Spiky Yellow Woodlouse
(*Pseudolaureola atlantica*)

A Strategy for its Conservation 2016 – 2021

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NOTE: This Strategy report is an iterative document that will be updated as necessary, and should be referred to and treated as a working document.

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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 around 460 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 threatened however, 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) 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.January). 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.January). More recent findings however have found *L. alticola* in abundance with all colour forms present throughout the Peaks (Mr L. Malan 2016, pers.comm.March). 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.January). It is likely that different *P. atlantica* subpopulations have been isolated for several centuries at least (Dr P. Lambdon 2016, pers.comm.January); 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).

One newly discovered population of a ‘spiky’ woodlouse, which may represent a separate species new to science, was found by Mr L. Malan, 2015. These woodlice in appearance are smaller than *P. atlantica,* exhibit a colour difference, have more prominent stripes, 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.January). It exhibits unusual features to that of *P.atlantica,* but is considered likely to be within the Genus *Pseudolaureola* (Stefano Taiti 2015, pers.comm.). So far only eight individuals have been observed; all in the space of 9 metres squared (Mr L. Malan 2016, pers.comm.January). More recently however, new information suggests a larger range for this undescribed striped woodlice species. Incidentally, the newest population is found on High Peak in vegetation wholly different from that of Mount Vessey, the first site where found. This woodlouse species has been found alongside *P. atlantica* at the High Peak site (Mr L. Malan 2016, pers.comm.March).

These have all been found in deadwood habitat, which is not considered to be a key habitat for *P. atlantica* (Mr L. Malan 2016, pers.comm.January). A proper analysis of their morphology compared to *P.atlantica* and other *Pseudolaureola* is required, though specimens have yet to be sent to a specialist for describing due to low numbers of individuals found (Mr L. Malan 2016, pers.comm.January). For the purpose of this Strategy for *P.atlantica*, this population is not considered at this stage.

Several research gaps are identified:

- *Genetic research is needed to understand genetic variation within species to facilitate an effective conservation approach*
- *Taxonomic work is needed to clarify if more than one species of* Pseudolaureola *exist on St Helena*

1.2. Biology & Ecology

P. atlantica can reach 1cm body length, with an even spread of sizes observed (Dr P. Lambdon 2016, pers.comm.January). 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.January).

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 appear to be closely associated with fern cover and high humidity (Dr P. Lambdon 2016, pers.comm.January). Black-Scale Fern *Diplazium filamentosum* appears to be the preferred host-plant and this association occurs at the *P.atlantica* sites at the Dell at High Peak (Lambdon, 2015). However, one of the newly found *P. atlantica* sites is on High Peak, but not under black cabbage canopy (Mr L. Malan 2016, pers.comm.March). The dominant vegetation type in this site is tree fern *Dicksonia arborescens* thicket with no black scale in that section of the site.

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. The black cabbage trees *M.integrifolium* act as keystone species in this ecosystem and their presence facilitates the necessary conditions for the endemic Endangered St Helena dogwood *Nesohedyotis arborea* and the endemic Endangered whitewood *Petrobium arboreum* to germinate (Percy and Cronk, 1995) and so these tree species are usually associated (Dr P. Lambdon 2016, pers.comm.January), see section 5 for more details. It is suspected that the size of black cabbage tree also generally facilitates the necessary high humidity requirements for *P. atlantica* (Dr P. Lambdon 2016, pers.comm.January). Older, bryophyte rich tree fern *Dicksonia arborescens* thicket appear to be prime habitat for *P. atlantica* (Mr L. Malan 2016, pers.comm.March). The 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). However, it currently remains uncertain what the driver of habitat preference is for the *P.atlantica* on Diana's Peak.

In 1993 *P. atlantica* were observed (>7 in a 30 minute period) during the day on an endemic St Helena redwood *Trochetiopsis erythroxylon* tree 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. March).

P. atlantica has been observed feeding on the micro-films covering fronds of Black-Scale Fern *Diplazium filamentosum* and other plants supporting this micro-film (Fig.3; Dr P. Lambdon 2015, pers.comm.December). 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.January). 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.January). Patches where *P. atlantica* is prevalent, *L. alticola,* another woodlouse species, is lacking or in low densities (Mr L. Malan 2016, pers.comm.March). 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.March).

Figure 3: A Scanning Electron Microscope (SEM) image of the mouthparts of *P. atlantica,* which are considered unusual for an isopod species (Steve Gechmeissmer).

Breeding has only been noted in females from the upper 10 - 20% of the size range (Lambdon, 2015). The eggs are glued to the underside of the mother and brooded within a marsupium i.e. with a membrane secreted over them (Dr P. Lambdon 2016, pers.comm.January). Typically the clutch size is between 8 and 11 individuals with the juveniles 'hatching' during mid-winter (August) in the wild (Dr P. Lambdon 2016, pers.comm.January). They are approximately 1.5 mm long on emerging, which is considered very large for a juvenile woodlouse (Dr P. Lambdon 2016, pers.comm.January). See figure 4.

Figure 4: *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?"

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.January).

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, 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.

Several research gaps are identified:

- *What potential engagement options are there for the future?*
- *Does* P. atlantica *removal pests from foliage for 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 which is now 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.March). 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, without a specific location and it was suspected that a small subpopulation could possibly have existed at Wash House (Lambdon, 2015). These records provide little more than suggestions, but they are sufficient to at least conclude that the range appears to have contracted substantially in the Diana's Peak area (Lambdon, 2015). 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 (Ms R. Cairns-Wicks and Ms V. Thomas 2013, pers. comm.).

4. Current distribution and demography

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 (HP1 & HP2; labelled 0 on Fig 5), separated by 100 m 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).

During 2015, the current Darwin Plus funded Cloud Forest & Associated Invertebrates project led by the Environment & Natural Resources Directorate (ENRD) of St Helena Government, has been surveying the endemic hardwood trees and has found *P. atlantica* in ten new locations for this species, nine over the southern side of Diana's Peak and a further site at High Peak (Table 1, Fig 5; Malan, 2015; Mr L. Malan 2016, pers.comm.March).

In summary, there are currently twelve known sites (three very recently found in 2016) supporting *P. atlantica* (Mr L. Malan 2016, pers.comm.March), nine of which are in Diana's Peak and three in High Peak. The locations of nice of these sites are indicated in Figure 7.

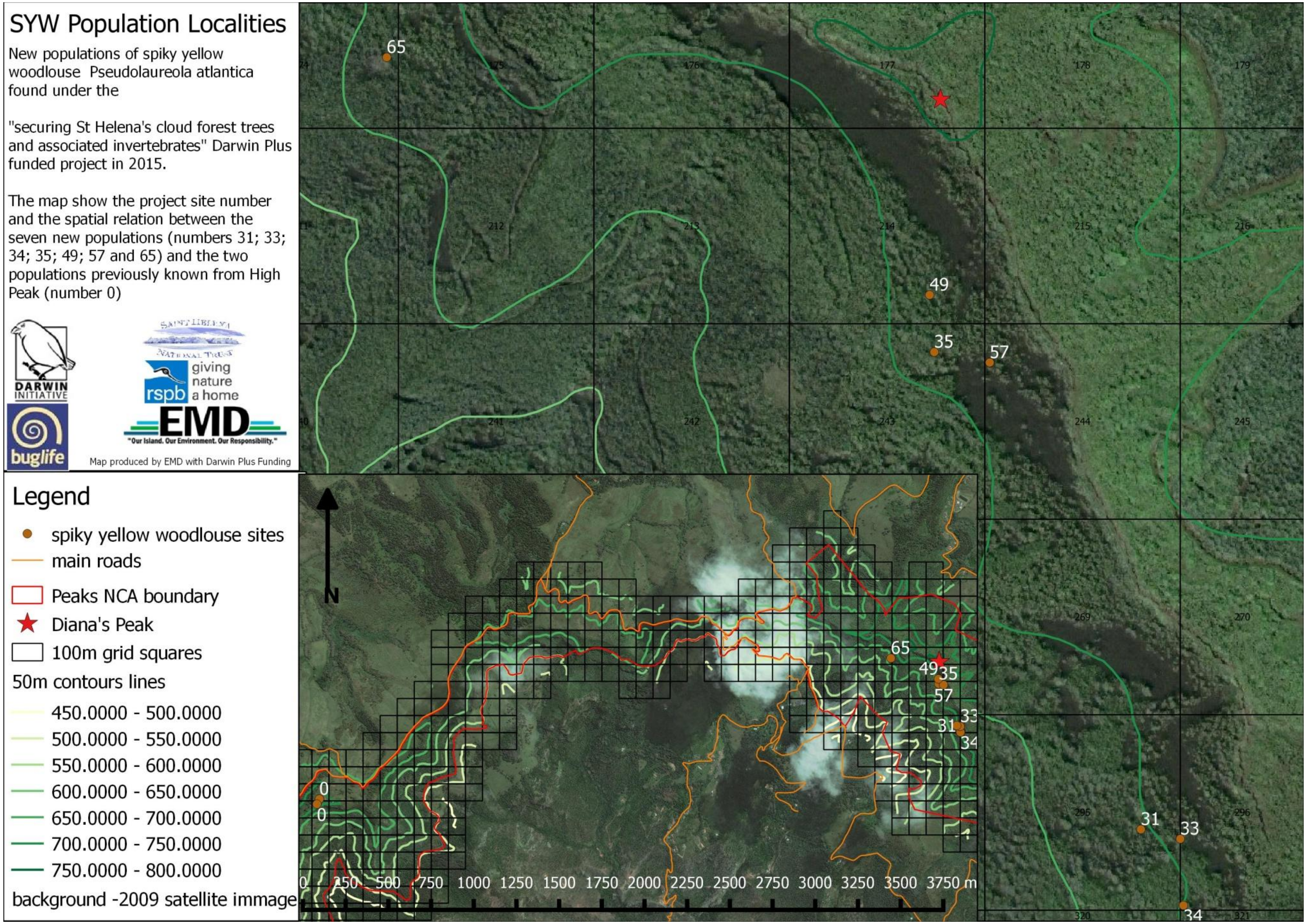
Table 1: The sites known to be supporting *P. atlantica* the number of *P. atlantica* observed. The dominant habitat type and distance from the next nearest site supporting *P. atlantica* are also indicated. See Figure 7.

Site Number	High Peak or Diana's Peak	Site Name	Minutes spent searching	Dominant habitat type	Next nearest site	Distance to next nearest site (m)	Number of SYW observed
1	High Peak	HP1 (0 on map)	NA	Black cabbage tree woodland & black scale fern	HP2	100	62
2	High Peak	HP2 (0 on map)	NA	Black cabbage tree woodland & black scale fern	HP1	100	40-80
3	Diana's Peak	65	5	1 x whitewood	49	304	14
4	Diana's Peak	31	0	6 x dogwoods	33	23	1
5	Diana's Peak	33	10	1 x dogwood	32	23	4
6	Diana's Peak	34	20*	5 x dogwood	33	34	23
7	Diana's Peak	35	10	1 x whitewood	49	29	1
8	Diana's Peak	49	20**	3 x whitewood	35	29	24
9	Diana's Peak	57	5	1 x dogwood	35	27	11
*10****	*High Peak*	*NA: High Peak*	*5*	*Unknown*	*Unknown*	*Unknown*	*6*
*11****	*Diana's Peak*	*NA: Diana's Peak*	*Unknown*	*Unknown*	*Unknown*	*Unknown*	*Unknown*
*12****	*Diana's Peak*	*NA: Diana's Peak*	*Unknown*	*Unknown*	*Unknown*	*Unknown*	*Unknown*
		Total					**c.220**

*a ten minute count was conducted on two separate occasions

**two counts were conducted at site 49 on two separate trees

*****NOTE: Three new sites have been recently found in 2016 (labelled as sites 10, 11, 12), data currently being analysed (Mr L. Malan 2016, pers.comm.March).**


SYW Population Localities
New populations of spiky yellow woodlouse Pseudolaureola atlantica found under the
"securing St Helena's cloud forest trees and associated invertebrates" Darwin Plus funded project in 2015.
The map show the project site number and the spatial relation between the seven new populations (numbers 31; 33; 34; 35; 49; 57 and 65) and the two populations previously known from High Peak (number 0)
DARWIN INITIATIVE
buglife
Saint Helena National Trust
rspb giving nature a home
EMD
"Our Island. Our Environment. Our Responsibility."
Map produced by EMD with Darwin Plus Funding
Legend
spiky yellow woodlouse sites
main roads
Peaks NCA boundary
Diana's Peak
100m grid squares
50m contours lines
450.0000 - 500.0000
500.0000 - 550.0000
550.0000 - 600.0000
600.0000 - 650.0000
650.0000 - 700.0000
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background -2009 satellite immage
N
0 250 500 750 1000 1250 1500 1750 2000 2250 2500 2750 3000 3250 3500 3750 m
65
49
35
57
31
33
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0

Figure 5: A map of nine currently known sites supporting *P. atlantica* across the central Peaks; seven of which have been discovered in 2015 through the Cloud Forest Darwin project (sites 31, 33, 34, 35, 49, 57 & 65); and an inset showing these in relation to the previously known sites at High Peak (0 & 0) (L. Malan, 2016).

NOTE: Three new sites have been recently found in 2016 and have not yet been mapped, data currently being analysed (Mr L. Malan 2016, pers.comm.March).

4.1. High Peak

In total, over the two sites at the Dell there are c.90 individual *P. atlantica*. The first (and best known) of these sites lies in a pocket of black cabbage tree *Melanodendron integrifolium* woodland known as ‘The Dell’. The copse is less than 30m wide, and even within it the subpopulation is highly localised; although a few scattered woodlouse individuals were sporadically found across the entire patch, the majority were restricted to a single fern stand spanning only seven by three metres (Lambdon, 2015). A capture-mark-recapture study was completed (Fig. 6) at the Dell and determined that the subpopulation consisted of c.62 individuals (Dr P. Lambdon 2016, pers.comm.January*).*

Figure 6: A marked individual *P. atlantica* as part of the capture-mark-recapture study to determine the subpopulation size of the Dell (P. Lambdon).

The second locality was first discovered during an abseiling exercise in 2009, with an estimated 40-80 individual *P. atlantica*, but subsequent verification was hampered by the inaccessibility of the site (Lambdon, 2015). It lies on a steeply-sloping ledge surrounded by dense cloud forest vegetation, and can only be reached on ropes (Fig. 7). The area is smaller than that of The Dell, lying entirely under the canopy of a single large Spoor tree (*Pittosporum viridiflorum*) (Lambdon, 2015).

The 2013 – 2014 survey was not entirely comprehensive due to access difficulties and detecting the species can be difficult in dense fern swards (Lambdon, 2015).

The current Darwin Plus funded Cloud Forest & Associated Invertebrates project led by ENRD has surveyed 80 sites, three of which are within the Dell at High Peak. During these surveys, no *P.atlantica* were found at the three sites in the Dell (Mr L. Malan 2016, pers.comm.March) which currently suggests the Dell sites may now represent a small constituent of the *P atlantica* population. However, the third site at High Peak, one of the newly found *P. atlantica* sites, is not in the Dell and not under black cabbage canopy (Mr L. Malan 2016, pers.comm.March).

Figure 7: The steep sided slopes of High Peak, the second location of *P. atlantica* on High Peak, found during the 2013-2014 surveys (P.Lambdon).

4.2. Diana's Peak

During 2015, the current Darwin Plus funded Cloud Forest & Associated Invertebrates project led by ENRD, has been surveying the endemic hardwood trees and has found *P. atlantica* in new locations for this species over the southern side of Diana's Peak (Table 1; Malan, 2015). The study has included timed point counts and timed active searching for *P. atlantica* at survey sites and has currently found between an estimated 66 and 78 individual *P. atlantica* in seven of the sites (Table 1, Fig 5; Mr L. Malan 2016, pers.comm.January), with a further two sites in Diana's Peak being documented (Mr L. Malan 2016, pers.comm.March).

It is highly likely that these timed counts are an underestimation of the numbers present, due to the limited amount of available time to complete the counts and searches. The distances between these sites are highlighted in Table 1. Sites 34, 33 & 31 are all found within a valley (Fig 5). Sites 57 & 35 are on a cliff down the side of a ridge, with site 49 immediately on the other side of that same ridge. Site 65 is completely separate with very little endemic vegetation, some present along its uphill edge only, which raises questions regarding the habitat specificity of the species (Mr L. Malan 2016, pers.comm.January).

Several knowledge gaps are identified:

- *More comprehensive and detailed surveys of these new sites are required to get accurate population estimates;*
- *Accurate habitat assessments are required to fully understand the habitat requirements of the species;*
- *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*
- *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 8. Its dark, humid conditions support a unique plant and invertebrate community. The site supporting the highest number of *P. atlantica* (with c.62 individuals, see Table 1) is found in the single remaining continuous stand at 'the Dell', which has been reduced to 250 m^2. 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).

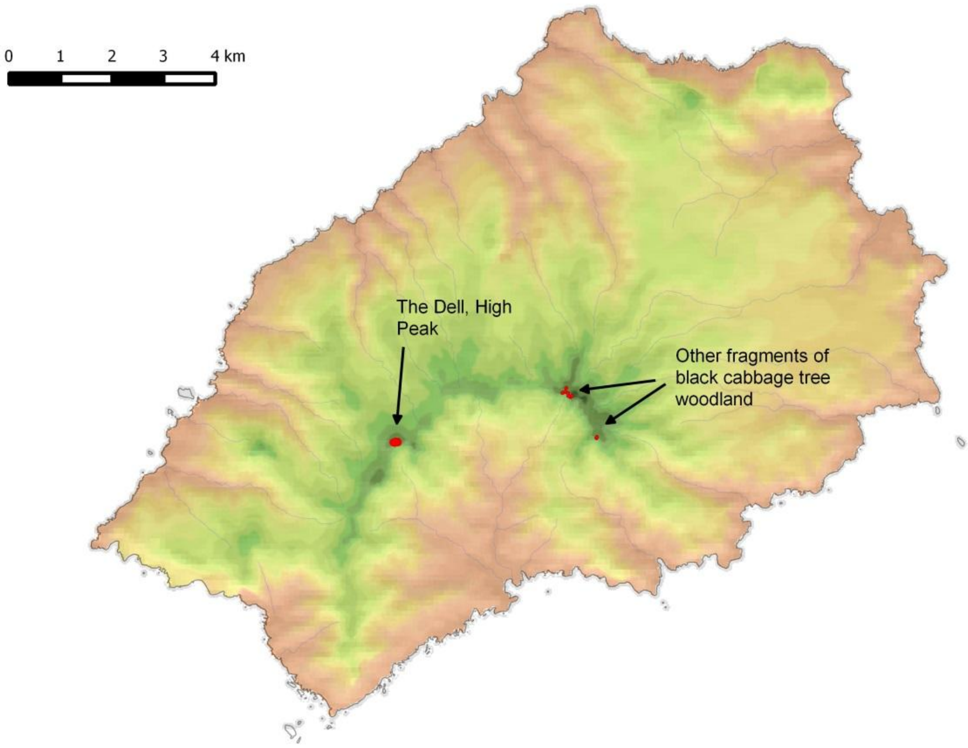

Figure 8: Location of the Dell (High Peak) on St Helena and remaining distribution of black cabbage tree woodland situated on Diana's Peak.

Black cabbage tree Melanodendron integrifolium *woodland cycle*

As a species, black cabbage *M. integrifolium*, Fig. 9, 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*.

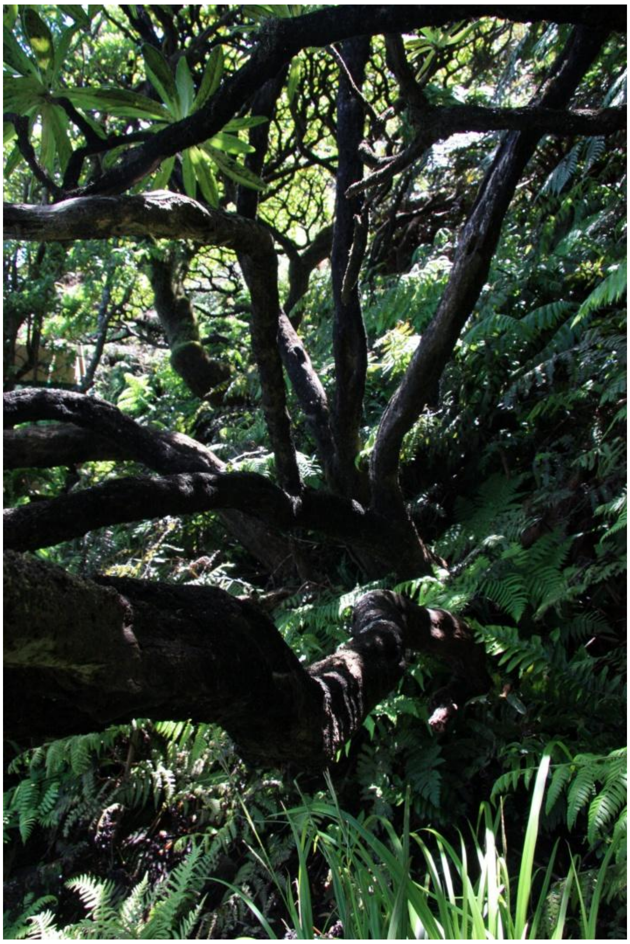

Figure 9: Black cabbage tree (*M. integrifolium)* woodland and associated fern-rich understory at the Dell, the location of the largest subpopulation of *P. atlantica* (P. Lambdon).

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.March). Proper climax black cabbage *M. integrifolium* woodland is likely to be more diverse than the meagre fragments now left. Other endemic could 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, BC 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.March).

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 species appears to be highly sedentary and since it is confined to the fern layer, it is assumed to travel by clambering from one frond to another. A gap of only a few metres thus imposes severe constraints on dispersal. Meanwhile, under the highly dynamic successional process operating in St Helena's cloud forest, any individual habitat patch is unlikely to persist for more than a few decades. The combined pressures could result in a high rate of local extinctions (Lambdon, 2015).

The condition of The Dell, the site of the largest *P. atlantica* population, 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,
- competition between *Dicksonia arborescens* and preferred host plant *Diplazium filamentosum, and*
- 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).

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). 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).

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
- *Impacts 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?*

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, the supporting habitat of the largest subpopulation of *P. atlantica* (Lambdon, 2015). A current three year Darwin Plus funded project on "Conservation of the Spiky Yellow Woodlouse and Black Cabbage Tree woodland on St Helena" is underway 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).

In terms of the habitat restoration work at the Dell, currently the "Conservation of the Spiky Yellow Woodlouse and Black Cabbage Tree woodland on St Helena" project has achieved the clearance of 1,500 metres square of pasture grasses and other invasive plants outside the Dell has been carried out. Planting and performance monitoring of established cloud forest species including over 500 dwarf Jellico *Berula burchellii* and 200 Diana's Peak grass *Carex dianae* that have been added to the site (provided by EMD) and over 100 black cabbage trees (*M.integrifolium)* have already been planted, with approximately 50 surviving (Dr R. Cairns-Wicks & Ms V. Thomas 2015, pers. comm.). A windbreak was established at this site but during a fierce winter at High Peak in 2014, relentlessly strong winds caused repeated damage to the original design of the windbreak, which led to abandonment of the structure in its original form (Dr P. Lambdon 2015, pers. comm.). Modified wind breaks have been put in place since to provide some protection to plantings (Fig.10).

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 10: The extent of the invasive plants situated alongside the black cabbage tree woodland at the Dell. Areas have been cleared as part of the ongoing Darwin project aiming to replant native vegetation which requires windbreaks to allow seedling establishment (R. Cairns-Wicks).

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.March).

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). However, due to unforeseen circumstances, this aspect of the current Darwin Plus project has now changed to focus on habitat restoration and further understanding the newly found *P. atlantica* sites.

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. 11.

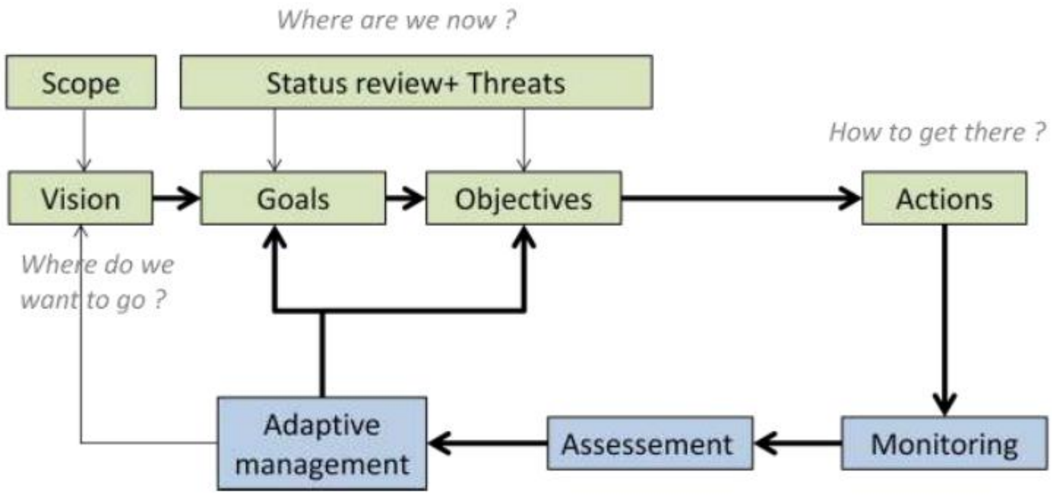

Figure11: Conservation strategy planning. Utilised from the Crau Plain Grasshopper Conservation Strategy, adapted from IUCN/SSC (2008).

As defined in the handbook, actions must be SMART: specific, measurable, achievable, realistic and time-bound. Targets were included in actions and goals.

Workshop

To develop this conservation strategy for the spiky yellow woodlouse, the approach of the IUCN Species Survival Commission (SSC) was used and technical support and expertise was sought from the IUCN Invertebrates Conservation Sub-committee, the IUCN Species Conservation Planning Sub-Committee and the Mid Atlantic Island Invertebrate Specialist Group. The IUCN SSC conservation planning approach requires a review of the species' status and its threats, and development of a Vision, Goals, Objectives and Actions. This was done through a participatory workshop involving species specialists and planners, state government agencies, managers, researchers and other stakeholders.

Participants

These included a local delegation of all those involved from the St Helena National Trust (SHNT) and the Environment & Natural Resources Directorate, St Helena Government (ENRD) held in St Helena, South Atlantic; and a concurrent delegation of all those involved from the Royal Society for the Protection of Birds, Buglife, Zoological Society of London (ZSL), Bristol Zoological Society, the Centre for Ecology and Hydrology (CEH) and two independent specialists (Roger Key and Phil Lambdon). Representatives from Marwell Wildlife were also consulted, but could not make the workshop (see Annex II for a detailed list of participants).

Programme

The workshop was held on the 22nd January 2016. During the workshop the vision and goals were discussed and modified by stakeholders and actions were discussed and drafted. A draft strategy was produced and circulated for consultation between 29th January and 26th February 2016 and any further comments on changes were collated between 26th February and 18th March 2016. All comments and edits from stakeholders were considered and incorporated into this Strategy document. Workshop programme is given in Annex I.

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.

Actions

1.1.1. Habitat assessment
Monitor and complete baseline assessment of the health and value of the habitat at each sub-population (site character assessment) by March 2017
Mapping of cloud forest vegetation areas across Central Peaks and identify sites with similar characteristics to the sites at which SYW is already found by March 2017
Prioritisation of SYW areas requiring urgent restoration efforts for habitat management plans (1.1.2) by end of 2017
Assess potential connectivity options between sub-population sites by end of 2017

1.1.2 Habitat management plans
Plans produced for priority SYW habitats across Central Peaks (as identified in 1.1.1.) by SHNT and EMD by end 2018
Plans incorporated into existing NCA and Peaks National Park Management Plans, by end 2018

1.1.3. Habitat restoration
Continue black cabbage restoration efforts at the Dell SYW subpopulation site (ongoing)
Sensitively adapt and document management approaches and habitat restoration techniques, incorporating knowledge gained from 1.1.1. (ongoing)
Implement habitat management plans (from 1.1.2.) for priority sites by 2020

1.1.4. EMD annual review of outcomes of implementation

OBJECTIVE 1.2. Addressing known threats

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

Actions

1.2.1. Predation
Explore the possible impacts of introduced invasive vertebrates and invertebrates on *P.atlantica* by end of 2017
Undertake any mitigation requirements and integrate into wider biosecurity work on island by 2018. *Integrated as part of St Helena Invertebrate Strategy (2016-2020)*

1.2.2. Parasitism, disease
Review literature on analogue species (if any) by end of 2016
If viable, take adults and juveniles into captivity and monitor for parasites by 2020

1.2.3. Climate change; integrated into St Helena Invertebrate Strategy (2016-2020) (Cairns-Wicks et al., in press)

Install weather station (donated by ZSL) in a suitable location of the SYW habitat for long term environmental recording by end 2016
Assess integration of SYW habitat conservation into cloud forest ecosystem use for climate change mitigation by 2020
Assessment to establish whether SYW habitat would be an effective indicator species for water management across the Peaks by 2018

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.

Actions

2.1.1. Explore the current status of the Diana's Peak sub-populations
Synthesise existing information of sub-populations by early 2016
Define methods for effective surveying of the Diana's Peak sub-populations by end of 2016
Survey and estimate sizes of existing Diana's Peak sub-populations by end of 2017

2.1.2. Establish a long-term annual monitoring programme
Define the key variables to be monitored at SYW sites and establish monitoring methodology by early 2016
Recruit a Project Manager and provide relevant training by mid-2016
Define and implement monitoring strategy by end of 2018

2.1.3. Take steps to define 'viable population' and 'optimal habitat'
Establish a habitat monitoring methodology by end of 2016
Obtain data on micro-habitat specifications (plant community structure, humidity, light, temperature, mist levels etc.) of each sub-population by end of 2017
Complete a risk analysis of establishing an ex situ population including an evidence base of analysed research data, examples and expert opinions by March 2017
Complete a population and habitat viability analysis by end of 2018

2.1.4. Ex-situ captive breeding trial
If appropriate, on the basis of the outcomes of 2.1.3, plan and complete a trial ex situ captive breeding programme to support and augment SYW sub-populations by 2018

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.

Actions

2.2.1. Lifecycle, breeding ecology and feeding ecology
Obtain information on analogue species and museum samples (if any) by end of 2016
Detailed observations of wild individual behaviour by end of 2018
Take adults and juveniles into captivity and study lifecycle, longevity, generation length and breeding ecology by 2020
Explore feeding preferences to determine if some sub-populations are in sub-optimal habitat (2021)

2.2.2. Population genetics

Using data from 2.2.1., obtain information on analogue species and museum samples (if any) by end of 2016
Define a specimen collection methodology, protocol and effective preservation by end of 2016
Explore options of genetic sampling by collecting samples in situ e.g. using exuviae and exoskeletons by end of 2018
Complete genetic analysis of *P.atlantica* (2021)
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 (2021)

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

Actions

3.1.1. Social surveys/questionnaires to determine existing public (St Helena and international audiences) knowledge of P.atlantica
Evaluate existing project and educational work and then check advocacy achievements, start 2016.

SHNT to feed results into Communications Strategy, to inform next engagement steps, by end 2017.

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

Actions

3.2.1. Establish the P.atlantica as the flagship for the invertebrate conservation on St Helena by end of 2017
Launch of a National spiky yellow woodlouse day in 2017

3.2.2. Develop a range of educational activities and interpretation for all ages (resourced education plan)
Educational materials created using existing materials that are updated and modified

3.2.3. Communications strategy in place to maximise audience awareness of the SYW.
Write communications strategy for SYW by mid 2016 to include as priorities:
Identify and define approach to audiences, both in St Helena and international
Interpretation signage on peaks trails
Film on woodlouse

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.

Actions

4.1.1. Draft with reference to existing management plans and sign MOU between SHNT, ENRD, RSPB and Buglife by 31st June 2016

4.1.2. Regular review and updating established by EMD

4.1.3. SHNT and partners build case for support, identify and approach potential donors to secure funding by 1st April 2017

OBJECTIVE 4.2. Increasing capacity

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

Actions

4.2.1. SHNT with support from international partners (RSPB, Buglife, Bristol Zoo,,Marwell and ZSL) secure finances actively supporting at least 2 new staff on the peaks by 1st April 2017.

Table 2: Actions details sheet

Action No.	Actions	Who	When	How	What resources needed	Indicator of success
	Goal 1: Management of *P.atlantica* habitat and sites					
	OBJECTIVE 1.1. HABITAT MANAGEMENT					
1.1.1.	*Habitat assessment*					
	Monitor and complete baseline assessment of the health and value of the habitat at each sub-population (site character assessment)	SHNT (PM); EMD	March 2017	Surveys	Existing project; staff time	Reporting
	Mapping of cloud forest vegetation areas across Central Peaks and identify sites with similar characteristics to the sites at which SYW is already found	SHNT (PM); EMD	March 2017	Surveys & GIS mapping	Existing project; staff time	GIS maps and database
	Prioritisation of SYW areas requiring urgent restoration efforts for habitat management plans (1.1.2)	SHNT (PM); EMD	End of 2017	Data analysis	Existing project; staff time	Reporting
	Assess potential connectivity options between sub-population sites	SHNT (PM); EMD	End of 2017	Data analysis; GIS mapping	Existing project; staff time	Reporting; GIS maps and database
1.1.2.	*Habitat management plans*					
	Plans produced for priority SYW habitats across Central Peaks (as identified in 1.1.1.)	SHNT; EMD	End of 2018	Data analysis; GIS mapping	Existing project; staff time	Plans produced
	Plans incorporated into existing NCA and Peaks National Park Management Plans	SHNT; ENRD	End of 2018	Policy updates	Staff time	Integrated plans produced
1.1.3.	*Habitat restoration*					
	Continue black cabbage restoration efforts at the Dell SYW subpopulation site	SHNT (PM); EMD	ongoing	Site management	Existing project; staff time	Reporting
	Sensitively adapt and document management approaches and habitat restoration techniques, incorporating knowledge gained from 1.1.1.	SHNT; EMD	ongoing	Monitoring	Staff time	Reporting
	Implement habitat management plans (from 1.1.2.) for priority	SHNT (PM);	2020	Site	Funding	Reporting

	sites	EMD		management	required	
1.1.4.	*EMD annual review of outcomes of implementation*	EMD	Annually	Review	Staff time	
	OBJECTIVE 1.2. ADDRESSING KNOWN THREATS					
1.2.1.	*1.2.1. Predation*					
	Explore the possible impacts of introduced invasive vertebrates and invertebrates on *P.atlantica*	SHNT (PM); EMD	End of 2017	Surveys	Existing project; staff time	Reporting
	Undertake any mitigation requirements and integrate into wider biosecurity work on island *Integrated as part of St Helena Invertebrate Strategy (2016-2020)*	SHNT (PM); EMD; biosecurity team	2018	Data analysis; policy updates	Existing project; staff time	Reporting
1.2.2.	*Parasitism, disease*					
	Review literature on analogue species (if any)	SHNT (PM); EMD	End of 2016	Data gathering and analysis	Staff time	Reporting
	If viable, take adults and juveniles into captivity and monitor for parasites	SHNT (PM); EMD; other stakeholders	2020	Translocation; establish captive breeding programme	Funding required	Reporting
1.2.3.	*Climate change; integrated into St Helena Invertebrate Strategy (2016-2020) (Cairns-Wicks et al., in press)*					
	Install weather station (donated by ZSL) in a suitable location of the SYW habitat for long term environmental recording	ZSL, RSPB, SHNT	End 2016	Install equipment	Existing project; staff time	Weather database
	Assess integration of SYW habitat conservation into cloud forest ecosystem use for climate change mitigation	SHNT (PM); EMD; other stakeholders	2020	Data analysis	Funding required	Reporting
	Assessment to establish whether SYW habitat would be an effective indicator species for water management across the Peaks	SHNT (PM); EMD; other stakeholders	2018	Data analysis	Funding required	Reporting
	Goal 2: Research					
	OBJECTIVE 2.1. POPULATION DYNAMICS					
2.1.1.	*Explore the current status of the Diana's Peak sites*					
	Synthesise existing information of sub-populations	SHNT; EMD; RSPB; Buglife; other stakeholders	Early 2016	Data analysis	Staff time	Reporting
	Define methods for effective surveying of the Diana's Peak sites	SHNT; EMD;	End of	Data analysis	Existing	Reporting

		RSPB; Buglife; other stakeholders	2016		project; staff time	
	Survey and estimate sizes of existing Diana's Peak sites	SHNT (PM)	End 2017	Surveys	Existing project; staff time	Reporting; Red-List update
2.1.2.	*Establish a long-term annual monitoring programme*					
	Define the key variables to be monitored at SYW sites and establish monitoring methodology	SHNT (PM)	Early 2016	Surveys; data analysis	Existing project; staff time	Reporting
	Recruit a Project Manager and provide relevant training	SHNT; EMD; RSPB; Buglife; other stakeholders	Mid-2016	Recruitment process	Staff time	Post filled; training completed
	Define and implement monitoring strategy by 2018	SHNT; EMD	ongoing	Produce monitoring guidelines	Staff time	Monitoring guidelines produced
2.1.3.	*Take steps to define 'viable population' and 'optimal habitat'*					
	Establish a habitat monitoring methodology	SHNT; EMD; RSPB; Buglife; other stakeholders	End of 2016	Produce monitoring guidelines	Existing project; Staff time	Monitoring guidelines produced
	Obtain data on micro-habitat specifications (plant community structure, humidity, light, temperature, mist levels etc.) of each sub-population	SHNT (PM)	End of 2017	Surveys; data analysis	Existing project; Staff time	Reporting; peer reviewed paper
	Complete a risk analysis of establishing an ex situ population including an evidence base of analysed research data, examples and expert opinions	SHNT; EMD; RSPB; Buglife; other stakeholders	March 2017	Data analysis	Existing project; Staff time	Reporting
	Complete a population and habitat viability analysis	SHNT; EMD; RSPB; Buglife; other stakeholders	End of 2018	Surveys; Data analysis	Funding required	Reporting; peer reviewed paper
2.1.4.	*Ex-situ captive breeding trial*					

	If appropriate, on the basis of the outcomes of 2.1.3, plan and complete a trial ex situ captive breeding programme to support and augment SYW sub-populations	SHNT; EMD; RSPB; other stakeholders	2018	Translocation; establish captive breeding programme	Funding required	Captive breeding programme established
	OBJECTIVE 2.2. BIOLOGY & ECOLOGY					
2.2.1.	*2.2.1. Lifecycle, breeding ecology and feeding ecology*					
	Obtain information on analogue species (if any)	SHNT; RSPB; other stakeholders	End of 2016	Data analysis	Staff time	Reporting
	Detailed observations of wild individual behaviour	SHNT (PM)	End of 2018	Surveys; Data analysis	Existing project; Staff time	Reporting
	Take adults and juveniles into captivity and study lifecycle, longevity, generation length and breeding ecology	SHNT; EMD; RSPB; other stakeholders	2020	Behavioural study; Data analysis	Funding required	Reporting; peer reviewed paper
	Explore feeding preferences to determine if some sub-populations are in sub-optimal habitat	SHNT (PM)	2021	Behavioural study; Data analysis	Funding required	Reporting; peer reviewed paper
2.2.2.	*2.2.2. Population genetics*					
	Obtain information on analogue species and museum samples (if any)	SHNT; RSPB; other stakeholders	End of 2016	Data analysis	Staff time	Reporting porting
	Define a specimen collection methodology, protocol and effective preservation	SHNT; ZSL; Bristol; Marwell; other stakeholders	End of 2016	Produce protocol guidelines	Staff time	Protocol guidelines produced
	Explore options of genetic sampling by collecting samples in situ e.g. using exuviae and exoskeletons	SHNT; EMD; RSPB; other stakeholders; academic institution	End of 2018	Produce protocol guidelines; sample collection	Funding required	PhD student in post; Reporting; peer reviewed paper
	Complete genetic analysis of *P.atlantica*	SHNT; EMD; other stakeholders; academic institution	2021	Sample collection; Genetic analysis	Funding required	PhD student in post; Reporting; peer reviewed paper
	Study phylogeny with molecular markers to test if	other	2021	Sample	Funding	Reporting; peer

	morphologically distinct populations represent unique species and to understand the relationships to other species of the genus	stakeholders		collection; Genetic analysis	required	reviewed paper
	Goal 3: Public awareness					
	OBJECTIVE 3.1. ASCERTAIN CURRENT LEVEL OF UNDERSTANDING					
3.1.1.	*Social surveys/questionnaires to determine existing public (St Helena and international audiences) knowledge of P.atlantica*					
	Evaluate existing project and educational work and then check advocacy achievements	SHNT; Buglife; CEH; other stakeholders	Start 2016	Review	Existing project; Staff time	Reporting
	SHNT to feed results into Communications Strategy, to inform next engagement steps	SHNT	End of 2017	Data analysis; strategy writing	Staff time	Strategy produced
	OBJECTIVE 3.2. WIDER EDUCATION & COMMUNCATIONS PLAN					
3.2.1.	*Establish the P.atlantica as the flagship for the invertebrate conservation on St Helena by end of 2017*					
	Launch of a National spiky yellow woodlouse day	SHNT; EMD	2017	Communications	Funding required; staff time	Communication pieces
3.2.2.	*Develop a range of educational activities and interpretation for all ages (resourced education plan)*					
	Educational materials created using existing materials that are updated and modified	SHNT; Buglife; CEH; other stakeholders	2017	Communications	Funding required; staff time	Educational materials produced
3.2.3.	*Communications strategy in place to maximise audience awareness of the SYW.*					
	Write communications strategy for SYW	SHNT;EMD; other stakeholders	Mid-2016	strategy writing	Staff time	Strategy produced
	Identify and define approach to audiences, both in St Helena and international	SHNT;EMD; other stakeholders	Mid-2016	Review	Staff time	Increased awareness of SYW
	Interpretation signage on peaks trails	SHNT; EMD	2017	Design and produce interpretation signs	Funding required; staff time	Signs deployed
	Film on woodlouse	SHNT;EMD; other	2018	Film team to St Helena	Funding required;	Footage produced

		stakeholders			staff time	
	Goal 4: Long-term resources					
	OBJECTIVE 4.1. LONG-TERM COMMITMENT & FUNDING					
4.1.1.	*Draft with reference to existing management plans and sign MOU between SHNT, ENRD, RSPB and Buglife*	SHNT; ENRD; RSPB; Buglife	June 2016	MOU written and signed	Staff time	MOU signed
4.1.2.	*Regular review and updating established by EMD*	EMD	ongoing	Report writing	Staff time	Reporting
4.1.3.	*SHNT and partners build case for support, identify and approach potential donors to secure funding*	SHNT; other stakeholders	April 2017	Donor identification; Proposal writing	Staff time	Funding secured
	OBJECTIVE 4.2. INCREASING CAPACITY					
4.2.1.	*4.2.1. SHNT with support from international partners (RSPB, Buglife, Bristol Zoo,,Marwell and ZSL) secure finances actively supporting at least 2 new staff on the peaks*	All stakeholders	April 2017	Funding secured; recruitment process	Funding required; Staff time	Two new staff in post

Resource Assessment

How much money is going to be needed to deliver this programme of work?

What can each partner/ organisation offer this project of work?

RSPB example: Logisitical support, help identify and aid funding applications, public awareness,

Note: To be completed once Project Manager in post

REFERENCES

Ashmole, P & M (2000) St Helena and Ascension Island: a natural history. Anthony Nelson, Oswestry

Buglife (2013) https://www.buglife.org.uk/bugs-brink

Cairns-Wicks, R., Kindemba, V. *Et al.* St Helena Invertebrate Strategy 2016 to 2020. St Helena National Trust, ENRD, Buglife & CEH. *In press*

Courchamp, F., J.L. Chapuis, and M. Pascal. (2003). Mammal invaders on islands: impact, control and control impact. *Biological Reviews* 78(3): 347-383.

Hochkirch A., Tatin L. and Stanley Price M. 2014. Crau plain grasshopper, A Strategy for its Conservation 2015-2020. IUCN-SSC & CEN PACA, Saint-Martin-de-Crau, France. 50pp

IUCN/Species Survival Commission (2008). Strategic Planning for Species Conservation: An Overview. Version 1.0. Gland, Switzerland: IUCN. 22pp

IUCN/SSC (2008). Strategic Planning for Species Conservation: A Handbook. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission. 104pp.

Kier G, H. Kreft, T. Ming, W. Jetzb, C. Ibischc Nowickic, J. Mutkea and W. Barthlotta.(2009). A global assessment of endemism and species richness across island and mainland regions. PNAS 23: 9322–9327.

Lambdon, P.W. 2015. *Pseudolaureola atlantica*. The IUCN Red List of Threatened Species 2015: e.T67368866A67368879. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T67368866A67368879.en. Downloaded on 05 January 2016.

Lambdon, P. & Ellick, S.M. (2016). *Melanodendron integrifolium*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. In press, 2016.

Mendel, H, Ashmole, P & Ashmole, M (2008) *Invertebrates of the Central Peaks and Peak Dale, St Helena*. Commissioned by the St Helena National Trust, financed by the Overseas Territories Environment Programme (OTEP)

Malan. L. (2015) *Announcement of third spiky yellow woodlouse population.* EMD publication, St Helena government

Millennium Ecosystem Assessment, (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC.

Paulay, G. (1994). Biodiversity on oceanic islands: its origin and extinction. *American Zoologist 34*: 134-144.

Rowe, R E (1995) *The population biology of Trochetiopsis: a genus endemic to St Helena*. D. Phil thesis, Oxford

Schmalfuss, H. (2003). World catalog of terrestrial isopods (Isopoda: Oniscidea). Stuttgarter Beiträge zur Naturkunde Serie A (Biologie), 654: 1-342.

ANNEX I: Workshop agenda

Spiky Yellow Woodlouse Conservation Planning Session

Friday 22nd January 2016

10:00 – 16:30 (GMT)

10:15-10:45	Welcome and introduction *(Sarah Havery)*
10:45-11:00	Scene setting: short presentation on SYW: summary of knowledge and work to date *(Phil Lambdon)*
11:00-11:15	Explanation of the workshop and structure of the day *(Sarah Havery)*
11:15-11:30	Vision for Spiky Yellow Woodlouse - an inspirational description of what participants want to achieve *(Jeremy Harris)*
11:30-11:45	*Tea break*
11:45-13:15	Goals and objectives - capture in greater detail what needs to be achieved, and where, to save the species *(Vicky Kindemba / Rebecca Cairns-Wicks)*

1) Research -> identify priorities to close those knowledge gaps, which are crucial for conservation (i.e. distribution, population trend, habitat preferences, threats etc.)

2) Management -> protection, site management, in situ and ex situ species support.

3) Public awareness

13:15-14:00	*Lunch*
14:00-15:00	Actions required for each objective: making them SMART (see examples): *(Vicky Kindemba /)*

- **What needs to be done? site specific, habitat specific, island-wide**
- By who? Individuals, organizations, partnership & cooperation
- What expertise is needed?
- What resources are needed? Finance, manpower, where do they come from?

15:00-15:30	Group consensus on priority objectives and actions *(Sarah Havery)*
15:30-16:15	Next steps: strategy content, prioritising work for the project and clarity on who is responsible for what and define a clear management structure. Editing and signing of MoU by SHNT, ENRD, RSPB & Buglife. *(Jeremy Harris)*
16:15 – 16:30	Quick summary of outputs, thank you and wrap up meeting *(Vicky Kindemba & Sarah Havery)*

ANNEX II: Workshop participants list

Sarah Havery (Royal Society for the Protection of Birds) *Host*

Vicky Kindemba (Buglife) *Host*

Rebecca Cairns-Wicks (St Helena National Trust) *Host*

Jeremy Harris (St Helena National Trust) *Host*

David Pryce (St Helena National Trust)

Lourens Malan (Environment & Natural Resources Directorate, St Helena Government)

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)

Roger Key (Consultant; independent specialist)

Phil Lambdon (previous Project Manager; independent specialist)

Alan Gray (CEH)