

Recovery Plan
For
Higo Chumbo
(*Harrisia Portoricensis*)



U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

HIGO CHUMBO (*HARRISIA PORTORICENSIS*) RECOVERY PLAN

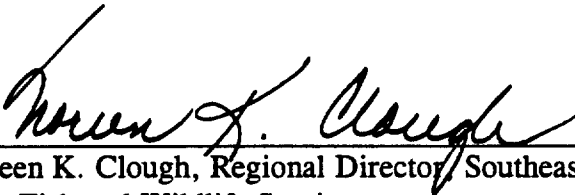
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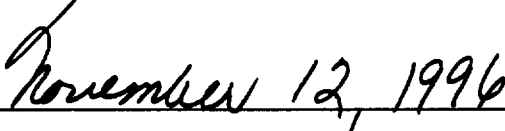
U.S. Department of the Interior
Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

Approved:



Noreen K. Clough, Regional Director, Southeast Region
U.S. Fish and Wildlife Service

Date:



November 12, 1996

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By approving this recovery plan, the Regional Director certifies that the data used in its development represent the best scientific and commercial information available at the time it was written. Copies of all documents reviewed in the development of the plan are available in the administrative record, located at the Boqueron, Puerto Rico, Field Office.

Literature Citations should read as follows:

U.S. Fish and Wildlife Service. 1996. *Harrisia portoricensis* (higo chumbo) Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 24 pp.

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EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR *HARRISIA PORTORICENSIS* (HIGO CHUMBO)

Current Status: *Harrisia portoricensis* is a slender, upright, columnar cactus, currently designated as threatened. It is usually unbranched and may reach up to 4.5 meters in height and 7 centimeters in diameter. It is currently known only from Mona, Monito, and Desecheo, all islands located in the Mona Passage between Puerto Rico and the Dominican Republic. Historically, the cactus was reported from the main island of Puerto Rico near Ponce.

Habitat Requirements and Limiting Factors: Higo chumbo is known from the several vegetation types on the island of Mona, but is most frequently observed in the cactus forest. The cactus was apparently eliminated from the Ponce area in Puerto Rico because of urban, industrial, and agricultural expansion. On Mona Island the species is threatened by proposed development and introduced animals such as feral goats and pigs. Because it is an attractive cactus, it may be subject to collection for use as an ornamental.

Recovery Objective: Delisting.

Recovery Criteria: *Harrisia portoricensis* may be considered for delisting when (1) an agreement among the Fish and Wildlife Service (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; (2) the Service has incorporated measures to protect the cactus into management plans available for the Desecheo National Wildlife Refuge; and (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.

Actions Needed:

1. Protect the existing population and its habitat through inter- and intra-agency agreements.
2. Develop or modify management plans for the species in cooperation with entities such as DNER.
3. Monitor known populations.
4. Enforce existing Commonwealth and Federal endangered species regulations.
5. Provide information to the public on *Harrisia portoricensis*.
6. Conduct research on the life history of the species and evaluate propagation techniques.
7. Conduct propagation and enhance existing populations or establish new ones on lands within protected areas in southwestern Puerto Rico.

Date of Recovery: Delisting should be initiated in 2015, if recovery criteria are met.

Recovery Costs: Recovery costs for *Harrisia portoricensis* have been estimated at \$74,000 for the first 3 years. Subsequent expenditures will depend upon the results of these preliminary studies, and therefore, can not be estimated at this time.

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PART I. INTRODUCTION

Higo chumbo (*Harrisia portoricensis*) is currently known only from Mona, Monito, and Desecheo. Mona and Monito Islands are Commonwealth Natural Reserves and the island of Desecheo is a National Wildlife Refuge. These islands are located in the Mona Passage between Puerto Rico and the Dominican Republic. Historically the cactus was reported from the main island of Puerto Rico near Ponce, but urban, industrial, and agricultural expansion resulted in the elimination of this population. On Mona Island the species is threatened by proposed development and the effects of introduced animals such as feral pigs and goats.

Higo chumbo was determined to be a threatened species on August 8, 1990, pursuant to the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1990). Critical habitat was not designated for this species because of the risks of vandalism, as well as its potential for overcollection for use as an ornamental.

Description

Harrisia portoricensis or higo chumbo belongs to the family Cactaceae, subfamily Cactoideae. The genus *Harrisia* was described in 1908 and Britton and Rose (1937) assigned the genus to the tribe Cereeae, subtribe Cereinae. According to these authors, *Harrisia* is distinguished from other genera in this subtribe by their arching or vine-like character; slender stems; and large, funnelform flowers solitary at the areoles. Two subgeneric sections were identified within the genus, of which *Harrisia* sect. *Harrisia* contains from 11 to 14 species native to Florida, the Bahamas, and the Greater Antilles.

Harrisia portoricensis was described by Britton in 1908, from a specimen collected near Ponce in southern Puerto Rico. It was described as a slender, upright, columnar cactus which is usually unbranched and may reach up to 2 meters (m) in height and 7 centimeters (cm) in diameter (Vivaldi and Woodbury 1981). Nevertheless, more recent observations indicate that the cactus may reach more than 4.5 m in height and may have as many as 40 branches. In addition, the branches may become thicker with age, particularly towards the base (Breckon and Kolterman 1994). It has from 8 to 11 ribs separated by shallow grooves. Spines from 2 to 7 cm long occur in groups about 1 to 2 cm apart (Vivaldi and Woodbury 1981).

Vivaldi and Woodbury (1981) reported that the funnel-shaped flowers, opening at night, are greenish-white and up to 13 cm in length. Breckon and Kolterman (1994) report that flower buds may reach up to 2 cm in length. Fruits are a round, yellow berry without spines with a white pulp in which numerous black seeds are immersed (Vivaldi and Woodbury 1981).

Distribution/Population Status

Harrisia portoricensis was collected for the first time from an area to the west of Ponce, known as Las Cucharas, by Britton and Cowell. The specimen was taken back to the New York Botanical Garden, and the specimen now considered to be the type was collected from that living plant (Britton and Wilson 1924; Vivaldi and Woodbury 1981). Nevertheless, most authors agree that the cactus has now been extirpated from the main island of Puerto Rico (Vivaldi and Woodbury 1981; Breckon and Kolterman 1994; Liogier 1994).

Today, higo chumbo is known only from three islands located to the west of Puerto Rico in the Mona Passage: Mona, Monito, and Desecheo (Figure 1).

Desecheo Island

Breckon and Kolterman (1994) estimate that approximately one-third (40 of 120 hectares) of the island of Desecheo is occupied by higo chumbo (Figure 2). The cactus was observed on the steep outer slopes of the island from Punta Canoas in the southwest, extending southeast and then northeast and northwest, about halfway to Corona del Norte in the north. Higo chumbo does not appear to be present between Corona del Norte and Radio Point. In a study area of approximately 4 hectares (see Figure 2), 43 adult and 12 juvenile plants (defined as less than .5 meters in height) were recorded (Breckon and Kolterman 1994).

Mona Island

Higo chumbo has been described as a dominant species in the vegetation type described by Cintrón and Rogers (1974) as "cactus forest," a vegetation type which covers approximately 39 hectares of Mona's total area of 5,521 hectares. Nevertheless, Breckon and Kolterman (1994) observed the cactus in other vegetation types, including "plateau forest," "depression forest," "cliffside forest," and "plateau scrub" (Figure 3). These authors established ten 10m X 10m plots (.1 hectare total area) in the latter vegetation type, finding a total of 36 adults and 16 juveniles in these plots.

Monito Island

Higo chumbo is known from the island of Monito (see Figure 1), but no information is available on the distribution or abundance of the species on this small island.

Reproductive Status

Preliminary observations have been made on flowering and fruiting of higo chumbo on the island of Mona. This information indicates that flowering and fruiting are

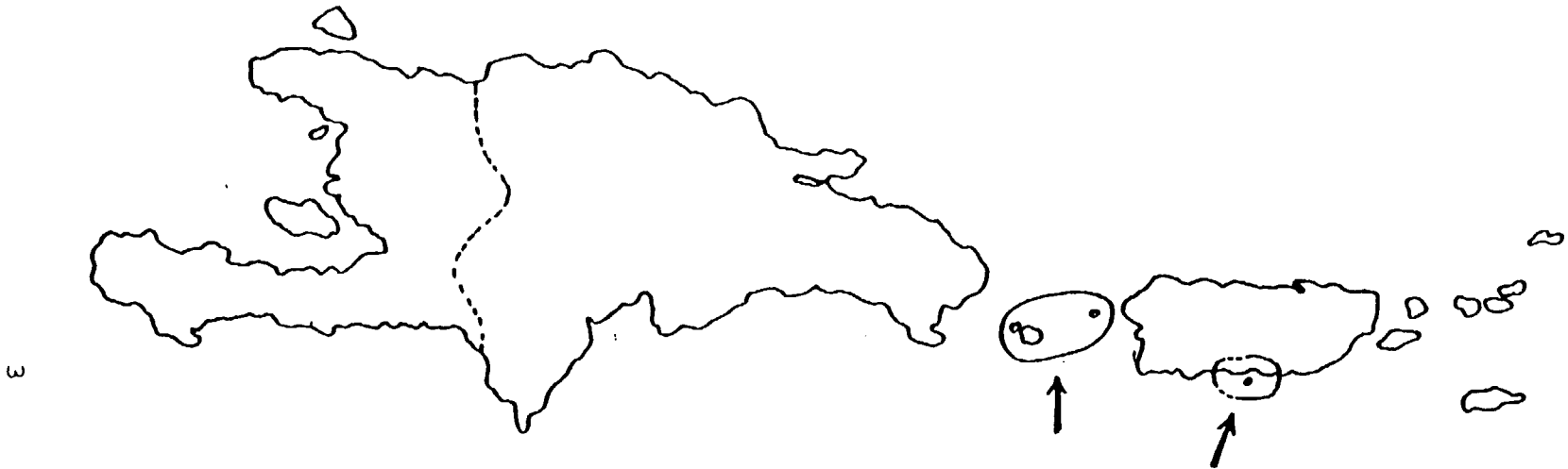


Figure 1. Distribution of *Harrisia portoricensis* Britton. The solid line represents the present distribution of the species on Desecheo, Mona, and Monito Islands; the dotted line represents its historical distribution on the southern coast of Puerto Rico, where the species has not recently been collected (from Breckon and Kolterman 1994).

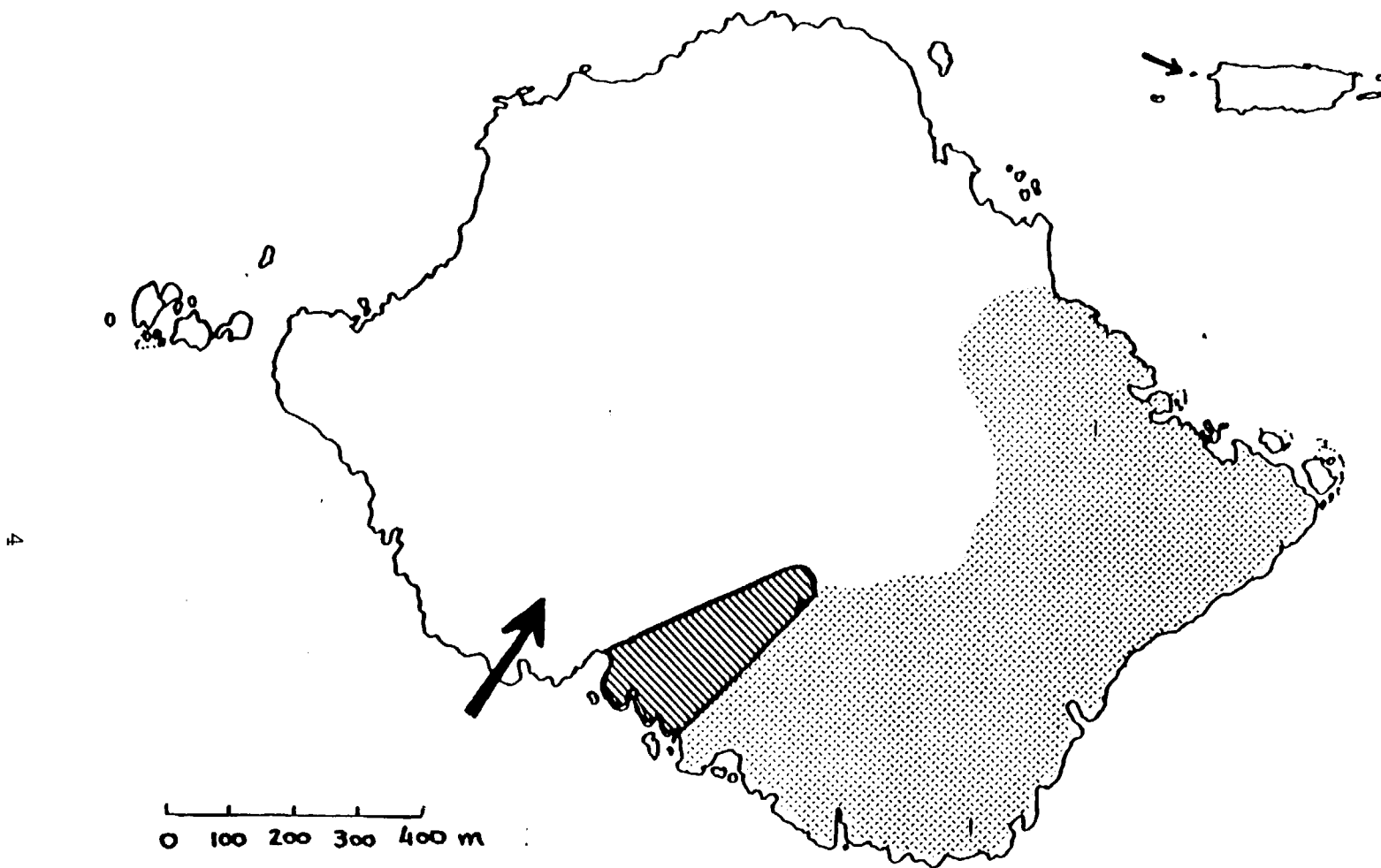


Figure 2. Map of Desecheo Island, Puerto Rico. Shading indicates the 4 ha study area in the southwestern part of the island where research on higo chumbo has been conducted. The arrow indicates the site to the northwest of the study area where several plants have been studied. Stippling represents the area in the eastern portion of the island where the cactus has been observed to be relatively abundant (from Breckon and Kolterman 1994).

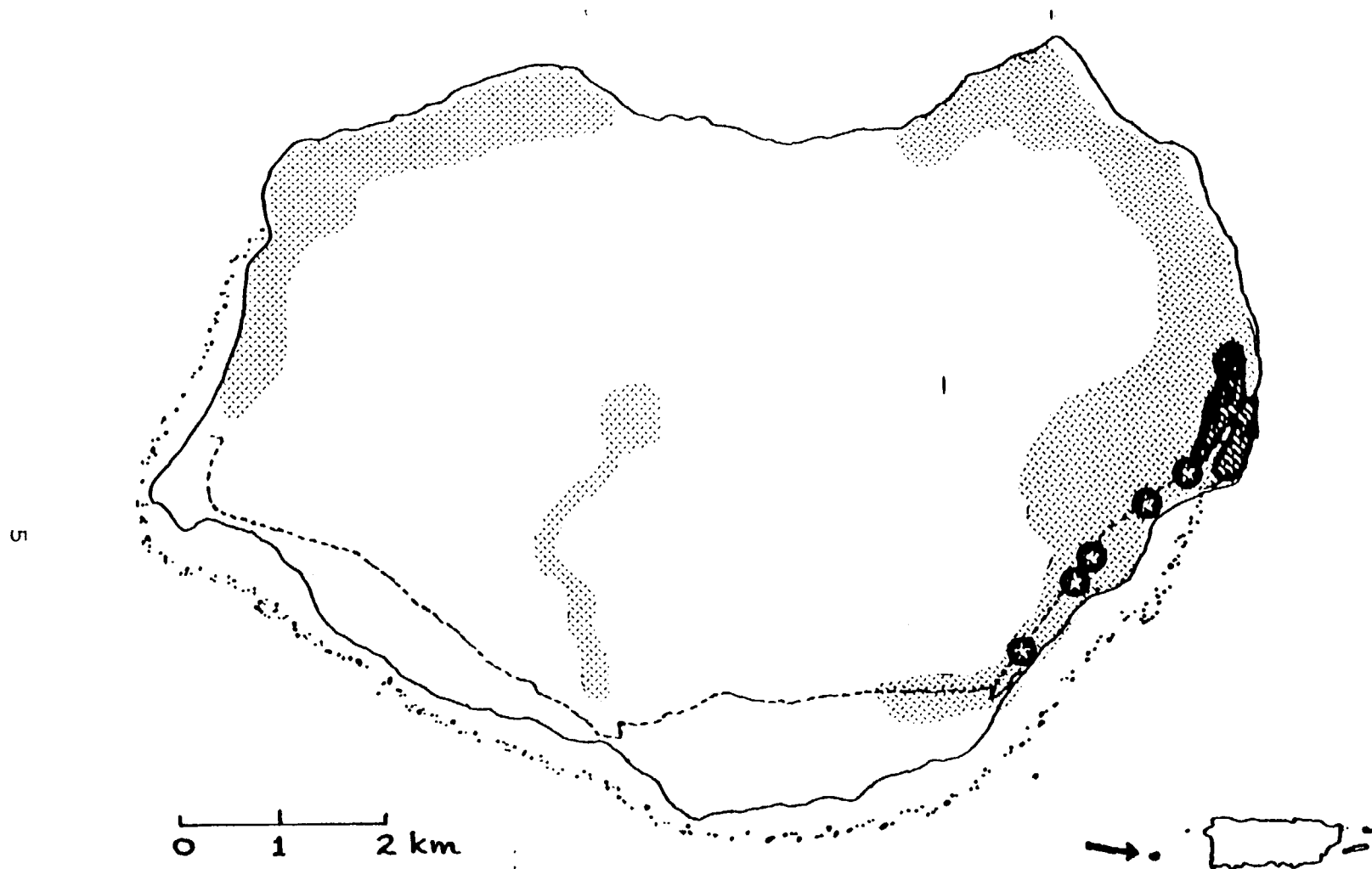


Figure 3. Map of Mona Island, Puerto Rico. Stars in solid circles indicate randomly selected points where two 10 x 10 m plots were established. Shading indicates the cactus forest where higo chumbo appears to be more common and stippling represents areas in other vegetation types where the cactus has also been observed (from Breckon and Kolterman 1994).

more active in the late spring and early summer than during early to mid-spring or fall (Breckon and Kolterman 1994). Flowers have been observed to open at about 9:30 p.m. and were at their peak by about 1:00 a.m. At that time they were approximately 20 cm long, and the expanded portion of the corolla was approximately 5 cm in diameter by 5 cm deep. Flowers began to close at about 2:30 a.m. and by the next morning they were completely closed again, but flowers may open on several successive nights. Flowers have copious watery nectar towards the base of the tube, but no apparent odor. Although not observed during the study period, bats are believed to be the principal pollinator. Moths were observed visiting the flowers. Birds, including the endangered yellow-shouldered blackbird (*Agelaius xanthomus*), were observed piercing the base of the closed corolla during the day, apparently to obtain nectar (Breckon and Kolterman 1994).

Viable seeds have been obtained from a fruit produced by a flower that never opened. Preliminary electrophoretic data, based on small sample sizes, indicate that higo chumbo may be genetically monomorphic or a clone. Individuals from Mona, Monito, and Desecheo, in this preliminary study, all have the same allelic profiles. Such information indicates that the species is capable of self-pollination or is apomitic. If, indeed, the species is genetically uniform, then new populations may be more easily initiated from cuttings than from seed. Nevertheless, the completion of ongoing studies being conducted for a M.S. thesis will provide further information (G.J. Breckon and D.A. Kolterman, pers. comm.).

The majority of mature fruits on the plants were observed to have been depredated upon by birds. Fruits which fall beneath the plants are fed upon by the threatened Mona ground iguana (*Cyclura stejnegeri*). Preliminary observations of distribution of higo chumbo show that plants are abundant near the entrances to caves, suggesting that bats that roost in the caves or birds that roost near them may be dispersing the seeds to these areas. The yellow-shouldered blackbird, as well as the pearly-eyed thrasher (*Margarops fuscatus*), have been observed feeding on mature fruits of higo chumbo (Breckon and Kolterman 1994).

During ongoing studies of reproductive biology, the germination of higo chumbo seeds in the excrement of a small, unidentified bird, was observed, indicating that seeds of the cactus can retain viability after passing through a bird's digestive system (Breckon and Kolterman 1994).

Population Structure and Dynamics

Data on population structure has been collected in study plots on both Desecheo and Mona Islands. Height was measured or estimated, the number of branches were counted and mortality, dieback, and disease were recorded. On Desecheo Island, in an area of 4 hectares, 43 adult and 12 juvenile plants (undamaged, unbranched plants less

than .5 meter in height) were located. No seedlings were found. Seven (58 percent) of the juvenile plants were found to be in the shade. On Mona Island, in ten 10 meter x 10 meter plots (total area of .1 hectare), 36 adult and 16 juveniles were recorded. Two of the juvenile plants were found growing in shaded conditions.

Plant height for adult cacti on Desecheo was bimodal, with a peak at 1.0 m and another at 2.5 m and heights which ranged from .5 m to 3.5 m. Most of the adult plants had relatively few branches, but seven (16 percent) had twenty or more. No significant correlation between plant height and the number of branches was observed. The smallest plants were found at the base of the slope in the study area and the largest near the top of the steep slopes in deeper soil. Plant height for adult cacti on Mona Island was unimodal, with a broad peak between 1.0 and 1.75 meters. Plant height ranged from .5 to 3.0 meters. Whereas no correlation was found between plant height and the number of branches on Desecheo, there was a correlation on Mona Island.

On both Mona and Desecheo, dieback and loss of branches appeared to be common, large branches were observed on the ground near some plants, but none appeared to have rooted. Smaller plants at the base of the slope in Desecheo appeared to be less healthy, with greater dieback and damage. Damaged plants on Desecheo were found to be shorter and less branched than those which were undamaged (Breckon and Kolterman 1994).

On Desecheo, 11 plants in the study area were found to have reproductive structures, whereas on Mona reproductive structures were observed on nine plants. On both islands, fertile plants were found to be significantly taller and more branched than sterile plants (Breckon and Kolterman 1994).

Habitat Description

The islands of Desecheo, Mona, and Monito are all located to the west of the main island of Puerto Rico, in the Mona Passage between Puerto Rico and the Dominican Republic. Mona Island is approximately 5,521 hectares in area, Monito approximately 16 hectares, and Desecheo about 120 hectares in size.

Of the three islands, the geology of Mona and Monito is the best known. These islands are composed of carbonaceous rocks that range from lower or middle Miocene to Holocene. The Isla de Mona dolomite and the Lirio limestone are the most abundant rocks, with the latter overlying the former (Vivaldi and Woodbury 1981). The topography of Mona is characterized by a very flat, gently sloping upland surface that is terminated by high, sheer cliffs along its northern and southern perimeters and by somewhat lower, less steep cliffs that descend to coastal lowlands in the west, southwest, and southeast. Mona consists primarily of a plateau about 100 meters above sea level, which is covered by rough, dog-toothed limestone on most of the surface and

is accentuated by loose rocks, cracks, ridges, small sinkholes, and other dissolution features. In some low areas or bajuras, deeper soils accumulate. The relief and topography of Monito are similar to that of Mona, while Desecheo is much more hilly. The soil type, limestone outcrop, covers almost the entirety of the island of Mona; nevertheless in the central part of the plateau, or in the bajuras, reddish soils which include silt loams, clay loams, and clays are found.

All three islands fall within the Subtropical Dry Forest Life Zone (Ewel and Whitmore 1973). This life zone is the driest of the six found in Puerto Rico, with mean annual rainfall ranging from 600 to 1000 millimeters. Precipitation on Mona is seasonal, with a dry season extending from January through July and a wetter season from August to December. Mean annual precipitation for the years of record reviewed by Calvesbert (1974) is approximately 80 cm. Mean daily temperature is about 87.7°F.

Cintrón and Rogers (1974) identified ten major vegetation types or plant communities on the island of Mona. These include plateau forest; plateau scrub; depression forest; plantation; coastal lowland forest; disturbed/successional; cactus/low scrub; cactus forest; cliffside; and coastal scrub. These authors describe *Harrisia portoricensis* as a dominant species in the canopy of the cactus forest type, a forest type which covers approximately 39 hectares of Mona Island. The cactus forest is dominated by tree-size cactus, which often reach over 6 meters in height. Other tree-size cactus, in addition to higo chumbo, which are found are *Lemaireocereus hystrix* (dildo español) and *Pilosocereus royenii* (sebucán). Associated shrub species include *Plumeria obtusa* (alhelí cimarrón), *Cordia globosa*, *Croton discolor*, *C. betulinus*, *Reynosa uncinata* (cascaroya), and *Corchorus hirsutus*.

The cactus has also been reported from the plateau forest, depression forest, cliffside forest, and plateau scrub vegetation types. The plateau forest covers the majority of the island and is an open shrubby association of small trees, most of which do not exceed 5 m in height. Dominant tree species in the plateau forest include *Coccoloba microstachya*, *Bursera simaruba* (ucar), *Tabebuia heterophylla* (roble), *Plumeria obtusa*, *Euphorbia petiolaris*, *Bourreria succulenta* (indio desnudo), and *Amyris elemifera* (tea). The forests of the depressions on the plateau (depression forests) are denser and trees are taller, 10 to 12 m in height, often overtopping the trees of the surrounding plateau forest. Dominant tree species include, among others, *Clusia rosea* (cupey), *Ficus citrifolia* (jagüey), and *Pisonia albida* (corcho). Where openings occur in the canopy, cacti are more frequent. Portions of the plateau which are subject to stresses such as high wind or salt spray or with extremely little soil are characterized by a shrubby growth (plateau shrub) less than 3 meters in height. Species composition of this vegetation type is similar to that of the shrub layer of the plateau forest and is dominated by species of *Croton* (Cintrón and Rogers 1974).

On the northern and eastern coasts of Mona, cliffs are sheer, undercut, and support

little vegetation. In the west and south, cliffs are less abrupt and some vegetation develops. Dominant species include *Pisonia albida*, *Capparis cynophallophora* (burro prieto), *C. flexuosa* (palinguán), *Bursera simaruba*, *Erythroxylon areolatum* (indio), and *Ficus citrifolia*. Large bromeliads are prominent on the southern cliffs.

Reasons For Listing

Harrisia portoricensis was listed as threatened in 1990. Destruction and modification of habitat have been, and continue to be, significant factors in the reduction of numbers of the species. Dry forests similar to that on Mona and Desecheo once covered much of southern and southwestern Puerto Rico. These have been destroyed or modified for urban, industrial, and agricultural development. The cactus is no longer found in the Ponce area, its type location. The islands of Mona and Monito are currently managed by the Puerto Rico Department of Natural and Environmental Resources. However, in the past, various proposals have been presented for using Mona Island as a superport and oil storage facility and as a prison. While an Administrative Order (95-8) for the establishment of public policy concerning the conservation of the islands of Mona and Monito has been approved by the Department, no formal management plan exists for the island of Mona.

Desecheo is currently protected and managed by the Fish and Wildlife Service as a National Wildlife Refuge; however, it was once managed as a breeding colony for monkeys by the National Institutes of Health. All three islands have been utilized in the past for bombing practices by the U.S. Navy.

While collecting of the species has not been documented to be a problem, collection of other species of cacti occurs even on public lands in Puerto Rico. Trade in all American species of cactus is regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Appendix II.

The larvae of the cactus moth (*Cactoblastis cactorum*) have caused damage to higo chumbo in the past; but, the moth has not been observed recently. Feral pigs on Mona Island have been observed to uproot the cactus while searching for edible roots. Feral goats on both Mona and Desecheo Islands forage on a variety of species and may be responsible for shifts in vegetation composition.

Conservation Measures

Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private agencies, groups, and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and

requires that recovery actions be carried out for all listed species. The protection required of federal agencies and the prohibitions against certain activities involving listed plants are discussed on this page.

Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as Federally endangered or threatened. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(4) requires that Federal agencies confer informally with the Fish and Wildlife Service on any action that is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat. If a species is subsequently listed, Section 7(a)(2) requires that Federal agencies ensure that any activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service.

Studies of the distribution, abundance, population size and structure, and reproductive biology are part of a Cooperative Agreement between the Fish and Wildlife Service and the University of Puerto Rico, Mayaguez Campus. A Master's thesis project on *Harrisia portoricensis* is currently ongoing. These will be continued through 1996. Preliminary results have been summarized in this recovery plan. Initial efforts at propagation of the species are also in progress.

Summary of Comments Received

A copy of the Technical/Agency Draft Recovery Plan for *Harrisia portoricensis* was sent to 13 reviewers, including three peer reviewers, for review and comment. A notice of availability of the Technical/Agency Draft was published in the *Federal Register* on September 1, 1995. Six letters of comment were received.

Dr. Gary Breckon and Dr. Duane Kolterman, of the University of Puerto Rico at Mayagüez, offered additional information on the species. Mr. Robert Matos, of the Department of Natural and Environmental Resources, provided information on the status of the islands of Mona and Monito, as well as on threats to the species. Comments that offered supplemental information have been incorporated into this plan.

PART II. RECOVERY

A. Recovery Objective

The objective of this recovery plan is to provide direction for reversing the decline of *Harrisia portoricensis* and for restoring the species to a self-sustaining status, thereby permitting it to be removed from the Federal Endangered Species List.

Harrisia portoricensis could be considered for delisting when the following criteria are met:

1. An agreement between the Fish and Wildlife Service (Service) and the Puerto Rico Department of Natural and Environmental Resources (DNER) has been prepared and implemented for the protection of the known populations on Mona and Monito Islands.
2. The Fish and Wildlife 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 Cabo Rojo National Wildlife Refuge or the Guánica Commonwealth Forest.

B. Outline Narrative

1. Prevent further habitat loss and population decline.
On Mona, Monito, and Desecheo islands, habitat and individual plants should be protected by the appropriate public agencies (DNER, Service).
11. Protect habitat.
The protection of higo chumbo's habitat where it is found on all three islands should be given priority.
 111. Develop and implement agreement between the Service and DNER for the protection of higo chumbo on Mona and Monito.
Currently no formal management plan is available for either the island of Mona or Monito. An agreement should be developed between the agencies which recognizes the presence of this species in the natural reserve and provides for its protection and long-term monitoring of growth and reproduction.
 112. Develop a management plan which provides for the protection of higo chumbo on Desecheo.
A management plan for the Desecheo National Wildlife Refuge should be developed by the Service which includes measures to protect known individuals and their habitat and provides for long-term monitoring of their growth and reproduction.
12. Monitor and protect plants.
In order to adequately protect individual plants, they must be monitored on a long-term basis. Monitoring should include observations on the impacts of introduced animals.
 121. Monitor known population.
Permanent plots on Mona and Desecheo should be established within which individual plants should be measured and marked. Basic field observations on higo chumbo in these plots will contribute to the information available on population structure and dynamics (including phenology, seed production, seed dispersal, recruitment success, site changes, and growth). Observations should consider the direct

impacts, if any, of feral goats and/or pigs on higo chumbo. The indirect impacts from shifts in vegetation composition caused by browsing also need to be studied.

122. Enforce existing Commonwealth and Federal endangered species regulations.

Because higo chumbo may be recognized by some as having horticultural value, the potential for taking may exist. Higo chumbo is currently only known from publicly owned land: Mona and Monito by the Commonwealth and Desecheo by the Service. The Commonwealth Department of Natural Resources' Regulation to Govern the Management of Threatened and Endangered Species of 1985 provides for criminal penalties for the illegal take of listed plant species on public land. In addition, development projects which occur in these areas are often funded through local or Federal agencies or require local permits. The Regulation's Section 10 provides for consultations on listed species which may be affected by a particular project similar to Section 7 of the Endangered Species Act. Section 7 of the Endangered Species Act would apply where Federal lands or federally funded or permitted projects are involved. In addition, the 1988 amendments to the Act prohibit the malicious damage or destruction on listed plants on Federal lands and the removal, cutting, digging up, or damaging or destroying of listed species in knowing violation of any Commonwealth law or regulation, including Commonwealth criminal trespass law.

123. Provide the public information on *Harrisia portoricensis*.

Information, including an illustration, for the public on *Harrisia portoricensis* will be prepared in both English and Spanish. The cactus is currently incorporated in a slide presentation on endangered species that is presented to local school groups, organizations, and agencies. Permitting and funding agencies (those potentially involved in Section 7 consultations) should be made aware of this and other

listed plants, the pertinent laws, and their responsibilities.

2. Continue to gather information on the distribution and abundance of higo chumbo on these three islands as well as on the main island of Puerto Rico.

Studies of the distribution and aspects of the life history of higo chumbo on Mona and Desecheo are currently ongoing. Such studies should be continued in order to make informed management decisions in the future and to establish recovery priorities.

21. Search for new populations.

While it is not likely that the species will be located on the main island of Puerto Rico, searches for new individuals and populations should be conducted in habitat which might have the potential to harbor individuals.

211. Identify and inventory potential sites.

Information is being collected in ongoing studies which will assist in a characterization of habitat. Based on this characterization, potential population sites should be identified and searched. The species' potential habitat will be limited in extent, presumably to the southwestern portion of Puerto Rico, therefore facilitating searches. Agencies and organizations that should be involved in these efforts include the Fish and Wildlife Service, the Department of Natural and Environmental Resources, local universities, and private conservation organizations.

212. Characterize sites to determine their suitability as future recovery sites.

If new populations are discovered, this information should be added to the database of the various agencies and organizations involved. In addition, newly discovered sites should be evaluated for the availability of propagative material and the potential for protection.

3. Conduct research.

Ongoing research with the species will identify critical aspects of the life history of higo chumbo that may require additional study.

31. Define habitat requirements.
Information available from existing studies should be evaluated to more clearly define habitat requirements.
32. Study reproductive biology and ecology of higo chumbo.
Ongoing studies have initiated research on reproductive biology and ecology of higo chumbo. Effective management and recovery of this cactus depends upon obtaining this information from these studies.
 321. Assess periodicity of flowering.
Studies should be continued to determine the frequency, timing, and abundance of flowering; pollination mechanisms; and the physical and biological factors controlling these events.
 322. Assess seed production and dispersal.
While preliminary studies indicate that the seeds are dispersed by birds, studies should be continued in order to identify agents of predation and/or dispersal.
 323. Evaluate seed viability and germination requirements.
Information on the environmental conditions required for germination should be obtained through field and laboratory studies.
 324. Evaluate requirements for establishment and growth.
Field and laboratory experiments should focus on this critical stage to determine the factors that affect establishment and survival.
33. Evaluate techniques for artificial propagation and develop propagation program.
Propagation techniques should be evaluated so that a propagation program with local nurseries may be developed.
 331. Assess methods of propagation.
Based on the availability of propagative material, economic and logistical considerations, and results

from the above research, determine the most feasible method of propagation and transplantation to existing or new sites. Sexual versus asexual reproduction should be evaluated as alternatives.

332. Develop artificial propagation program.

This species should be included in the ongoing artificial propagation program at local nurseries (e.g., the Department of Natural and Environmental Resources).

4. Establish new populations.

Areas for the establishment of new populations of *Harrisia portoricensis* should be selected and new populations established.

41. Select appropriate sites for population introduction or enhancement using artificially propagated material.

Habitat requirements must be considered in order to assure the success and relevance of transplanting propagated material.

411. Select sites and assess habitat suitability.

Using information from Task 31 above, inventory potential sites for the introduction and establishment of new populations of *Harrisia portoricensis*.

Primary consideration should be given to the introduction of higo chumbo in protected areas in southwestern Puerto Rico, such as the Guánica Commonwealth Forest, the Boquerón Commonwealth Forest (lighthouse area), the Cabo Rojo National Wildlife Refuge, or land managed by the Puerto Rico Conservation Trust (e.g., Guaniquilla).

412. Assure site protection.

If proposed sites are not already on protected land, steps must be taken to provide for their protection. Management plans for these new sites should be developed or modified to include considerations for this species.

413. Introduce and monitor plants.

Success of plantings should be carefully monitored.

5. Refine recovery goals.

As additional information on the biology, ecology, propagation, and management of *Harrisia portoricensis* is accumulated, it will be necessary to better define, and possibly modify, recovery goals.

51. Determine number of individuals and populations necessary to ensure species stability and self-perpetuation.

Environmental and reproductive studies, together with the relative success of population protection measures, will allow more precise and realistic recovery goals to be established.

52. Determine what additional actions, if any, are necessary to achieve recovery goals.

If there are any actions not included in this recovery plan which, during the recovery process become recognized species needs, they should be incorporated into the plan.

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PART III. IMPLEMENTATION SCHEDULE

Priorities in Column 4 of the following Implementation Schedule are assigned as follows:

- Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
- Priority 3 - All other actions necessary to provide for full recovery of the species.

List of Abbreviations

- DNER - Puerto Rico Department of Natural and Environmental Resources
- ES - Fish and Wildlife Service, Ecological Services Division
- LE - Fish and Wildlife Service, Law Enforcement Division
- CINWR - Fish and Wildlife Service, Caribbean Islands National Wildlife Refuge
- BotGar - Botanical Gardens
- Univ. - Universities

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURA- TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATE (\$K)			COMMENTS
				REGION	FWS DIVISION	OTHER	FY1	FY2	FY3	
1	111	Develop and implement agree- ment between Service and DNER for pro- tection of higo chumbo on Mona and Monito.	2	4	ES	DNER	No cost anticipated.			
1	112	Develop manage- ment plan which provides for the protection of higo chumbo on the island of Desecheo.	2	4	ES CINWR	DNER	No cost anticipated.			
1	121	Monitor known populations.	Cont.	4	ES CINWR	DNER Univ.	4	4	4	
1	122	Enforce existing Commonwealth and Federal endangered species regulations.	Cont.	4	ES LE	DNER	3	3	3	25 percent of DNER ranger
2	123	Provide public information on higo chumbo.	2-4	4	ES	DNER	1	1	1	

PRIO- RITY	TASK #	TASK DESCRIPTION	TASK DURA- TION (YRS)	RESPONSIBLE PARTY			COST ESTIMATE (\$K)			COMMENTS
				REGION	DIVISION	OTHER	FY1	FY2	FY3	
2	211	Identify and inventory potential sites.	2-4	4	ES	DNER	3	3		
2	212	Characterize sites to determine their suitability as future recovery sites.	2-4	4	ES CINWR	DNER Univ.				
2	31	Define habitat requirements.	2-4	4	ES	DNER Univ.	3	3	3	
2	321	Assess periodicity of flowering.	2-4	4	ES CINWR	DNER Univ.	6	6	6	6K/yr includes 321,322,323, and 324.
2	322	Assess seed production and dispersal.	2-4	4	ES CINWR	DNER Univ.				
2	323	Evaluate seed viability and germination requirements	2-4	4	ES CINWR	DNER Univ.				
2	331	Assess methods of propagation.	2-4	4	ES CINWR	DNER Univ. BotGar	2	2	2	

PRIORITY	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATE (\$K)			COMMENTS
				REGION	DIVISION	OTHER	FY1	FY2	FY3	
2	332	Develop artificial propagation program.	Cont.	4	ES CINWR	DNER Univ. BotGar	2	2	2	This species should be incorporated into ongoing efforts.
2	411	Select sites and assess habitat suitability.	2-4	4	ES CINWR	DNER Univ.		2		
2	412	Assure site protection.	2-4	4	ES CINWR	DNER Univ.				
2	413	Introduce and monitor plants.	2-4	4	ES CINWR	DNER			3	
3	51	Determine number of individuals and populations to ensure stability and self-perpetuation.	Cont.	4	ES CINWR	DNER				
3	52	Determine what additional actions are needed to achieve recovery objectives.	Cont.	4	ES CINWR	DNER				

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