Spiky Yellow Woodlouse

(*Pseudolaureola atlantica*)

A Strategy for its Conservation 2021 – 2026

Original edited by Sarah Havery, Vicky Wilkins, Rebecca Cairns-Wicks, Phil Lambdon, Lourens Malan

Updated 2021 version edited by Amy-Jayne Dutton, Martina Peters, Vicky Wilkins, Sarah Havery, Rebecca Cairns-Wicks & Lourens Malan

Revised 2021 version was edited by:

Amy-Jayne Dutton (SYW expert), **Martina Peters** (St Helena National Trust), **Vicky Wilkins** (IUCN Mid-Atlantic Islands invertebrate Specialist Group - MAIISG), **Sarah Havery** (Royal Society for the Protection of Birds), **Rebecca Cairns-Wicks** (St Helena Research Institute) and **Lourens Malans** (St Helena Nature Conservation Group)

Original document was edited by:

Sarah Havery (Royal Society for the Protection of Birds), **Vicky Wilkins-Kindemba** (Buglife)**, Rebecca Cairns-Wicks** (St Helena National Trust)**, Phil Lambdon** (Project Manager), **Lourens Malan** (Environment & Natural Resources Directorate, St Helena Government)

In collaboration with:

Jeremy Harris (St Helena National Trust), **David Pryce** (St Helena National Trust), **Mike Jervois** (Environment & Natural Resources Directorate, St Helena Government), **Derek Henry** (Environment & Natural Resources Directorate, St Helena Government), **Andrew Darlow** (Environment & Natural Resources Directorate, St Helena Government), **Paul Pearce-Kelly** (Zoological Society of London), **Mark Bushell** (Bristol Zoological Society), **Tim Woodfine** (Marwell Wildlife), **Roger Key** (Consultant), **Alan Gray** (CEH), **Jonathan Hall** (Royal Society for the Protection of Birds), **Axel Hochkirch** (Chair of the IUCN SSC Invertebrate Conservation Sub-Committee), **Mark Stanley Price** (IUCN SSC Invertebrate Conservation Sub-Committee)

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Contents

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Cover photo: Amy-Jayne Dutton

INTRODUCTION

Islands hold a disproportionate amount of the world's biodiversity (Kier *et al.* 2009). The habitats and species dependent on islands are severely threatened by human activity such as habitat destruction (Millennium Ecosystem Assessment, 2005) and the introduction of non-native species (Courchamp 2003, Paulay 1994).

St Helena, a UK Overseas Territory, is a 14 million year old island of volcanic origin in the South Atlantic Ocean (figure 1), 4,000 km east of Rio de Janeiro and 1,950 km west of the coast of Angola and Namibia. Like many island ecosystems, St Helena is ecologically distinctive - supporting unique habitats such as the cloud forests of the Central Peaks. Many endemic species of flora and fauna abound on this island, and it is considered a global hotspot for invertebrate biodiversity (Buglife, 2013). St Helena supports over 420 invertebrate species found nowhere else on earth, which represents the highest number of endemic invertebrates of all the UK Overseas Territories (Churchyard *et al.,* 2014).

The summit ridge, known as the Central Peaks, is the highest part of St Helena at around 700-800 metres. Regularly enveloped in orographic cloud, it is covered with fragmented cloud forest, comprising endemic cabbage tree *Melanodendron integrifolium* woodland and tree-fern *Dicksonia arborescens* thicket. On St Helena the cloud forest is a hotspot and key habitat for invertebrates; with more than 200 endemic invertebrates occurring in the Central Peaks, comprising over half the endemic fauna (Buglife, 2013).

Unfortunately, human activities have had a severe impact on the unique ecosystems of St Helena. Habitat destruction, through the historic clearance for timber, the introduction of livestock and the clearance of the cloud forest for the introduced invasive New Zealand flax *Phormium tenax* plantations, coupled with the ongoing problems of further intentionally and accidently introduced invasive plants and animals; has led to the fragmentation of habitats, isolation of populations and dramatic population declines of native flora and fauna. The remnants of the native biodiversity are now struggling to survive in tiny fragments. Sadly, this has led to extinction for some invertebrates – such as the Giant earwig *Labidura herculeana*, Giant ground beetle *Aplothorax burchelli* and St Helena darter *Sympetrum dilatatum* which have become globally extinct within the memory spans of long-term residents living on the island (Buglife, 2013). (*Note: S.dilatatum* not been formally assessed as extinct by IUCN, but is very likely to be extinct based on existing information).

There are many iconic species still under threat of extinction, including St Helena's flagship invertebrate - the Spiky yellow woodlouse *Pseudolaureola atlantica*.

Figure 1: (a) An aerial view of the island of St Helena, south Atlantic; (b) The Black cabbage tree woodland of the cloud forest at the Dell, High Peak (Phil Lambdon); (c) The landscape across the hills of St Helena (Jonathan Hall).

STATUS REVIEW

1. Species description

1.1. Systematics/Taxonomy

The Spiky yellow woodlouse *Pseudolaureola atlantica* (Vandel, 1977) is endemic to the island. It belongs to the family Armadillidae, which currently requires further study in terms of evolutionary phylogeny (Lambdon, 2015). As presently defined, the genus *Pseudolaureola* (Kwon, Ferrara & Taiti, 1992) comprises just four species with a remarkably disjunct distribution across humid forests of the tropical Afro-Australasian zone (IUCN, 2016). In addition to the Atlantic outpost occupied by *P. atlantica*, the other taxa from the genus are found in Madagascar, New Caledonia and Western Australia (Schmalfuss, 2003). Related genera (e.g. *Laureola*) have a predominantly southern African distribution but some do extend as far as south-east Asia. *P. atlantica* is synonymous with *Laureola atlantica* Vandel, 1977 (Lambdon, 2015).

Variations in colour and differences in morphology are commonly found in separated populations of both plant and invertebrate species on St Helena (Dr P. Lambdon 2016, pers. comm.). For example, there is a small endemic woodlouse species (*Littorophiloscia alticola* Vandell 1977), found in association with *P.atlantica,* that exhibits colour variation between subpopulations, with some appearing yellow-grey and other individuals being reddish (Dr P. Lambdon 2016, pers. comm.). More recent findings however have found *L. alticola* in abundance with all colour forms present throughout the Peaks (Mr L. Malan 2016, pers. comm.). Colour variation has recently been observed in *P. atlantica* which has included some very pale and some dark individuals (Fig. 2; Malan, 2015). It is currently unknown what the cause is of this colour variation, and whether this is influenced by the environment (e.g. food, substrate or climate) or if habitat fragmentation has had an impact in terms of genetic variation through the isolation of populations. Individual habitat patches are often isolated by complex topography and have been isolated for hundreds of years, and many plant and invertebrate species have not evolved good dispersal mechanisms, resulting in less gene flow between subpopulations (Dr P. Lambdon 2016, pers. comm.). It is likely that different *P. atlantica* subpopulations have been isolated for several centuries at least (Dr P. Lambdon 2016, pers. comm.). Therefore, a genetic study is required to determine if the subpopulations should be regarded as separate conservation units.

Figure 2: The colour variations of the recently found *P. atlantica* on Dogwood trees in Diana's Peak (Malan, 2015). Note the interesting star branching of one of the spines in the top right photo (Malan, 2015).

A newly discovered ‘spiky’ woodlouse was found by Mr L. Malan, 2015. This may represent a separate species new to science (Dr S. Taiti, 2016). These woodlice in appearance are smaller than *P. atlantica* and display two distinct colour morphs; a dull grey with pale central stripe form found commonly on High Peak (Fig 3; Dutton, 2016), and a brighter cream colour with lateral dark brown stripes and pale central stripe. Both have similar armature; blunt-ended spines rather than sharp, and spines which are almost restricted to the wider mid-dorsal area rather than extending laterally (Dr R. Key & Mr L. Malan 2016, pers. comm.). It exhibits unusual features to that of *P. atlantica,* but is considered likely to be within the Genus *Pseudolaureola* (Stefano Taiti 2015, pers. comm.). It is nominally referred to as the 'stripy spiky'. This woodlouse was first found on Mount Vessey but has subsequently been found alongside *P. atlantica* on High Peak (Mr L. Malan 2016, pers. comm.). These have been seen in deadwood habitat, as well as on fern fronds, and cover a larger range than first suspected.

(a)   (b)

Figure 3: (a) The recently discovered 'stripy spiky', seen on High Peak (Dutton, 2016) (b) stripy spiky with juvenile spiky yellow woodlouse (Dutton, 2016)

A proper analysis of their morphology compared to *P. atlantica* and other *Pseudolaureola* is required, and specimens were sent to specialist Stefano Taiti for describing (Malan, 2016 pers. comm.). For the purpose of this Strategy for *P. atlantica*, this population is not considered at this stage but is suggested to be placed on the protected species list under the EPO (St Helena Environmental Protection Ordinance).

Several research gaps are identified:

- *Genetic research is needed to understand genetic variation within species to facilitate an effective conservation approach*
    - *Update: Exoskeleton was collected in 2016 and sent for analysis, this material is not adequate and specimens are required (M. Blake, 2016, pers. comm.)*
- *Taxonomic work is needed to clarify if more than one species of* Pseudolaureola *exist on St Helena*
    - *Update: Specimens have been sent to Stefano Taiti for description (Malan, 2016)*

1.2. Biology & Ecology

P. atlantica can reach 1cm body length, with an even spread of sizes observed (Dr P. Lambdon 2016, pers.comm.). They have an iconic yellow colouration which is speculated to be a form of camouflage or anti-predator warning (Dr P. Lambdon 2016, pers.comm.). Individuals are cryptic against fern fronds and easily overlooked.

Very little is known about the biology and ecology of this species. It is arboreal and has generally been considered to be found on fern fronds forming the understory of black cabbage tree *Melanodendron integrifolium* woodland, where its habitat preferences appeared to be closely associated with fern cover and high humidity (Dr P. Lambdon 2016, pers.comm.). However, as a result of research carried out between 2015 and 2017 under Darwin Initiative Projects DPLUS025 and DPLUS029 *P. atlantica* is now known from more varied habitat, on a number of plant species including non-native species (Table 1), within the cloud forest. While it is commonly found on the fern understory of trees in the cloud forest, it has also been regularly seen in areas of tree fern thicket with no tree canopy including on fronds exposed to the high winds, and in the tree canopy itself (Figure 4).

Table 1. Plant species *P. atlantica* observed on

Endemic	***Non-native***
St Helena tree fern (*Dicksonia arborescens*)	[1]Bilberry tree (*Solanum mauritianum*)
St Helena Dogwood (*Nesohedyotis arborea*)	[1]Whiteweed (*Austroeupatorium inulifolium*)
Whitewood (*Petrobium arborium*)	[1]Bramble (*Rubus pinnatus*)
He cabbage (*Pladaroxylon leucodendron*)	[1]Flax (*Phormium tenax*)*
Black scale fern (*Diplazium filamentosum*)	
Brown scale fern (*Pseudophegopteris dianae*)	
[1]Sickle fern (*Asplenium platybasis* var. *platybasis*)*	
[1]Plastic fern (*Asplenium compressum*)*	

*Single observation or night sighting [1]First seen 2016/17

Figure 4: *P. atlantica* on exposed tree fern frond

The habitat conditions are currently considered to be the driver of habitat preference (Dr P. Lambdon & Dr R. Cairn-Wicks 2015, pers.comm.), however these conditions are not yet fully understood. A number of Diana's Peak locations of *P. atlantica* have found to be associated with the St Helena dogwood *N.arborea* and the whitewood *P. arboreum* (Malan, 2015). Older, bryophyte rich tree fern *Dicksonia arborescens* thicket appears to be prime habitat for this species (Mr L. Malan 2016, pers.comm.). In 1993 *P. atlantica* were also observed visiting an endemic St Helena redwood *Trochetiopsis erythroxylon* tree (>7 in a 30 minute period) planted at the edge of the Dell (Rowe, 1995). They were regularly observed being active in redwoods *T. erythroxylon* and at the time was thought to be visiting flowers for nectar and possibly pollen (Mr P. Pearce-Kelly 2016, pers. comm.).

The finding of *P. atlantica* in a number of habitat situations on the Peaks, as well as on differing plant species, suggesting that they have less specific condition requirements than originally thought (A Dutton, 2017, pers. comm.). However, the absence of the *P. atlantica* from areas within the habitat that appear suitable, suggest additional drivers affecting presence.

P. atlantica have been observed appearing to feed on detritus and snail excrement (A. Dutton 2017, pers. comm.), as well as the micro-films covering fronds of Black-Scale Fern *Diplazium filamentosum* and other plants (Fig.5; Dr P. Lambdon 2015, pers. comm.). The films are presumed to be composed of micro-debris, fern spores, pollen, algae and/or fungi, although whether one or more of these components is preferred has not been determined (Dr P. Lambdon 2016, pers. comm.). Interestingly, observations of *P. atlantica* in Diana's Peak indicate that they may access food sources from different plant species to that of the Dell subpopulation (Malan, 2015). Furthermore, they give the impression of being more social, congregating in one part of a tree or in one tree, despite other apparently suitable habitat being available, however the reason for their grouped congregations is not understood (Mr L. Malan 2016, pers. comm.). Direct interaction between individuals was rarely observed (A. Dutton 2017, pers. comm.). Patches where *P. atlantica* is prevalent, *L. alticola,* another woodlouse species, is lacking or in low densities (Mr L. Malan 2016, pers. comm.). This might indicate some form of territorial behaviour, or deliberate avoidance, possibly due to the need to compete for food sources, or a number of other reasons (Mr L. Malan 2016, pers. comm.).

Figure 5: A Scanning Electron Microscope (SEM) image of the mouthparts of *P. atlantica,* which are considered unusual for an isopod species (Steve Gechmeissmer).

While individuals can be active during the day, moving along fronds or feeding, it is thought that most significant movement occurs at night (A Dutton, 2017 pers. comm.), as is the case with other woodlice (Sutton, 1972). Individuals were observed moving across the ground at night and covering several metres in a short space of time (A. Dutton 2017, pers.comm.). The use of red torchlight allowed for night-time observations and did not seem to affect their behaviour.

P. atlantica fluoresce under ultraviolet (UV) light (Dutton & Pryce 2018; Figure 6). This appears to be an unusual trait for a woodlouse, with only one other woodlouse species recorded to do so (Giurginca *et al*. 2015). This striking trait was confirmed in November 2016 and the use of a UV torch has provided a simple but effective search technique. Individuals are detected more easily using this method, and night surveys have allowed for a more confident assessment of presence or absence with thorough inspection of the vegetation. This method has been a key element in improving information on the number and distribution of this species with over 4 times as many individuals at night with the UV torch than detected during comparable daytime searches.

Figure 6: *P. atlantica* under UV light (Amy Dutton, 2017)

Breeding has only been noted in females from the upper 10 - 20% of the size range (Lambdon, 2015). The eggs develop within a brood pouch formed by special plates below the abdomen which females moult to produce (Sutton, 1972). Breeding occurs throughout the year (A. Dutton 2017, pers. comm.), with a typical clutch size of between 8 and 11 individuals (Dr P. Lambdon 2016, pers. comm.*).* They are approximately 1.5 mm long on emerging, which is considered very large for a juvenile woodlouse (Dr P. Lambdon 2016, pers. comm.*).* See figure 7. Newly emerged young do not fluoresce under UV light.

Figure 7: *P.atlantica* and juveniles on blackscale fern *Diplazium filamentosum* (Phil Lambdon).

Several research gaps are identified:

- *A number of key questions regarding biology & ecology remain to be answered, such as:*
- *What is the lifecycle of P. atlantica? What are the limitations for survival? What time of day are they most active? What are their food requirements? Does this vary between subpopulations? How long do they live? Do they breed more than once? How fast do they grow? How often do they moult? Would they breed more regularly under optimum conditions? Does food availability constrain their growth rate? What constitutes optimum conditions? What is their reproductive rate?"*
- *In depth life-history knowledge is needed for a Population Viability Analysis to be undertaken*

2. Functions and values

The functional role of *P. atlantica* in the ecosystem is not currently understood. *P. atlantica* does not fill a role as primary decomposers or pollinators, though it is suspected it may play a role in regulation of the epiphyllous flora of black-scale fern and other endemic plant species; though this has not yet been studied (Dr P. Lambdon 2016, pers. comm.).

The societal value of *P. atlantica* would be as a flagship species for the endemic invertebrates of St. Helena and its unique cloud forest habitat. The Bugs on the Brink project 2012-2015, led by Buglife and SHNT, has involved an education programme aimed at local school children, which had a focus on *P. atlantica*. A potential captive breeding programme and wider conservation work could provide opportunities for further public engagement.

A survey was undertaken in 2016 to establish baseline knowledge of the spiky yellow woodlouse on St Helena. While recognition was generally high, there was still evidence of misunderstanding of the species, including some concern that it was a pest species, highlighting the importance of further education. This species has been promoted during events and through press-releases, articles and blogs (e.g. RSPB, 2016). There was particularly good uptake on the articles about its fluorescence under UV light (January 2017). The popularity of these articles demonstrates its attractiveness and potential as a high profile species. In addition, there has been a drive to increase products available on island utilising and so promoting its image.

Several research gaps are identified:

- *What potential engagement options are there for the future?*
- *Does P. atlantica remove pests from foliage on native vegetation?*

3. Historical account

Over recent decades there has been clear evidence of decline in both the number and distribution of *P. atlantica* subpopulations and the number of individuals, and there is no obvious reason to assume that these trends have halted (Lambdon, 2015). It is believed that the losses are strongly linked to reduction in the area of suitable habitat (Lambdon, 2015). Previously common at the site originally believed to hold the largest subpopulation (the Dell); local accounts indicate that this subpopulation has declined substantially over the past 10 - 20 years (Lambdon, 2015).

Distribution

It is difficult however, to determine how extensively the distribution of *P. atlantica* has retracted because there have been so few records of invertebrates on St Helena. Nineteenth century authors such as Melliss (1875) were unaware of it entirely, which may suggest that the distribution has been confined to few, very restricted and isolated localities for some time (Lambdon, 2015).

The first comprehensive entomological survey of St Helena was conducted by the Royal Museum of Central Africa, Tervuren (Belgium) in the 1960s (Basilewsky 1977). They recorded *P.atlantica* only from High Peak.

In 1993, as part of a wider ZSL invertebrate survey visit a relatively numerous population was seen and a small number of living specimens were collected as an initial *ex-situ* breeding attempt (Mr P. Pearce-Kelly 2016, pers. comm.). See section 7.3 for more details.

A further detailed study of the Central Peaks in 2005-06 (Mendel *et al.,* 2008) identified a separate subpopulation near Mt Actaeon (the most northerly of three summits along Diana's Peak Ridge) and reported additional accounts from locals of the species occurring nearby in Wells' Gut. More recently a number of islanders report seeing *P. atlantica* at the head of Byron's Valley within the past decade (this could conceivably be the same locality as that of Mendel *et al.* 2008). Other accounts, from the few older residents familiar with the upland forests (also Q. Cronk *pers. comm*. 2014), describe seeing more general sightings but without a specific location, and it was suspected that a small subpopulation could possibly have existed at Wash House (Lambdon, 2015). Movement around the Peaks has altered since the installation of wide, accessible paths, reducing the likelihood of contact with individuals, and so detection and perceived presence is likely to be lower.

Philip and Myrtle Ashmole recorded spiky yellow woodlice from a tiny cave (small overhang) on the northern slope of High Peak (Ashmole P & M, 2000). They recorded it again in 2005-06. The cave is isolated from the cabbage tree woodland in sheep pasture and there appears to be little surrounding habitat to support the species outside of the cave. More recent visits found no evidence of continued presence. A further sighting was made in a hollow below The Dell in 2009 (K. Herian and L. Malan pers. comm.), but no individuals could be found here in 2013 (Lambdon, 2015).

Abundance

There can be little doubt that it has also suffered considerable declines from the sites where it currently occurs at High Peak. In 1993 it was recorded on redwoods (>7 sited in a 30 minute period) (Rowe, 1995). It was still sighted regularly at The Dell as recently as the late 1990s (Dr R. Cairns-Wicks and Ms V. Thomas 2013, pers. comm.).

4. Current distribution and demography

There have been substantial changes in the known distribution of *P. atlantica* since 2015.

A survey of *P. atlantica* was conducted in 2013 – 2014 by P. Lambdon, assessing potential habitat sites on St Helena, during which individuals were found at only two locations, separated by 100m and occurring on the steep, south facing cliffs of High Peak at the Dell (Lambdon, 2015). The two tiny patches of forest where small numbers persist are very close together and effectively comprises a single subpopulation within two forest fragments creating two populations (Lambdon, 2015).

In 2015, the Darwin Plus funded Cloud Forest & Associated Invertebrates project led by the Environment & Natural Resources Directorate (ENRD) of St Helena Government, surveyed the endemic hardwood trees and found *P. atlantica* in 15 new locations for this species, nine over the southern side of Diana's Peak and a further site at High Peak (Mr L. Malan 2016, pers.comm.).

During 2016/17 searches were undertaken by A. Dutton around the locations of the endemic hardwood trees and other cloud forest habitat areas identified by L. Malan to hold or potentially hold *P. atlantica*. These included binocular counts, point search counts and general searches, both during the day and at night. It was found that individuals extended beyond the immediate surroundings of the trees; this included areas of tree fern thicket, as well as areas of mixed native and invasive plant species. Individuals were found at a distance of up to 60m away from the original identified tree location and were found to be in high numbers in some locations investigated with UV torch (maximum of 57 individuals in 5 minutes within a 2m radius of a static searcher). Searches with UV torch were limited to areas accessible at night and the established paths.

Searches with the UV torch along the public paths around Diana's Peak at night also revealed new locations of *P. atlantica* individuals. Four locations were identified next to the path, with 1 to 21 individuals detected in 5 minute static counts. These were between 40m and 60m from the nearest known locations and suggests higher mobility than thought, and/or greater occupied range than previously suspected. Additionally, the use of the UV torch was able to categorically confirm the absence of *P. atlantica* in some locations thought to be prime habitat. See Figure 8 for approximate search areas.

The population estimate for *P. atlantica* in 2017 was 980 individuals. This is likely to be an underestimate due to limitations in surveying the entire potential habitat range. *P. atlantica* have now been seen in over 60 points across the Peaks. These range from 2m apart to 280m apart on Diana's Peak and up to 45m apart on High Peak, with approximately 3km between the two areas (Fig. 11 & 12). Currently, *P. atlantica* are thought to occupy approximately 0.27ha on High Peak and 4.4ha on Diana's Peak This has been estimated from occupied points with a 10m buffer on High Peak and a 30m buffer on Diana's Peak where there is more available habitat.

In 2016/17 numbers range from a single individual to a maximum of 57 in a 5-minute active search (UV torch), with up to 30 individuals seen during 10-minute binocular searches of trees (daytime).

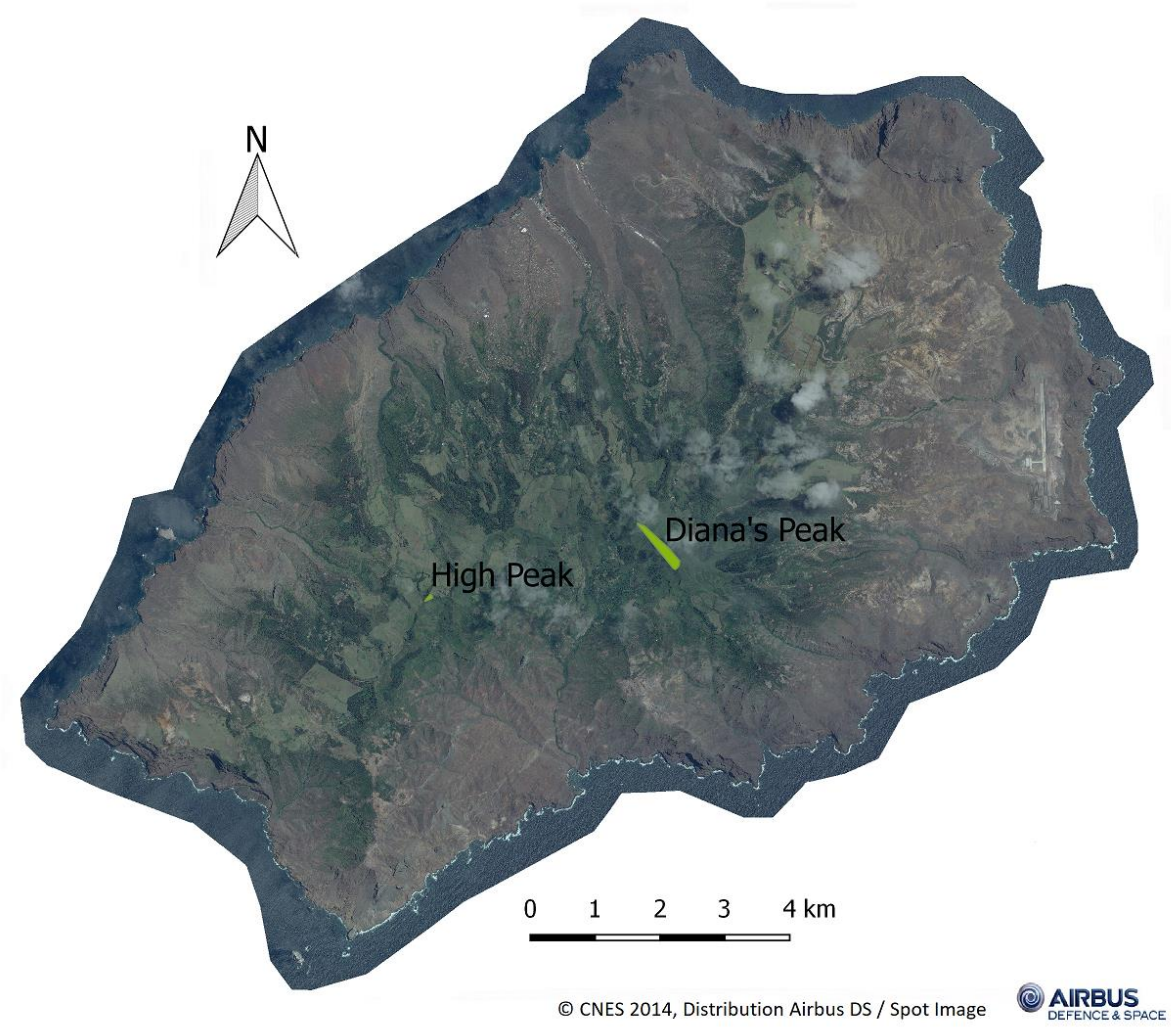

Figure 8: Locations of High Peak (just below the 'H') and Diana's Peak on St Helena and areas of potential *P. atlantica* presence

4.1. High Peak

In total on High Peak there was estimated to be 310 individuals of *P. atlantica* in 2017.

The area known as 'The Dell' was thought to contain the entirety of the remaining *P. atlantica* population of around 50 individuals. This is a well-known and studied small pocket of black cabbage tree *Melanodendron integrifolium* woodland less that 30m wide. It has a mature tree canopy, primarily black cabbage trees but also several dogwoods and two he cabbages, as well as lobelia (*Trimeris scaevolifolia*) and a variety of ferns as the understory. Rare bryophytes have been recorded here. Tree fern thicket is present on one side of the Dell, with pasture grass and flax encroaching on the others. Within the Dell there is little established litter layer except toward the back where tree fern dominates. It is often damp and muddy and the ground is easily churned during access. This now seems to be a small portion of the area where this species is found, with individuals regularly found in the tree fern thicket to the west of the Dell, as well as a greater proportion of the population in the second area found on High Peak. A capture-mark-recapture study was completed (Fig. 9) at the Dell and determined that the subpopulation consisted of c.62 individuals (Dr P. Lambdon 2016, pers.comm.January*).* Later investigations with a UV torch found only 12 individuals in the Dell during a night search while an area of tree fern approximately 40m away regularly held 30-40 individuals (A. Dutton 2017, pers. comm.).

There is another area of apparently suitable tree fern thicket approximately 50m to the west of the Dell that does not appear to be occupied by *P. atlantica* despite their proximity.

Figure 9: A marked individual *P. atlantica* as part of the capture-mark-recapture study to determine the subpopulation size of the Dell (P. Lambdon).

A second subpopulation of *P. atlantica* was found in 2009 in a more westerly location, originally accessible by rope. This site has a number of mature black cabbage trees, established tree fern thicket, some fern understory, and small whitewood, dogwood and he cabbage trees. The area under the large spoor tree (*Pittosporum viridiflorum*) was considered the area available to *P. atlantica* and this was originally estimated to hold 40-80 individual *P. atlantica*, (Lambdon, 2015). Around the endemic tree species there has been some intense vegetation management and regeneration of both endemic and non-native species is occurring. *P. atlantica* have been found to be present on two he cabbages, black scale fern and tree fern, bramble and one individual on the spoor tree. The ground is extremely steep and extensive searches are impractical. In 2017 a UV survey of this area recorded 170 individuals in 7 point counts, compared with just 42 individuals detected that day across the same points.

Figure 10: The steep sided slopes of High Peak, the second location of *P. atlantica* on High Peak, found during the 2013-2014 surveys (P.Lambdon).

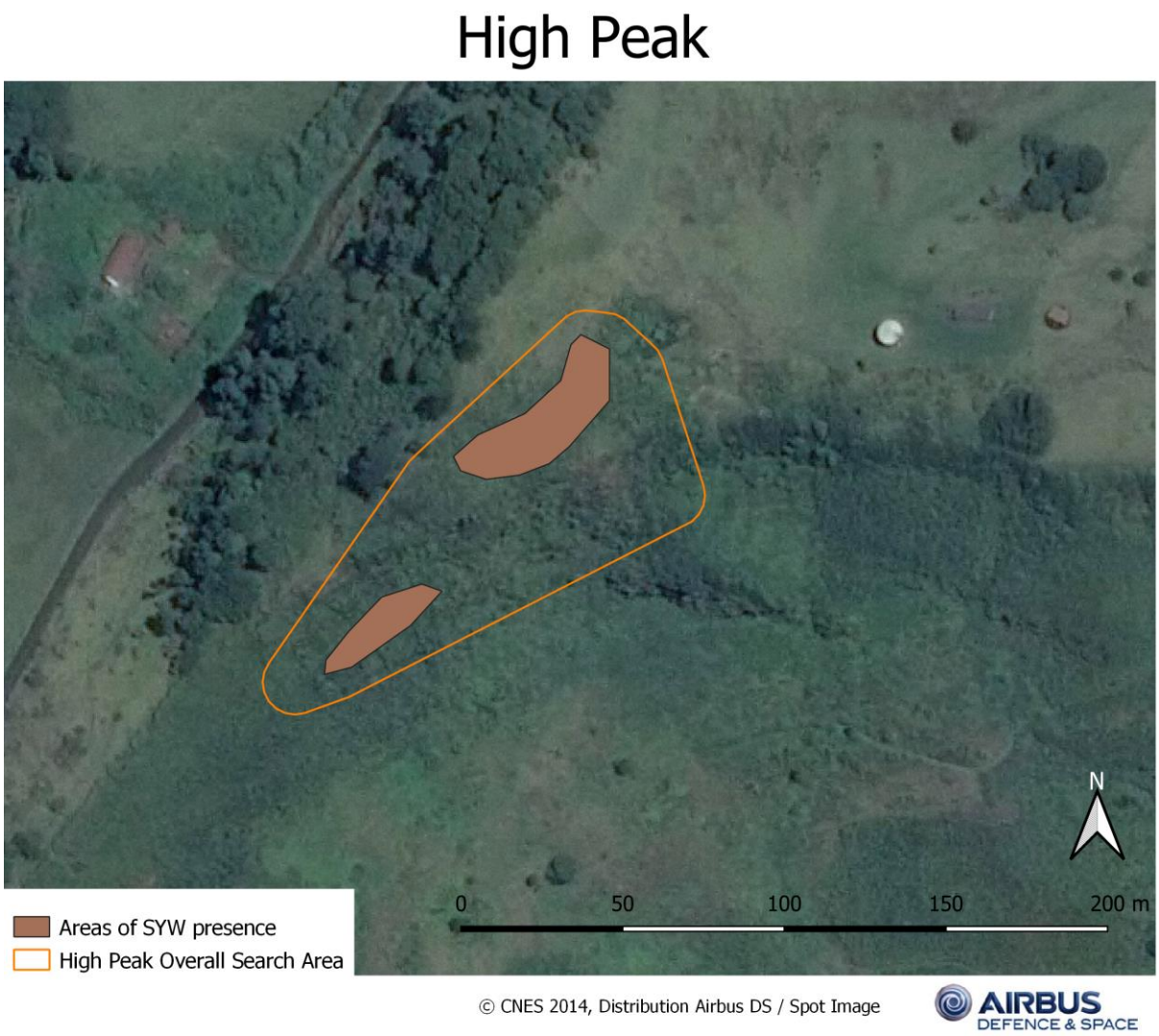

Figure 11: Search locations on High Peak. Bottom left are the 10 points of the second High Peak site. Top right is the Dell.

4.2. Diana's Peak

In 2017 it was estimated that there were 670 individuals present on the Diana's Peak ridge. This area includes the three peaks of the high central ridge and surrounding cloud forest vegetation.

It was on Diana's Peak where subpopulations of *P. atlantica* were detected on a number of endemic trees by L. Malan as part of the Darwin Plus funded Cloud Forest & Associated Invertebrates project led by ENRD.
P. atlantica had been noted from a small patch of cloud forest vegetation during a survey in 2006 around Cuckold's Point (most westerly of the three Peaks) by Mendel *et al.* (2008). This area still supports *P. atlantica* and the subpopulation appears to be expansive and mobile below Cuckold's Point.
Finding subpopulations on Diana's Peak ridge has greatly improved knowledge of *P. atlantica* distribution and numbers. This was then expanded with searches through surrounding areas, including leading to or from known sites, and on adjacent ridges.

The endemic trees with *P. atlantica* presence are predominantly dogwood, but also include whitewoods and he cabbages. Most of the endemic trees surveyed are away from easily accessible areas and require experience and knowledge to find, as well as careful movement when accessing. Searches have found *P. atlantica* in the vegetation around endemic trees, including on non-native species. *P. atlantica* were also present in tree fern thicket at a distance (over 60m) from known occupied trees.

The habitat around occupied endemic trees consists of predominately tree fern, or areas of invasive vegetation including flax, whiteweed and bilberry. Many of the endemic trees have had vegetation management undertaken around them to create space between them and the encroaching non-native vegetation. In some areas the endemic ferns are returning well, although regrowth of the invasive species is also substantial.

P. atlantica sites are almost exclusively on the south-southwestern side of the High Central Ridge, with some individuals having been found on the crest of the Peaks in several locations through the use of a UV light. Subpopulations of over 60 individuals have been found in the vicinity of both Cuckolds Point and Mount Actaeon.

A number of locations were searched on the northeastern side of the ridge, including both point counts and general searches during the day and UV night searches. A single individual was found during a general invertebrate search on tree fern approximately 120m to the northwest of known *P. atlantica* sites, but repeat visits to this location, including searches with UV light, have not revealed further individuals and this does not appear to be an established subpopulation location. Two individuals were also located in a restoration plot on the north-eastern side but similarly no further *P. atlantica* were located. Night surveys, although informative, were restricted due to accessibility and likelihood of vegetation damage.

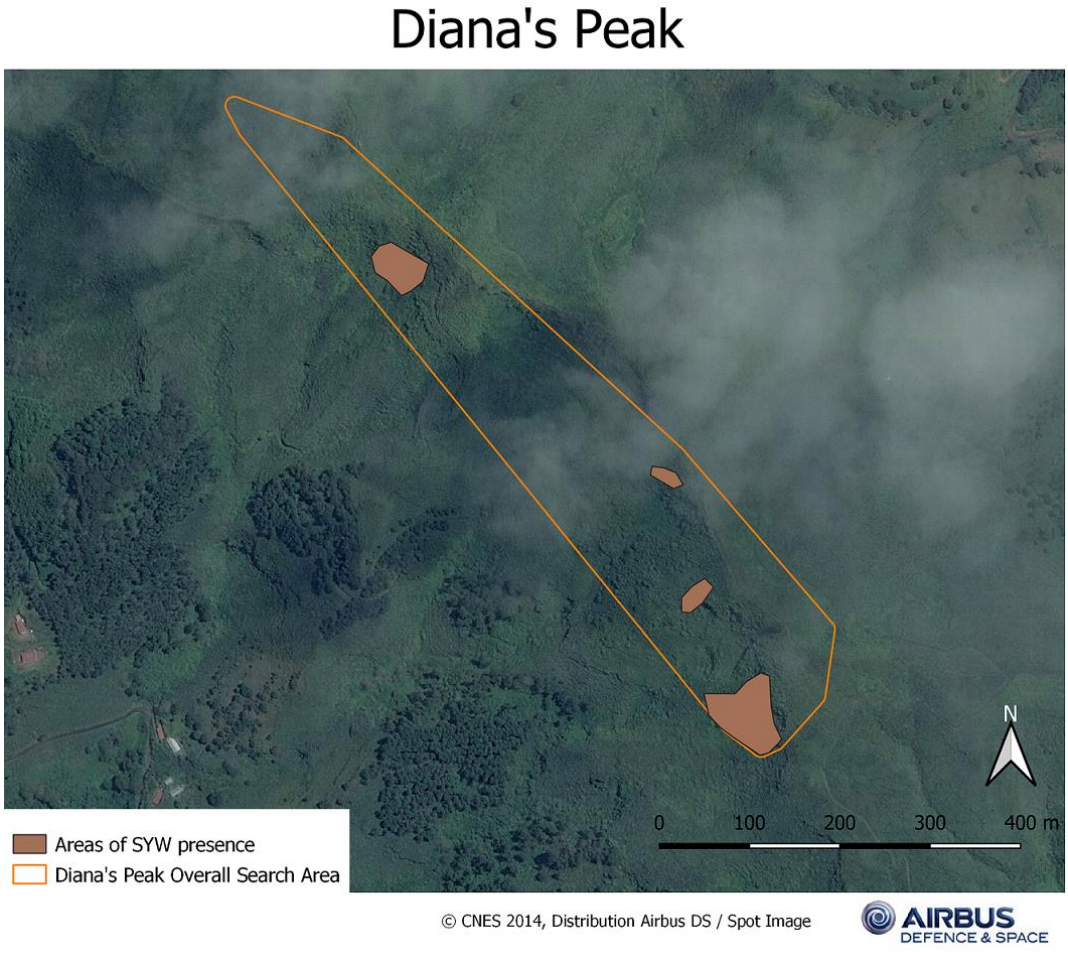

Figure 12: Search locations on Diana's Peak ridge

Several knowledge gaps are identified:

- *More comprehensive and detailed surveys of these new sites are required to get accurate population estimates;*
    - *Unlikely to be able to get to all areas where individuals are so a limited number of sites have been visited due to access and disturbance*
- *Accurate habitat assessments are required to fully understand the habitat requirements of the species;*
    - *Picture becoming more complicated with more findings*
- *The size of potentially suitable habitat present is key to understanding the suitability of these habitat patches and long-term sustainability of these sites; a better understanding of habitat needs and any subpopulation differences*
    - *Mapping project on St Helena provides overview of potential habitat which could help to inform further work*
- *Long-term monitoring method to understand population trend*
- *(1) what is the likely outcome of doing nothing? (2) What is the best "do something" option?*

5. Habitat and resource assessment

Fragments of cloud forest are now confined only to High Peak and the Diana's Peak range, but even these have been substantially degraded following invasion by numerous non-native plant species. Vigorous competitors such as Whiteweed *Austroeupatorium inulifolium*, Small Fuchsia *Fuchsia coccinea*, Bilberry Tree *Solanum mauritianum* and Blackberry *Rubus pinnatus* are well evidenced problems, but other small, ground cover species are likely to have imposed more subtle yet important pressures on native species (Lambdon, 2015).

The Black cabbage tree *Melanodendron integrifolium* woodland of the Central Peaks of St Helena is a unique cloud forest habitat which is now almost extinct following the large-scale conversion of upland areas to flax plantations (Lambdon, 2012). The remaining patches of black cabbage tree woodland habitat are indicated in Figure 13. Its dark, humid conditions support a unique plant and invertebrate community. The Dell has become more exposed in recent years with the loss of wind attenuating low tree cover in front of it, notably redwoods and hybrids planted in front of the Dell which were removed or died, and therefore the loss of canopy structure within it. As a result, further black cabbage trees are rapidly succumbing to strong winds due to this exposure (Lambdon, 2015). This tiny fragment is home to several other highly threatened species, including several bryophytes and five endangered ferns (Lambdon, 2015).

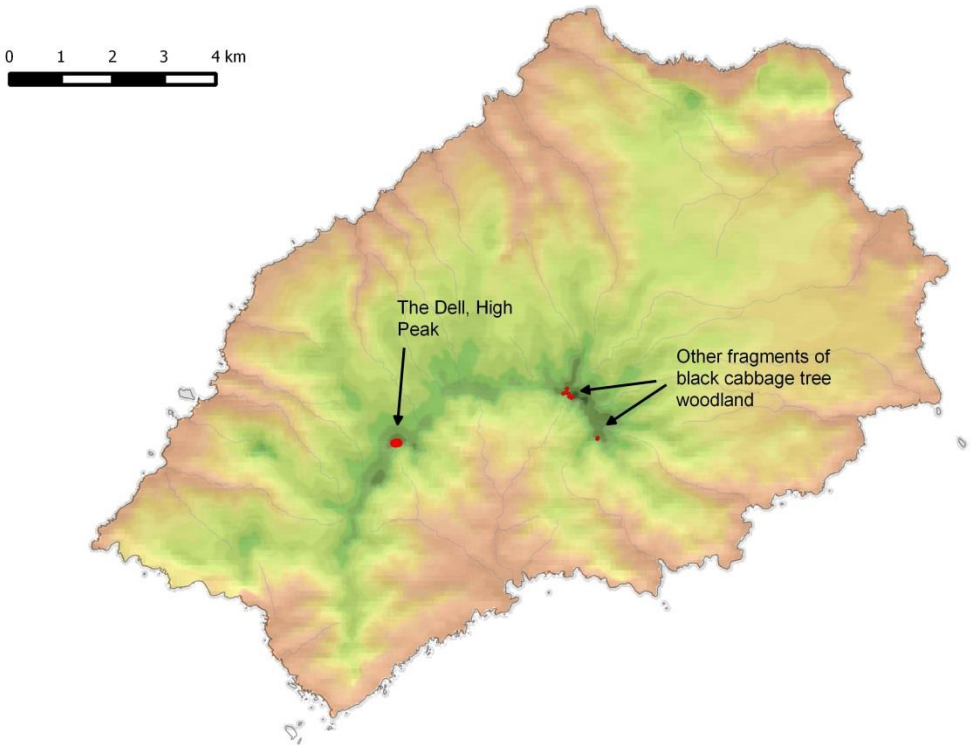

Figure 13: Location of the Dell (High Peak) on St Helena and remaining distribution of black cabbage tree woodland situated on Diana's Peak.

Black cabbage tree Melanodendron integrifolium *woodland cycle*

As a species, Black cabbage *M. integrifolium*, Fig. 14, remains a moderately common component of the cloud forest flora, but stands of several trees growing in close proximity are required to create the dark, humid conditions necessary to support a characteristic understory community, and these are extremely rare (Lambdon, 2015). Although The Dell comprises 25 mature cabbage tree individuals, very few other copses of more than three trees survive (Lambdon, 2015). Even in areas where there are concentrations of black cabbage the understory is sometimes dominated by tree ferns *Dicksonia arborescens*, which accumulates a heavy, acid leaf litter which smothers the open ground needed for more diverse herbaceous species to establish (Lambdon, 2015). Conditions are dependent however, on the maturity of the *D. arborescens* thicket. Older, bryophyte rich *D. arborescens* thicket seem to be prime habitat (Mr L. Malan 2016, pers.comm.March). The most recently found *P. atlantica* sites are within such vegetation and appear to support good density of *P. atlantica*.

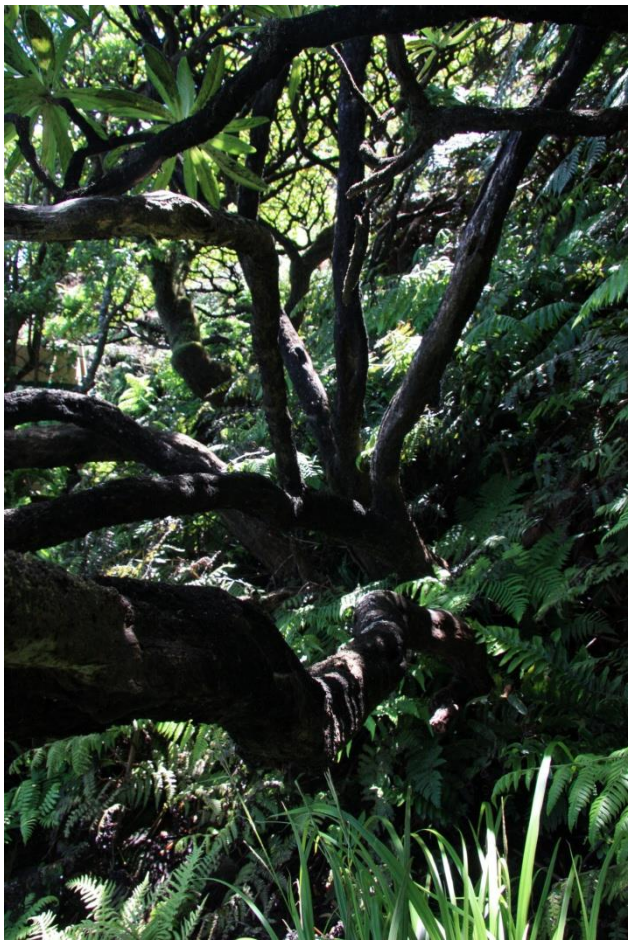

Figure 14: Black cabbage tree (*M. integrifolium)* woodland and associated fern-rich understory at the Dell .3 (P. Lambdon).

The lack of useful historical data limits our understanding of what the climax vegetation of the cloud forests might have looked like, but from observations it is likely to be black tree cabbage *M. integrifolium* woodland (Mr L. Malan 2016, pers. comm.). Proper climax black cabbage *M. integrifolium* woodland is likely to be more diverse than the meagre fragments now left. Other endemic cloud forest trees (Whitewood *Petrobium arboreum*, Dogwood *Nesohedyotis arborea*, He cabbage *Pladaroxylon leucodendron* and She cabbage

Lachanodes arborea and Redwood *Trochetiopsis erythroxylon*) all seem capable to reach higher height than *M. integrifolium* do, but in the protected valleys at lower elevation, dominance would depend on which of these species does best. At high elevation (judging by a very few remaining, slowly declining, black cabbage trees which could not have grown to their current size and form in isolation) there might well have been quite substantial *M. integrifolium* woodlands at the higher elevations. Tree fern thicket *Dicksonia arborescens* seems to function as some sort early successional stage which becomes more diverse as older fern fall and get covered in epipiphytes and tree seedlings. Standing *D. arborescens* trunks that are exposed often have small cabbage tree seedlings on them which can survive for many years without seemingly gaining in size. Meanwhile their roots, protected within *D. arborescens* roots follow gravity and once establishing a foothold in the soil below *D. arborescens* they have magnificent and surprisingly fast growth. In this fashion, *D. arborescens* thickets are succeeded by the trees (Mr L. Malan 2016, pers. comm.).

Several knowledge gaps are identified:

- *The understanding of ecosystem function might be critical for identifying restoration details to effect expansion and protection of habitat*
- *A thorough habitat assessment, including mapping, of potentially suitable habitat is required across the Peaks, highlighting currently known P. atlantica sites and potential new sites*
- *The quality and sustainability of the habitat at each site needs to be determined and assessed*

6. Threat analysis

6.1. Habitat degradation & fragmentation

The main threat for *P. atlantica* is habitat degradation and fragmentation, notably associated with the loss of Black cabbage tree *M. integrifolium* woodland (Lambdon, 2015). Degradation has limited the amount of suitable habitat and fragmentation has undoubtedly imposed major limitations on the ability of *P. atlantica* to recover. The sustainability of the sites where *P. atlantica* are found is currently unknown. Over recent decades there has been clear evidence of decline in both the number and distribution of *P. atlantica* at the Dell and the total number of individuals and it is thought that these losses are heavily linked to a dwindling area of suitable habitat (Lambdon, 2015).

The condition of The Dell has deteriorated substantially in recent years due to a combination of factors, including:

- A lack of germination microsites for *M. integrifolium,*
- habitat isolation preventing re-colonisation of preferred habitat,
- wind damage,
- kikuyu grass *Pennisetum clandestinum* encroachment

Black cabbage tree *M. integrifolium* is a member of the Asteraceae and possesses light, wind-blown seed which requires bare ground to germinate (Lambdon, 2015). The native flora contains few low-growing, colonial spreading herbs, and so the habitats the Black cabbage tree occupied would thus have originally contained plenty of bare ground. The arrival of pasture grasses and the introduced feather moss *Pseudoscleropodium purum* have increasingly reduced the availability of bare ground, resulting in more limited germination opportunities for endemic trees (Lambdon, 2015). The site is isolated on three sides by pasture which limits further colonization and spread of plant species, and leaves the copse exposed to very strong winds which scour the upper parts of High Peak for much of the year. A number of trees have fallen during storms since 2008. This has further opened the canopy, making the site even more vulnerable to tree losses and reducing the copse ability to trap humidity. The fern layer can be heavily buffeted during the winter months leaving many fronds ragged. There are concerns that this dominant component of the upland forests is declining (Lambdon and Ellick 2015), and in particular that further habitat losses will become apparent as the current older trees die (Lambdon, 2015). Kikuyu grass *Pennisetum clandestinum* has encroached onto areas of open ground where light now penetrates (Lambdon, 2015).

High Peak, including the Dell, is an important area to maintain for the *P. atlantica* subpopulation that persists in this area. Its diminutive size means that not only is it important to manage the vegetation to ensure high quality habitat, but that effects of any actions taken should be thoroughly considered so that negative impacts will be minimised.

While it was thought that *P. atlantica* required adjacent ferns to enable dispersal, individuals have been observed to walk across the ground during the night, and so dispersal may not be as limited as first feared. However, few individuals have been seen on black scale fern where there is no canopy, and it is suspected that the turnover of fronds of this species may be too high to support continued persistence of *P. atlantica* without associated cover and

greater stability provided by tree ferns or tree species (A. Dutton, 2017 pers. comm.). The dynamics of the vegetation and the impacts on *P. atlantica* should be further assessed and considered.

The presence of *P. atlantica* on Diana's Peak ridge has provided the species with greater resilience, but the size of the area, terrain, and number of plant species which threaten the continuation and regeneration of the cloud forest species provides a challenging future for the species in this area. Whiteweed *Austroeupatorium inulifolium* and Bilberry *Solanum mauritianum* invade bare areas, reducing available niches for native flora and Fuchsia *Fuchsia coccinea* grows through and over the tree ferns smothering their growth. Targeted actions are needed to ensure key areas are adequately managed.

6.2. Invasive species and pathogens

The impacts of predators and diseases are less certain. Numerous invertebrate threats (e.g. the woodlouse spider, *Dysdera crocata*) have been introduced to St Helena, although the 2013-2014 study did not record any incidences of losses to them and few potential predators or diseases were noted (Lambdon, 2015). The impacts of introduced small mammals (*Rattus rattus*, *Rattus norvegicus* and *Mus musculus*), which are prevalent near The Dell, are unknown but these species are considered unlikely to present an acute threat as they are too heavy to climb onto the fern fronds (Lambdon, 2015). However, rat damage to Tree ferns can be substantial in some areas, indirectly affecting habitat availability for *P. atlantica* if they are allowed to roam unchecked.

Figure 15: Rat caught on camera trap in the Dell, High Peak.

Predation by the introduced African grass frog (*Strongylopus grayi*) is another consideration, and a few individuals have been heard calling in the area (Lambdon, 2015). This introduced amphibian was not seen near the main colony area during repeated day and night searches in 2013, but its distribution and potential impacts require further research (Lambdon, 2015).

The presence of rabbits *Oryctolagus cuniculus* around the Dell has caused the loss of some established tree saplings, particularly St Helena dogwood. Trapping for these has been

undertaken when there is evidence of their presence, with several being removed over 2016/17 and no tree loss during this time.

Several gaps are identified:

- *Are current subpopulations viable? How much suitable habitat is actually and potentially available?*
- *How much habitat is needed to sustain viable subpopulations? How can adequate habitat level be restored?*
- *How much suitable habitat is needed to sustain a viable population?*
- *Impacts of introduced invertebrates such as Woodlouse spider Dysdera crocata*
- I*mpacts of introduced vertebrates, such as rats, mice & frogs* (*Rattus rattus*, *Rattus norvegicus, Mus musculus and Strongylopus grayi)*
- *How can the optimal habitat of the species be promoted/expanded?*
- *How do the vegetation dynamics affect the presence and distribution of P. atlantica.*

7. Conservation and management

7.1. Research and status

The conservation status of *P. atlantica* has been assessed for the first time, through funding from FFI's Flagship Species Fund, which has led to *P. atlantica* being classified as Critically Endangered (under criteria B1ab(i,ii,iii,iv,v); B2(i,ii,iii,iv,v); C2a(ii); D) according to IUCN Red List criteria (Lambdon, 2015).

7.2. Habitat restoration

All potential habitat for *P. atlantica* now lies within the Central Peaks National Park (part of the recently designated National Conservation Area network) and will be protected under the National Conservation Area development plans, which are expected to be in place in the near future. The species is also protected under the new Environmental Protection Ordinance which was brought into force in January 2016.

The immediate practical challenge lies in protecting the remaining known subpopulations. Urgent measures are needed to secure the future of the Dell's ecosystem (Lambdon, 2015). A three year Darwin Plus funded project on "Conservation of the Spiky Yellow Woodlouse and Black Cabbage Tree woodland on St Helena" was undertaken, aiming to stabilize this last surviving fragment of black cabbage tree (*M. integrifolium)* woodland, therefore enhancing populations of several very rare endemic ferns and invertebrates and improve wind protection though the addition of wind breaks (Lambdon, 2015). This project cleared pasture grasses and other invasive plants outside of the Dell. A shade canopy was established but harsh weather conditions caused rapid deterioration of the structure and modified wind breaks were installed instead to slow but not completely block the weather, providing some shelter for plant establishment. Planting and performance monitoring of established cloud forest species including over 700 dwarf Jellico *Berula burchellii* and 400 Diana's Peak grass *Carex dianae* that have been added to the site (provided by EMD) and

over 400 black cabbage trees (*M.integrifolium)* have already been planted (2017). Following this project this document provides an important element to drive future work forward.

The cloud forest habitat not only supports *P. atlantica*, but is also vitally important for the survival of highly threatened epiphytes (e.g. common and dwarf tongue-ferns, *Elaphoglossum conforme* and *Grammitis ebenina* and several specialized invertebrate species (e.g. the rainbow leaf beetle *Vernonia wollastoniana* and the endemic spider *Tecution mellissii*) (Lambdon, 2015).

Figure 16: Site appearance at the end of the Darwin Plus project, 2017 (A. Dutton)

7.3. Captive breeding

In 1993, as part of a wider ZSL invertebrate survey visit, a limited investigation of the Central Peak invertebrates, a relatively numerous population was seen and a small number of living specimens were collected as an initial *ex-situ* breeding attempt. Unfortunately, the population died shortly after arriving in UK, testifying to their delicate nature (Mr P. Pearce-Kelly 2016, pers.comm.).

The habitat restoration work will take many years to mature sufficiently for the habitat requirements of *P.atlantica*. The Darwin Plus project therefore was initially aiming to start the captive breeding programme for *P.atlantica*, effectively safeguarding this species by allowing time for habitat restoration (Lambdon, 2015). The aim was to set up the captive breeding colony in 2015 at St Helena Government's conservation facilities on-island (the 'Scotland' site), aiming to secure a nucleus of individuals under protected management which can be used to populate an eventual reintroduction programme (Lambdon, 2015). Due to the additional subpopulations being found, the population does not appear to be in immediate danger and the decision was taken to focus on habitat restoration and further understanding the newly found *P. atlantica* sites. Further knowledge of the species' requirements would provide more confidence in the success of a captive breeding programme. A Risk Analysis

has been produced to give initial guidance if a captive breeding programme is determined to be of importance into the future.

Several knowledge gaps are identified:

- *What habitat management techniques will have minimal impact on the conditions of the existing P.atlantica sites?*
- *What defines the population of P. atlantica?*
- *How could a captive breeding programme be started without harming the wild population?*
- *What are the requirements that must be met in the captive population to optimize captive breeding?*
- *What are the resource needs to enable a captive breeding programme to be established?*

CONSERVATION STRATEGY PLANNING

Methodology

To develop the conservation strategy of the spiky yellow woodlouse the handbook of the IUCN Species Survival Commission (IUCN SSC 2008), strategies from other species and advices from experts were used, particularly the Crau plain grasshopper (Hochkirch *et al.,* 2014). Definitions of Vision, Goals, Objectives and Actions were adopted from the IUCN SSC handbook. The way they interact through the conservation strategy planning is shown in Fig. 17. As defined in the handbook, actions must be SMART: specific, measurable, achievable, realistic and time-bound. Targets were included in actions and goals.

The knowledge review in this Strategy was updated in July 2017 by Amy-Jayne Dutton, with contributions from Rebecca Cairns-wicks and Lourens Malans. Following the findings of final year of the 'Conservation of the spiky yellow woodlouse and black cabbage tree woodland' Darwin project and then conservation strategy was again updated in 2021 further adding to the knowledge section and revising actions based on a consultative process.

Figure 17: Conservation strategy planning. Utilised from the Crau Plain Grasshopper Conservation Strategy, adapted from IUCN/SSC (2008).

Progress on goals during the last conservation plan (2016-2021)

Goal 1: Management of *P. atlantica* habitat and sites

The results of the project entitled 'Conservation of the Spiky Yellow Woodlouse and Black Cabbage Tree woodland on St Helena' (Dutton 2017a&b) confirmed a number of key new pieces of knowledge about the species to support long-term management work, as well as building upon findings of the project 'Securing St Helena's rare cloud forest trees and associated invertebrates' (Malan 2018). This included the fact that *P. atlantica* are found on vegetation apart from ferns under Black Cabbage trees, plus a better idea of what plants they are using, which included invasive species (adjacent to core habitat) within the Peaks. These broader requirements have made it more difficult to pin down specific habitat requirements, but new records have given a better understanding of *P. atlantica* relationship with vegetation, which can be factored into management actions. In terms of climatic needs, although broader than originally thought they still seem limited to the cloud forest. As with the rest of the Peaks they are at risk from increased drought and other extreme weather events due to climate change; and therefore, should be integrated into broader climate mitigation measures for the Peaks.

Restoration planting has taken place in front of the Dell, as well as other areas. Planting and establishment of cloud forest species has included over 700 Dwarf Jellico *Berula burchellii*, 400 Diana's Peak Grass *Carex dianae* and over 400 Black Cabbage Trees *M. integrifolium* (all provided by EMD) and which were planted by 2017. There has also been invasive plant species control in the same areas. The *P. atlantica* is also an important flagship species and its conservation is considered within the revised Peaks Management Plan (2021-2026) (Havery 2020).

Goal 2: Research

In terms of research progress, as well as better understanding ecological needs (Dutton 2017a&b) to facilitate habitat management other wider discoveries were made. The discovery that SYW could be surveyed much more accurately at night using UV (a five-fold increase) has given a much better understanding of the population size and distribution. It has also provided a more robust monitoring method as the species is high cryptic and difficult to spot by eye in daylight. This allowed a more accurate population size estimate to be made, approximately 980 in 2017, which is much larger than previously believed. This method also first demonstrated that they maintain a presence on some invasive species.

In terms of other behaviour, they appear to not only graze on the algal layer on plants, but are more opportunistic feeders, taking a variety of vegetative food. It was also concluded that they breed throughout year through observations of small juveniles in the hotter February ('summer'), not just the cooler season (August). In terms of social interactions not much was observed, there appeared some interaction with newly emerged juveniles, and they generally appear to be more mobile on a night.

Unfortunately, there was little information from analogue species, which are also understudied in other parts of the globe.

Originally ex-situ had been recommended but this has been deemed less necessary for conservation purpose once the population was found to be healthier than previously believed. There is a question whether an ex-situ population would provide beneficial life history studies, but on-island consensus on this would be needed before this was established. The collection of exuviae to allow genetic studies was found to provide insufficient DNA.

Goal 3: Public awareness

The 'Conservation of the Spiky Yellow Woodlouse and Black Cabbage Tree woodland on St Helena' project did a range of awareness raising events and materials, including:

- Posters are present in St Helena National Trust main entrance, also used on events
- There is a Spiky yellow woodlouse page on Facebook with videos and information
- A questionnaire about SYW knowledge got 83 responses, with 73% heard of *P. atlantica* before and two thirds did think that it is important to St Helena
- Presentation to local councillors – Friday 14th October 2016
- St Helena National Trust Council presentation – November 2016
- Blog written by Project Manager, publicised by both RSPB and Buglife (total 9400 views)
- Two Christmas markets attended – Spiky yellow woodlouse merchandise and information
- Article in the 'Trusted' newsletter – December 2016 and April 2017
- Publicity of SYW Fluorescence –January 2017, video on Facebook received over 1500 views.
- Class talk due to fluorescence publicity – Friday 3rd February 2017
  Nature Day – Saturday 4th March 2017
- St Pauls Primary Science Fair, Library open day all 2017
- Mentioned in a BBC article
- Press release on end of project and estimated SYW numbers May 2017
- Board above the Dell installed with SYW information

Goal 4: Long-term resources

The embedding of the Spiky Yellow Woodlouse into the 'Implementing the Peaks Management Plan (2021-2026)' (Havery 2020) as a key flagship species, will help to ensure long-term work and focus.

Revision of actions and activities for 2021-2026

The Vision, Goals and Objectives have been retained from the original plan, and actions and activities revised to form the 2021-2026 SYW Conservation Plan. These revisions were made initially by Amy-Jayne Dutton and then through discussions with Martina Peters and Vicky Wilkins, before a more open consultation with comments from Sarah Havery and Rebecca Cairns-wick and Lourens Malan provided updated information to the knowledge review in 2017.

VISION

The Central Peaks cloud forest ecosystem is a unique habitat whose biodiversity value will be restored and expanded to create high quality well-connected cloud forest, such that it will sustainably support a viable population of the spiky yellow woodlouse *Pseudolaureola atlantica,* which are found only in this ecosystem. The species will be a flagship for the conservation of the Central Peaks and all invertebrates on St Helena.

The vision was carefully worded to reflect the following points:

(i) 'Support a viable population': more studies are needed on population dynamics, habitat suitability and threats to define a minimum viable population

(ii) 'High quality well-connected cloud forest': protected natural habitat suffers from fragmentation, thus protection, enhancement and restoration is urgently needed

(iii) 'Flagship for conservation': largely unknown to the public, so awareness has to be enhanced.

Once the vision had been defined, the workshop participants identified how to achieve this vision.

GOALS, OBJECTIVES AND ACTIONS

See Table 2: Actions Details Sheet for details for each Action.

Goal 1: Management of *P.atlantica* habitat and sites

To sustainably preserve, improve and increase the area of suitable *P.atlantica* habitat under enhanced conservation management using habitat restoration techniques; enabling the management of existing and new subpopulations.

('Sustainably' also referring to the finances and human resources in place as well as biological and ecological context)

OBJECTIVE 1.1. Habitat management

Strategic long-term adaptive habitat management aiming to increase area of habitat, improve quality of existing habitat (including micro-habitat requirements) and work towards improved connectivity. Habitat management plans in place and actively co-ordinated to fit in with an overarching strategy across whole of the Central Peaks.

OBJECTIVE 1.2. Addressing known threats

Threats to the species survival from habitat loss, predation, disease and climate change greatly reduced by 2021.

Goal 2: Research

Improve understanding of the species' ecology and population dynamics; and define a 'viable population' and 'optimal habitat' to facilitate evidence-based conservation and achieve more sustainable sub-populations.

OBJECTIVE 2.1. Population dynamics

Identify the number and location of existing sub-populations, define habitat specifications and spatial extent and establish a monitoring programme to estimate the population size, trends and other relevant factors; utilise monitoring and survey data to identify attributes of a 'viable sub-population' and remaining 'optimal habitat'; and establishing a 'back-up' ex-situ population if required.

OBJECTIVE 2.2. Biology & ecology

Increase understanding of this species' biology and general ecology, the role it plays within the ecosystem and analyse population genetics, to improve the effectiveness of conservation work.

Goal 3: Public awareness

To raise the public profile of the species as a flagship for invertebrate conservation and the Central Peaks cloud forest ecosystem; by increasing understanding, awareness and value of the species' international importance, to attract support and associated resources for its conservation.

OBJECTIVE 3.1. Ascertain current level of understanding

Ascertain how many people understand, and the level of understanding, regarding the SYW to inform future engagement

OBJECTIVE 3.2. Wider education and communication plan

Increase local and international opportunities to engage with, and learn about *P.atlantica*, in order to encourage value, protection and long term funding for its conservation

Goal 4: Long-term resources

Sustainable, long-term resources secured enabling aims of strategic Action Plan to be achieved, improving the capacity within St Helena to deliver effective conservation programmes.

OBJECTIVE 4.1. Long-term commitment & funding

Secured long-term commitment and funding to the conservation strategy of *P.atlantica* by signatories and integrate into other management plans and policies. Demonstrating clear engagement and support from partners and collaborators.

OBJECTIVE 4.2. Increasing capacity

At least 2 dedicated, trained and resourced field operatives working on *P.atlantica* habitats

Table 2: Actions details sheet (orange highlighted activities to be delivered through the Peaks Management Plan and this will be a wide partnership project, and SHNT are the representative of this partnership)

GOAL 1 Habitats and sites:

Action No.	Original Actions	Priority (1-urgent, 3 low)	Who	When	How	What resources needed	Output(s)	Indicator of success
	Goal 1: Management of *P. atlantica* habitat and sites							
	Habitat assessment							
1.1.1.	Monitor a selected SYW area(s) to determine health and value and long-term trends in vegetation quality	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	PhD or targeted project	Staff time	Summary of sub-population sites, data on vegetation condition and/or changes	Data on selected areas available and regularly updated. Status and trends in vegetation health identified, informing restoration efforts
	Use existing maps (DPLUS52) of the Central Peaks to identify sites of SYW presence and potential presence	2	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Maps, mapping technology and skills, staff time,	Maps with likely areas identified	Differences in vegetation detectable on maps for area identification

	Update vegetation maps as needed	2	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Skills, staff time	Updated vegetation maps	Maps up to date
	Prioritisation of SYW areas requiring urgent restoration efforts for habitat management plans (1.1.2)	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan		SYW area(s) receive habitat management	Increased native vegetation presence in/around identified SYW areas
	Assess potential connectivity options between sub-population sites	2	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan		Habitat management undertaken between known SYW areas	Maps showing increased native vegetation (reduced flax in particular) between known SYW areas
1.1.2.	*Habitat management plans*							
	Actions for SYW (as identified in 1.1.1) embedded within management actions across Central Peaks	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Staff time,	Consideration of SYW areas whenn planning planting or management work	SYW areas have improved native vegetation presence
	Ensure priority SYW actions are maintained in updates of Peaks Management Plan and other appropriate plans	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan		SYW habitat increases/improves as part of Peaks Man Plan work	SYW specific outputs
1.1.3.	*Habitat restoration*							

	Continue black cabbage restoration efforts at the Dell SYW subpopulation site	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Plants, nursery capacity, staff time	Restoration; reduction in invasive species and increase in native vegetation	Planting and survival records
	Sensitively adapt and document management approaches and habitat restoration techniques, incorporating knowledge gained from 1.1.1.	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Staff time		Increased planting, survival and native species coverage
	Implement habitat management plans (from 1.1.2.) for priority sites	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Staff time, equipment	Restoration; reduction in invasive species and increase in native vegetation	Increased planting, survival and native species coverage
1.1.4.	Annual collaborative review of implementation outcomes	1	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale		Time		Review report
	OBJECTIVE 1.2. ADDRESSING KNOWN THREATS							
	1.2.1. Predation							
1.2.1.	Explore the possible impacts of introduced invasive vertebrates and invertebrates on *P.atlantica*	2	SHNT Invertebrate Specialist (Peaks project)	Peaks project timescale	Within Peaks Management Plan	Staff time, equipment (cameras)	Observations, data of specific findings,	Report on findings of invasive species impacts
	Undertake any mitigation requirements and integrate into wider biosecurity work on island *Integrated as part of St Helena Invertebrate Strategy (2016-2020)*	1	Invert biosecurity lead at SHNT to collaborate with SHG Biosecurity	Ongoing	Via Invertebrate Strategy	Staff time	Biosecurity data on invertebrate interceptions	Increased interceptions, reduced invasive species presence

Goal 2 Research

Action No.	Revised Actions	Priority (1 urgent, 3 low)	Who	When	How	What resources needed	Output(s)	Indicator of success
	Goal 2: Research							
	OBJECTIVE 2.1. POPULATION DYNAMICS							
2.1.1.	*Explore the current status of the Diana's Peak sites*							
	PhD programme for in-depth species research	2	MAIISG UKOTs lead to identify opps with other partners support, SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	publications and PhD research results	PhD completed
2.1.2.	*Establish a long-term annual monitoring programme*							
	Monitor a selected SYW area(s) to determine health and value and long-term trends in vegetation quality	1	MAIISG UKOTs lead to identify opps with other partners support, SHRI, SHNT	Annual for subset of sites? As part of other vegetation monitoring?	PhD or targeted project	Academic partner	Summary of sub-population sites, data on vegetation condition and/or changes	Data on selected areas available and regularly updated. Status and trends in vegetation health identified, informing restoration efforts
	Monitor distribution and numbers at selected sites as proxy for population (path survey and 1 known occupied area each on High Peak and Diana's Peak)	1	MAIISG UKOTs lead to identify opps with other partners support, SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	Monitoring data,	Presence and distribution recorded, conservation actions amended

	Regular monitoring reviews and data analysis updating SYW knowledge review	1	MAIISG UKOTs lead to identify opps with other partners support, SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	Monitoring data,	Changes recorded and tracked, informing conservation actions
2.1.3.	*Take steps to define 'viable population' and 'optimal habitat'*							
	Obtain data on micro-habitat specifications (plant community structure, humidity, light, temperature, mist levels etc) of selected subpopulation(s)	2	MAIISG UKOTs lead to identify opps with other partners support, SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	Data on micro-habitat similarities/differences, plant community structure,	Identification of consistent features of SYW sites to inform conservation action
2.1.4.	*Ex-situ captive breeding trial*							
	OBJECTIVE 2.2. BIOLOGY & ECOLOGY							
2.2.1.	*2.2.1. Lifecycle, breeding ecology and feeding ecology*							
	Obtain information on analogue species (if any)							COMPLETED
	Update observations of wild individual behaviour	2	MAIISG UKOTs lead to identify opps with other partners support; SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	Data on behaviour and interactions, publication(s)	Greater understanding of life history and population dynamics
	Explore feeding preferences to determine if some sub-populations are in sub-optimal habitat	2	MAIISG UKOTs lead to identify opps with other partners support: SHRI, SHNT	By 2026	PhD or targeted project	Academic partner	Data on feeding habitats and foodstuffs, Stomach analysis	Greater understanding of feeding can inform conservation actions
2.2.2.	*2.2.2. Population genetics*							

	Obtain information on analogue species and museum samples (if any)							
	Maintain and update specimen collection methodology, protocol and preservation	2	MAIISG UKOTs lead to identify opps with other partners support; SHRI, SHNT	By 2026	Check specimens, review procedure	Academic partner	Specimen methodology updated as required	Effectively preserved specimens maintained and utilised in research
	Explore options of genetic sampling by collecting samples in situ e.g. using exuviae and exoskeletons							COMPLETED
	Complete genetic analysis of *P.atlantica*	3	MAIISG UKOTs lead to identify opps with other partners support: SHRI, SHNT	By 2026	Targeted project, specimens sent to lab	Academic partner	Genetic data, publication	Greater understanding of species and taxonomic links. Potential information for conservation actions.
	Study phylogeny with molecular markers to test if morphologically distinct populations represent unique species and to understand the relationships to other species of the genus	3	MAIISG UKOTs lead to identify opps with other partners support; SHRI, SHNT	By 2026	Targeted project, specimens sent to lab	Academic partner	Genetic data, publication	Divergences and similarities more fully understood, informing conservation actions.
2.2.3	*Parasitism, disease*							
	Monitor individuals for parasites in wild	3	MAIISG UKOTs lead to identify opps with other partners support; SHG	By 2026	PhD or targeted project	Academic partner	Potential incidents of parasitism recorded,	Parasites identified, informing conservation actions

			SHNT					
1.2.3.	*Climate change; integrated into St Helena Invertebrate Strategy (2016-2020) (Cairns-Wicks et al., in press)*							
	Maintain weather station and regular data collection	3	Conservation Director with Met Station (Development phase)	By 2026	Via Met station	Working equipment	Weather data records for the peaks	Weather data collected

Goal 3 Public Awareness

Action No.	Revised Actions	Priority (1-urgent, 3 low)	Who	When	How	What resources needed	Output(s)	Indicator of success
	Goal 3: Public awareness							
	OBJECTIVE 3.2. WIDER EDUCATION & COMMUNCATIONS PLAN							
3.1.1	*Establish the P.atlantica as the flagship for the invertebrate conservation on St Helena by end of 2017*							
	Support Peaks focussed Activity Day including SYW activities/information	2	SHNT Invertebrate Specialist (Peaks project)	By 2026	Both within Peaks Management Plan and for targeted projects	Peaks project team established	Activities, community involvement	Participation records/numbers, increased community understanding and support
3.1.2.	*Develop a range of educational activities and interpretation for all ages (resourced education plan)*							
	Maintain and update SHNT, EMD and wider educational materials to include SYW	1	SHNT Conservation Director; EMD	By 2026	Looking of opportunities in SHNT and EMD existing work	Ongoing education material development	Educational materials on SYW	Increased knowledge of SYW in children

3.1.3.	*Communications strategy in place to maximise audience awareness of the SYW.*							
	Maintain communication around SYW with key audiences, both in St Helena and international	1	SHNT Invertebrate Specialist (Peaks project); EMD	By 2026	Both within Peaks work and for targeted projects	Peaks project team established	Articles, press releases, education resources	Ready recognition of SYW and its needs by the general population
	Interpretation signage on peaks trails	2	SHNT Invertebrate Specialist (Peaks project); EMD	By 2026	Within wider Peaks project	Peaks project team established	Suitable interpretation available	Increased awareness and understanding of SYW on island

Goal 4 Long-term resources

Action No.	Revised Actions	Priority (1-urgent, 3 low)	Who	When	How	What resources needed	Output(s)	Indicator of success
	Goal 4: Long-term resources							
	OBJECTIVE 4.1. LONG-TERM COMMITMENT & FUNDING							
4.1.1.	SHNT and EMD supported by MAIISG to build partnerships and secure funding when appropriate	1	MAIISG UKOT Lead with other partners	By 2026	Exploring partner and funding opportunities	Staff time	Projects and new partnerships established	Ongoing delivery of the plan activities, specifically research
4.1.2	Funding secured to delivery Peaks Management Plan	1	RSPB, SHNT, EMD	By 2022	Funding applications submitted	Funding to be secured	New peaks project and SYW actions active	SYW actions implemented

	OBJECTIVE 4.2. INCREASING CAPACITY							
4.2.1.	*4.2.1. SHNT secure finances actively supporting at least 2 new staff on the peaks*	1	SHNT Invertebrate Specialist (Peaks project); RSPB	By 2026	Both within Peaks work and for targeted projects	Funding	Peak project active and staffed	Project being delivered

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