostly about 3 inches.
Stem ribs	Mostly 9 or 10, tuberculate.	Mostly 9 or 10, tuberculate.	8-12, mostly 10, not markedly tuberculate.	About 10, tuberculate.	About 8, tuberculate.	5-8, tuberculate.
Spines	Gray, black, pink, or basally tan, or sometimes straw-color, up to 1 to 2½ inches long, nearly straight, rarely angled.	Gray, pink, or at first straw-color, usually up to 1¾ to 2¾ inches long, striate, smooth or angled.	Tan or pink, becoming light gray, up to 1½ inches long, nearly straight, not angled.	Dark gray, up to 1 to 1½ inches long, nearly straight, not angled.	Gray or tan, 1 to 1¾ inches long, nearly straight, 6 or (3-4), 4-angled.	Gray, ¾ to 1 inch long, nearly straight, 3-angled.
Central spines	1-3, light or dark, spreading or the longest deflexed, up to 1/32 inch in basal diameter.	1-2, light, usually twisting, often striate, about 1/32 inch in basal diameter.	2-4, gray, spreading, 1/48 to 1/24 inch or a little more in basal diameter.	1-3, the largest deflexed, acicular, gradually tapering, with minute striations, up to 1/16 inch in basal diameter.	1 (or 0-2), gray, spreading, up to twice as long as the radial, up to 1/20 inch thick, 6-7-angled.	0 (or rarely 1 and then like the radial).
Radial spines	5-11, half as long to sometimes nearly as long as the central.	5-8, half as long to sometimes nearly as long as the central.	9-12, tannish or light gray, about half as long as the central.	5-11, often slightly curved, pinkish-tan, shorter than the central.	5-8, tan or gray, up to 1/24 inch in diameter	3-6, tan or gray, spreading or recurving, up to 1/16 inch thick.
Flower shape & approximate size	Slender, 1 to 1½ inches in diameter, 1¼ to 2 or 2½ inches long.	Slender, 1½ to 2 inches in diameter, 1½ to 2 inches long.	Slender, 1½ inches in diameter, 2 to 2¾ inches long.	Broad, about 2 inches in diameter, 2½ inches long.	Broad, 2¾ inches in diameter, 2½ inches long.	Broad, 2 inches in diameter, 2 to 2½ inches long.
Style (approximate size)	1/24 inch in diameter, equal to or longer than the perianth.	1/24 inch in diameter, equal to or longer than the perianth.	1/24 inch in diameter, about equal to or longer than the perianth.	1/12 inch in diameter, equal to the perianth.	. .	. .
Geographical distribution	Upland Arizona. Central Utah to southern Colorado and southwestern Texas. Southward in Mexico to Durango.	Northwestern Arizona in Mohave County. Southeastern California; southern Nevada; southwestern corner of Utah.	Southeastern Arizona. Southwestern and south-central New Mexico; Trans-Pecos Texas. Northwestern Mexico.	Arizona between Superior and Globe.	Northern edge of Arizona. Southcentral and southwestern Colorado; northernmost New Mexico.	Near Ft. Defiance, Arizona. Southernmost Colorado; westcentral and central New Mexico.

Range of
Echinocereus triglochidiatus
var. arizonicus
as delineated 4/82

the description and lying in a narrow corridor between Miami and Superior, Arizona are considered to be E. triglochidiatus var. arizonicus. The map on page 5 provides a general outline of the known distribution.

As inventories and morphological studies progress we can expect modification of the current distribution. While collection has apparently reduced the number of individuals within its range, the overall distribution is probably much as it was when Europeans arrived on the scene.

As presently known, E. triglochidiatus var. arizonicus occurs almost totally on lands within the National Forest System. A few scattered plants occur on private lands. Future surveys may reveal the existence of the cactus on Bureau of Land Management and Arizona state lands south of its present range.

Habitat

Echinocereus triglochidiatus var. arizonicus grows in a mixture of or ecotone between Interior Chaparral and Madrean Evergreen woodland. The plant has not been found in areas typical of Interior Chaparral, that is, with a dense shrub overstory. It prefers open slopes or the understory of a more open canopy.

The terrain throughout virtually the entire range is rugged with steep-walled canyons, and boulder-pile ridges and slopes. The cactus is found scattered here and there on open slopes, in narrow cracks between boulders and in the understory of shrubs. While the cactus requires the stability of protected rock cracks, ledges and flat spots for establishment, some plants have been found in eroded areas exposed and lying on the gound surface.

Table two page 7 provides a partial list of associated species.

Elevation of the preferred habitat ranges from near 1,150 to about 1,600 m. Average annual precipitation is 48 cm. The average number of frost-free days are 245.

Table Two

Partial Listing of Species in Association with Echinocereus triglochidiatus var. arizonicus in ecotone between Madrean Evergreen Woodland and Interior Chaparral

Agave chrysantha
Andropogon barbinoides
Antirrhinum nuttallianum
Arctostaphylos pringlei
Arctostaphylos pungens
Astragalus allochrous
Bouteloua curtipendula
Carpochaete bigelovii
Castilleja sp.
Cercocarpus montanus
Crossosoma bigelovii
Dasylirion wheeleri
Echinocereus fasciculatus var. bonkerae
Eriogonum wrightii
Garrya wrightii
Juniperus deppeana
Juniperus erythrocarpa
Mammillaria microcarpa
Mimulus guttatus
Muhlenbergia emersleyi
Nolina microcarpa
Opuntia spinosior
Penstemon pseudospectabilis ssp. connatifolius
Perityle gilensis
Pinus monophylla
Poa longiligula
Quercus emoryi
Quercus turbinella
Rhamnus croceus
Rhus ovata
Rhus trilobata
Solanum xanti
Sphaeralcea rusbyi var. gilensis
Yucca baccata

No detailed soil survey has yet been made for this area but geologic parent materials consist of volcanic tuff, dacite and granite. The tuff and granite are acidic in nature. Dacite is held as basic but is actually more neutral in comparison with basic basalt or acidic granite. Tests on soils near populations of the cactus on dacite and granite yielded a pH of about 6, slightly acid.

Portions of the miami Superior area are heavily mineralized with extensive past and present copper mining activity. Generally, as one proceeds from non-mineralized areas populated with the cactus toward mineralized areas, sightings decrease. Past mining activity has rarely been in or near suitable habitat for the cactus, but exploratory drilling for underlying deposits is having an increasing impact on this taxon.

Population Biology

Demography

Echinocereus triglochidiatus var. arizonicus is widely scattered along a corridor several miles wide in relatively inaccessible terrain. The rugged nature of its habitat inhibits detection and while only a few hundred individuals are known, intensive searches have covered only a small fraction of available habitat.

In 1977, the cactus was known from an area perhaps two miles square (Fletcher, 1979). By 1982 the known range was expended to include populations scattered over an area some seven miles long and four miles wide. Spotty distribution and varying population sizes makes estimating the total number of plants difficult. According to surveyes conducted by Fletcher the number of individuals would be as low as 1,500 or over 14,000.

Table Three page 9 provides demographic information summarized from studies conducted by Museum of Northern Arizona personnel (Phillips et al. 1979).

Table Three

Measurements on populations were taken for the first twenty plants found in an area. The rest of the plants found per location were only measured for stem and fruit number. Therefore, the populations were combined for Density measurements and split for measurement of other population characteristics.

Population	Density
1	11 plants/11,250 m^2 = .10 plants/100 m^2
2	88 plants/ 565.8 m^2 = 2.19 plants/100 m^2
3	56 plants/2560 m^2 = 15.55 plants/100 m^2

Population	Average clump diam.(cm)	Range (cm)	Average diam. of lgst. stem (cm)	Range
1	31.5	7.5-58.0	6.1	5.0-7.5
2a	35.7	11.0-110.0	6.7	5.5-8.0
b	--	--	--	--
3a	36.4	5.5-81.0	7.0	6.0-10.0
b	--	--	--	--

	Average diam smlst. stem (cm)	Range	Average ht. smlst stem (cm)	Range
1	4.3	2.5-6.0	7.1	3.0-13.0
2a	4.4	2.5-8.0	6.2	3.0-15.0
b	--	--	--	--
3a	4.4	3.0-6.5	8.0	4.0-22.0
b	--	--	--	--

	Average # stems/ plant	Range	# of plants
1	11	1-21	11
2a	11	2-41	20
b	12	1-38	68
3a	11	1-38	20
b	10	1-25	36
			155

Reproductive biology

Fifty-two percent of the plants measured were in a reproductive state. The non-reproducing cacti did not show any smaller measurements than the reproductive cacti. The main type of reproduction for this taxon seems to be asexual. Over 70% of the plants were producing offsets from the base of the cacti. No pollinators were observed during the June study.

Flowering: 80/155 = 51.61%
Non-reproducing: 75/155 = 48.39%

Phenology

Echinocereus triglochidiatus var. *arizonicus* flowers annually from late April to mid-May. Weather can hasten, prolong or inhibit flowering by a couple of weeks. Fruit is set in May and June.

Hybridization

This cactus appears to intergrade with *E. triglochidiatus* var. *neomexicanus* and perhaps *E. triglochidiatus* var. *melanacanthus*. Delineation of morphological types to be held as var. *arizonicus* necessitates further study and refinement.

Impacts and Threats

So far as is known the present and historic range of *E. triglochidiatus* var. *arizonicus* are the same. In the more accessible areas collection has thinned populations and some habitat has been destroyed by mining activities and road construction. Predation causes loss of at least some individuals. Periodically, freeze loss is significant.

Collection

Comparison of isolated and roadside populations shows evidence of diminished population levels in readily accessible portions of the range of this cactus and tends to support reported collection pressures. The effect of collection on longterm survival is not presently known and individuals in accessible populations need to be tracked to record effects of collection.

The vast majority of the range is accessible only by foot.

Since Echinocereus triglochidiatus var. arizonicus is a large heavy cactus, the rugged nature and inaccessibility of the terrain should prevent all but the most determined of collectors from harvesting mature plants from remote areas. However, the extent of seed collection is unknown and studies need to be made to determine how much of a given crop can be taken without having an adverse effect on regeneration.

This cactus is one of several varieties of a species common in Arizona and the flowers of all varieties, though attractive, are similar. Several of these varieties are sufficiently alike that to the casual collector of landscape cacti, one variety would easily substitute for another. This similarity lessens the desirability of var. arizonicus. Collection of this taxon is minor in comparison to collection and desirability of other Federally listed Arizona cacti such as Pediocactus bradyi and P. peeblesianus var. peeblesianus.

Habitat Modification

Construction of Highway 60 and its later realignment destroyed some suitable habitat and undoubtedly a few plants. Likewise, construction of the transmission line that crosses Highway 60 probably displaced some plants and habitat. Six plants were removed and transplanted to Boyce Thompson Arboretum in 1978 to permit construction of the Silver King substation for the Salt River project. Most of the remaining ground disturbance activities relate to mining.

The Globe-Miami Superior area is one of concentrated mining activity. Numerous mines occur within and at the periphery of the range of this cactus. It is not known how many plants have been destroyed by mining, but in general the cactus does not prefer the habitats of mineralized areas. Surveys around old and active mines in the area have failed to turn up any substantial populations close enough to be adversely affected.

A greater threat is mining exploration. Most roads have been constructed to provide exploration access. A few of these have been routed through occupied habitat. The surface geology of the habitat of variety arizonicus is not well mineralized; however, the subsurface geology is sufficiently mineralized in portions of the range to warrant test drilling, and in some locations large areas of occupied habitat have been claimed. Should mining proceed, the amount of disturbance is dependent both on whether the mine is open pit or shaft and how much surface area will eventually be covered by tailings. Whether or not these mining claims are activated, continued exploration disturbance is the greatest factor adversely affecting the cactus. Withdrawl from mineral entry of a portion of the range of this cactus may be necessary in order to achieve a goal of delisting.

Predation

The effect of livestock on seedling survival is not known. Exclosure studies are needed in order to address potential trampling and cover removal conflicts.

Javelina feed extensively on cacti in some areas. The possibility of javelina taking the Arizona hedgehog has not been investigated, but the javelina population should be monitored closely.

Insect damage has been noted but no studies have been conducted on its extent or effect on seed production or plant survival.

Freeze Loss

Freeze damage occasionally reduces populations in more exposed sites significantly. In April 1981 four plants in a population of 15 had apparently died from freezing. No studies have been conducted on the extent of loss or

damage by freezing. Freeze loss has the capacity to affect management and recovery. If there is a relationship between ground cover and freeze loss, allowable use of grasses by livestock may have to be reduced. If there is no correlation, recovery goals may have to be raised to take this factor into account.

Management and Research Efforts

A lack of available funds have limited recovery activities to date. Survey and determination of suitable habitat comprised the program until 1983. Funds to construct a study exclosure were allocated to the Tonto National Forest in fiscal year 1983 and funds will be allocated to initiate a propagation program in fiscal year 1984.

The recovery of E. triglochidiatus var. arizonicus cannot be achieved without alleviating collection pressure. Enforcement of regulations will deter law abiding citizenry but will not reduce black market trade. A key to recovery lies in providing all of the E. triglochidiatus var. arizonicus the market demands. The taxon cannot be downlisted until commercial market needs are met regardless of how many specimens have been returned to the wild. At the onset of such a program one can only guess how many plants must be available for sale commercially per year. Any figure would have to be evaluated once attained. With these limitations being realized, a number of 5,000 individuals each year for a five year period as available for trade is set as an objective prior to downlisting to Threatened. With 5,000 individuals in the commercial pipeline each year it would not be long before the novelty of owning an Arizona hedgehog cactus would diminish and with it commercial demand. Thereafter, a smaller yearly quota might be possible.

Concommitant with removal of collection pressures is a goal of 10,000 individuals established as a stable wild population, and establishment of an area withdrawn from mineral entry sufficiently large to maintain the majority of the 10,000 wild individuals. The size is to be determined by future surveys. Other activities are in support of the attainment of these three goals.

PART II

RECOVERY

A step-down approach is followed in setting a course of action for the recovery of E. triglochidiatus var. arizonicus. The prime objective of the recovery plan is to initially recover the cactus to the point it can be downlisted to Threatened status and perhaps eventually be delisted altogether.

Intermediate headings in the outline contain general measures or actions contributing to recovery efforts. More specific tasks are included as sub-headings.

Three primary goals have been set as requirements before downlisting to Threatened can be considered. These goals are providing 5,000 plants into the commercial pipeline each year for 5 years, attaining a wild population level of 10,000 plants, and establishing a safe area of suitable habitat withdrawn from mineral entry. The size of the withdrawl is to be determined by future survey but should contain sufficient habitat to house the majority of the 10,000 wild plants. The goals are to be evaluated upon attainment and prior to downlisting.

Step-down Outline

Objective: Manage *E. triglochidiatus* var. *arizonicus* to attain and maintain a natural population at a level permitting the taxon to be down-listed to Threatened. A long-term goal of delisting is dependent upon removal of collection pressures and other threats and a requirement of continued favorable management consideration by land managers after delisting.

1. Remove existing and potential threats to *E. triglochidiatus* var. *arizonicus* by enforcement of existing regulations and management for protection.
    11. Enforce existing regulations.
        111. Prohibit all collection of specimens except as research determines permissible and prohibit collection of seeds except for propagation purposes.
        112. Follow guidelines as set forth by Bureau of Land Management and Forest Service policy to ensure survival of the Arizona Hedgehog.
        113. Enforce provisions of applicable State laws.
        114. Enforce provisions of 1982 amendments to the 1973 Endangered Species Act.
    12. Withdraw from mineral entry those areas with minimal mineral potential.
2. Provide data enabling management decisions to attain and maintain healthy populations in their natural habitat.
    21. Inventory for *E. triglochidiatus* var. *arizonicus*.
        211. Search for new populations.
        212. Map populations to determine numbers in known populations.
    22. Investigate taxonomic relationships between *E. triglochidiatus* var. *arizonicus* and nearby var. *melanacanthus* and var. *neomexicanus*.

221. Compare morphological variations.

222. Make chromosome counts.

223. Conduct electrophoretic/chromatographic studies.

23. Study environmental parameters of suitable habitat.

231. Soils.

232. Water relations.

233. Study freeze effects.

234. Biotic relationships.

2341. Construct exclosures for long term study.

2342. Study relation of javelina to E. triglochidiatus var. arizonicus populations.

2343. Other herbivores.

2344. Pollinators.

24. Study population biology of the cactus.

241. Life history characteristics.

242. Demographic trends.

3. Use results of No. 2 above to protect populations on all lands.

31. Develop Forest Service Action Plan and BLM Management Plans.

311. Manage off road vehicle (ORV) use.

312. Continue to monitor all activities that could affect populations and promote conservation measures through the planning process.

3121. Ensure grazing systems are compatible.

3122. Monitor mineral exploration to ensure alleviation of potential conflicts.

3123. Monitor other programs such as road maintenance, transmission lines rights-of-ways, and recreation to ensure alleviation of potential conflicts.

32. Encourage cooperation of private landowners as opportunities arise.

33. Encourage management of State lands and development of a plant cooperation agreement.

34. Monitor effect of javelina on the Arizona hedgehog and control javelina populations within the range.

35. Acquire occupied suitable habitat presently in private ownership as available.

4. Propogate E. triglochidiatus var. arizonicus greenhouse stock.

41. Develop improved propogation techniques.

42. Reintroduce cultivated plants into unoccupied or depleted suitable habitat.

43. Provide stock to outlets for eventual commercial use.

5. Develop public awareness, appreciation, and support for recovery of E. triglochidiatus var. arizonicus.

NARRATIVE

1. Remove existing and potential threats to E. triglochidiatus var. arizonicus by enforcement of existing regulations and management for protection. If the long-term goal of delisting is to be achieved, all existing populations must be protected by enforcing existing regulations and managing for protection of both plants and suitable habitat.

11. Enforce existing regulations.

111. Collection of plants should be prohibited except in accordance with recovery efforts. Collection of seeds should be prohibited except for propagation purposes. As recovery progresses, studies should be conducted to determine how much collection of plants or seeds can be tolerated with a given plant density without reducing the survivability of a population. This would help establish at what point the plant is fully recovered.

112. Forest Service and Bureau of Land Management must adhere to their guidelines for management of Federally listed species on lands under their administration in order to ensure compliance with Section 7 of the Endangered Species Act.

113. Enforce provisions of applicable State and Federal laws. This species is prohibited from collection except under permits for scientific or educational purposes by the Arizona Native Plant Law.

114. Enforce provisions of 1982 amendments to the 1973 Endangered Species Act. Section 9.a.2.B. of the 1982 amendments makes it unlawful to reduce to possession any Endangered species of plants from under Federal jurisdiction.

12. Withdraw from mineral entry those areas with minimal mineral potential. Since prospecting for minerals provides the source of most ground

disturbing activities within the range of the Arizona hedgehog, surveys should be made to delineate habitat with minimal mineral potential. The low mineral potential areas are then to be removed from mineral entry. If the withdrawn area is insufficient in size to contain the majority of the needed wild populations it will have to either be enlarged accordingly or restrictions must be placed on the type of exploration activity allowed.

2. Provide data enabling management decision to attain and maintain healthy populations in their natural habitat.

21. Complete inventory for E. triglochidiatus var. arizonicus.

211. The search for new populations outside the known range should continue. The red fruits of this taxon lend to dispersal of seed by birds. We may expect to find additional new populations outside the known range.

212. Within the known range the inventory of populations should continue. Populations need to be mapped and counted for numbers of individuals. Some populations should be mapped using a nearest neighbor method to allow comparative long-term studies.

22. Investigate taxonomic relationship between E. triglochidiatus var. arizonicus and vars. melanacanthus and neomexicanus. Echinocereus triglochidiatus var. arizonicus appears to be a valid taxon but taxonomic parameters and relationships are poorly understood. The following studies may indicate a more proper inclusion of additional populations into our concept of var. arizonicus.

221. Morphological variation between and within populations and varieties are not well understood and necessitate further study.

222. Chromosome counts should be made of these related entities in central Arizona. Echinocereus triglochidiatus var. arizonicus has the general appearance of a polyploid.

223. Electrophoretic and chromatographic studies need to be conducted on the entire complex of E. triglochidiatus var. arizonicus, var. neomexicanus and var. melanacanthus. Populations from throughout the ranges of these entities should be included.

23. Studies of environmental parameters of the apparent preferred habitat would yield information better delineating habitat requirements. This would not only aid reintroduction and management efforts, but would enhance survival of cultivated plants.

231. Detailed knowledge of geologic parent material and soils of the preferred habitat of this cactus would help select areas for further search and answer questions on distribution limits.

232. Information on the relationship between precipitation and/or water availability on germination patterns would be helpful in seeding and transplant efforts.

233. Hard freezes are known to reduce natural populations of this cactus. Knowledge of temperature preferences and limits would aid in transplant efforts and determination of suitable habitat. In addition, if the amount of grass cover has an effect on freeze loss then allowable use by livestock would necessitate adjustment accordingly. If no such or similar correlation can be found, the number of plants desired prior to downlisting might have to be reevaluated.

234. Biotic relationships.

2341. Exclosures of two types, one excluding livestock, the other excluding rodents are necessary to determine effects of livestock grazing, and predation on this cactus. A smaller rodent exclosure can be placed inside the livestock exclosure. At least one exclosure for each major geologic or soil type is preferred.

2342. More information is necessary on the effects different densities of javelina have on E. triglochidiatus.

2343. Herbivores, such as the insects noted damaging some individuals of this cactus, are in need of further study to determine extent of damage.

2344. An understanding of the pollinators would aid in reintroduction efforts, range delineation and growth experiments.

24. Study population biology of the cactus about which almost nothing is presently known.

241. Life history characteristics.

The frequency of establishment of seedlings, survivorship, fecundity, density dependence as it relates to pollination and seed-set, and the reproductive index of the taxon are some factors that need to be considered.

242. Demographic trends.

A determination of population trends as related to human activities and natural factors is necessary to determine future allowable seed harvest and assess transplant or other population augmentation needs.

3. Utilize findings of studies in number two above to protect populations on all lands, public and private.

31. Develop Forest Service Action Plan and BLM Management Plans. Unless implemented, a recovery plan will not enhance a species' recovery. Management plans such as a Forest Service Action Plan ensure full partnership with the Fish and Wildlife Service in recovery efforts.

311. The rugged nature of the terrain in the preferred habitat restricts most ORV use. However, no cross country ORV use should be permitted. Vehicle traffic should be restricted to existing primitive roads. Appropriate signs should be placed between Oak Flat and Pinto Creek along U. S. Highway 70.

312. Continue to monitor all activities that could affect populations and promote conservation measures through the planning process.

3121. Utilize exclosure studies as in 2341 above to ensure livestock management systems are compatible with seedling establishment needs. No conflict between seedling establishment and trampling has been detected, but no comparative studies have yet been conducted.

3122. Mineral exploration and mining activities should be monitored and sufficiently controlled to ensure alleviation of possible conflicts.

3123. Activities such as fence, road and transmission line construction, dispersed recreation, and water development need to be monitored to ensure alleviation of potential conflicts.

32. Cooperation of private landowners can provide support to the recovery of this cactus. Organizations such as the Nature Conservancy can be solicited for this effort.

33. If found on state lands within its range proper management of

E. triglochidiatus var. arizonicus can play a prominent role its recovery. All attempts at obtaining management on these lands should be encouraged. Coordination and cooperation between the F&WS and the State is essential. Development of a plant cooperation agreement is desirable.

34. Control javelina populations within the range. No javelina damage has been noted to date; however, cactus damage in other areas indicates the presence of javelina needs to be monitored and controlled.

35. Pursue acquisition of occupied suitable habitat presently in private ownership as it becomes available. The Endangered Species Act is only effective in protecting populations on Federal land. Realty actions such as exchanges and purchases either directly by agencies involved or through the Nature Conservancy are to be considered for populations on private land.

4. Propagate E. triglochidiatus var. arizonicus greenhouse stock.

41. Develop improved propagation techniques. Cultivation of seed stock can be speeded by using grafted propagules rather than individuals raised from seed.

42. Reintroduce cultivated plants into unoccupied or depleted suitable habitat. A wild population of 10,000 plants is set as a goal prior to consideration of downlisting to Threatened. This number will be evaluated for adequacy on attainment.

If studies on density dependence indicate a specific density of flowering plants increases seed set, populations below that density can be augmented by cultivated specimens or transplants. Reintroduction of cultivated plants to unoccupied suitable habitat with the range can

also enhance recovery efforts. Isolated specimens at the fringe of suitable habitat could be relocated to supplement a low density population elsewhere or used to serve as breeding stock. Transplants or reintroduction to locations susceptible to illegal collection should be made last, that is, at the lowest level of priority.

43. Provide stock to outlets for commercial use. For species where collection pressures are contributing to their decline, alleviation of these pressures are necessary for species' recovery. Prohibition of collecting will alleviate some pressures but also create additional black market demand. Providing stock to trade outlets as soon as possible will help in decreasing black market demand. Addition of 5,000 plants per year into the commercial pipeline for five years is set as a goal prior to consideration of downlisting to Threatened. This number will be evaluated for adequacy on attainment.

5. Develop public awareness, appreciation, and support for recovery of E. triglochidiatus var. arizonicus. Education of the public and government personnel is a vital part of the recovery process. Cooperation at all levels is essential for the ultimate success of recovery.

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PART III - IMPLEMENTATION SCHEDULE

Priorities in column four of the implementation schedule are assigned using the following guidelines:

Priority one (1) -Those actions absolutely necessary to prevent extinction of the species.

Priority two (2) -Those actions necessary to maintain the species' current population status.

Priority three (3) - All other actions necessary to provide for full recovery of the species.

Abbreviations used:

BLM - USDI, Bureau of Land Management

FS - USDA, Forest Service

FWS - USDI, Fish and Wildlife Service

SE - Office of Endangered Species

LE - Law Enforcement

PART III - IMPLEMENTATION SCHEDULE

GENERAL CATEGORY (1)	PLAN TASK (2)	TASK # (3)	PRIORITY # (4)	TASK DURATION (5)	RESPONSIBLE AGENCY FWS REGION (6)	RESPONSIBLE AGENCY FWS PROGRAM (6a)	RESPONSIBLE AGENCY OTHER (7)	FISCAL YEAR COSTS (EST.) FY 1 (8)	FY 2	FY 3	COMMENTS (9)
I1	Monitor Known Populations	2	1	Ongoing	2	SE	FS	3,000	3,000	3,000	
M1	Initiate Commercial Propagation Program	4	1	Ongoing	2	SE	FS	5,000	5,000	5,000	Program duratio dependent upon commercial demand
O2	Enforce ESA Regulations	11	1	Ongoing	2	LE SE	FS	1,500	1,500	1,500	
O3	Mineral Entry Withdrawl	12	1	1	2	SE	BLM FS	5,000			
I1	Survey potential habitat	21	2	Ongoing	2	SE	BLM FS	5,000	5,000	5,000	
M3	Develop Management Plans	31	2	1	2	SE	BLM FS	2,000			
M4	Monitor & Control javelina	34	2	Ongoing	2	SE	BLM FS	3,000	3,000	3,000	
R3, R6	Study Population Biology and Ecology	2	2	Ongoing	2	SE	FS	10,000	10,000	10,000	
O4	Develop State Coop Agreement	33	3	1	2	SE		1,000			
R13, M2	Initiate Reintro-duction Program	42	3	Ongoing	2	SE	BLM FS	5,000	5,000	5,000	
R7	Develop enhanced propagation tech-niques	41	3	3	2	SE	FS	5,000	5,000	5,000	
A1, A4	Acquire habitat	35	3	Ongoing	2	SE					
O1	Develop Public Support	5	3	Ongoing	2	SE	FS BLM	3,000	3,000	3,000	