A plan for the conservation of endemic and native flora on Ascension Island

A guide to conservation management, produced for the Ascension Island Threatened Plants Restoration Project funded by the Overseas Territories Environmental Projects scheme, DEFRA, U.K.

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I. Introduction

Ascension Island Government Conservation Department was established on Ascension Island in 2001, following recognition of the need for action to preserve the unique natural heritage of this tiny overseas territory of the United Kingdom. Whilst the spectacular seabird and turtle populations have always attracted public attention, the need to view the island as a single ecological unit, to provide stewardship of its many facets, is a fundamental aim of those concerned. The preservation of the remaining native plant species is one important element of this aim, and one which is inter-liked with maintaining a healthy and rich local environment. As relatively little work had previously been conducted on Ascension's terrestrial ecosystems, the past two decades have been marked by a gradual process of learning through practical management trial and error. The path has sometimes been a difficult one, but has been marked by many significant steps forward, particularly the designation of the Green Mountain area as a national park on 25th June 2005. The small but dedicated team of professionals and volunteers have already made an impressive contribution to conserving Ascension's natural heritage.

The relatively recent start of the conservation process on Ascension, together with the unique and severe problems faced (see Section II), has meant that developments have been rapid. As a result of this, there is a regular need to review the current state of the programme, and to develop new plans for future action. The Threatened Plants Restoration Project emerged as part of this need, aiming to both assess and develop capacity for future preservation of the island's endemic vascular plant species. Previous guidelines were already in existence, particularly through the Ascension Island Management Plan (Pickup 1999) and a series of species action plans drawn-up in 1998 (Gray et al., 2000).

Species action plans are now a standard form of management document used widely throughout the United Kingdom, and they present a valuable format for use with the ongoing management of Ascension's endemic species . They require updating periodically e.g. every ten years, therefore, a revised set of plans are included in Section VI. However, a "species-lead" approach is insufficient, in isolation, to adequately address the need for future action on Ascension (see Section III). As the habitat required for the endemic species to flourish is now very severely degraded, a "site-lead approach" is necessary, in order to restore areas where functional communities could once again coexist sustainably. It is therefore vital to include other native, non-endemic species within this plan; these will form an important element within such restored communities. Reference to these other native community elements are largely restricted to vascular plants – although we recognize that bryophytes, invertebrates and fungi are also very important, there remains insufficient information to address their conservation needs at present. It is hoped that further research will permit such necessary advances in future years.

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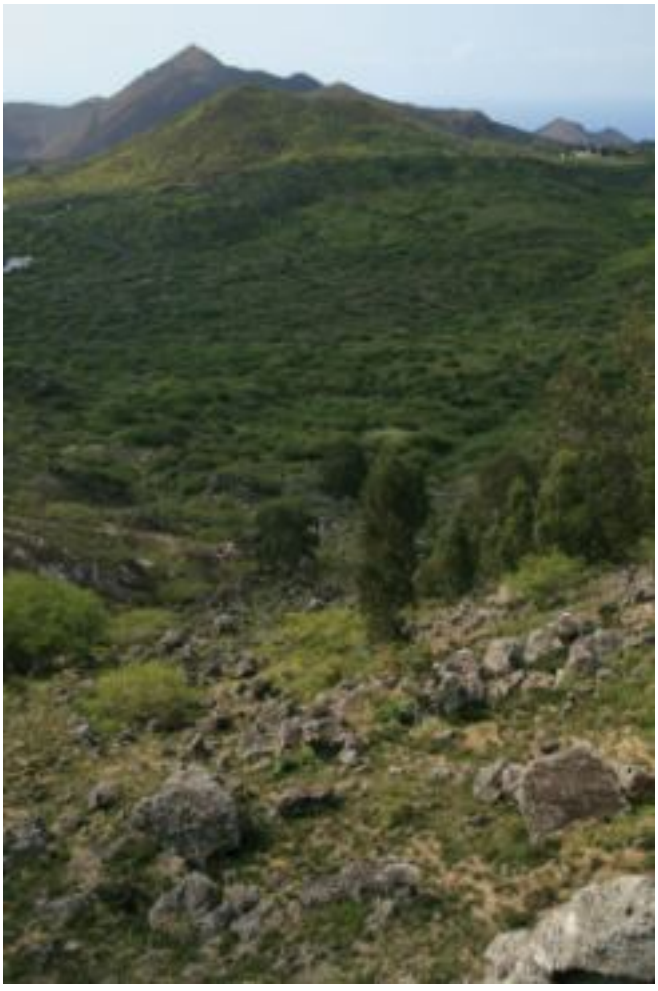
II. The decline of Ascension's flora

Perhaps more than almost any other small geographical region on Earth, the ecology of Ascension Island has been subjected to extreme human influences since its discovery in 1502. This is largely a consequence of low diversity of native plants and animals, resulting from a relatively young geological age (only approximately 1 million years) and acute isolation, both of which have lead to a low rate of colonization, but also a high frequency of volcanic activity which may have lead to periodic extinctions amongst the early colonizers (Ashmole & Ashmole, 2000). However, the interior of the island was barely explored by botanists until the mid 1800s, some 350 years after discovery. It is quite possible that the original flora and fauna was richer than currently recorded and that some species had already been lost by this stage, escaping the attention of science.

The first major human impact was probably the release of goats onto the hill slopes by early passing sailors, to provide food for subsequent expeditions. Due to the remoteness of Ascension, the flora was largely founded from specialist long-distance colonists or had evolved from these species in the absence of browsing, and was therefore poorly-adapted to the new pressures. It is likely that browsing alone caused considerable devastation over the first centuries before settlement. A permanent naval colony was established by the British in 1815 to guard against attack on St. Helena, 800km to the south, following the incarceration of Napoleon. In order to survive in the barren, dry landscape, it was necessary for the garrison to establish a farm, and subsequently to encourage the widespread planting of trees (for shelter, wood and fruits) and grasses (for pasture). Despite difficult early years, their project to "green the island" was ultimately a success (Ashmole & Ashmole, 2000; Hart-Davis, 1972).



Large areas of previously sparsely-vegetated hillside are now covered with invasive species such as Mexican thorn, *Prosopis juliflora*

The native ecosystems present at the time of human arrival on Ascension were still at a relatively early stage of development, which made them particularly susceptible to invasion and disruption by introduced plants. Furthermore, as they contained little of value to the human colonists (e.g. there was only one shrub capable of providing a source of wood), the deliberate destruction of native habitats and replanting occurred

on a massive scale. The most significant event in this process of transformation was brought about by the eminent botanist Joseph Dalton Hooker, who visited the island on the return of the Ross expedition from Antarctica in 1843. Based on his experiences, he presented a landmark paper to the Royal Society in 1854, in which he advocated the mass planting of trees, shrubs and grasses for pasture on Ascension with the aim of greatly increasing mist interception, soil development, water storage capacity, and reducing erosion. This plan was subsequently implemented by the Royal Botanic Gardens at Kew, London, and entailed the introduction of over 220 exotic species from diverse parts of the world. Today, Green Mountain is largely covered with dense invasive vegetation and man-made cloud forest. Even the lowland areas have been substantially invaded by non-native shrublands. Guava (*Psidium guajava*) became widespread in the south-east during the early 1800s, but Mexican thorn (*Prosopis juliflora*) has spread rapidly since the 1970s and yellowboy (*Tecoma stans*) even more recently than this (Duffey, 1964; Hemsley, 1885).

Artificial cloud forest on Coronation Peak: a direct legacy of Hooker's experiment

The consequences of anthropogenic change have been severe (Fairhurst, 2004; Gray *et al.*, 2005; Packer, 2002). Introduced species now comprise approximately 90% of the higher plant flora. Of the 10 known species endemic to the island, only seven are thought to remain today, and all of these are considered to be threatened. Lower plants (bryophytes) have been poorly-studied on Ascension, although it is probable that several of the endemic mosses and liverworts are also now very endangered. All habitats have been subject to encroachment by introduced species to a considerable extent, and virtually nothing still exists that could be described as truly "native habitat", with the possible exception of some areas of extremely barren coastal desert, and some relict fragments of upland vegetation on exposed, misty slopes (although the latter are now heavily weed-infested). These vestiges comprise only 1-2% of the total area of Ascension.

III. The need for a habitat-lead approach to conservation

There is now a common belief that conservation is not sustainable when carried out at the scale of individual species and needs to encompass the dynamism that biological communities exhibit. The Convention on Biological Diversity (CBD) promotes an ecosystem approach by which they mean conserving

"a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit".

The high value of biodiversity at a global scale and in particular, the benefits of preserving natural environments for the functioning of the environment are now widely recognized. Despite this, the world-wide loss of high-quality habitats continues at an alarming rate. A commitment to prevent the extinction of further species from the planet is one way to draw a "line in the sand", in order to limit the on-going deterioration.

The primary purpose of a habit restoration is to conserve Ascension's remaining populations of native and endemic species, thereby preventing their extinction. The decision to take this action, entailing significant expense and manpower costs over a prolonged period, is not a formality. As stated above Ascension no longer has definable native ecosystems or plant communities (or only very small and scattered ones). The approach adopted here therefore needs to beginning with the creation of 'novel' habitats created from a mix of native species.

Three criteria often used to establish whether a re-introduction programme should go ahead, are that:

(1) the species formerly occurred in the area;
(2) there should be sufficient habitat available to sustain a viable population of the species;
(3) the causes of the original decline have now abated.

In the present case, Criterion 1 is implicit in the aims of the project and Criterion 2 is easily met. There are large areas of land on the island which are currently not utilized, and are currently infested with undesirable species. Criterion 3 is the most difficult to justify. Despite the dominance of introduced species, it does not follow that Ascension's original endemic residents should be dismissed as evolutionary failures. In fact, they are clearly capable at surviving in very harsh environments, and still often perform well against the introductions in the most extreme places. Given suitable conditions, it seems reasonable to assume that they will again be capable of holding their own. The difficulty is in providing such conditions. This is the main theme of the latter part of this document.

A second reason for establishing habitat restoration is that in many cases, the newly-evolving, non-native habitats on Ascension remain species-poor in themselves, and may not integrate efficiently with each other to provide the functional services which are necessary to ensure a suitable ecological balance. Large areas are swamped by monocultures of vigorous shrubs. In some cases, such habitats may be prone to erosion (such as those covered by yellowboy), fire risk (e.g. with Mexican thorn and *Casuarina equisetifola*), support few pollinators or other useful insects, and lack resilience (i.e., the ability to recover the original community structure and function when exposed to

damaging events such as natural disasters), due to poorly-developed successional cycles. They are difficult to maintain and may impact on economic and recreational interests. There is clearly a benefit to the island in managing the environment so it functions in a "healthy way", and restoring areas of semi-native habitat offer one possibility of moving towards this.

Only in the highest altitude zone, with its tall fern stands and exposed rock outcrops is there still a case for the preservation of extant habitat areas. The remaining pristine fragments of these areas have a high biodiversity value and host a large proportion of the populations of several threatened higher plants and bryophytes. Their restoration (and reclamation from suitable weed-dominated land) is of a high priority.

In all other cases, the original communities no longer exist. The rapid spread of several dominant invasive species has irretrievably changed the physical characteristics of the environment on the island, and this has often favoured further colonization by non-native under-storey species at the expense of the native flora. The ability of the natives to co-exist with invaders has been poor. "Habitat restoration" therefore implies the creation of entirely new habitat areas, based on the former native ones but not identical as we have little idea how the communities were assembled. However, in order to secure viable populations of the endemic species, careful management of both invasive plants and grazing animals will be necessary.

Given the extreme extent of the problem on the island, these goals are only realistically achievable at a habitat scale, as suitable and sustainable micro-niches do not exist within the present matrix of dense invasive vegetation. As the original native species must have coexisted in communities they therefore have overlapping habitat requirements. The creation of zones where several threatened plants can be managed together adds an efficiency of scale and effort to the conservation programme. Clearly, other taxa, including invertebrates, fungi and slime moulds are important parts of these communities, and must be considered in parallel with the conservation of endemic and native plant species. At present, relatively little is know about these taxon and further efforts to integrate them into conservation efforts should form part of the project.

IV. Ultimate goals for restored habitats

The ultimate goals of the habitat restoration are: *to provide adequate refuges for all endemic and native plants of Ascension to survive in the long term, co-occurring in functional, semi-natural communities and requiring minimal management.*

The key elements of this objective are that the plan should be:-

1) **Focused on ecological communities**, involving a mix of suitable species which interact in a mutually beneficial way.
2) **Based predominantly around endemic and native species**. This does not imply that non-natives must be completely excluded in order for the endemic to flourish; merely that the two components must be mutually sustaining.
3) **Large-scale**, providing sufficient habitat for the native and endemic flora that the populations are not threatened with imminent extinction.
4) **Designed to maintain local genetic variability** (which may reflect adaptation to local conditions) , by respecting the boundaries of geographically distinct sub-populations and attempting to secure the future of each individually.
5) **Sensitive to meta-population dynamics**. Providing a network of patches sufficiently connected that migration can occur between them, thus allowing recolonisation if local catastrophe should impact an individual site.
6) **Sympathetic to the natural ecology and ranges of the species involved**, avoiding creating artificial species mixes where possible (although this is unlikely to be 100% practical), or translocation to areas where a particular species is unlikely to have ever occurred.
7) **Self-sustaining to the highest degree possible**, entailing minimal management to control invasive species and grazing animals, and with no requirement to re-stock the habitats with individuals raised from cultivated sources.
8) **Inclusive of local residents and tourists**. It is essential that the concerns of islanders are taken into account and that they are encouraged to feel ownership of the project, through voluntary participation, educational materials and through encouraging recreational visits to the sites.

V. Barriers to achieving habitat restoration on Ascension

Consideration must be given to the following difficulties:-

1) **Invasive vegetation**
The large number of invasive plant species now present on Ascension represent perhaps the greatest threat to the success of any habitat restoration project. Unfortunately, the list of introductions includes some of the most notorious pest species in the tropics, comprising many extremely vigorous and competitive threats. The high abundance of these species compared to the tiny populations of endemic species currently confers them with a considerable advantage: any area cleared is likely to be colonized naturally by invaders much more rapidly than by native species.

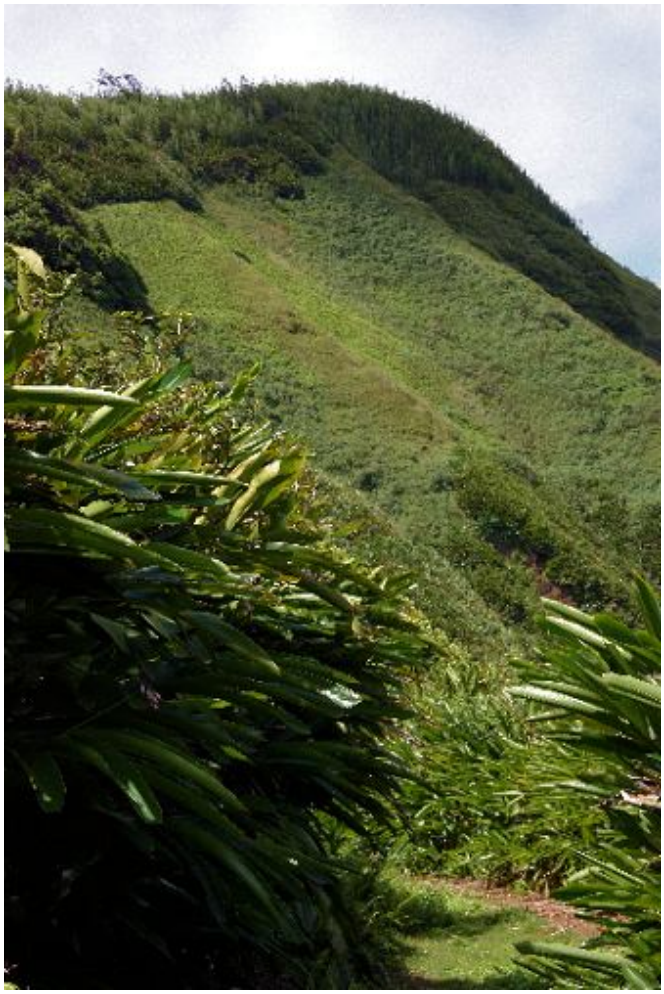
Lowlands

The most barren coastal areas, which constitute the strongholds of *Euphorbia origanoides*, remain relatively invasion-free and in these cases the immediate issue is therefore least serious. However, the dry lowlands are rapidly being colonized by a number of species, and the situation is likely to deteriorate in the future. Tropical heliotrope *Heliotropium curussavicum* has advanced particularly quickly around the coasts, and is now locally dominant, whereas populations of tree tobacco *Nicotiana glauca* have exploded in less than 20 years. Once a degree of cover has been established, this increases the likelihood of colonization by other herbs, and furthermore, encourages rabbits and sheep to graze at lower altitudes. These bring further seeds on their coats and in dung. It is likely to be difficult, but important, to reduce the encroachment of weeds onto target areas. One approach may to create buffer zones around any designated reintroduction sites, in which invasive species are controlled. However, this is best addressed as part of an integrated conservation management plan for the lowlands as a whole. It will be difficult to implement such a plan with limited manpower, and this is likely to remain an obstacle for the immediate future at least.

Mid altitudes

In the dry climate of Ascension, most of the original native mid-altitude habitats probably always included a reasonable proportion of bare ground, leaving them vulnerable to immigration from germinating propagules. Invaders with mobile seeds and high germination rates in these environments therefore present a considerable problem. Such species may be wind-dispersed (e.g. yellowboy and buttonweed *Spermacoce verticillata*), or spread by herbivores such as sheep (in the case of Mexican thorn) and rats (especially in the case of guava and tungy *Opuntia stricta* var. *dillenii*). Whilst the latter category may be controlled if the herbivores can be excluded, wind-dispersed species, and those with fruits distributed by mynah birds, are more difficult to restrict. Once again, there is a wider need for the control of such species as part of an island-level management strategy, but endemic restoration cannot wait in the hope of this future possibility.

Uplands



The southern slopes of Green Mountain, now topped by a cloud forest of non-native species. They are infested with ginger *Alpinia zerumbet* (foreground) and other invasive shrubs at the expense of native fern swards.

At higher altitudes, the original fern-dominated communities were likely to have been dense and vigorous. Although perhaps more resistant to invasion than elsewhere, they have never the less suffered from encroachment, which has crucially been facilitated by other forms of habitat degradation: notably land clearance and grazing. Since land clearance is no longer an issue, there is now some hope for successful recovery. Elsewhere (e.g. in recent experiences on St. Helena), establishing a tight native sward with continuous ground cover has proved reasonably effective at preventing the encroachment of undesirable species. This technique is likely to be key to the long-term stability of native species stands, although certain invaders are well-adapted to infiltrating dense vegetation and may still represent a significant threat. These species normally display a vine-like or creeping habit, and can draw on resources from elsewhere to send-out long pioneering stems into otherwise impenetrable thickets (e.g. blackberry *Rubus pinnatus*, tallow vine *Commelina diffusa* and *Buddleja madagascarensis*).

Not all upland areas are densely-vegetated, and open habitats are also critical to the survival of key endemic populations. *Sporobolus caespitosus, Xiphopteris ascensionense, Anogramma ascensionis* and *Asplenium ascensionis* are all at least partially dependent on the presence of exposed, rocky banks with little competition. It seems likely that such habitats have become scarce over the past century, with shrubs and many small weedy species colonizing the more favourable outcrops. The maidenhair ferns *Adiantum raddianum* and *A. capillus-veneris* have spread to occupy a large part of the available cliff habitat, particularly in the damper areas which provide the best conditions for growth. Even the lush *Marattia purpurascens* community which formerly dominated the highest altitudes may have been partially dependent on the periodic presence of bare ground (see Section VI).

Both *Marattia purpurascens* and the tiny endemic fern *Xiphopteris ascensionense* are capable of surviving on tree branches, or in the dark under-storey to the man-made

forests at high altitudes, although they are here threatened by the few invasive species well-adapted to low light levels, particularly Koster's curse *Clidemia hirta* and *Begonia hirtella*. Koster's curse is a more general problem as it will also grow through dense vegetation and the fruits may be dispersed by rats and mynah birds, which are both extremely difficult to exclude from an area.

2) **Herbivores**

The primary problem associated with herbivores is the effect of browsing by introduced vertebrates. Ascension has been free of goats since the 1940s, but a large sheep population persists, mostly at mid altitudes where there is abundant grassland available although they regularly stray more widely. Sheep straying into coastal areas are a particular concern for the highly grazing-sensitive *Euphorbia origanoides*. At higher altitudes, they are also damaging to the grass *Sporobolus caespitosus*, which can be easily uprooted, and hence is now largely confined to inaccessible rocky ledges. Rabbits are perhaps even more of a serious issue as they are widespread from the lowlands to near the summit of Green Mountain and can cause substantial damage. They probably represents the most serious single threat to *Euphorbia origanoides*, but will destroy seedlings of most species. Observations of their impacts on Green Mountain experimental plots suggest that even unpalatable ferns can be vulnerable when growing on more open terrain: intruders will graze young shoots and damage the rootstocks by digging.

A large-scale eradication of rabbits and sheep would be extremely costly, logistically difficult and may not meet with public approval. This is unlikely to be a realistic option for the foreseeable future. Fencing is the simplest means of control, and it may be possible to exclude sheep from reasonably large areas in this way. However, fencing is difficult to maintain, and just a few animals infiltrating an exclosure could have a devastating impact if not removed quickly. Rabbit-proof fencing is costly and on-going vigilance is required, initially to remove undetected individuals from the enclosed area and then to guard against breaches. Manual trapping of intruders is slow and labour-intensive. Even in the lowlands it may not be impossible to maintain areas of restored habitat without fencing, as attested by the survival of a large natural spurge population on Hummock Point. However, fences would undoubtedly have to play an important role in the early stages of most planned projects, and in areas with high densities of grazers (e.g around Georgetown), permanent maintenance of exclosures may be necessary.

In addition, rats and mice represent a lesser threat, although have also been recorded as taking the fruits of *Euphorbia origanoides*. Donkeys may have a direct impact on any attempt to re-establish spurge around former strongholds in Georgetown and Comfortless Cove, and present a significant management issue as vectors of Mexican thorn seed.

Invertebrate herbivores are currently less of a serious issue on Ascension as few of the most voracious generalist pests have yet been recorded on the island. The cotton cushion scale *Icerya purchasi* has recently been noted on a wide range cultivated and wild plants, including some of the endemic species, and this could be a potential problem in the future if it spreads further. Extreme care must be taken when cultivating material for habitat restoration in order to not spread this pest inadvertently to new areas.

3) **The limited functional diversity amongst the remaining endemic and native flora**

The original native flora of Ascension was characteristic of a young, remote island. Such simple communities may be vulnerable to collapse, or deterioration, if one or two of the key structural components are lost. In the appropriate conditions, the native communities may still be resilient and competitive, as shown by the *Marattia purparascens* - *Histiopteris incisa* fern swards on the upper southern slopes of Green Mountain. However, this community has preserved two strongly dominant elements. Particularly in the case of the mid-altitude species, such dominant community members no longer exist. The endemic shrub *Oldenlandia ascensionis* is now very probably extinct, as is the moderately large, tussocky grass, *Sporobolus durus*. Both of these would probably have been important in shaping the structure of their original communities. Similarly, the fern *Dryopteris ascensionis* was likely to have once contributed to a dense sward at mid to high altitudes. Without these important components, the task of recreating functional habitats becomes increasingly difficult. In particular, the ability to exclude invasive vegetation is substantially weakened with the loss of important ground cover species.

In view of these losses, it may be necessary to experiment with the inclusion of relatively benign non-native species, either as direct replacements for the extinct constituents or to supplement the development of stable, mature communities in other ways. A good example of the latter has been provided by the colonization of the cloud forest zone by the endemic ferns *Marattia purpurascens* and *Xiphopteris ascensionense*, which utilize branches and (in the former case) the under storey. Such habitats are now valuable for conservation, despite having formed around conspicuously non-native trees. Indeed, they have perhaps proved critical in rescuing the declining *X. ascensionense* from extinction - a species originally confined to dwindling areas of exposed, rocky outcrops.

4) **Incomplete knowledge of the true historical range of the species**

The modern distribution of Ascension's endemic species clearly only hints at their original ranges, now reduced to isolated pockets where conditions have permitted them to survive in the face of other pressures. These pockets do not necessarily indicate the full environmental tolerances of the species, and indeed may be somewhat unrepresentative of their original core habitats. In fact, each species probably occurred across a relatively wide range of ecological situations because in the simplified native communities there was relatively little competition to displace them, even if the environment was sub-optimal. For example, the mid-altitude plateau which extends from the foot of Green Mountain to White Hill receives a steady supply of incoming mist and rain brought in from the Atlantic by the constant south-easterly winds. It must surely have once been reasonably well vegetated with a variety of native plants, but no record remains of these communities and since the area has been over-run with dense guava scrub for the past two centuries, no vestiges remain.

As a result of the loss of native habitat, it should not be assumed that the present conditions are necessarily a good guide to where the species are best suited to grow. Although based on very little evidence, educated judgement and experimentation is required to determine suitable environmental limits, and to develop appropriate community assemblages for each targeted locality. The process requires some degree of imagination, and for this reason, Section VI is deliberately somewhat speculative in discussing possible former habitats. However, any habitat recreation should respect that

vegetation types evolve natural ecological limits. It is not desirable to develop restoration plans which attempt to introduce plants well outside what was likely to have been their historical ranges, or in unsuitable associations.

5) **Incomplete knowledge of habitat requirements and the best cultivation techniques for the species**

To attempt any form of reintroduction programme, it is essential to have a good working knowledge of the ecology of the species concerned. In general for Ascension's endemic flora, very little research has been conducted (with the exception of *Euphorbia origanoides*, although even in this case, habitat restoration could be further informed by additional work). Furthermore, cultivation knowledge must encompass appropriate techniques for multiplying plants in sufficient quantities, adapting them for the field environment and ensuring that they can maintain themselves unaided in the new habitat. Although trials are currently underway for some species, the solutions to these problems are not yet fully known.

The lack of information is a significant obstacle. It would be highly unadvisable to launch a large-scale habitat project without being moderately sure of the outcome. Based on present knowledge there would be a significant risk of failure, and this could ultimately be highly damaging. However, it is imperative that some habitat management is initiated in the relatively short term rather than waiting for answers to emerge. Experimentation in the form of field trials is an obvious first step to reintroduction. Thus, the initial steps in the management programme should focus on small scale experiments, perhaps within fenced enclosures, where development work is undertaken. Once field-based plots are established, they can be expanded to encompass a wider area.

VI. The endemic plants of Ascension Island – Species Action Plans and further management notes

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1) The extinct species

Review of progress in implementing previous Species Action Plan
Searches for the four known extinct endemic species have been undertaken regularly by Stedson Stroud as part of routine observations whilst working on different parts of the island and the 2008 botanical survey by the South Atlantic Invasive Species project also covered the island thoroughly, with particular attention to some likely endemic localities. Other visitors have contributed to the efforts within a more restricted time frame (e.g. Alan Gray). No sightings have been made, and all species were red-listed as "Extinct" in 2003. However, in August 2009, a few seedlings of *Anogramma ascensionis* were located during a routine plant survey. This species is therefore due to be reclassified as Critically Endangered in the IUCN red list and has been given a more detailed treatment in the current species action plans. An updated prognosis for the remaining three species is as follows:

1.1) ***Dryopteris adscensionis***
This species has not been observed since 1889, although a potential sighting was reported in 1976 near Garden Cottage. When the location was revisited a year later, no trace could be found, and the area is now heavily overgrown with smothering vegetation (Cronk, 1980). From collected specimens, it appears that the species was a fairly small *Dryopteris*, and was probably adapted to grow in low fern swards in exposed places. Due to the density of tall, vigorous invasive species now present on Green Mountain, it seems unlikely that any suitable habitat now remains. The only remaining chances of persistence are on inaccessible rocky outcrops, where individual sporophyte plants could potentially be rather persistent. It is not known whether *D. adscensionis* is capable as surviving for extended periods in its inconspicuous sexual stages (as a small, filmy gametophyte or as a filametous protonema), but this also cannot be ruled-out and such plants would be almost impossible to detect. However, given the absence of any mature sporophyte records, the chances of rediscovery seem remote.

1.2) ***Oldenlandia adscensionis***
As no live plants have been seen since 1888, it now seems highly likely that this species is extinct. A possible sighting in the 1980s at Devil's Riding School was investigated by Quentin Cronk and George Benjamin, although the report could not be verified and subsequent checks of the location have revealed nothing (Cronk, 1980). Although reports of tree-sized plants on Ascension were made by William Dampier prior to human settlement, later reports suggest that the last surviving individuals of *O. adscensionis* were mostly small shrubs, perhaps persisting for a few decades at most, and regular recruitment would therefore be necessary for survival. This implies a small population rather than an isolated individual could have survived to the present day. Although it is possible that such a population remains on an inaccessible rock face, it seems increasingly unlikely that it would continue to evade attention, especially as occasional propagules may be washed down to the base of the slope. A further threat comes from the now widespread *Spermacoce verticillata*, a closely-related dwarf shrub which could potentially hybridise with the now massively outnumbered endemic genetic stock.

Perhaps the greatest possibility of survival is via the germination of a dormant seed. As a species capable of surviving on arid slopes with infrequent rains, it seems likely that the species was adapted to at least short periods of dormancy although there is no information on the persistence of the seed bank. However, detection of an isolated seedling remains highly improbable, and the propagules would be extremely vulnerable to grazing by sheep or rabbits within the first few months.

1.3) ***Sporobolus durus***
This tall grass was last seen in 1886 on the lea slopes of Weather Post. The low altitude given for the location (460m) suggests that it was found near the foot of the cliffs overlooking Cricket Valley or on the crags above Goat Hole. Confusingly, *S. caespitosus* has an outpost at the former locality, and it is possible that the extinct species was merely a form of its surviving close relative. Only a few records have ever been made, so it has almost certainly been extremely rare since the colonization of the island by man. The eastern hills are characterized by large expanses of remote cliff face and friable rocky outcrops which few if any people have explored, and there remains a small possibility that it persists somewhere in this area. As a perennial grass, it may be capable of enduring for long periods in small patches, maintained by slow vegetative growth. This possibility merits further scrutiny of the cliffs of Cricket Valley, Weather Post and White Hill. However, the closely-related introduced Cape grass, *Sporobolus africanus*, is also very abundant in this area, and there remains a risk that the last populations succumbed to hybridisation. Also, the similarity of the two species may make it very difficult to identify non-flowering specimens.

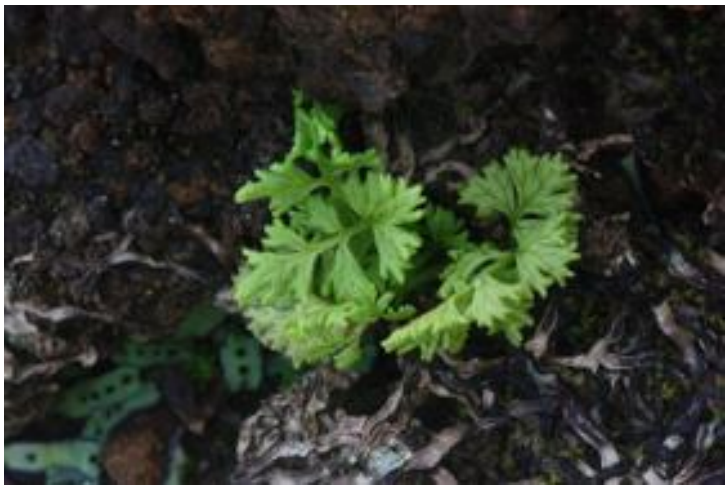
Revised Species Action Plan

Objectives
(i) Survey suitable habitat areas for each of the above species, particularly after periods of rain

Implementation targets
(i) Conduct yearly low-intensity surveys coincident with periods of rainfall in all suitable habitat areas. (**Time frame:** Ongoing)
(ii) Ensure that accessible literature is available in the form of posters and plant guides (leaflets or books), thus enabling islanders and visitors to recognize and report potential sightings to the Conservation Department. (**Time frame:** some literature could be produced within 1 year)

2) *Anogramma ascensionis*, Ascension Island parsley fern

Review of progress in implementing previous Species Action Plan



This species was considered likely to be extinct in the previous action plan and was Red Listed as such in 2003. However, four seedling sporophytes were rediscovered by Stedson Stroud, Phil Lambdon and Olivia Renshaw on 27th July 2009, and intensive efforts have subsequently been made to secure the survival of cultivated stock from these. The plants were tended regularly and watered during dry periods, one via a drip system. They were also fenced for protection against herbivores. Although one seedling died in the first few weeks, and none of the plants have yet attained a span of more than 10 cm, it was possible to harvest small fertile fronds from the two strongest individuals on 30th September 2009, which were rushed within 24 hours to the micro-propagation facilities at the Royal Botanic Gardens, Kew in the U.K. Apparently healthy spores were obtained, and these are now being cultured by Viswambharan Sarasan of the Conservation Biotechnology Unit. If successful, these will be reared to the sporophyte stage using techniques developed for the European relative, *An. leptophylla* as a template, and further spores collected. Some will be stored in cryo-preservation, and others multiplied on to produce a substantial stock. Further fertile fronds produced from the wild plants may be used to attempt a cultivation programme on Ascension, and also allowed to disperse naturally in the hope that further wild plants will germinate in future.

Management notes

An. ascensionis has been very close to extinction for over 100 years and has only been seen twice during this period. Consequently, very little is known about its ecology or former distribution. In the 1850s Joseph Hooker noted it growing on wet rocks and banks on the weather side of Green Mountain between 365 and 550m, and in 1958 Eric Duffey found it at 730m on the north side of Green Mountain near Rupert's Path, perhaps in a moderately dry location. The population rediscovered recently was growing on a sharp ridge leading down to Breakneck valley - also a dry cinder cliff, at approximately 600m, although the plants are clustered around horizontal strata where some moisture appears to accumulate. It is likely that the true altitudinal range was higher than suggested by Hooker, as several of his quoted elevations appear to be underestimated. In general therefore, one can perhaps surmise that *An. ascensionis* frequented moderately dry to moderately damp rocks between 500 and 750m. This habitat seems to correspond to that displayed by the closely-related *An. leptophylla* in southern Europe, which can withstand fairly arid conditions thanks to the ability to perennate as a vegetative bud for part of the year.

Efforts to re-establish this species in the wild are urgently needed. At least some populations probably always grew in very bare areas rather than associated strongly with native communities (As with *Asplenium ascensionis*), and therefore the conservation of *Anogramma ascensionis* may be better suited to a species- rather than site-lead approach. At its current site, it appears to co-occur with the liverwort *Plagiochasma rupestre*, and the distribution of this species could be a useful indicator of other potentially suitable locations. However, reintroduction should focus on both wet and dry habitats, and therefore some restoration could be centred around drip areas along with *Asplenium ascensionis* and some key bryophytes. The spread of maidenhair ferns may have been an important contributory factor in the decline of the species and its removal and the maintenance of free areas in critical locations is likely to be highly beneficial.

Revised Species Action Plan

Objectives
(i) Determine the current status and ecology of wild populations on Green Mountain
(ii) Maintain a cryo-preserved stock of spores, at least in the U.K.
(iii) Maintain a viable stock of cultivated plants in the U.K. and on Ascension Island.
(iv) Identify suitable sites and establish trials for reintroduction of plants to the wild.

Implementation targets
(i) Monitor the site in Breakneck Valley, and similar localities nearby, for the appearance of new gametophytes and sporophytes. (**Time frame:** Every August for the next 5 years)
(ii) If appropriate, take action to preserve surviving populations *in situ*, e.g. by fencing from grazing (**Time frame:** 1 year, or as soon as possible)
(iii) Establish a cryopreserved stock of spores in the U.K. from the first generation of plants reared (**Time frame:** 1 year)
(iv) Develop and document appropriate cultivation techniques for both micropropagation and larger-scale stock production. (**Time frame:** 5 years)
(v) Establish a permanent cultivated stock of plants on Ascension Island, either directly from the wild or by via material sent from the U.K. (**Time frame:** 5 years)
(vi) Identify sites for potential reestablishment, including areas of both damp and dry rock habitat. (**Time frame:** 7 years)
(vii) Initiate an experimental reintroduction programme in dry rock habitats, with the results to be carefully monitored and reported (**Time frame:** 10 years)
(viii) Assess the feasibility of reintroducing *An. ascensionis* to damp rock areas as part of a wider habitat restoration programme, aimed at clearing invasive species and reinstating native bryophyte and vascular plant communities. (**Time frame:** 10 years)

3) *Asplenium ascensionis,* Ascension Island spleenwort

Review of progress in implementing previous Species Action Plan

Relatively little work has been conducted on this species. It is the most abundant of the endemic species on Green Mountain, and as populations are fairly persistent and seem relatively stable, it is currently regarded as the lowest priority. Since current funding does not yet stretch even to other higher priorities, there is little immediate hope of extending it to this species. However, this does not imply that further work is not needed. We know very little about the ecology of all of the mountain endemics and there is no clear evidence to show whether or not the habitats are gradually being lost to invasive weeds, particularly maidenhair fern (*Adiantum* species), which are now dominant over many of the rock faces. Progress to date is starting to fill-in some of the knowledge gaps: Most of the main accessible populations are currently being monitored during the annual plant census. As part of the threatened plants project, long-term monitoring plots have been established in several areas to assess invasion and acquire basic data on population structure. Spore banking is also being undertaken, and methods of cultivation are being investigated.

Management notes

This small fern grows in rock crevices, predominantly on Green Mountain but also on the north side of Cricket Valley and very rarely along lower south-facing slopes from Castle Hill to Weather Post and Middleton's Ridge. It is commonest at moderately high altitudes, up to 760m and becomes rare below 550m, although a flourishing population exists as low as 430m in Cricket Valley. Most of the extant population is restricted to southern aspects and it remains unknown whether it formerly occurred on the north side of Green Mountain. The rocks here tend to be substantially drier and may have been less suitable, but they have also been heavily-invaded by maidenhair ferns. It is perhaps likely that *As. ascensionis* was abundant at least around the several damp drips in this area before being out-competed. In a few situations it can grow as a carpet on the ground and once probably did this more often, but the few places where it still does so are in heavily-shaded situations at the foot of rocks. Although in the 1870s, Hooker states that it was "most abundant under the scrub and ferns on the weather side of Green Mountain", it no longer occurs in such habitats. It probably has the most stable population of all the endemics but remains rather restricted. It does not co-occur with other endemics to a great extent, although may have formerly occurred near *Pteris adscensionis* in heavily

shaded areas near its lower altitudinal limits, and may have sometimes been associated with *Anogramma ascensionis*.

The main habitat restoration work for *As. ascensionis* may comprise the clearance of maidenhair fern populations from suitable habitats and reintroduction of material to these sites from cultivated stock. Drip areas may be particularly important for this activity, and it may also be appropriate to revegetate such areas with endemic and native bryophytes, although *As. ascensionis* may be unsuited to the wettest areas of rock and would fare better around the drier, marginal crevices. Re-invasion by maidenhair fern could be a substantial problem in such areas, and as yet, no strategy for preventing this has been developed.

Revised Species Action Plan

Objectives

(i) Continue and expand monitoring programme to identify long-term population trends.
(ii) Instigate further research into the ecology of *A. ascensionis* to guide management practice.
(iii) Maintain spores and live material from differing sub-populations, as a conservation fail-safe.
(iv) Instigate genetic research into the taxonomic status and the genetic variation of *A. ascensionis*.
(v) Initiate research to identify feasibility of expanding present populations as part of a wider habitat management strategy.

Implementation targets

(i) Maintain annual plant census, where possible extending survey to cover new sites but ensuring a simple, accurate methodology (**Time frame:** Ongoing)
(ii)
(iii) Complete and maintain spore bank, with spore viability tested on regular intervals (**Time frame:** 1 year/Ongoing)
(iii) Determine and refine cultivation techniques, and maintain a small stock of plants in the shade house from different sub-populations (**Time frame:** 1 year/Ongoing)
(iv) Assess further research requirements into the ecology of *A. ascensionis* necessary to guide management practice, and initiate a study programme. (**Time frame:** 10 years)
(v) Instigate genetic research into the taxonomic status and the genetic variation of *A. ascensionis* (**Time frame:** 10 years)
(vi) Initiate work aimed at restoring native bryophyte and vascular plant communities to areas of damp rock on Green Mountain, as part a wider habitat management strategy, in which *As. ascensionis* can be included. (**Time frame:** 10 years)

4) *Euphorbia origanoides*, Ascension Island spurge

Review of progress in implementing previous Species Action Plan

Implementation of the previous action plan is reasonably advanced. Alan Gray and Stedson Stroud have advanced the knowledge of the species and recently collated known ecological information into a paper (Gray *et al.*, 2009). Thus, the factors which need to be considered in a reintroduction programme are now better understood, largely as a result of cultivation trials conducted near South Gannet Hill, although restoration has not proceeded beyond this. Alan Gray has secured some money for a study of the population genetics, which is taking place this year. Plants have readily been grown from seed by Stedson Stroud and most populations are currently in cultivation on island. In addition there are collections of seed from several populations in CEH Edinburgh (Alan Gray), and Kew. Maintaining a cultivated stock from each sub-population is logistically difficult, partly because *E. origanoides* is a relatively short-lived species and the plants must be renewed on a regular basis. Since seed production is relatively small and unpredictable, the numbers required for this process are relatively large, and a substantial amount of space is required. Preventing cross-fertilization between subpopulations is difficult if limited space is available. One way to overcome this may be to further develop field nursery facilities, where the plants require less maintenance. An annual survey of population numbers been initiated, although it is a difficult species to survey as the plants are mostly small and dispersed thinly over a very wide area, much of which is difficult to access. The population centres shift slightly from year to year, which makes repeated monitoring of fixed plots difficult.

Management notes

Uniquely amongst Ascension's endemic species, relatively good distribution records for *E. origanoides* exist back to the early 1900s, highlighting several areas of the coast where populations formerly occurred. It is likely that this represents part of a continuum of decline. Although the earliest botanical reports are not specific about the distribution or abundance of the species, it seems likely that bushes were once abundant over much of the coastal lowlands. Extant plants have been found from 26 to 306m in altitude, which is

probably a good reflection of their true historical range. Today, they occur in several discrete areas which might constitute distinct sub-populations. Minor, but reasonably consistent differences between locations support this idea, although plants are morphological variable and these could also be responses to the local environment.

Euphorbia origanoides is now most prevalent in extremely marginal habitat: very barren and often composed of loose scree where few other species exist. In the more stable localities where it still rarely survives, plants can develop into larger sub-shrubs. Even in these places, conditions tends to be very arid with very sparse cover of other vegetation. In the north and east it often co-occurs with *Cyperus appendiculatus*. The large population of both species on the plateau of Hummock Point is of global conservation importance. Elsewhere, there are few associates, but one might expect that when *E. origanoides* formerly grew further inland, it may have formed mature sub-shrub communities interspersed with several other native species of the coastal lowlands.

Initially, the major barrier to restoration lies in ensuring that any areas selected are free from grazing and invasive weed species. Since suitable habitats are open, partly-disturbed and largely bare of other vegetation, they are highly vulnerable to colonization by other plants, and easily accessible to sheep and rabbits. At present, Mexican thorn tends to remain at low densities in many of the very dry, coastal areas, and has not seriously impacted many of the traditional *E. origanoides* locations. This does not mean that it will not do so in the future. Also, because Mexican thorn creates shade and lays down litter, it encourages other changes in the local ecology, permitting greater establishment of other herbs and encouraging the spread of ant colonies. Invasion by other weeds, such as *Heliotropium curassavicum*, *Waltheria indica* and *Nicotiana glauca*, remains a general management problem. Perhaps even more importantly, *E. origanoides* is extremely sensitive to vertebrate grazing. Therefore, reintroduction areas would have to be fenced and managed with an adequate invader-free buffer zone, but it may be possible to identify areas where relatively suitable conditions already exist without too much intervention. Furthermore, natural population numbers fluctuate greatly depending on drought conditions, and any initially small population established in a new area are vulnerable to extinction without intensive management. Thus, a reintroduction will be difficult to achieve and time consuming. With careful planning it remains practical, but sufficient time and resources must be available.

Potential *E. origanoides* hybrid, Comfortless Cove

One new issue which needs to be addressed is the potential for hybridisation between *E. origanoides* and other weedy *Euphorbia* species on Ascension. At present, an unidentified *Euphorbia* is known from at least two locations which could prove to be a hybrid. If so, this could represent a serious threat to the genetic integrity of the endemic populations.

Revised Species Action Plan

Objectives

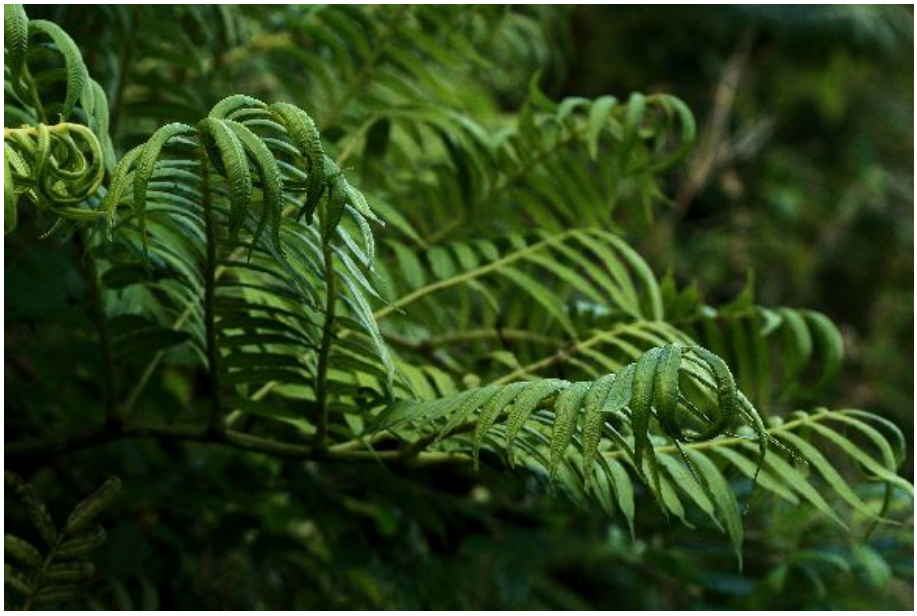
(i) Continue and expand monitoring programme to identify long-term population trends.
(ii) Extend existing research into the ecology of *E. origanoides* to guide management practice.
(iii) Maintain seed and live material from differing sub-populations, as a conservation fail-safe.
(iv) Develop genetic research into the taxonomic status and the genetic variation of *E. origanoides.*
(v) Initiate research to identify feasibility of expanding present populations as part of a wider habitat management strategy.

Implementation targets

(i) Maintain annual plant census, ensuring a simple, accurate methodology (**Time frame:** Ongoing)
(ii) Complete and maintain seed bank (**Time frame:** 1 year/Ongoing)
(iii) Develop suitable field nurseries or maintain shade-house collections of cultivated plants from different sub-populations, ensuring minimal cross-contamination of genetic material (**Time frame:** 1 year/Ongoing)
(iv) Determine the identity of the possible hybrid between *E. origanoides* and another weedy *Euphorbia* species on Ascension. If a hybrid origin is confirmed, assess the overall threat and develop management plans to deal with it, including the reduction or removal of the source of contamination. (**Time frame:** 2 years)
(v) Complete genetic research into the taxonomic status and the genetic variation of *E. origanoides* (**Time frame:** 2 years)
(vi) Assess further research requirements into the ecology of *E. origanoides* necessary to guide management practice, and initiate a study programme. (**Time frame:** 5 years)
(vii) Initiate restoration work aimed at re-vegetating dry, lowland areas with *E. origanoides* and other native species, as part of a broader habitat management plan. (**Time frame:** 10 years)

5) *Marattia purpurascens*

Review of progress in implementing previous Species Action Plan



Techniques for propagating *M. purpurascens* via crown buds have been developed by Stedson Stroud, and cultivated material is also now present at the Royal Botanic Gardens, Kew. A method for raising larger numbers of plants from spores is probably needed for larger-scale restoration as it is not ideal to re-vegetate large areas from a few clones due to the limited genetic diversity. Small-scale restoration into semi-wild situations (within rabbit fencing) have been trialled by Stedson Stroud with some success, but as the seedlings are vulnerable to desiccation, grazing and competition from invasive plant species, the area of readily-available habitat is very limited and currently confined to shady forest canopy. Here, invasion by Koster's curse (*Clidemia hirta*) is a significant problem. Ultimately, it may be desirable to target more natural, open sites on the mist-exposed south and east slopes of the mountain for additional locations. Further observations on the ecology of the species may help to identify additional habitat requirements.

Management notes

This large, imposing fern is unlikely to have ever been very common and may always have been confined to the highest, most heavily mist-drenched slopes on the south face of Green Mountain (Cronk, 1980; Duffey, 1964). As a cloud forest has developed around the summit area, the population has adapted to this environment and it now occurs both as an epiphyte and as an under-storey species in densely-shaded areas. However, it is relatively uncommon in such habitats.

Details of the original native community with which *M. purpurascens* co-existed are incomplete. We know that in the mid 1880s, the summit was largely covered with "a carpet of ferns", although little information was recorded on the composition of this ecosystem. Today, the main native associate is the vigorous patch-forming fern *Histiopteris incisa*. Hooker reported that it covered "many acres on the weather side of Green Mountain", but gave the altitudinal range as between 365 and 550m. This is much lower than that at which *H. insica* currently survives and seems likely to be a mistake. Assuming that the "many acres" were mostly around the summit of the mountain, one could assume that this was the dominant fern over a wider area than *M. purpurascens*, a

possibility which is supported by the extant distribution of relict population fragments. Alongside these two large ferns, other smaller species may have persisted, particularly in gaps, or where the canopy was thin. A ground layer of *Asplenium ascensionis* could have survived in moderate shade (this supposition is based entirely on the observation of Hooker given above), and the extinct *Dryopteris ascensionis* is thought to have also contributed to the community. Buckshorn *Lycopodium cernuum* and thick tufts of the moss *Campylopus ascensionis* probably became important on the more exposed ridges and banks, where they are still prevalent today in a very few places. Exposed, high altitude banks on the south side of Green Mountain contain a diverse and presumably largely native community of bryophytes including *Anastrophyllum ascensionis*, *Symphogyna convoluta*, *Fossombronia*, and *Microlejeuna* sp., together with the endemic fern *Xiphopteris ascensionensis*. These communities may formerly have been more widespread, colonizing temporary areas of bare ground between the fern sward.

The native high altitude fern community is now severely degraded and the survival of *M. purpurascens* perhaps at risk, the major current threat being the encroachment of introduced vegetation. Although still relatively common over a very restricted area between 749 and 850m, the *M. purpurascens* - *H. incisa* sward is now substantially fragmented and surrounded by a sea of grass. *Buddleja madagascarensis* partially smothers a large part of the lower habitat area and weeds such as blackberry *Rubus pinnatus*, raspberry *Rubus rosifolius*, Koster's curse, buttonweed and the pepper *Piper aduncum* are frequently found growing through the stands.

Left: Remaining fragments of *M. purpurascens* - *H. inscisa* habitat on the south slopes of Green Mountain. Right: *M. purpurascens* seedlings (dark green fronds) colonizing an area of exposed bank

The numbers of *M. purpurascens* have probably not declined greatly in the last 50 years because plants appear to be rather long-lived and are extremely tolerant of shading and competition. The main concern is that they appear to have a very low rate of seedling recruitment. Until further research has been conducted, it is not possible to be certain whether this is a natural phenomenon or indicates a potentially serious decline in ecological viability. One possible explanation is that successful recruitment of young ferns was once concentrated on temporary patches of damp, open ground where land slips or the death of large, old *M. purpurascens* clusters had created gaps. This is supported by the presence of a vibrant thicket of young specimens amongst rich growths at two locations where such conditions still exist. However, these ephemeral habitats are now extremely rare. Any canopy gaps are rapidly in-filled by weeds, especially cow grass *Paspalum scrobiculatum*, which cover the ground before fern gametophytes can establish. *M. purpurascens* plants can propagate vegetatively via crown buds, but these usually appear to remain attached to the parent plant and do not disperse.

At the very least, the native communities of Green Mountain's upper south-facing slopes are now in poor condition and urgently need restoration. If the rate of *M. purpurascens* recruitment has declined substantially due to habitat deterioration, then the consequences may only become evident over a long time period as older plants die. In this case, action is imperative to rescue the species from extinction. However, until its regeneration cycle is better understood, it is not possible to be sure of the most appropriate restoration strategy. The removal of large weeds is clearly an essential part of any course of action, but it may also be necessary to create recolonisation zones within the main habitat area which will encourage seedling establishment. This may require a more ambitious effort to eradicate grasses from the restoration localities entirely, so that young fern and bryophyte communities have the opportunity to develop. *H. incisa* must clearly form a major part of the restored community, but has a much more aggressive growth strategy than *M. purpurascens*, so that establishing a suitable ecological balance between the two fern species may be complex. Research is also needed to understand how the two species coexist. Other native community members should be encouraged in suitable microhabitats.

Whilst the natural, exposed locations traditionally occupied by *M. purpurascens*, are essential for its survival, additional consideration must be given to the more recent, non-native habitats where it occurs. The wetter, exposed parts of the summit cloud forest are unlikely to host particularly high densities of the recent colonist because the low light levels create an inhospitable environment. However, there remains the potential that these areas could act as a useful supplement to available habitats, and could yet contain a significant proportion of the population. It may also be remembered that the cloud forest has probably displaced a large part of the original fern carpet, and this additional area is probably quite valuable in conservation terms. It is not clear whether plants do better in the tree-dominated part of the forest or under bamboo stands. In the former, small epiphytic colonies high in the canopy are difficult to count, whilst in the latter, access is restricted by the steep terrain and dense thicket of culms. However, most of the easily visible plants in the bamboo zone appear to be growing on decaying wood, and this habitat may therefore become less suitable as the remaining old trees decline. In both areas, the main threat is posed by Koster's curse, which can form a dense under-storey even in deep shade, and is thus a strong competitor. The epiphytic part of the population faces similar threats from non-native invaders to those experienced by *Xiphopteris ascensionense* (see below).

Revised Species Action Plan

Objectives
(i) Continue monitoring programme to identify long-term population trends.
(ii) Establish research into the ecology of *M. purpurascens* to guide management practice and determine long-term population threats.
(iii) Maintain seed and live material as a conservation fail-safe.
(iv) Instigate genetic research into the taxonomic status and the genetic variation of *M. purpurascens.*
(v) Initiate research to identify feasibility of expanding present populations as part of a wider habitat management strategy.

Implementation targets
(i) Maintain annual plant census, ensuring a simple, accurate methodology (**Time frame:** Ongoing)
(ii) Develop techniques for cultivating *M. purpurascens* from spores (**Time frame:** 2 years)
(iii) Initiate detailed monitoring and ecological research order to assess the ecological implications of invasive plants on the open hillside populations, how seedling recruitment occurs and hence whether the population is subject to severe long-term threat. (**Time frame:** 5 years)
(iv) Complete genetic research into the taxonomic status and the genetic variation of *M. purpurascens.* (**Time frame:** 10 years)
(v) Initiate work aimed at restoring areas of *M. purpurascens – Histiopteris incisa* community on the upper south slopes of Green Mountain. (**Time frame:** 10 years)
(vi) Monitor the limits of the bamboo forest near the summit of Green Mountain in order to determine whether the stand is expanding, and evaluate potential control plus restoration options for reclaiming prime native habitat. (**Time frame:** establish monitoring within 1 year)

6) *Pteris adscensionis*

Review of progress in implementing previous Species Action Plan

Given the extremely low numbers present in the wild 10 years ago (perhaps less than 50 mature individuals), substantial progress has been made towards securing the future of this species. Stedson Stroud has successfully developed techniques for growing *P. adscensionis* from spores, can produce plants in large numbers and has established a field nursery on Green Mountain. The basic growth requirements are now known and the plants are currently flourishing and producing abundant spores. It will still be some time before such a patch is self-sustaining as there are still no juvenile plants establishing from spores, and it remains to be seen whether the stand remains resilient against invasive species. Cryopreserved gametophytes are held in storage at Kew, although a little further work is needed to ensure that the different populations are present in storage and cultivation. It should soon be possible to identify further sites for reintroduction within the natural range of the species. A considerable expansion is necessary to secure enough wild populations for long-term safety, but re-establishing fern swards in the wild necessitates a large amount of clearance of invasive species and considerable investment in growing and planting new stock. Furthermore, adequate barrier zones must be developed around the patches to minimize weed re-invasion. Currently, money and manpower are limiting, although since the knowledge capacity has now been developed, it is important not to lose momentum. To evaluate the conservation status of the species, it is important to understand the persistence and recruitment rates of current populations. In order to find the most effective conditions for survival, it would be useful to know when and where the gametophytes germinate, under what conditions seedlings are most successful and how many survive to adulthood.

Management notes

The population of *P. adscensionis* is currently very restricted. Two main relict areas persist, consisting of a small number of plants on dry, shady cinder banks at the bottom of Breakneck Valley, and a larger population widely scattered over the trachyte cliffs on the north side of Cricket Valley. A few individuals, mostly growing from dry rock crevices, may be found erratically between these two areas, and one outpost comprising less than 10 plants is known from a deep crevice on the north side of the mountain.

It is probably safe to assume that *P. adscensionis* was once considerably more widespread than it is today. Hooker and Hemsley makes no comment on its abundance, but since they were both able to find it during relatively short visits, we can assume that it was moderately common until the 1870s (Hemsley, 1885). Hooker described it as occurring in "clefts and shaded places on the Green Mountain", between 365 and 550m. The habitat and altitudinal range correspond with those of today (the present altitudinal range is 337 to 697m), which suggests that it has always been a mid-altitude species with a cliff-dwelling ecology. However, it is likely that a healthy population was found continuously around the lower part of the Mountain, which would have formerly included all the modern relict localities. Many parts of this range are characterized by rather dry, bare rock crevices which probably never hosted many other species. However, in places, it would variously have overlapped with the ranges of other natives, forming loose communities. These may have included *Anogramma ascensionis*, *Asplenium ascensions*, the extinct shrub *Oldenlandia adscensionis*, the grasses *Digitaria ciliaris* and *Polypogon tenius*, and the ferns *Christella dentata*, *Nephrolepis hirsutula* and *Psilotum nudum*.

It is difficult to understand why *P. adscensionis* is not still more common, as particularly at lower altitudes, where maidenhair ferns are less prevalent, large expanses of apparently suitable cliff habitat remains. One possible explanation is that the current localities are all relicts of secondary habitat, regularly replenished by spores from elsewhere, and that the stable major part of the population occurred in community zones which no longer exist. Before the historical period on Ascension, *P. adscensionis* may have formed sparse swards across the open foothills. If so, this must have been totally destroyed by a combination of grazing (initially by goats), and displacement by introduced plants (perhaps driven by humans as land was converted to pasture). *P. adscensionis* forms moderately small, shuttlecock shaped tufts which would be capable of forming thin stands. Even in cultivation it does not grow particularly tall, which suggests that it is not a strong competitor, but appears to be better adapted than most of the native ferns at surviving the moderately dry conditions which periodically exist near the base of Green Mountain. The rhizomes are short and do not spread rapidly, suggesting a low capability to establish vigorous, dense swards. Sporophytes appear to persist for only a few years, at least in cultivation although this has yet to be confirmed by field observation. However, the wide geographical range of occasional outlying plants suggests that the spores are efficiently dispersed and germinate readily, making it an excellent colonist. Perhaps therefore, *P. adscensionis* was an opportunist species, quick to exploit gaps in the ground cover although perhaps requiring shade of other vegetation, particularly to establish.

Revised Species Action Plan

Objectives
(i) Continue monitoring programme to identify long-term population trends.
(ii) Conduct further research into the ecology of *P. adscensionis* to guide management practice.
(iii) Maintain seed and live material from all distinct sub-populations as a conservation fail-safe.
(iv) Instigate genetic research into the taxonomic status and the genetic variation of *P. adscensionis.*
(v) Establish plants at population expansion sites by natural means and/or from nursery populations.

Implementation targets
(i) Maintain annual plant census, ensuring a simple, accurate methodology (**Time frame:** Ongoing)
(ii) Maintain and expand monitoring on network of long-term monitoring plots, enabling a more detailed assessment of losses to invasive species and population dynamics. (**Time frame:** Ongoing, every 3-5 years)
(iii) Ensure that spore bank contains material from all subpopulations (**Time frame:** 2 years)
(iii) Ensure that stock of all subpopulations are maintained in cultivation (**Time frame:** 2 years)
(iv) Complete genetic research into the taxonomic status and the genetic variation of *P. adscensionis.* (**Time frame:** 10 years)
(v) Initiate a reintroduction programme aimed at restoring *P. adscensionis* to areas within its former native range, as part of a broader habitat management plan. (**Time frame:** 10 years)

7) *Sporobolus caespitosus*

Review of progress in implementing previous Species Action Plan

Numbers are monitored as part of the annual plant census, but accurate records have not been compiled for sufficient time to identify long-term population trends. In particular, we do not know if the germination sites are gradually being overgrown by weeds in wild situations, or whether establishment is affected by climate or grazing. In response, permanent long-term monitoring plots have been established as part of the threatened plants project. Stedson Stroud has successfully developed a protocol for growing this grass from seed. Specimens have been planted near the summit of Green Mountain on an open, level soil and found to grow much more vigorously then in wild situations. They are starting to self-seed. Some suitable areas for restoration on Green Mountain exist, but the experiences of preliminary trials by Stedson Stroud suggest that the major management issue is in keeping these areas protected from sheep, and free from invasion, which can be very labour-intensive. Furthermore, populations should be integrated into restoration plans for the other endemic species on Green Mountain to create sympathetic habitats.

Management notes

In its extant localities, *Sporobolus caespitosus* occurs under a narrow range of marginal ecological conditions. On Green Mountain, it is found on exposed, relatively bare banks and outcrops between 599 and 760m, always facing into the south-easterly trade winds. As a result, it receives very high levels of moisture from mist and rain, but may also benefit from the low cover of invasive weeds in these extreme habitats. *S. caespitosus* is clearly well adapted to survive in the harsh climate: the foliage grows in dense, sub-spherical tufts, insulated by persistent dead leaves. The flowering spikes are short and remain partly hidden in the leaf tuft, which probably helps to protect them against damage. Dispersal appears to occur largely down-wind, and seedlings seem to be relatively common which suggests a healthy establishment rate.

Some of the banks populated by *S. caespitosus* are composed of relatively bare, eroding cinder. However, it reaches higher densities on damper outcrops with a diverse community of bryophytes, and often co-occurs with *Xiphopteris ascensionense*. Other

occasional native associates include the grasses *Polypogon tenuis* and *Digitaria ciliaris*. Such habitats are now very rare, which probably explains why only approximately 5 populations now exist on the mountain. It is also very vulnerable to grazing, especially by sheep which can easily dislodge tufts from their fragile root-hold. The creation of more suitable habitat would be beneficial to preserve and expand the population, concomitant with establishing herbivore-free zones and control of invasive weeds to prevent restored banks from returning rapidly to their infested state.

The potential for expanding the overall population within its current range is limited, because the amount of suitable habitat area is never likely to be very large. As an additional measure, it may therefore be appropriate to consider developing new habitat areas elsewhere. Trials in the restoration area on Green Mountain suggest that under favourable, less exposed conditions, plants can form larger, more luxuriant tussocks up to 40cm in diameter, and may even be capable of forming loose swards. Populations of this type could potentially be recreated at various localities around the mountain, provided a suitable strategy could be implemented to limit the impact of grazing and encroachment by vigorous non-native vegetation.

Whilst the current altitudinal limits suggest that *S. caespitosus* has very specific ecological requirements, the extant habitats could represent the last strongholds of a species which was formerly more widespread. Evidence for this is suggested by the presence of a single outlier population on Weather Post. Here, it is still restricted to exposed, windy locations on the cliff edge, but the habitat is situated at a lower altitude and is substantially drier. The plants may also be larger on average. This locality may have been colonized relatively recently, but it may alternatively represent a last relict of a habitat range which extended to the foot slopes of Green Mountain and across the south-eastern plateau. Under such relatively benign conditions, a sparse tussock grassland could have existed, although the extinct sister species, *Sporobolus durus*, may have been better suited to these conditions. We have no remaining knowledge of the native habits which once existed in this area, but the possibility of *Sporobolus* grassland seems realistic and may merit some trials to assess whether *S. caespitosus* could fulfil such an ecological role.

Revised Species Action Plan

Objectives

(i) Continue monitoring programme to identify long-term population trends.
(ii) Establish research into the ecology of *S. caespitosus* to guide management practice.
(iii) Maintain seed and live material from distinct sub-populations as a conservation fail-safe.
(iv) Instigate genetic research into the taxonomic status and the genetic variation of *S. caespitosus.*
(v) Establish plants at population expansion sites by natural means and/or from nursery populations.

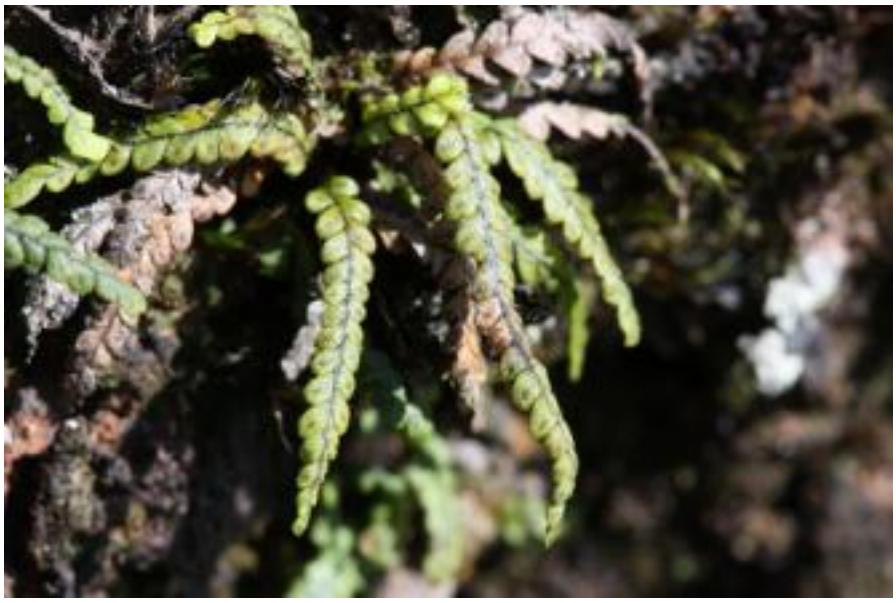
Implementation targets

(i) Maintain annual plant census, ensuring a simple, accurate methodology (**Time frame:** Ongoing)

(ii) Maintain monitoring on network of long-term monitoring plots, enabling a more detailed assessment of losses to invasive species and population dynamics. (**Time frame:** Ongoing, every 3-5 years)
(iii) Ensure that seed bank contains material from all subpopulations (**Time frame:** 2 years)
(iii) Ensure that stock of all subpopulations are maintained in cultivation (**Time frame:** 2 years)
(iv) Complete genetic research into the taxonomic status and the genetic variation of *S. caespitosus*, especially with the aim of elucidating the relationships between Green Mountain and Weather Post populations. (**Time frame:** 10 years)
(v) Initiate reintroduction programme aimed at restoring *S. caespitosus* to suitable areas on Green Mountain, as part of a broader habitat management plan. (**Time frame:** 10 years)
(vi) Establish trials into the feasibility of introducing *S. caespitosus* to mid-altitude areas in the south-west of Ascension as part of a longer-term restoration plan. (**Time frame:** 10 years)

8) *Xiphopteris ascensionense*

Review of progress in implementing previous Species Action Plan



Little work has been conducted on this species. The main barriers to progress are a lack of funding, and, although the population remains extremely localized, it currently seems to be relatively stable and therefore has not been seen as a priority. However, the very limited area of the current colony makes this endemic highly vulnerable to catastrophic events such as disease, drought or land-slips. Despite this, we do not yet know whether its habitat range is restricted by the types of bryophyte present, or the amount of mist and rain. Experimental trials and monitoring would be needed to evaluate these factors. No nursery work or spore banking has yet been conducted. The germination requirements are still unknown, and it seems likely that this may be a more difficult species to cultivate as it does not naturally grow on loose soil. However, work is planned before the end of the threatened plants project. An annual survey of population numbers been initiated, although it is an extremely difficult species to survey as the plants are very small, the counts are subjective and much of the population is hidden high in the canopy. A network of permanent quadrats has recently been established for detailed population monitoring, which may be an effective additional tool to evaluate changes in numbers over time.

Management notes

This tiny fern now occurs in two distinct habitat areas, which must be considered separately. Its original native habitats were the damp, exposed rocks and banks on the upper south side of Green Mountain, where it still co-occurs with *Sporobolus caespitosus* and the characteristic bryophyte community of these habitats. As with *S. caespitosus*, it is entirely confined to the windward-faces of these banks, and although having a wider geographical range than its associate, being dotted on small, bare cinder outcrops as far west as the Old Marine Barracks, it is more likely to be critically-dependent on the high levels of moisture which it receives in the extant locations, and which provide suitable conditions for the gametophytes to develop. Thus, it is unlikely to have ever occupied a much wider distribution than at present. *X. ascensionense* is probably less vulnerable to grazing than *S. caespitosus* due to its diminutive size, but remains very sensitive to competition from non-native species.

X. ascensionense has more recently managed to colonize the trees of the man-made cloud forest which now dominate the summit area of Green Mountain; a habitat which is in keeping with that of its closest African relatives. Although very local, this area now holds the majority of the total population, and must be considered as an important part of any conservation plans. The ferns occur on bryophyte-laden branches of both trees and bamboo culms, although is probably much more common on the former. Whilst tufts of fronds are often most conspicuous in deep, thick growths of moss, particularly of *Calymperes ascensionis*, the ability to germinate through such a dense sward appears to be limited. Most young plants are restricted to areas of exposed bark which have developed a thin layer of alga or protonema, or are covered with a film of decaying bryophyte and lichen. Such areas are usually semi-permanently wet, and may become covered with luxuriant carpets of gametophytes. Patches like this account for a relatively small part of the epiphytic microhabitat of the forest as a whole. They are probably created when a patch of moss turf falls from the tree during high winds, and are gradually lost as a new moss cover develops. Thus, *X. ascensionense* can be seen as an early-successional species in this cycle, dependent on continued loss and renewal of moss. The cycle could yet be threatened by encroaching invasive species such as *Clidemia hirta* and *Begonia hirtella* which readily colonize the moss sward and, aside from directly competing with *X. ascensionense*, may help to stabilize the habitat and therefore limit the bryophyte habitat prone to decay.

The area of available cloud forest is rather small (approximately 7.5 Ha), and currently the population of *X. ascensionense* extends across only approximately half of this. Due to the extremely restricted global range, it would be desirable to encourage the population to establish more widely. It is not yet clear whether this is indeed a viable aim, because the area currently occupied is characterized as the wettest part of the forest. Elsewhere the potential colonization patches may be limiting, with exposed areas of bark subject to longer dry periods unsuitable for establishment. One small patch observed away from the core population area, on a wind-exposed corner of Elliot's path which was still moderately wet, appeared to be rather marginal – the very plants stunted and clearly not very vigorous. However, it is possible that low numbers could persist where the gametophytes can establish within the denser moss tufts, where the micro-environment is more humid.

Revised Species Action Plan

Objectives

(i) Continue monitoring programme to identify long-term population trends.
(ii) Establish research into the ecology of *X. ascensionense* to guide management practice and assess the threat posed by climate change.
(iii) Maintain spores and live material as a conservation fail-safe.
(iv) Instigate genetic research into the taxonomic status and the genetic variation of *X. ascensionense.*
(v) Conduct trials to establish plants at population expansion sites.

Implementation targets

(i) Maintain annual plant census, ensuring a simple, accurate methodology, with the limits of the areas counted clearly defined (**Time frame:** Ongoing)

(ii) Maintain monitoring on network of long-term monitoring plots, enabling a more detailed assessment of losses to invasive species and population dynamics. As some of the current sites are managed by weeding, unmanaged control plots should be established to identify the consequences of weed invasion (**Time frame:** Ongoing, every 3-5 years)
(ii) Maintain a small stock of cultivated plants in the nursery (**Time frame:** 1 year/Ongoing)
(iii) Develop a spore bank (**Time frame:** 1 year)
(iv) Initiate expansion trials by transplanting small populations on dead branches to uncolonized areas of forst on the upper slopes of Green Mountain. The performance should be carefully recorded. (**Time frame:** 5 years)
(v) Complete genetic research into the taxonomic status and the genetic variation of *X. ascensionense.* (**Time frame:** 10 years)
(vi) Initiate reintroduction programme aimed at restoring *X. ascensionense* to suitable areas of native habitat on the upper south faces of Green Mountain, as part of a broader habitat management plan. (**Time frame:** 10 years)

VII. Other native species of conservation concern

Approximately 25 vascular plant species are thought to be native to Ascension, and all are important to in the preservation of the island's ecological heritage and functioning. However, most of the non-endemic natives remain locally widespread, and are not globally-threatened. It is unnecessary to draw-up detained conservation plans for these. However, the following three species merit more careful consideration in future conservation planning:

1) *Cyperus appendiculatus*

This native sedge is a near-endemic which, outside Ascension, only occurs on Trinidade and Fernando de Noronha. Since Ascension forms a large part of the word range, the population is internationally important and the species should be treated as a conservation priority. *Cyperus appendiculatus* is much less threatened than any of the narrow endemics, although it is more or less confined to the eastern side of the island, growing as a small, hardy plant on the lower south-east slopes where subject to the persistent winds, and as a larger, tussock-forming sedge further north, especially in the sandy basin between Sister's Peak and Bear's Back. There is no reason to assume that it ever extended far into the western lowlands, and was not recorded by the earliest botanists who probably did not venture far from Georgetown. It frequents rather bare, dry habitats with little ground cover. In its core areas, native associates include *Euphorbia origanoides*, the grass *Aristida asdcensionis* and purslane *Portulaca oleracea*, although small non-natives form a more important part of many community assemblages. Due to the present abundance of *C. appendiculatus*, it is probably not necessary to create any new habitat areas for it, although the species should be considered for inclusion as part of restoration areas where the geographical location and environmental conditions are suitable.

2) *Hymenophyllum* sp., Filmy fern

The presence of this tiny, delicate fern on Green Mountain remains a mystery. It was not discovered until 29th July 2009 and there are no historical records of *Hymenophyllum* species on the island. Thus far, only a tiny population has been located growing on moss-covered bamboo stems near the summit. The recent occurrence, few individuals and apparent confinement to a highly non-native habitat (bamboo did not start to colonize the mountain until approximately one century ago), all point towards a recent introduction. However, the biology of the species make this highly unlikely. *Hymenophyllum* spp. are restricted to pristine, very moist, shady habitats, and hence have restricted distributions in remote, forested places. They are extremely sensitive to desiccation, and therefore it is virtually impossible that mature plant fragments could have survived the journey to Ascension. The spores are green, and must germinate within a few days (in some species up to 2 weeks) or will die. It therefore seems unlikely that they were transported on human clothing. Introduction of mature plants on the branches of cultivated plants is possible, but little mature stock has been introduced for 100 years or more, and the probability of such sensitive epiphytes surviving the long sea voyage is low.

As a result, it is more realistic to consider that the original material arrived via wind-blown spores. This natural colonization is sufficient for the species to be considered a native, even if very recent. However, it is equally possible that it may have been an ancient native, previously undetected. Although the identification has not yet been confirmed, the plants observed thus far appear very similar to *H. cappilaceum*, previously thought to be endemic on St. Helena. This species is now very rare in its stronghold, and spores were more likely to have found their way to Ascension at least 1-2 centuries ago when the source population was much larger. They may have been part of the original native vegetation of Green Mountain, growing on wet rocks near the summit. Due to extensive habitat destruction, the population may have been extremely small and inconspicuous by the time the early botanists arrived, particularly as some *Hymenophyllum* species can survive for prolonged periods as virtually undetectable gametophytes. A small population may have subsequently found new habitat growing as sporophytes on bamboo stems. These could also have remained undetected for many years, as most of the bamboo stand is inaccessible to humans, and even the plants recently found growing along the Dew Pond track are extremely difficult to see, or easily passed-over as a liverwort.

It will probably never be know whether the *Hymenophyllum* present on Ascension is indeed native. However, it should be treated as a conservation concern, particularly if it proves to be the globally-threatened *H. cappilaceum* from St. Helena. It is therefore essential to secure an identification as soon as possible. In order to achieve this, it will probably be necessary to grow mature plants to the spore-producing stage in cultivation. Subsequently, it may prove necessary to maintain cultivated stocks, and develop the techniques for growing plants from spores. A survey of the bamboo forest should also be conducted, to assess the overall population size and distribution.

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3) *Ophioglossum* sp., Lily fern

This tiny fern has yet to be identified to species level, but is likely to belong to the widespread African taxon, *O. polyphyllum*. Although Hooker commented that it the fronds were much narrower than those of *O. polyphyllum* on St. Helena, this does not appear to be true in general. Until confirmed, we cannot rule-out the possibility that it is an endemic form to Ascension, but at the very least it is almost certainly native. On a local level it is a rare species, despite being difficult to count due to the unpredictable and ephemeral appearance of the sporophytes. They usually appear in clusters after rains and may persist for a few months. Many die before fruiting, either due to dessication or to grazing, especially by rabbits, but it seems that the relatively few successful individuals are capable of producing enough spores to sustain colonies between generations. Despite this, the population may well be in decline as a result of the expanding rabbit population.

The preferred habitats are almost always at low altitudes (30 to 510m) and very dry. Colonies are very rarely found growing in light soils, but are usually much more characteristic of the black, gravely cinder which occurs near Devil's ashpit. This cinder has often been used for surfacing roadsides and areas near buildings in the lowlands, and many records have been located around habitation on these substrates. *Ophioglossum* gametophytes are short, stalk-like subterranean structures which lack chlorophyll. It is likely that gravels provide the ideal soil consistency for them, neither too compacted or too dry.

VIII. Habitat restoration on Ascension Island

Appropriate habitat restoration schemes for Ascension require the following three elements:

1. The removal of invasive species from potentially valuable areas
2. The revegetation of such areas with native and endemic species, aimed at developing self-sustaining ecosystems composed of vascular plants, bryophytes and native invertebrates.
3. The development of techniques for ensuring that the restored areas remain invasion-free with little or no intervention over a prolonged time period.

Element 3 may involve fencing against mammals, the creation of invasive-free buffer zones, the construction of invasion-resistant barriers such as hedges of non-adventive species, or the development of complex, dense swards within the native communities which provide little space for invaders to gain a foothold. As little work has yet been done on either element 2 or 3, it is not yet possible to develop such plans in any great detail. However, some basic principles can be set forth.

Priorities for restoration should initially focus on five community types:

1. The *Euphorbia origanoides* community

This will be focused in dry lowland areas. Conservation of the threatened *E. origanoides* is a central goal, and initially it may be appropriate to establish trials in parts of the inhospitable coastal zone, which remain relatively barren with few invasive species or herbivores. However, subsequent restoration could progress further inland, becoming integrated with efforts to control Mexican thorn and recreate suitable habitat for threatened invertebrate communities. High-grade fencing of the locations may be essential, at least in the short-term, due to the sensitivity of *E. origanoides* to grazing. Appropriate native higher plants to include in the assemblage alongside the endemic spurge are as follows:

	Western Ascension	Eastern Ascension
lily fern *Ophioglossum* sp.	•	
purslane *Portulaca oleracea*	•	
hogweed *Boerhavia diffusa*	•	
the grass *Aristida ascensionis*	•	•
Cyperus appendiculatus		•

2. The native mid-altitude community

The native communities of mid-altitudes have effectively been extinct since botanical recording began, and hence we have little information to assess what it may have looked like. However, certain species which were undoubtedly key components of these communities are now extremely threatened, and therefore the necessity for restoration of some form of suitable habitat is a high priority. Some idea of the likely composition of

the mid-altitude communities can be obtained from the current relict distributions of the extant flora. It is likely that the richest communities occurred on the lower south slopes of Green Mountain, from Mountain Red Hill west to Cricket Valley and Weather Post, where regular mist and rain roll-in from the sea. This area would seem to be the most appropriate to focus efforts. Any programme would require an extensive effort to control invasive species, especially guava. Appropriate species for reintroduction include the following:

Sporobolus caespitosus
Pteris adscensionis
Cyperus appendiculatus
Whisk fern *Psilotum nudum*
the grass *Aristida ascensionis*
Tropical finger grass *Digitaria ciliaris*

The endemics *Pteris adscensionis* and *Sporobolus caespitosus* are clearly focal to the conservation effort, although since neither naturally occurs in open communities at these altitudes any longer, a considerable amount of trial and effort may be necessary to assess whether they can indeed form self-sustaining populations together. The extinct *Oldenlandia adscensionis* probably formerly formed an important element of the original community and it may be necessary to consider including a non-aggressive introduced species as a surrogate for this, to add structure to the vegetation. However, this approach requires very careful consideration due to potential unforeseen consequences. Fencing against sheep and rabbits is likely to be essential, at least in the early stages, and reinvasion is likely to be a substantial problem initially.

3. The *Marattia purpurascens – Histiopteris incisa* community

This community was probably dominant over the highest altitudes of the south side of Green Mountain, but is now increasingly suffering from fragmentation and invasion. Since *M. purpurascens* is long-lived and recruitment appears to be very low on the open hillsides, it is not yet clear whether the long-term viability of the community is more seriously damaged than its current state suggests. Any efforts to re-establish the community would initially require a better understanding of the population dynamics of *M. purpurascens*. It is likely that some open areas are important to recruitment and for the survival of additional community members. Due to the dense, vigorous nature of the community, it may be relatively easy to establish resistance against reinvasion, and the steepness of the hillsides may aid efforts to exclude herbivores, although they also make the terrain potentially difficult and dangerous to work on. Reclamation of some parts of the bamboo forest might be considered as part of the project. The community contains the following associated species, particularly on more exposed ridges:

buck's-horn *Lycopodium cernuum*
the fern *Christella dentata*
the moss *Campylopus ascensionis*
a range of other native bryophytes

4. The *Sporobolus caespitosus – Xiphopteris ascensionense* community

This community still occurs on exposed crags and banks on the upper south face of Green Mountain although it is increasingly suffering from weed invasion. It is closely-associated with the *Marattia purpurascens – Histiopteris incisa* community, occurring in rocky areas between the denser fern sward and probably intergrading with it on land slips and barer ground, where it may be succeeded by colonizing ferns. Therefore, the two community types should be considered as part of the same ecosystem and addressed jointly in any restoration scheme. Weed invasion is the most severe issue faced by the community at present. The additional community members are mostly a range of native and endemic bryophytes, which are still poorly known. Therefore, a detailed study of these species is a high priority and should proceed the commencement of any restoration project.

5. The native wet rock community

Ascension Island has no natural freshwater streams or rivers, but there are a number of locations where water percolates through the coarse cinder to form drips and areas of wet rocks. Conditions in these areas are undoubtedly amongst the most favourable for growth on Green Mountain, and would therefore probably have supported a relatively rich lithophytic assemblage. Unfortunately the community is now almost extinct, largely as a result of colonization by aggressive weeds, particularly the two maidenhair fern species. Loss of native habitat to such invasives is a problem across both dry and wet rocks on Green Mountain and is the likely cause of virtual extinction in *Anogramma ascensionis* and probable decline in *Asplenium ascensionis* and other species. However, as the wet rock communities were undoubtedly the richest, it seems most appropriate to focus initial restoration work in these areas. Relevant community members include:

Sporobolus caespitosus
Anogramma ascensionis
Asplenium ascensionis
Slender beard-grass *Polypogon tenuis*
A native bryophyte community assemblage

Clearly, there is a high degree of overlap with the *Sporobolus caespitosus – Xiphopteris ascensionense* community of drier, exposed crags, and the restoration programme would be similar. The initial focus would be the removal of maidenhair ferns and other undesirable species, with extensive measures to prevent reinvasion, which is likely to be very rapid.

Restoration programmes should conform to the following principles:

- All reintroductions should be carefully recorded, to that it is possible to separate natural population expansion and contraction from artificial population trends. This is essential in order to correctly assess developing threats to the species, such as the impact of climate change and encroachment by invasives.

- All reintroduction schemes should be followed-up with detailed long-term monitoring, to assess factors such as the rate of spread, preferred microhabitats for germination, and

growth rates of seedlings. Such information is vital to adequately assess the success of the scheme, and to develop improved methodology for subsequent efforts.

- Since so little is known about the approaches necessary to implement the habitat management plan, it will be essential to commence any programme with small-scale pilot trials, which should be designed according to accepted scientific principles in order to establish the best way to proceed to a larger project. It may be necessary to run such trials for several years, but they can form part of the initial research requirements set-out in this document, and should ideally form the basis for more extensive work. For example, initial fenced enclosures could be developed into field nurseries in order to supply a stock of plants to vegetate a wider surrounding area.

- Habitat management plans should be integrated with the requirements of the Species Action Plans, and in most cases should form the major tool for implementing them.

Time frame: The development of restoration projects across 5 separate communities is an ambitious goal which will require a considerable level of funding, time and manpower. Consequently, it cannot be expected that this will be achieved over a short time period. However, efforts to assemble the knowledge and necessary infrastructure should be ongoing. A realistic 10 year target would be to initiate any major research needed, as specified in this document, and to commence pilot restoration work in at least 3 of the five communities described above.

Semi-natural *Sporobolus caespitosus – Xiphopteris ascensionense* community on Windy Ridge. A number of invasive species such as Koster's curse *Clidemia hirta*, pig's-ears *Centella asiatica* and Cape grass *Sporobolus africanus* have started to colonize.

Appendix 1:
Working defintions of sub-populations within Ascension's endemic flora

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Anogramma ascensionis
Only 4 plants are currently known in the wild, all at one locality. This clearly represents a single population, but progeny should be obtained from all 4 individuals to maximize the genetic diversity of the species. Any additional patches discovered will present an invaluable opportunity for increasing this genetic diversity further.

Asplenium ascensionis
It is not clear that distinct sub-populations exist for this species. With the exception of the outliers in the south-east, the population is more or less continuous. However, at the very least, three areas should be identified across the spectrum:

- Cricket Valley, including outliers e.g. on Weather Post and White Hill
- Green Mountain, including all localities above 650m and any outliers at lower altitudes on the eastern slopes.
- Breakneck Valley, and all areas further east than this (e.g. the cliffs above Palmer's, the cave near the Nine Pines).

Euphorbia origanoides
Subpopulations currently identified are as follows:-

- Wig Hill, Letterbox and Spire Beach (plants in these areas appear to be similar in growth form and ecology, but if possible it may be better to treat the two areas as distinct).
- Hummock Point valley (small plants from this area are morphologically distinct from their neighbours, although as they grow on dry lava, this could merely be a response to the conditions)
- Hummock Point plateau
- Sister's Peak
- Comfortless Cove (this population may now be extinct in the wild, but progeny was recently obtained from a single specimen. Plants were formerly large and shrubby, and may represent a distinct population which occupied the area around Georgeotown.)
- Mars Bay, including South Gannet Hill, Round Hill and Cotar Hill

Marattia purpurascens
Since this species has probably always been confined to the upper south slopes of Green Mountain, it is difficult to treat it as more than one sub-population. However, cultivated stock should be derived from a selection of plants across the range in order to maximize genetic diversity.

Pteris adscensionis
Three subpopulations can be identified. Small outliers growing on rocks more widely across the south side of the island probably developed from pioneer spores liberated by plants in one of the core population areas.

- Cricket Valley
- Breakneck Valley
- Cronk's Path

Sporobolus caespitosus
Only two subpopulations are likely to exist:-

- Green Mountain (plants still occur in approximately 5 areas on Green Mountain, but all are relatively close and probably not genetically-isolated. However, cultivated stock should be derived from a selection of plants across these areas in order to maximize genetic diversity.)
- Weather Post

Xiphopteris ascensionense
Since this species has probably always been confined to the upper south slopes of Green Mountain, it is difficult to treat it as more than one sub-population. However, cultivated stock should be derived from a selection of plants across the range in order to maximize genetic diversity.

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