

Recovery plan for eight species of flowering plants, *Carex bermudiana*, *Peperomia septentrionalis*, *Phaseolus lignosus*, *Erigeron darrelliannus*, *Galium bermudense*, *Chiococca alba*, *Hypericum hypericoides*, *Psychotria ligustrifolia* in Bermuda



Government of Bermuda
Ministry of The Environment and Sports
Department of Conservation Services

Recovery plan for eight species of flowering plants,
Carex bermudiana, Peperomia septentrionalis, Phaseolus lignosus,
Erigeron darrelliannus, Galium bermudense, Chiococca alba,
Hypericum hypericoides, Psychotria ligustrifolia
in Bermuda

Prepared in Accordance with the Bermuda Protected Species Act 2003

Funded in part by:



Primary Author

This recovery plan was prepared by:

Samia Sarkis

Protected Species Coordinator

Department of Conservation Services

17 North Shore Road, Hamilton FL04

Bermuda

Contact: Samia Sarkis: scsarkis@gov.bm

Cover Photo: Bermuda sedge surrounded by invasive species by Alison Copeland
Department of Conservation Services, Bermuda

Published by



Government of Bermuda

Ministry of the Environment and Sports

Department of Conservation Services

December 2009

“To conserve and restore Bermuda’s natural heritage”

CONTENTS

LIST OF FIGURES.....	i
LIST OF TABLES.....	i
DISCLAIMER	ii
ACKNOWLEDGEMENTS	iii
EXECUTIVE SUMMARY	1
PART I: INTRODUCTION.....	3
A. Brief Overview	3
Historical Distribution	3
B. Current Protection Status.....	5
Local Protection	5
Habitat Protection	5
Global Protection	6
C. Taxonomy and Description of Species	6
D. Ecology	11
Habitat Requirements	11
E. Current Threats.....	13
F. Current Status.....	13
Global Distribution.....	13
Local Distribution.....	14
G. Current Conservation Action	15
PART II: RECOVERY.....	16
A. Recovery Goal	16
B. Recovery Objective and Criteria	17
C. Recovery Strategy.....	17
D. Tools Available for Strategy.....	17
E. Step-down Narrative of Workplan	18
F. Estimated Date of Down Listing	20
G. Recovery Costs.....	20
PART III: IMPLEMENTATION	21
REFERENCES.....	22

LIST OF FIGURES

Figure 1 Bermuda sedge, <i>C. bermudiana</i> . (Photo: M. Thomas)	6
Figure 2. Bermuda pepper, <i>P. septentrionalis</i> (Photo: R. Mareira)	7
Figure 3. Wild Bermuda pepper, <i>P. septentrionalis</i> . (Photo: L. Greene)	7
Figure 4. Wild Bermuda bean, <i>P. lignosus</i> . (Photo: L. Greene)	8
Figure 5. Darrell’s fleabane, <i>E. darrelliannus</i> ,	8
Figure 6. Bermuda bedstraw, <i>G. bermudense</i> (Photo: L. Greene).....	9
Figure 7. Bermuda snowberry, <i>C. alba</i> . (Photo: R. Marirea).....	9
Figure 8. St. Andrew’s Cross, <i>H. hypericoides</i> , in Bermuda. (Photo: R. Marirea).....	10
Figure 9. St. Andrew’s Cross flower, Bermuda (Photo:R. Marirea)	10
Figure 10. Wild coffee, <i>P. ligustrifolia</i> . (Photo: M. Thomas)	11
Figure 11. Darrell’s fleabane growing on Bermuda’s shore (Photo: A. Copeland)	12

LIST OF TABLES

Table 1. Bermuda status (as per IUCN criteria) for threatened native and endemic flowering plants. (E) refers to endemic, (N) refers to native.....	5
Table 2. Last recorded Bermuda locations for protected flowering plant species (J. Madeiros, <i>pers.comm</i> ; D. Wingate, <i>pers.comm</i> ; * BBP, unpub.).....	15

DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. They are as comprehensive as deemed necessary to the recovery actions outlined for bermuda. We, the department of conservation services, publish recovery plans, preparing them with the assistance of field scientists, other government departments, and other affected and interested parties, acting as independent advisors to us. Plans are submitted for additional peer review before they are adopted by us, and formulated with the approval of interested parties mentioned in parts II and III of the plan. Objectives of the recovery plan will be attained and necessary funds made available subject to budgetary and other constraints affecting the parties involved. Recovery plans do not represent the official positions of any individuals or agencies involved in the recovery plan formulation, other than our own. They represent our official position only after they have been signed by the Director of Conservation Services as approved. Approved recovery plans are subject to modifications as dictated by new findings, changes in species status, and the completion of recovery actions.

Literature citation of this document should read as follows: Sarkis S., 2009. Recovery plan for eight species of flowering plants, *carex bermudiana*, *peperomia septentrionalis*, *phaseolus lignosus*, *erigeron darrelliannus*, *galium bermudense*, *chiococca alba*, *hypericum hypericoides*, *psychotria ligustrifolia*, in Bermuda. Department of Conservation Services, Government of Bermuda. 28 pages.

An electronic version of this recovery plan will also be made available at www.gov.bm.



Acting Director
Department of Conservation Services
Government of Bermuda

13th January 2010

Date

ACKNOWLEDGEMENTS

The drafting and publication of this recovery plan was supported by an Overseas Territories Environmental Program (OTEP) grant BDA 202, for which we are grateful. Thank you to the “Plant Action Team” of Bermuda, made up of keen field botanists donating their time and sharing their knowledge and enthusiasm, allowing for the compilation of as much data as possible. Much of the information on the local distribution of these plants was made available through the experience of former and current terrestrial conservation officers, David Wingate and Jeremy Madeiros, as well as that of Robin Marirea, of the Bermuda Aquarium Museum & Zoo. Special thanks to Colin Clubbe, Martin Hamilton and Thomas Heller at the Royal Botanic Gardens Kew, London, for their verification of the taxonomy, and their assistance in developing a sound recovery plan. Many thanks to Lisa Greene for sharing with us the Museum photo collection for many of these plants, and for her assistance in the reviewing of this document. Last but not least, thank you to Alison Copeland for her final edits.

EXECUTIVE SUMMARY

Current species status:

This recovery plan addresses the need for actions to conserve eight threatened species of flowering plants, *Carex bermudiana*, *Peperomia septentrionalis*, *Phaseolus lignosus*, *Erigeron darrelliannus*, *Galium bermudense*, *Chiococca alba*, *Hypericum hypericoides*, *Psychotria ligustrifolia*, in Bermuda. All species are recorded as endemic or native to Bermuda, however their taxonomy needs to be verified. All species are listed under the Protected Species Act 2003, as Critically Endangered, Endangered or Vulnerable as per IUCN criteria. Many of the species were seen frequently and recorded to be common in early 1900s literature. Despite some conservation efforts over the past years, plant populations have declined to low levels, estimated to be in the range of 12 to 1000 mature plants depending on the species. Current legislation does also include habitat protection as long as plants inhabit areas within Parks, nature reserves or woodland reserves; this pertains to all species covered in this plan, except for *G. bermudense*, *E. darrelliannus* and *P. ligustrifolia*. Comprehensive data on population distribution, status and genetic variation is needed for these species.

Habitat Requirements and Threats:

All eight species have various habitat requirements, favouring, wooded marshy situations, shaded rocks, rocky woodlands, or hillsides. One of the major threats facing these species is the loss of habitat resulting from human development, especially for those with specialized niche requirements, like the Bermuda pepper (*Peperomia septentrionalis*). The second major threat to these endemic plant species is the presence of invasive plant species. The latter overshadow many of the threatened plants, and also chemically alter the soil, inhibiting growth of the endemic species. This has been found true namely for the Bermuda sedge (*Carex bermudiana*).

Recovery Objective:

The principal aim of this Recovery Plan is to ensure the genetic preservation of endemic species and to improve the population status of all listed species through habitat protection and the establishment of *ex situ* populations.

Recovery Criteria:

Favourable conservation status will be achieved when:

- Verification of taxonomy and population level variation are completed
- Current population distribution is thoroughly assessed
- Critical habitats are identified and listed under the Protected Species Act 2003
- Translocation of all species to a minimum of 10 sites around the island is successful
- Stable reproducing population of each species at each of the 10 sites
- Public awareness of threatened status of listed species is increased through documentation and media

Actions Needed:

1. Population level genetic analyses for each plant species
2. Long-term preservation of seed for each species at the Millennium Seed Bank
3. Survey and mapping of existing populations
4. Propagation through seed germination and/or cuttings
5. Increasing extent of occupancy through translocation
6. Ensure long-term sustainability of natural populations through engagement of the community

Recovery Costs: The total cost of recovery actions cannot be defined at this point. Funding needs to be secured, additional to the core funding obtained through government funds, for implementing the necessary research studies on the natural population status, habitat requirements, and propagation techniques for these flowering plants. Developing budgets for each action are the responsibility of the leading party as outlined in the workplan.

Date of Recovery: Verifying the current taxonomy and assessing population genetic variation of the listed species is the first step in implementing the recovery plans. For species proved not to be endemic and lacking a globally threatened status, a re-assessment for listing under the Protected Species Act 2003 will be required. Meeting the recovery objectives for the threatened plant species depends on the success of propagation and translocation, as well as on the availability of suitable habitats. At least 10 years will be allocated to evaluate the results of conservation efforts by monitoring growth, survival and reproduction of the species; down-listing will therefore first be considered at this time.

PART I: INTRODUCTION

A. BRIEF OVERVIEW

The flowering plant species, *Carex bermudiana*, *Peperomia septentrionalis*, *Phaseolus lignosus*, and *Erigeron darrelliannus*, currently considered endemic to Bermuda, and *Chiococca alba*, *Galium bermudense*, *Hypericum hypericoides*, and *Psychotria ligustrifolia* native to Bermuda are listed under the Protected Species Act 2003, as Critically Endangered, Endangered or Vulnerable as per IUCN criteria. Population levels are extremely low for the majority of these plants, and/or are fragmented making them vulnerable to a rapid decline. Suitable habitats on the whole are declining due in great part to increasing development and uncontrolled growth of invasive species.

This recovery plan discusses threats and conservation efforts for the eight plant taxa individually, summarizing current knowledge of the taxonomy, distribution, habitat requirements, biology and threats for each species. The plan recommends the ex situ preservation of genetic material through the Millennium Seed Bank and the development of a propagation programme aiming to expand the geographical distribution of these species across Bermuda. If these measures are successfully carried out, it may be possible to remove *Chiococca alba*, and *Erigeron darrelliannus* from the list, and reclassify *Carex bermudiana*, *Peperomia septentrionalis*, *Phaseolus lignosus*, *Galium bermudense*, *Psychotria ligustrifolia* and *Hypericum hypericoides* to a less threatened status.

Historical Distribution

Historical records for these endemic plant species were made by Lefroy (1884) and Britton (1918). The synopsis given below for each species is taken from Britton (1918).

Carex bermudiana: This species was reported as very rare and presumably on the verge of extinction in 1918. It was first collected by J. Dickinson circa 1699. The specimen was preserved in the Sloane Herbarium at the British Museum of Natural History and not again collected by botanists until found by Britton in the autumn of 1905. Its nearest relative was believed to be *Carex walteriana bailey* of the southeastern United States. It was suggested by Britton (1918) that the Bermuda species may have sprung from seeds of *C. walteriana bailey* transported to the island by winds or birds.

Peperomia septentrionalis: This species was recorded by Britton (1918) as being abundant on shaded rock in the areas of Tucker's Town to the Causeway and about the northern part of Harrington Sound. It was also found at the time in the cave near Smith's Parish Church and in Paget Marsh. It was then believed that the species probably had its closest relative in *Peperomia obtusifolias* (L.) of the West Indies, but differed in shorter and broader leaves and in features of its minute fruits. These differences were apparent when the two were seen growing together in greenhouses. The fruits of these plants when ripe, adhere to other objects and the species has probably originated from such fruits brought to Bermuda by a migratory bird, adhering to its feet or plumage, the plant becoming differentiated through isolation.

P. septentrionalis was first described by Stewardson Brown, in the Proceedings of the

Academy of Natural Sciences of Philadelphia 1909:490, Ja 1910, and was thought nearest to *P. magnoliaefolia microphylla* Dahlst., of West Indian mountains by this author. In the literature, it has also been referred to as *P. obtusifolia* (L.) Deitr, by Reade, and by Lefroy. *Phaseolus lignosus*: Records of the species were made in 1918 on the shorelines of Castle Harbour and Harrington Sound. There was some occurrence at Hungry Bay. It was first described by Britton himself (1918), who believed its nearest relative to be *P. polystachyus* (L.) B.S. P., of the eastern United States. More recent suggestions have been made that the species possibly arrived as seeds drifted onto Bermuda's shore (D. Wingate, *pers. comm.*).

Erigeron darrellianus: This species was recorded as common in rocky situations in 1918 (Britton, 1918). It remained botanically unnamed, until 1883, when it was published by Hemsley in the *Journal of Botany* 21:104. It was named in honour of Hon. J. K. Darrell, a prominent member of an old Bermuda family. Britton (1918) notes it as similar to *Conyza rivularis* Gardn., of Brasil.

Galium bermudense: This species was recorded as native by Britton (1918), and was found to be common on hillsides of Bermuda at the time. It was also reported in the Southeastern United States and Bahamas. It was believed that its seed was transported to Bermuda by a bird. The plant is first recorded by Plunkenet, in his "Almagestum Botaniucum" (Britton, 1918).

Chiococca alba: This species was recorded as frequent on hillsides by Britton (1918). The glossy foliage, beautiful flowers and fruit make this one of the most attractive and interesting plants of Bermuda. It was long supposed to be identical with *C. alba* of Florida and the West Indies, its nearest relative. However Stewardson Brown described the species as endemic in "Proceedings of the Academy of Natural Sciences of Philadelphia" 1909, as *Chiococca bermudiana* S. Br.. It was reported to differ from *C. alba* by lighter green foliage, larger leaves, stouter and longer pedicels and larger berries, being a much more elegant plant when in bloom. It is readily grown. It was believed that the species probably originated from seed of *C. alba* transported to Bermuda from Florida or the Bahamas by a bird, there producing plants which subsequently, through isolation, developed differently from their ancestors. However, for some time now, the name *C. bermudiana* has been considered by some (see North American Flora V. 32(4), 1934) to be a synonym of the widespread and very variable species *C. alba*. In this document, the nomenclature of the World Checklist of Rubiaceae is followed (T. Heller, *pers. comm.*).

Hypericum hypericoide subsp. *hypericoides*: Previously known as *Ascyrum macrosepalum* S. Br. In Bermuda, the species was frequent in marshes and on hillsides according to Britton (1918). He suggested that its nearest relative is *A. linifolium* Spah, of the southeastern United States and the Bahamas, from which it differs by larger leaves, larger broadly ovate cordate sepals, and in its seeds. These features were first recorded in *Journal of the New York Botanical Garden* 13:192, 1912. In his 1957 revision of the genus *Ascyrum*, W. P. Adams (*Rhodora* 59:73-95) included both *A. macrosepalum* and *A. linifolium* as a synonym of *A. hypericoides* L. var. *hypericoides*, a species with a wide variation in morphology across its distribution, attributed to varying environmental conditions. Subsequent changes have been made to the classification of these plants. In the current document, the nomenclature used by N. Robson (*Bull. Nat. Hist. Mus. London*,

Bot. 26(2):75-217 (1996) is followed, where the Bermudan plant is given as *H. hypericoides* subsp. *hypericoides* (T. Heller, *pers.comm.*).

Psychotria ligustrifolia: Britton (1918) classified this species as native. It was found to be frequent at the time in rocky woodlands between Castle Harbour and Harrington Sound. The species was reported in Paget Marsh in 1914. It was recorded in Florida and the West Indies, and its seed was thought to be brought to Bermuda by a bird (Britton, 1918).

B. CURRENT PROTECTION STATUS

The only current protection for the eight plants listed within this recovery plan, is that provided for by the Protected Species Act 2003. Table 1 provides the local status of each species classified according to criteria set by the International Union for the Conservation of Nature (IUCN).

Table 1. Bermuda status (as per IUCN criteria) for threatened native and endemic flowering plants. (E) refers to endemic, (N) refers to native.

Flowering Plants	Local Classification
Bermuda sedge (<i>Carex bermudiana</i>) (E)	Critically Endangered (CR), B1, C
Wild Bermuda pepper (<i>Peperomia septentrionalis</i>) (E)	Critically Endangered (CR) B1
Wild Bermuda bean (<i>Phaseolus lignosus</i>) (E)	Critically Endangered (CR) B1, C
Darrell's' fleabane (<i>Erigeron darrelliannus</i>) (E)	Vulnerable (VU), B2
Bermuda bedstraw (<i>Galium bermudense</i>) (N)	Endangered (EN), B1
Bermuda snowberry (<i>Chiococca alba</i>) (N)	Vulnerable (VU), D
St. Andrew's Cross (<i>Hypericum hypericoides</i>) (N)	Critically Endangered (CR), B1
Wild coffee (<i>Psychotria ligustrifolia</i>) (N)*	Critically Endangered (CR), C

*species not officially listed to date.

Local Protection

Legal Protection

The Protected Species Act 2003 considers as an offence the willful destruction, damage, removal or obstruction of a habitat, and the taking, importing, exporting, selling, purchasing, transporting or having in possession a protected species. Offenders are liable to a fine of \$5,000 and up to \$10,000 for continuing offences.

Habitat Protection

For those individuals inhabiting areas protected under the Department of Parks, as parks, nature reserves or woodland reserves, protection by the Parks Authority is provided under the overarching objective to “safeguard and maintain plants, animals and fragile ecosystems”. At the time of writing, this specifically refers to Bermuda sedge, wild Bermuda bean, wild Bermuda pepper, Bermuda snowberry and St. Andrew's Cross, found in the nature reserves of Nonsuch Island, Walsingham Trust and National Trust property. These areas are protected under the Bermuda National Parks Act 1986, which prohibits the taking of any flora or fauna within parks.

Global Protection

The listing of native species under Bermuda legislation is justified by the globally threatened status of these species and concurs with conservation action worldwide. For those species known to be native, their conservation status in other jurisdictions is given below; for others, such as *Galium bermudense*, taxonomy still remains to be verified, and relevant documentation on global protection cannot be given at this time.

Chiococca alba is considered threatened in the state of Florida (Wunderlin and Hansen, 2003). A subspecies of *Hypericum hypericoides* (ssp. *multicaule*) is listed as Endangered by the states of Massachusetts and New York (Natural Heritage and Endangered Species Program, 2004; Department of Environmental Conservation, 2000). *Psychotria ligustrifolia* (Northrop) Millsp. is listed as Endangered by the State of Florida (Coile and Garland, 2003).

C. TAXONOMY AND DESCRIPTION OF SPECIES

Bermuda sedge, *Carex bermudiana*

Class: *Monocotyledons* (Monocots)

Order: *Cyperales* (Grass family, Sedge family)

Family: *Cyperaceae*

Genus: *Carex*

Species: *bermudiana* Hemsl.

Figure 1. Bermuda Sedge, *C. bermudiana*. (Photo: M. Thomas)



The following description is taken from Britton (1918):
The Genus name *Carex*, refers to grass-like herbs of northern and temperate countries.

The *Cyperaceae* family is composed of grass-like and rush-like herbs. Sedges differ from true grasses in having solid, angular (usually triangular) stems. It is a perennial which reproduces by rhizomes. Bermuda sedge also reproduces by seed. Root-stock stout and short; culms are rather stout, smooth, sharply e-angled, nearly erect, 1 ½'-2 ½' tall. Leaves are glabrous, roughish-margined, the lower often as long as the culm; spikes 5-8 linear, 1"-2" long, densely many-flowered, the upper 1-4 staminate, at least the summit, the lower 2-4 mostly all pistillate, the lowest filiform-stalked, the others sessile or nearly so; scales ovate, greenish-white, aristate, glabrous, longer than the perigynia or the upper about equaling them; perigynia glabrous, oblong, strongly ribbed, the short beak 2-cleft; styles 3; achene short-stalked.

Wild Bermuda pepper, *Peperomia septentrionalis*

Class: *Magnoliopsida*

Order: *Piperales*

Family: *Peromiaceae/Piperaceae*

Genus: *Peperomia*

Species: *septentrionalis* S. Br.

The following description is taken from Britton (1918):

This is a perennial, fleshy, glabrous; stem branched, the branches spreading or ascending, stout, 6"-18" long, the plants often growing in large clusters. Leaves alternate, deep green and somewhat shining, above, paler green, black-dotted and dull beneath, petioled, ovate, oval or obovate, obtuse or emarginated at the apex, narrowed or obtuse at the base, the blades 1 ½"-2 ½" long, the stout petioles 1 ½" long or less, the midvein prominent beneath, the 9-11 lateral veins obscure; spikes terminal, or borne in the upper axils, solitary or several, 2"-6" long, densely flowered; nutlets minute, oblong, slightly papillose, with a subulate, straight or slightly curved back.

It is currently seen to grow to at least 6" (15cm) in shaded rocky areas in Bermuda (Ogden, 2002; L. Greene, *pers.comm.*).

Figure 2. Bermuda Pepper, *P. septentrionalis*
(Photo: R. Mareira)



Figure 3. Wild Bermuda pepper, *P. septentrionalis*. (Photo: L. Greene)



Wild Bermuda bean, *Phaseolus lignosus*

Class: *Magnoliopsida* (Dicotyledons)

Order: *Fabales*

Family: *Leguminosae/Fabaceae*

Genus: *Phaseolus*

Species: *lignosus* Britton

Figure 4. Wild Bermuda bean, *P. lignosus*. (Photo: L. Greene)



Taxonomic description by Britton (1918):

A perennial with woody stems, 20' long or more and ¼" thick, branched, the young twigs puberulent, some becoming glabrous. Stipules ovate, or ovate-lanceolate, acute, striate-nerved; petioles glabrous, 1"- 3 ½" long; leaflets ovate, membranous, glabrous, 4" long or less, acuminate at the apex, rounded or sub-truncate at the base, the terminal one equilateral, long-stalked, the others short-stalked and obliquely inequilateral; racemes long-peduncled, puberulent, several-many flowered, 3'-5' long; pedicels filiform; calyx broadly campanulate, its teeth broad and short; corolla white to purple, the standard suborbicular, clawed; pod flat, curved acute at each end, about 2" long; seeds obliquely oblong, little flattened, brown shining, ¾" long.

It is currently identified locally, as a climbing vine with white to purple flowers (Ogden, 2002).

Darrell's fleabane, *Erigeron darrelliannus*

Class: *Magnoliopsida* (Dicotyledons)

Order: *Asterales*

Family: *Compositae* (sunflower or daisy family) (also known as *Asteraceae*)

Genus: *Erigeron*

Species: *darrelliannus*

Figure 5. Darrell's fleabane, *E. darrelliannus*, in Bermuda (Photo: L. Greene)



Taxonomic description by Britton (1918):

Perennial, shrubby, 1'-4½' high, branched, the stem and branches glabrous or pubescent. Leaves thin, oblong or oblanceolate, glabrous, pubescent or ciliate, the lower ones clustered, 3"-5" long, crenate-dentate with apiculate teeth, or entire, obtuse or acute at the apex, narrowed at the base into short petioles, the upper ones scattered, sessile, much smaller, acute, entire; heads numerous, corymbose paniculate; bracts of the inflorescence linear; involucre campanulate-cylindric, about, ¾" its bracts linear-lanceolate, membranous, acuminate, imbricated in about 3 series, the inner scarious-margined, much longer than the outer; rays about 30, linear, white spreading; receptacle pitted; achenes linear, sparingly pubescent; pappus whitish, 2-3 times as long as the achene;

disk-flowers with a narrow, 5-lobed corolla.

Its daisy-like white flowers with a yellow centre are easily recognizable (Ogden, 2002).

Bermuda bedstraw, *Galium bermudense*

Class: *Magnoliopsida* (Dicotyledons)

Order: *Rubiales*

Family: *Rubiaceae*

Genus: *Galium*

Species: *bermudense* L.

Figure 6. Bermuda bedstraw, *G. bermudense* (Photo: L. Greene)



The following description is by Britton (1918):

This is a perennial, much branched, hirsute, hispid or nearly glabrous, 6"-2' high. Leaves in 4's, 1-nerved, oval, mucronate, rather thick, the margins more or less revolute in drying; flowers few terminating the branchlets, white; pedicels, rather stout, becoming deflexed in fruit; fruit fleshy, minutely pubescent. *G. uniflorum* of Lefroy, of Hemsley and of H.B. Small; *G. hypocarpium* of Beade.

Bermuda snowberry, *Chiococca alba*

Class: *Magnoliopsida* (Dicotyledons)

Order: *Rubiales*

Family: *Rubiaceae*

Genus: *Chiococca*

Species: *alba* (L.) Hitchc.

Common Names: milkberry, snowberry

Figure 7. Bermuda snowberry, *C. alba*. (Photo: R. Marirea)



The following taxonomic description is by Britton (1918):

A shrub, 2'-6' high, or sometimes vine-like and 10'-15' long, glabrous, the rather stout branches light green, terete or nearly so. Leaves elliptic to ovate, 2"- 4 ½" long, ¾"-2 ½" wide, firm in texture, light green on both sides, slightly darker above than beneath, acute or short-acuminate at the apex, narrowed at the base, the midvein rather prominent on both sides, the lateral veins few, relatively obscure, the stout petioles; stipules low and broad, mucronate; panicles about as long as the leaves; flowers

numerous, fragrant; pedicels rather stout; calyx turbinate-campanulate, its lobes triangular, acutish, much shorter than the tube; corolla yellow, its tube narrowly funnel-form, about twice as long as the ovate-lanceolate lobes; stamens borne at the base of the corolla-tube, filaments

much shorter than the anthers; style as long as the corolla-tube; fruit compressed, becoming subglobose, pure, white, shining, the withering corolla long-persistent.

It is currently considered, in Bermuda, a very attractive, shiny-leaved, dark green sprawling bush or vine. It produces showy yellow flowers in summer and autumn which attract bees, and white berries which attract birds in the spring. (Ogden, 2002).

St. Andrew's Cross, *Hypericum hypericoides* (L.) Crantz

Class: *Magnoliopsida* (Dicotyledons)

Order: *Theales*

Family *Clusiaceae* (Mangosteen family)

Genus: *Hypericum* L.

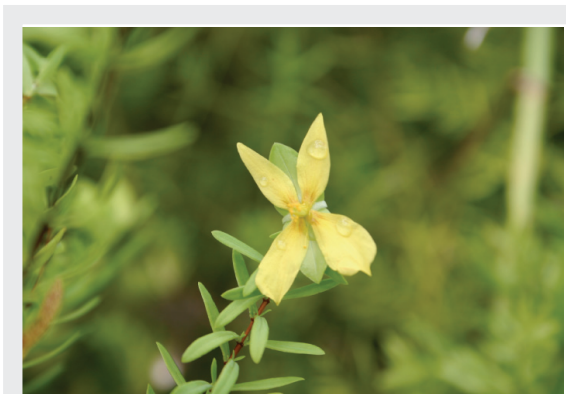
Species: *hypericoides* (L.) Crantz

Subspecies: *hypericoides*

Figure 8. St. Andrew's Cross, *H. hypericoides*, in Bermuda. (Photo: R. Marirea)



Figure 9. St. Andrew's Cross flower, Bermuda (Photo:R. Marirea)



Taxonomic description by Britton (1918):

An erect shrub, 1'-2½', high, with slender leafy branches. Leaves are linear-oblong, sessile, dull green, obtusish, but minutely apiculate at the apex, narrowed to the base, copiously punctuate, the midvein prominent beneath; cymes terminal 1-few-flowered; outer sepals broadly ovate, obtuse, subcordate; petals oblique, spreading in 2 nearly parallel pairs, linear-oblong, acute, fugacious, bright yellow; capsule oblong, narrowed at both ends, apiculate about as long as the outer sepals, twice as long as the narrow, inner ones; seeds greenish-brown, oblong, obtuse at each end about.

Recently it has been recorded in Bermuda as growing to 3ft (1m). Its reddish stems, small yellow-green leaves and attractive yellow flowers are easily identifiable by gardeners (Ogden, 2002).

Wild coffee, *Psychotria ligustrifolia*

Class: *Magnoliopsida* (Dicotyledons)

Order: *Rubiales*

Family: *Rubiaceae*

Genus: *Psychotria*

Species: *ligustrifolia* (Northr.) Millsp.

Common names: Bermuda wild coffee (in Bermuda), Bahamas wild coffee

Figure 10. Wild coffee, *P. ligustrifolia*. (Photo: M. Thomas)



Taxonomic description by Britton (1918):

A glabrous shrub growing 4'-8' high. Leaves oblong, or oblong-oblongate, 2"-4" long, ½"-1 ½" in width, rather firm in texture, pinnately few-veined, dark green and somewhat shining above, paler green and commonly with small tufts of hairs in the axils of the veins beneath, acute or acuminate at the apex, narrowed at the base into slender petioles $\frac{3}{12}$ " long or less, the deciduous stipules sheathing, subulate-tipped; peduncles ½"-2" long, slender; panicles several-many-flowered, 1"-2" broad; flowers very nearly sessile, the minute calyx 5-6 toothed, the white corolla tubular-

campanulate; fruit oblong, several-ribbed, dark red.

In Bermuda, this attractive evergreen shrub or small tree, seems to grow to 4' (1.2m) with dark green foliage and scarlet berries in December (Ogden, 2002). Its dark green leaves are highly rippled along the edge. Leaves are opposite one another on the stem, and it is at the base of the leaf stems where flowers cluster, and then later fruit are held (L. Greene, *pers.comm.*). Flowers, borne in the spring and summer, are white and fragrant. Trees begin to bear after three to four years and bear well after six to eight. Fruit take seven to nine months to mature. Immature fruit are green, turning crimson red as they ripen and black when they are dry.

D. ECOLOGY

Habitat Requirements

The information in this Ecology Section is specific to Bermuda.

Carex bermudiana: This species favours wooded marshy situations and shaded rocky places (Britton, 1918). The Bermuda sedge grows best under a cedar/palmetto forest.

Peperomia septentrionalis: Wild Bermuda pepper grows on shaded rocks (Britton, 1918). This species does seem to have a more specialised niche, requiring moist areas in rocky outcrops.

Phaseolus lignosus: Bermuda bean grows in rocky woodlands (Britton, 1918). It thrives in forest clearings, and should be planted in semi-open thickets, sheltered from salt spray (Ogden, 2002).

Figure 11. Darrell's fleabane growing on Bermuda's shore (Photo: A. Copeland)



Erigeron darrelliannus: Darrell's fleabane was found in rocky situations by Britton (1918). It is currently thought to be ideal for rock gardens, banks and road cuttings (Ogden, 2002). It is found at present in sandy, coastal hillside, close to water, or rocky offshore islands.

Galium bermudense: The Bermuda bedstraw was recorded by Britton (1918) on hillsides.

Chiococca alba: Britton (1918) records the Bermuda snowberry as growing on hillsides. It is still found to grow

widespread in upland situations, as a bush in the open or sprawling vine-like under the canopy in a forest (Ogden, 2002).

Hypericum hypericoides: St. Andrew's Cross is currently found in peat marshes and on dry hillsides in grassy situations according to the Gardener's Guide (Ogden, 2002), much in the same environment as that stated in Britton (1918).

Psychotria ligustrifolia: The rocky woodlands habitat of the wild coffee as recorded by Britton (1918) still proves true, as it does not become overshadowed on rocky outcrops.

Reproduction and Life Cycle

Much of the information below is reported local knowledge, taken from informal in-house publications, documented as BAMZ (Bermuda Aquarium Museum & Zoo) or BZS (Bermuda Zoological Society) reports, available at the BAMZ library.

Carex bermudiana: The Bermuda sedge is known to flower in the spring (Britton, 1918). It is currently self-propagating at Nonsuch Island. Propagation is by seed or by dividing a section of the roots. Controlled propagation by seed is more difficult to achieve, although promising results have been obtained in 2007 by local propagators (namely the non-Governmental organisation Save Open Spaces, or SOS).

Peperomia septentrionalis: The wild Bermuda pepper flowers from autumn to spring (Britton, 1918). Propagation is easily done by cuttings, or by seed germination. The optimal time to collect cuttings seems to be between September and April. Treating with a weak hormone rooting substance and placing under mist in propagation compost is recommended. Rooting occurs in 14 days with a high success rate (90-95%) (Atherton, 1998). From these, one to two years is required prior to planting (J. Madeiros, *pers.comm.*).

Phaseolus lignosus: Controlled propagation of the wild Bermuda bean is easily done by seed. It is a perennial vine, twining rather like a pole bean.

Erigeron darrelliannus: Darrell's fleabane flowers from spring to autumn (Britton, 1918). This species propagates by seed transported by wind. It readily self-seeds, and dies back to the ground every year. Seed can be collected in August/September, varying yearly (J.

Madeiras, *pers.comm.*). Time to germination has been observed to be from 4-12 weeks, and one year is required prior to planting. It has a life span of three years.

Galium bermudense: Bermuda bedstraw flowers from spring to autumn (Britton, 1918).

Chiococca alba: Bermuda snowberry flowers in the autumn and the fruit is ripe in winter (Britton, 1918). This species can be easily propagated from seed in the dried berries, or by cuttings. It has been found that using rooting hormone facilitates growth when using cuttings (J. Madeiros, *pers.comm.*); rooting should occur within two months (Atherton, 1998). Yearly variations have been observed in the appearance of seed, occurring in June/July or September/October. Germination time during controlled propagation has been observed to range between 6-18 weeks, and time to planting of one to two years. The Bermuda snowberry seems to have a high tolerance to environmental and climatic conditions, facilitating its recovery.

Hypericum hypericoides: It has been shown that St. Andrew's Cross propagates readily from the numerous tiny seeds which it produces (Ogden, 2002). Seeds can be collected between July and September. It has been observed that it takes approximately 6-12 weeks for germination (J. Madeiros, *pers.comm.*).

Psychotria ligustrifolia: Wild coffee flowers in spring. It seeds from October to December. This plant propagates from dried seed which is slow to germinate, taking 12 -24 weeks (J. Madeiros, *pers.comm.*). It is a very slow growing species with time to planting ranging from two to four years (Ogden, 2002; J. Madeiros, *pers.comm.*).

E. CURRENT THREATS

Two major threats common to the survival of the flowering plants listed above, have been identified by local field botanists. These include, overshadowing by invasive plant species and loss of habitat caused by human development. For those species with a more specialized niche requirement, like the Bermuda pepper, the loss in habitat poses a serious threat. The health of individual plants has also been observed to be on the decline in the past five years for this species, leading to an overall decline. For others, like the Bermuda sedge, invasive species are a threat as they chemically alter the soil, inhibiting growth of the endemic species. However, it has to be noted that this may be true for the younger seedling, but mature individuals of the Bermuda sedge are generally healthy. In the case of Darrell's fleabane, individuals are healthy, but large populations are limited by habitat as the invasive *Casuarina* sp. overshadows it, and other climbing invasive species smother it.

F. CURRENT STATUS

Global Distribution

The distribution range for only those species known to be native at the time of writing is given below.

The distribution of the snowberry, *Chiococca alba*, ranges from the Southeastern U.S.A (Texas, Florida) (Hatch *et al.*, 1990; Wunderlin *et al.*, 1996) , extending to Central America

– namely, Belize, Costa Rica, El Salvador, Guatemala, Nicaragua and Mexico (Balick *et al.*, 2000; Stevens *et al.*, 2001) – and throughout the Caribbean on a number of islands (Antigua and Barbuda, Bahamas, Barbados, Puerto Rico, and the U.S. Virgin Islands) (Britton and Wilson, 1926; Liogier and Martorell, 1999). It has also been recorded in South America, from Guyana and Venezuela, to Brazil, Ecuador, Peru, Argentina and Paraguay (Jorgensen and Leon-Yanez, 1999; Zuloaga and Morrone, 1996).

St. Andrew's Cross, *Hypericum hypericoides*, is recorded in the Northeastern U.S.A., North Central, Eastern and Southern parts of the U.S., ranging from Texas (Hatch *et al.*, 1990) to the state of New York and north to Massachusetts (Mitchell, 1986; Magee and Ahles, 2007). Its range extends to Mesoamerica countries of Guatemala, Honduras and Mexico. It is also found in the Caribbean Islands of Bahamas, Cuba, Dominican Republic, Haiti, Jamaica and Puerto Rico (Liogier and Martorell, 1999), but appears to be notably absent in the U.S. Virgin Islands.

Bermuda bedstraw, *Galium bermudense*, although considered a native to Bermuda, requires further identification before ascertaining its species name. Therefore, global distribution cannot be stated at the time of writing.

Wild coffee, *Psychotria ligustrifolia*, is found in Florida, including the Monroe Keys and Puerto Rico (Wunderlin *et al.*, 1996; Britton and Wilson, 1926).

Local Distribution

Bermuda is an archipelago of 150 small islands located in the Atlantic Ocean at latitude 32° 19' N and longitude 64° 46' W. The total combined land area of all Bermuda's islands is 55 km². The closest point of continental land is Cape Hatteras, North Carolina, on the eastern seaboard of the United States, which lies 965 km to the west. The influence of both the Gulf Stream, which flows to the west of the island, and the annual Bermuda-Azores high pressure system result in a mild sub-tropical climate. Mean monthly air temperatures range from 18.5°C in February to 29.6°C in August. The mean annual rainfall is 150cm and is not highly seasonal being distributed throughout the year although October (16cm average) is the wettest month and April is the driest (10cm). Humidity is uniformly high at 70-82% year round (Anderson *et al* 2001).

Table 2. Last recorded Bermuda locations for protected flowering plant species (J. Madeiros, *pers.comm*; D. Wingate, *pers. comm*; * BBP, unpub.).

Common name	Scientific name	Estimated Population	Distribution
Bermuda sedge	<i>Carex bermudiana</i>	<200 mature plants	Paget Marsh, Abbott's cliff, Nonsuch Island, Butterfield Nature Reserve. Only seen at 1* site.
Wild Bermuda pepper	<i>Peperomia septentrionalis</i>	<500 mature plants	Walsingham Trust, Blue Hole Hill, Paget Marsh, Paynter's Hill, Abbott's cliff, Quarry Hill. Only seen at 1*site.
Wild Bermuda bean	<i>Phaseolus lignosus</i>	<200 mature plants	Walsingham Trust, Nonsuch Island, Blue Hole Hill.
Darrell's fleabane	<i>Erigeron darrelliannus</i>	>1,000 mature plants	South Shore sandy embankments. 15* sites island wide.
Bermuda bedstraw	<i>Galium bermudense</i>	Uncertain	Great Sound islands (Saltus Island), Dundonald woodlands. Vesey Nature Reserve. Reported from 10* sites islandwide.
Bermuda snowberry	<i>Chiococca alba</i>	>1,000 mature plants.	Walsingham Trust, Blue Hole Hill, Nonsuch Island, Great Sound Islands, St. George's Islands. Recorded in approx. 50 * sites around Bermuda.
St. Andrew's Cross	<i>Hypericum hypericoides</i>	<250 mature plants	Devonshire Marsh, Paget Marsh, Harbour Road (National Trust Property).Recorded in *4 sites island wide.
Wild Coffee	<i>Psychotria ligustrifolia</i>	<12 mature plants.	Walsingham Trust, Paynter's Hill

* Bermuda Biodiversity Project (BBP) terrestrial surveys conducted in 1998-2000.

G. CURRENT CONSERVATION ACTION

Preliminary surveys and observations by local field botanists provide some information on the location of these species, as recorded in Table 2 above, but are not comprehensive. Conservation efforts are currently driven by the interest of individuals, NGO and/or government-based, and result in sporadic propagation and translocation measures. There is no well defined programme, but there is a general consensus that seedlings should be grown and planted in various nature reserves to expand geographical distribution and/or re-introduce species to sites where they have been previously recorded. Controlled propagation techniques for most of these species are known, and are readily done when required. The Bermuda bean has been shown to be relatively easy to grow, where seed is collected, sowed in pots or into the ground. Propagation by cuttings has proved successful for the Bermuda pepper. The Department of Parks has propagated Bermuda sedge by dividing section of roots; a small stock of seedlings in the Government nursery is maintained. The Bermuda snowberry has potential as a landscaping species, and there is an ongoing propagating programme with the government nursery. A local NGO, Save Open Spaces (SOS) has also been recently propagating Bermuda sedge, Darrell's fleabane, Bermuda pepper and Bermuda snowberry.

It therefore appears that successful propagation for most of these species is feasible, and simply requires an established programme and coordinated effort for seed or cutting collection, and planting in selected habitats.

PART II: RECOVERY

A. RECOVERY GOAL

The principal aim of this Recovery Plan is to ensure the genetic preservation of endemic species, and to improve the population status of all listed species through expansion of their geographical distribution using controlled propagation. If successful the long-term survival of Bermuda's threatened plants will be attained. Ultimately, down-listing and/or removal of the species from the Protected Species List is strived for.

The short-term goal (two years) is to first verify the taxonomic status of threatened species through herbarium vouchers and assess population level genetics, identifying "parent" populations. This will assist in ensuring habitat protection and in developing suitable management measures. Secondly, the preservation of endemic genetic material needs to be ensured through the Millennium Seed Bank, and a comprehensive evaluation of existing populations for all species needs to be documented.

The long-term goal (10 years) is to expand the geographical distribution of threatened species to an island-wide scale, through habitat protection and restoration, and controlled propagation, to ensure self-sustainability at several sites across the island.

B. RECOVERY OBJECTIVE AND CRITERIA

Favourable conservation status will be achieved when:

- Verification of taxonomy and population level variation are completed
- Current population distribution is thoroughly assessed
- Critical habitats are identified and listed under the Protected Species Act 2003
- Translocation of all species to a minimum of 10 sites around the island is successful
- Stable reproducing population of each species at each of the 10 sites
- Public awareness of threatened status of listed species is increased through documentation and media

These overall objectives translate into specific targets outlined below:

Short-term target (two years): A standardized population survey for all threatened species as developed during an initial workshop with experts from Royal Botanic Gardens Kew, U.K. and outlined in the proceedings (Sarkis, 2007). A standardized tissue and seed collection programme for genetic analysis and preservation. Taxonomy for all species verified, and population genetics analysed using DNA. Assessment of critical and suitable habitats for plant growth and survival.

Long-term target (10 years): The development of a propagation programme for all threatened species; for species with very low population numbers, seedling production is required for genetic preservation; for all species, seedling production will allow for translocation to selected sites. Monitoring of translocated populations is required to assess successful growth, survival and reproduction. A minimum of 10 locations per species with self-sustaining population is strived for.

C. RECOVERY STRATEGY

The population growth of most of the species addressed in this recovery plan is limited by availability of adequate habitat. This habitat loss is often caused by the presence of invasive species and by human development. For most of these species, current populations are low but stable, with healthy individuals. Bermuda pepper appears to be the only species with a more specialized niche requirement, the loss of which is contributing to the “Endangered” status of the species. For these reasons, the recovery strategy will focus on habitat protection, including control of invasive species, and translocation of species to selected sites across the island. This will expand the geographical distribution of the species to managed sites, allowing for the species to reproduce and become self-sustaining. Prior to these actions, the endemic status of each species needs to be ascertained, as it appears to be debatable for some. In the event that a threatened species is endemic, the preservation of the species becomes even more critical, and active intervention is urgent. The development of a seed preservation programme in collaboration with the Millennium Seed Bank, U.K., provides a long term assurance that the gene pool of such species will be maintained. Precedent community programmes, such as the widely acknowledged successful “Plant One on Me” project, promoting the Bermuda cedar, provide a positive template for similar intervention for other threatened species. The engagement of existing NGOs working towards the propagation of plants is critical in large scale seedling production, and that of the community in supporting translocation efforts, necessary to long-term sustainability. In addition, the integration of endemic and native planting in future developments will be strived for.

D. TOOLS AVAILABLE FOR STRATEGY

A 2007 workshop with experts from Royal Botanic Gardens Kew has already provided the standard protocol for collecting sample material necessary for herbarium vouchers and genetic analysis. In addition, available technology (handheld GPS) was demonstrated in the same workshop, for the purpose of accurate documentation of population locations. Similarly, seed collection and shipment for preservation at the Millennium Seed Bank was standardized by the same experts. Implementation of the tissue and seed material has already been initiated, with the help of a volunteer team of local field botanists. Coordination and additional funds are required to ensure its completion.

Collected seeds preserved at the Bank are re-assessed for viability every 10 years; this implies that a long-term seed collection programme needs to be established in Bermuda, allowing for seed collection and shipping every 10 years to the Millennium Seed Bank, should stored seeds lose their viability during long-term storage.

Sporadic surveys have been conducted in the past, and more recent ones have been recorded in an electronic database. Coordinates have been recorded using a GIS system. This system provides an accurate location of the species, and allows for computer mapping of the populations. More comprehensive surveys will be conducted in the early part of this recovery plan to supplement the existing information following the standardized record-keeping protocol, during the 2007 workshop (Sarkis, 2007).

Finally, although a structured propagation programme is not in place, the techniques for propagation for most of these species have been established. For the most part, they have

proven successful. Propagation is done either through seed germination or by cuttings, and translocation attempts to other habitats have been promising. Bermuda-based NGOs have expressed the will to assist in seedling production, as has the Department of Parks. Community clubs have also indicated interest and should be encouraged to help in the growing of species across the island, and planners such as landscape architects may be brought on board for larger scale integration of natives and endemics in developments, including golf courses. Long-term sustainability will only be achieved with the help of the afore-mentioned groups, and requires an island wide programme, such as that conducted for the Bermuda cedar in previous years.

E. STEP-DOWN NARRATIVE OF WORKPLAN

The following abbreviations are used throughout the next two sections:

DCS – Department of Conservation Services

SOS – Save Open Spaces (NGO)

BAMZ – Bermuda Aquarium Museum & Zoo

Government nursery – Tulo Valley site (Department of Parks)

Parks – Department of Parks

BSAP – Biodiversity Strategy Action Plan

KEW – Royal Botanic Gardens Kew, U.K.

The actions needed to achieve recovery are as follows:

1. Population level genetic analyses of plant species

Actions proposed:

- Identification and sample collection of “parent” populations
- Verification of taxonomy using herbarium vouchers
- DNA analyses of collected samples

Work Team: DCS, BAMZ, KEW

Team Leader: DCS

Assistance: Members of the community

Outputs: Determination of status of extant populations in Bermuda.

List of Equipment: Funding required for part-time collector for a period of two years, and for genetic analyses

2. Long term preservation of threatened species

Actions proposed:

- Seed collection and shipment following standard protocol
- Seed storage at Millennium Seed Bank

Work Team: DCS, SOS, BAMZ, Seed Bank

Team Leader: DCS

Assistance: Members of the community

Outputs: Ex situ preservation of Bermuda’s endemic plants.

List of Equipment: GPS system, record-keeping sheets, collection and shipment materials, funding for shipment and for part-time collector for a period of two years.

3. Population assessment

Actions proposed:

- Standard survey with GPS coordinates and mapping
- Entry into electronic database

Work Team: DCS, SOS, BAMZ

Team Leader: DCS

Assistance: Members of the community

Outputs: Comprehensive database for Bermuda's threatened native and endemic plant species

List of Equipment: Handheld GPS, funding for part-time surveyor for a period of two years, survey material

4. Active propagation

Actions proposed:

- Programme development to maximize genetic variability among populations, and identify optimal germination techniques
- Seedling production through seed germination and/or cuttings

Work Team: DCS, SOS, BAMZ, Government nursery

Team Leader: DCS

Assistance: Members of the community

Outputs: Availability of seedling for translocation programme. Series of reports on propagation techniques for future efforts.

List of Equipment: Propagation materials.

5. Expanding extent of occupancy

Actions proposed:

- Site selection
- Habitat restoration protocol for 4-5 sites
- Habitat management, including control of invasive species
- Translocation of seedlings
- Monitoring of growth and survival

Work Team: DCS, SOS, Parks

Team Leader: DCS

Assistance: Members of the community

Outputs: Increasing habitat availability for threatened species, expanding island wide distribution. Monitoring report on growth and survival assessing habitat suitability.

List of Equipment: Material for translocation, culling of invasives.

6. Ensure long-term sustainability of natural populations

Actions proposed:

- Engagement of the community through workshops
- Engagement NGOs in propagation of threatened flowering species for planting by community
- Engagement of developers and landscape architects in planting endemic and native species in new developments

Work Team: DCS, NGOs, Government nursery

Team Leader: BSAP coordinator

Assistance: Members of the community

Outputs: Public awareness and engagement of the community in long-term conservation of endemic and native species. Publication of pamphlets on techniques for cultivation. Education in appropriate plantings for private properties.

List of Equipment: Funds for workshops and publications.

F. ESTIMATED DATE OF DOWN-LISTING

It is anticipated that it will take two years to confirm the taxonomy and genetic status of listed species. For species proved not to be endemic, and without a globally threatened status, a re-assessment for listing under the Protected Species Act 2003 will be required. It is anticipated that a first monitoring report on the growth, survival and reproduction of translocated species will be produced in three years time. A series of translocation events should be conducted to confirm the preliminary results. It is only once that growth, survival and reproduction of a species at a minimum of 10 sites will be determined that down-listing will be considered. This will be first considered in 10 years from the start of implementation of this plan.

G. RECOVERY COSTS

The total cost of recovery actions cannot be defined at this point. Funding needs to be secured, additional to the core funding obtained through government funds, for implementing the necessary research studies on the natural population status, habitat requirements, and propagation techniques for these flowering plants. Developing budgets for each action are the responsibility of the leading party as outlined in the workplan.

PART III: IMPLEMENTATION

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

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

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

Priority #	Task #	Task description	Task Duration	Responsible Party
1		Taxonomy and genetic status	24 months	
	1	Sample collection	12 months	DCS, BAMZ
	1	Herbarium verification	12 months	KEW
	2	DNA Analyses	12 months	KEW
1		Preservation of threatened species		
	3	Seed collection	24 months initially 12 months every 10 years thereafter	DCS
	4	Storage in Seed Bank	indefinite	Millennium Seed Bank
2		Population assessment	24 months	
	5	Plant surveys	24 months	DCS
	6	Database entry	2 months	DCS
2		Propagation		
	7	Programme development	1 month	DCS
	8	Seedling production	10 years	Government nursery, DCS
3		Increasing range of distribution	10 years	
	9	Site selection	2 months	DCS, Parks
	10	Habitat restoration	5 years	DCS, Parks
	11	Habitat management	Yearly	DCS, Parks
	12	Translocation	10 years	DCS, Parks
	13	Monitoring and Reporting	yearly	DCS
3		Long-term sustainability	indefinite	
	14	Community workshops	1 month, every 2 years	BSAP coordinator, Parks
	15	Collaboration with NGOs for planting in community	indefinite	BSAP coordinator, Parks
	16	Plantings in new developments	indefinite	BSAP coordinator, Government nursery

REFERENCES

- Anderson C., H. De Silva, J. Furbert, A. Glasspool, L. Rodrigues, W. Sterrer and J. Ward. 2001. Bermuda Biodiversity Country Study. Bermuda Zoological Society and Bermuda Aquarium Museum and Zoo. Contribution # 44. 123 pages.
- Atherton R., 1998. Propagation of Native and Endemic Bermuda Plants. Arrowroot Factory, Bermuda Botanical Gardens, Paget. 5 pages.
- Balick M. J., M.H. Nee and D. E. Atha, 2000. Checklist of the vascular plants of Belize, with common names and uses. *Memoirs of the New York Botanical Gardens*. V. 85.
- BBP, unpublished. Survey of Bermuda's Flora, 1998-2000. Bermuda Biodiversity Project, Bermuda Aquarium Museum & Zoo.
- Britton N., 1918. *Flora of Bermuda*. Charles Scribner's Sons, New York. 585 pages.
- Britton N.L., and P. Wilson, 1926. *Botany of Porto Rico and the Virgin Islands*, Scientific Survey of Porto Rico and the Virgin Islands.
- Coile N.C., and M.A. Garland. 2003. Notes on Florida's endangered and threatened plants (29 January 2005). Florida Department of Agriculture & Consumer Services, Division of Plant Industry.
- Department of Environmental Conservation, 2000. Regulations, Chapter II. Lands and Forests. Part 193: Trees and Plants.
- Greene L., *Personal communication*, 2007. Collections Officer, Natural History Museum. Bermuda Aquarium Museum & Zoo, Government of Bermuda, Bermuda.
- Hatch S.L., K.N. Gandhi and L.E. Brown, 1990. Checklist of the vascular plants of Texas (MP-1655)
- Heller T., *Personal communication*, 2009. Seed Collection Officer, Millennium Seed Bank Project. Royal Botanic Gardens, Kew, London, U.K.
- Jørgensen P. M. and S. León-Yáñez, eds. 1999. Catalogue of the vascular plants of Ecuador. *Monogr. Syst. Bot. Missouri Bot. Gard.* 75.
- Lefroy J.H., 1884. Part II: The Botany of Bermuda. *Bull. Nat. Mus.* No. 25:33-140
- Liogier A.H. and L.F. Martorell, 1999. *Flora of Puerto Rico and adjacent Islands: A systematic synopsis*, 2nd ed.
- Madeiros J. *Personal communication*, 2007. Terrestrial Conservation Officer. Department of Conservation Services, Bermuda.
- Magee D. and H.E. Ahles, 2007. *Flora of the Northeast: A Manual of the Vascular Flora of New England and Adjacent New York*. Edition 2. 1214 pages
- Mitchell R.S. (ed.), 1986. A checklist of New York State plants. *Contributions of a Flora of New York State*, Checklist III. *New York State Bulletin*, No. 458.
- Natural Heritage and Endangered Species Program, 2004. Massachusetts list of endangered, threatened, and special concern species (29 January 2005). Massachusetts Division of Fisheries and Wildlife
- Ogden G., 2002 (ed.). *Bermuda, A Gardener's Guide*. The Garden Club of Bermuda. 225 pages. Medicinal properties of plants by Juliet Duncan p. 183-185
- Sarkis S., 2007. *Bermuda's Threatened Plants Workshop*. Department of Conservation Services. BAMZ library. 42pages.
- Stevens W. D., C. Ulloa Ulloa, A. Pool and O.M. Montiel (eds.), 2001. *Flora de Nicaragua*. Tomos 1-3. *Monographs Systematic Botany from the Missouri Botanical Gardens* 85. *Miss. Bot. Gard. Press*. P.O. Box 299, St. Louis, MO 63166-0299, U.S.A

- Wingate D., *Personal communication*, 2009. Former terrestrial Conservation Officer. Department of Conservation Services, Bermuda.
- Wunderlin R.P., B.F. Hansen and E.L. Bridges, 1996. Atlas of the Flora of Florida. Florida Department of State. Tampa (CD-ROM).
- Wunderlin R.P. and B.F. Hansen. 2003. Guide to the vascular plants of Florida, 2nd ed. University Press of Florida, Gainesville.
- Zuloaga F. O. & O. Morrone, eds. 1996. Catálogo de las plantas vasculares de la República Argentina. I. Pteridophyta, Gymnospermae y Angiospermae (Monocotyledonae), II. Dicotyledonae. Monogr. Syst. Bot. Missouri Bot. Gard. 60, 74., 1999