

**NATIONAL RECOVERY PLAN
FOR THE
Christmas Island Spleenwort
*Asplenium listeri***



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Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

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This recovery plan sets out the actions necessary to stop the decline of, and support the recovery of, the listed threatened species or ecological community. The Australian Government is committed to acting in accordance with the plan and to implementing the plan as it applies to Commonwealth areas.

The plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

INTRODUCTION

Purpose and legislative context

This draft recovery plan has been prepared under the terms of Part 13 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and associated Regulations.

The Minister must make and implement recovery plans, or adopt plans prepared by others (including State agencies), for threatened species (other than conservation dependent species) listed under the EPBC Act [ss.269; 269A]. When endorsed by the Commonwealth Minister, recovery plans are statutory documents. They provide guidance for government decision makers when assessing development applications and Natural Heritage Trust funding proposals.

The EPBC Act sets out requirements for the content of recovery plans [s.270] with more specific requirements in Regulations [7.11]. Recovery plans:

- set out management actions necessary to stop the decline of, and support the recovery of, the listed species to maximise the long term survival of the species in the wild;
- set out actions required to protect and restore important populations of the species and its habitat, and to manage and reduce threatening processes; and
- provide a planned framework for key interest groups and responsible government agencies to coordinate their work to conserve the species.

This plan is for the listed Critically Endangered plant species *Asplenium listeri* (Aspleniaceae) (Christmas Island Spleenwort) which is found only on Christmas Island (Indian Ocean), an external Territory.

PART A: SPECIES INFORMATION AND GENERAL REQUIREMENTS

A.1 Species

This recovery plan addresses the management requirements for conservation of *Asplenium listeri* (Christmas Island Spleenwort). This is a fern endemic to Christmas Island, where it is known from a very small number of localities growing among rocks and on cliffs of exposed limestone outcrops.

Technical description: Small, lithophytic fern with rhizome shortly creeping, stout, scaly; scales narrowly ovate about 3 to 6mm long, long-acuminate, latticed, dark brown, glossy; fronds in a crown. Stipe slender, about 2.5 to 3.5cm long, slender, black, with some scales at the base. Fronds short, erect, about 3.5 to 9cm long, pinnate, with about 8 to 18 pinnae which are gradually reduced towards the apex; pinnae ovate, about 8 to 18mm long, with several lobes divided to near mid-vein, unequal-sided, incised and toothed, cuneate at the base, more or less glabrous, coriaceous, with stalk 0.3mm long; lateral veins forked, free. Sori linear along lateral veins; indusium linear (DuPuy 1993b).

Illustrations: DuPuy (1993b) p.555; Fig. 97 A fertile plant x0.5; B fertile pinna x2 (ill. E. Catherine)

Photograph: DuPuy (1993b) p.330 Fig.67

A.2 Taxonomy

Asplenium listeri C.Chr. *Index Filicum* 118 (1906)

Family Aspleniaceae: Polypodiatae: Plantae

The *Asplenium* genus is large, with more than 600 species distributed worldwide.

The genus is named (1753) from Greek *a* (not) and *spleen* (a spleen) referring to the former use of some species as a remedy for disorders of the spleen. Dioscorides used the name *asplenon* for this type of fern. The species is named for naturalist Joseph Jackson Lister, who first collected a specimen of the species in 1887 (DuPuy 1993b).

Other names in use: none known

Common name: Christmas Island Spleenwort

Confusing species: The morphology of the closely related *Asplenium polyodon* G. Forst. (Sickle Spleenwort, Mare's Tails Fern) can be highly variable, displaying at times a marked similarity to *Asplenium listeri* in pinnae shape and sori. The most distinguishing features are the harder and generally smaller fronds of *A. listeri*, which may be an adaptation to its exposed lithophytic habitat (Reddell *pers. comm.*).

A.3 Conservation Status

Current listing:

Listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Critically Endangered on 23 July 2002.

This listing decision was partly based on the species being known from a single location with limited extent and area. Although there are reports of new populations, the limited available information indicates continued eligibility for listing: the number of known individuals is less than 300; the distribution remains very restricted (including extent of occurrence, area of occupancy and extent of habitat); and the distribution is presumed vulnerable to stochastic disturbance events, as two of the four new locations are outside the national park.

In addition a decline could be inferred from the inability to relocate vaguely defined points for early collections (there are no data to indicate the rate of any decline). Alternatively, it may be speculated that low population numbers reflect a recently evolved species (likely to be a variant of *Asplenium polyodon*) that has adapted to a relatively specialised habitat, with potential over time to extend its range. However, certainty would require more research. In the absence of such certainty, the precautionary principle requires recovery actions to be based on a possible decline and a 'no-regrets' policy.

A.4 Meeting objects of the EPBC Act

The EPBC Act requires that recovery plans specifically address the objects of that Act:

- a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and
- b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and
- c) to promote the conservation of biodiversity; and
- d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples; and
- e) to assist in the co-operative implementation of Australia's international environmental responsibilities; and
- f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and
- g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

The Threatened Species Scientific Committee (TSSC) considers that objects a), b), and c) are inherently addressed by virtue of the purpose of a recovery plan. The remaining objects are addressed specifically below.

A.4.1 International Obligations

Asplenium listeri is not listed under any international agreement specified in the EPBC Act.

The implementation of Australia's international obligations is not affected by this plan.

Asplenium listeri is not included in the list of species under CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) that had effect from 11 January 2002.

A.4.2 Affected interests

The following interested parties were provided with draft material for comment during the preparation of this plan:

Parks Australia North Department of the Environment & Heritage	Australian Government agency responsible for management of Christmas Island National Park and of listed species in the Territory under the EPBC Act and Regulations
Department of Transport & Regional Services	Australian Government agency responsible for providing State-type services in the Territory, including management of Crown Land
Shire of Christmas Island	Elected body
Christmas Island Phosphates	Company mining phosphate
Asia Pacific Space Centre	Company proposing to build spaceport
Department of Finance and Administration	Australian Government agency managing Immigration Reception and Processing Centre
Union of Christmas Island Workers	Industrial union
Island Care Inc	Community based organisation

A.4.3 Indigenous people

Christmas Island does not have an indigenous population. The first settlement from 1888 was by workers for the Clunies-Ross family who held the Cocos (Keeling) Islands. These were a mix of Javanese people and Cocos-Malays. In addition, Chinese labourers were employed in mining from the late 1890's. In the 1996 census the population was 1,906 - about 70% of Chinese descent, about 20% of European or Australian descent and about 10% of Malay descent (DoTaRS 2002).

A.5 Benefits to other species

Protective measures proposed for *Asplenium listeri* are likely to have few (or no) implications for other species because of its restricted distribution, the paucity of species associated with its habitat, and the minimal recovery options available.

There are not likely to be conservation agreements with landholders because of the national park/ Crown land tenure of its localities.

There may be limited (or no) increases in community awareness because of the suggested confidentiality of locality information.

No negative impacts are likely to affect non-target species or an ecological community arising from implementation of this plan.

A.6 Social and economic impacts

Whilst the known localities of *Asplenium listeri* are outside areas of current economic activity, there is some potential for the presence of the species to constrain economic activity or development. However, this arises from the listing of the species under the EPBC Act, which invokes a range of protective provisions and offences where a population is to be affected, rather than from the provisions of this plan. This necessitates careful attention to inclusion of *Asplenium listeri* in environmental assessments and management standards across the island, regardless of specific tenure.

The magnitude of any potential constraint cannot be estimated, as it will vary with the location, size and extent of an affected population, and the nature and extent of the activity, proposed or current.

Actions arising from this plan that may have some potential to constrain economic activity or development include:

- possible future addition of areas to the Christmas Island National Park specifically to protect an occurrence of *Asplenium listeri*
 - possible identification of *Asplenium listeri* as an element in the heritage values or attributes of a place on the Register of the National Estate or a future heritage listing under the EPBC Act; and
 - possible future addition of areas to the Register of Critical Habitat established under the EPBC Act, affording an additional layer of protection under that Act in Commonwealth areas.
-

PART B: DISTRIBUTION AND LOCATION

B.1 Distribution

B.1.1 Christmas Island - overview

Asplenium listeri is known only from Christmas Island, a territory of the Commonwealth of Australia, located in the Indian Ocean at about 10°25'S and 105°40'E. The island lies approximately 2,600 kilometres west of Darwin and 360 kilometres south of Jakarta and the western end of Java. The island covers approximately 135 square kilometres (13,500 hectares), of which about 85 square kilometres (8,500 hectares) (63%) is gazetted as Christmas Island National Park, a Commonwealth reserve under the EPBC Act.

The island is formed on the peak of a volcanic mountain which rises steeply about 5,000 metres from the ocean floor. Successive layers of coral reefs were formed over the igneous core at each stage of its emergence from the ocean, leading to development of a near-continuous limestone cap. As the island became raised above sea level the ocean excavated new cliffs at each stage, leading to a topography of stepped terraces and inland cliffs.

Most of the coast consists of sheer rocky cliffs 10 to 20 metres high, often undercut, with a few beaches of sand and coral rubble. The interior comprises an irregular plateau from 160 to 360 metres elevation, separated from the coast by a series of steep slopes or cliffs with narrow terraces between. Across the island, substrates are almost entirely derived from limestone, with deep soils on the plateau and upper terraces, becoming progressively thinner and drier towards the more rocky lower terraces.

The island experiences a tropical equatorial climate, with a mean annual rainfall of 2,110 millimetres, reduced during years when the El Niño effect is in operation. The tropical climate leads to a marked seasonality in rainfall, with the dry season from May to November (August to October being the driest months, although some rainfall is received during this period) and the wet season from December to April when the north-west monsoon prevails (January to March being the wettest months). This seasonality is not expressed in other factors, with relative humidity stable year round at 80-90%, and similarly with temperature at 23 to 29°C.

The native vegetation of the island is predominantly evergreen, with a dense canopy, epiphytes, emergent trees and a sparse forest floor harvested by numerous land crabs. In addition to the primary rainforest (30 to 40 metres with emergents to 50 metres), other vegetation zones have been delineated as: marginal (terrace) rainforest (20 to 30 metres); open, scrubby and vine forests; coastal fringe; shorecliffs/spray zone; and mined areas (DuPuy 1993a).

B.1.2 Distribution of *Asplenium listeri*

Asplenium listeri is endemic to Christmas Island (DuPuy 1993b).

Historical

The species is named for naturalist Joseph Jackson Lister, who visited in H M Survey Vessel *Egeria* in September-October 1887. Lister collected a specimen of the fern, probably near Flying Fish Cove towards the north-eastern corner of the island. A single specimen was reported by H N Ridley in 1906 from this same vicinity at Toms Ladder (DuPuy 1993b). There is no longer evidence for the species in this area, despite attempts to locate the type locality (Green *pers. comm.*).

Known

The species is now known from five localities.

Population 1 was the first locality recorded (and the only one known at the time the species was nominated for listing) at Gannet Hill, above the limestone terraces on the eastern side of the island. Because the original collections by Lister and Ridley no longer exist, the species was newly described from a single specimen collected at this locality in April 1987 (DuPuy 1993b).

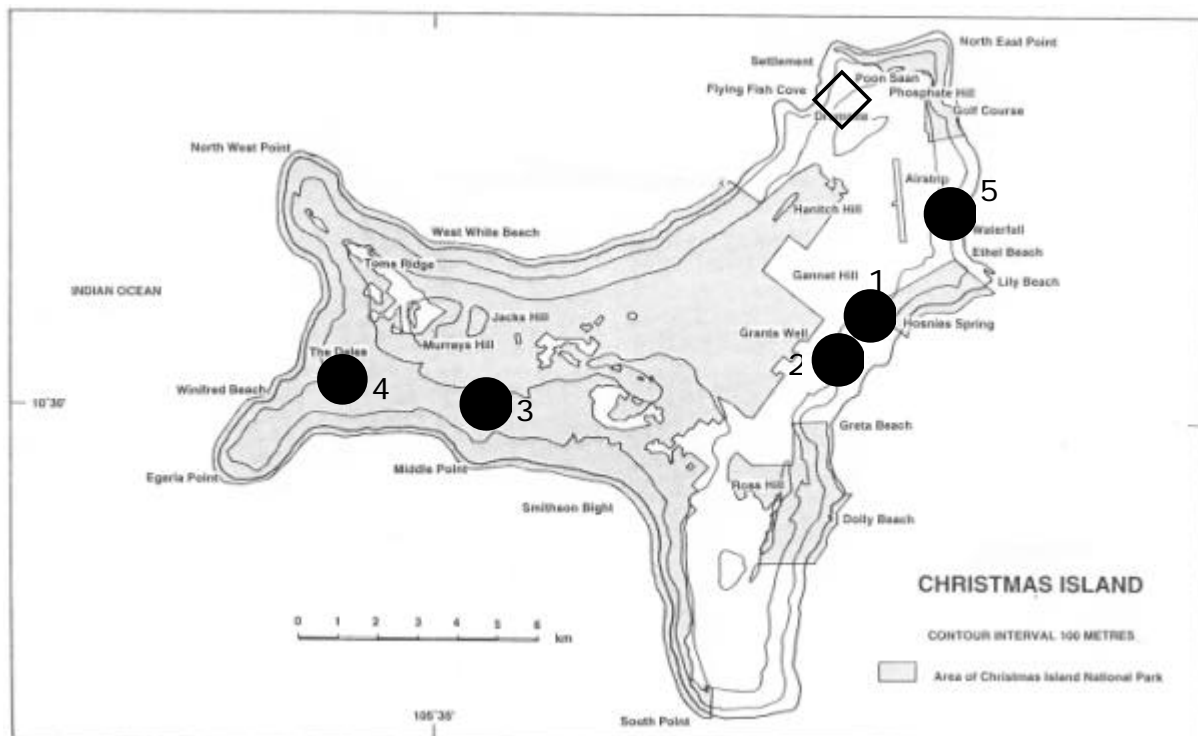
Three additional localities were located during a survey of flora in March-April 2002 (Holmes & Holmes 2002):

- **Population 2** - on the eastern terrace of the island on the Greta Beach Road a few kilometres south-west of the Gannet Hill locality.
- **Population 3** - on the southern side of the island at Aldrich Hill approximately 9 kilometres to the west of the Greta Beach Road locality.
- **Population 4** - near Sydney's Dale (Dale No.6) on the western side of the island; about 4 kilometres west of Aldrich Hill and 13 kilometres west of Greta Beach Road/Gannet Hill.
Note: this population was not relocated despite two attempts (Claussen *pers. comm.*).

These populations when combined total less than 300 individuals.

Population 5 was located in March 2003 by plant ecologists carrying out environment impact assessment for an expansion of phosphate mining. This was north of the Resort on the eastern terrace. The precise location will be provided when the draft environmental impact statement has been released, but will be kept confidential (Zimmermann; Reddell *pers. comm.*).

Figure 1 Localities for *Asplenium listeri*



Base map © Commonwealth of Australia

- Known localities
- ◇ Type locality (not extant)

Unconfirmed

Although other occurrences have been reported, these appear to coincide with confirmed sites:

- A population of about 20 mature individuals with hundreds of sporelings, was located in about 1996 north of the Resort, above a spring and stream bed, and below a mining lease (Hart *pers. comm.*). This site is apparently not the same as **Population 5** (Bennett *in litt.*)
- The Commonwealth database notes a site at Jones Spring (about 600 metres north of the Resort on the east coast) and said to have approximately 500 individuals (90% juveniles). This was not

relocated despite attempts in 2001 and 2002 (Claussen *pers. comm.*). This site is almost certainly the site noted above which was reported in about 1996.

- A population of unknown size was reported in the vicinity of the Greta Beach Road on the east coast in approximately late 1996, but this was not readily relocated (Hart *pers. comm.*). This is highly likely to be **Population 2** which was (re)located in March-April 2002.

B.1.3 Important populations

An important population is one that is necessary for the species' long-term survival and recovery. This may include populations that are:

- key sources for reproduction and dispersal
- necessary for maintaining genetic diversity
- near the limit of the range of the species.

All known occurrences of *Asplenium listeri* need to be regarded as important populations, based on:

- endemic status
- highly restricted occurrence; and
- uncertainty surrounding the reasons for its rarity.

Any additional populations that are located within the term of this plan need to be similarly regarded as important populations.

B.1.4 Potential habitat

Despite the limited occurrences, 'potential habitat' appears to be:

- limestone rock crevices at the uppermost part of inland cliffs above terraces (or cuttings of similar structure)
- between about 110 and 255 metres elevation; and
- often beneath or near *Ficus microcarpa*.

Populations can easily remain undetected in this habitat, since much of the terraces and associated cliffs (particularly on the northern and southern sides) are infrequently visited. Survey of cliff-tops for populations is an extremely difficult undertaking due to inhospitable terrain and the nature of the vegetation (Claussen *pers. comm.*). These same factors make it difficult to assess the suitability of such areas as potential habitat for colonisation or (re)introduction.

A number of informants (Tranter *pers. comm.*; Hart *pers. comm.*) suggest that the greatest potential for new populations (or for colonisation or reintroduction) is at the inland cliff-tops of the eastern terraces, broadly facing the prevailing south-easterly trade winds which provide moisture to an otherwise very dry and exposed situation.

This is the zone with the largest area lying outside the national park and is the focus of most of the island's recreational development (the eastern beaches) and some of the most significant infrastructure development (a new port and associated roading, and expansion of the airport), with possible expansion of phosphate mining on the inland side of cliff-tops.

In view of this, all potential habitat (as described above) needs to be carefully surveyed for the presence of *Asplenium listeri* when proposed developments are assessed.

It has been suggested that potential habitat may also include artificially moist areas in the vicinity of water supply works, such as Jedda Cave and Jane-Up, within the altitude range for the species at 210 and 200 metres elevation respectively (Sewell *pers. comm.*). However, these sites have previously been surveyed with no *Asplenium listeri* being located (Claussen *pers. comm.*).

B.2 Habitat that is critical to the survival of the species

B.2.1 Defining and mapping habitat critical to the survival of the species

Definition of habitat that is critical to the survival of *Asplenium listeri* is based on the following matters from EPBC Regulation 7.09:

- habitat used in periods of stress
- habitat used to meet essential life cycles

- habitat used by important populations
- habitat necessary to maintain genetic diversity and long-term evolutionary development
- habitat necessary to ensure the long-term future of the species through reintroduction or re-colonisation.

Based on current knowledge of the biology and habitat in known locations, habitat critical to the survival of *Asplenium listeri* needs to include:

- all limestone rock crevices in the vicinity of known occurrences - reflecting uncertainty regarding reasons for the extremely limited distribution of the species and potential threats to survival; and
- taller vegetation structures on the inland side of cliff-top sites and relatively open exposure to the coast (refer C.1 below)

The environs of any additional populations that are either newly confirmed or newly located or more precisely defined within the term of this plan need to be similarly regarded.

Due to the uncertainty of current location information and limited knowledge on the ecology and specific habitat requirements, the habitat critical to the survival of the species cannot be mapped accurately at this time.

To protect the species the precise locations of all populations should remain confidential in any listing or public record. As an aid to confidentiality, a buffer of at least 1 kilometre around all known populations should be applied in publicly available mapping for EPBC referral and enquiry purposes.

PART C: THREATS

C.1 Biology and Ecology relevant to threatening processes

Asplenium listeri is a small terrestrial fern with shortly creeping rhizomes and fronds up to 9cm long held in a crown. The species is described (DuPuy 1993b) as an occasional (rare) component of the sparse vegetation community characteristic of inland cliffs which rise above marginal rainforest on the terraces. It is not recorded from the other vegetation zones (being primary rainforest; marginal terrace rainforest; open, scrubby and vine forests; coastal fringe; shorecliffs/spray zone; and mined areas).

Asplenium listeri appears to be quite specialised in its habitat of limestone rock crevices in otherwise dry and exposed sites, where few other species are found. These sites tend to be rocky and narrow cliff-top strips up to 15 metres wide, between a very open aspect on the seaward side and a forest structure increasing up to 40 metres high on the inland side (Reddell *pers. comm.*). Such situations are well placed to interrupt and capture moist flow from south-easterly trade winds (Tranter *pers. comm.*). Some sites may be partly shaded, beneath or near *Ficus microcarpa* (Holmes & Holmes 2002).

It is highly likely that distribution and propagation of the species are related to moisture retention. While the island experiences generally high rainfall, the limestone outcrops are highly porous due to joints and solution. As a result, surface water is rare, being restricted to perennial springs. These are effluxes associated with the junction of limestone with underlying basalt, and surface flow continues where they flow over volcanic rock. Most effluxes lie at elevations below the occurrences of *Asplenium listeri* (which are >100 metres elevation).

It is interesting to note that the first collection of the species by Lister took place at the peak of the dry season and probably on the northern side of the island (DuPuy 1993b). The specimen that Lister collected may have been in an ideal microhabitat, perhaps associated with a seep, or it may have been collected after unseasonal rain. In 2001 specimens kept at a nursery on Christmas Island would apparently die off when deprived of water for a short period and quickly recover when watered again. This suggests that the vegetative parts would more normally die off during the dry season, and re-sprout during the next wet (Sewell *pers. comm.*). It was observed that the specimens did not appear to benefit from regular abundant irrigation, as befits the habitat preferences of the species (Claussen *pers. comm.*).

The habit of growth in rock crevices is likely to afford the rhizome a degree of protection from drying out in the dry season, a protective effect heightened by accumulation of organic debris as mulch in the crevices (Hart *pers. comm.*). In other situations, this habit may also protect the rhizome from occasional fire, which is not currently seen as an issue on Christmas Island (Claussen *pers. comm.*; Reddell *pers. comm.*)

The species appears to be slow-growing and not vigorous (Reddell *pers. comm.*). Its restricted distribution and its apparent absence from potential habitat suggest that the species is by no means aggressive in colonising or propagating.

Despite the high degree of specialisation implied by the habit of growing in exposed rock crevices, *Asplenium listeri* was recorded in one location growing in the same crevice as the closely related but larger *Asplenium polyodon* G. Forst. (Sickle Spleenwort, Mare's Tail Fern). This is an unusual occurrence for the latter, which is more normally (and frequently) found in epiphytic situations utilising the root ball of *Asplenium nidus* L. (Bird's Nest Fern) (DuPuy 1993b).

One can only speculate on the implications of the two cohabiting in a rock crevice. The rarity of the situation might suggest *A. polyodon* is not a significant competitor for *A. listeri*. Alternatively, the already more widespread *A. polyodon* might be capable of broadening its habitat choices at the expense of *A. listeri*.

It has been speculated that *A. listeri* is actually a variant of *A. polyodon* that has become a rock crevice specialist (Reddell *pers. comm.*). If this is so, the occurrence of two distinct forms in the one crevice is of considerable interest. Greater certainty would require professional taxonomic review.

C.2 Identification of threats

Potential threatening processes for *Asplenium listeri* include:

- removal or modification of actual or potential habitat by phosphate mining or by construction of roads or other developments
- weed invasion arising from rehabilitation of mined areas or from construction
- predation by exotic species or changes in native species composition arising from activity of exotic species
- human traffic
- unauthorised collecting of specimens
- stochastic disturbance events e.g. cyclones, severe dry seasons
- fire.

The factors that have led to the limited occurrence and loss of locations for the species are not clear. At the time of initial listing, stochastic events were presumed to be significant (TSSC 2002).

C.2.1 Mining

Mining of phosphate-rich soils from between limestone pinnacles began near Phosphate Hill in 1899 and has continued in most years to the present day. The original mining took place on the eastern side of the island and spread westwards with associated construction of access roads. In the late 1960's drill line surveying to map accurately the phosphate reserves resulted in a parallel grid of lines being cleared every 120 metres over most of the plateau (CofA 2002).

Rehabilitation of mining fields has been carried out in several phases. The earliest rehabilitation involved levelling of pinnacles, reintroduction of stockpiled low phosphate overburden, and planting with exotic tree and shrub species. In later phases, replanting utilised only native species. Mining fields in the geographic area of the National Park were excluded from the Park to allow them to be worked out, subject to environmental controls. In February 1998 a lease was signed to allow mining activities to continue for a further 21 years (CofA 2002).

The current distribution of *Asplenium listeri* on exposed cliff-tops suggests that it is unlikely that past mining or associated roading and surveying have removed actual or potential habitat. It is not known whether deposition of dust from mining and associated roading and transport (which can smother vegetation) has affected any population of *Asplenium listeri*.

It is possible that **Population 5** is adjacent to an area that may be proposed for mining in the future. The draft EIS for the proposed expansion of mining submitted in 2003 states that all populations of *Asplenium listeri* will be preserved and sufficient buffer zones established (Bennett *in litt.*).

Location of a population in an area likely to be affected by heavy dust deposition should result in specific requirements to mitigate this potential impact.

C.2.2 Construction

There are several recent, current or potential developments involving construction activity on the island. These include:

- proposed expansion of nine sites for **phosphate mining** (EPBC referral 2001/487) - the environmental assessment for this proposed expansion is due to be released in 2004.
- construction of the **Asia Pacific Space Centre** near South Point - the Centre is primarily located in former mined areas; survey has not located any specimens (APSC 2003), and it is not likely to affect a population. The construction environmental management plan states that any specimens of threatened species identified on the site would be retained (APSC 2003). The Centre will be located above one of the areas offering potential habitat for *Asplenium listeri* on cliff-tops above the eastern terraces towards South Point.
- associated construction of **common use infrastructure** including a new port facility between Waterfall and Norris Point on the east coast (referral 2001/435), upgrade of the Linkwater Road between the new port and Lily Beach Road (referral 2001/436) and an expansion of the airport (referral 2001/434) - the environmental assessment reports comment on the presence of a number

of endemic and listed plant species but *Asplenium listeri* was not recorded or expected (GHD 2002a; 2002b; 2003).

- construction of an **Immigration Reception and Processing Centre** (IRPC) on the central plateau area towards North West Point and associated infrastructure (exempt from the EPBC Act by Ministerial decision 3 April 2002) - this construction was not in a location likely to contain *Asplenium listeri*. Most of the activity was within a former mined area (ML 138 and ML 139) (Exemption notice April 2002).
- a **radio system upgrade** for the Australian Federal Police at Murray Hill (referral 2002/718) - no additional information located
- construction of a **mobile phone tower/base station** at Limestone Hill near South Point (referral 2002/694) - the environmental assessment report did not record *Asplenium listeri* (Holmes 2002).
- possible extension or modification of the **Christmas Island Tourism Resort and Casino** on the eastern coast north of Ethel Beach (closed in 1998 but may be redeveloped) – no additional information located.

None of these developments are likely to affect a known population of *Asplenium listeri*.

Apart from new developments, there is potential for construction as part of maintenance to be a potential threat, specifically:

- any widening or modification of the Greta Beach Road in the vicinity of **Population 2**; and
- maintenance or construction for water supply infrastructure that may be potential habitat [see B.2.2 above].

C.2.3 Weeds

No Weeds of National Significance are known to affect any populations of *Asplenium listeri*.

Numerous species of weeds have invaded forest margins along roads and tracks and around mining fields, and sparse vegetation communities, such as those on the terraces, are also vulnerable to such invasion.

The very hardy native ferns *Nephrolepis multiflora* (scurfy sword fern) and *Nephrolepis biserrata* (broad sword fern) can spread aggressively to form dense and tangled colonies which confound access, and compete strongly with other plants (Swarbrick 1997). *N. multiflora* is particularly noted as an invader of mining fields (CofA 2002) where it is often dominant in areas of poor thin soil and limestone pinnacles, while also forming dense thickets more than 2 metres tall in damper, more shaded gullies towards the margins of old mines (DuPuy 1993c). However, there is no evidence that either species is competing with *Asplenium listeri* in its exposed cliff-top habitat (Reddell *pers. comm.*).

With the possible (and uncertain) exception of former habitat that may have been affected by weed invasion following mining, the specialised habitat now occupied by *Asplenium listeri* makes it unlikely that weed invasion has contributed to the restricted distribution of the species through competition, and there is no reference to weed species in records of known localities. The most recent survey notes that the species is not subject to tangible threats from invasive weeds (Holmes & Holmes 2002).

C.2.4 Exotic fauna

There are no records indicating any specific threats from the activity of exotic fauna.

The species occasioning most concern on the island in recent times is yellow crazy ant (*Anoplolepis gracilipes*), which was introduced accidentally between 1915 and 1934. It has recently undergone a population explosion and the ants have formed multi-queened 'supercolonies'. This has had a marked impact on other terrestrial fauna such as land crabs and in turn has changed the vegetation profile in some forest types. Although *Asplenium listeri* may be vulnerable to episodic changes in canopy density or encroachment by other vegetation (Holmes & Holmes 2002), the effects brought about by the yellow crazy ant are not considered likely to affect the areas associated with *Asplenium listeri* (Claussen *pers. comm.*).

Of greater potential impact may be the giant African snail (*Achatina fulica*) which feeds on a wide variety of plants but may be expected to take refuge in moist locations, including those favoured by ferns. It is not known whether this species has had, or is likely to have, any impact on *Asplenium listeri*. Although the presence of land crabs appears to restrict the distribution of the snail,

this controlling effect may be compromised by reduced crab populations brought about by the yellow crazy ant infestation (CofA 2002).

Crazy ant populations are responding to a program of aerial baiting, however the potential for increased spread of the snail may be inferred, because there may be a gap of many years before land crabs recover to a level sufficient to control snail populations. Parks Australia monitor presence/absence of the snail during surveys for crazy ant populations, and these data could be related to the distribution of *Asplenium listeri* to assess any interactions (Jeffery *pers. comm.*).

Also of potential concern is an exotic millipede which feeds on vegetable matter and occurs in very high densities in certain areas (Sewell *pers. comm.*). No additional information was located on this.

C.2.5 Human traffic

The potential habitat for *Asplenium listeri* is for the most part highly inaccessible due to the steep and rocky cliffs, pinnacles and screes, and inhospitable due to the dry and exposed nature of the sites and the types of vegetation in the vicinity (often dense and dominated by stinging trees and prickly plants). As a result, pressure of human traffic is not likely to pose a threat to populations of the species (Reddell *pers. comm.*).

C.2.6 Unauthorised collecting

There is no evidence of unauthorised collecting of *Asplenium listeri*. However, members of this extensive genus are particularly attractive for cultivation, with some highly variable in habit and suitable for selection for cultivation, while others form excellent specimens for baskets (Jones & Clemesha 1981; DuPuy 1993b).

There is potential for collecting of specimens or propagules of rare species by or on behalf of fern enthusiasts. The likelihood or extent of such a demand cannot be predicted. However, in view of the small population numbers known and the uncertainty of factors restricting distribution, any such predation could pose a significant threat to the survival of the species. Confidentiality of precise locations would appear to offer the best safeguard against this practice.

C.2.7 Stochastic events

Because of the tropical location of the island, severe rainfall events associated with the monsoon are common in the wet season, although the extent and impacts of these cannot be predicted. Severe dry seasons tend to coincide with the El Niño effect in the Pacific (CofA 2002), and these events may be increasing in frequency and severity.

Confident assessment of the impact of stochastic events (as for other potential impacts) requires further study of the life cycle, longevity and regeneration requirements of the species - information which is currently not available (Reddell *pers. comm.*).

However, applying the precautionary principle, it is reasonable to expect that *Asplenium listeri* could be affected by severe rainfall events through scouring and transport of soils and mulch from rock crevices to expose the rhizome, and/or by severe dry seasons through desiccation.

In view of the exposed nature of the species' cliff-top habitat, such events have the potential to be significant factors in limiting its occurrence and potentially in threatening its continued survival. These events were seen as the most concerning threat at the time of initial listing (TSSC 2002).

C.2.8 Fire

Fire is not currently seen as an issue on Christmas Island (Claussen *pers. comm.*; Reddell *pers. comm.*), however it is noted that a fire did occur in the terrace rainforests during the long dry of 1994 and again in September 1997 (GHD 2002a). If dry seasons become more severe more frequently, then impact from fires may become an issue for many species that are not adapted to such events.

C.3 Areas and populations under threat

In view of uncertainty about the factors that have restricted distribution, the degree of threat to any particular area or population is difficult to estimate.

No populations are known to be threatened by current or proposed mining or construction, and there is no imminent concern about weed invasion, the impact of exotic fauna, or unauthorised collecting.

Some of the known populations may be less likely to face these types of threats because they are located within the Christmas Island National Park. These include:

- **Population 1** - Gannet Hill
- **Population 3** - Aldrich Hill; and
- **Population 4** - Sydney's Dale.

It is also notable that The Dales area, being a Wetland of International Importance under the Ramsar Convention, is a matter of national environmental significance under the EPBC Act.

The Plan of Management for the National Park noted a number of proposed extensions to the park, including:

- an area on the east coast between Margaret Knoll and Ross Hill (excluding mining fields) and taking in Gannet Hill (excluding mining fields); and
- an area on the east coast south of the Ross Hill section around South Point (excluding mining fields) to join the existing Park boundary.

These extensions may afford a higher degree of protection from development to **Population 2** and some of the areas likely to contain potential habitat for *Asplenium listeri*, but may not afford a higher degree of protection from development to **Population 5**.

However, listing of the species as a threatened species under the EPBC Act offers a degree of protection irrespective of land tenure.

PART D: OBJECTIVES, PERFORMANCE CRITERIA AND ACTIONS

D.1 Recovery objectives, timelines and performance criteria

The overall goal is **to improve the conservation status of the species**.

We will know we have achieved this when at least one of the parameters that warrant the conservation status of critically endangered is improved sufficiently to consider an improved status of endangered (or better). This may not be achieved within the life of this plan.

Specific objectives to advance this goal within the life of the plan include:

Objectives	Performance criteria	Timeline
<i>Objective 1:</i> To abate and avert threats to the species	No population of the species is impacted by a threatening process	Review and assess annually.
<i>Objective 2:</i> To improve knowledge of factors in the restricted distribution of the species	A comprehensive list of environmental factors (physical and biological) and/or a predictive model assist(s) location of additional populations	Review annually; assess at the end of five years
<i>Objective 3:</i> To increase the number of known occurrences	At least one additional population (or an enlarged population) of the species has been located in the wild	Review annually; assess at the end of five years

D.2 Evaluation of success or failure

Performance will be evaluated annually, and assessed overall after five years as part of revising this plan, by a recovery team comprising representatives of Commonwealth agencies and community interests, supported by independent scientific advice.

The proposed member organisations include:

- Parks Australia North, Department of the Environment & Heritage
- Shire of Christmas Island
- Island Care Inc
- Department of Transport & Regional Services
- Australian National Herbarium, Department of the Environment & Heritage
- Christmas Island Phosphates

D.3 Actions to achieve objectives

Within the life of this plan:

No.	Action	Suggested timing
<i>Objective 1: To abate and avert threats to the species</i>		
1.1	Keep locations of populations confidential	Continuing
1.2	Monitor visitor pressure and impact on Gannet Hill population	Continuing
1.3	Ensure inclusion of <i>Asplenium listeri</i> in all guidelines and specifications for environmental assessment and standards, particularly along the east coast	Continuing
1.4	Pursue national park status for the Ross Hill Gardens area and around South Point, and other areas related to populations of <i>Asplenium listeri</i> that are located within the term of this plan	Initially by Year 3; then continuing
1.5	Consider need for listing on the EPBC Register of Critical Habitat to strengthen legal protection, with update as new populations are located	By Year 2; then continuing
1.6	Expand content about <i>Asplenium listeri</i> (and other listed plant species) in future national park management plans with specific reference to recovery plans and relevant threat abatement plans (keeping precise locations confidential)	Next revision – 2007/8
1.7	For the population at The Dales, and if a population is located at Hosnie's Spring, update the relevant Ramsar Information Sheet and description of ecological character to ensure the most robust protective framework under the EPBC Act	The Dales – Year 1; Hosnie's Spring - as soon as relevant
<i>Objective 2: To improve knowledge of factors in the restricted distribution of the species</i>		
2.1	Survey all known occurrences of <i>Asplenium listeri</i> to compile a comprehensive list of environmental factors (physical and biological) and base data (including photographic) for population monitoring	Year 1
2.2	Consider use of the above to develop predictive models to assist location of additional populations	By Year 3
<i>Objective 3: To increase the number of known occurrences</i>		
3.1	Survey potential habitat for more populations, with focus on the east coast, including Hosnie's Spring (following a wet season)	By Year 2
3.2	Examine the need for and potential of <i>ex situ</i> cultivation	Year 2
3.3	Examine potential for (re)introduction of <i>Asplenium listeri</i> into additional east coast terrace cliff-tops	By Year 5 for review of this plan

PART E: MANAGEMENT PRACTICES

All occurrences of *Asplenium listeri* are considered to be important populations, and their environs are considered to be habitat critical to their survival. Because the numbers are so low and the range so restricted, any impact on any population of the species may be significant.

A significant impact on a critically endangered or endangered species may arise from:

- reducing the size of, or fragmenting, a population of the species
- reducing the area occupied by the species
- adversely affecting or decreasing availability or quality of habitat critical to survival of the species
- introducing invasive species that compete with, modify habitat for, or prey on, the species.

Any proposed development or maintenance activity in the vicinity of a known occurrence of *Asplenium listeri* or in an area identified as potential habitat needs to be preceded by:

- survey for the species; and
- (wherever it is found) comprehensive documentation of the population and site factors; and
- detailed attention to measures to avoid or mitigate impact on any population.

Specific attention needs to be paid to proposed developments and maintenance activities in areas of known or potential habitat on or near the tops of inland cliffs that may increase vulnerability of the species to:

- modification of habitat by mining or excavation, construction, clearing of native vegetation; or
- weed invasion, or exotic fauna; or
- dust deposition; or
- human traffic; or
- unauthorised collecting.

Mapping for EPBC public enquiry purposes needs to remain coarse, with at least a 1 kilometre buffer around known localities. If predictive models are developed, potential habitat should be mapped in a similar fashion for public enquiry.

PART F: DURATION AND COSTS

F.1 Duration and costs

Costs envisaged in implementing this plan are:

Action	Year 1	Year 2	Year 3	Year 4	Year 5
Keep locations of populations confidential [1.1]	Continuing – nil cost				
Monitoring of visitor pressure and impact on Gannet Hill population [1.2]	Regular and continuing Minimal cost				
Inclusion in all guidelines and specifications for environmental assessment and standards, particularly along the east coast [1.3]	Continuing – nil cost				
Pursue national park status for Ross Hill Gardens area and around South Pt [1.4]			Minimal cost		
Pursue national park status for areas associated with any populations located within the term of this plan [1.4]	Continuing – Minimal cost				
Consider need for listing on EPBC register of critical habitat, with update as new populations are located [1.5]			Continuing - Minimal cost		
Expand content about <i>Asplenium listeri</i> (and other listed plant species) in future national park management plans [1.6]				Minimal cost	
Update Ramsar Information Sheet and description of ecological character for The Dales [1.7]	Minimal cost				
Update Ramsar Information Sheet if population at Hosnie’s Spring [1.7]	If/when relevant – Minimal cost				
Collection and collation of data about known locations and populations [2.1]	\$4,000				
Consider predictive models to assist location of additional populations [2.2]			Not known		
Survey of potential habitat for additional populations, especially east coast [3.1]; (actual timing depends on wet season)	\$5,000				
Examine the need for and potential of <i>ex situ</i> cultivation [3.2]		Not known			
Examine potential for (re)introduction of into additional east coast cliff-tops [3.3]				Not known	
Communication costs associated with annual evaluation by the recovery team	Annual Minimal cost				

F.2 Resource allocation

Estimated costs assume that much of the work can be carried out by personnel on Christmas Island (i.e. no allowance is made for airfares and accommodation). Although some external assistance may be required in design of survey and documentation methods and in review of results, this may not need to be on-site.

Efficiencies may be gained by:

- combining the effort for actions 2.1 and 3.1 (combined cost about \$7,000)
- ensuring that future versions of the Christmas Island National Park management plan incorporate actions arising from this recovery plan and from all others in force for the island
- integration of continued data collection with other Natural Heritage Trust programs and relevant environmental assessments on the island; and
- use of one recovery team on the island to implement and evaluate all recovery plans for threatened plant species and any relevant threat abatement plans.

For some actions in Years 3 to 5, likely costs are not known because they depend on the outcome of earlier efforts. For example, collation of data on known populations [2.1] may obviate the need for any additional expenditure on predictive models [2.2], or else may provide a firmer indication of the likely complexity of such models and what allocation may be required. Similarly, examination of potential for (re)introduction [3.3] may depend entirely on the outcome of examination of *ex situ* cultivation [3.2]. Such costings should be developed as the work of the recovery team progresses to Year 3.

Items shown as ‘minimal cost’ relate almost entirely to the national park area and would in most cases be expected to be contributed by Parks Australia.

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