

Higo Chumbo
(*Harrisia portoricensis*)

5-Year Review:
Summary and Evaluation



U.S. Fish and Wildlife Service
Southeast Region
Caribbean Ecological Services Field Office
Boquerón, Puerto Rico

5-YEAR REVIEW

Higo Chumbo / *Harrisia portoricensis*

I. GENERAL INFORMATION

A. Methodology used to complete the review: This review was prepared by a Service recovery biologist and summarizes information that the Service has gathered in the species file. The information consists of a status survey (Breckon and Kolterman 1994); a Master Degree thesis conducted by Santiago-Vélez (2000) from the University of Puerto Rico, Mayaguez Campus; the revision of the flora of Desecheo Island, Puerto Rico (Breckon 2000); and the flora of Monito Island, Puerto Rico (Breckon et al. 1998). On September 12, 2005, we published a notice in the *Federal Register* (70 FR 53807) announcing the initiation of the 5-year review of the plant, higo chumbo (*Harrisia portoricensis*), and requesting new information concerning the biology and status of the species. A 60-day comment period was opened. No information on higo chumbo was received from the public. We sent the review to botanical experts in Puerto Rico (see List of Peer Reviewers section). Comments, suggestions and additional information and references received from botanical experts from the Caribbean Island National Wildlife Refuge (NWR) and species experts were evaluated and addressed as appropriate (see Appendix A). Editorial comments were incorporated into the review accordingly.

***Please see our new signature page is included on page 19. On August 22, 2016, the Service published a notice in the Federal Register (81 FR 56692), requesting new information concerning the biology and status of this species. We did not receive new information from the public. However, all information we have gathered in the time since our last five-year review is outlined in Appendix B along with our current recommendation of status.*

B. Reviewers

Lead Region: Kelly Bibb, Southeast Region, Atlanta, Georgia. (404) 679-7132.

Lead Field Office: Marelisa Rivera, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico. (787) 851-7297, extension 231.

C. Background

1. Federal Register Notice citation announcing initiation of this review:
September 12, 2005; 70 FR 53807.

2. Species Status: 2009 Recovery Data Call; Stable. In 2009, changes in species distribution and habitat conditions had not been reported. All islands where the species is present are managed for conservation. The Service is re-starting a monkey eradication program and a goat control program in the Desecheo NWR for the benefit of native flora and fauna, including higo chumbo. The Service is also initiating a program to reintroduce the species within its natural range in the main island of Puerto Rico.

3. Recovery Achieved: 1 (1 = 0-25% recovery objectives achieved)

4. Listing History

Original Listing

FR notice: 55 FR 32252

Date listed: August 8, 1990

Entity listed: Species

Classification: Threatened

5. Review History:

August 8, 1990 Final Rule (55 FR 32252), Recovery Plan for Higo Chumbo (*Harrisia portoricensis*), approved and signed on November 12, 1996 (U.S. Fish and Wildlife Service 1996)

The Service conducted a five-year review for the higo chumbo in 1991(56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that, if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. In particular, no changes in status were proposed for this plant.

A status survey conducted by Breckon and Kolterman (1994) provides population estimates that were not included in the recovery plan. The information on species abundance provided by Breckon and Kolterman (1994) will be considered new information and will be analyzed in this review. Information on species' biology and ecology, and habitat characteristics discussed in Breckon and Kolterman (1994) were incorporated into the recovery plan and will not be repeated in this review.

Recovery Data Call: 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009

6. Species' Recovery Priority Number at start of review (48 FR 43098): 14. At the time of listing, the higo chumbo was recognized as a species with low degree of threat because all site locations are publicly-owned and managed for conservation. Recovery potential for the species was considered to be high.

7. Recovery Plan:

Name of plan: *Harrisia portoricensis* (higo chumbo) Recovery Plan.

Date issued: November 12, 1996.

II. Review Analysis

A. **Application of the 1996 Distinct Population Segment (DPS) policy:** Higo chumbo is a plant and, therefore, not covered by the DPS policy. The other DPS questions will not be addressed further in this review.

B. **Recovery Criteria**

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? No. Although the higo chumbo has an approved recovery plan establishing delisting as the recovery objective, it does not specify the number of new self-sustainable populations needed to delist the species.

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available (most up-to-date) information on the biology of the species and its habitat? No. The recovery plan called for new populations capable of self perpetuation to be established in protected areas such as the Guánica Commonwealth Forest or the Cabo Rojo National Wildlife Refuge, but did not establish the number of populations needed to meet the criteria. Additionally, two of the criteria mention the need for developing agreements and plan to protect the species within Commonwealth and Service protected areas. These species-specific agreements may not be needed since a Cooperative Agreement between the Service and the Puerto Rico Department of Natural and Environmental Resources is in place since 1983 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico. Furthermore, managing Mona, Monito and Desecheo Islands for the conservation of fish and wildlife resources, including federally-listed species, is part of the missions of both conservation agencies managing these lands, and conservation is ensured by existing regulatory mechanisms. However, the criteria should mention the number of individuals and the specific management activities needed to ensure the species recovery in these areas.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and there is no new information to consider regarding existing or new threat)? No.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The approved plan states that higo chumbo may be considered for delisting when the following criteria are met:

1. An agreement among the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) has been prepared and implemented for the protection of the species on Mona and Monito Islands.
2. The Service has incorporated measures to protect and recover the cactus into management plans available for the Desecheo National Wildlife Refuge.
3. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas such as the Guánica Commonwealth Forest or the Cabo Rojo National Wildlife Refuge.

The first two criteria have been met. The Puerto Rico Department of Natural and Environmental Resources (DNER) has been conducting a Wildlife Restoration project funded by the Service's Federal Assistance Program in Mona for more than two decades. The intent of this program is to control feral goats and hogs for protecting higo chumbo and other federally-listed species from predation by these exotic species within the island. Additionally, DNER has approved laws and regulations to protect federally-listed species within Commonwealth jurisdiction (see C.2.d for further detail). The Desecheo Island is a National Wildlife Refuge managed by the Service as a conservation area. Although the refuge does not have an approved Comprehensive Conservation Plan (CCP), the Service has conducted efforts to manage fish and wildlife resources on the island. Between 1998 and 2003, the Service removed 7,987 goats from Desecheo as part of the management efforts to protect the island's fish and wildlife resources, particularly federally-listed plants from predation by this exotic species (USFWS, unpublished data, 2003). Between 2008 and 2009, the Service entered into an agreement with Island Conservation to control invasive species in Desecheo. As part of the project, 90% of the monkeys were removed from the island (Silander, USFWS, personal communication 2009).

The Service has started the process of developing CCPs for all refuges in Puerto Rico and the US Virgin Islands, including the CCP for the Desecheo NWR.

Criterion 3 has been initiated. In May 2009, the Service in collaboration with DNER and the University of Puerto Rico planted twenty-five individuals of higo chumbo at the Boquerón Commonwealth Forest, Los Morillos area. This project constitutes the first steps of establishing additional self-sustaining populations in protected areas. Additional introductions are planned for the near future.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Species' abundance, population trends, demographic features, or demographic trends

The higo chumbo is a slender, upright, columnar cactus, endemic to Puerto Rico, which belongs to the family Cactacea. When the higo chumbo was listed in 1990 and the recovery plan approved, the species was known from only three offshore islands in Puerto Rico; Mona, Monito and Desecheo. These islands are managed by the Service and DNER as refuges and natural reserves. A historic collection was reported from one locality in the main island of Puerto Rico, to the west of Ponce. However, it has been reported as extirpated from the main island (Breckon and Kolterman 1994; Fish and Wildlife 1996; Santiago-Vélez 2000). No population estimates were available at the time of listing, nor were discussed in the recovery plan.

Breckon and Kolterman (1994) conducted a status survey for the species. In Desecheo National Wildlife Refuge, they estimated that the species occupied one third of the island (40 ha or 98.8 acres) and that there are about 430 adult plants and 120 juvenile plants for a total population size, excluding seedlings, of about 550 plants. They defined "juvenile plants" as those that are unbranched, undamaged, and less than 0.5 m (19.7 in) tall. The existence of individuals of different sizes indicates that reproduction and recruitment are occurring. Additionally, fertile plants were observed during phenological observations, documenting an increased percentage of fertile plants from February to April. The presence of dead individuals provides evidence of population turnover in Desecheo (Breckon and Kolterman 1994). Breckon (2000) documented that 31 percent of the flora in Desecheo has been extirpated in the past 27 years. Breckon (2000) also reported that the population of higo chumbo decreased during the three year study period (1994-1997). He reported the species as common to scattered on the south-facing coastal slopes above Canoas and around mouth of East Valley, extending to east-facing coastal slopes where it is rarer. However, he reported the higo chumbo absent from the west and north sides of the island. Breckon (2000) reported the death of a number of large plants caused by Hurricane Hortense (September 10, 1996). He did not find evidence of goats damaging the species, but monkeys were observed breaking off and eating the upper part of a young stem during a severe dry spell in March 1996. Santiago-Vélez (2000) reported that the population in Desecheo has dramatically diminished; she only reported less than five individuals on the island. In 2003, close to nine individuals were reported on the northeast slope of the island (Joseph Schwagerl, USFWS, pers. comm. 2006). This last observation represents approximately 1.6 percent of the individuals observed in 1994.

Breckon and Kolterman (1994) proposed a minimum estimate of 20,280 plants (14,040 adults and 6,240 juveniles) in Mona Island. Breckon and Kolterman (1994) suggested that the species is more abundant than their estimates suggest since they observed that the species occurs at a higher density in the Cactus Forest and also occurs in other types of vegetation, including Plateau Forest, Depression Forest, Cliffside Forest and the Plateau Shrub Forest. Julissa Rojas-Sandoval (CATEC, personal communication, 2009) estimated the population of higo chumbo in Mona Island at approximately 59,000 plants.

In Mona, Breckon and Kolterman (1994) reported indicators of reproduction, recruitment and population turnover. Flowering and fruiting were observed more active during the late spring and early summer.

The species is also present in Monito Island. Breckon et al. (1998, p.134) reported the species as common in Monito Island, but did not provide a population estimate in Monito Island. They reported many individuals with damage, probably from Hurricane Hortense, and the plant apparently not as abundant in 1997 as in 1994. They observed saplings and seedlings. Julissa Rojas-Sandoval (CATEC, personal communication, 2009) estimated approximately 148 individuals of higo chumbo in Monito Island. All individuals observed were adults, no seedlings nor juveniles were observed in the island.

b. Genetics, genetic variation, or trends in genetic variation

Population genetics for the species was examined by Santiago-Vélez (2000) by using starch gel electrophoresis, particularly allozyme-isozyme electrophoretic techniques. The main purpose of this study was to determine the genetic variability and structure, within and among populations of higo chumbo. She sampled 24 individuals in each sampling site (Mona, Monito and Desecheo Islands) for a total of 72 individuals. Allele frequencies for the 15 enzymes assayed in all three populations of higo chumbo showed no variation for any of the individuals assayed. This means that genetic variability at the individual, population, and species level in higo chumbo is absent. However, Santiago-Vélez (2000) concluded that this was not unexpected for the species given the species is short lived and the populations are small and isolated. The apparent paucity of pollination and the species' ability to form viable seeds without pollination, suggest to the author that higo chumbo is either self-compatible, and capable of auto-pollination or that it is apomictic. Apomictic processes mimic many of the events of sexual reproduction and give rise to fertile seeds. The fertile seeds that result from apomictic reproduction contain embryos that have, barring mutation, a genetic constitution identical to that of the female parent (Santiago-Vélez 2000). Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009a) discarded apomixes, but suggest that this species most likely has a wind-aided self-pollination mechanism. The authors found that progeny resulting from natural and self-pollination experiments showed signs of inbreeding depression compared with progeny resulting from cross-pollination; however, the magnitude of the inbreeding

depression was less than 50 percent (Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman 2009a).

c. Taxonomic classification or changes in nomenclature

No new information exists regarding changes in nomenclature or taxonomy.

d. Spatial distribution, trends in spatial distribution, or historic range

The species since listed is restricted to three islands; Mona, Monito and Desecheo. However, small efforts have been conducted to introduce the species in the Cabo Rojo National Wildlife Refuge and Caja de Muertos Natural Reserve in Ponce, Puerto Rico. At present time, only one individual of higo chumbo is present in the Cabo Rojo National Wildlife Refuge (J. Schwagerl, USFWS, pers. comm. 2006), and about 5 plants in Caja de Muertos Natural Reserve (Kolterman, UPR, pers. comm. 2006). In 2009, the Service in collaboration with DNER and the University of Puerto Rico planted twenty-five individuals of higo chumbo at the Boquerón Commonwealth Forest, Los Morillos area.

e. Habitat or ecosystem conditions

Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009b) suggest that in Mona Island, two common native shrub species (*Croton discolor* and *Reynosa uncinata*) may operate as nurse plants for seedlings of higo chumbo. The authors conducted seed germination and seedling transplantation experiments. They reported that none of the seeds sown in open sites with direct sunlight exposure germinated. Seeds placed in shade treatment in the field (under *C. discolor*) germinated, although at lower rate than under laboratory conditions. Additionally, the authors reported a higher percent of seedling survival beneath the canopy of *R. uncinata* and *C. discolor*. Based on these field experiments, the authors concluded that suitable conditions for germination and establishment of higo chumbo seedlings occur in shaded areas beneath the canopy of native shrubs.

f. Other relevant information

Santiago-Vélez (2000) also studied aspects of reproductive ecology, including phenology, pollination, seed dispersal and propagation. She documented that the species may flower any time during the year; however, peak flowering typically was from May to July. Bud production appeared to be triggered by rainfall. Small flower buds would persist for weeks before expanding and opening usually after a heavy rain. Santiago-Vélez (2000) did not find evidence that the flower would open for more than one night. Observations indicate that the species does not have to open its flowers to set fruit with viable seeds, thus indicating it is not an obligate outcrosser, and is capable of either apomixis or autopollination. She observed moth and caterpillars visiting flowers in Mona. Only seeds collected from droppings of the pearly-eyed thrasher (*Margarops fuscatus*) feeding on higo cumbo's fruits in

Mona germinated. Seeds collected from other bird's feces [Greater Antillean grackle (*Quiscalus niger*) and the yellow-shouldered blackbird (*Agelaius xanthomus*)] did not germinate. None of the cuttings collected in the field survived in the greenhouse.

Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009a) documented general aspects of the pollination biology and breeding system of higo chumbo in Mona. The authors found that higo chumbo has a partially self-compatible breeding system. More than 76 percent of seeds in the population studied were produced through selfing (Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman 2009a).

Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009a) reported animal visits to flowers as very infrequent. During 322 hours of direct observations and videotaping for 38 different plants, the authors only recorded five visits in five different plants. Visits were performed by the hawkmoth species *Pseudosphinx tetrio*. All the recorded visits lasted one second or less. The authors indicate that hawkmoths are unlikely to be effective pollinators given that the visits were of very short duration, and the proboscis of *S. tetrio* in Mona Island are very short relative to the length of higo chumbo corollas (Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman 2009a). The authors suggest that this species most likely has a wind-aided self-pollination mechanism. They propose that wind-aided self-pollination is the only mechanism that can explain the high levels of fruit production in the population of higo chumbo in Mona (Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman 2009a).

Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009a) conducted different pollination treatments, including: natural pollination, autogamy (covered flowers), artificial self-pollination, artificial cross-pollination and agamospermy (flower buds were bagged, and when flowers opened they were emasculated (pollen removed) and bagged again immediately after emasculation. Natural and artificial pollination treatments yielded fruits although the percentage is higher for natural pollination. There was no evidence of auto-fertilization of flowers or asexual production of fruits. Overall, the authors found 23% difference between the natural pollination and the cross-pollination treatments in the proportion of flowers that set fruit, and 18% difference between the cross-pollination and self-pollination treatments. Additionally, the authors found that seeds from the natural pollination and self-pollination treatments were significantly smaller and lighter than seeds from the cross-pollination treatment (Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman 2009a). The authors detected higher fruit fitness on fruits produced by cross-pollination.

2. Five Factor Analysis

(a) Present or threatened destruction, modification, or curtailment of its habitat or range;

When the species was listed in 1990, the Service identified habitat destruction and modification as one of the most significant factors affecting the species. Although the species was restricted to three protected islands, the Service discussed past land use proposals for Mona and Monito and previous military use of the Desecheo National Wildlife Refuge. At present time, Mona, Monito and Desecheo Islands are designated as conservation areas by the Commonwealth of Puerto Rico and the Federal government. Several Commonwealth and Federal laws and regulations protect the species and its habitat within these three protected areas. Mona and Monito islands have been managed by the Puerto Rico Department of Natural Resources as a natural reserve since 1973. The Desecheo National Wildlife Refuge was established in 1976. The Service does not anticipate present or threatened habitat destruction within these protected areas, thus we believe that this factor should not be considered a present threat for the species.

(b) Overutilization for commercial, recreational, scientific or educational purposes;

In the final rule, taking for these purposes was not documented as a factor in the decline of the species. Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates trade of all American species of cactus. At present time, we are not aware of overutilization of this species for commercial, recreational, scientific or educational purposes. We believe that this factor should not be considered a present threat for the species.

(c) Disease or predation;

Damage by the larvae of the cactus moth (*Cactoblastis cactorum*), feral pigs and goats was identified in the listing rule as threats for the species. The cactus moth occurs naturally in the northern parts of Argentina, in Uruguay and Paraguay, and in the southern parts of Brazil. The moth was introduced into Australia and South Africa, and from there has spread to the Caribbean islands and the United States. Cactus moth larvae live and feed communally inside the flat pads of most prickly pear cactus in the genus *Opuntia* (Zimmermann et al. 2005). The presence of the cactus moth has been documented in Monito and Desecheo Islands and was probably responsible for the extirpation of *Opuntia repens* on both islands (Breckon et al. 1998; Breckon 2000). At present time, there is no information suggesting that the cactus moth is affecting the higo chumbo.

In Desecheo National Wildlife Refuge, Breckon (2000) documented predation of higo chumbo by rhesus macaques. The monkeys were observed breaking off and

eating the upper parts of a young stem during a severe dry spell in March 1996. Breckon (2000) observed at least 11 macaques in a single troop in the island. He did not find evidence of goat damage on the species. Breckon and Kolterman (1994) documented damage of higo chumbo individuals by goats in Mona Island, however, based on their observations, the goats do not appear to represent a major source of damage to the plants. Damage of higo chumbo by feral pigs is not documented in the studies reviewed.

Beginning in 1998, the columnar cactus within the Commonwealth Guánica Forest in southern Puerto Rico exhibited symptoms of malformations due to unknown reasons. These malformations progressively extended to the majority of the individuals of Sebucán (*Pilosocereus royenii*) within the forest. In 2008, the Puerto Rico Department of Agriculture identified the infestation by the *Harrisia* cacti mealybug (*Hypogeococcus pungens*) as the cause of these malformations (Cannals, DNER, unpublished data 2009). Currently, the infestation has extended along the southern coast of Puerto Rico, from Cabo Rojo to Yabucoa.

The mealybug is native to the region of Argentina where it has natural predators. It was imported to Australia and used as a biological control of the *Harrisia* cactus in Queensland. Later it was used in South Africa for the control of *Cereus jamacaru* and *Harrisia marlinii*. It is not clear how the insect reached the West Indies, but the trade of ornamental plants is one possible explanation. The female is almost sessile and typically lays the eggs at the growing tip or meristem of the branches. This creates a change in the hormone production within the plant that leads to the production of new branches by lateral buds. Subsequently these new branches are infested and the continuous production of new branches generate a tumor like structure. Observations on infested individuals indicate the plants reduce the production of flowers and fruits and, therefore, the natural recruitment of the species is diminished. Furthermore, infected individuals of *Pilosocereus royenii* die within few years. This pest usually affects the apex or meristem of the plant, stimulating lateral buds that are eventually affected by the insect (ARC-PPRI 2002).

Individuals of higo chumbo cultivated at Cabo Rojo National Wildlife Refuge have been infected severely and introduced plants have died rapidly. Although this pest has not been observed within the islands harboring the natural population of higo chumbo, personnel from the Puerto Rico Department of Agriculture understand that the insect may reach these islands in the near future.

Julissa Rojas-Sandoval (CATEC, personal communication, 2009) observed that 40 percent of adult individuals of higo chumbo marked in Mona Island and 88 percent of individuals marked in Monito Island, present tissue lesions caused by the infestation by a non-identified insect. She observed that infested plants die in four months.

Based on the above, disease and predation should be considered as the major threat to the species. Based on the limited distribution of the species, we consider the threat high and imminent.

(d) Inadequacy of existing regulatory mechanisms;

In the final rule, the inadequacy of existing regulatory mechanisms to protect the species was identified as a threat. In 1999, the Commonwealth of Puerto Rico approved the Law # 241 known as the “Nueva Ley de Vida Silvestre de Puerto Rico” (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve and enhance both native and migratory wildlife species; declare property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, regulate hunting activities, and regulate exotic species among others. In 2004, the DNER approved the “Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico” (Regulation 6766) to regulate the management of threatened and endangered species in Puerto Rico. The higo chumbo has been included in the list of protected species and designated as vulnerable. This regulation under Article 2.06 prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico.

The habitat on which the higo chumbo depends is protected by the Commonwealth of Puerto Rico and the Service. Mona and Monito Islands were declared as Natural Reserves by the Commonwealth of Puerto Rico, and managed for conservation by the DNER since 1973. The Desecheo Island was established as National Wildlife Refuge in 1976. The protection and management of these areas as natural reserves and refuges, respectively, is ensured by local and Federal statutes.

Based on the presence of local laws and regulations protecting this species and its habitat, we believe that inadequacy of existing regulatory mechanisms should no longer be considered a threat.

(e) Other natural or manmade factors affecting its continued existence;

Breckon et al. (1998) and Breckon (2000) observed damages on higo chumbo individuals in Desecheo and Monito Islands caused by Hurricane Hortense. However, tropical ecosystems and species are adapted to these natural events. We consider the level of this threat to be low.

Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (2009b) identified the spreading of exotic guinea grass (*Megathyrsus maximus*) as a threat to the species in the south eastern side of Mona Island. Based on experiments conducted by the authors, they found that only 15 percent of the seedlings growing beneath the shade of the guinea grass survived and the diameter of seedlings growing beneath the guinea grass was significantly lower than seedlings growing under native shrubs.

The authors concluded that habitat microenvironmental conditions beneath the canopies may play a primary role in the germination, establishment and growth of higo chumbo on Mona. Effects to these habitat conditions may affect the recruitment of higo chumbo on the island.

At present time, Julissa Rojas-Sandoval and Elvia Meléndez-Ackerman (CATEC, personal communication, 2009) are conducting research on the possible effects of climate change on higo chumbo on Mona Island. Results of these studies are pending for publication in 2010. They have observed that recruitment stages (seeds, seedlings and juveniles) are very vulnerable to changes to microclimatic conditions. For that reason, the authors believe that higher temperatures caused by climate change in Mona may adversely affect natural recruitment. Additionally, increased rainfall events may affect flower development. The authors reported abortion of 30 percent of the flower buds after heavy rains in September 2009 (associated to storm Omar).

Based on the above, we believe that higo chumbo is currently threatened by other natural and manmade factors.

3. Synthesis

Based on the information gathered and analyzed for this review, the distribution of higo chumbo has not changed since the species was listed. At present time, three populations of this endemic cactus are known to occur in three discrete and protected islands: Mona, Monito and Desecheo. However, additional efforts are currently being conducted by local and Federal agencies to introduce the species in three additional protected areas; the Cabo Rojo National Wildlife Refuge, Caja de Muertos Natural Reserve in Ponce, and the Boquerón Commonwealth Forest. The species is considered very abundant on Mona (between 20,000 to 50,000 individuals), but in low numbers in Monito (less than 150 individuals) and very rare in Desecheo. In recent years, the population of higo chumbo in Desecheo has dramatically diminished. The last observation in 2003 reported nine individuals, approximately 1.6 percent of the individuals observed in 1994. Based on genetic tests, genetic variability at the individual, population, and species level in higo chumbo is very low or absent.

The recovery plan approved in 1996, established three recovery criteria for delisting. The first two recovery criteria established the creation of agreements to protect the species within Mona, Monito and Desecheo. We consider that these criteria have been met because there are appropriate mechanisms to protect the species and its habitat within its current distribution, including 1) the existing legal statutes designating Mona and Monito as natural reserves and Desecheo as a National Wildlife Refuge; 2) current management plans and activities on the islands; 3) existing Cooperative Agreements between the Service and DNER to establish

vigorous endangered species programs in Puerto Rico; and 4) present laws and regulations protecting the species and its habitats.

The recovery plan also established that delisting may occur when new populations capable of self perpetuation are established in protected areas such as the Guánica Commonwealth Forest or the Cabo Rojo National Wildlife Refuge. However, the plan did not establish the number of populations needed to meet the criteria. Although efforts have been taken to introduce the species in Cabo Rojo NWR, Caja de Muertos Natural Reserve, and Boquerón Commonwealth Forest, only a few individuals are currently established in these areas and these individuals cannot not be considered self-sustainable populations.

Based on the analysis of the 5 listing factors, we believe that higo chumbo still meets the definition of a threatened species. The species is currently threatened by Factor C (disease and predation) and Factor E (other natural and manmade factors). Disease and predation are currently considered as the major threats to the species. In Desecheo and Mona, the species continue to be affected by predation by exotic species (e.g. monkeys, goats, feral hogs). In 2008, the Puerto Rico Department of Agriculture identified infestation by the *Harrisia* cacti mealybug affecting eight species of cacti in the Guánica Commonwealth Forest. Currently, the infestation has extended along the southern coast of Puerto Rico, from Cabo Rojo to Yabucoa. Although this pest has not been observed within the islands harboring the natural population of higo chumbo, personnel from the Puerto Rico Department of Agriculture understand that the insect may reach these islands in the near future. On Mona Island about 40 percent of adult studied individuals of higo chumbo and 88% of individuals studied on Monito Island present tissue lesions caused by an unidentified insect. Infested plants have been observed to die in four months. The effects of hurricanes and climate change may also threaten the species.

III. RESULTS

A. Recommended Classification: Higo chumbo should remain listed as threatened. No change in status is recommended.

IV. Recommendations for Future Actions

1. Establish the number of self-sustainable populations needed to delist the species.
2. Continue control of exotic species in Desecheo and Mona.
3. Continue propagation efforts to introduce individuals in Desecheo to augment existing population, and establish additional populations in protected areas. Due to the current threat of infestation of wild populations with the *Harrisia* cacti mealybug, priority should be given to the establishment of a seedbank to ensure the availability of healthy plants.

4. Continued monitoring of current populations is needed to detect presence of infestation with *Harrisia* cacti mealybug.
5. Conduct surveys in Monito and Desecheo to establish the current population number.

V. References

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Appendix A

Summary of peer review for the 5-year review of Higo Chumbo / *Harrisia portoricensis*

This 5-year review was reviewed internally by Carlos A. Diaz and Edwin E. Muñiz from the Caribbean Field Office; and Susan Silander and Joseph Schwagerl from the Caribbean Islands National Wildlife Refuge. They mostly provided editorial comments that were incorporated into the review. Once the comments were added to the document, it was sent to six outside peer reviewers via electronic mail. The outside peer reviewers were chosen based on their qualifications and knowledge of the species. We indicated our interest in all comments the reviewers may have about the higo chumbo, specifically in any additional information on the status and current threats to the species.

Comments were received by e-mail and telephone conversations from two researchers currently conducting studies on the species in Mona Island. Comments consisted of additional information, study results and references on the species biology, ecology and threats. All information provided and references were incorporated into the review as appropriate.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Higo Chumbo / *Harrisia portoricensis*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

 X No change is needed

Review Conducted By: Marelisa Rivera, Caribbean Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve Edwin Muiz Date 15 Jan 2010

REGIONAL OFFICE APPROVAL:

Acting

Lead Regional Director, Fish and Wildlife Service

Approve Anna L. Velez Date 1-20-10

The Regional Director must sign all 5-year reviews, unless the authority has been delegated by the Regional Director.

FY 2017 APPROVAL*

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approved Edwin Muiz Date 2/6/2018

In 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.

Field Supervisor signature on this document reflects:

1. We have no new information received, no new public comments, and the original five factor analysis remains an accurate reflection of the species current status.
2. X We have obtained a small amount of new information that we have summarized in Appendix B, received no new public comments, and the original five factor analysis remains an accurate reflection of species current status.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of “Higo Chumbo” *Harrisia portoricensis*

Appendix B. Summary of new information obtained since the 2010 5 Year Review.

1. Update information

Harrisia portoricensis or Higo Chumbo was extirpated from the main island of Puerto Rico. The only known natural populations are found on the offshore islands of Mona and Monito, and the Desecheo National Wildlife Refuge (DNWR), all west of Puerto Rico (USFWS 1996). Frank (2012) suggested that Higo Chumbo must have originated from *H. divaricate* in Hispaniola and subsequently dispersed to Puerto Rico. However, additional evidence is needed to determine that relationship. Table 1 presents the most up to date number of individuals known to occur in natural populations of Higo Chumbo.

Mona

The estimates of this species reported by Rojas-Sandoval and Meléndez-Ackerman (2013a) for Mona Island are higher than those reported (20,280 individuals) by Breckon and Kolterman in 1994 (Table 1). Rojas-Sandoval and Meléndez-Ackerman (2013a) used Forest Inventory and Analysis (FIA) methodology to obtain their estimates. The FIA survey included distribution data for the whole Island instead of just the cactus forest, which was the presumed distribution for this species initially. The FIA survey yielded density values for Higo Chumbo on Mona Island equal to 0.001 plants/m² and a population size estimate of 59,857 (SE = 1058) individuals, which Rojas-Sandoval and Meléndez-Ackerman (2013a) used to obtain their estimate. Rojas-Sandoval and Meléndez-Ackerman (2013a) also indicated that the demographic profile of Higo Chumbo in Mona Island included adults (59%), juveniles (34%), and seedlings (7%) stages, suggesting that some recruitment is occurring.

Monito

The first population estimate of Higo Chumbo on Monito Island is from 2007-2009 (Rojas-Sandoval and Meléndez-Ackerman, 2013a). They estimated the population in approximately 149 individuals and suggested that the population structure was mostly composed of adults, seedlings were absent. In 2014, biologists from the U.S. Fish and Wildlife Service (USFWS), Puerto Rico Department of Natural and Environmental Resources (PRDNER), and Island Conservation (IC) conducted a rapid assessment of the Higo Chumbo population on Monito Island (USFWS 2014). They reported 136 individuals of the species distributed throughout most of Monito Island. Of these, 98 (72%) were adults and 38 (28%) were juveniles. No seedlings were documented during the assessment, nor were signs of disease or pests affecting the species were observed (USFWS 2014).

Desecheo

In late 2000, the USFWS and IC initiated a project to remove feral goats, macaque monkeys, and rats from DNWR. However, eradication efforts began decades ago. For example, the macaques eradication was initiated in 1977 (Evans 1989), with increased

efforts between 1985 and 1987, and a more recent attempt since 2009 (Figuerola-Hernández *et al.* 2017). As of December 2013, the macaque population was considered functionally extinct (i.e., reproduction ceased with only one wild macaque known to remain on the island) (Figuerola-Hernández *et al.* 2017, Hanson *et al.* in press). Goat removal was initiated in 1976, with most individuals being removed between 1998 and 2003, the last individuals were removed in 2009 (C. Hanson pers. obs., cited in Figuerola-Hernández *et al.* 2017). Then, in 2012 IC initiated a project to eradicate invasive rodents from Desecheo Island, with a second attempt in 2016 (Figuerola-Hernández *et al.* 2017). The restoration program and conservation actions implemented in Desecheo resulted in the eradication of goats, macaque monkeys and rodents, and the Island was declared free of invasive vertebrates in 2017 (Figuerola-Hernández *et al.* 2017, Hanson *et al.* in press).

The main goal of these efforts was to restore the native biological community of this Island, thus, the ecological integrity of the DNWR. Between 2010 and 2013, IC, Effective Environmental Restoration Inc. (EER) and USFWS biologists conducted several assessments for Higo Chumbo on the Island. The assessments included tagging and GPS coordinates of each individual, systematic monitoring on population structure, and overall status of the population (Figuerola-Hernández *et al.* 2017). After four years of continuous monitoring, they reported 72 individuals of Higo Chumbo with increments in height and branches throughout the study years (Figuerola-Hernández *et al.* 2017). During the most recent visit to Desecheo in February 2018, IC documented approximately 40-45 new individuals of Higo Chumbo, including adults and juveniles (C. Figuerola-Hernández, IC, pers. comm., 2018). From the 72 individuals reported in 2017, during this trip IC found 25 dead. However, they were able to observe several other individuals that were not tagged due to inaccessibility (C. Figuerola-Hernández, IC, pers. comm., 2018).

Table 1. Number of individuals observed in natural populations since 2009.

Location	Number of individuals	Year	Source
Mona Island	Approx. 59,000	2009	Rojas-Sandoval and Meléndez-Ackerman 2013a
Monito Island	149	2007-2009	Rojas-Sandoval and Meléndez-Ackerman 2013a
Monito Island	136	2014	USFWS 2014
Desecheo NWR	72	2013	Figuerola-Hernández <i>et al.</i> 2017

2. Five Factor Analyses

- (a) **Present or threatened destruction, modification, or curtailment of its habitat or range.**

At the time of listing, habitat modification and destruction were identified as the main threats to Higo Chumbo. At present, the species is restricted to three protected islands (i.e., Mona, Monito and Desecheo). The Service does not anticipate present or threatened habitat destruction within these protected areas, thus we believe that this factor should not be considered a present threat for the species.

(b) Overutilization for commercial, recreational, scientific, or educational purposes.

This factor is still not considered a threat to the species at this time.

(c) Disease or predation.

At present, Monito and Desecheo Islands are considered free of invasive vertebrates (USFWS 2014, Figuerola-Hernández *et al.* 2017), but feral invasive species (i.e., goats, pigs) continue to be present on Mona Island, impacting its ecosystem and the native flora and fauna of the Island (Rojas-Sandoval 2010). Although Rojas-Sandoval and Meléndez-Ackerman (2013a) documented some natural recruitment of Higo Chumbo in Mona Island, they stated it is affected by predation and trampling of seedlings and juveniles by feral goats and pigs, which caused about 20% mortality of these two size classes.

In 2010, lesions in Higo Chumbo caused by hemipteran *Leptoglossus* sp. were reported on Mona Island (Rojas-Sandoval 2010). This insect has been observed laying eggs and feeding on branches and main stems of this cactus, causing damages that eventually led to bacterial and fungal infections, which may kill Higo Chumbo plants within a few months (Rojas-Sandoval 2010, Rojas-Sandoval and Meléndez-Ackerman 2013a). A total of 85% of adult plants (total plant length > 50 cm) and 32% of juvenile plants (total plant length > 10 cm) were affected in different forms (e.g., tunnels, holes, rotting, or dry tissues) (Rojas-Sandoval 2010, Rojas-Sandoval and Meléndez-Ackerman 2013a). Lesions increased progressively, resulting in necrosis of branches and main stems that drop off entirely, causing an adult mortality rate of 93% (Rojas-Sandoval and Meléndez-Ackerman 2013a). Interestingly, no seedlings were found with lesions (Rojas-Sandoval and Meléndez-Ackerman 2013a).

In Monito Island, Rojas-Sandoval and Meléndez-Ackerman (2013a) documented lesions in more than 95% of the Higo Chumbo plants they monitored. This is consistent with what O. A. Monsegur (USFWS biologist) found in 2014. About 90 % of the tagged individuals showed evidence of lesions and in average, the individuals with six branches and that were multiple branched presented noticeable damage and necrosis to stems and branches (USFWS 2014).

According to Rojas-Sandoval and Meléndez-Ackerman (2013a), although the number of Higo Chumbo individuals in Mona Island is substantial and higher than previously reported, tissue damage can be an important threat for the species, which can be more relevant to the smaller Monito Island population.

Another potential threat to Higo Chumbo is the *Harrisia* cacti mealybug (HCM; *Hypogeococcus pungens*). Although this pest has not yet been recorded in the islands of Mona, Monito, and Desecheo, it has been documented in Puerto Rico affecting different species of the Cactaceae family (Segarra-Carmona *et al.* 2010). This mealybug infests the apical meristems area of the stems, producing abnormal stem growth of the plants, and affects the production of flowers and fruits, eventually causing the plants to stop growing and dying (Segarra-Carmona *et al.* 2010, ARC-PPRI 2002). Mealybugs spread through various means including wind, water, rain, birds, and humans (Mani and Shivaraju 2016). Therefore, there is potential that HCM reached the islands of Mona, Monito, and Desecheo transported by the recent hurricanes Irma and Maria.

(d) Factor D. Inadequacy of existing regulatory mechanisms.

Based on the existence and implementation of local laws and regulations protecting all listed species, and the current occurrence of Higo Chumbo in protected reserves, we continue to believe that inadequacy of existing regulatory mechanisms is not a current threat to Higo Chumbo.

(e) Factor E. Other natural or manmade factors affecting its continued existence.

As reported in the previous 5 year status review (2010), the natural recruitment of seedlings of Higo Chumbo in Mona Island is compromised by competition with the African Guinea grass (*Megathyrsus maximus*). This invasive species could alter microclimate and nutrient cycling of the habitat that Higo Chumbo depends on (Rojas-Sandoval and Melendez-Ackerman 2012). On Mona Island, these authors demonstrated that suitable conditions for germination and establishment of Higo Chumbo seedlings had higher probabilities of survival and grew better when they were transplanted beneath the canopy of native shrubs rather than beneath the exotic grass species. In addition, the modification of micro-environmental conditions by the invasive grass may lower the probability of recruitment and establishment of Higo Chumbo (Rojas-Sandoval and Melendez-Ackerman 2012). A demographic model was developed to evaluate how the invasive grass *M. maximus* affects the population dynamics of Higo Chumbo (Rojas-Sandoval *et al.* 2016). Overall, models predicted that Higo Chumbo populations in grass-invaded areas might become extinct in the next 14-59 years, suggesting that the long-term persistence of this cactus may be linked to the fate of the grass invasion and the ability of Higo Chumbo's population growth is severely limited (Rojas-Sandoval and Melendez-Ackerman 2013b, Rojas-Sandoval *et al.* 2016).

In October 31, 2017, staff from the Caribbean National Wildlife Refuge, IC, and EER visited DNWR to assess Desecheo Island after hurricanes Irma and Maria struck Puerto Rico and continued its path very close to Desecheo. The conclusion of the assessment was that the Island was not significantly impacted and disturbed by the hurricanes (Figuerola-Hernández 2017). They found the canopy was open in areas and many of the trees lost all their foliage, but the vegetation was re-sprouting and with flower buds. In the specific case of Higo Chumbo, they found some big individuals had been torn from the root, but several young individuals were growing in good conditions around the area

(Figuerola-Hernández 2017). In addition, they observed several landslides along the cliffs surrounding the valleys and on the northern and eastern slopes of Desecheo. In February 2018, IC visited the Island of Desecho again and found that most of the Higo Chumbo individuals that had been torn by hurricane Maria were resprouting (C. Figuerola-Hernández, IC, pers. comm. 2018).

Although no current information is available about the effects of hurricanes Irma and Maria on the islands of Mona and Monito, due to its limited distribution and relatively low number of natural populations, we consider the cumulative effects of hurricanes and exotic and invasive species (plants and animals) to be detrimental to the Higo Chumbo.

Synthesis

This 5-year status review provides an update on the population status of Higo Chumbo since the previous 2010 5-year review. The distribution of Higo Chumbo has not changed since the species was listed (i.e., Mona, Monito and Desecheo islands). On Mona, the latest study indicates that the population size of the species is approximately 59,000 individuals. In 2014, the USFWS in collaboration with PRDNER, and IC, documented a total of 136 adult Higo Chumbo individuals in Monito Island where no seedlings or juveniles were recorded.

The DNWR was visited regularly between 2010 and 2013 by USFWS, IC and other collaborators to evaluate the species after the removal of macaque monkeys and goats. It was documented that the Higo Chumbo population increased from few individuals in 2003 to 72 individuals and several seedlings in 2013. This increment has been attributed to the successful eradication of mammals in the Island.

Although a rapid post hurricane assessment for Higo Chumbo at the DNWR indicated that the species did not suffer significant impacts, the USFWS and IC will conduct a formal assessment to evaluate the effects of the hurricanes on the species in DNWR.

Despite the recent progress in recovery efforts, including mammal eradication on Monito and Desecheo Islands, this species continues to be limited to three offshore islands and they are vulnerable to competition of invasive grass, diseases, predation and natural events such as hurricanes.

Based on the information gathered for this review, Higo Chumbo continues to be threatened by Factor C (disease and predation), and Factor E (other natural or manmade factors affecting its continued existence). Therefore, the status of this species stills meet the definition of threatened species under Endangered Species Act.

Recommendations

- Implementation of biosecurity measures in order to avoid transporting the *Harrisia* cacti mealybug or other pests into the islands where it occurs.
- Continue monitoring the recovery of the species in DNWR.

- Establish a surveillance program for early detection of the HCM in case it invades the Mona, Monito, or Desecheo Islands.
- Conduct a study to characterize the pathology causing the lesions found in the Higo Chumbo population of Mona and Monito Islands to determine implications of this threat for the species.
- Establish a management strategy designed to control or eradicate the invasive Guinea grass.
- Continue monitoring the known populations to determine its long-term status.

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