Draft Recovery Plan for *Coryphantha scheeri* var. *robustispina* (Pima pineapple cactus)
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Draft Recovery Plan for *Coryphantha scheeri* var. *robustispina* (Pima pineapple cactus)

2017

Region 2
U.S. Fish and Wildlife Service
Arizona Ecological Services Office
Tucson, Arizona

Approved: DRAFT

Regional Director, Southwest Region, Region 2,
U.S. Fish and Wildlife Service

Date: XX, XX, 2017
Disclaimer

Recovery plans delineate reasonable actions that are believed to be required to recover and protect listed species. We, the U.S. Fish and Wildlife Service (Service), publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, state agencies, Tribal agencies, and other affected and interested parties. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as, the need to address other priorities. Costs indicated for action implementation and time of recovery are estimates and subject to change. Recovery plans do not obligate other parties to undertake specific actions, and may not represent the views or the official positions of any individuals or agencies involved in recovery plan formulation, other than the Service. Recovery plans represent the Service’s official position only after they have been signed by the Director or Regional Director as approved. Recovery plans are released for public comment and submitted to peer review before we adopt them as approved final documents. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

Literature Citation Should Read as Follows:


Executive Summary

Current Species Status

Coryphantha scheeri var. robustispina (Pima pineapple cactus) was listed as endangered under the Endangered Species Act (Act) on September 23, 1993 (58 FR 49875); critical habitat was not designated. A second 5-year status review is currently in internal review. The taxon inhabits Lower Sonoran desert-scrubland, desert-grassland, or the ecotone between desert-scrubland and desert-grassland, and has been documented between 728 and 1,280 meters (m)(2388 and 4,200 feet (ft)) elevation in southeastern Arizona and northern Sonora, Mexico (Tonn pers. comm. March 16, 2016). We are currently aware of fewer than 5,750 extant C. scheeri var. robustispina individuals across the range of the taxon, and an additional approximately 1,800 that are documented as dead, largely due to development and mining projects over several years (Tonn pers. comm. November 4, 2015).

Habitat Requirements and Limiting Factors

Coryphantha scheeri var. robustispina is considered sparsely distributed on the landscape, typically aggregated into low and high density areas adjacent to each other (McDonald and McPherson 2006, p. 65). The taxon is self-incompatible (incapable of self-fertilization and thus requiring outcrossing) and research indicates areas with higher density of C. scheeri var. robustispina plants have greater pollination and thus more fruit production than areas where plants are more widely dispersed (McDonanald and McPherson 2006, p. 16). Ideal C. scheeri var. robustispina habitat has an assortment of other cacti species such as Opuntia engelmannii, O. fulgida, and Ferocactus wislizeni, as well as native bunch grasses (Service 2000a, p. 9). Collectively, cacti within the habitat provide enough pollen to provision the nests and support survivorship of their shared pollinator, the cactus specialist bee, Diadasia rinconus (McDonald and McPherson 2006, p. 33; Blair and Williamson 2008, p. 428). Preservation of C. scheeri var. robustispina necessarily also requires preservation of habitat and pollination corridors for D. rinconus. Research also indicates that given the loss of individual C. scheeri var. robustispina to drought in recent years, topographic diversity among preserved habitats may provide microclimate differences important for long-term C. scheeri var. robustispina survival (Baker 2011, p. 31).

Recovery Priority

The recovery priority number for C. scheeri var. robustispina is 3C, meaning that the listed entity is a subspecies, the level of threat is high, there is a conflict with some form of economic activity (urbanization), and recovery potential is high.

Recovery Strategy

The principal C. scheeri var. robustispina recovery strategy is to preserve and restore quality habitat to protect individuals and their seedbanks within two recovery units representing the range of the taxon. The two recovery units center on the Altar and Santa Cruz Valleys of southeastern Arizona. The major threats within the Altar Valley Recovery Unit, which is
managed primarily for livestock grazing, include the spread of invasive, non-native grasses and the resultant altered fire regimes and increased competition. A major threat within the Santa Cruz Valley Recovery Unit, which includes Tucson, Nogales, and the urban areas between, is urbanization. Throughout the entire range, *C. scheeri* var. *robustispina* is stressed by drought and climate change impacts, as well as predation by mammals and insects. The preservation and restoration of habitat within these two recovery units will allow a stable, self-sustaining population to persist with some level of connectivity between individuals throughout the range, and provide opportunities for population expansion.

We define a stable and self-sustaining population as one that shows positive population growth over a 15-year period, with evidence of natural reproduction and establishment. The recovery strategy entails minimizing or ameliorating the most significant long-term threats to the continued existence of the species, which are: 1) habitat loss due to commercial and residential development and 2) non-native plant competition and alteration of fire regimes. Additional efforts will focus on improving our understanding of *C. scheeri* var. *robustispina* ecology, distribution, and threats, as well as, on reducing the impacts of stressors such as drought and climate change, predation by mammals and insects, recreation and border activity, and livestock overgrazing.

**Recovery Goal**

The ultimate goal of this recovery plan is to outline specific actions that, when implemented, will sufficiently reduce the threats and stressors to *C. scheeri* var. *robustispina*, ensure its long-term viability in the wild, and allow for its removal from the list of threatened and endangered species.

**Recovery Objectives**

1) **Threat-based objective:** Reduce or mitigate habitat loss and degradation, non-native species spread and the resultant altered fire regimes and increased competition, and other stressors, to enhance the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

2) **Habitat-based objective:** Conserve, restore, and properly manage the quantity and quality of habitat needed for the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

3) **Population-based objective:** Conserve, protect, and restore existing and newly discovered *C. scheeri* var. *robustispina* individuals and their associated seedbanks needed for the continued survival of the taxon. The population must be self-sustaining, of sufficient number to endure climatic variation, stochastic events, and catastrophic losses, and must represent the full range of the species’ geographic and genetic variability.

**Recovery Criteria**

**Downlisting of Coryphantha scheeri var. robustispina to threatened status may be considered when all of the following conditions have been met to address the threats and stressors to the species:**

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1. **Threat-based objective**: Reduce or mitigate habitat loss and degradation, non-native species spread and the resultant altered fire regimes and increased competition, and other stressors, to enhance the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

**Criterion**: The successful accomplishment of threat and stressor reduction and mitigation is demonstrated by an increased number of acres of optimal or good *C. scheeri* var. *robustispina* habitat (see “Habitat-based objective” for details). Habitat is considered optimal when: it is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of *C. scheeri* var. *robustispina*; it has less than 20 percent cover of non-native plant species; it contains contiguous habitat and corridors for pollinators; and where *C. scheeri* var. *robustispina* numbers are observed to be stable or increasing and remain that way. Habitat is considered good when the cover of non-native plants remains between 20 and 35 percent and the land is managed in such a way that promotes the continued existence or expansion of the *C. scheeri* var. *robustispina* population.

**Justification**: Accomplishment of this criterion depends on successful habitat conservation (e.g. land preservation, conservation banking, and strategic habitat restoration) and land management planning to reduce threats and stressors to *C. scheeri* var. *robustispina* (e.g. non-native species management and restoration, land use planning, and soil compaction and erosion prevention) on all lands where *C. scheeri* var. *robustispina* occur.

2. **Habitat-based objective**: Conserve, restore, and properly manage the quantity and quality of habitat needed for the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

**Criterion**: At least 8,094 hectares (20,000 acres) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be in optimal condition and remain that way. At least 24,281 hectares (60,000 acres) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be in good condition and remain that way. Collectively, this represents approximately 43 percent of the known range of *C. scheeri* var. *robustispina*. Additional acres of lesser quality *C. scheeri* var. *robustispina* also exist throughout the range of the species; some of which occurs on lands where ongoing efforts may continue to improve habitat quality. While no analysis exists which can help us estimate the total acres of habitat needed to support a viable *C. scheeri* var. *robustispina* population, we believe that achieving the above targets of optimal and good habitat could significantly improve the conservation trajectory and status of this taxon to the point of downlisting under the Act.

**Justification**: *Coryphantha scheeri* var. *robustispina* plants that occur in optimal or good condition habitats, as defined above, should have the greatest resistance to non-native plant invasion and associated high severity fire, as well as, to climatic extremes and other threats or stressors. We expect that these habitats will have healthy pollinator populations that enable gene flow between *C. scheeri* var. *robustispina* individuals, thus maintaining their long-term genetic diversity.

3. **Population-based objective**: Conserve, protect, and restore existing and newly discovered *C. scheeri* var. *robustispina* individuals and their associated seedbanks needed for the continued survival of the taxon. The population must be self-sustaining, of sufficient number to endure
climatic variation, stochastic events, and catastrophic losses, and must represent the full range of the species’ geographic and genetic variability.

**Criterion:** Protect mature *C. scheeri* var. *robustispina* individuals and their seedbanks in each recovery unit. Quantitative monitoring of established plots across a variety of land ownerships and with landowner support is conducted within each of the two recovery units every 3 to 5 years with plots demonstrating that the population is increasing a minimum of 10 years over a 15 year period.

**Justification:** A mature individual is one that is capable of flowering and producing viable seed. Only mature individuals are considered in meeting this criterion, since large numbers of *C. scheeri* var. *robustispina* seeds may germinate following sporadic rainfall but not live long enough to reproduce. The number of monitoring plots and transects and their locations will be determined within a monitoring plan to be written within five years of the finalization of this document. The 15-year length of this time frame reflects the minimum period required to judge whether a population is stable, declining, or increasing. Due to the wide variation in the region’s annual rainfall and the frequencies of severe droughts and freezes, populations will naturally fluctuate. The numbers of individuals during a single year or short span of years may provide a skewed representation of a population’s longer-term trend.

**To delist** *C. scheeri* var. *robustispina*, the first two criteria for downlisting must be met or surpassed, and monitoring must demonstrate that the population is increasing for a minimum of 20 years over a 30 year period.

**Actions Needed**

1) Reduce the effects of human population growth and development by protecting *C. scheeri* var. *robustispina* habitat, seedbanks, and pollinator corridors.
2) Increase *C. scheeri* var. *robustispina* habitat quality by reducing non-native plant competition, improving native plant diversity and structure, and restoring ecosystem function and natural fire regimes.
3) Conduct research and monitoring that will facilitate better understanding of the taxon’s: a) population dynamics and trends, b) life history, c) response to threats, stressors, and land management activities, d) distribution and genetics, and e) other relationships key to its recovery.
4) Develop effective propagation, transplant, and *in situ* planting strategies to promote the introduction and augmentation of *C. scheeri* var. *robustispina* throughout the range of the taxon.
5) Assure the long-term success of *C. scheeri* var. *robustispina* through collaborative partnerships, community involvement, application of regulations, and public education and outreach.
6) Practice adaptive management in which recovery is monitored and recovery tasks are revised by the Service in coordination with a recovery implementation team as new information becomes available.

**Estimated Date and Cost of Recovery**
Date: 2046
Cost: $62,910,560
Resumen Ejecutivo

Estado Actual de la Especie

*Coryphantha scheeri* var. *robustispina* (Biznaga-partida de Espinas Gruesas) fue listada como en peligro de extinción bajo la Acta de Especies en Peligro de Extinción (Acta) el 23 de septiembre de 1993 (58 FR 49875); no se designó hábitat crítico. La segunda evaluación del estado de 5 años está bajo revisión interna. El taxón habita matorral desértico de Sonora bajo, la pradera desértica, o el.ecotono entre matorral desértico y pradera desértica, y se ha documentado entre 728 y 1,280 metros (m) (2388 y 4,200 pies) elevación en el sureste de Arizona y el norte de Sonora, Mexico (Tonn comm. pers. 16 de marzo de 2016). Actualmente conocemos menos de 5,750 individuos de *C. scheeri* var. *robustispina* existentes por el rango de distribución del taxón, y aproximadamente 1,800 adicionales documentados como muertos, principalmente debido a proyectos de desarrollo y minería durante varios años (Tonn comm. pers. 4 de noviembre de 2015).

Requisitos de Hábitat y Factores Limitantes

*Coryphantha scheeri* var. *robustispina* se considera escasamente distribuido en el paisaje, típicamente agregada en áreas adyacentes de densidad baja y alta (McDonald and McPherson 2006, p. 65). El taxón es auto incompatible (o sea no es capaz de auto fertilización y así requiere cruces externas) y investigación indica áreas con más alta densidad de plantas de *C. scheeri* var. *robustispina* tienen más polinización y así mas producción de fruta que áreas donde las plantas están más dispersas (McDonanald and McPherson 2006, p. 16). El hábitat ideal de *C. scheeri* var. *robustispina* tiene una variedad de otras especies de cactus como *Opuntia engelmannii*, *O. fulgida*, y *Ferocactus wislizeni*, tal como gramas nativas (Service 2000a, p. 9). Colectivamente, los cactus dentro del hábitat proveen suficiente polen para proporcionar los nidos y apoyar sobrevivencia del polinizador compartida, la abeja especialista de cactus, *Diadasia rinconus* (McDonald y McPherson 2006, p. 33; Blair y Williamson 2008, p. 428). Preservación del *C. scheeri* var. *robustispina* también requiere preservación del hábitat y corredores de polinización para *D. rinconus*. Investigación también indica que dado la perdida de individuos de *C. scheeri* var. *robustispina* a sequía en años recientes, la diversidad topográfica entre los hábitats preservadas puede proveer diferencias micro climáticas importantes para la sobrevivencia de *C. scheeri* var. *robustispina* a largo plazo (Baker 2011, p. 31).

Prioridad para la Recuperación

El número de prioridad para la recuperación de *C. scheeri* var. *robustispina* es 3C, el cual significa que la entidad listada es un subespecie, el nivel de amenaza es alta, hay conflicto con algún forma de actividad económica (desarrollo), y la potencial para recuperación es alta.

Estrategia para la Recuperación

La estrategia principal para la recuperación del *C. scheeri* var. *robustispina* es preservar y restaurar la calidad de hábitat para proteger individuos y sus bancos de semillas dentro de dos unidades de recuperación las cuales representan el rango de distribución del taxón. Las dos
unidades de recuperación se centran en los valles Altar y Santa Cruz en el sureste de Arizona. Las amenazas mayores dentro de la Unidad de Recuperación de Valle Altar, la cual se maneja principalmente para ganadería, incluye la propagación de gramas invasores, no-nativas, y el resultante alteración del régimen de incendios y aumento de competencia. Una amenaza mayor dentro de la Unidad de Recuperación de Santa Cruz, la cual incluye Tucson, Nogales, y las áreas urbanas entre ellos, es urbanización. Por todo el rango de distribución, C. scheeri var. robustispina está estresada por sequía e impactos de cambio climático, tal como depredación por mamíferos e insectos. La preservación y restauración de hábitat dentro de estas dos unidades de recuperación dejará que una población estable y auto sostenible persiste con algún nivel de conectividad entre individuos por todo el rango de distribución y proveerá oportunidades para expansión de la población.

Definimos una población estable y auto sostenible como uno que muestra crecimiento positivo de población durante un periodo de 15 años, con evidencia de reproducción y establecimiento natural. La estrategia de recuperación involucra minimizar y reducir las amenazas más importantes a largo plazo a la existencia seguida de la especie, las cuales son: 1) perdida de hábitat debido al desarrollo comercial y residencial, y 2) competencia con plantas no-nativas y alteración de regímenes de incendios. Esfuerzos adicionales enfocará en mejorar nuestro entendimiento de la ecología, distribución, y amenazas de C. scheeri var. robustispina, tal como reducción de los impactos de estresores como sequía y cambio climático, depredación por mamíferos e insectos, recreación y actividades fronterizas, y sobrepastoreo de ganadería.

**Meta de Recuperación**

La meta esencial de este plan de recuperación es perfilar acciones específicas que, cuando implementadas, reducirán las amenazas y estresores de C. scheeri var. robustispina suficientemente así que asegurará su viabilidad a largo plazo en el silvestre y deja que se remueva de la lista de especies amenazadas y en peligro de extinción.

**Objetivos de Recuperación**

4) **Objetivo basado en amenazas:** Reducir o mitigar la perdida y degradación de hábitat, la dispersión de especies no-nativas, y la alteración del régimen de incendios y el aumento de competencia resultantes y otros estresores para mejorar la seguida sobrevivencia de C. scheeri var. robustispina y sus polinizadores.

5) **Objetivo basado en hábitat:** Conservar, restaurar, y maneja apropiadamente la cantidad y calidad de hábitat necesaria para la seguida sobrevivencia de C. scheeri var. robustispina y sus polinizadores.

6) **Objetivo basado en población:** Conservar, proteger, y restaurar existentes y recién descubiertos individuos de C. scheeri var. robustispina y sus bancos de semillas necesarias para la seguida sobrevivencia del taxón. La población debe estar auto sostenible, de suficiente números para aguantar variación climática, eventos estocásticos, y pérdidas catastróficas, y debe representar el rango completo de la variabilidad geográfica y genética de la especie.

**Criterios de Recuperación**
Cambiar el estatus de *Coryphantha scheeri* var. *robustispina* a amenazada puede considerarse cuando cumplen todas las siguientes condiciones dirigidas a las amenazas y estresores a la especie:

1. **Objetivo basado en amenazas:** Reducir o mitigar la perdida y degradación de hábitat, la dispersión de especies no-nativas, y la alteración del régimen de incendios y el aumento de competencia resultantes y otros estresores para mejorar la seguida sobrevivencia de *C. scheeri* var. *robustispina* y sus polinizadores.

   **Criterio:** El logro exitoso de reducción y mitigación de amenazas y estresores se demuestra por un aumento del número de acres de hábitat buena u óptima para *C. scheeri* var. *robustispina* (ver “Objetivo basado en hábitat” para detalles). Hábitat se considera óptima cuando: está protegida para propósitos de conservación, se maneja de manera que promueva la sobrevivencia de *C. scheeri* var. *robustispina* a largo plazo; tiene menos de 20 por ciento de cobertura de especies de plantas no-nativas, contiene hábitat contiguo y corredores para polinizadores, y donde se observa números estables o creciendo de *C. scheeri* var. *robustispina* y que sigue así. Hábitat se considera buena cuando la cobertura de plantas no-nativas queda entre 20 y 35 por ciento y el terreno se maneje de tal manera que promueva la seguida existencia o expansión de la población de *C. scheeri* var. *robustispina*.

   **Justificación:** El logro de este criterio depende de conservación de hábitat exitosa (p. ej. preservación del terreno, bancos de conservación, restauración de hábitat estratégica) y planificación de manejo de terreno para reducir las amenazas y estresores de *C. scheeri* var. *robustispina* (p.ej. manejo de especies no-nativas y restauración, planificación del uso de suelos, y prevención de compactación de suelo y erosión) en todo los terrenos donde ocurre *C. scheeri* var. *robustispina*.

2. **Objetivo basado en hábitat:** Conservar, restaurar, y maneja apropiadamente la cantidad y calidad de hábitat necesaria para la seguida sobrevivencia de *C. scheeri* var. *robustispina* y sus polinizadores.

   **Criterio:** Por lo menos 8,094 hectáreas (20,000 acres) de hábitat de *C. scheeri* var. *robustispina* por unidad de recuperación están documentadas en condición optima y quedan así. Por lo menos 24,281 hectáreas (60,000 acres) de hábitat de *C. scheeri* var. *robustispina* por unidad de recuperación están documentadas en condiciona buena y quedan así. Colectivamente, esto representa aproximadamente 43 por ciento del rango conocido de *C. scheeri* var. *robustispina*. Acres adicionales de hábitat de *C. scheeri* var. *robustispina* de calidad menor también existe por todo el rango de distribución de la especie; de la cual, algunas acres ocurre en tierras donde hay esfuerzos continuos para mejorar la calidad de hábitat. Aunque no existe un análisis que nos puede ayudar estimar las acres totales de hábitat necesarias para apoyar una población sostenible de *C. scheeri* var. *robustispina*, creemos que lograr las metas arriba de hábitat optima y buena, podría mejorar significativamente la trayectoria de conservación y el estatus de este taxón al punto de cambiarlo a amenazada bajo la Acta.
Justificación: Plantas de Coryphantha scheeri var. robustispina que ocurren en hábitats de condición optima o buena, como definida arriba, debe tener la mayor resistencia a invasión de plantas no-nativas y asociadas con incendios de alta gravedad, tal como extremos climáticos y otras amenazas y estresores. Esperamos que estos hábitats tendrán poblaciones saludables de polinizadores que habilita el flujo genética entre individuos de C. scheeri var. robustispina, así manteniendo su diversidad genética a largo plazo.

3. Objetivo basado en población: Conservar, proteger, y restaurar existentes y recién descubiertos individuos de C. scheeri var. robustispina y sus bancos de semillas necesarias para la seguida sobrevivencia del taxón. La población debe estar auto sostenible, de suficiente números para aguantar variación climática, eventos estocásticos, y pérdidas catastróficas, y debe representar el rango completo de la variabilidad geográfica y genética de la especie.

Criterion: Proteger individuos maduros C. scheeri var. robustispina y sus bancos de semillas en cada unidad de recuperación. Monitoreo cuantitativo de parcelas establecidas en una variedad de tipos de tenencia de tierra y con el apoyo de los propietarios se lleva a cabo dentro de cada una de las dos unidades de recuperación cada 3 a 5 años con parcelas que demuestran que la población está creciendo por un mínimo de 10 años durante un periodo de 15 años.

Justificación: Un individuo maduro es uno que es capaz de florecer y producir una semilla viable. Solo individuos maduros se considera en cumplir con este criterio porque grandes números de semillas de C. scheeri var. robustispina pueden germinar después de lluvias esporádicas, pero no sobreviven por suficiente tiempo para reproducir. El número de parcelas de monitoreo y transectos y sus ubicaciones se determinará dentro de un plan de monitoreo que se escribirá dentro de cinco años de la finalización de este documento. La duración de 15 años refleja el periodo mínimo para decidir si una población es estable, declinando, o creciendo. Debido a la variación amplia de la lluvia de la región, y las frecuencias de sequias y congelaciones graves, las poblaciones fluctúa naturalmente. Los números de individuos durante un año o un lapso corto de años pueden proveer una representación sesgada de la tendencia de una población a largo plazo.

Para remover C. scheeri var. robustispina de la lista, los primeros dos criterios para cambiar el estatus a amenazada deben cumplirse o superarse, y el monitoreo debe demostrar que la población está creciendo por un mínimo de 20 años durante un periodo de 30 años.

Acciones Necesarias

7) Reducir los efectos del crecimiento de la población humana y desarrollo por medio de proteger el hábitat de C. scheeri var. robustispina, sus bancos de semillas y los corredores de polinizadores.
8) Mejorar la calidad de hábitat de C. scheeri var. robustispina por medio de reducir la competencia con plantas no-nativas, mejorar la diversidad y estructura de plantas nativas, y restaurar la función del ecosistema y el régimen natural de incendios.
9) Llevar a cabo investigación y monitoreo del taxon que facilitara un mejor entendimiento de: a) las dinámicas y tendencias poblacionales, b) el ciclo biológico, c) la respuesta a
amenazas, estresores, y actividades de manejo de terreno, d) la distribución y genética, y e) otras relaciones clave para su recuperación.

10) Desarrollar estrategias eficaces de propagación, trasplantación, y sembrando en su lugar para promover la introducción y aumentación de *C. scheeri* var. *robustispina* por todo el rango de distribución del taxón.

11) Asegurar el éxito a largo plazo de *C. scheeri* var. *robustispina* por medio de asociaciones colaborativas, involucramiento de la comunidad, aplicación de las regulaciones, y educación y divulgación pública.

12) Practicar el manejo adaptativo en cual la recuperación se monitorea y el Servicio puede cambiar las tareas de recuperación en coordinación con un equipo de implementación de recuperación cuando nueva información sea disponible.

**Fecha Estimada y Costo de Recuperación**

Fecha: 2046
Costo: $62,910,560
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Acknowledgements

The recovery planning process has benefitted from the advice and assistance of many individuals, agencies, and organizations. We thank the following individuals for providing information and insight; we apologize to anyone whose name was omitted inadvertently from this list:

Marc Baker, Southwestern Botanical Research
Chenevert-Steffler, Buenos Aires National Wildlife Refuge
Katie Cline, Natural Resources Conservation Service
Dan Cohan, formerly of Buenos Aires National Wildlife Refuge
Pat King, Altar Valley Conservation Alliance
John Kraft, Coronado National Forest
Christopher Jarchaw, United States Geological Survey
Brian Powell, Pima County Office of Sustainability and Conservation
Iris Rodden, Pima County Natural Resources Parks and Recreation
Sue Schuetze, Arizona Game and Fish Department
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Sabra Tonn, Arizona Game and Fish Department

The primary author of this recovery plan is Julie Crawford, Plant Ecologist, Arizona Ecological Services Office, Flagstaff, Arizona. Some information and photographs used in this document are from an earlier draft recovery plan written by contractor Marc Baker in 2012. Jennifer Smith-Castro translated the Executive Summary into Spanish. Additional thanks go to the following for their technical assistance and review and editing of this document: Julie McIntyre, Sarah Rinkevick, Jean Calhoun, and Scott Richardson.
Part I. Background

1. Overview
On July 1, 1975 (40 FR 27824), *C. scheeri* var. *robustispina* was included among 3,000 plant species under status review by the Service. The review, based on a report provided by the Smithsonian Institution, considered *C. scheeri* var. *robustispina* a threatened candidate species. On December 15, 1980 (45 FR 82480, p. 82499), *C. scheeri* var. *robustispina* was identified under the Endangered Species Act (Act) as a category 1 candidate species. Candidate species are those fish, wildlife, and plants for which we have on file sufficient information on biological vulnerability and threats to support preparation of a listing proposal, but for which development of a listing regulation is precluded by other higher priority listing activities. The taxon remained a category 1 until it was proposed for listing on April 20 1992 (57 FR 14374). *Coryphantha scheeri* var. *robustispina* was listed as endangered under the Act on September 23, 1993 (58 FR 49875); critical habitat was not designated. The decision to list the taxon was based upon the threats of illegal collection, as well as, habitat degradation and destruction resulting from recreation, historical and present overuse of the habitat by livestock, mining, agriculture, road construction, urbanization, and range management practices to increase livestock forage. Other threats and stressors to the taxon addressed in this recovery plan include non-native plant invasion, unnatural fire regimes, predation, and drought exacerbated by climate change.

The first 5-year status review for *C. scheeri* var. *robustispina* was completed by the Service and signed on February 8, 2007 (Service 2007, entire). Based on the static or declining status of the species across its range and continued threats and stressors, it was recommended in the 5-year Review that the taxon remain listed as endangered. A second 5-year status review is currently in internal review. The recovery priority number for *C. scheeri* var. *robustispina* is 3C, meaning that the listed entity is a subspecies, the level of threat is high, there is a conflict with some form of economic activity (urbanization), and the potential for recovery is high. A draft Recovery Plan, written by a contractor, was sent for review to the Service on March 28, 2012. Due to other higher priorities, it was not finalized at that time. This document utilizes some information and photographs from that draft plan.

2. Description
Individuals of *C. scheeri* var. *robustispina* are small, hemispheric to cylindrical, stem succulent perennials of the Cactaceae (cactus family) (Figure 1). Individual stems reach 5 to 46 centimeters (cm) (1.9 to 18.1 inches (in)) in height and 5 to 21 cm (1.9 to 8.3 in) in diameter, are comprised primarily of tough, fleshy pulp, and are protected by a leathery outer skin (Arizona Rare Plant Guide Committee 2001, unpaginated). Stems may be singular or form clumps. The surface of the stems are covered in 2 to 3 cm (0.8 to 1.2 in) long rounded projections called tubercles, each of which is grooved along the upper surface and contains one to several extra-
floral nectaries (place that secretes nectar to attract pollinators) along the groove (Figure 2) (Roller 1996a, p. 9; Baker 2011, p. 17). At the tip of each tubercle, arising from small bumps called areoles, are groupings of 7 to 20 straw-colored spines that darken with age (Roller 1996a, p. 9; Parfitt and Gibson 2004, p. 226). There is an average of two thick central spines, one of which is generally hooked and averages 1.7 millimeters (mm) (0.07 in) thick and 3 cm (1.2 in) long (Baker and Butterworth 2013, p. 996). There are 6 to 16 thinner radial spines about 1.1 to 3.5 cm (1.43 to 1.38 in) long (Parfitt and Gibson 2004, p. 226). The young areoles are covered densely with deciduous wool (Benson 1969, p. 195; Benson 1982, p. 818).

The stems of *C. scheeri* ssp. *robustispina* arise from taproots that are deeper than most Sonoran Desert cacti (Roller 1996b p. 1) at about 15 cm deep (Schmalzel 2000a, p. 2). Lateral roots are found between 2 and 5 cm below the soil surface and extend approximately 1 meter (3.28 feet) in length (Schmalzel 2000a, p. 2; Schmalzel 2000b, p. 8). SWCA (1999, p. 16) reported observing a lateral root extending 3 to 4 meters (9.8 – 13.1 feet) in the direction of coppice mounds (piles of fine surface materials). Schmalzel (2000a, pp. 16-17) noticed that 9 of 37 individual *C. scheeri* ssp. *robustispina* plants in the Altar Valley had roots that grew, he believed, along gradients of moisture, particularly toward coppice mounds. Although this was not scientifically tested, he hypothesized that this may allow faster penetration of the soil by rain and reduce surface evaporation.

The flowers of *C. scheeri* ssp. *robustispina* average 6.5 cm (2.6 in) long with pale yellow tepals (petals and sepals) that are variously tinged with red pigments (Figure 3). Flowers generally open early to mid-July following summer rains; fruit matures a few weeks later (Roller 1996a, p. 54). The pale green fruits are narrowly ellipsoid, 3.2 to 5.7 cm (1.25 to 2.25 in) long and 1.3 to 1.9 cm (0.5 to 0.75 in) wide, with a soft rind and juicy sweet pulp surrounding a mass of brown to black seeds (Benson 1969, p. 195).
3. Taxonomy
Arthur Schott originally described the taxon as *Mammillaria robustispina* from a collection he made from near El Sásabe, Sonora, Mexico (holotype MO 2017438) and the name was published by George Engelmann in 1856 (*M. robustispina* Schott ex Engelmann). Britton and Rose (1923, pp. 33-34) transferred the species to *Coryphantha* (*C. robustispina*). The name of the taxon was recombined by Benson (1982, p. 820) to *C. scheeri* var. *robustispina* and then again to *C. robustispina* (Schott ex Engelm.) Britton & Rose ssp. *robustispina* by Taylor (1998, pp. 17-18). According to Taylor, the species name *C. robustispina* has priority over the epithet *C. scheeri*. This view is accepted by Anderson (2001, p. 196). Within this document, however, we refer to the taxon as *C. scheeri* var. *robustispina*, the name in use when the taxon was listed endangered under the Act in 1993 and how the taxon has been referred to in Service documents since that time.

A morphometric study in 2004 suggested that a taxonomic cline exists between all *C. robustispina* occurring between Arizona and Texas and therefore no varieties are valid (Schmalzel et al. 2004, p. 553). Three varieties, *robustispina*, *uncinata* and *scheeri*, have been investigated recently and were shown to be geographically isolated (Baker 2005, p. 6), significantly different morphologically (Baker 2003, p. 17), and significantly different genetically (Butterworth 2010, p. 14; Baker and Butterworth 2013, p. 996), warranting subspecific division. We accept this varietal differentiation in this document.

4. Distribution
In the United States, *C. scheeri* var. *robustispina* is found across roughly 149,209 hectares (368,702 acres) of land within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including acreage of some lands that connect the two valleys. Plants are found on lands owned or managed by the Federal government (approximately 12 percent), State government (approximately 46 percent), Tribal government (approximately 2 percent), and private entities (approximately 40 percent; Figure 4).

There is no indication that the historical range of the taxon differs widely from the current known distribution. The type specimen was collected on the Sonoran side of the United States - Mexico border, just south of the Baboquivari Mountains (Benson 1982, p. 820); surveys

Figure 4. Land ownership within the *C. scheeri* var. *robustispina* population of southern Arizona (orange polygon).
indicate that this specimen was collected at the extreme southwestern edge of its range (Baker 2005, p. 6). *Coryphantha scheeri var. robustispina* occur within two subbasins of the Santa Cruz Watershed: Brawley Wash and the Upper Santa Cruz (Figure 5). These subbasins face largely differing threats and stressors and are managed in differing ways. Therefore, we are using these subbasins as the basis for our recovery units, which we describe later in this document. Because less than two percent of the known plants occur more than 900 meters (2,952.8 feet) apart, (the distance where individual *C. scheeri var. robustispina* are likely to be completely isolated genetically), we consider the all *C. scheeri var. robustispina* individuals as components of a single population.

5. Abundance

Between 2004 and 2005, Baker conducted a study in Arizona and Sonora that was designed to estimate the geographic distribution and relative densities for individuals of *Coryphantha scheeri var. robustispina*. Surveys took place in the following general areas: south of Sásabe, Sonora; south of Nogales; from north of Benson, Arizona; south to the U. S. - Mexico border; north of Douglas, Arizona; and southeast of Tucson, Arizona. Within the Benson and Douglas areas, no individuals were located, although most habitats surveyed were similar to known *C. scheeri* sites in elevation, topography, vegetation type, and plant cover (Baker 2005, p. 1). Surveys conducted south of the international border focused on three areas that had not been formally surveyed, which were geographically intermediate between known localities of var. robustispina and var. uncinata. These surveys resulted in a total of five individuals (one per 54 hectares surveyed) now known for Sonora, all less than 10 kilometers (km) (6.2 miles (mi)) from the international border. As potential habitat appears unlikely farther south, it is unlikely that there are significant populations of *C. scheeri ssp. robustispina* in Sonora or elsewhere in México (Baker 2005, p. 6).

*Coryphantha scheeri var. robustispina* is typically found widely spaced in the landscape. In a 1992 study intended to better define the range of the species, Ecosphere Environmental surveyed over 809 hectares (2,000 acres) of habitat with characteristics that could support *C. scheeri var. robustispina*, finding 195 clumps (an estimated 649 individuals) total on roughly 101 of the hectares (250 acres; pp. 9-10). They concluded that the plants were scattered within moderate sized areas in favorable habitats and widely dispersed in less optimal habitat (Ecosphere Environmental 1992, p. 3). They did not however, provide definitions of favorable or less optimal habitat.
There have been attempts to estimate the number of individual *C. scheeri* var. *robustispina* plants across the range of the taxon based on a sampling of field surveys and extrapolation. These extrapolations however, do not account for the variability in density that occurs within suitable habitat for this species and, therefore, are not reliable. For example, within the Buenos Aires National Wildlife Refuge in the Altar Valley, 612 plants (living and dead) have been found on over 20,234 hectares (50,000 acres) of potential habitat (Chenevert-Steffler pers. comm. January 29, 2015). In contrast, 477 individuals were found during surveys of 723.2 hectares (1,787 acres) of potential habitat on State Trust and Santa Rita Experimental Range lands in the Santa Cruz Valley (Ecosphere Environmental Services Inc. 1995, p. 1). Appendix 1 demonstrates the number of individuals and acres of suitable habitat surveyed from the vast majority of surveys conducted for the species since 1985. A total of 6,712 individuals have been documented in our files from these surveys of 43,072 hectares (106,433 acres) of suitable habitat. Similarly, as of the summer of 2015, the Arizona Natural Heritage Program database of locations for this taxon consisted of 7,558 records, of which 1,837 were known to no longer exist, primarily due to development and not natural causes (Tonn pers. comm. November 4, 2015).

Relatively few studies have been conducted where individual *C. scheeri* var. *robustispina* were monitored over time. In 1997, Robert Schmalzel established a permanent plot to study *C. scheeri* var. *robustispina* growth and age structure on the King Anvil Ranch in the Altar Valley; this plot was revisited in 1998, 1999, and 2000 (Schmalzel 2000b, p. 6). In this study, 139 individuals were followed, of which 15 died between 1997 and 2000 (Schmalzel 2000b, p. 7). During a follow-up study by Marc Baker and Rafael Rouston initiated in 2002, it was reported that “many” of the 139 plants measured by Schmalzel were dead, with no apparent cause of death discovered (Dimmit and Brusca 2004, p. 5). In this follow-up study, long-term plots were established at six locations within the Altar Valley, including the area previously studied by Schmalzel (Dimmit and Brusca 2004, p. 2). In 2003, a total of 260 individuals were located on the six plots; these plants were evaluated on six additional occasions through 2012, when 93 plants remained (Baker 2013, p. 4). Rodent and insect predation, drought, and poor habitat condition are commonly associated with *C. scheeri* var. *robustispina* death (Phillips et al. 1981, p. 10; Mills 1991, p. 5; Schmalzal & McGibbon 2010, pp. 3, 10-11; Baker 2011, pp. 6; Baker 2013, p. 4; Service 2015a, p.1; Service 2015b, p. 2).

Between 1995 and 2007, 45 individual *C. scheeri* var. *robustispina* were monitored in an exclosure on Coronado National Forest land in the Santa Cruz Valley. By the last check of these individuals in 2010, no living plants were found (Coronado National Forest 2010, entire). It should be noted, however, that in a partial survey of this area in 2015, some *C. scheeri* var. *robustispina* were found both within and outside of this exclosure (Service 2015b, entire). Similarly, plants are monitored regularly on the Pima County and Palo Alto Pima pineapple cactus Conservation Banks. On one portion of the County-owned bank in 2006, 67 plants were mapped; when last counted in 2014, 13 of the original 67 plants remained alive and 11 new plants had been found (Pima County 2015, p. 1). Within or adjacent to the Palo Alto Conservation Bank, 49 plants were found in 2001; as of September, 2015, 9 of the original individuals remained alive and 11 new plants were discovered (Westland 2015, p. 2).
6. Habitat

*Coryphantha scheeri* var. *robustispina* is typically found in open areas within the Sonoran Desert-scrub and desert-grassland vegetation types and in areas transitional between these vegetation communities (Figure 6; Roller and Halverson 1997, pp. 267-268). Routson (2003, p. 3) found that individuals of *C. scheeri* var. *robustispina* within the Altar Valley occurred most frequently in disclimax desert-grassland among woody vegetation on well-drained soils. Many studies describe the subshrubs *Zinnia* species (desert zinnia), *Gutierrezia sarothrae* (snakeweed), *Isocoma tenuisectus* (burroweed), and *Eriogonum* spp. (buckwheat) as common associates (Schmalzel 2000c, p. 1; McPherson 2002, p. 3; McDonald 2005, p. 58; Service 2007, p. 9). Schmalzel (2000, p. 2) noted greater rates of mortality among *C. scheeri* var. *robustispina* occurring under the canopies of *Prosopis velutina* (velvet mesquite). Similarly, Kidder (2014, entire) found occupied sites were characterized by overall high incoming solar radiation (Kidder 2015, p. 110). McPherson (2002, p. 3), however, found individuals occur more frequently under the canopy of perennial plants than at a distance of at least 1 meter (3.28 feet) from the canopy edge.

The taxon is generally found on deep, silty and gravelly, alluvial soils at elevations between 728 and 1,280 meters (2388 and 4,200 feet; Ecosphere Environmental, 1992, p. 11; Roller and Halverson 1997, p. 267; McPherson 2002, p. 2; Kidder 2015, p. 110; Tonn pers. comm. March 16, 2016). Although *C. scheeri* var. *robustispina* have been located on early (Holocene) and late (Pleistocene) Quaternary, as well as Cenozoic period soils, individuals appear to be more abundant on the younger alluvia and less
abundant on older, nutrient-poor alluvia (SWCA 1999, p. 6; Figure 7). Schmalzel (2000b, p. 10) suggests both Holocene and Pleistocene surfaces are needed for the persistence of *C. scheeri* var. *robustispina*, with the younger, more nutrient-rich Holocene soils where *C. scheeri* var. *robustispina* grow more quickly, but can perish in more frequent fire, and the older and nutrient-poor Pleistocene soils acting as refugia where vegetation and fire are sparse. Figure 7 illustrates the affinity of the taxon for Quaternary soils throughout its range.

McPherson (2002, p. 2) also noted that individuals of *C. scheeri* var. *robustispina* are associated with coppice mounds about 70 percent of the time and may be creating the mounds when small particles of silt, sand, and organic matter are blown into the spines of the cactus and drop to the base. McDonald (2005, p. 58) noted that 93 percent of 374 individual *C. scheeri* var. *robustispina* found in burned and unburned areas of the Altar Valley were on coppice mounds. SWCA (1999, p. 16) reported that some of the highest densities of *C. scheeri* var. *robustispina* individuals occur within 10 meters (32.8 feet) of *Dipodomys spectabilis* (banner-tailed kangaroo rat) mounds. SWCA suggested that *C. scheeri* var. *robustispina* individuals access nutrients from *D. spectabilis* feces by sending out long lateral roots (SWCA 1999, p. 16). However, Schmalzel (2000b, p. 9) noted that of 154 plants studies on a permanent plot in the Altar Valley, only two plants were growing directly on *D. spectabilis* mounds.

7. Life History and Ecology

*Coryphantha scheeri* var. *robustispina* is a perennial shrub with succulent stems, which, along with the flowers, fruits, and seeds, are palatable to some degree to animals. Although individuals can have a longevity of 30 or more years (Roller 1996a, pp. 38, 41; Schmalzel pers. comm. May 22, 2000), in some areas, such as the Buenos Aires National Wildlife Refuge, they have a much shorter lifespan, possibly due to competition with non-native grasses (Cohan, pers. comm. June 19, 2015). Schmalzel (2000a, p. 20) hypothesized that competition with grass is inversely correlated to *C. scheeri* var. *robustispina* growth, seed output, and longevity, though this has not been tested.

Flower buds begin to appear in mid-May and the timing is related to photoperiod and rainfall (Roller 1996a, p. 58). Flowering usually occurs in early to mid-July or five to seven days after the first summer rains of at least three millimeters and continues through the monsoon season (Kearney and Peebles 1951, p. 577; Roller 1996a, p. 58; Kidder 2014, entire). Flowers persist for a single day, yet the timing of flowering may assist with pollination, as there are few cacti species which bloom at this same time, resulting in a greater potential for pollination success (McDonald and McPherson 2005, p. 531).

Pollinators of *C. scheeri* var. *robustispina* are fairly well known. Flowers of the taxon are morphology typical for the subgenus Cactoideae and exhibit characteristics considered generalized with respect to pollination, that is, the pollen being easily accessible to many different types of pollinators. Known pollinators include both native insects and the non-native European honeybees (*Apis mellifera*) (Roller 1996a, p. 63). Schmalzel (2000c, p. 2) reported collecting and identifying from *C. scheeri* ssp. *robustispina* in the Altar Valley the following flower visitors: *Diadasia rinconis* (Anthrophoridae), *Agapostemon melliventris* (Halictidae), *A. Cockerelli* (Halictidae), and *Dialectus* (Halictidae), though he concludes that the primary pollinator is *Diadasia rinconus* (Schmalzel 2000d, p. 8). A 2005 pollination study of *C.
robustispina ssp. robustispina also concluded that Diadasia rinconis is the primary pollinator of the taxon (McDonald 2005, p. 17). Although most pollen transfer occurs within a few hundred meters of C. scheeri var. robustispina individuals, D. rinconis is capable of transporting pollen 1.2 kilometers (3,937 feet) or more (McDonald 2005, p. 29). As C. scheeri var. robustispina is not able to self-polinate (Service 2000a, p. 4), they become isolated from potential pollination after 600 meters (1,968.5 fee) and are likely to be genetically isolated after 900 meters (2,953 feet; McDonald 2005, p. 30).

Fruit and seed dispersal for the taxon is probably facilitated, for the most part, by rodents and, perhaps less so, by ants. It has also been hypothesized that jack rabbits may play a key role in fruit and seed dispersal (Westland 2005, p. 33; Schmalzel and McGibbon 2010, p. 11). In 2001, Westland (2005, p. 33) examined jackrabbit dung and discovered intact C. scheeri var. robustispina seeds within. They noted that dung increased around plants at the time fruits are maturing. A study conducted by Baker and Routson beginning in 2002 documented ants eating the fruits and transporting seeds, as well as the presence of a single seed in jackrabbit feces, which also supports the jackrabbit dispersal hypothesis (Baker 2013, p. 33). In a study of antelope jackrabbit habitat structure and vegetation characteristics, Altemus (2016, p. 10) did not detect a spatial association between the jackrabbits and the presence of C. scheeri var. robustispina, but suggested further study was warranted, as this was a habitat selection study for the herbivore and did not emphasize the distribution of fruits. Additionally, Harris' antelope squirrels (Ammospermophilus harrisi), cottontail rabbits (Sylvilagus audubonii), and birds have been observed feeding on fruits and may play a part in seed distribution (Roller 1996a, p. 64; Baker 2011, pp. 23-24).

Wildlife photography using motion sensors in 2010 and 2011 caught individuals of Harris' antelope squirrel 114 times (excluding photos taken within 15 minutes of each other). Individual desert cottontail were photographed 31 times, kangaroo rats (Dipodomys sp.) 19 times, and jackrabbits (Lepis sp.) 9 times (Baker 2011, pp. 23-24). Harris antelope squirrels were the only animals caught in the act of eating fruits (Figure 8) and marking cacti. Westland (2005, p. 33) hypothesized that pronghorn (Antilocapra americana) may have historically provided long distance dispersal and gene flow across the range of C. scheeri var. robustispina. Baker (2013, p. 33) hypothesized that roadrunners, doves, and other birds may be long distance seed dispersers.

Data suggest that an abundance of seeds are produced by C. scheeri var. robustispina. Baker (2012, p. 21) reported that over a six-year period, 32% of the individuals among six sites in the Altar Valley produced mature fruits, with an average of 2.37 fruits per fruit-bearing individual.
Mills (1991, p. 5) reported that the average C. robustispina ssp. robustispina fruit contains nearly 120 seeds. Thus, each year, on the average, each C. scheeri var. robustispina individual produces 91 seeds (120 seeds/fruit × 2.37 fruits per fruit-bearing plant × 0.32 fruit-bearing plants/total plants). Similarly, Roller (1996, p. 72) studied seed at five sites spread across the taxon’s range and found the average number of seeds produced per fruit was 89. Mills (1991, p. 4) noted an average of 114 seeds per fruit on 21 fruits collected from 17 plants on the west side of the Sierrita Mountains. Schmalzel (2002, p. 4) in a study of hand pollinated plants in a greenhouse situation found the mean number of seeds produced per fruit was 87, with a large range from 19 to 156 seeds per fruit. He notes that other cacti have disproportionate seed production among individual plants and that seed size varied greatly between plants as well, with a median seed mass of 5.32 milligrams (sd = .94 mg).

Ample seed production, however, does not necessarily equate to persistent seedbanks or recruitment. One study reported the results of two trials where 200 or more C. scheeri var. robustispina seeds were planted and germination was followed (Schmalzel 2002, p. 7). In the first trial, 16 of 220 seeds germinated in the first year and none in the second. In the second trial, 35 of 200 seeds germinated; 30 in the first year and 5 in the second year of study (Schmalzel 2002, p. 7). In another study, field germination testing found that C. scheeri var. robustispina seeds had high germination rates of 88% (Roller 1996a, p. 75). Observations over a 22-month period showed continuous germination indicating that there is no set dormancy period for the seeds (Roller 1996a, p. 72). The study also found that C. scheeri var. robustispina seeds require at least 96 hours of high water saturated soil in order to imbibe and temperatures above 19 degrees Celsius and below 38 degrees Celsius in order to germinate (Roller 1996a, pp. 65-66). We are not aware of any tests of seedbank viability over time.

8. Reasons for Listing and Current Threats and Stressors
In determining whether to list, delist, or reclassify a species under section 4(a) of the Act, we evaluate the threats to the species based on the five categories outlined in section 4(a)(1) of the Act: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Threats identified in the 1993 C. scheeri var. robustispina listing document include: habitat loss due to mining, agriculture, road construction, and urbanization (Factor A); non-native plant competition and alteration of the fire regime (Factor A); habitat degradation due to historical and present overuse of the habitat by livestock (Factor A); and illegal collection (Factor B). In addition, threats and stressors identified through research and section 7 consultations that could potentially impact C. scheeri var. robustispina include recreation and border activities (Factor A), predation by small mammals and insects (Factor C); inadequacy of existing regulatory mechanisms (Factor D); the effects of drought and climate change (Factor E); and small population size and isolation (Factor E). All of these threats and stressors are discussed below; a list of threats and stressors and associated recovery objectives, criteria, and actions can be found in Table 1.
<table>
<thead>
<tr>
<th>Listing Factors</th>
<th>Threats and Stressors</th>
<th>Recovery Objectives</th>
<th>Recovery Criteria</th>
<th>Recovery Actions</th>
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<td>2a-b, 3b-c, 4a, 4c, 5a-c, 6a-c</td>
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<td>Inadequacy of existing regulatory mechanisms</td>
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<td>1, 2, 3</td>
<td>1a-d, 3c, 4a-c, 5a-c, 6a-c</td>
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Table 1. Threats and stressors tracking table for *Coryphantha scheeri var. robustispina*

**Factor A: Present or Threatened Destruction, Modification or Curtailment of Habitat or Range**

**Habitat loss due to commercial development**

The primary habitats of *C. scheeri var. robustispina* are open areas on flat ridge tops or areas with less than 15 percent slope, which are also areas very well suited for human development. Urban and suburban development in the areas south and west of Tucson, Green Valley, and Nogales, Arizona and mining in the Sierritas and Green Valley, threats first recognized in the 1980s (Phillips et al. 1981, p. 11; Mills 1991, p. 7; Reichenbacher 1985, p. 21; Service 2000a, p. 7), are responsible for complete and permanent modification of lands that previously supported *C. scheeri var. robustispina* and its pollinators. By 2000, the Service estimated that 43 percent of the total habitat surveyed to date had been modified or destroyed due to urbanization (Service 2001, p. 6). For example, 143 hectares (353 acres) of habitat and 47 individual plants were lost to a single housing development project in 1998 (Service 1998, p. 16). The trend continues; in 2014, 197 hectares (487 ac) of suitable *C. scheeri var. robustispina* habitat and 99 individual plants were lost to a single infrastructure development project.

Since its listing in 1993, there have been 76 formal section 7 consultations under the Act involving *C. scheeri var. robustispina* in southern Arizona resulting in the direct mortality of more than one thousand individual *C. scheeri var. robustispina*, and 3,238 hectares (8,000 acres) of suitable habitat, most of which were related to construction activities. Consultations under the Act only occur for projects with a Federal nexus, either occurring on Federal lands or using Federal dollars or needing a Federal permit. Therefore, many projects that occur within the range of *C. scheeri var. robustispina* do not undergo section 7 consultations, and the Service
does not typically receive information regarding the status or loss of plants or habitat associated with those projects.

In summary, *C. scheeri* var. *robustispina* occur on land with less than 15 percent slope that is well suited for human development. Habitat loss to mining and urbanization has been and continues to be a major threat to *C. scheeri* var. *robustispina*. Thousands of acres of suitable habitat and more than a thousand individuals have been lost to this threat since the taxon was listed. This threat remains high.

**Non-native plant invasion and altered fire regimes**

*Coryphantha scheeri* var. *robustispina* occur in both the desert-grassland and desert-scrubland plant communities, especially in the ecotone of the two (Roller 1996a, p. 9). Non-native grasses in both communities compete with native plants for water and nutrients, reduce community composition and structure, and alter fire frequency and intensity.

**Desert-grassland**

Occurring roughly every 10 to 20 years and following periods of adequate moisture, large-scale low-severity fire defined historical disturbance regimes of desert-grassland plant communities of southern Arizona and northern Mexico (McPherson and Weltzin 2000, p. 5; Brooks and Pyke 2002, p. 6; McDonald and McPherson 2011a, p. 385). Through intensive cattle grazing beginning in the 1820s and improved fire-suppression techniques thereafter, the fire return interval increased to 50 years or more by the late 1800s (Thomas 1991, p. 13). Due to the changing fire regime, overutilization of range for cattle grazing, and extirpation of prairie dogs, historically an important source of woody plant mortality in the Altar Valley, *P. velutina* became less vulnerable to mortality and began encroaching into these native grasslands (Parmenter and Van Devender 1995, p. 214; Bahre 1995, p. 241; Van Auken 2000, p. 205; Sayre 2007, p. 42; Lindsay et al. 2011, p. 3252).

Efforts initiated several decades later to control *P. velutina* invasion included mechanical removal and high intensity prescribed fire. In addition, by the 1930s, non-native grasses such as *Eragrostis lehmanniana* (Lehmann’s lovegrass) was intentionally planted to revegetate degraded landscapes, decrease erosion, and increase forage production for livestock (Anable et al. 1992, p. 181; Sayre 2007, p. 42; McDonald and McPherson 2011a, p. 385).

Figure 9. Grassland condition within general locations of *C. scheeri* var. *robustispina* of southern Arizona (orange polygon), illustrating the condition of the desert-grassland habitat of the taxon. Geospatial data from TNC, 2004.
Eragrostis lehmanniana has numerous competitive advantages over native grasses. They have the ability to re-sprout from roots not killed by hot fire, are not hampered by the reduction in mycorrhizae associated with fire and erosion, are able to produce copious seed earlier than native grasses, and maintain large seedbanks (Anable et al. 1992; O’Dea 2007, p. 149). This species outcompetes native grasses and forms monotypic stands across large areas of grassland habitat (Figure 9).

This results in the reduction of structural and spacial diversity of habitats, alteration of wildfire patterns, and competition with native plants, including C. scheeri var. robustispina, for water, light, and nutrients. Between 1932, when E. lehmanniana was introduced into southern Arizona, and 1991, 145,000 hectares (358,303 acres) of desert-grassland had been impacted by this non-native (Anable et al. 1992, p. 181). By 2003, Gori and Enquist (p. 10) suggest that the non-natives E. lehmanniana and E. curvula (Boer lovegrass) were common or dominant on 566,560 hectares (1,400,000 acres) of land in southeastern Arizona. The Forest Service estimates that up to 75 percent of C. scheeri var. robustispina habitat has been infested by E. lehmanniana (ADA 2010, entire). Figure 9 demonstrates our best estimate of the distribution of native, non-native, and shrub invaded grasslands within and nearby C. scheeri var. robustispina habitat (The Nature Conservancy 2004, entire).

Within the Buenos Aires National Wildlife Refuge, it is thought that competition from E. lehmanniana has reduced longevity of individual C. scheeri var. robustispina to less than one third the typical lifespan of the species (Schmalzel 2000a, p. 20; Cohan, pers. comm. June 19, 2015). In addition, survivorship of C. scheeri var. robustispina at Buenos Aires National Wildlife Refuge was only 31 percent after fires in areas with high densities of E. lehmanniana, whereas, 70 percent survived in areas with low E. lehmanniana densities (Roller and Halvorson 1997, p. 12).

Within a single fire event in native grassland, some patches may burn at high temperatures, while others burn lightly or do not burn at all. Fire-free refugia for C. scheeri var. robustispina may be small (Figure 10) or non-existent (Figure 11) in grasslands infested with non-natives grasses. The number of individual cacti in habitat infested with non-native grasses may decrease over time if recruitment does not keep up with losses due to fire and other threats or stressors.

Desert-scrubland
Desert-scrubland, where there is decreased annual precipitation compared to desert-grasslands, is typically characterized by low and discontinuous plant fuels, plants that lack fire-adapted characteristics, and fire return interval that may have historically been greater than 250 years (McLaughlin and Bowers 1982, p. 246; Thomas 1991, p. 11; Alford et al. 2005, p. 451; Brooks and Pyke 2002, p. 5; Brooks and Chambers 2011, p. 433). Fine fuels, typically only at adequate densities following wet winters or in a few areas with perennial grasses, allowed for small, low severity fires (Schmidt and Rogers 1988, p. 437; Brooks and Chambers 2011, p. 433; Esque et al. 2013, p. 223). Since the 1800s, the invasion of non-native grasses, primarily Pennisetum ciliare (buffelgrass), into this plant community has led to biomass accumulation and continuity sufficient to carry fire (Salo 2005, p. 166). In an attempt to restore degraded grassland in Arizona, in the 1940s the U.S. Soil Conservation Service introduced the P. ciliare. Since the 1960s, this species was used extensively in Arizona and Sonora, Mexico for livestock forage and
now impacts millions of acres of lands in the region (Martin-R. et al. 1995, p. 60; Van Devender et al. 1997, p. 3; Lyons et al. 2013, p. 66).

**Figure 10.** Example of small *C. scheeri* var. *robustispina* refugia habitat (bare soil) within *E. lehmanniana*-dominated grassland.

**Figure 11.** Example of *C. scheeri* var. *robustispina* without refugia from non-native *E. lehmanniana.*

Fires occurring on lands infested by *P. ciliare* are more severe and frequent than fires in surrounding ecosystems, even in communities with comparable fuels (McDonald and McPherson 2011b, p. 1152). *Pennisetum ciliare* can resprout within days of fire; however, native plants not adapted to fire suffer greater losses in cover and species richness (McDonald and McPherson 2011b, pp. 1152-1153). Increases in non-native grass cover in deserts can also increase habitat for rodents (Olsson et al. 2012, p. 18). Rodents consume cacti for water, especially in times of drought (Riegel 1941, p. 96; Orr et al. 2015, p. 1058). In addition, non-native grasses in deserts may be detrimental to the survival of ground nesting native bee species that require sparsely vegetated habitat (Lindsay et al. 2011, p. 3262), which in turn may impact *C. scheeri* var. *robustispina* pollination and survival.

**Fire and cacti**

Although succulents can be severely damaged or destroyed by fire, they may survive burning by: a) occupying open microsites characterized by low fuel abundance, especially on rocky ridgetops, b) plants being missed by the fire due to the mosaic burn pattern of fires, c) seedlings shrinking into the soil at certain times of the year when fire may be present, d) evolving morphological or physiological fire tolerance, e) producing thick callous tissue following damage which may protect plants in subsequent fire, or f) production of offsets after injury or death (Thomas 1991, pp. 13 and 20; Tolley 1992 p. 6; Roller 1996a, pp. 17, 34, 39, 77; Roller and Halverson 1997, p. 5; McDonald and McPherson 2006, pp. 54, 56, 66; 58 FR 49875, p.
Coryphantha scheeri var. robustispina do not appear to be well-adapted to the more frequent and hotter fires more typical of today’s invaded systems.

Although cacti typically do not burn, they do scorch and blister, damaging epidermal and mesophyll tissue (Figure 12), and spines can be burned off, leaving plants unprotected from predation and more vulnerable to killing frost (Figure 13; Thomas 1991, pp. 14 and 17; Robinett 1996, entire; McDonald and McPherson 2011b, p. 1151). Response of cacti to alterations in fire frequency and intensity have been studied to some extent and some insight can be gleaned from short-term fire response studies of other cacti species. In a study of grasslands in southern Arizona, Humphrey and Everson (1951, p. 266) found greater mortality of three Opuntia species on burned vs. unburned areas one year following high intensity fire. In a study of P. ciliare infested Sonoran Desert, McDonald and McPherson (2011, p. 1152) found that nearly 90 percent of cacti photosynthetic tissue was damaged by high severity fire. In addition, flowers, fruits, and seeds that are burned halt sexual reproduction temporarily, even if the cactus is not killed; disruption of seed entering the seedbank may impact future recovery. Although some cacti seed are able to withstand extremely high temperatures, seeds are not stimulated to grow due to fire, as in other plants that are adapted to fire (Thomas 1991, p. 19).

Following another Sonoran Desert fire, mortality of cacti species following frequent fires was reduced due to the presence of rocky outcrops which provided refuge (Thomas 1991, p. 19). Similarly, Thomas and Goodson (1991, entire) followed four species of small globular cacti after grassland fires on the Appleton-Whittell Research Ranch and Buenos Aires National Wildlife Refuge of southeastern Arizona. They found that immediately after fire, there was no significant difference in the number of dead individuals between burned and unburned areas across all four species studied. However, one year after the fire, 30 to 50 percent of burnt plants had died compared to less than 20 percent of unburned plants. After four years, 80 percent of the burnt cacti had died. For two of the cacti species this was significantly greater mortality than unburnt.
plants, however, for a third species, unburnt and burnt plant mortality was more-or-less equal. For the fourth species, mortality of control plants exceeded those burnt, possibly due to old age of the unburnt plants, or release from competition plus a nitrogen pulse in those that had burnt.

In another cactus study from southern Arizona, Thomas and Goodson (1992, p. 99) found that repeated or intense fires resulted in reduced cactus survivorship; fewer post-fire survivors result in long-term decline, as frequent fires do not allow time for seedling establishment and population recovery. In a 16 year study of Coryphantha, Echinocereus, Echinomastus, and Mammilaria cacti, Thomas (2006, p. 9) found that within two years of a grassland fire, less than 25 percent of 50 tagged cacti perished. All plants however, died within a 16 year period (less than half the typical lifespan of C. scheeri var. robustispina) and a new cohort replaced the original plants (Thomas 2006, p. 9).

Of 16 individual C. scheeri var. robustispina studied in the Altar Valley two years post-burn, Maender (1993, entire) found fire damage as follows: a single plant with no damage, two plants with slight damage, two plants with moderate damage, 10 plants with severe damage, and one plant that had died. He noted that the unharmed or slightly damaged plants may not have had available fuels associated with them. In a pre- and one-year post-fire study of 26 C. scheeri var. robustispina plants of the Altar Valley, Cline (2015, p. 4) found a significant decrease in the health and survival of the cacti in both control and burn areas. Of the three healthy individuals that did burn, post-fire monitoring found that one was scorched from radiant heat, one had slight yellowing with charred spines, and a third was dead, but had eight healthy pups. Other cacti in this study were killed or damaged from frost, infrastructure development, drought, and rodent predation. Cacti in the control area also showed significant decrease in health and survivorship, primarily due to frost, drought, and predation.

In 1995, a prescription fire was lit on a pasture in the Altar Valley in which pre-burn C. scheeri var. robustispina surveys were conducted. One year following this fire, Robinett (1996, entire) revisited these same C. scheeri var. robustispina individuals and reported roughly equal mortality (20 to 30 percent) of C. scheeri var. robustispina on and off the prescription burn area, saying mortality was likely due to drought. He also noted some of the burned plants were eaten by small mammals. Schmalzel (2000b, p. 9) noted that this pasture had not burned in 50 to 100 years and had the potential for fairly dense stands of perennial grasses and six- weeks grama under the right rainfall conditions. Schmalzel (2000b, p. 9) stated that nearly all C. scheeri var. robustispina were killed by the fire. He did not indicate the conditions of this fire, the species of perennial grass involved, or how many years post-fire he made his observations.

In 2005, McDonald revisited this and other nearby burned and unburned pastures. He found the overall post-fire demography and density of C. scheeri var. robustispina both on and off of burned areas did not differ (McDonald 2005, p. 61). He noted that some C. scheeri var. robustispina may have escaped fires in microsites with little fuel, but that it is possible that most of the plants examined in this study established after the fire (2005, p. 61). McDonald feels that the distribution and abundance of C. scheeri var. robustispina may ebb and flow based on regional rainfall patterns, grass production, and fire dynamics. McDonald also noted that the burned areas of his study, which included the 1995 fire, did not have high amounts of E. lehmannii or other non-native species. He warned that caution should be taken when restoring
fire in areas outside of historic conditions (e.g. with increasing *E. lehmannii*), as this could profoundly change community composition and possibly decrease *C. scheeri* var. *robustispina* survival (McDonald 2005, p. 75).

In summary, historically, low severity fires that occurred every 10 to 20 years in grasslands, or every 250 years in deserts, likely posed no threat to the long-term survival of *C. scheeri* var. *robustispina* individuals. When invaded by non-native grasses, fire frequency and intensity increase, leading to the deterioration of both natural grassland and desert communities (Olsson et al. 2012, p. 10; Steidel et al. 2013, p. 529). Non-native grasses produce more fine fuels than native vegetation, allowing for a more uniform and higher intensity burn compared with the discontinuous fuels of some native grasslands and deserts, thus reducing the number of microsite refuges safe from fire (58 FR 49875, p. 49876; McPherson and Weltzin 2000, p. 7; Brooks and Pyke 2002, p. 5). *Coryphantha scheeri* var. *robustispina* is not fire adapted, but may survive fires through refugia, chance, shrinking into the ground, or producing offsets or possibly recolonization from a surviving seedbank. Research into the relationship of fire, non-native species, and *C. scheeri* var. *robustispina* and their seedbanks is essential to understand the tolerance of this taxon to wildland and prescription fires. Research into desert-shrubland and desert-grassland restoration is also essential.

**Habitat degradation due to historical and present overuse of the habitat by livestock**

Native grasslands of southern Arizona have declined in size and health since the 1800s for a variety of natural and human-related reasons (Hastings 1959, p. 62; Bahre 1995, pp. 230-231). In the 1800’s, the Altar and Santa Cruz Valleys were said to have been open grassland supporting prairie dogs, large herds of pronghorn antelope, and Mexican wolves (BANWR 2012, entire; Bahre 1995, p. 231). By the early 1860s, there was a boom in ranching in southern Arizona which ended with the droughts of 1891-1893 and 1898-1904 when widespread livestock die off occurred (Sayre 2007, p. 42; Austin 2010, p. 8). Stocking rates prior to 1920 are estimated to have been roughly ten times greater than stocking rates today (Sayre 2007, p. 42). During this time, antelope and large predators were displaced, and prairie dogs, an important source of woody plant mortality, were extirpated (Parmenter and Van Devender 1995, pp. 198, 203, 214; Van Auken 2000, p. 205; Sheridan 2001, p. 146).

Livestock over-use during these drought periods, as well as the droughts of the 1920s and 1950s, caused or contributed to soil erosion and compaction, arroyo formation, reduced water infiltration rates and increased runoff, invasion or expansion of woody perennials, increases in open disturbed patches available for non-native plant invasion, and shifts in understory species composition to less diverse and less palatable plant species, among other impacts (Klemmedson 1956, p. 137; Ellison 1960, p. 24; Arndt 1966, p. 170; Gifford and Hawkins 1978, p. 305; Waser and Price 1981, p. 407; Robinson and Bolen 1989, p. 186; Holechek et al. 1998, pp. 191–195, 216; Loftin et al. 2000, pp. 57–58; and Sayre 2005, p. xiv). Much of the range of *C. scheeri* var. *robustispina* has been heavily grazed historically and degradation of the habitat has occurred. Although used to a lesser extent than historically, some management practices that continue today, such as chaining, ripping, and the planting of non-native grasses as forage, continue to contribute to the modification and loss of *C. scheeri* var. *robustispina* habitat and individuals. Although livestock are not known to eat *C. scheeri* var. *robustispina*, they can step on or knock
over individual *C. scheeri* var. *robustispina*, especially smaller individuals which can be easily destroyed (Ecosphere Environmental Services, Inc. 1992, p. 24; Service 2002, p. 10).

Studies of other threatened, globular cacti of the Sonoran Desert have shown that low intensity grazing which occurs with high frequency over a long period of time can also negatively impact cacti through increased soil erosion, solar radiation, and a reduction in soil humidity (Ureta and Martorell 2009, p.1992). In this study however, a second cacti species benefited from moderate livestock use which thinned competing grasses (Ureta and Martorell 2009, p. 1998). Although many species are vulnerable to disturbance, some cacti species tolerate or even benefit from low to moderate disturbance through increased recruitment in newly created environments (Martorell et al. 2012, p. 336). Mills (1991, p. 3) noted a higher quantity of *C. scheeri* var. *robustispina* individuals along cattle trails, though suggested it could be due to higher visibility there. Reichenbacher and Associates (1985, p. 21) noted *C. scheeri* var. *robustispina* occurred more regularly in areas where grasses were at least partially grazed by cattle and the cacti were released from competition. Thomas et al. (in preparation, p. 10) noted higher survival of *C. scheeri* var. *robustispina* when vegetation cover within 1 meter (3.28 feet) of individuals was low, vs. high. Similarly, there have been a few instances where *C. scheeri* var. *robustispina* have been reported following certain mechanical disturbances such as road construction or chaining, which reduced competition with other plants for nutrients, water, and light (Service 2002, p. 10; Service 2004, p. 38). Ureta and Martorell (2009, p. 1998) report on a disturbance threshold, whereby even cacti that typically benefit from moderate disturbance are negatively impacted. Where that threshold is for *C. scheeri* var. *robustispina* is not known.

In summary, landscape-level impacts from historical livestock over-use are a stressor to *C. scheeri* var. *robustispina*, as these effects may be long-term due to slow or stagnant recovery in dry ecosystems. Overgrazed lands have altered microclimate and hydrology, increased soil compaction and erosion, reduced structural complexity and abundance of the vegetation community, and species composition; all of which can impact suitability of habitat for *C. scheeri* var. *robustispina*. Livestock may also directly impact seedlings and adult plants. Low to moderate intensity grazing may aid *C. scheeri* var. *robustispina* through the creation of open areas free of competition and with reduced fuels, but higher intensity grazing has negative impacts such as soil erosion, soil compaction, hydrologic and micro-climatic changes, and invasion or expansion of non-native grasses (Service 2000a, p. 9). Research into the relationship of grazing and *C. scheeri* var. *robustispina* is needed to determine both benefits and the threshold at which disturbance no longer benefits the taxon.

### Recreation and Border Activity

* Coryphantha scheeri* var. *robustispina* is impacted by off road vehicle use which modifies habitat and results in the destruction of cacti. Individual cacti have been observed to be run over by off road vehicles (Service 2004, p. 38). On the Coronado National Forest, *C. scheeri* var. *robustispina* occur both within and outside of an exclosure; those within are protected from direct impact from off road vehicle use common to the area. Plants occurring outside of the exclosure are subject to direct mortality or habitat destruction due to off road vehicle use. During 2015 *C. scheeri* var. *robustispina* monitoring, erosion from Forest Service Road 61 was noted within the exclosure at a known *C. scheeri* var. *robustispina* location; the plant was missing, perhaps buried under sediment or washed away (Service 2015b, p. 7).
In 2010, Schmalzel and McGibbon (2010, p. 11) noted trails, trash, human tracks, and off road vehicle tracks within the Palo Alto Pima pineapple cactus Conservation Bank. These activities were not directly impacting known *C. scheeri* var. *robustispina* plants, but contribute to the overall deterioration of the habitat. Similarly, Pima County (2015, p. 1) noted a moderate amount of immigrant traffic including trails, trash, and cut fences. They conclude that this traffic is unlikely to have resulted in measurable impacts to the *C. scheeri* var. *robustispina* population.

In summary, off road vehicle use and illegal border activity contribute to the overall degradation of *C. scheeri* var. *robustispina* habitat. In addition, individual *C. scheeri* var. *robustispina* have been run over by off road vehicles. Although these activities could impact individual *C. scheeri* var. *robustispina*, off road vehicles and illegal border activity are not likely significant sources of mortality for the taxon as a whole.

Factor B: Overutilization for commercial, recreational, scientific, or educational purposes:

A 1981 report on the status of the species states that *C. scheeri* var. *robustispina* is sought by private and commercial collectors (Phillips et al. 1981, p. 12). Reports indicate theft of this species has occurred (e.g. Kendall 1990, entire; Spiller 1996, entire, Richardson pers. comm. Feb 9, 2016). Illegal collection is among the threats discussed in the 1997 listing document (58 FR 49875, p. 49878). The listing rule examines three specific examples of plant theft and other, less verifiable, incidents are reported. Some of these incidents indicate hobbyists and commercial collectors are specifically interested in *C. scheeri* var. *robustispina*, while at other times it appears the collectors are just taking all cacti in a general area. An inquiry with the Arizona Department of Agriculture in 2015 revealed no current knowledge of a threat to this species from collection (Schade pers. comm. April 20, 2015). In early 2016 however, seven of nine individuals that had been transplanted for mitigation due to a development project, were found missing during follow-up watering visit.

In summary, in the past, illegal collection has been identified as a threat to *C. scheeri* var. *robustispina*. Although illegal collection could impact *C. scheeri* var. *robustispina*, it is unlikely a significant source of mortality for the taxon as a whole. Illegal collection is difficult to detect and only one incident has been reported in recent years. Therefore, continued outreach and education related to the issue of illegal collection remains an important tool in the conservation of this taxon.

Factor C: Disease or predation:

In general, cacti are susceptible to attacks from numerous types of insects, and *C. scheeri* var. *robustispina* is no exception (Figure 14). The interior flesh of cacti provides both a nesting area and food source for beetles, weevils, and other insects. Once an infestation has occurred, cacti can die from the eating and tunneling activities or from the introduction of fungus or disease. Drought may cause physiological stress responses in plants, such as limiting their photosynthesis and cell growth. Plants already stressed from prolonged drought are more susceptible to insect attack and disease (Mattson and Haack 1987, p. 110). Predation by mammals and insects occurs on both adult *C. scheeri* var. *robustispina* and seedlings (Phillips et al. 1981, p. 10; Mills 1991, p.
Primary insect predators of *C. scheeri* var. *robustispina* are the native *Gerstaeckeria* sp. (cactus weevil) (Schmalzel 2002, p. 3), the native *Moneilema* sp. (cactus beetle), and the native *Cactobrosis* sp. (pyralid moth) (SWCA 1999, p. 19). Cactus weevils are stem-boring insects; the adults feed externally while the larvae feed internally (Burger and Louda 1995, p. 1560). Cactus beetle adults feed on pads or terminal buds of cacti; their larvae burrow into stems or roots causing the severing of root and stem, collapse, and death of plants (Johnson 1989, p. 10; Kelly and Olsen 2011, p. 7). Pyralid moth larvae feed in the base of flower buds and tunnel into cacti plants leaving open wounds subject to bacterial infection. Zimmerman hypothesized that *Gerstaeckeria* sp. and *Moneilema* sp. have increased in numbers in recent years due to climate warming, which facilitates longer breeding cycles and more reproduction in these insect predators (Rutman 2007, p. 6). Mills (1991, p. 6) hypothesized that cactus weevils could be causing high mortality and be responsible for the low density of *C. scheeri* var. *robustispina* across the range.

Figure 14. Insect damage on *C. scheeri* var. *robustispina*, 2015. Photo by the Service.

Ants have been documented on *C. scheeri* var. *robustispina* (Mills 1991, p. 4; Baker 2011, p. 17). While ants do consume seed, they also scatter seed away from the mother plant thereby reducing predation by small mammals (O’Dowd and Hay 1980, p. 536; Vander Wall et al. 2005, p. 802). Ants may also aid in reducing the seedbank of competing plant species (O’Dowd and Hay 1980, p. 539). It was noted during 2015 monitoring of *C. scheeri* var. *robustispina* in a grassland community, that areas barren of plants (including the exotic *E. lehmanniana*) supported a greater number of both ant colonies and *C. scheeri* var. *robustispina* individuals (Service 2015b, p. 7). The harmful or helpful role of these insects remains unknown and warrants research. Predation by grasshoppers has also been observed (Figure 15).

Figure 15. Grasshoppers and ants observed on and consuming *C. scheeri* var. *robustispina*, 2003. Photo by the Service.

Predation of *Coryphantha scheeri* var. *robustispina* by mammals is well-documented. *Ammospermophilus harrisii* (Harris’ Antelope Squirrel), *Lepus alleni* (antelope jackrabbits) and *Sylvilagus audubonii* (desert cottontail) are known to eat stem material of *C. scheeri* var.
Despite the robust nature of \textit{scheeri} var. \textit{robustispina}, especially when other food sources are scarce, such as in times of drought (Phillips et al. 1981, p. 10; Mills 1991, p. 5; Schmalzal & McGibbon 2010, pp. 3, 10-11; Baker 2011, pp. 6; Service 2015a, p.1; Service 2015b, p. 2). Baker (2013, p. 4) concluded that 167 of 260 plants studied in six locations of the Altar Valley died between 2003 and 2012 from drought, rodent and insect predation, over shading, and erosion. In March 2015, researchers noted Kangaroo rat burrows and trails dominated the landscape of Pima County’s Madera Highlands Conservation Bank (Service 2015a, p. 1). Here, predation on several of the remaining living \textit{scheeri} var. \textit{robustispina} plants, as well as, other cacti in the area, was moderate to severe, even causing death (Service 2015a, p. 1).

Researchers have noted \textit{scheeri} var. \textit{robustispina} mortality caused by \textit{Pecari tajacu} (javelina) within the Buenos Aires National Wildlife Refuge (King 1993, entire; Roller and Halverson 1997, p. 12). Schmalzel (2002, p. 27) noted that \textit{P. tajacu} ranked high among mortality factors of \textit{scheeri} var. \textit{robustispina}. These and other animals can also impact cacti by digging under stems, or, at least for larger animals, knocking over or trampling stems. The impacts from \textit{P. tajacu} may be particularly important given that populations of \textit{P. tajacu} have entered Arizona only within the past few hundred years (AGFD 2015, entire) providing little time for \textit{scheeri} var. \textit{robustispina} to evolve defenses.

In summary, there are many insect and mammalian predators to \textit{scheeri} var. \textit{robustispina} adults and seedlings. Predation increases during times of drought and following damage to protective spines, such as post-fire. Many individual \textit{scheeri} var. \textit{robustispina} die or become disposed to death annually from predation which has been recorded on numerous occasions over the past decade.

**Factor D: Inadequacy of existing regulatory mechanisms:**

Approximately six percent of all known \textit{scheeri} var. \textit{robustispina} occur on the Buenos Aires National Wildlife Refuge, one percent on Coronado National Forest land, and five percent on Bureau of Land Management lands. The Act provides some protection for listed plants on land under Federal jurisdiction or on other lands. This protection includes the ability to implement conservation measures and best management practices to reduce the threats and stressors to \textit{scheeri} var. \textit{robustispina} from livestock overgrazing, urban development, recreation, border activity, and non-native plant invasion and associated alteration of fire regimes through the section 7 process.

Approximately 46 percent of \textit{scheeri} var. \textit{robustispina} occur on State Trust lands and approximately 40 percent of \textit{scheeri} var. \textit{robustispina} occur on private land. Federally-listed plants occurring on State and private lands have limited protection under the Act, unless also protected by State laws or a Federal nexus is in place, such as with federally-funded or federally-permitted projects. The Arizona Native Plant Law (Arizona Revised Statutes, Chapter 7, 2007, entire) prohibits collection without obtaining a permit on all public lands and directs that plants may not be moved off private property without contacting the Arizona Department of Agriculture. Due to the difficulty in implementing this law, it may not be effective in reducing impacts from illegal collection, nor does it protect habitat.
Approximately two percent of *C. scheeri* var. *robustispina* occur on Tribal land of the Tohono O’odham Nation. The Nation provides protection to the plant through conducting surveys prior to the implementation of any ground disturbing projects. In addition, Article 3 Section 7301 of the Tohono O’odham code states that no person shall destroy, dig up, mutilate, collect, or transport any native plant or plant part on Nation trust lands without first obtaining the required permit (TON, undated).

In summary, because most *C. scheeri* var. *robustispina* occur on private and State Trust lands, they and their habitats are not subject to Federal protection unless there is a Federal nexus to a proposed action. Habitat loss due to urbanization remains a substantial threat to *C. scheeri* var. *robustispina* on these lands. Although best management practices may be implemented with regard to livestock grazing, development, recreation, border issues, and non-native plant invasion and associated alteration of fire regimes, management is not continuous across the range of the species and *C. scheeri* var. *robustispina* remain vulnerable to these threats and stressors. There are no regulations in place that address stressors to *C. scheeri* var. *robustispina* and its habitat from predation, drought and climate change, or small population size.

**Factor E: Other natural or manmade factors affecting its continued existence:**

**Drought and Climate Change**

Cacti are vulnerable to disturbance because they grow slowly, their germination and establishment occurs with low frequency, and they have little capability to recover from disturbance (Portilla 2011, p. 509). Disturbance can reduce recruitment, survival, fecundity, and population growth; disturbance coupled with drought, however, can have greater negative impact on cacti.

Southeastern Arizona and much of the American Southwest have experienced serious drought in recent decades (Bowers 2005, p. 421; Overpeck et al. 2013, p. 3; CLIMAS 2015a, entire) and precipitation is projected to be less in the future with climate change (Seager et al. 2007, p. 1181; Karl et al. 2009, pp. 24, 33). Most climate change scenarios predict that the American southwest will also get warmer during the 21st century (Overpeck et al. 2013, p. 5; Karl et al. 2009, p. 129). The most recent water year in review (October 2011 to September 2012) indicated that drought conditions and above average temperatures were abundant throughout the southwest (CLIMAS 2012, entire). In June of 2014, it was reported that 72 percent of Arizona was experiencing severe drought, 16 percent of the state was experiencing extreme drought, and water reservoir storage levels dropped to 46 percent (CLIMAS 2014, p. 2). Also, 2014, recorded the highest temperatures in southern Arizona since record keeping began in 1881 (CLIMAS 2015b, Climate Summary). The current trend in the Southwest of less frequent, but more intense, precipitation events leading to overall drier conditions is also predicted to continue (Karl et al. 2009, p. 24).

Plants already stressed from prolonged drought are more susceptible to insect attack and disease (Mattson and Haack 1987, p. 110), and such attack is prevalent among adult *C. scheeri* var. *robustispina* across their range (see discussion above in *Factor C. Disease or Predation*). These insects may be increasing due to warmer winters in recent decades (Rutman 2007, p. 6). Predation of cacti by small mammals may also increase during drought conditions and can cause declines in *C. scheeri* var. *robustispina* populations. Drought is also directly related to *C.
scheeri var. robustispina population health with regard to reproduction and establishment. As with many cacti species, seed germination and seedling survival is dependent on precipitation (Jordan and Nobel 1981, p. 905). Even if seedbanks exist and persist, which we do not know, adequate precipitation during the seedling’s first year of growth is essential for survival (Roller 1996a, p. 38). In studies of seed germination, Roller (1996a, p. 77) found that on average 88 percent of all seed produced during the summer monsoon season germinated; however, only a small portion of the seedlings survived. Surveys show few seedlings and young juvenile plants among the C. scheeri var. robustispina population (e.g. Ecosphere Environmental Services Inc. 1995, pp. 17-21; Schmalzel 2000d, p. 5; Baker 2011, pp. 5-7).

Heat stress in adult cacti is minimal compared to other plant species, as they are able to survive heat stress due to both morphology and metabolism (Smith et al. 1984, pp. 647, 650; Wahid et al. 2007, p. 199). Extreme temperatures can, however, negatively impact seedling survival in many Sonoran Desert plants, and drought coupled with high temperatures lessens temperature tolerance in seedlings (Nobel 1984, pp. 310, 316).

In summary, since the late 1990s, the southwestern United States has been experiencing drought conditions and increasing high temperatures. Climatic predictions suggest continued less frequent, but perhaps more intense, summer precipitation, reduced winter precipitation, and increasing temperatures in this region (Seager et al. 2007, p. 1181; Archer and Predick 2008, pp. 23–24; Karl et al. 2009, p. 24). Drought and increased temperatures increase C. scheeri var. robustispina stress, reduce defenses to predation and disease, and reduce reproduction, among other impacts. These impacts will continue to affect C. scheeri var. robustispina and its habitat throughout its range into the foreseeable future.

**Small Population Size and Isolation**

High community diversity is important to the survival of C. scheeri var. robustispina, as this cactus is not abundant enough to sustain its main pollinators. A key pollinator for C. scheeri var. robustispina is a bee, Diadasia rinconis, which requires species of Cylindropuntia, Opuntia, and Ferocactus to survive (McDonald and McPherson 2006, p. 33; Blair and Williamson 2008, p. 428). McDonald (2005, p. 29) found that under favorable circumstances certain C. scheeri var. robustispina pollinators could transport pollen up to 1.2 kilometers (3,937 feet), but most pollen only travels less than 900 meters (2,952.8 feet) (McDonald 2005, p. 29). He also concluded that C. scheeri var. robustispina individuals start to become isolated from potential pollination after 600 meters (1,968.5 feet) and are likely to be completely isolated after 900 meters (2,952.8 feet) where they are likely to become genetically isolated with higher likelihood of inbreeding (McDonald 2005, p. 30). Fehlberg and Nidey noted that cacti species, even rare species, may have higher levels of heterozygosity and outcrossing, in general, with C. scheeri var. robustispina being no exception (Fehlberg and Nidey 2015, p. 7). Habitat fragmentation reduces the likelihood of successful pollination as C. scheeri var. robustispina become more and more isolated from one another and plant community diversity is reduced. Over time, this process could lead to loss in heterozygosity and the variability needed for adaptation to changing conditions, seed production and viability, and eventually extinction. In addition, the small number of individuals located in southern Arizona and northern Sonora makes C. scheeri var. robustispina vulnerable to catastrophic events, such as regional drought.
In summary, \textit{C. scheeri} var. \textit{robustispina} is a sparsely distributed plant that requires habitat connectivity and proximity to other plants for effective pollination. Large scale threats and stressors such as habitat degradation and regional drought increase the potential for isolation and genetic loss. Current information indicates that roughly 98 percent of all known \textit{C. scheeri} var. \textit{robustispina} occur within 900 meters (2,952.8 feet) of one another. Should development or other threats or stressors remove or cause the deterioration of corridors and connectivity, this could result in genetic isolation and inbreeding.

9. Past Conservation Efforts

The following are conservation efforts that have occurred since \textit{C. scheeri} var. \textit{robustispina} was listed in 1993:

1) The government of Pima County began developing the Sonoran Desert Conservation Plan in 1998 and has been implementing the plan since 2001 (Pima County 2000, entire). The plan was developed to conserve habitats and protect endangered species, while at the same time allowing development to continue on private lands. A main component of the Sonoran Desert Conservation Plan is the Multi-species Conservation Plan, which is targeted for finalization in 2016. This document includes specific conservation measures to help ensure the long-term conservation of 44 endangered or at risk plant and animal taxa, including \textit{C. scheeri} var. \textit{robustispina} (Pima County 2010, entire). Through these planning efforts, Pima County owns or holds a grazing lease to the following properties, all of which contain \textit{C. scheeri} var. \textit{robustispina}: Marley Ranch, Rancho Seco, Sopori Ranch, and Canoa Ranch, as well as, portions of Buckelew Farm, the King 98 Ranch, and the Diamond Bell Ranch. Each area is used for minimal recreation, as open space, and for cattle grazing according to a strict set of standards and guidelines (Pima County 2010, p. A-182).

2) In 2002, the Palo Alto Conservation Bank was created on 411.2 hectares (1,016 acres) of land in the Altar Valley of southeastern Arizona. This privately-owned conservation bank protects, in perpetuity, this area of habitat set aside for the preservation of \textit{C. scheeri} var. \textit{robustispina}. Landowners, municipalities, and developers are able to purchase habitat conservation credits to offset the loss of \textit{C. scheeri} var. \textit{robustispina} and their habitat by development and other land uses.

3) In 2006, Pima County established a \textit{C. scheeri} var. \textit{robustispina} mitigation bank on 214 hectares (529 acres) divided into two subunits (Pima County 2006, p. 1). Pima County Natural Resources Parks and Recreation is responsible for managing the parcels and monitoring the cacti. Landowners, municipalities, and developers are able to purchase habitat conservation credits to offset the loss of \textit{C. scheeri} var. \textit{robustispina} and their habitat by development and other land uses.

4) The City of Tucson’s Draft Greater Southlands Habitat Conservation Plan, if finalized, could be important for the preservation of large tracks of \textit{C. scheeri} var. \textit{robustispina} habitat. The Greater Southlands Habitat Conservation Plan Planning Area includes approximately 52,600 hectares (130,000 acres) of developed and undeveloped land within and outside of the current city limits and encompasses much of the northeastern portion of the geographic range for \textit{C. scheeri} var. \textit{robustispina}. This document proposes to set aside Important Riparian Areas and
Biological Core Management Areas that could include valuable *C. scheeri* var. *robustispina* habitat in terms of numbers of individuals, diversity of occupied habitats, and providing a corridor for pollinators and gene flow.

5) The Buenos Aires National Wildlife Refuge in the Altar Valley of southeastern Arizona supports *C. scheeri* var. *robustispina* individuals. Here, the cacti are mostly found in the grasslands, where the main threats to their survival are non-native grasses and wildfire and/or prescribed fire. Refuge personnel contribute to conservation works by protecting all known *C. scheeri* var. *robustispina* from any prescribed burn activity (58FR 49875, pp. 49875-49876).

6) The Arizona Sonora Desert Museum stores the seed of *C. scheeri* var. *robustispina* for conservation and education purposes, and maintains approximately 36 individuals growing on their grounds and in greenhouses (Montgomery 2012, p. 1). The Pima County Natural Resources, Parks and Recreation Native Plant Nursery obtained 6 individual plants in 2014 which are used for educational purposes (Byrd pers. comm. July 10, 2014).

7) Research into transplanting *C. scheeri* var. *robustispina* as a conservation measure is ongoing and results thus far have been mixed. For example, in 1996, 47 individual *C. scheeri* var. *robustispina* were transplanted to three sites in the Santa Cruz Valley (McIntosh and Baldwin 2001, p. 3). These plants were last monitored in 2001, when at two of the sites relatively few individuals had died, yet all individuals (24) had died at the third site. These plants had been bare rooted and hardened off under shade. Schmalzel (2000a, p. 14) found that bare-rooted individuals had appreciable loss of weight and this should be considered in salvage efforts. Prior to another construction project between 2004 and 2005, during development and construction activities at a site near Tucson, 81 individual *C. scheeri* var. *robustispina* were transplanted (Westland 2014, p. 2). These individuals were watered in June of 2006 and were monitored periodically thereafter (Westland 2014, p. 3). In 2008, 43 transplanted individuals were still alive; in 2012, 28 of these were still alive (Westland 2014, p. 4). These plants will be monitored again in 2016.

In 1999, 46 *C. scheeri* var. *robustispina* were bare-rooted and transplanted due to a construction project and their status checked a few months later; 4 individuals had perished (SWCA 2000, p. 5). Similarly, in very preliminary research just six months following transplanting, Schmalzel (2000c. p. 12) found that 6 of 6 transplanted adults had survived and one was producing fruit. Neither of these transplant projects was followed over time, and the ultimate survival or mortality, as well as, reproductive potential post-transplant remain unknown. In 2005, 21 *C. scheeri* var. *robustispina* were transplanted beneath several mesquite trees on private property near Tucson (Westland 2006, p. 1). In 2015, personnel from Pima County located 19 of these individuals and noted that not only had they survived for ten years, many had pups, flowers, and or fruits (Powell and Rice 2015, pp. 1-2). Unfortunately, the circumstances of the initial transplant were not recorded, so we are unable to replicate their method.

Recent studies within the Pascua Yaqui tribal *C. scheeri* var. *robustispina* conservation land (a 13.8 hectare [34 acre] parcel set aside to mitigate *C. scheeri* var. *robustispina* loss on tribal land) and the Sierreta Pipeline transplanting site (part of mitigation measures for the creation
of the pipeline through *C. scheeri* var. *robustispina* habitat) will provide much needed information on the possibility of transplanting as a tool for conservation.

A possible alternative to transplanting is the sowing of seeds directly in the field (*in situ*) and covering them with hardware cloth to prevent predation. This method has shown some success (Schmalzel 2000a, pp. 13-14; Service 2015b, pp. 3-4), but more research is needed. The substrate seeds are sown onto also needs further examination. For example, preliminary work by Schmalzel (2000c, p. 12) indicated that germination occurred in 4 of 8 cages where seeds were sown on soil with a thin crust of cyanobacteria. In this same work, no seeds germinated from 16 cages where seeds were sown on either coppice mounts or sandy shifting soil.

**Part II. Recovery**

1. **Recovery Strategy**

The principle *C. scheeri* var. *robustispina* recovery strategy is to preserve and restore quality habitat to protect individuals and their associated seedbanks within two recovery units representing the range of the taxon. The two recovery units center on the Altar and Santa Cruz Valleys of southeastern Arizona. The major threats within the Altar Valley Recovery Unit, which is managed primarily for livestock grazing, include the spread of invasive, non-native grasses and the resultant altered fire regimes and increased competition. A major threat within the Santa Cruz Valley Recovery Unit, which includes Tucson, Nogales, and the urban areas between, is urbanization.

Throughout the entire range, *C. scheeri* var. *robustispina* is stressed by drought and climate change impacts, as well as predation by mammals and insects. The preservation and restoration of habitat within these two recovery units will promote a stable, self-sustaining population to persist with some level of connectivity between individuals, and provide opportunities for population expansion.

To be deemed stable and self-sustaining, the population must demonstrate positive population growth over a 15-year period, showing evidence of natural reproduction and establishment. The recovery strategy entails minimizing or ameliorating the most significant long-term threats to the continued existence of the taxon, which are: 1) habitat loss due to mining and urbanization and 2) non-native plant competition and alteration of fire regimes. Additional efforts will focus on improving the baseline understanding of *C. scheeri* var. *robustispina* ecology, distribution, and threats, as well as, reducing the impacts of stressors such as drought and climate change, predation by mammals and insects, recreation and border activity, and livestock overgrazing.
2. Recovery Goal

The ultimate goal of this recovery plan is to outline specific actions that, when implemented, will sufficiently reduce the threats and stressors to *C. scheeri* var. *robustispina*, ensure its long-term viability in the wild, and improve its status to the point that protection under the Act is no longer necessary.

3. Recovery Objectives

Major Objectives:

1) **Threat-based objective:** Reduce or mitigate habitat loss and degradation, non-native species spread and the resultant altered fire regimes and increased competition, and stressors, to enhance the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

2) **Habitat-based objective:** Conserve, restore, and properly manage the quantity and quality of habitat needed for the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

3) **Population-based objective:** Conserve, protect, and restore existing and newly discovered *C. scheeri* var. *robustispina* individuals and their associated seedbanks needed for the continued survival of the taxon. The population must be self-sustaining, of sufficient number to endure climatic variation, stochastic events, and catastrophic losses, and must represent the full range of the species’ geographic and genetic variability.

Detailed Objectives:

1) **Threat-based objectives.**

   **Listing Factor A (habitat loss and degradation).**

   1.1 Prevent the net loss or significant degradation of habitat within the population of *C. scheeri* var. *robustispina* and its pollinators. Loss or degradation of some occupied habitats may be mitigated by a proportional increase or improvement of other occupied habitats; this may be accomplished through improved management, the in-perpetuity protection of existing occupied habitat, successful habitat restoration, or the discovery of new occupied habitats.

   1.2 Reduce impacts from non-native plant invasion. Currently, the principle non-native species threats to *C. scheeri* var. *robustispina* are *E. lehmanniana* and *P. ciliare*. Work toward developing methods of habitat restoration in lands infested with these and other non-native species.

   **Listing Factor B (over-utilization).**

   1.3 Prevent depletion of extant *C. scheeri* var. *robustispina* population and associated soil-seed bank. Seed collection, propagation, augmentation, and reintroduction efforts must comply with Service policy on controlled propagation of endangered species (Service 2000b, entire), including the prior establishment of a controlled propagation and reintroduction plan.

   **Listing Factor C (disease and predation).**
1.4 A *C. scheeri* var. *robustispina* monitoring protocol will be developed and implemented to monitor for ongoing predation.

1.5 If excessive predation impact is occurring, individual *C. scheeri* var. *robustispina* plants may be protected with wire cages, hardware cloth, or other means of protection, as appropriate.

Listing Factor D (The inadequacy of existing regulatory mechanisms).

1.6 Protect *C. scheeri* var. *robustispina* in the United States through the Act. When delisted, the continued status of the taxon should be tracked according to a post-delisting monitoring plan.

1.7 Collaborate and communicate with Tribal and State scientists, conservation planners, and private land owners to promote the species’ conservation on State and private lands; seek information on the species status on Tribal and private lands.

1.8 Collaborate and communicate with Mexican government agencies, scientists, and conservation organizations to promote the species’ conservation in Mexico; seek information on the species status and protection in Mexico.

Listing Factor E (other natural or man-made factors).
The population-based objectives below apply also to Factor E.

2) **Habitat-based objectives.**

Listing Factor A (habitat loss and degradation)

2.1 Determine the climate, soils, hydrology, and associated vegetation of *C. scheeri* var. *robustispina* habitat to guide surveys and conservation.

2.2 Increase the amount of protected *C. scheeri* var. *robustispina* habitat through acquisition of land for conservation purposes, successful habitat restoration on protected lands, or improved management and protection of existing habitat.

2.3 Alleviate habitat fragmentation and isolation and increase pollinator corridor protection. Habitats must be large enough to support healthy pollinator populations and allow for gene flow among neighboring individuals. Ideally, *C. scheeri* var. *robustispina* habitats are intact or restored to optimal or good condition, and these lands are managed for conservation of native flora and fauna and contain associated cacti species required by pollinators. Areas of smaller, protected, habitat patches may be considered suitable through linkage by intact or restored ecological corridors sufficient to allow passage of the insect pollinators of *C. scheeri* var. *robustispina* between habitat blocks.

2.4 Determine the best habitat management practices, and implement these practices where this is possible. Document the effects on *C. scheeri* var. *robustispina* habitat by wildfire and
prescription fire, non-native plant invasions, livestock grazing, and off road vehicle use.
Implement best management practices where suitable habitat occurs on lands under Federal
jurisdiction, and provide technical assistance and incentives to implement these practices on
suitable habitat not under Federal jurisdiction.

3) Population-based objectives.

Listing Factor E (other natural or man-made factors)

3.1 Encourage scientific study to improve our understanding of *C. scheeri* var. *robustispina*
biology, ecology, abundance, status, threats and stressors, viability, propagation, restoration
of individuals and of habitat, distribution, and genetics in the United States and Mexico.
Develop effective methods of survey and coordinate surveys by qualified individuals in
potential habitats throughout southern Arizona and northern Sonora, Mexico to demonstrate
the species’ presence and abundance or absence. Report on the associated species, habitats,
ecology, and threats and stressors to *C. scheeri* var. *robustispina*. Surveys may be conducted
on public lands and where private landowners and *ejidos* have granted permission for this
purpose.

3.2 To determine long-term population trends, conduct long-term monitoring of *C. scheeri*
var. *robustispina* individuals (e.g. size, health, phenology, etc.), habitat characteristics (e.g.
associated species cover, soil moisture, solar radiation, etc.), and threats and stressors (e.g.
non-native plants, fire, predation, trampling, soil compaction, soil erosion, etc.). Ensure
monitoring of transplanted individuals, plants grown *in situ*, and plants that have experienced
disturbances such as fire and non-native invasion. Monitor the impacts of habitat restoration
on individual *C. scheeri* var. *robustispina* plants. Monitoring may be conducted on public
lands and where private landowners and *ejidos* have granted permission for this purpose.
Monitoring must be carried out in a manner that minimizes potential negative impacts on the
species and its habitat. Written agreements to continue monitoring after downlisting must be
in place.

3.3 Prevent a net loss or decline of documented *C. scheeri* var. *robustispina* plants through
improved management, protection, and augmentation of the existing population, successful
reintroduction of plants, or the discovery of new plants. Augmentation and reintroduction
must comply with Service policy on controlled propagation of endangered species (Service
2000b, entire), including the prior establishment of a controlled propagation and
reintroduction plan.

3.4 Prevent the depletion of genetic diversity within the *C. scheeri* var. *robustispina*
population resulting from inbreeding depression (when closely related individuals mate and
offspring have high chance of maintaining disadvantageous traits), outbreeding depression
(when non-closely related individuals mate and fitness is low), genetic swamping (when
genes from one group dominate over another group), or other factors. This objective requires
a thorough understanding of the species’ reproductive biology, pollination and pollinators,
breeding system, and genetic variation within the population. This factor also requires the
preservation of connectivity between individuals within the population.
3.5 Increase the number of protected plants to confer the resiliency, redundancy, and geographic and genetic representation necessary for the continued survival of *C. scheeri* var. *robustispina*. This objective may be reached largely through the conservation of land containing suitable habitat for the taxon. This objective may be reached in part by augmenting the natural population and by reintroducing plants onto protected land, within the species’ range and known habitat types, in accordance with the Service policy on controlled propagation of endangered species (Service 2000b, entire) and a controlled propagation and reintroduction plan.

3.6 Determine the best *C. scheeri* var. *robustispina* management practices and implement these practices where this is possible. Document threats and stressors and monitor their effects on *C. scheeri* var. *robustispina* plants by both proactive and reactive actions, such as wildfire, non-native plant invasion, and predation by mammals and insects. Implement best management practices where plants occur on lands under Federal jurisdiction, and promote these practices on populations not under Federal jurisdiction.

3.7 Establish plants at botanical gardens for research, recovery, and educational purposes, and maintain seeds for conservation and recovery at seed storage facilities.

3.8 Develop public outreach, collaborative partnerships, agency management plans, and agreements with private land owners in the United States and Mexico that encourage *C. scheeri* var. *robustispina* conservation.

4. Recovery Criteria

Recovery criteria are the objective, measurable criteria that, if met, provide a basis for determining whether a species can be considered for reclassification (downlisting to threatened status or removing it from the list of threatened and endangered species [delisted]). Because the same five statutory factors must be considered in delisting as in listing, 16 U.S.C. § 1533 (a),(b),(c), the Service, in designing objective, measurable criteria, must address each of the five statutory delisting factors and measure whether threats and stressors to the *C. scheeri* var. *robustispina* have been ameliorated (see Fund for Animals v. Babbitt, 903 F. Supp. 96 [D.D.C. 1995]).

**Downlisting of Coryphantha scheeri var. robustispina** to threatened status may be considered when all of the following conditions have been met to address the threats and stressors to the species:

1. **Threat-based objective:** Reduce or mitigate habitat loss and degradation, non-native species spread and the resultant altered fire regimes and increased competition, and stressors to enhance the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

   **Criterion:** The successful accomplishment of threat and stressor reduction and mitigation is demonstrated by an increased number of acres of optimal or good *C. scheeri* var. *robustispina* habitat (see “Habitat-based objective” for details). Habitat is considered optimal when: it is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of *C. scheeri* var. *robustispina*; it has less than 20 percent cover of non-native plant species; it contains contiguous habitat and corridors for pollinators;
and where *C. scheeri* var. *robustispina* numbers are observed to be stable or increasing and remain that way. Habitat is considered good when the cover of non-native plants remains between 20 and 35 percent and the land is managed in such a way that promotes the continued existence or expansion of the *C. scheeri* var. *robustispina* population.

**Justification:** Accomplishment of this criterion depends on successful promotion of habitat conservation (e.g. land preservation, conservation banking, and strategic habitat restoration) and land management planning to reduce threats and stressors to *C. scheeri* var. *robustispina* (e.g. non-native species management and restoration, land use planning, and soil compaction and erosion prevention) on all lands where *C. scheeri* var. *robustispina* occur. Threats to habitat quality may occur at low levels without significant impact to *C. scheeri* var. *robustispina*, but at some unknown threshold, these threats may reduce the ability of habitat to provide sufficient resources for survival and reproduction. When severe, these threats to habitat quality may render the habitat unsuitable for use by *C. scheeri* var. *robustispina*, although thresholds are unknown. *Coryphantha scheeri* var. *robustispina* populations would remain vulnerable to extinction as long as threats to their habitat remain in place. Non-native plant invasion and altered fire regimes, commercial and residential development, unmanaged grazing, drought and climate change, and unauthorized or excessive off-highway routes and trails are the most likely threats to *C. scheeri* var. *robustispina* habitat quality.

2. **Habitat-based objective:** Conserve, restore, and properly manage the quantity and quality of habitat needed for the continued survival of *C. scheeri* var. *robustispina* and its pollinators.

**Criterion:** At least 8,094 hectares (20,000 acres) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be in optimal condition and remain that way. At least 24,281 hectares (60,000 acres) of *C. scheeri* var. *robustispina* habitat per recovery unit are documented to be in good condition and remain that way. Collectively, this represents approximately 43 percent of the known range of *C. scheeri* var. *robustispina*. Additional acres of lesser quality *C. scheeri* var. *robustispina* also exist throughout the range of the species; some of which occurs on lands where ongoing efforts may continue to improve habitat quality. While no analysis exists which can help us estimate the total acres of habitat needed to support a viable *C. scheeri* var. *robustispina* population, we believe that achieving the above targets of optimal and good habitat could significantly improve the conservation trajectory and status of this taxon to the point of downlisting under the Act.

**Justification:** *Coryphantha scheeri* var. *robustispina* plants that occur in optimal or good condition habitats, as defined above, should have the greatest resistance to non-native plant invasion and associated high severity fire, as well as, climatic extremes and other threats or stressors. We expect that these habitats will have healthy pollinator populations that enable gene flow between *C. scheeri* var. *robustispina* individuals, thus maintaining their long-term genetic diversity.

3. **Population-based objective:** Conserve, protect, and restore existing and newly discovered *C. scheeri* var. *robustispina* individuals and their associated seedbanks needed for the continued survival of the taxon. The population must be self-sustaining, of sufficient number to endure
climatic variation, stochastic events, and catastrophic losses, and must represent the full range of the species’ geographic and genetic variability.

**Criterion:** Protect mature *C. scheeri* var. *robustispina* individuals and their associated seedbanks in each recovery unit. Quantitative monitoring of established plots across a variety of land ownerships and with landowner support is conducted within each of the two recovery units every 3 to 5 years with plots demonstrating that the overall population is increasing a minimum of 10 years over a 15 year period.

**Justification:** A mature individual is one that is capable of flowering and producing viable seed. Only mature individuals are considered in meeting this criterion, since large numbers of *C. scheeri* var. *robustispina* seeds may germinate following sporadic rainfall but not live long enough to reproduce. The number of monitoring plots and transects and their locations will be determined within a monitoring plan to be written within five years of the finalization of this document. The 15-year time frame reflects the minimum period required to judge whether a population is stable, declining, or increasing. Due to the wide variation in the region’s annual rainfall and the frequencies of severe droughts and freezes, populations will naturally fluctuate. The numbers of individuals during a single year or short span of years may provide a skewed representation of a population’s longer-term trend.

To delist *C. scheeri* var. *robustispina*, the first two criteria for downlisting must be met or surpassed, and monitoring must demonstrate that the population is increasing for a minimum of 20 years over a 30 year period.

**5. Recovery Action Outline and Narrative**

The recovery action outline and narrative below lists actions, including site-specific management actions, required to meet the recovery objectives of this recovery plan. Please refer to Table 1 for a clear association among threats, stressors, and recovery actions.

1) **Conserve existing and newly discovered *C. scheeri* var. *robustispina* and associated habitat, including unoccupied areas that provide habitat and connectivity for pollinators.**

   a) Promote urban planning for compact urban development, increase open space preservation, and connective habitat corridors.

   Collaborations such as Pima County’s Sonoran Desert Conservation Plan and Multi-Species Conservation Plan are essential for planning for development within *C. scheeri* var. *robustispina* in the United States. The human population of Pima County is expected to increase by one third in the next 35 years; development planning, including a better understanding of the role and value of open space preserved within developments, especially in the areas of Tucson and the Santa Cruz Valley, are essential to the conservation of this taxon.

   b) Engage in land acquisition to reduce habitat fragmentation and increase connectivity.
Tools for the protection of *C. scheeri* var. *robustispina* on privately-owned lands may include the purchase and management of such lands by government agencies or other conservation partners. Management of acquired properties would prohibit habitat conversion to urban uses. Managers would also develop and implement management plans promoting the conservation of *C. scheeri* var. *robustispina*. Potential sources of funding for the purchase of such properties include section 6 acquisition funds for habitat conservation plans, bond monies through county governments, or Wildlife Refuge acquisition funds.

c) Develop conservation easements for the protection of *C. scheeri* var. *robustispina* on private lands.

The protection of *C. scheeri* var. *robustispina* on privately-owned lands may also occur through the voluntary donation or sale of a conservation easement by a willing landowner to a qualified non-profit organization or branch of government. In a conservation easement, the land remains in private ownership with landowners in full control of their property. The deed of easement will, however, identify compatible and incompatible land uses and other management considerations for the taxon and its habitat. At a minimum, the deed of easement must prohibit habitat conversion to urban uses within *C. scheeri* var. *robustispina* habitat. Such lands must be covered by a management plan with best management practices that benefit *C. scheeri* var. *robustispina*.

d) Develop and monitor conservation mitigation banking to promote the protection of *C. scheeri* var. *robustispina* habitat.

Conservation mitigation banks aid in the protection of *C. scheeri* var. *robustispina* habitat that is being lost to urban development and other threats and stressors. Such banks offer a market framework where the purchase of conservation bank credits for project-related impacts can be offset through a one-time credit purchase. There are currently two *C. scheeri* var. *robustispina* banks in place.

2) **Restore functional *C. scheeri* var. *robustispina* habitat in the U.S. and Mexico.**

a) Develop and implement land management plans that support and promote the taxon, including through the reduction of non-native plant species and unnatural fire regimes, soil erosion, soil compaction, and headcutting.

Management plans will include provisions, as appropriate, for habitat maintenance and restoration including decrease in cover of non-native plants, remediation of unnatural fire regimes and the development of natural refugia, increased soil retention and water infiltration, decreased soil compaction and erosion, minimization of mechanical damage to plants, and identification of locations suitable for transplanting or growing cacti from seed.

In particular, non-native plants put undue stress on *C. scheeri* var. *robustispina* and its habitat by competing for light, water, and nutrients, as well as by altering the fire regime and reducing available refugia. Efforts should be made to prevent further introduction or
spread of non-natives in systems that support *C. scheeri* var. *robustispina*. Whenever possible, established non-native plants should be removed from systems that support *C. scheeri* var. *robustispina* and landscapes restored to promote native species and ecosystem function.

Management actions must be monitored (pre- and post-, when possible) to assess their effectiveness or discover unintended consequences. Management plans shall be modified if they are unsuccessful at providing protection and promoting recovery of *C. scheeri* var. *robustispina* and its habitat. This will facilitate the implementation of an adaptive management approach to recovery.

b) Work toward a better understanding of transplanting and seeding requirements for *C. scheeri* var. *robustispina* which could be implemented in appropriate habitat.

Past efforts to transplant individual *C. scheeri* var. *robustispina* to other locations have had limited success. As such, the Service does not currently consider transplanted *C. scheeri* var. *robustispina* as functional in their environment. Development of tested protocols that obtain high transplant success rates are needed. In addition, development of tested protocols for growing cacti from seed *in situ* in appropriate habitat that is managed for the conservation of the taxon, are needed.

3) **Develop range-wide standardized long-term monitoring of individuals in established plots, as well as their habitats, threats, and stressors.**

a) Monitor individuals in established plots across the range of the taxon using a tested standard protocol to enable an understanding of the long-term trend of the species, its habitat, threats, and stressors.

Develop and test a range-wide standardized long-term monitoring approach that will be adopted by all land managers, land owners, and conservation partners which will enable an understanding of current status and knowledge of when recovery criteria have been met. This will include: 1) timing of survey, 2) protocol for surveying and measuring individuals and their habitats, and 3) assessing the health of plants, threats, and stressors. Monitoring should also include pollinators, predators, climate, and other factors that may be influencing the taxon. Monitoring must be carried out in a manner that minimizes potential negative impacts on the species and its habitat. Written agreements to continue monitoring after downlisting must be in place.

b) Check the effectiveness of management actions by monitoring individuals subjected to natural and prescribed fire, mechanical site disturbance, various grazing regimes, various restoration techniques, and other management considerations.

Monitoring of plants that have experienced disturbance should take place at least every 3 years over a period of 15 years and, whenever possible, include pre-disturbance monitoring.
c) Monitor in situ grown and transplanted individuals for effectiveness of sowing, planting, and transplanting protocols.

Plants grown in situ or transplanted to a new location should be monitored at least every 3 years over a period of 15.

4) **Encourage scientific study to improve our understanding of** *C. scheeri* var. *robustispina* **biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitats, distribution, and genetics in the United States and Mexico.**

a) Identify information gaps, compatible land uses, threats, stressors, and appropriate management actions that lead to the conservation of the taxon.

It is important to identify gaps in our current understanding of the taxon and how it relates to certain land management practices. Such information will inform better management of the taxon for its continued protection and recovery. For example, we currently lack adequate information related to the threshold at which disturbances such as cattle grazing are beneficial or detrimental to the taxon, the impact of natural and prescribed fire in relation to non-native grasses and fire-free microsites, the impacts of drought, illegal collection, off road vehicles, mining, and other threats and stressors.

b) Conduct surveys in appropriate habitat, using a tested standard protocol, to better understand the geographic range and habitat requirements of the taxon.

There is potential habitat in both the United States and Mexico that has not been surveyed for the presence of *C. scheeri* var. *robustispina*. Additional surveys are needed and repeated surveys or monitoring conducted to confirm continued presence at known locations.

c) Conduct research related to the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of the taxon.

Although we currently know more about *C. scheeri* var. *robustispina* than at the time of listing, there remains a great deal about the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of this taxon that we still do not understand. Examples of research that is needed to help recover this species include:

i) how long this taxon is able to withstand drought (seedbank longevity, predation impacts, desiccation, etc.)

ii) what is the relationship of the taxon to natural and prescribed fire in non-native invaded landscapes,

iii) what is the threshold at which disturbance negatively impacts the taxon,

iv) what is the tolerance of the taxon to grazing, trampling, soil compaction, and soil erosion,
v) what are the most cost-effective and appropriate methods of habitat restoration in non-native invaded landscapes? E.g. can the use of mycorrhizae or soil bacteria aid in restoration of *Eragrostis*-dominated grasslands,

vi) what is the relationship of the taxon to ants, jackrabbits, and other predators or dispersal agents, and

vii) what is the minimum patch size and degree of connectivity needed for this taxon to persist?

5) **Maintain plants in captivity at botanic garden and seeds at seed storage facilities; encourage research into propagation, in situ seed planting, and transplanting methods.**

a) Promote the propagation and planting of individuals *ex situ* at botanic gardens for conservation and public education purposes.

Botanic gardens are protected and carefully managed areas that provide a last resort option for protecting individual plants threatened with habitat destruction. Botanic gardens also serve the important purpose of educating the public regarding threatened and endangered plants, and are sources of research, especially regarding genetics, propagation, and transplanting techniques.

b) Maintain seed from plants across the geographic range of the taxon for conservation purposes.

Ensure that seed is collected following the Center for Plant Conservation guidelines, is collected across both wet and dry years, and from a variety of geographic areas to ensure maximum genetic variability. Seed should be stored at both the Agricultural Research Service National Center for Genetic Resources Preservation in Fort Collins, Colorado and stored according to protocols at a local facility such as the Arizona Sonora Desert Museum in Tucson, Arizona. In accordance with protocol, seed would be tested regularly for viability and replaced as necessary. Seeds would be used for research, seed banking, augmentation, and reintroduction.

c) Develop effective approaches to *in situ* conservation.

Because transplanting success has historically been variable, transplant methodology and *in situ* planting of seed in the field using hardware cloth or other techniques warrant further examination.

6) **Develop public outreach, collaborative partnerships, and agreements with private land owners in the United States and Mexico that encourage *C. scheeri* var. *robustispina* conservation.**

a) Increase public outreach regarding threats, stressors, and conservation measures relating to *C. scheeri* var. *robustispina* in both the United States and Mexico.

Work with both United States and Mexican government agencies, academic institutions, non-government organizations, and private citizens to promote public outreach and

b) Develop collaborative partnerships and agreements with private land owners that result in management plans or that otherwise encourage *C. scheeri* var. *robustispina* conservation in the United States and Mexico.

Develop partnerships with both United States and Mexican government agencies, academic institutions, non-government organizations, and private citizens to promote study, conservation, and recovery of the taxon throughout its range. The creation and adherence to management plans that address threats and stressors are necessary to protect the taxon and its habitat. Plans should include prescriptions to protect *C. scheeri* var. *robustispina* from habitat degradation, non-native plant species, and that address restoration of habitat and the timing and intensity of prescribed burns.

c) Develop a recovery implementation team comprised of species experts, agency and non-government agency partners, landowners, and stakeholders to meet regularly, review progress, discuss problems, and revise this plan as needed.

This plan may need to be revised to address changing conditions, incorporate new findings, and update recovery actions. To ensure plan use and usefulness, the involvement of an implementation team is suggested.
Part III. Implementation

The following implementation schedule is comprised of three overarching elements that then tier down to individual recovery actions for implementation. The implementation schedule outlines actions and estimated costs for this draft recovery plan. It is a guide for meeting the objectives discussed in Chapter II. This schedule also prioritizes actions, provides an estimated timetable for performance of actions, and proposes the responsible parties for actions. For the sake of brevity in the Implementation Schedule, annual costs are shown for the first 5 years, along with an estimated total cost over a 20 year period. Actions are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. The most detailed actions are assigned a priority number for implementation. The actions in the Implementation Schedule, when accomplished, should result in the recovery and conservation of the species.

Key to Terms and Acronyms Used in the Recovery Action Narrative and Implementation Schedule:

Priority numbers are defined per Service policy (Service 1983) as:

**Priority 1:** An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

**Priority 2:** An action that must be taken to prevent a significant decline in the species population/habitat quality or some other significant negative impact short of extinction.

**Priority 3:** All other actions necessary to provide for full recovery of the species.

**Definition of Action Durations:**

**C = Continual** - An action that may not be currently underway, but will be implemented throughout the 20 year recovery period on a routine basis, once initiated.

**I = Initial** – An action that will be done initially once the recovery plan is adopted.

**P = Periodic** – An action that will be done periodically or on a rotating basis, such as monitoring.

**5 = Every 5 years** – An action that will be done every five years, such as the review of the status of the species.

**TBD:** To Be Determined.
Responsible Parties:

ADOT       Arizona Department of Transportation
ALWT       Arizona Land and Water Trust
ARS        Agricultural Research Service
ASDM       The Arizona Sonora Desert Museum
ASU        Arizona State University
BLM        Bureau of Land Management
DBG        The Desert Botanical Garden
FWS        United States Fish and Wildlife Service
GOV        State or local governments and municipalities
NGO        Non-government organization
PYT        Pascua Yaqui Tribe
PVT        private citizens
SNAT       Secretaría de Medio Ambiente y Recursos Naturales
TNC        The Nature Conservancy
TON        Tohono O’odham Nation
UA         University of Arizona
USFS       United States Forest Service
USGS       United States Geological Survey
UNAM       Universidad Nacional Autónoma de Mexico
USON       Universidad de Sonora

Responsible parties are those agencies who may voluntarily participate in implementation of particular actions listed within this draft recovery plan. Responsible parties may willingly participate in project planning, or may provide funding, technical assistance, staff time, or any other means of implementation; however, responsible parties are not obligated to implement any of these actions. Other parties are invited to participate in the recovery of *C. scheeri* var. *robustispina*, as well.
Implementation Schedule.

Costs are shown in 1,000s of dollars; Total Cost is shown for a 20 year period. Total cost over a 20 year period is $62,910,560.

The importance of preserving functional *C. scheeri* var. *robustispina* habitat, including corridors for pollinators, in the United States cannot be overstated in the recovery of this and co-occurring listed species. The Pima County Association of Governments (2013, entire) projects current population of Pima County, where most *C. scheeri* var. *robustispina* occur, is 1,008,442 and it will rise to 1,518,154 by 2050. This projection emphasizes the need for urban development planning to concentrate development near urban areas and provide for conservation lands and corridors. It also emphasizes the need to restore existing *C. scheeri* var. *robustispina* habitat.

Restoring and preserving desert-scrub and desert-grassland will benefit *C. scheeri* var. *robustispina* and many other co-occurring listed and unlisted plant and animal species, ecosystem services provided by healthy landscapes, and economic benefits such as from increased tourism. Actions taken to improve desert-scrub and desert-grassland habitats for *Gopherus morafkai* (Sonoran desert tortoise), *Glaucidium brasilianum cactorum* (cactus ferruginous pygmy-owl), *Leptonycteris curasoae yerbabuenae* (lesser long-nosed bat), and the *Colinus virginianus ridgewayi* (masked bobwhite) would benefit *C. scheeri* var. *robustispina*; therefore, costs listed below may not reflect the actual cost of recovery as such costs may be distributed across a variety of efforts targeting desert-scrub and desert-grassland restoration, reducing the recovery cost per species.
### Implementation Schedule for *Coryphantha scheeri* var. *robustispina*

<table>
<thead>
<tr>
<th>Priority Number</th>
<th>Action Number</th>
<th>Action Description</th>
<th>Responsibility</th>
<th>Total Cost (1,000s)</th>
<th>Cost (1,000s); Time Frames (Years)</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1a-b</td>
<td>Engage in land acquisition to reduce <em>C. scheeri</em> var. <em>robustispina</em> habitat fragmentation and increase connectivity.</td>
<td>C</td>
<td>FWS PC TNC</td>
<td>40,000</td>
<td>10,000 10,000 10,000 10,000 10,000</td>
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<tr>
<td>1</td>
<td>1c</td>
<td>Develop conservation easements for the protection of <em>C. scheeri</em> var. <em>robustispina</em> on private lands.</td>
<td>C</td>
<td>ALWT FWS TNC PVT</td>
<td>20,000</td>
<td>5,000 5,000 5,000 5,000 5,000</td>
</tr>
<tr>
<td>1</td>
<td>1d</td>
<td>Develop and monitor conservation mitigation banking to promote the protection of <em>C. scheeri</em> var. <em>robustispina</em> habitat.</td>
<td>C</td>
<td>ALWT FWS GOV PVT TNC</td>
<td>55</td>
<td>15 14 13 13</td>
</tr>
<tr>
<td>Priority Number</td>
<td>Action Number</td>
<td>Action Description</td>
<td>Action Duration</td>
<td>Responsibility</td>
<td>Total Cost (1,000s)</td>
<td>Cost (1,000s); Time Frames (Years)</td>
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</tr>
<tr>
<td>1</td>
<td>2a, 6b</td>
<td>Develop and implement land management plans that support and promote the taxon, including through the reduction of non-native plant species, soil compaction and erosion, and headcutting.</td>
<td>C</td>
<td>ALWT BLM FWS PVT TNC USFS</td>
<td>2304.2</td>
<td>579 575 575 575</td>
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<tr>
<td>1</td>
<td>2b, 3c</td>
<td>Work toward a better understanding of transplanting and seeding requirements for <em>C. scheeri</em> var. <em>robustispina</em> which could be implemented in appropriate habitat.</td>
<td>I</td>
<td>ASDM ASU DBG FWS PVT UA USFS</td>
<td>90</td>
<td>60 30 0 0</td>
</tr>
<tr>
<td>2</td>
<td>3a</td>
<td>Monitor individuals in established plots across the range of the taxon to enable an understanding of the long-term trend of the species, its habitat, threats, and stressors.</td>
<td>P</td>
<td>BLM FWS TNC TON USFS USGS</td>
<td>27.56</td>
<td>10.04 5.84 5.84 5.84</td>
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<tr>
<td>Priority Number</td>
<td>Action Number</td>
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<td>Responsibility</td>
<td>Total Cost (1,000s)</td>
<td>Cost (1,000s); Time Frames (Years)</td>
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<tr>
<td>2</td>
<td>3b</td>
<td>Check the effectiveness of management actions by monitoring individuals subjected to natural and prescribed fire, mechanical site disturbance, varied grazing regimes, and other management considerations.</td>
<td>P</td>
<td>BLM FWS, GOV TON, USFS USGS</td>
<td>27.3</td>
<td>9.975</td>
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<tr>
<td>2</td>
<td>3c</td>
<td>Monitor in situ grown and transplanted individuals for effectiveness of sewing, planting, and transplanting protocols.</td>
<td>P</td>
<td>BLM FWS, GOV PYT, TON USFS</td>
<td>27.3</td>
<td>9.975</td>
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<tr>
<td>2</td>
<td>4a</td>
<td>Identify information gaps, compatible land uses, threats, stressors, and appropriate management actions that lead to the conservation of the taxon.</td>
<td>5</td>
<td>FWS</td>
<td>5.6</td>
<td>1.4 1.4 1.4 1.4</td>
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<td>Cost (1,000s); Time Frames (Years)</td>
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</tr>
<tr>
<td>2</td>
<td>4b</td>
<td>Conduct surveys in appropriate habitat to better understand the geographic range and habitat requirements of the taxon.</td>
<td>P</td>
<td>BLM FWS GOV TON USFS USGS</td>
<td>29.2</td>
<td>7.3 7.3 7.3 7.3 7.3</td>
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<tr>
<td>2</td>
<td>4c</td>
<td>Conduct research related to the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of the taxon.</td>
<td>P</td>
<td>ALWT ASDM ASU BLM DBG FWS GOV PVT SNAT TNC UA USFS USGS USON UNAM</td>
<td>180</td>
<td>60 60 30 30 30</td>
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<td>2</td>
<td>5a</td>
<td>Promote the propagation and planting of individuals <em>ex situ</em> at botanic gardens for conservation and public education purposes.</td>
<td>C</td>
<td>ASDM DBG</td>
<td>38</td>
<td>9.5 9.5 9.5 9.5 9.5</td>
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<tr>
<td>1</td>
<td>5b</td>
<td>Maintain seed from plants across the geographic range of the taxon for conservation purposes.</td>
<td>C</td>
<td>ARS ASDM DBG</td>
<td>2</td>
<td>0.5 0.5 0.5 0.5 0.5</td>
</tr>
<tr>
<td>Priority Number</td>
<td>Action Number</td>
<td>Action Description</td>
<td>Action Duration</td>
<td>Responsibility</td>
<td>Total Cost (1,000s)</td>
<td>Cost (1,000s); Time Frames (Years)</td>
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</tr>
<tr>
<td>2</td>
<td>5c</td>
<td>Develop effective approaches to <em>in situ</em> conservation.</td>
<td>P</td>
<td>ALWT ASDM ASU BLM DBG FWS GOV PYT PVT SNAT TNC UA USFS USON UNAM</td>
<td>90</td>
<td>60 30 0 0</td>
</tr>
<tr>
<td>3</td>
<td>6a</td>
<td>Increase public outreach regarding threats, stressors, and conservation measures relating to <em>C. scheeri</em> var. <em>robustispina</em> in both the United States and Mexico.</td>
<td>C</td>
<td>ALWT BLM FWS GOV NGO PVT SNAT TON TNC USFS</td>
<td>12</td>
<td>3 3 3 3</td>
</tr>
<tr>
<td>3</td>
<td>6c</td>
<td>Develop a recovery implementation team comprised of species experts, agency and non-government agency partners, landowners, and stakeholders to meet regularly, review progress, discuss problems, and revise this plan as needed.</td>
<td>5</td>
<td>ALWT ASDM DBG FWS GOV NGO PVT TON TNC USFS</td>
<td>22.4</td>
<td>5.6 5.6 5.6 5.6</td>
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Literature Cited


Pima County. 2015. Pima County Pima pineapple cactus (Coryphantha scheeri var. robustispina) conservation bank status update, January 2015. 4 pp.


Reichenbacher, F. W. 1985. Rare plant survey: Selected areas of the Schuk Toak and San Xavier Districts of the Papago Indian Reservation, Sells, Arizona. 72 p.

Riegel, A. 1941. Some coactions of rabbits and rodents with cactus. Transactions of the Kansas Academy of Science 1903-(44): 96-103.


Rutman, S. 2007. Acuña cactus (Echinomastus erectocentrus var. acunensis) draft summary of available information.


Taylor, N. 1998. Coryphantha robustispina (Engelm.) Britton & Rose, the correct name for the taxon variously known as Coryphantha scheeri Lemaire and Coryphantha muehlenpfordtii Britton and Rose (nom. illeg.). Cactus Consensus (Dec, no.6).


United States Fish and Wildlife Service (Service). 2004. Biological Opinion for the proposed issuance of a Presidential Permit to construct a new, double-circuit, 345,000-volt transmission line from Sahuarita, Arizona to a sub-station in Nogales, Arizona, continuing south across the United States-Mexico border for approximately 60 miles into Sonora, Mexico.

United States Fish and Wildlife Service (Service). 2002. Biological Opinion for the proposed issuance of a National Pollution Discharge Elimination System (NPDES) permit to Asarco, Inc. for the Mission Complex located near Sahuarita, Pima County, Arizona.


United States Fish and Wildlife Service (Service). 1998. Biological Opinion for the proposed issuance of a permit to authorize discharge of fill material into 2.7 hectares (6.6 acres) of unnamed washes for the residential development of property named Las Campanas Housing Development. May 26, 1998.


Personal Communication


Tonn, S. Email from Sabra Tonn, HDMS Program Supervisor, Arizona Game and Fish Department, to Julie Crawford, U.S. Fish and Wildlife Service Plant Ecologist. November 4, 2015.

Tonn, S. Email from Sabra Tonn, HDMS Program Supervisor, Arizona Game and Fish Department, to Julie Crawford, U.S. Fish and Wildlife Service Plant Ecologist. March 16, 2016.
APPENDIX 1
Documented *C. scheeri* var. *robustispina* individuals (alive and dead) located during surveys in appropriate southern Arizona habitat and the number of acres surveyed to locate them. There may be minor overlap of individuals across surveys. This represents the majority of known *C. scheeri* var. *robustispina* surveys in southern Arizona since 1985. The current status of these individuals is unknown.

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Individual Plants</th>
<th>Acres</th>
<th>Month</th>
<th>Day</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altar Valley, Vaya Strip, 10k WSW of Three Points – Reichenbacher and Associates</td>
<td>24</td>
<td>4,480</td>
<td>November</td>
<td>19</td>
<td>1985</td>
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<tr>
<td>NW portion of the San Xavier District, SE of Tucson – Reichenbacher and Associates</td>
<td>220</td>
<td>15,760</td>
<td>November</td>
<td>19</td>
<td>1985</td>
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<tr>
<td>SSC Sierrita Ring site - Mills SWCA</td>
<td>8</td>
<td>27</td>
<td>May</td>
<td>11</td>
<td>1987</td>
</tr>
<tr>
<td>Black Wash, Black Wash #2, Coyote Mountains, SRER, TASRI, Pascua Yaqui, Valencia, Snyder Hill -Ecosphere Environmental Services Inc.</td>
<td>249</td>
<td>2,363</td>
<td>March</td>
<td>2</td>
<td>1991</td>
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<td>Arizona Electric Power Cooperative Valencia 115 kV Powerline - SWCA</td>
<td>49</td>
<td>14</td>
<td>September</td>
<td>7</td>
<td>1991</td>
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<tr>
<td>University of Arizona southern Avra Valley project (In 02-21-94-F-100)</td>
<td>2</td>
<td>65</td>
<td>June</td>
<td>1</td>
<td>1993</td>
</tr>
<tr>
<td>Private development n. of Green Valley (In 02-21-94-F-100)</td>
<td>22</td>
<td>80</td>
<td>June</td>
<td>1</td>
<td>1993</td>
</tr>
<tr>
<td>La Canada Norte II housing development north of Green Valley (In 02-21-94-F-100)</td>
<td>9</td>
<td>43</td>
<td>December</td>
<td>1</td>
<td>1993</td>
</tr>
<tr>
<td>Anvil Ranch San Pedro Pasture RX Burn 02-21-94-F-100</td>
<td>185</td>
<td>1,690</td>
<td>May</td>
<td>11</td>
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<td>Corona Ridge National Forest surveys</td>
<td>45</td>
<td>30</td>
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<td>Sahaurita Unified School District 02-21-95-F-089</td>
<td>1</td>
<td>0.25</td>
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<td>Sierra Tordilla/Alisos Grazing allotments 2-21-95-F-293</td>
<td>39</td>
<td>20</td>
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<td>Sopori Access Road 2-21-95-I-386</td>
<td>36</td>
<td>6</td>
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<td>19</td>
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<td>New Pascua 2-21-95-F-117</td>
<td>45</td>
<td>200</td>
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<td>Two Hills housing project 02-21-95-F-046</td>
<td>5</td>
<td>12</td>
<td>November</td>
<td>22</td>
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<tr>
<td>TASRI Reservoir, 15 km SE of Tucson - Ecosphere Environmental Services Inc.</td>
<td>293</td>
<td>2,280</td>
<td>February</td>
<td>1</td>
<td>1997</td>
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<tr>
<td>Tucson Proving Grounds / new high school2-21-97-I-133</td>
<td>15</td>
<td>58</td>
<td>April</td>
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<td>1997</td>
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<tr>
<td>Coyote Mountain and Santa Rita Experimental Range Areas surveys - Ecosphere Environmental Services Inc.</td>
<td>517</td>
<td>2,120</td>
<td>June</td>
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<td>1997</td>
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<tr>
<td>ASARCO Mission Complex - Dames and Moore</td>
<td>405</td>
<td>1,975</td>
<td>June</td>
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<tr>
<td>Tucson Aqueduct System Reliability Investigation Reservoir (02-21-91-F-406)</td>
<td>214</td>
<td>1,334</td>
<td>February</td>
<td>11</td>
<td>1998</td>
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<td>Las Campanas Housing Development (2-21-96-F-134)</td>
<td>47</td>
<td>437</td>
<td>May</td>
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<td>ASARCO Mission Complex</td>
<td>405</td>
<td>752</td>
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<td>27</td>
<td>1998</td>
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<td>CapLink Pipeline 2-21-99-I-190</td>
<td>6</td>
<td>68</td>
<td>May</td>
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<tr>
<td>Realign and Channelize Unnamed Washes on an 80 Acre Parcel for the Tohono O’odham Gaming Authority (2-21-99-F-170)</td>
<td>41</td>
<td>66</td>
<td>January</td>
<td>5</td>
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<tr>
<td>Altar Valley Survey by M. Baker</td>
<td>93</td>
<td>980</td>
<td>July</td>
<td>10</td>
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<td>Arizona State Prison Expansion South of Tucson (NPDES) (02-21-99-F-227)</td>
<td>68</td>
<td>1,295</td>
<td>August</td>
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<td>Palo Alto Ranch PPC Conservation Bank - SWCA</td>
<td>18</td>
<td>100</td>
<td>January</td>
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<td>Pima County Proposed Sand and Gravel Operation on North Side of Helmet Peak Road 02-21-00-F-248</td>
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<td>15</td>
<td>January</td>
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<td>Project Title</td>
<td>Individual Plants</td>
<td>Acres</td>
<td>Month</td>
<td>Day</td>
<td>Year</td>
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<tr>
<td>Guy Street, Stagecoach Road, Anvil Tank, South of Black Hills, Square Tank,</td>
<td>250</td>
<td>435</td>
<td>February</td>
<td>1</td>
<td>2001</td>
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<tr>
<td>Cerro Prieto Wash, East of Blanco Tank, Mouth of Mendoza</td>
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<td>Madera Highlands Proposed by Harvard Investment, Inc., East of Green Valley,</td>
<td>49</td>
<td>162</td>
<td>February</td>
<td>14</td>
<td>2001</td>
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<td>Arizona 02-21-99-F-273</td>
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<td>Safeway Shopping Ctr. - Sahuarita , Arizona 02-21-01-F-271</td>
<td>1</td>
<td>13</td>
<td>August</td>
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<td>2001</td>
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<tr>
<td>Altar Valley survey for Bureau of Reclamation - Harris Environmental Group</td>
<td>564</td>
<td>2,100</td>
<td>September</td>
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<td>Green Valley Performing Arts Center 02-21-01-F-417</td>
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<td>16</td>
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<td>Tucson Federal Prison 02-21-01-F-101</td>
<td>18</td>
<td>423</td>
<td>March</td>
<td>18</td>
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<td>Duval Mine Road Traffic Interchange 02-21-02-F-071</td>
<td>10</td>
<td>18</td>
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<td>Mission Mine 02-21-03-F-0014</td>
<td>306</td>
<td>165</td>
<td>December</td>
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<tr>
<td>Solar del Viejo 02-21-05-F-0346 (Withdrawn)</td>
<td>120</td>
<td>138</td>
<td>August</td>
<td>31</td>
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<td>Santa Rita Mountain Ranch 02-21-03-F-0406</td>
<td>268</td>
<td>1,597</td>
<td>November</td>
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<td>Canoa Hills Estates 02-21-03-F-374</td>
<td>23</td>
<td>21</td>
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<td>15</td>
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<tr>
<td>Lease of public land to Pima County for a recreational park</td>
<td>25</td>
<td>80</td>
<td>March</td>
<td>23</td>
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<td>02-21-02-I-0240</td>
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<td>345,000-volt transmission line from Sahuarita, Arizona to a sub-station</td>
<td>52</td>
<td>29</td>
<td>April</td>
<td>26</td>
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<td>in Nogales, Arizona 01-21-00-F-0427</td>
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<td>Corona de Tucson - Tierra Right of Way Services</td>
<td>1</td>
<td>67</td>
<td>June</td>
<td>4</td>
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<td>Construction of road and Utility Crossing in an unnamed Wash at the Mirasol</td>
<td>61</td>
<td>17</td>
<td>June</td>
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<td>Development 02-21-03-F-0483</td>
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<td>Right of Way south Country Club Road Sahuarita</td>
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<td>Santa Rita Residential Development (Sycamore Canyon) 02-21-04-F-0122</td>
<td>7</td>
<td>128</td>
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<td>New Tucson, in unnamed washes at Corona de Tucson 02-21-04-F-0200</td>
<td>272</td>
<td>50</td>
<td>December</td>
<td>15</td>
<td>2004</td>
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<td>Santa Rita Foothills Estates, in unnamed washes located in Corona de Tucson</td>
<td>32</td>
<td>157</td>
<td>June</td>
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<td>02-21-04-F-0403</td>
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<td>98 ranch - EPG Consulting</td>
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<td>July</td>
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<td>Change of Access Located within ADOT Right-of-Way for Interstate 19</td>
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<td>August</td>
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<td>02-21-05-F-0265</td>
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<td>Solar del Viejo 02-21-05-F-0346 (Withdrawn)</td>
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<td>Andrada Ranch 02-21-05-F-0347 (Withdrawn)</td>
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<td>79</td>
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<td>Pima County Pima Pineapple Cactus Conservation Bank</td>
<td>91</td>
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<td>Ocotillo Preserve Residential Subdivision 02-21-02-F-0210 and</td>
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<td>92</td>
<td>February</td>
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<td>02-21-04-F-0160</td>
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<td>Pima County DOT and Flood Control District Hayhook Road construction</td>
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<td>17</td>
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<td>21</td>
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<td>Diablo Village Residential Subdivision 22410-2006-F-0138</td>
<td>63</td>
<td>189</td>
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<td>Bajada Ranch 22410-2006-F-0471</td>
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<tr>
<td>City of Tucson section 2, township 15 south range 15 east</td>
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<td>Las Delicias BANWR and AZ State Lands RX burn</td>
<td>97</td>
<td>1,151</td>
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<td>SFPPLP, El Paso to Phoenix Expansion 22410-2006-F-0470</td>
<td>28</td>
<td>73</td>
<td>February</td>
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<td>Fagan Ranch Residential Development 22410-2006-F-0537</td>
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<td>376</td>
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<td>Nationwide Differential Global Positioning System property - Westland</td>
<td>2</td>
<td>11</td>
<td>October</td>
<td>22</td>
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<td>Parcel 19 Pima County - Tierra Right of Way</td>
<td>31</td>
<td>59</td>
<td>November</td>
<td>5</td>
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<tr>
<td>Improvements to State Route 86 between Sandario Road and Kinney Road</td>
<td>7</td>
<td>142</td>
<td>July</td>
<td>2</td>
<td>2008</td>
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<td>22410-2008-F-0281</td>
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<td>BANWR FMP and reinitiation 22410-2005-F-0243-R001</td>
<td>485</td>
<td>58,733</td>
<td>March</td>
<td>23</td>
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<td>Project Title</td>
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<td>Month</td>
<td>Day</td>
<td>Year</td>
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<td>Community Water Company of Green Valley Central Arizona Project Water Delivery System 22410-2009-F-0090</td>
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<td>14</td>
<td>May</td>
<td>20</td>
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<td>Pascua Yaqui Fee Land - Terracon</td>
<td>40</td>
<td>364</td>
<td>July</td>
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<td>New Tucson Substation 22410-2010-F-0458</td>
<td>25</td>
<td>25</td>
<td>November</td>
<td>2</td>
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<td>Traffic Interchange Ramp Connections between I-19 and Sahuarita Road 22410-2011-F-0343</td>
<td>25</td>
<td>34</td>
<td>September</td>
<td>6</td>
<td>2011</td>
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<td>Rosemont Copper Mine, Pima County 22410-2009-F-0389</td>
<td>67</td>
<td>33</td>
<td>October</td>
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<td>Sierrita Pipeline Project 02EAAZ00-2013-F-0035</td>
<td>142</td>
<td>487</td>
<td>April</td>
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<td>2014</td>
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<td>Stormwater Controls Project for Asarco's Mission Complex 02EAAZ00-2014-F-0456</td>
<td>6</td>
<td>60</td>
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<td>Pima County Marley Ranch partial survey</td>
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<td><strong>Total</strong></td>
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