

**PETITION TO LIST TWO ARIZONA PLANTS
FROM THE SKY ISLANDS
AS THREATENED OR ENDANGERED UNDER THE
ENDANGERED SPECIES ACT**



Graptopetalum bartramii © Alan Cressler

CENTER FOR BIOLOGICAL DIVERSITY

July 7, 2010



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TO: Mr. Ken Salazar
Secretary of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

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Dear Secretary Salazar:

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. §1533(b), Section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 553(e), and 50 C.F.R. §424.14(a), the Center for Biological Diversity, Tierra Curry, and Noah Greenwald hereby formally petition the Secretary of Interior to list Bartram stonecrop (*Graptopetalum bartramii*), and beardless chinch weed (*Pectis imberbis*), two rare Arizona plants from the Madrean Sky Islands, as Threatened or Endangered species and to designate critical habitat concurrent with listing. Petitioners file this petition under the Endangered Species Act, 16 U.S.C. sections 1531-1543 (1982). This petition is filed under 5 U.S.C. section 553(e), and 50 C.F.R. part 424.14 (1990), which grants interested parties the right to petition for issuance of a rule from the Assistant Secretary of the Interior. The petitioners request that Critical Habitat be designated as required by 16 U.S.C. 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553). Petitioners realize this petition sets in motion a specific process placing definite response requirements on the FWS and very specific time constraints upon those responses.

Bartram stonecrop is a rare and beautiful succulent which occurs in Cochise, Pima, and Santa Cruz counties, Arizona, and is severely threatened by collection and habitat destruction. There are only 12 historically known populations of this plant in Arizona, several of which may now be extirpated. Endangered Species Act protection for this plant is long overdue, as it was known to qualify for Federal protection in 1982. Beardless chinch weed is a flower in the aster family which is severely threatened by livestock grazing, road maintenance, recreation, mining, and other threats. It is known from only 13 sites in Cochise, Pima, and Santa Cruz counties, and was recommended for Federal protection in 1982. There is no question that both these rare plants qualify for listing under the Endangered Species Act.

PETITIONER:

The Center for Biological Diversity is a nonprofit conservation organization with 255,000 members and online activists dedicated to the protection of endangered species and wild places. <http://www.biologicaldiversity.org>

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Pectis imberbis © Dr. Mark Fishbein

EXECUTIVE SUMMARY

The two plant species presented in this petition-- Bartram stonecrop (*Graptopetalum bartramii*) and Beardless chinch weed (*Pectis imberbis*) are in danger of becoming extinct and need Endangered Species Act protection to ensure their continued survival.

Bartram stonecrop is a rare succulent known only from 12 small, widely scattered populations in the Baboquivari, Chiricahua, Dragoon, Mule, Patagonia, Rincon, Santa Rita, and Tumacacori mountains in Cochise, Pima, and Santa Cruz counties, Arizona (Van Devender 1981, AGFD 2001). A single stonecrop plant was detected in Mexico southeast of the Patagonia Mountains in the 1940's, but this species has not since been detected in Mexico (Phillips et al. 1982). Due to its rarity and beauty, Bartram stonecrop is highly threatened by collection. It is also threatened by mining, livestock grazing, recreation, and other factors. Van Devender (1981) observed that the stonecrop likely qualified for Federal Threatened status due to observed population declines, collection pressure, and threats from mining activities. Phillips et al. (1982) recommended Federal protection for the stonecrop due to the threats to its survival from collection and habitat loss and degradation. The U.S. Fish and Wildlife Service Office of Endangered Species in Albuquerque prepared an unpublished determination that *G. bartramii* qualified for Threatened status under the Act, stating, "[T]he Director has determined that *Graptopetalum bartramii* is in danger of becoming extinct throughout all or a significant portion of its range" (FWS undated).

Beardless chinch weed is a rare flower in the aster family known from 13 small, scattered locations in the Atascosa, Huachuca, Patagonia, and Santa Rita mountains and Canelo Hills in Cochise, Pima, and Santa Cruz counties, Arizona (Van Devender 1981, Arizona Game and Fish Department 2003). It is the rarest species of *Pectis* in the United States (AGFD 2003). This flower was historically known from Mexico, but has not been redetected there since 1940, despite extensive searches (Fishbein and Warren 1994). Beardless chinch weed is highly threatened by livestock grazing, recreation, road maintenance, mining, and other factors. It was recommended for Federal Threatened status in 1982 by Keil, an Arizona botanist, due to grazing threats and occurrence in small, localized populations (1982 pers. comm. cited in Phillips et al. 1982b). It is unquestionable that after nearly 30 years of delay, both these rare Arizona species merit prompt Federal protection under the Endangered Species Act.

INTRODUCTION

The Sky Islands of the southwest United States and Northwest Mexico are mountain ranges which harbor high levels of species diversity due to the convergence of several climate and vegetation zones and the isolation of mountain habitats by the surrounding desert and plains. The two petitioned plant species, Bartram stonecrop (*Graptopetalum bartramii*) and beardless chinch weed (*Pectis imberbis*) are known only from the Sky Islands. *Graptopetalum* is a genus of attractive perennial succulents comprised of twelve species in the *Crassulaceae* family. The entire *Graptopetalum* genus occurs only in Arizona and Mexico. *Graptopetalum bartramii* is one of only two species in the genus which occur in Arizona (Phillips et al. 1982). *Pectis* is a genus in the aster (daisy) family that is found in warm and tropical areas in the Americas. *Pectis imberbis* is the only member of the genus in Arizona, and is the rarest species of *Pectis* in the United States (AGFD 2003).

Unfortunately the Sky Islands and the host of rare species they support are widely threatened by human activities (Felger and Wilson 1999, Warshall 1999, Sky Island Alliance 2007). Bartram stonecrop is in danger of becoming extinct due to overutilization and habitat loss and degradation (Phillips et al. 1982, FWS undated). This plant is collected due to its rarity and beauty, and the threat posed to the species by

collection is magnified by threats from mining, recreation, livestock grazing, and other factors such as global climate change. Beardless chinch weed is in danger of becoming extinct due to grazing, road maintenance, mining, recreation, and other threats to the flower and its habitat. Browsing by cattle prevents chinch weed from flowering which can only occur after plants have reached sufficient height to reproduce. Because it is adapted to disturbed environments such as road cuts, it is highly vulnerable to trampling by recreationists and to road maintenance activities such as herbicide application. There are no existing regulatory mechanisms which protect these rare Arizona species from the numerous threats they face. Both these plants occur in small populations in only a dozen or so widely scattered locations, are known to have been extirpated from several sites, and warrant Endangered Species Act protection.

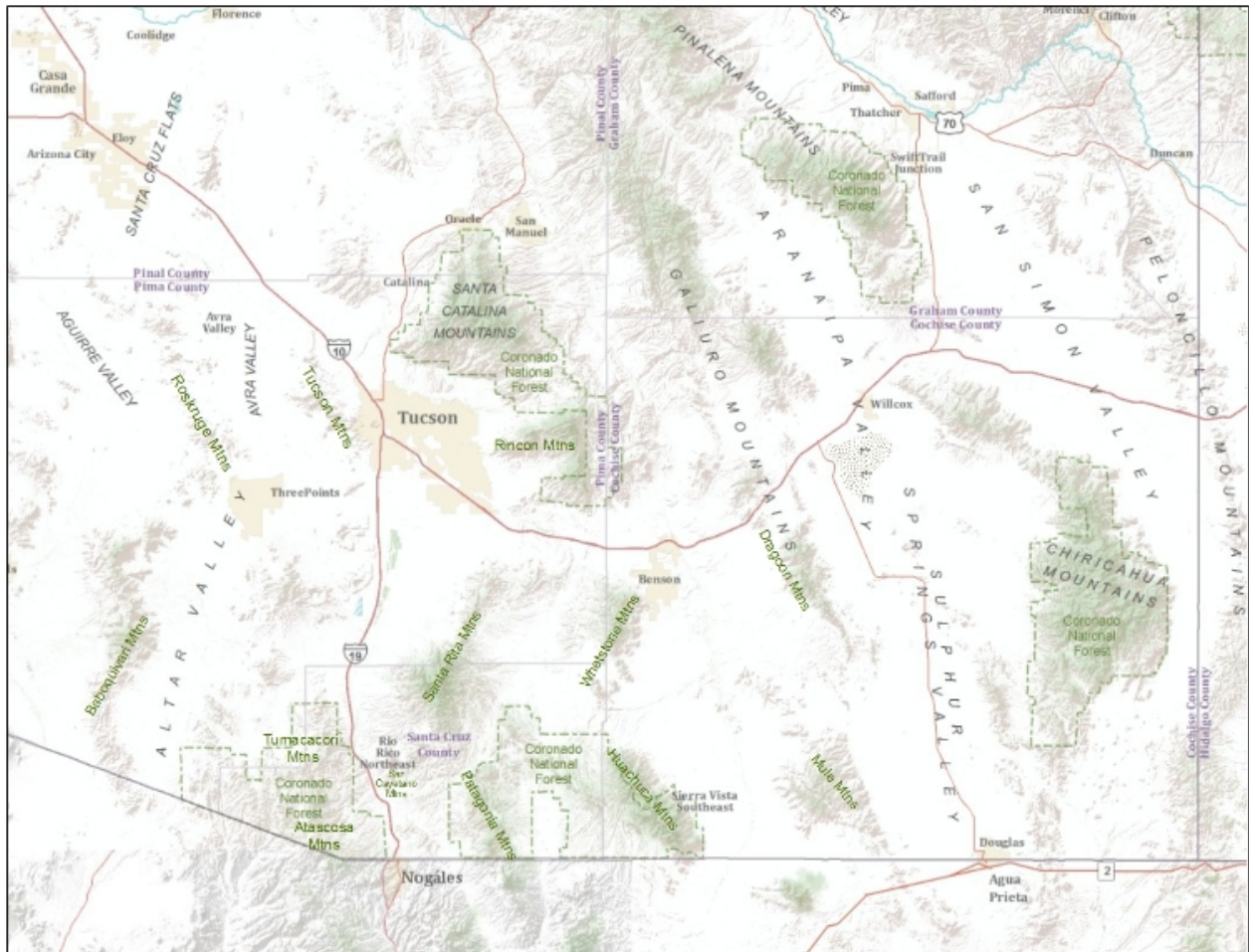


Figure 1. Map of the Sky Island Mountain Ranges.

SPECIES ACCOUNTS

Bartram stonecrop (*Graptopetalum bartramii*)

Description

Bartram stonecrop (*Graptopetalum bartramii*) is a succulent flowering plant in the order Rosales, family Crassulaceae (Kartesz 1994). This perennial is also known as *Echeveria bartramii* and other common names include Bartram's stonecrop, Patagonia mountain leatherpetal, and Bartram's live-forever (NatureServe 2010).

Habitat

Bartram stonecrop grows in canyons, rocky outcrops, and cliff faces in oak and pine-oak woodland, grassland, and Madrean evergreen woodland communities. It is associated with moist shady areas, rock drips, heavy litter cover, north exposure, and spikemoss, liverworts, lichens, and ferns. It is known from elevations ranging from 3,650-6,700 feet (Van Devender 1981, Arizona Game and Fish Department 2001, NatureServe 2010). Its preference for moist microhabitat conditions makes it susceptible to threats from drought, global climate change, and water pollution.

Ecology

This perennial succulent reproduces both sexually and vegetatively, flowering and fruiting from September to February. *Graptopetalum bartramii* and *Pectis imberbis* (the other plant in this petition) can occur nearby each other but in different habitats (Phillips et al. 1982b).

Range

Graptopetalum bartramii occurs in several mountain ranges in southern Arizona, but populations are typically small and widely scattered making them highly vulnerable to extirpation (U.S. Forest Service 1991). There are 12 known localities in Arizona including Cochise, Pima, and Santa Cruz counties in the Baboquivari, Chiricahua, Dragoon, Mule, Patagonia, Rincon, Santa Rita, and Tumacacori mountains (Van Devender 1981, AGFD 2001). McLaughlin and Bowers (1990) categorize this plant as an Apachian endemic. There is a record of a single plant near Pacheco, Chihuahua, Mexico, southeast of the Patagonia Mountains (Moran 1949 in Phillips et al. 1982), but the species has not been redetected in Mexico.

Populations, Status, and Trend

There are 12 known populations of Bartram stonecrop in Arizona, and one historical occurrence in Mexico which may no longer be extant (Van Devender 1981). It occurs in several mountain ranges, but populations are typically small and isolated (U.S. Forest Service 1991). Although several scattered localities are known, only a handful of viable populations of mature, reproducing plants are known (Moore 2010). Phillips et al. (1982) located five populations of this species in 1980 and 1981 in the Coronado National Forest, with total estimated population size of approximately 300 plants. They report that plants are either widely scattered or in compact colonies. Individual population size

ranged from 9-112 plants. Van Devender (1981) reports that *Graptopetalum bartramii* was not found in new areas or relocated in a previous locality in Sycamore Canyon, and reports that it has declined in the Atascosa Mountains.

Nabhan et al. (1989) describe this plant as at-risk. It is ranked by NatureServe (2010) as vulnerable (G3S3). This plant is known to have been in need of federal protection for decades. Thirty years ago, Van Devender (1981) reported that it probably qualified for Federal Threatened status due to observed population declines, collection pressure, and threats from mining activities. Phillips et al. (1982) conducted a status review of Bartram stonecrop and recommended it for Federal listing, stating:

“*Graptopetalum bartramii* is a relatively rare species with an estimated known total habitat of 2.8 square kilometers in several areas in the Coronado National Forest. The populations are small (9-112) plants and isolated from each other by significant distances between suitable habitats. It is threatened throughout its range by destruction of the habitat, overuse of the habitat, and by collection of the plants. The authors of this report recommend to the Director, U.S. Fish and Wildlife Service, that pursuant to the Endangered Species Act of 1973, as amended, *Graptopetalum bartramii* (Rose) be given Federal Status of Threatened.”

At some point, the FWS Office of Endangered Species in Albuquerque prepared an unpublished determination that *G. bartramii* qualified for Threatened listing under the Act, stating:

“After a thorough review and consideration of all the information available, the Director has determined that *Graptopetalum bartramii* is in danger of becoming extinct throughout all or a significant portion of its range due to one or more of the factors described in Section 4(a) of the Act” (FWS undated).

It was listed as a Category 1 Candidate by FWS in the 1980 Notice of Review. *Graptopetalum bartramii* is currently a Federal Species of Concern.

Land Management

Bartram stonecrop occurs on lands managed by the Coronado National Forest and the BLM Tucson Field Office. Phillips et al. (1982) report a population from the Baboquivari Mountains on the Tohono O'odham Reservation. It may also occur in Saguaro National Park and the Nature Conservancy Thomas Canyon Preserve (AGFD 2001).

THREATS

Present or threatened destruction, modification, or curtailment of habitat or range

Mining

Mining and mineral exploration are known threats to the survival of Bartram stonecrop (Arizona Game and Fish Department 2001). Mining has posed a threat to this species for decades throughout its range, and prompted Van Devender (1981) to suggest Federal Threatened status for the stonecrop.

Phillips et al. (1982) report two populations of stonecrop which were threatened by adjacent mining sites, stating:

“Test pits along the stream have removed portions of the habitat through erosion at the first site and, although the mine is not currently in operation, resumption of activity would damage the habitat and the species. The second mine site has recently been reactivated. Population 2 could easily be destroyed if the Nogales-Ruby Road were widened; blading could also undermine the slope and cause extensive erosion . . . The mining operations in the area pollute the stream and may affect the water quality available to the populations.”

The population in the Santa Rita Mountains is potentially threatened by the proposed Rosemont open-pit copper mine that would destroy at least 4,400 acres of habitat (Augusta Resource Corporation 2010). There is a documented occurrence of the stonecrop within one mile of the proposed mine footprint (Arizona Game and Fish Department Heritage Data Management System 2010), and this plant could thus potentially occur within the footprint itself. Mining both destroys habitat outright and degrades water quality available to the stonecrop (Phillips et al. 1982). The Rosemont mine is expected to contaminate streams with heavy metals and to reduce water availability (Pima County 2008) which would cause habitat loss for species which are dependent on moist conditions for survival, like Bartram stonecrop. Even if the mine’s footprint and waste piles did not directly destroy the stonecrop’s habitat, microhabitat conditions would be altered in adjacent habitat as well due to loss of vegetative cover, increased wind, and increased reflection, which would degrade the moist microhabitat conditions on which this plant depends. The stonecrop is also threatened by dust which would result from mining, ore transport, and associated activities which could negatively affect photosynthesis. Mining and resultant access roads would also exacerbate the threat of collection for this plant. Proposed post-mining land uses at the Rosemont site include livestock grazing and off-road vehicle riding (SWCA 2009), both of which also threaten the stonecrop. Whether or not the currently proposed mine at the Rosemont site is developed, mining will remain a threat to this plant as the property has changed ownership multiple times.

It is unknown whether this species is still extant in Mexico, but the Mexican portion of its range is also threatened by mining activities (Felger and Wilson 1999).

Livestock Grazing

Habitat destruction caused by livestock grazing poses a rangewide threat to the survival of Bartram stonecrop. In addition to habitat destruction resulting from grazing, individual plants can be trampled by cattle (Arizona Game and Fish Department 2001). Because there are so few populations of this species, and because populations consist of few individuals, grazing poses a significant threat to the stonecrop. Most, if not all, populations of this species occur in areas of cattle grazing (Phillips et al. 1982). The majority of this species’ range is on the Coronado National Forest, which is extensively grazed. The Forest Service has acknowledged that grazing may cause trampling of and herbivory on individual stonecrop plants (FS 2003, 2004, 2005, 2007, 2007e, 2008c, 2008d, 2008e, 2008f, 2008g), but has taken no actions to protect this species. The threats to individual plants acknowledged by the Forest Service actually comprise a threat to the survival of the entire species because there are only 12 known populations and populations typically consist of few individuals.

Impacts to individual plants could easily result in population extirpation, and every population is significant to the survival of this rare species.

If Mexican populations of this species are still extant, it is also threatened by livestock grazing in Mexico, as livestock imports to the United States are an important source of revenue for Mexican ranchers and there are few places in the Sierra Madre Occidental where cattle and goats are not grazed (Felger and Wilson 1999).

The threat posed by livestock grazing is magnified by the other threats facing this rare species including collection and mining. For example, in the Rosemont area of the Santa Ritas where the stonecrop is threatened by mining, it is also threatened by livestock grazing (SWCA 2009).

Recreation

Recreational activities are a known threat for *Graptopetalum bartramii*. The sites where this species occurs are “all in areas that receive moderate to heavy recreation use in the form of hiking, camping, and hunting” (Phillips et al. 1982). The Arizona Game and Fish Department (2001) cites trampling by recreationists as a threat to the stonecrop. Due to the high impact of recreation visitors and researchers in the Dragoon, Chiricahua, and Peloncillo mountains of Coronado National Forest, approval of research permits by the Forest Service was temporarily suspended in recent years (Stolp 2005). Recreational use of its habitat also makes this succulent more vulnerable to collection (Phillips et al. 1982).

Bartram stonecrop is threatened by off-road vehicle use (Moore 2010). It is well-known that habitats in the Coronado National Forest have been degraded by authorized and unauthorized off-road vehicle use. The Coronado National Forest is currently amending the Forest Plan to allow off-route driving up to 300 feet from designated routes for the purpose of dispersed camping (FS 2010). The explicit authorization of off-road driving threatens species which could be crushed by vehicles and this threat will escalate as camping corridors expand and more habitat is destroyed, creating ever-increasing areas of degradation.

Other Known Habitat Threats

Bartram stonecrop is threatened by road construction and maintenance, including the expansion of Ruby Road (AGFD 2001). It is also potentially threatened by road construction and maintenance for mining activities for the proposed Rosemont Copper Mine (AGFD 2010). Border Patrol activities along Ruby Road may also threaten this plant (Tumacacori Wild Undated).

Bartram stonecrop is potentially threatened by the spread of invasive buffelgrass (*Pennisetum ciliare*) and by buffelgrass removal efforts including burning and herbicide application. Buffelgrass could outcompete stonecrop, and removal efforts could harm individuals and therefore populations given the small population size of the stonecrop. Buffelgrass invades both valleys and lower slopes and steep rocky hillsides and is expanding very rapidly (Arizona-Sonora Desert Museum 2010). Buffelgrass control efforts are escalating, including aerial herbicide applications which threaten non-target species such as Bartram stonecrop (eg. Garcia and Conway 2007).

The status of the lone known population of this plant in Mexico is unknown, but its habitat is known to be threatened by the drug trade. Both the cultivation of marijuana and opium poppies and the aerial spraying of herbicides in drug control efforts threaten rare species such as the stonecrop (Felger and Wilson 1999). This species is also threatened by agricultural practices in Mexico. The wholesale clearing and replacement of native vegetation in Sonora and Sinaloa began in the late 1960's, and slash and burn and other agricultural practices threaten even rural, isolated, and high elevation areas (Felger and Wilson 1999).

Disease or Predation

Phillips et al. (1982) report an indirect predation threat to one population of stonecrop that was observed to be uprooted by erosion due to a rodent burrow above the plant's site.

The stonecrop may be threatened by herbivory from cattle ((FS 2003, 2004, 2005, 2007, 2007e, 2008c, 2008d, 2008e, 2008f, 2008g).

Overutilization

Collection is a documented threat to Bartram stonecrop. Although it is illegal to remove species of *Crassulaceae* from the wild under Arizona Native Plant Law, collection still occurs due to the attractiveness of the stonecrop which is cultivated as an ornamental (Van Devender 1981, Phillips et al. 1982, FWS undated, U.S. Forest Service 1991, AGFD 2001). AGFD (2001) reports that illegal collection is the main management issue for this species. Because there are only 12 known populations of this plant, most of which have low densities, collection poses a primary threat to its survival (Van Devender 1981). The Forest Service (1991) reports that populations of Bartram stonecrop have apparently declined due to collection, stating: "Because it has small, discrete populations it is vulnerable to a variety of disturbances, particularly collection" (U.S. Forest Service 1991). Phillips et al. 1982 report that all sites where this species occurs receive moderate to heavy recreation use and that recreationists might be tempted to collect the plant, especially when it is in bloom. Collection for research also threatens the stonecrop. A portion of one plant is known to have been collected for an insect life cycle study (Phillips et al. 1982). The threat posed to the stonecrop by collection is heightened by other threats such as mining. Because so few populations are known, every population is significant to the survival of the species.

Inadequacy of Existing Regulatory Mechanisms

There are no existing regulatory mechanisms which adequately protect the stonecrop. It is a Federal Species of Concern but this designation provides the plant with no actual protections. Phillips et al. (1982) report that no specific habitat management or protection practices are known to be carried out for this species at any sites.

The stonecrop is provided some protection from collection under state law. All species of *Crassulaceae* are protected from collection by the Arizona Native Plant Law, except under permit from the Commission of Agriculture and Horticulture (Phillips et al. 1982). Despite this protection, collection still occurs (Van Devender 1981, Phillips et al. 1982, FWS undated, U.S. Forest Service 1991, AGFD 2001).

Graptopetalum bartramii is a Forest Service and BLM Sensitive Species, but protections afforded to Sensitive Species are discretionary and there is no record of protective measures being taken for this plant. The stonecrop is widely threatened by livestock grazing, and the Forest Service has not implemented protections for the plant. The majority of this species' range is on the Coronado National Forest, which is extensively grazed. The Forest Service has been inconsistent in assessing the threat posed to the stonecrop by grazing and has taken no actions to protect the plant. Some Environmental Assessments and Biological Evaluations state that grazing may impact individuals of Bartam stonecrop due to trampling and herbivory (FS 2003, 2004, 2005, 2007, 2007e, 2008c, 2008d, 2008e, 2008f, 2008g), and others state that there is no impact (FS 2007a, 2007f, 2008b). In particular, the Santa Catalina Ranger District states that there is no impact of grazing on Bartram stonecrop, whereas other ranger districts acknowledge that grazing may impact individual plants. The Forest Service assessment of impact is inconsistent even within a single ranger district—the 2007 Biological Evaluation for the Horseshoe, Sulphur Draw, Sanford and Cienega Allotment Management Plans in the Douglas Ranger District states that grazing may impact individuals of Bartram stonecrop (FS 2007b), but the 2007 Environmental Assessment for the same allotments (FS 2007c) states that there is no impact.

Even where the Forest Service acknowledges that individuals may be impacted, the agency states that impacts to individuals are not likely to result in loss of viability (eg. FS 2007b). This assertion, however, is contradicted by the distribution and life history of this species. The threats to individual plants acknowledged by the Forest Service actually comprise a threat to the survival of the entire species because there are only 12 known populations and populations typically consist of few individuals. Impacts to individual plants could easily result in population extirpation, and every population is significant to the survival of this rare species. Grazing occurs throughout the species' range, and the threat posed by grazing has not been assessed on a rangewide basis.

The stonecrop is threatened throughout its range by mining. The environmental assessment for the recently proposed Rosemont copper mine in the Santa Ritas (SWCA 2009), where the stonecrop is known to occur within one mile of the mine's footprint, does not address potential impacts to the plant.

There is one population of this species on Saguaro National Monument which enjoys some habitat protection, but remains vulnerable to collection.

There is one known locality for this plant in Mexico, in the northern Sierra Nevada Occidental in Chihuahua, but its status there is unknown (Van Devender 1981). There are no existing regulatory mechanisms in Mexico which protect this species, and it is unlikely that even if conservation efforts have been undertaken in its habitat that they would afford the plant with any protection. For example, Felger and Wilson (1999) state:

“Conservation efforts in Mexico have suffered from under funding and neglect, Although several areas in northwestern Mexico have special conservation status, enforcement of environmental policy and protection of natural areas has been lax or nonexistent. For instance in Sonora the Sierra Bavispe, Sierra de los Ajos and the nearby Sierra de la Purica and Sierra Buenos Aires were granted protection during the 1930's. However these areas have not been

managed as preserves and, like many other areas that have been given special status, they have not escaped logging or cattle ranching.”

Other Natural or Anthropogenic Factors

Bartram Stonecrop is vulnerable to extinction because it occurs in small, discrete populations that are susceptible to extirpation (U.S. Forest Service 1991, AGFD 2001, Matthies et al. 2004). Natural reproductive rates appear to be low for this plant, and young sterile rosettes are highly vulnerable to disturbance (Moore 2010). This plant occurs in moist microhabitat conditions in well-developed cryptobiotic soils, and if the plants lose their protective shelter or soil, they dry out and die (Moore 2010).

Stochastic events such as floods threaten this species. Plants growing close to the stream bed or subject to erosion could be removed by high water flooding (Phillips et al. 1982). Drought is also a threat. Annual precipitation in the region has been less than average since 1995, resulting in severe drought conditions locally and regionally (Westland Resources 2007, p. 3). Global climate change is expected to increase the frequency and intensity of severe weather events such as droughts and floods in the southwest and also to create drier overall conditions, which threatens endemic species such as the stonecrop which are dependent on specific microhabitat conditions for survival (U.S. Global Change Research Program 2009). Global climate change will also likely reduce the population viability of rare plants like Bartram stonecrop (Maschinski et al. 2006).

In sum, *Graptopetalum bartramii* is highly threatened by collection, mining, livestock grazing, recreation, climate change, and other disturbances, and existing regulatory mechanisms do not adequately protect this species or its habitat. Bartram stonecrop needs Endangered Species Act protection to ensure its continued survival.

Beardless Chinch Weed (*Pectis imberbis*)

Description

Beardless chinch weed (*Pectis imberbis*) is a flowering plant in the order Asterales and family Asteraceae (Compositae) (Kartesz 1994). It is an herbaceous perennial with yellow flowers and thick narrow leaves (Van Devender 1981). Other common names for this flower include beardless chinchweed, beardless fetid-marigold, and hierba de venado.

Habitat

Pectis imberbis grows in open settings in grassland, desert-grassland, oak-grassland, oak woodland, and tropical deciduous forest habitats at elevations of 2,950 – 6,475 feet (Van Devender 1981 Fishbein and Warren 1994, AGFD 2003). It is adapted to disturbance and grows along road-cuts (NatureServe 2010). Fishbein and Warren (1994) suggest that the rocky slopes above arroyos are the natural habitat of this species and that roadside habitats may represent population sinks. It prefers sunny south slopes with few associated species (Phillips et al. 1982b). Despite the ability of this plant to grow in disturbed areas, it remains exceedingly rare and its occurrence in disturbed environments may heighten its vulnerability to extirpation from activities such as road-maintenance, off-road vehicle use, and mining.

Range

Beardless chinch weed occurs in small, isolated populations scattered across several mountain ranges. NatureServe (2010) reports that *Pectis imberbis* is known from at least nine element occurrences in southern Arizona and northern Mexico (based on Keil 1978). Van Devender (1981) reports thirteen localities for this plant in southern Arizona. The Arizona Game and Fish Department (2003) reports that it is known from Cochise, Pima and Santa Cruz counties, including the Atascosa, Huachuca, Patagonia, and Santa Rita mountains, and the Canelo Hills.

In Mexico the species was historically known from western Chihuahua and eastern Sonora (AGFD 2003). *Pectis imberbis* was last reported from Mexico in 1940, and has not been observed in the Mexican portion of its range since then, despite extensive searches (Phillips et al. 1982b, Fishbein and Warren 1994).

Ecology

Beardless chinch weed blooms from August to October after summer rains (AGFD 2003). *Pectis imberbis* and *Graptopetalum bartramii* (the other plant in this petition) can occur nearby each other but in different habitats (Phillips et al. 1982b).

Populations, Status, and Trend

Pectis imberbis is the rarest *Pectis* species in the United States (Van Devender 1981). This plant is present in small populations and is quite rare throughout its range (Phillips et al. 1982b). Fishbein and Warren (1994) describe its distribution as very localized and widely dispersed, stating: “Given

its predilection for disturbed habitats, it is surprising that *P. imberbis* is apparently so rare.” They suggest that its rarity may result from heavy grazing and recreation pressure (Fishbein and Warren 1994).

The number of individuals in known populations is small (U.S. Forest Service 1991). Keil (1978) reports 9 collection sites, with each population consisting of fewer than 10 individuals. Deecken (1991, 1992, 1994) reports population sizes of 4, 15, and 20 plants. Phillips et al. (1982b) report three populations consisting of a total of 89 plants, and another population of 11 plants. AGFD (2003) reports that population sizes range from 20-30 individuals to a maximum of 100 individuals.

In extensive surveys in potential habitat for this species, Fishbein and Warren (1994) did not detect any new populations. They conclude that “despite the ability of this species to persist (perhaps as sink populations) on disturbed roadcuts, it is a very rare species in natural habitats in Arizona.”

Phillips et al. (1982b) did not detect any seedlings of this species, but assumed that populations were stable. Of the 9-13 known locations of this species in Arizona, several may have been extirpated. AGFD (2003) reports that monitoring on the Coronado Forest began at four sites in 1995. Several locations on Coronado NF have not been seen since late 1970s. Phillips et al. (1982b) did not relocate southern Arizona populations outside the Atascosa Mountains. A previously known population in the Atascosas was not redetected in 1995 or 1997 (Malusa 1995, Newman 1997).

This species has not been detected in Mexico since 1936. As of 1982, Keil was unable to locate the species in Mexico, despite concerted effort. Since 1982 there has been extensive collecting in the known localities for this species in Mexico, as well as in other areas of suitable habitat, yet it has not been detected (Fishbein and Warren 1994).

Pectis imberbis was listed as a Category 1 Candidate by FWS in the 1980 Notice of Review, as a Category 2 Candidate in 1983, and was removed from the Candidate list in 1996. It is now a Federal Species of Concern. It is ranked by NatureServe (2010) as vulnerable globally and critically imperiled in Arizona (G3S1). The global ranking of vulnerable needs to be updated since the species is likely extirpated in Mexico. Keil (1982 pers. comm., cited in Phillips et al. 1982b) recommends Federal Threatened status due to small, localized populations and grazing threats.

Land Management

Eight of the thirteen known Arizona locations of this plant are on the Coronado National Forest. This flower also occurs on National Park Service land in the Coronado National Memorial and on the Audubon Research Ranch. It possibly occurs on Department of Defense lands on the Fort Huachuca Military Reservation (AGFD 2003).

THREATS

Present or threatened destruction, modification, or curtailment of habitat or range

Livestock Grazing

Livestock grazing is a primary documented threat to *Pectis imberbis* (Arizona Game and Fish Department 2003, NatureServe 2010). The plant's rarity in Arizona may be the direct result of heavy grazing pressure because plants do not flower until they are over 0.5 m tall and under heavy grazing pressure they may be unable to attain adequate size. (Phillips et al. 1982b, Fishbein and Warren 1994).

Deecken (1992) reports a population of this species from the edge of a cow path. Eight of the thirteen known Arizona locations of this plant are on the Coronado National Forest which is heavily grazed. The Forest Service has acknowledged that individuals of this species may be impacted by livestock herbivory and trampling (FS 2003, 2004, 2005, 2006), yet have taken no actions to protect this plant. Grazing impacts on individuals actually represent threats to entire populations of this species due to its small population size (as few as four individuals) and low number of total populations (13 known in Arizona, several of which have been extirpated).

The threat posed to *P. imberbis* by grazing is magnified by other threats. In the Santa Ritas this plant is threatened by both grazing and copper mining (SWCA 2009, AGFD 2010). In Mexico it is threatened by grazing and deforestation, both of which “have greatly accelerated recently and continue to do so” (Fishbein and Warren 1994).

Mining

In the Santa Ritas, *P. imberbis* is potentially threatened by a proposed 4,400 acre open-pit copper mine (Augusta Resource Corporation 2010). It is known to occur within 3 miles of the mine's proposed footprint (AGFD 2010), and may thus potentially occur within the footprint. Because this flower grows in disturbed environments, it is highly vulnerable to being destroyed by mining and road-maintenance activities, pesticide application, etc. The proposed post-mining land uses at Rosemont include livestock grazing and off-road vehicle use (SWCA 2009), both of which also threaten beardless chinch weed. It may also be threatened by mining and mineral exploration in other parts of its Arizona range, as it can occur near *Graptopetalum bartramii* (Phillips et al. 1982b), and *G. bartramii* is known to be threatened by mining (Van Devender 1981, Phillips et al. 1982, Arizona Game and Fish Department 2001). *Pectis imberbis* is also threatened by copper mining in Mexico (Felger and Wilson 1999).

Recreation

Trampling by recreationists threatens *P. imberbis*. Erosion resulting from increased use of the Arizona Trail is a “serious threat” to one population of this species (Fishbein and Warren 1994). Due to the high impact of researchers and recreation visitors on the Douglas Ranger District, including the Dragoon, Chiricahua, and Peloncillo mountains, approval of research permits had to be suspended (Stolp 2005).

Motorized recreation threatens *P. imberbis*. It is well known that habitats in the Coronado National Forest have been degraded by authorized and unauthorized off-road vehicle use. The Coronado National Forest is currently amending the Forest Plan to allow off-route driving up to 300 feet from designated routes for the purpose of dispersed camping (FS 2010). The explicit authorization of off-road driving threatens species which could be crushed by vehicles and this threat will escalate as camping corridors expand and more habitat is destroyed, creating ever-increasing areas of degradation. Because beardless chinch weed occurs in disturbed habitats and road-cuts, it is particularly threatened by expanded off-route recreation.

Other Known Habitat Threats

Pectis imberbis occurs on roadways and is threatened by road maintenance, road widening, and erosion (Phillips et al. 1982b). Populations of this species “could be eliminated by road maintenance” (Phillips et al. 1982b). Fishbein and Warren (1994) suggest that roadside habitats may be sink populations for this plant. It is threatened by weed control along roadways in the Coronado National Forest (FS 2004b). It is also potentially threatened by currently proposed road decommissioning projects on the Coronado (FS 2009b, 2009c). Because so few populations of this species are known, the extirpation of any population would be significant to the survival of the species.

Competition and habitat degradation from the spread of invasive buffelgrass (*Pennisetum ciliare*) threaten *P. imberbis*, as both these species prefer disturbed habitats and roadcuts. Buffelgrass invades both valleys, lower slopes, and steep rocky hillsides and is expanding very rapidly (Arizona-Sonora Desert Museum 2010). Beardless chinch weed is threatened by buffelgrass itself and by removal efforts. Buffelgrass control efforts are escalating, including aerial herbicide applications which threaten non-target species such as *P. imberbis* (eg. Garcia and Conway 2007).

Ongoing and accelerating deforestation threatens this species in Mexico (Fishbein and Warren 1994). It is also threatened in Mexico by agriculture, drug cultivation, and aerial spraying of herbicides in drug control efforts (Felger and Wilson 1999).

Disease or Predation

Pectis imberbis is threatened by herbivory from cattle (Phillips et al. 1982b, Deecken 1992, Fishbein and Warren 1994, FS 2003, 2004, 2005, 2006, SWCA 2009). Because of small population size (as few as 4 plants), grazing could extirpate entire populations of this rare species, which is known from only 14 sites rangewide.

Inadequacy of Existing Regulatory Mechanisms

Pectis imberbis is a Federal Species of Concern but this designation provides no regulatory protection. It is not protected by Arizona Native Plant Law (Phillips et al. 1982b). It is a Forest Service Sensitive Species, but protections afforded to the plant in this category are discretionary and the Forest Service has not taken actions to protect this plant from grazing, road maintenance, motorized recreation, noxious weed control, or other threats. The Forest Service has acknowledged

that individuals may be impacted by grazing, but has failed to consider the impacts of grazing on a cumulative basis. Because there are only approximately a dozen populations of this species, and because population size is small, impacts on individuals represent threats to populations, and the survival of every population is important to the survival of the species.

Keil (1982 pers. comm., cited in Phillips et al. 1992b) recommends Federal Threatened status for *P. imberbis* due to its distribution in small, localized populations and grazing threats.

If this plant is still extant in Mexico, there are no existing regulatory mechanisms there which would protect the species from the multiple threats it faces (Felger and Wilson 1999).

Other Natural or Anthropogenic Factors

Pectis imberbis is vulnerable to extinction because only 9-14 populations have been documented rangewide, and population size is small, ranging from 4 -100 individuals. Several populations have already been extirpated. Fragmented plant populations are at increased risk of extinction (Lennartsson 2002). Small population size makes this species vulnerable to site disturbing activities (U.S. Forest Service 1991) and stochastic genetic and environmental events including drought, fire, flooding, and climate change (Phillips et al. 1992b, Matthies et al. 2004). Annual precipitation in the region has been less than average since 1995, resulting in severe drought conditions locally and regionally (Westland Resources 2007, p. 3). Global climate change is expected to increase the frequency and intensity of severe weather events such as droughts and to create drier overall conditions, threatening the survival of rare species such as beardless chinch weed (U.S. Global Change Research Program 2009). Global climate change will also likely reduce the population viability of rare plants such as beardless chinch weed (Maschinski et al. 2006). Small population size may also interfere with successful pollination. Larger sites of flowering plants may have a better chance of receiving enough pollinator visits and enough of the appropriate type of pollen to ensure successful fertilization and site persistence (FWS 2010).

In sum, *Pectis imberbis* is declining, highly threatened, and in dire need of Endangered Species Act protection. There are only 14 known historical populations of this species, and it is likely extirpated in Mexico and at several sites in Arizona. Remaining populations are threatened by livestock grazing, mining, road construction, and other factors.

CONCLUSION

Graptopetalum bartramii and *Pectis imberbis* are rare Arizona species that are gravely threatened by mining, livestock grazing, recreation, climate change, collection, and other factors. These two imperiled Sky Island species are not adequately protected by any existing regulatory mechanisms and unquestionably qualify for Endangered Species Act protection.

REQUEST FOR CRITICAL HABITAT DESIGNATION

We request and strongly recommend that all known locations for these plant species be designated as critical habitat concurrent with species' listing. As required by the Endangered Species Act, the Secretary shall designate critical habitat concurrent with determination that a species is endangered

or threatened (16 U.S.C. 1533(a)(3A)). Critical habitat is defined by Section 3 of the ESA as: (i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the Secretary that such areas are essential for the conservation of the species. 16 U.S.C. §1532(5).

Because collection is a documented threat to *Graptopetalum bartramii*, we recommend designation of large polygons of critical habitat that are sufficiently large so as not to reveal the locations of this rare plant.

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Literature Cited

Arizona Game and Fish Department (AGFD). 2010. Heritage Data Management System.

Arizona Game and Fish Department (AGFD). 2003. *Pectis imberbis*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 5 pp.

Arizona Game and Fish Department. 2001. *Graptopetalum bartramii*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 4 pp.

Arizona-Sonora Desert Museum. 2010. Invaders of the Sonoran Desert Region. Buffelgrass (*Pennisetum ciliare*). Accessed May 20, 2010 at:
http://www.desertmuseum.org/invaders/invaders_buffelgrass.php

Augusta Resource Corporation. 2010. Rosemont Copper. Accessed May 14, 2010 at:
<http://www.augustaresource.com/section.asp?pageid=7158>

Coronado Planning Partnership. 2008. State of the Coronado National Forest: An Assessment and Recommendations for the 21st Century.

Deecken, T. 1991, 1992, 1994. Species Occurrence Records. *Pectis imberbis*. Arizona Game and Fish Department.

Felger, R.S. and M.F. Wilson. 1999. Northern Sierra Madre Occidental and its Apachian outliers: a neglected center of biodiversity. p. 36-59 in: DeBano, L.F., ed. Biodiversity and the Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico. 669 pp.

Fishbein, M. and P. Warren. 1994. Population studies of sensitive plants of the Lone Mountain Ecosystem Management Area, Coronado National Forest, Arizona.

Fonseca, J. 2009. Draft Review of Talus Snail (*Sonorella*) Occurrence and Threats in Pima County. Pima County Office of Conservation Science and Environmental Policy. April 2009. Arizona Game and Fish Department (AGFD). 2003. *Pectis imberbis*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 5 pp.

Garcia, V. and C. J. Conway. 2007. Glyphosate Applications to Control Buffelgrass in Pima County: Effects on Burrowing Owls. Wildlife Research Report #2007-07. USGS Arizona Cooperative Fish and Wildlife Research Unit, Tucson, Arizona.

Kartesz, J.T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. 2nd edition. 2 vols. Timber Press, Portland, OR.

Keil, D.J. 1978. Revision of *Pectis* section *Pectidium* (Compositae: Tageteae). *Rhodora* 80:144-145.

Lennartsson, T. 2002. Extinction Thresholds and Disrupted Plant-Pollinator Interactions in Fragmented Plant Populations. *Ecology* 83(11):3060-3072.

Malusa, J. 1995. Coronado Plant Surveys 1995.

Maschinski, J., J.E. Baggs, P.F. Quintana-Ascencio, and E.S. Menges. 2006. Using Population Viability Analysis to Predict the Effects of Climate Change on the Extinction Risk of an Endangered Limestone Endemic Shrub, Arizona Cliffrose. *Conservation Biology* 20(1): 218-228.

Matthies, D., I. Brauer, W. Maibom, and T. Tschardtke. 2004. Population size and the risk of local extinction: empirical evidence from rare plants. *Oikos* 105:481-488.

McLaughlin, S.P. and J.E. Bowers. 1990. A floristic analysis and checklist for the northern Santa Rita Mountains, Pima Co., Arizona. *Southwestern Naturalist* 35(1):61-75.

Moore, L.B. 2010. Southern Arizona Desert Plants. Accessed May 11, 2010 at: <http://www.mineralarts.com/cactus/graptopetalum.html>

Nabhan, G.P., E. Saucedo Monarque, P. Olwell, P. Warren, W. Hodgson, C. Gallindo-Duarte, R. Bittman, and S. Anderson. 1989. Plants at risk in the Sonoran Desert: an international concern. Introduction and a preliminary list. *Agave* 3(3): 14-15.

Newman, T. 1997. Email to Emilia Falk. Subject: *Pectis*. August 14, 1997.

Phillips, A.M., B.G. Phillips, N. Brian, J. Mazzoni, L.T. Green. 1982. Status Report: *Graptopetalum bartramii* Rose. Submitted to U.S. Fish and Wildlife Service Albuquerque. May 20, 1982.

Phillips, A.M. III, B.G. Phillips, L.T. Green III, J. Mazzoni and N. Brian. 1982b. Status report on *Pectis imberbis* Gray. For U. S. Fish and Wildlife Service. Albuquerque, New Mexico. 13 pp.

Pima County Administrator. 2009a. Letter to Tom Vilsack, U.S. Department of Agriculture. Re: Rosemont Mine. September 1, 2009.

Pima County Administrator. 2009b. Letter to Jeanine Derby, Coronado Forest Supervisor. Re: Alternatives Analysis: Rosemont Environmental Impact Statement. September 30, 2009.

Pima County Office of Conservation Science and Environmental Policy. 2008. Multispecies Conservation Plan Draft 5. Dec. 24, 2008.

Sky Island Alliance. 2007. Website. Accessed May 11, 2010 at:
<http://www.skyislandalliance.org/explore.htm>

Stolp, B. 2003. Email communication. Subject: Research Permit on the Coronado National Forest. April 19, 2005.

SWCA Environmental Consultants. 2009. Biological assessment, Rosemont Copper Mine Project. Prepared for Coronado National Forest May 2009. Accessed April 27, 2010 at:
http://rosemonteis.us/techreports/biological_asses_swca.pdf

Tumacacori Wild. Undated. The Border and Wilderness: The Tumacacori Highlands Wilderness Proposal. Accessed May 19, 2010 at: <http://www.tumacacoriwild.org/border.html>

U.S. Fish and Wildlife Service. Undated. Endangered and Threatened Wildlife and Plants Determination that *Graptopetalum bartramii* is a Threatened Species. Office of Endangered Species, Albuquerque, New Mexico. Provided to the Center for Biological Diversity via Freedom of Information Act Request.

U.S. Fish and Wildlife Service. 2009. Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered With Critical Habitat; Proposed Rule. 74 FR 66865.

U.S. Fish and Wildlife Service. 2010. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to Delist *Cirsium vinaceum* (Sacramento Mountains thistle). 75 FR 30757. June 2, 2010.

U.S. Forest Service. 2010. Scoping Notice: Proposed Forest Plan Amendments to achieve consistency with the Travel Management Rule. Coronado National Forest. May 21, 2010.

U.S. Forest Service. 2009. Coronado National Forest Ecological Sustainability Report. Southwestern Region February 2009.

U.S. Forest Service. 2009b. Scoping Notice: Decommissioning of unauthorized roads on the Nogales Ranger District. Accessed May 27, 2010 at:
<http://www.fs.fed.us/r3/coronado/forest/projects/environ/environ.shtml>

U.S. Forest Service. 2009c. Scoping Notice: Decommissioning of unauthorized roads on the Santa Catalina Ranger District. Accessed May 27, 2010 at:
<http://www.fs.fed.us/r3/coronado/forest/projects/environ/environ.shtml>

U.S. Forest Service. 2008. Memorandum of Understanding between Coronado National Forest and Rosemont Copper Company.

U.S. Forest Service. 2008b. Environmental Assessment Santa Catalina Mountains Allotments Analysis. Samaniego Ridge, Cañada del Oro, American Flag, Interocean, Finley Springs, Redington Pass and Bellota Allotments. Santa Catalina Ranger District, Coronado National Forest Pima and Pinal Counties, Arizona.

U.S. Forest Service. 2008c. Biological Evaluation Authorization of Grazing on the Barboot, Big Bend, Boss, Bruno, Hunt Canyon, Lower Rucker, Pedregosa, and Rak Grazing Allotments Douglas Ranger District Coronado National Forest May 12, 2008.

U.S. Forest Service. 2008d. Environmental Assessment Barboot, Big Bend, Boss, Bruno, Hunt Canyon, Lower Rucker, Pedregosa and Rak Grazing Allotments Douglas Ranger District, Coronado National Forest Cochise County, Arizona.

U.S. Forest Service. 2008e. Biological Evaluation Pine, Pinery, Paradise, Cave Creek, Upper Rock Creek, Lower Rock Creek and Turkey Creek Allotments Douglas Ranger District Coronado National Forest January 2008.

U.S. Forest Service. 2008f. Biological Evaluation for Forest Service Sensitive Species, Management Indicator Species, Neotropical Migratory Birds and Important Bird Areas Authorization of Grazing on the Fourn, Granite Springs, Half Moon, Noonan, Reppy, Slavin, and Walnut Springs Allotments, Dragoon Mountains, Douglas Ranger District Coronado National Forest Cochise County, Arizona June 2008.

U.S. Forest Service. 2008g. Environmental Assessment Whetstone Mountains Allotments Analysis Benson, Coal Mine, Knear, Mescal, Middle Canyon and Wakefield Allotments

Sierra Vista Ranger District, Coronado National Forest Pima and Cochise Counties, Arizona.

U.S. Forest Service. 2008h. Notice of intent to prepare an Environmental Impact Statement for the Rosemont Copper Project, Coronado National Forest. March 13, 2008. 73 FR 13528.

U.S. Forest Service. 2007a. Biological Evaluation Authorization of Grazing on the American Flag, Interocean, Finley, Samaniego, Canada del Oro, Redington Pass, and Bellota Grazing Allotments Santa Catalina Ranger District Coronado National Forest Pima and Pinal Counties, Arizona December 2007.

U.S. Forest Service. 2007b. Biological Evaluation Horseshoe, Sulphur Draw, Sanford and Cienega Allotment Management Plans Douglas Ranger District Coronado National Forest Cochise County, Arizona April 2007.

U.S. Forest Service. 2007c. Environmental Assessment Horseshoe, Sulphur Draw, Sanford and Cienega Allotments Douglas Ranger District, Coronado National Forest Cochise County, Arizona.

U.S. Forest Service. 2007d. Environmental Assessment Alisos, Oak Bar and Santa Cruz Allotments Analysis Sierra Vista Ranger District, Coronado National Forest Santa Cruz County, Arizona.

U.S. Forest Service. 2007e. North Chiricahua NEPA Group Biological Evaluation September 6, 2007.

U.S. Forest Service. 2007f. Biological Evaluation Authorization of Grazing on the Last Chance, Barney, Fresno, Happy Valley, Cumero, Rock Pile, Rincon and Agua Verde Allotments Santa Catalina Ranger District Coronado National Forest Pima and Pinal Counties, Arizona December 2007.

U.S. Forest Service. 2006. Biological Evaluation O'Donnell, Post Canyon, Sycamore, Sawtelle, U-D and Miller Canyon Allotments Sierra Vista Ranger District Coronado National Forest Cochise and Santa Cruz Counties, Arizona March 2006.

U.S. Forest Service. 2005. Biological Evaluation Alisos, Oak Bar and Santa Cruz Allotments Grazing Authorization and Allotment Management Plans Sierra Vista Ranger District Coronado National Forest Santa Cruz County, Arizona March 2005.

U.S. Forest Service. 2004. Biological Evaluation Farrell, Harshaw, Lewis, McFarland and Weiland Allotments Grazing Authorization and Allotment Management Plans Sierra Vista Ranger District Coronado National Forest Santa Cruz County, Arizona January 2004.

U.S. Forest Service. 2004b. Environmental Assessment for Management of Noxious Weeds and Hazardous Vegetation on Public Roads on National Forest System Lands. Southwest Region. Accessed May 13, 2010 at: <http://www.fs.fed.us/r3/projects/ro/ea-noxiousweeds/ea-weedsch4.html>

U.S. Forest Service. 2003. Biological Evaluation Duquesne, Lochiel and Hayfield Allotment Management Plans Sierra Vista Ranger District Coronado National Forest Santa Cruz County, Arizona January 2003.

U.S. Forest Service. 1991. LMP Monitoring Report 1986-1991 Sensitive Plants Coronado National Forest.

U.S. Global Change Research Program. 2009. Global climate change impacts in the United States: Southwest. Accessed May 12, 2010 at: <http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/southwest>

Van Devender, T.R. 1981. Report on Field Researches for Coronado National Forest. Arizona Natural Heritage Program.

Warshall, P. 1999. The Madrean Sky Island Archipelago: A Planetary Overview. p. 1-18 in: DeBano, L.F., ed. Biodiversity and the Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Northwestern Mexico. 669 pp.

Westland Resources, Inc. 2009. Status Report: Talussnail surveys and literature review in the Rosemont Project Area and Vicinity. Prepared for Rosemont Copper Company. September 16, 2009. Project No.: 1049.14 350 350.

Westland Resources, Inc. 2007. Mine Plan of Operations. Prepared for August Resource Corporation. Accessed April 27, 2010 at: <http://www.augustaresource.com/section.asp?pageid=6320>

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