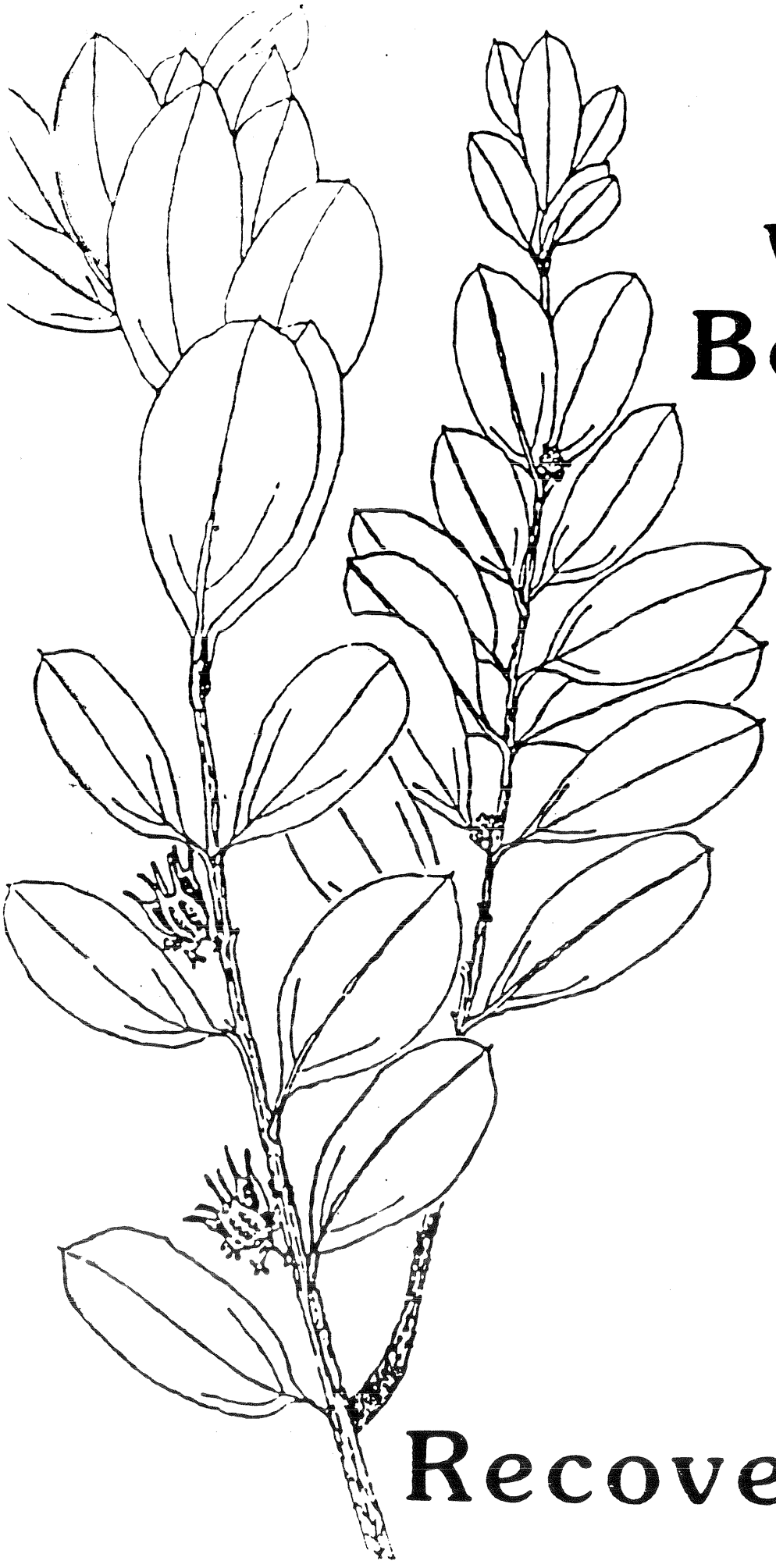

Vahl's Boxwood

Recovery Plan

VAHL'S BOXWOOD (*Buxus vahlii*) RECOVERY PLAN

prepared by

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

Approved:
Regional Director

Date: April 28, 1987

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Literature citations should read as follows:

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EXECUTIVE SUMMARY

1. Point or condition when the species can be considered recovered?

The primary objective of this recovery plan is to provide guidance for reversing the decline of Buxus vahlii and restore the species to a stable, secure, and self-sustaining condition, thereby permitting its reclassification from endangered to threatened status.

2. What must be done to reach recovery?

Protect existing populations and their habitats, and establish new populations at other protected sites in the karst region of northern Puerto Rico.

3. What specifically must be done to meet the needs of #2?

Protection of existing populations could be achieved through redesignation of private land to protective status (e.g., conservation or scenic easement), and/or the development of conservation agreements with landowners. At Punta Higüero, control of human access may be necessary. Establishment of new populations would require the study of natural reproductive processes, their application in artificial propagation, and the introduction or reintroduction of plants to ecologically appropriate and adequately protected sites.

4. What management/maintenance needs have been identified to keep the species recovered?

Existing and new populations and their habitats must be protected and managed to permit plant growth, the production of viable seed, and seedling establishment. Concomitantly, there should be a continuing search for new populations in the karst region of northern Puerto Rico.

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PART I. INTRODUCTION

Vahl's boxwood (*Buxus vahlii*) is an evergreen shrub or small tree endemic to the island of Puerto Rico, where it is known from only two locations within the karst region on the northern side of the island. Since historical records of the species include only these populations in Puerto Rico, the reasons for its extreme rarity are obscure, but can probably be attributed to the extensive deforestation and human development that have occurred throughout the lowland areas of the island. Approximately 85 plants are known to survive in the two populations, one of which is on private land, the other on land owned by the Commonwealth of Puerto Rico.

Buxus vahlii was determined to be an endangered species on August 13, 1985 (*Federal Register* 50: 32572), pursuant to the Endangered Species Act of 1973, as amended. Critical habitat has not been designated for this species because there exists the possibility of overcollection for scientific purposes and because of the species' potential ornamental value.

Description

Buxus vahlii, a member of the boxwood family (Buxaceae), was first described in 1859 by the French botanist M.H. Baillon, based on material of unknown origin previously ascribed to Crantzia laevigata by the Danish botanist Martin Vahl. Until the early 1950's, the only known locality for the species was Punta Higüero, near Rincón in northwest Puerto Rico. At that time, a second population was discovered by R.O. Woodbury in Hato Tejas, near Bayamón.

Some confusion has existed over the nomenclatural designation and distribution of Buxus vahlii, although consensus now seems to have been reached among contemporary Caribbean botanists. The type material was originally identified as Crantzia laevigata (=Buxus laevigata, a more widely distributed Caribbean species), and later properly described as Buxus vahlii by Baillon. Britton and Wilson (1923) placed the species in the genus Tricera, together with Tricera laevigata var. sancticrucis, a taxon described by H.F. Eggers in 1876 from St. Croix, now part of the U.S. Virgin Islands. Thus, Little, et al. (1974), while recognizing the determination of Baillon, followed Britton and Wilson by including St. Croix in the range of Buxus vahlii. In a more recent re-evaluation of the species' record, Vivaldi and Woodbury (1981) were unable to find

material from St. Croix that could be attributed to Buxus vahlii. Therefore, it must be assumed that the species is either endemic to Puerto Rico or has been extirpated from St. Croix.

Buxus vahlii is an evergreen shrub or small tree reaching 16 feet (5 meters) in height, with a stem diameter of 5 inches (13 centimeters). The leaves are simple, opposite, and oblong to obovate. One diagnostic character is the presence of two grooves in the stem below each node. The species generally flowers and sets seed between December and April. The flowers are small and unisexual, borne together in a cluster (an axillary raceme) on the same plant. The fruit is a three-horned capsule approximately 0.25 inches (6 millimeters) long.

Distribution

Assuming either incorrect identification or extirpation, it can be concluded that Buxus vahlii is not present on St. Croix, and is restricted to the island of Puerto Rico. On Puerto Rico, the species has been confirmed from two locations: Punta Higüero and Hato Tejas (Figure 1). A specimen collected by A.A. Heller and reported as being from the Ponce area is believed to have been mislabeled (Vivaldi and Woodbury 1981).

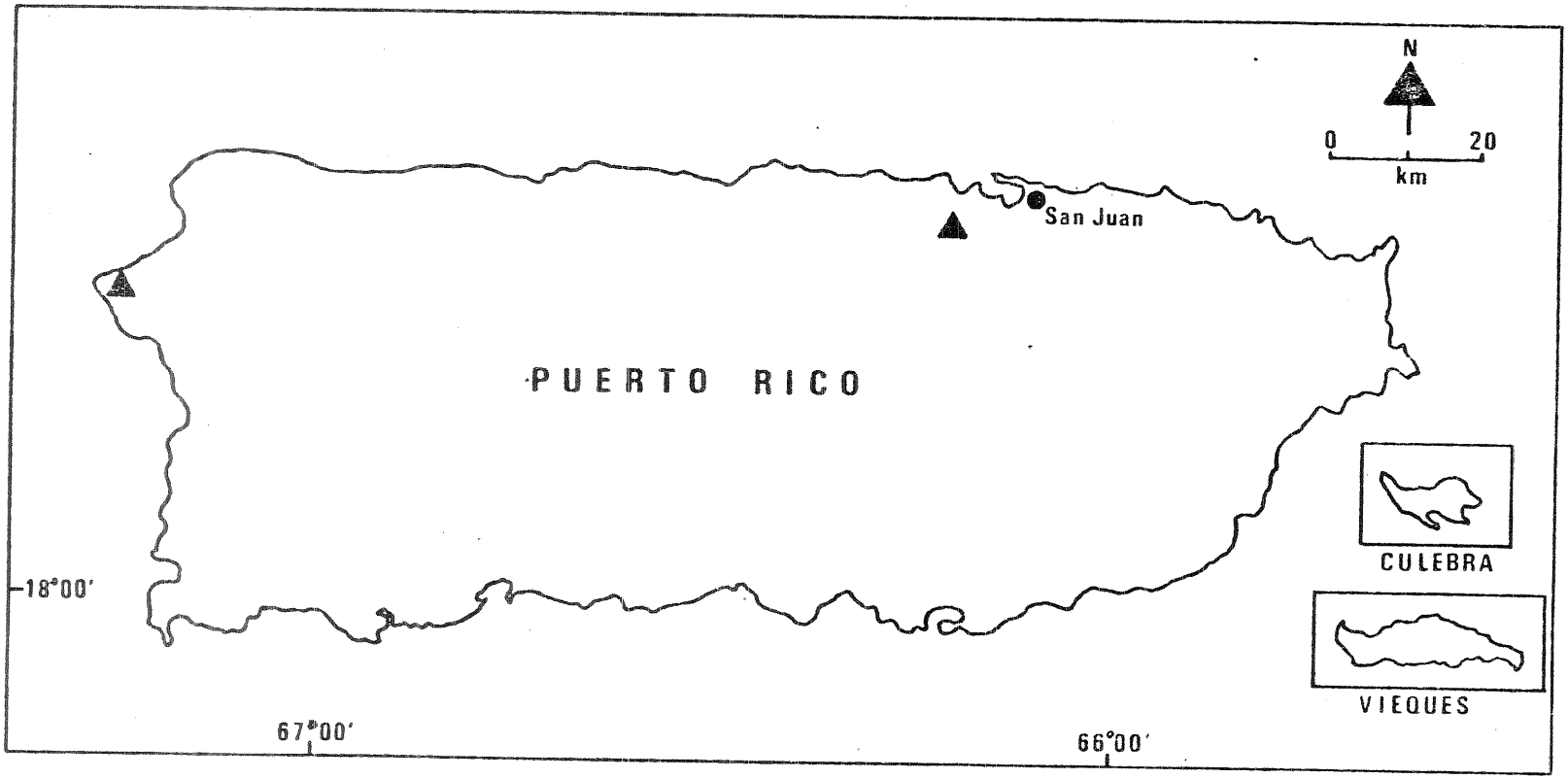

Figure 1. Present distribution of Buxus vahlii. Population locations indicated by (▲).

With only two known collection sites, Buxus vahlii appears to be a species which has never been common, although a more thorough search of the karst region of northern Puerto Rico may turn up additional populations between the two widely separated sites.

Population Status

Both of the known populations of Buxus vahlii have been surveyed several times in recent years, and can be described as follows:

1. Punta Higüero (north of Rincón) - approximately 60 individuals exist on the west side of a ravine less than 1 mile (about 1 kilometer) northeast of Punta Higüero, within 200 yards (190 meters) of the shoreline. All of the plants are of low stature (less than 5 feet or 1.5 meters in height) and are slightly chlorotic, apparently resulting from exposure to high winds, salt spray, and possibly a lack of canopy shading. This population was discovered by Paul Sintenis in 1886, and has persisted at this site for one hundred years, although it is not known how large the population was at the time of its discovery. The land is owned by the Commonwealth of Puerto Rico, and managed by the P.R. Electric Power Authority.

2. Hato Tejas (west of Bayamón) - a relatively healthy population of approximately 25 plants persists in remnant forest on private land adjacent to a major commercial development area in northeast Puerto Rico. This population was discovered by R.O. Woodbury in the early 1950's.

A total of about 85 plants exists in these two populations. Since the species is not known to regenerate vegetatively, it can be assumed that the number of stems tallied at these sites accurately reflects the number of individuals present.

Reproductive Status

There have been no studies of the reproductive biology or ecology of Buxus vahlii. The species' floral morphology suggests that pollination is effected by wind or insects, and that self-pollination is possible. The species appears to produce relatively large quantities of seed in most years. At Punta Higüero, the presence of seedlings and several size classes within the population, including many younger individuals not present during earlier surveys, indicate that recruitment has occurred at least during the past seven years. Thus there has been viable seed production, and suitable conditions for seedling establishment and growth do exist, in spite of the harsh conditions at this site.

Examination of plants within the two known populations has provided no evidence that the species regenerates vegetatively, thus it is unlikely that this mode of regeneration contributes significantly to population growth or maintenance.

Habitat Description

Buxus vahlii is restricted to semievergreen forests of the subtropical moist forest zone (*sensu* Ewel and Whitmore 1973), and has been found only below 330 feet (100 meters) elevation in the limestone hills of the karst region of northern Puerto Rico. This life zone and its associated forest types cover a greater area of Puerto Rico than any other "climatic association" (*sens. lat.*). However, because of their geographic extent, low elevation, and relatively productive soils, these lands have been nearly totally deforested, and almost all of the existing forest cover is second-growth.

The annual rainfall of subtropical moist forests reaches 80 inches (2000 millimeters). In Puerto Rico, rainfall is unevenly distributed during the year, with a distinct, bimodal wet season between May and November, followed by an extended dry season. Annual temperatures on the north coast average 25 C, with a seasonal

variation of only 3-5 C. High annual temperatures and incoming solar radiation, together with seasonal rainfall, mean that potential evapotranspiration is high and that available moisture will exceed requirements for plant growth only during the wet season (Ewel and Whitmore 1973).

The limestone karst region of northern Puerto Rico is characterized by an undulating topography of relatively low relief, but with typical karst features such as steep, rounded hills ("haystacks"), sinkholes, caves, and subterranean streams (Monroe 1976). The soils are usually limestone-derived, poorly developed, and excessively drained, although a considerable amount of alluvium originating in uplands of volcanic origin has been incorporated into bottomland soils, which show greater development and higher productivity. On the limestone hills, soil development and moisture capacity decrease with elevation, and most hills are topped with outcrops of the parent Aymamon Limestone.

At Hato Tejas, the semievergreen forest within which Buxus vahlii is found is composed of an overstory of two tree strata, with an open understory and sparse ground cover. Much of the upper canopy (dominated by Bursera simaruba or Bucida buceras) is deciduous, while most subcanopy species (largely Eugenia, Guaiacum, and/or Coccoloba spp.) are evergreen. Lianas are

common, while epiphytes are less evident than in the wetter forests of higher elevations (Vivaldi and Woodbury 1981). Associated with Buxus vahlii at this site are two other evergreen subcanopy trees, Coccoloba diversifolia and Casearia silvestris, as well as a ground cover on exposed limestone that includes the bromeliad Pitcairnia angustifolia, the cycad Zamia latifoliolata, and Anthurium acaule. The site is heavily shaded by the forest canopy and its topographic position on a steep, east-facing rocky slope. However, like most small evergreen trees of the karst region, Buxus vahlii seems well adapted to conditions of reduced light and poor soil development.

In contrast to Hato Tejas, the Punta Higüero site has been largely deforested and is occupied by small examples of tree species more typical of coastal forests (e.g., Guettarda scabra, Coccoloba uvifera, and Erithalis fruticosa), as well as several salt-tolerant shrub and herbaceous species. Some introduced species (such as Terminalia catappa) are also present. The low stature and relatively sparse, chlorotic foliage of Buxus vahlii at this site reflect increased exposure to sunlight, wind, and salt spray resulting from the absence of a well-developed canopy and the population's close proximity to the shoreline. Soil development is also poor, and there is an abundance of exposed limestone.

It is difficult to describe the role or importance of Buxus vahlii in the forest communities where it is found today, given the nearly total alteration of forest cover that has taken place over the last two centuries. Even if it is assumed that present species composition and relative dominance approximate past conditions, only two rather different examples exist of Buxus vahlii distribution and ecological importance, thus conclusions regarding species relationships and habitat requirements must be largely speculative. The fact that the surviving plants of both populations are restricted to ravines may be of ecological significance or merely an artifact of past human disturbance.

Known and Suspected Limiting Factors

Historically, the factor which has most likely been responsible for limiting the distribution of Buxus vahlii has been the nearly complete deforestation of Puerto Rico's lowlands. Most of the level ground has been converted to agriculture, while steeper, less productive land has been utilized for grazing. The most rugged or inaccessible sites (i.e., hilltops and sinkholes) have been selectively cut for wood to provide construction materials or charcoal. While the latter impacts have had a significant effect on forest habitats, the impacts have probably not been sufficient to eliminate all individuals of a particular plant species. As a result,

some of Puerto Rico's rarest plants have persisted on the limestone hills of the karst region. There is no evidence that Buxus vahlii has ever been common, but it is likely that the species was more abundant in pre-Columbian times.

More recently, population growth and urbanization have shifted economic emphasis away from traditional agricultural practices toward industrial expansion, with a resultant increase in the construction of high-density housing, roads, and service facilities. Lands formerly in cultivation which might have had the potential to revert to forest have been permanently converted to human use, while other lands supporting second-growth forests are facing a second, more devastating, human threat. Today, not only are forests cleared, but terrain is altered, and in some cases, whole limestone hills are removed to supply construction material, or to make way for housing, factories, and roads. Although these impacts have not been documented as factors which have led to the loss of any Buxus vahlii populations, it must be assumed that such losses have occurred. A portion of the Hato Tejas population was destroyed by limestone mining several years ago (Vivaldi and Woodbury 1981). In the future, rare or relictual species like Buxus vahlii will be less likely to survive these modern threats.

Threats to Future Existence

The two known populations of Buxus vahlii face a variety of specific threats related to the general problems outlined above. The Hato Tejas population is located on private land surrounded by urban and industrial developments, and is on the edge of an inactive limestone quarry. Even minor expansion of existing facilities would eliminate the remaining plants.

At Punta Higüero, Buxus vahlii is somewhat more protected than at Hato Tejas, and the threats to its continued existence at this site are more subtle. The plants are located on Commonwealth land which has been cleared and grazed in the past, and are close to private dwellings. The coastline both east and west of the ravine where the population is found is one of the most popular recreation areas on the island. Use of local beaches for camping and other activities has occasionally resulted in brushfires. If a fire were to start nearby during the dry season, it could spread to the ravine and destroy all or part of the population. More intensive use (e.g., overgrazing, construction, trash disposal) of the uplands surrounding the ravine could also have an effect on this population. The site is on the eastern edge of Commonwealth land managed by the Puerto Rico Electric Power Authority (PREPA), which at one time considered construction of a power plant nearby. Presently, PREPA is considering

designation of its land as a "green belt", and apparently does not intend to develop the site (G.A. Pottinger, pers. comm.).

Collecting of Buxus vahlii has not been documented as a factor leading to the decline of the species. However, the number of remaining plants is small enough that taking for any purpose could become a threat in the future, particularly if horticultural interest in the species develops (see below).

Cultivation Potential

Although there is no documentation that Buxus vahlii has been taken for horticultural purposes, most species in the boxwood family have been used as ornamentals. Therefore, it is possible that Buxus vahlii might eventually be recognized as having some ornamental value. Propagation from cuttings is being attempted, although it is too early to judge its success (J. Popenoe, pers. comm.), and one attempt to propagate the species from seed was unsuccessful (Vivaldi and Woodbury 1981). It is not yet known whether ex situ propagation is sufficiently feasible to provide a source of material for reintroduction of the species in Puerto Rico.

PART II. RECOVERY

A. Recovery Objective

The objective of this recovery plan is to provide guidance for reversing the decline of Buxus vahlii and restoring the species to a stable, secure, and self-sustaining status, thereby permitting it to be reclassified from endangered to threatened, and perhaps eventually allowing its removal from the Federal list.

Buxus vahlii could be considered for reclassification to a threatened species when 1) the two known populations at Hato Tejas and Punta Higüero are placed under protective status, and 2) at least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache). These must be considered minimum requirements, and should be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. On the other hand, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than propagation, to achieve a minimum number of plants.

B. Step-down Outline

1. Prevent further habitat loss and population decline.
    11. Habitat protection.
        111. Obtain protective status for the two known population sites.
            1111. Develop cooperative agreement with Puerto Rico Electric Power Authority.
        112. Control access at Punta Higüero.
    12. Plant protection.
        121. Monitor known populations.
        122. Enforce existing Commonwealth regulations prohibiting take.
        123. Educate the public on plant conservation values and regulations.
2. Continue to gather information on the distribution and abundance of Buxus vahlii in northern Puerto Rico.
    21. Continue search for new populations.
        211. Identify and inventory potential sites.
        212. Characterize sites to determine their suitability for future recovery actions.
3. Research.
    31. Define habitat requirements.

32. Determine reproductive biology and ecology of Buxus vahlii.

321. Assess periodicity of flowering and pollination mechanisms.

322. Assess seed production and dispersal.

323. Evaluate seed viability and germination requirements.

324. Evaluate seedling establishment and growth.

33. Evaluate feasibility of artificial propagation.

331. Evaluate relative feasibility of propagation from seed versus cuttings.

332. Determine feasibility of ex situ production of seed and cuttings.

34. Select appropriate sites for population enhancement, reintroduction, or introduction using artificially propagated material.

341. Assess habitat suitability.

342. Assess site protection.

3421. Proceed with designation of protective status, if necessary.

3422. Develop management plans for new sites.

4. Refine recovery goals.

41. Determine number of populations and individuals necessary to ensure species stability, security, and self-perpetuation.

    411. Determine relative importance of continued propagation and reintroduction versus habitat protection.

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

C. Outline Narrative

1. Prevent further habitat loss and population decline.

Habitats and plants at remaining population sites must be protected to prevent species extinction, maintain genetic diversity, and provide sources of propagative material.

11. Habitat protection.

Highest priority must be given to protection of existing population sites.

111. Obtain protective status for the two known population sites.

Since there are only two known populations of Buxus vahlii, at Punta Higüero and Hato Tejas, every effort should be made to develop suitable alternatives for site protection through public or private agencies (e.g., conservation or scenic easement).

1111. Develop cooperative agreement with Puerto Rico Electric Power Authority.

An alternative to redesignation of the Punta Higüero population site would be the development of a cooperative

agreement with the PR Electric Power Authority to protect and manage the site.

112. Control access at Punta Higüero.

Since the adjacent beach areas receive heavy public use, it is important that access to the population site be controlled or prohibited. Some combination of posting and fencing may achieve this goal, although these actions may also draw attention to the site.

12. Plant protection.

In addition to habitat protection, the continued health and survival of individual plants within each population should be monitored and additional steps taken to prevent human disturbance.

121. Monitor known populations.

All known populations of Buxus vahlii should be monitored at regular intervals to determine mortality (natural or human-related), observe phenology and reproductive events, assess recruitment, and identify changes in site conditions (natural or human-related).

122. Enforce existing Commonwealth regulations prohibiting take.

The Commonwealth's 1985 Regulation to Govern the Management of Threatened and Endangered Species provides for criminal penalties for illegal take of listed plant species, regardless of land status. Buxus vahlii is on the Commonwealth list, and the regulation must be enforced with regard to this species.

123. Educate the public on plant conservation values and regulations.

Federal and Commonwealth conservation agencies should take the lead in educating the public on general conservation values, with emphasis on the importance of protecting endangered plants and the existence of Federal and Commonwealth laws prohibiting collecting and vandalism.

2. Continue to gather information on the distribution and abundance of Buxus vahlii in northern Puerto Rico.

Decisions regarding management of existing populations and recovery priorities will be affected by the species' abundance and additional biological or ecological information.

21. Continue search for new populations.

The karst region of northern Puerto Rico is sufficiently rugged that the likelihood of undiscovered Buxus vahlii populations remains high.

211. Identify and inventory potential sites.

There should be a systematic evaluation and inventory of all potential population sites in northern Puerto Rico.

212. Characterize sites to determine their suitability for future recovery actions.

Where new populations are discovered, not only should new ecological and biological information be added to the existing data base, but each site should also be evaluated to determine its value as a source of propagative material and its potential for protection. If no plants are present, the suitability of the site for introduction of the species should be assessed.

3. Research.

Although the benefits of research are primarily long-term, there is so little information available on Buxus

vahlii that many studies can be directed at the near-term needs of the species.

31. Define habitat requirements.

Using information gained from study of the two known population sites, together with any additional information obtained from new sites, the habitat requirements of Buxus vahlii should be more clearly defined. Qualitative and quantitative data on site conditions (soils, microclimate, biotic associations, etc.) will be needed to guide site and species management decisions.

32. Determine reproductive biology and ecology of Buxus vahlii.

The scarcity of knowledge on the reproductive biology of this species limits management of existing populations and delays establishment of new populations.

321. Assess periodicity of flowering and pollination mechanisms.

It is necessary to determine the frequency with which flowering occurs, and the physical or biological factors controlling its timing and abundance. In addition, the species'

pollination mechanisms should be identified, and requirements for their maintenance included in the development of management plans.

322. Assess seed production and dispersal.

The numbers of seed produced and their mode of dispersal should be assessed. Seed predators and dispersal agents, and the conditions which lead to successful dispersal to "safe sites" (i.e., sites that are physically and biologically suitable for germination and growth) should be identified.

323. Evaluate seed viability and germination requirements.

It is necessary to evaluate the proportion of seed produced which are viable (based on embryo development or germinability), and the environmental conditions required for germination. This would include both laboratory and field germination experiments.

324. Evaluate seedling establishment and growth.

Conduct field experiments in conjunction with 323. above to determine suitable microsite conditions for seedling establishment and

factors affecting seedling survival, the most critical stage in recruitment.

33. Evaluate feasibility of artificial propagation.

Continue present work on artificial propagation from both cuttings and seed. This should include a preassessment of effects on the source population.

331. Evaluate relative feasibility of propagation from seed versus cutting.

Based on the availability of propagative material, economic and logistical considerations, and field success, determine the most feasible methods of propagation and transplantation to existing or new sites.

332. Determine feasibility of ex situ production of seed and cuttings.

Determine whether there is sufficient live material in ex situ cultivation to provide a less destructive source of propagative material for use in the field.

34. Select appropriate sites for population enhancement, reintroduction, or introduction using artificially propagated material.

The success and ecological appropriateness of

planting or transplanting propagative material depend upon adequate consideration of geography and habitat.

341. Assess habitat suitability.

Using information gained in 31. above, inventory potential sites to determine their suitability for supporting new or supplemental plantings of Buxus vahlii.

342. Assess site protection.

In addition to a suitable environment, the feasibility of site protection must also be considered.

3421. Proceed with designation of protective status, if necessary.

If sites proposed are not already on protected land, steps must be taken to alter the status of such land to provide protection for new species' populations.

3422. Develop management plans for new sites.

In accordance with guidelines established in 111. above, develop appropriate plans for management of new sites. If the site is already within an existing management

area, existing plans should be modified to consider the presence and needs of Buxus vahlii.

4. Refine recovery goals.

As additional information on the biology, ecology, and propagation of Buxus vahlii is gathered, it will be necessary to better define, and possibly modify, recovery goals.

41. Determine number of populations and individuals necessary to ensure species stability, security, and self-perpetuation.

Based on environmental and reproductive studies, together with the relative success of population protection measures, more precise and realistic recovery goals for this species can be established.

411. Determine relative importance of continued propagation and reintroduction versus habitat protection.

It is particularly important that there be some shift in emphasis from propagation to protection if new, self-sustaining populations are discovered.

42. 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 must 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 forseeable 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.

GENERAL CATEGORIES FOR IMPLEMENTATION SCHEDULE

Information Gathering - I or R (research)

1. Population status
2. Habitat status
3. Habitat requirements
4. Management techniques
5. Taxonomic studies
6. Demographic studies
7. Propagation
8. Migration
9. Predation
10. Competition
11. Disease
12. Environmental contaminant
13. Reintroduction
14. Other information

Management - M

1. Propagation
2. Reintroduction
3. Habitat maintenance and manipulation
4. Predator and competitor control
5. Depredation control
6. Disease control
7. Other management

Acquisition - A

1. Lease
2. Easement
3. Management agreement
4. Exchange
5. Withdrawal
6. Fee title
7. Other

Other - O

1. Information and education
2. Law enforcement
3. Regulations
4. Administration

Vahl's Boxwood (Recovery Priority #5)

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
A-2,3,6	Obtain protective status for two known population sites	111	1	5 yrs.	4	SE	PRDNR, CTPR PREPA				
M-3 A-3	Cooperative agreements with PREPA for Punta Higüero	111	1	1 yrs.	4	SE	PREPA, PRDNR				Alternative to Task 111 for Punta Higüero
I-4 O-2,3	Control access at Punta Higüero	112	2	3 yrs.	4	SE	PRDNR, PREPA	5K	5K	5K	
I-1 M-3	Monitor known populations	121	1	Ongoing/ Continuous	4	SE	PRDNR				
O-2,3	Enforce Commonwealth regulations prohibiting take	122	1	Ongoing/ Continuous	4	SE,LE	PRDNR				
O-1	Educate public on plant conservation values and regulations	123	2	Continuous	4	SE	PRDNR	1K	1K	1K	
I-1,2	Continue search for new populations	21	2	Continuous	4	SE	PRDNR	1K	1K	1K	
R-3	Define habitat requirements	31	2	3-5 yrs.	4	SE	PRDNR, Univ.	2K	2K	2K	

Vahl's Boxwood

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
R-6,14	Determine reproductive biology and ecology	32	2	3-5 yrs.	4	SE	Univ.	15K	15K	15K	Costs to include Tasks 321, 322, and 324.
R-14	Assess periodicity of flowering and pollination mechanisms	321	2	3-5 yrs.	4	SE	Univ.				
R-14	Assess seed production and dispersal	322	2	3-5 yrs.	4	SE	Univ.				
R-7,14	Evaluate seed viability and germination requirements	323	2	3-5 yrs.	4	SE	Univ., BotGar	5K	5K	5K	
R-6,14	Evaluate seedling establishment and growth	324	2	3-5 yrs.	4	SE	Univ.				
M-1,2	Evaluate feasibility of artificial propagation	33	2	Ongoing/ Continuous	4	SE	BotGar	1K	1K	1K	Costs to include Tasks 331 and 332
M-1	Evaluate relative feasibility of propagation from seed vs. cuttings	331	2	Ongoing/ Continuous	4	SE	BotGar				
M-1	Determine feasibility of ex situ production of seed and cuttings	332	2	Ongoing/ Continuous	4	SE	BotGar				

Vahl's Boxwood

Implementation Schedule

General Category	Plan Task	Task Number	Priority	Task Duration	Responsible Agency			Estimated Fiscal Year Costs			Comments/Notes
					FWS						
					Region	Division	Other	FY 1	FY 2	FY 3	
M-2,3	Select sites for enhancement, reintroduction, or introduction of propagated material	34	3	Continuous	4	SE	PRDNR				
I-2 M-3	Assess habitat suitability	341	3	Continuous	4	SE					
M-3,5 A-2,3,6	Assess site protection	342	3	Continuous	4		PRDNR, CTPR				
I-1	Determine number of populations and individuals necessary to perpetuate species' existence	41	3	5 yrs.	4	SE	PRDNR, BotGar, Univ.				
I-4	Determine additional actions necessary to achieve recovery goals	42	3	5 yrs.	4	SE	PRDNR				

LIST OF ABBREVIATIONS

BotGar = botanical gardens
CTPR = Conservation Trust of Puerto Rico
LE = Division of Law Enforcement, FWS
PRDNR = Puerto Rico Department of Natural Resources
PREPA = Puerto Rico Electric Power Authority
SE = Endangered Species Program, FWS
Univ. = universities

PART IV. APPENDIX

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