

**United States Department of the Interior  
U.S. Fish and Wildlife Service  
2321 West Royal Palm Road, Suite 103  
Phoenix, Arizona 85021  
Telephone: (602) 242-0210 FAX: (602) 242-2513**

AESO/SE  
02-21-03-F-0374

January 15, 2004

Ms. Cindy Lester  
Chief, Arizona Section, Regulatory Branch  
U.S. Army Corps of Engineers  
Arizona-Nevada Field Office  
3636 North Central Avenue, Suite 760  
Phoenix, Arizona 85012-1936

Reference File: 2000-01237-RJD

Dear Ms. Lester:

This biological opinion (BO) responds to the U.S. Army Corps of Engineers' (COE) request for consultation pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. *et. seq.*, ESA). Your request for formal consultation was dated June 19, 2003 and received by us on June 20, 2003. At issue are impacts that may result to the endangered Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*) (PPC) from the proposed issuance of a Section 404 permit under the Clean Water Act to construct four road crossings in unnamed washes along an approximately 4,100-foot extension of Camino de la Canoa to reach the 96-acre Canoa Hills Estates. One additional road crossing in an unnamed wash would be constructed within Canoa Hills Estates to access seven of the residential lots. Canoa Hills Estates is located within the San Ignacio de la Canoa land grant approximately four miles south of Green Valley, Pima County, Arizona. You have determined that the project may adversely affect PPC.

We concurred with your determination that the project may affect, but is not likely to adversely affect, the endangered cactus ferruginous pygmy-owl (CFPO) (*Glaucidium brasilianum cactorum*) in our August 25, 2003, letter to you.

This BO is based on information provided in the October 2002 biological assessment (BA) and a supplement to the BA dated June 6, 2003 (all prepared by SAGE Landscape Architecture and Environmental, Inc.), meetings, and other sources of information. Literature cited in this BO is not a complete bibliography of all literature available on the species of concern, the effects from residential development, the project area, or other subjects considered in this opinion. A complete administrative record of this consultation is on file at the Arizona Ecological Services Field Office.

## **Consultation History**

August 15, 2002: We met with SAGE, Inc. staff and the applicant to discuss the project.

April 8, 2003: We met with SAGE, Inc. staff and the applicant to discuss the project and issues related to the consultation.

June 13, 2003: We received the supplement to the BA with the proposed conservation measures for the project.

August 21, 2003: Phone call with SAGE, Inc. staff to discuss CFPO issues.

October 22, 2003: We requested an additional 45 days to complete the consultation.

## **BIOLOGICAL OPINION**

### **DESCRIPTION OF THE PROPOSED ACTION**

The applicant proposes to construct residential development on 96 acres of vacant land located in the San Ignacio de La Canoa Land Grant, Pima County, Arizona. The parcel's eastern boundary abuts the Santa Rita Experimental Range, which is the western boundary of Section 2 in Township 19 South, Range 14 East. The southern boundary is adjacent to Pima County's Canoa Ranch. The development plan calls for 20 lots to be sold to buyers who will then design and build their own homes within building envelopes approved through deed restrictions. The 96-acre parcel is zoned as rural homestead by Pima County with minimum lot sizes of 180,000 square feet or 4.13 acres. Camino de La Canoa forms the western boundary of the project and Camino de Rondo forms the southern boundary with Pima County's Canoa Ranch property. Pima County is requiring that the applicant pave Camino de La Canoa and Camino de Rondo as part of the planning and zoning process.

There are a total of 23 PPC (five were dead) on the project site. Suitable PPC habitat was determined to be 21.2 acres within the 96-acre development. All of the PPC are located in this 21.2 acres. Additional information, maps, and other details are provided in the October 2002 BA, supplements to the BA, and are incorporated here by reference.

### **Proposed Conservation Measures**

The applicant and COE propose the following conservation measures to minimize the effects to PPC and its habitat:

1. The applicant will purchase 20 acre-credits in a Service-approved PPC conservation bank before development begins. This purchase of credits will offset the unavoidable impacts to the 21.2 acres of PPC habitat in the project area.

2. The applicant will draft language in the deed restrictions that will conserve the PPC that are present. These restrictions will include (1) placement of building envelopes to avoid PPC, (2) prohibition of modification or alteration of natural vegetation outside of the building envelope, and (3) prohibition of domestic livestock within the subdivision (including horses). We will review the deed restrictions before development takes place.

## STATUS OF THE SPECIES

### Pima Pineapple Cactus

#### Life History

The final rule listing Pima pineapple cactus as endangered was published on September 23, 1993 (58 FR 49875). The rule became effective on October 25, 1993; no critical habitat has been designated. Factors that contributed to the listing include habitat loss and degradation, habitat modification and fragmentation, limited geographic distribution and plant species rareness, illegal collection, and difficulties in protecting areas large enough to maintain functioning populations. The biological information below is summarized from the proposed and final rules, and other sources.

Pima pineapple cactus is a low-growing hemispherical cactus with adults varying in stem diameter from 5.0 cm (2.0 inches) to 21.0 cm (8.3 inches) and height from 4.5 cm (1.8 inches) to 45.7 cm (18.0 inches). Individuals are considered adults when they reproduce sexually. Plants can be either single or multi-stemmed with yellow flowers blooming with the summer rains. Clusters of Pima pineapple cactus stems are formed primarily from vegetative clones produced at the plant base (Benson 1982, Roller 1996). The diagnostic field character of this taxon is the presence of one stout, straw-colored, hooked central spine. Radial spines extend laterally around the central spine and average 10 to 15 spines on large cacti and 6 on small cacti (Benson 1982).

Pima pineapple cactus occurs south of Tucson, in Pima and Santa Cruz counties, Arizona and adjacent northern Sonora, Mexico. It is distributed at very low densities throughout both the Altar and Santa Cruz valleys, and in low-lying areas connecting the two valleys.

Groups of flowers begin to bloom for single day periods five to seven days after the first monsoon rains. Flowering is triggered by as little precipitation as 3 mm (0.12 inches). Generally flowers begin opening midmorning and close at dusk (Roller 1996). Adult plants bloom one to three days each year; flowering is usually over by the end of August. Cross-pollination produces significantly more viable seeds than self-pollination. Fruits are mature within two weeks following successful pollination. Germination has been observed in the field during the summer monsoon rainy season (Roller 1996). Anecdotal observations indicate the species' flowers are visited by a variety of native bees and European honey bees, which have been observed to leave the flowers with their forehead and hind legs covered in Pima pineapple cactus pollen.

Habitat fragmentation and isolation may be an important factor limiting future seed set of this cactus. Recent data show that the species cannot successfully self pollinate in situ and is reliant

on invertebrate pollinators. One hypothesis is that the spatial distribution pattern of individual Pima pineapple cacti within a given area may regulate pollinator visitations, thus resulting in more successful cross-pollination and subsequent seed set over the population (Roller 1996). If the pollinators are small insects with limited ability to fly over large distances, habitat fragmentation may contribute to a decrease in pollinator effectiveness with a subsequent decrease in seed set and recruitment.

### Population Stability

Extrapolations from recent (1992-1997) surveys of known Pima pineapple cactus locations suggest that the cactus may be more numerous than previously thought. Projections based only on known individuals may underestimate the total number of individuals. This in no way indicates that the cactus is not rare or endangered. Pima pineapple cactus is widely dispersed in very small clusters across land areas well suited for residential, commercial, or mining development. Field observations suggest a great deal of land area within the range boundaries would not support Pima pineapple cactus today due to historical human impacts. Thus, populations are already considerably isolated from each other in many portions of the range, and population size and apparent recruitment varies significantly across the range. On a more local scale, population variability may relate to habitat development, modification, and/or other environmental factors such as slope, vegetation, pollinators, dispersal mechanisms, etc.

The transition zone between the two regions of vegetation described by Brown (1982) as semidesert grassland and Sonoran Desert scrub contains denser populations, better recruitment, and individuals exhibiting greater plant vigor. Vegetation within this transition zone is dominated by mid-sized mesquite trees, half shrubs (snakeweed, burroweed, and desert zinnia), and patches of native grass and scattered succulents. Because populations are healthier in this transition zone, conservation within these areas is very important (Roller and Halvorson 1997). However, this important habitat type is not uniformly distributed throughout the plant's range. Populations of Pima pineapple cacti are patchy, widely dispersed, and highly variable in density. The higher population densities have only been documented at three sites. Compared to other surveys, two of these sites are very small in scale and range from 6.3-7.5 plants per ha (1-3 plants per acre). Other densities across the majority of the plant's range vary between one plant per 1.9 ha (4.6 acres) and one plant per 8.5 ha (21 acres) (Mills 1991, Ecosphere 1992, Roller 1996).

Land areas surrounding developed parts of Green Valley and Sahuarita, Arizona, (including adjacent areas of the San Xavier District of the Tohono O'odham Nation) may be important for the conservation of this species within its range. Analysis of surveys conducted from 1992 to 1995 with a multivariate statistical analysis documented a pattern of greater population densities, higher ranks of cactus vigor, and better reproduction occurring within the transition vegetation type found in this area of the northern Santa Cruz Valley (Roller and Halvorson 1997). This area could be defined as an ecotone boundary between semidesert grassland and Sonoran desert scrub.

Seedling and sub-adult size classes are uncommon in documented populations across the plant's range. However, this may be a function of the difficulty of finding such small, well-camouflaged

plants in a large-scale survey, or because the establishment phase of the seedling may be limited in some unknown way. Research on Pima pineapple cactus reproduction has suggested that the establishment phase of Pima pineapple cactus life history may limit recruitment within populations (Roller 1996). Evidence presented to support this conclusion was the abundance of flowers, fruits, and viable seed, and the rarity of seedling presence at different sites spread throughout the plant's range (Roller 1996). Other research has confirmed that the establishment phase of other Sonoran cacti species may be critical for survival to reproductive maturity (Steenbergh and Lowe 1977).

### Status and Distribution

Generally, the Pima pineapple cactus grows on gentle slopes of less than 10 percent and along the tops (upland areas) of alluvial bajadas nearest to the basins coming down from steep rocky slopes. The plant is found at elevations between 2,360 ft. and 4,700 ft. (Phillips *et al.* 1981, Benson 1982, Ecosphere 1992), in vegetation characterized as either or as combination of both the Arizona upland of the Sonoran Desert scrub and semidesert grasslands (Brown 1982).

The acquisition of baseline information began with surveys documenting the presence of Pima pineapple cactus as early as 1935. More intensive surveys were initiated in 1991 and other research established in 1993 further investigated the reproductive biology, distribution, fire effects, and mortality associated with various threats. Therefore, the best available baseline information is relatively recent and may not represent actual changes in distribution since the decline in the status of the species began.

Widely scattered surveys have been conducted across sites that varied considerably in cacti density. Densities ranged between 0.1-7.5 plants per ha (0.05-3 plants per acre). Pima pineapple cactus occurs in 50 townships within its U.S. range. However, a considerable amount of land area within the range boundaries does not provide habitat for the species due to elevation, topography, hydrology, plant community type, and human degradation. To date, an estimated 22,959 ha (56,730 acres or 10 to 20 percent of the U.S. range) have been surveyed. Not all of this area has been intensively surveyed; some has only been partially surveyed using small land blocks to estimate densities rather than 100 percent ground surveys. A conservative estimate of total cacti located to date would be 3,800 individuals. The majority of those were located after 1991.

It is important to clarify that the above number represents the total number of locations ever found and not the current population size. It would be impossible to estimate densities over the remaining unsurveyed area because of the clumped and widely dispersed pattern of distribution of this species. Of the 3,800 individuals recorded to date, 2,203 (58 percent) of them have been removed. This quantity includes observed and authorized mortalities and individuals transplanted since the species was listed in 1993. A small portion of these mortalities were caused by natural factors (i.e., drought). Moreover, this figure does not take into account those cacti that are removed from private land or lost to other projects that have not undergone section 7 review.

Transplanted individuals are not considered as functioning within the context of a self-sustaining population. Efforts to transplant individual cacti to other locations have only had limited success and the mortality rate has been high, especially after the first year. Furthermore, once individuals are transplanted from a site, it is considered to be extirpated as those individuals functioning in that habitat are irretrievably lost. We view transplanting cacti as a measure of last resort for conserving the species. Transplanting will be recommended only when on-site and off-site habitat conservation is not possible and the death of cacti is unavoidable.

The area of habitat reviewed under section 7 of the ESA between 1987 and 2000 (i.e., habitat developed or significantly modified beyond the point where restoration would be a likely alternative) is approximately 9,886 ha (24,429 acres), which represents 43 percent of the total area surveyed to date. In 1998, more than 445 ha (1,100 acres) of Pima pineapple cactus habitat were lost including 143 ha (353 acres) from the Las Campanas Housing Development project, and 304.6 ha (752 acres) from the ASARCO, Inc. Mission complex project. In 2000, 237.3 ha (586 acres) of habitat were lost with the expansion of a state prison in Tucson. In 2001, 71.7 ha (177 acres) of habitat were lost through development, but 375.8 ha (888 acres) of occupied and suitable habitat were conserved through conservation easements. We are aware of housing developments along Valencia Road, Pima County, Arizona, in the vicinity of T15S, R12E, Section 15 and surrounding areas, that support Pima pineapple cactus. These developments affect several hundred acres of habitat and have not been evaluated through the section 7 process. The number of acres lost through private actions, not subject to Federal jurisdiction, is not known but given the rate of urban development in Pima County, we believe it is significant.

Most of the documented habitat loss has occurred south of Tucson down through the Santa Cruz Valley to the town of Amado. This area is critical for the future recovery of the species. The expansion of urban centers, human population, and mining activities will continue to eliminate habitat and individuals, and result in habitat fragmentation.

The protection of habitat and individuals is complicated by the varying land ownership within the range of this species. An estimated 10 percent of the potential habitat for Pima pineapple cactus is held in Federal ownership. The remaining 90 percent is on Tribal, State, and private lands. Most of the federally owned land is either at the edge of the plant's range or in scattered parcels. The largest contiguous piece of federally-owned land is the Buenos Aires National Wildlife Refuge, located at the southwestern edge of the plant's range at higher elevations and lower plant densities.

Based on surveys and habitat analysis, areas south of Tucson through the Santa Cruz Valley to the town of Amado and surrounding developed parts of Green Valley and Sahuarita, and parts of the San Xavier District of the Tohono O'odham Nation, appear to support abundant populations, some recruitment, and units of extensive habitat still remain. However, the primary threat to the status of this species throughout its range is the accelerated rate (i.e., since 1993) at which this prime habitat is being developed, fragmented, or modified.

The Arizona Native Plant Law may delay vegetation clearing on private property for the salvage of specific plant species within a 30-day period. Although the Arizona State Native Plant Law

prohibits the illegal taking of this species on state and private lands without a permit for educational or research purposes, it does not provide for protection of plants in situ through restrictions on development activities.

Based on current knowledge, urbanization, farm and crop development, and exotic species invasion alter the landscape in a manner that would be nearly irreversible in terms of supporting Pima pineapple cactus populations. Prescribed fire can have a negative effect if not planned properly.

Other specific threats that have been previously documented (U.S. Fish and Wildlife Service 1993), such as overgrazing and mining, have not yet been analyzed to determine the extent of effects to this species. However, partial information exists. Mining has resulted in the loss of hundreds, if not thousands, of acres of potential habitat throughout the range of the plant. Much of the mining activity has been occurring in the Green Valley area, which is the center of the plant's distribution and the area known to support the highest densities of individuals. Overgrazing by livestock, illegal plant collection, and fire-related interactions involving exotic Lehmann lovegrass (*Eragrostis lehmanniana*) may also negatively affect Pima pineapple cactus populations (U.S. Fish and Wildlife Service 1993).

Even with complete data on historical change related to Pima pineapple cactus distribution and abundance, we cannot reliably predict population status due to compounding factors such as climate change, urbanization, and legal and political complexities (McPherson 1995). We do not know if the majority of populations of Pima pineapple cactus can be sustainable under current reduced and fragmented conditions. Thus, there is a need to gather information on limits to the plant's distribution under current habitat conditions.

In summary, monitoring has shown that the range-wide status of the Pima pineapple cactus appears to have been recently affected by threats that have completely altered or considerably modified more than a third of the species' surveyed habitat, and have caused the elimination of nearly 60 percent of documented locations. Dispersed, patchy clusters of individuals are becoming increasingly isolated as urban development, mining, and other commercial activities continue to detrimentally impact the habitat. The remaining habitat also is subject to degradation or modification from current land- management practices, increased recreational use when adjacent to urban expansion (i.e., off-road vehicle use and illegal collection), and the continuing aggressive spread of nonnative grasses into habitat. Habitat fragmentation and degradation will likely continue into the foreseeable future based on historical data and growth projections produced by the Pima County Association of Governments (1996). There is very little Federal oversight on conservation measures that would protect or recover the majority of the potential habitat. Even some areas which have had section 7 consultations on them have been modified and may not be able to support viable populations of the Pima pineapple cactus over the long-term.

## **ENVIRONMENTAL BASELINE**

The environmental baseline includes past and present impacts of all Federal, State, or private actions in the action area, the anticipated impacts of all proposed Federal actions in the action area that have undergone formal or early section 7 consultation, and the impact of State and

private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform from which to assess the effects of the action now under consultation.

A total of 23 PPC were detected on the site, five of which were dead. The applicant delineated suitable habitat for PPC and determined that 21.2 acres would support PPC. All of the suitable habitat is located in the southeastern quadrant of the property. The majority of the PPC were found on the relatively flat bajadas as is typical for this species. The average density on the site is 1.1 PPC/acre. Based on all the projects reviewed by our office that have affected PPC, a density of 1.1 would be considered high density. Anything less than 0.09 PPC/acre is considered low density, and sites with densities above 0.31 PPC/acre are considered high. This would indicate that the proposed development site supports better-than-average habitat and that conservation in the area is important.

The PPC are not distributed randomly throughout the property, but occur in clusters. All of the PPC were found in the southeastern portion of the property, associated with reddish, oxidized soil. We have seen this pattern in other projects in the general area.

The action area is defined as the footprint of the development (96 acres) and a 0.25 mile area surrounding the project boundaries, the latter of which encompasses the area most likely to incur indirect effects from the housing development. PPC are known and suspected to occur on lands surrounding the project. Development may affect the overall population dynamics of PPC in the general area. While an attempt has been made to minimize the effects of the development on PPC, there may be additional effects over a larger area that cannot be quantified. Access to the site is on existing roads. The action area is surrounded by private land on the north and west, the Santa Rita Experimental Range on the east, and Pima County land to the south. Several large housing subdivisions are being built to the north, northeast, and northwest of the action area. PPC are known from these areas, but the projects did not undergo section 7 consultation. There will undoubtedly be continued new residential development in those areas.

## **EFFECTS OF THE ACTION**

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

The proposed action will result in the modification and destruction of all the suitable PPC habitat (21.2 acres) within the action area. The exact amounts are not known, as the individual lot configuration has not been determined. All of the suitable habitat will become portions of individual lots. As stated in the proposed conservation measures, placement of individual building footprints will be done in a way that avoids PPC. Those PPC that cannot be avoided



will be moved to another location within the same lot. The conservation value of this action is uncertain. Transplanted PPC have low levels of survival and it is not known if the PPC will still function as a population inside someone's yard. Past efforts to transplant individual PPC to other locations have had only limited success. On a project in Green Valley, where transplanted PPC were monitored for survival for two years following their transplant, there was a 76% survival rate (SWCA, Inc 2001). On another project in Green Valley, PPC transplanted in 2001 showed a 47% mortality after one year (WestLand Resources, Inc. 2003).

As a result, the PPC and its habitat located within the action area will be compromised at best, or ecologically dead, in the worst scenario. Also, the roads within the subdivision will fragment the habitat. The applicant has proposed to offset the effects to PPC and its habitat by purchasing conservation bank credits in a Service-approved conservation bank for PPC. The high density of PPC in the action area suggests that the area supports high-quality habitat. The applicant has agreed to compensate for the loss of habitat at a 1:1 ratio. The Service recommended a higher replacement ratio, but it was not within the financial means of the applicant. At least there will be a minimum amount of conservation to offset the potential loss of PPC and the values of the habitat to the species, including the seed bank. In summary, the proposed project will result in the loss of 21.2 acres of high-quality PPC habitat and up to 18 live PPC on the site. It remains to be seen how effective conservation will be for the remaining PPC within this residential development.

This project contributes to the recovery of PPC and its habitat because it does provide for off-site protection of occupied PPC habitat within the conservation bank, which is protected in perpetuity. PPC will not be able to survive in the long-term in small, fragmented areas surrounded by urban development. Large, contiguous blocks of habitat need to be set aside, protected, and managed for their natural values. All of the proposed conservation actions included in the project description are critical to offset impacts to PPC and its habitat.

## CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Development in this geographic region can be expected to increase. State and private lands not presently developed in the area are quickly becoming urbanized. We know of at least two other residential developments that are being built in the immediate area. Much of this development has no Federal nexus. We know of no planned activities on the Santa Rita Experimental Range, which is directly east of this project. Without any protection under the Act, the only protection available is through the Arizona Native Plant Law, which provides only for salvage for scientific and educational purposes. Regardless of salvaged cacti transplant success, the habitat would be lost.

Much of the habitat and the individuals of the species are at significant risk of destruction or continued degradation. There is little regulatory authority to use in reducing those risks.

## CONCLUSION

After reviewing the current status of PPC, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of PPC. No critical habitat has been designated, therefore, none will be affected. We base this conclusion on the following:

1. The applicant will offset the loss of 21.2 acres of PPC habitat by purchasing 20 credits (thereby protecting 20 acres of PPC habitat) in a Service-approved conservation bank for PPC. The bank provides protection in perpetuity for the cactus and its habitat. The bank contributes to the overall recovery and conservation of the species.

## INCIDENTAL TAKE STATEMENT

Sections 7(b)(4) and 7(o)(2) of the ESA do not apply to listed plant species. However, protection of listed plants is provided to the extent that the ESA requires a Federal permit for removal or reduction to possession of endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any other area in knowing violation of any regulation of any State or in the course of any violation of a State criminal trespass law. Neither incidental take nor recovery permits are needed from us for implementation of the proposed action.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend that the Corps request that the applicant monitor the PPC within the subdivision to ascertain whether any significant conservation benefits to PPC were derived from the deed restrictions on the property.

In order that we be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

### REINITIATION NOTICE

This concludes formal consultation on the 96-acre Canoa Hills Estates. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded (not applicable to this consultation); (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

We appreciate your efforts to identify and minimize effects from this project. If we can be of further assistance, please contact Mima Falk (520) 670-4550) or Sherry Barrett (520) 670-4617. Please refer to consultation number 02-21-03-F-0374 in future correspondence regarding this project.

Sincerely,

/s/ Steven L. Spangle  
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, NM (ARD-ES)  
Assistant Field Supervisor, Fish and Wildlife Service, Tucson, AZ

Acting Chief, Habitat Branch, Arizona Game and Fish Department, Phoenix, AZ  
Director, Arizona Game and Fish Department, Tucson, AZ  
Arizona Department of Agriculture, Phoenix, AZ (Attn: Jim McGinnis)  
SAGE Landscape Architecture & Environmental, Inc., Tucson, AZ (Attn: Bruce Pavlick)

**LITERATURE CITED**

- Bahre, C.J. 1985. Wildfire in southeastern Arizona between 1859-1890. *Desert Plants* 7:190-194.
- Benson, L. 1982. *The Cacti of the United States and Canada*. Page 820. Stanford University Press Stanford, California.
- Brown, D.E. 1982. Biotic communities of the American Southwest--United States and Mexico. *Desert Plants* 4:123, 181.
- Ecosphere Environmental Services Inc. 1992. Final Report: A survey for threatened and endangered plant species at three proposed reservoir sites and associated pipelines. Bureau of Reclamation contract 0-CS-32-1950. Farmington, New Mexico. 69 pp.
- McPherson, G.R. 1995. The role of fire in desert grasslands. Pages 130-151 in M.P. McClaran and T.R. Van Devender (editors), *The Desert Grassland*. University of Arizona Press, Tucson, Arizona.
- Mills, G.S. 1991. Miscellaneous notes on (*Coryphantha scheeri* var. *robustispina*). Unpublished report. U.S. Fish and Wildlife Service, Arizona Ecological Services Office, Phoenix, Arizona.
- Phillips, A.M. III, B.G. Phillips, N. Brian. 1981. Status report for *Coryphantha scheeri* var. *robustispina*. U.S. Fish and Wildlife Service, Office of Endangered Species, Albuquerque, NM. Unpublished Report.
- Pima County Association Of Governments, 1996. Population handbook 1995.
- Roller, P.S. 1996. Distribution, growth and reproduction of Pima pineapple cactus (*Coryphantha scheeri* Kuntz var. *robustispina* Schott). M. S. Thesis, University of Arizona.
- Roller, P.S. and W.L. Halvorson. 1997. Fire and Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*) in southern Arizona in *Proceedings of the Effects of Fire on Threatened and Endangered Species Symposium*. Coeur d' Alene, Idaho. November 1995.
- Sage Landscape Architecture & Environmental, Inc. 2002. Biological Assessment for a Clean Water Act Section 404 permit application for a housing subdivision on 96 acres in San Ignacio de La Canoa land grant, Pima County, AZ.
- Sage Landscape Architecture & Environmental, Inc., 2003. Addendum A to the Biological Assessment.
- Steenbergh, W.F. and C.J. Lowe. 1977. Ecology of the saguaro: II. Reproduction, germination, establishment, growth, and survival of the young plant. National Park Service Monograph Series Number 8. U.S. Government Printing Office, Washington, DC.

SWCA, Inc. 2001. September 12, 2001 Technical Memorandum regarding the Pima pineapple cactus mitigation program at Las Campanas.

U.S. Fish and Wildlife Service, 1993. Determination of endangered status for the plant Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*). Federal Register 58 (158): 49875-49880.

WestLand Resources, Inc., 2003. May 5, 2003 Technical Memorandum regarding the transplanted Pima pineapple cactus at the Madera Highland Reserve.

Wright, H.A. and A.W. Bailey. 1982. Fire ecology United States and Canada. Pages 138-148. John Wiley & Sons, Inc., New York, New York.