Habitat Survey Report:

Dry Gut and the Southern Ridge of Prosperous Bay Plain

FINAL REPORT

by

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Commissioned by the St Helena Government

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Summary

The survey of Dry Gut and the southern ridge of Prosperous Bay Plain was commissioned by the Director of Air Access and fieldwork carried out between 16th June and 10th July. An interim report was produced in August 2012 and this final report has developed from this and replaces it.

This final report includes the complete plant and invertebrate species list, identified as far as possible with locally available resources, the results of soil sample analysis and an analysis of the key findings of the invertebrate and habitat surveys together with recommendations for mitigation for the impacts of development for air access.

Dry Gut is a diverse and biologically rich valley for species adapted to arid habitats. Lichens are the dominant organism with seventy different species identified, this approximates to one third of the total number of species found on St Helena (note all lichens on St Helena are indigenous, a few are endemic and these are all found within the arid coastal zone). Dry Gut also supports the largest population of the rare endemic barn fern, ***Ceterach haughtonii* on the island. The ephemeral stream that runs through the base of the valley is also a rare habitat on St Helena, and a habitat type that we know very little about.

The construction of the embankment will have a significant impact on the whole ecology of Dry Gut. It will lead to the loss of those habitats within the footprint and significant modification of the remaining habitats within Dry Gut. The embankment will lead to the creation of a new range of environmental conditions. Some may be similar to existing which in time could support the range of species which currently exist in the Gut, but rare habitats and any rare species associated with them may not be and the new set of environmental variables may support different floristic compositions. As the dominant organisms in Dry Gut are lichens colonisation of new substrate will take years, and decades to recover. The type of rock used on the outer face of the embankment, the angle it is placed at, the amount of compaction etc. will all have bearing on what species are able to colonise and establish.

The southern ridge is part of Prosperous Bay Plain. PBP's ecological value to St Helena and the world has been established through the work of Philip and Myrtle Ashmole (Ashmoles, 2004a). It is a site of international importance. The southern ridge sites are part of PBP and as such share characteristics and values with other similar areas across PBP. We found them to be ecologically rich and valuable habitats supporting rare and threatened species such as the mole spider **Lycosidae?.*

Valuable habitats, supporting endemic and indigenous species, some rare, will be significantly adversely directly and indirectly impacted by land take on the southern ridge for the site construction compound and associated drainage.

Less disturbed areas that supported good populations of native plants are also better quality habitats for native invertebrates. Non-native species are often prevalent in disturbed sites. The loss of habitat and disturbance associated with the airport construction has the potential to contribute to an increasing prevalence of non-natives. To create enhanced areas of restored habitat as part of the mitigation it will be important to establish conditions suitable for native species. Soil substrate, surface rocks and native plant cover will be critical elements.

With the permanent loss of most of the eastern and southern ridges and their associated habitats to the construction of the runway and supporting infrastructure (permanent and temporary) protection of the Central Basin and its borders (out with the construction footprint) must be the principal focus of conservation efforts. The aim should be to protect and conserve as much intact and continuous habitat as possible. Where loss is unavoidable, mitigation should include minimising land take, enhancing adjacent areas to act as strongholds for recruitment post construction and if possible retaining satellites within the construction footprint. Alien species control will be a key element of restoration efforts.

With due care in planning and implementation of mitigation and with continuity in management, secured through long term funding, the establishment of favourable conditions for native flora and fauna should be possible.

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1. Introduction

This study was commissioned by The Airport Project Director, Airport Directorate, St Helena Government on the 16th June 2012.

2. Terms of reference

The purpose of the study was:

To describe the location, habitat status and ecology of habitats that support endemic invertebrate fauna and flora that will be imminently lost or impacted by the construction.

Activities and Outcomes required to fulfil the purpose included:

- Design a methodology for the survey that is scientifically robust
- Map habitats in Dry Gut, parts of the southern ridge of Prosperous Bay Plain that will be immediately impacted or lost to the temporary and permanent construction works.
- Collate baseline data on invertebrates and plants. This data will build on available existing data from previous studies.
- Present observations on the ecology of any endemic species found
- Recommend measures to inform the approach to re-instatement of the affected areas.

3. Extent of the survey

Robert Kleinjan, Halcrow Environmental Monitor, described the extent of the construction works and study. Basil Read was expected to begin construction, towards the end of June, of a new road from the existing track on the southern ridge of Prosperous Bay Plain into Dry Gut. The purpose of the road is to provide access to begin preparatory work for the construction of the embankment, beginning with grading of the valley floor in preparation for construction of the culvert. The road will be a single carriageway down into the base of the valley with a parallel single highway for vehicles back coming up. Work is also expected to begin imminently on the southern ridge of Prosperous Bay Plain. The development will include works site offices and parking, wash-bays, workshop, water and diesel storage, concrete batching plant, stockpile areas container holding area and extend between the two highest points on the southern ridge.

4. Outcomes and timetable

- Interim Report

The initial findings of the survey were discussed with Robert Kleinjan, Isabel Peters, and Annina Van Neel on the completion of the fieldwork at the Halcrow offices on 10th July 2012. This was to inform and facilitate action at an early an opportunity as possible

A draft interim report was submitted on the 6th August and the final interim survey report submitted on the 20th August and appendices 24th August. The Appendices included maps of the survey areas and full survey site descriptions. The report, the key findings and recommendations were discussed with Andreas Huber, Isabel Peters, Annina Van Neel, Nicky Stevens, and Gareth Johnston on 6th September. The interim survey report provided a near complete analysis of the findings providing the evidence base for recommended actions so that mitigatory actions could continue and at a time when they could have an impact. The report was produced after provisional sorting and identification of samples had been undertaken but in advance of final verification of some of the more difficult to identify invertebrate and lichen specimens and also the results of soil sample analysis, which had been sent off island.

- Final Report

The final report which replaced the interim report was submitted on 15th October 2012.

The report was signed off after amendments were made to the final report in March 2013. Key changes, over and above formatting and correction of typographical errors, included the removal in Section 5 Constraints of repeated reference to time constraints, the removal from the results Section 7 where recommendations were made and their re-insertion into Recommendations 10, and the addition of a paragraph titled Wirebirds to section 7.3.4 Vertebrates.

- Reference specimens.

Those invertebrate species for which identification has not been possible on-island will be posted to Roger Key. Lichens will be sent to André Aptroot. Confirmed identifications will be fed back to the St Helena Government when they become available. It is suggested that the invertebrate reference specimens remain on island and could be deposited with the St Helena National Trust as an interim measure, under the auspices of the Darwin Invertebrate Project, until a more suitable alternative can be agreed.

5. Constraints of the study

In any study there are constraints and compromises, the design and execution of this survey was limited by:

- The local availability of people and equipment

The study was required at short notice and the time frame within which the practical field work could take place had to be planned to work in advance of construction works and to work around the availabilities of personnel needed to support the study. Equipment was borrowed from the Pest Control Team at the Agriculture and Natural Resources Directorate, Phil Lambdon (his personal equipment) and Ed Thorpe (left on island by the Ashmoles). The Pest Control team provided field support to the invertebrate survey. A limited range of trapping methods, physical searches (including bashing plants, lifting stones, digging) and pitfall traps, were chosen because of the amount of time that would be required to carry out a detailed study, resource availability and the ability to replicate the survey. As a result the number and diversity of species found should be considered to represent a subset of those present. It was not possible, to carry out an invertebrate study as intensive as the Ashmoles. A finer detailed habitat survey with a more systematic approach to surveying and sampling would have yielded more detailed information to support habitat restoration but the time available for fieldwork precluded this. The survey adopted easily replicable low tech methods that provide a good base for identifying floral and faunal composition (for this time of year) and cover that can be used to set targets for habitat enhancement, reinstatement and a baseline for monitoring. It also identifies the need for action for key species, and should serve as a baseline indicator of the status of the habitats, subject to its recognised limitations.

- Dry Gut and Prosperous Bay Plain are arid environments whose ecologies change significantly between seasons, according to water availability.

This survey was carried out between June and July. The first flush of winter flowering desert annuals were germinating and flowering but late comers like **Hydrodea cryptantha* were quite scarce. Species composition and vegetation cover will vary between seasons as well as year-to-year variations. Invertebrate communities will also vary between seasons. It is possible that ephemeral invertebrate communities could emerge in late winter, feeding from the seed of the annual plants that form an abundant flush after the rains. For example, algal crusts were a frequent feature of level areas of dusty substrate in samphire, (i) *Suaeda fruticosa*, dominated areas of the southern ridge. These were dry at the time of survey, despite the winter months, and are obviously an important component of the desert ecology that could provide food for small grazing invertebrates at the bottom of the food chain. Beetles were also notably poorly represented in collections. This could be a seasonal effect as well as a result of the limited range of collecting techniques used.

- The taxonomic identification of some of the samples cannot be carried out on island and samples will be sent off to specialists elsewhere.

A few specimens of invertebrates (for example *Salticids*, *Opogona*) and lichens cannot be identified locally, using local entomologists and available literature. Invertebrate specimens will be sent to Roger Key (to co-ordinate identification with relevant specialists where necessary) and lichens to André Aptroot for assistance in identification. Determining their identity is not considered to be critical to the conclusions of this report, but will be useful to aid our understanding of the desert ecology. The Ashmoles found that for some species from obscure groups, such as the tineid moths and wolf spiders, there was no one studying them. Eight years on from the Ashmoles study, we still don't have scientific names for the wolf spiders. The Lurking Wolf Spider was provisionally assigned to the genus **Trochosippa?* and the Mole Spider to **Lycosidae sp?* (Ashmole and Ashmole, 2004; Mendel, Ashmole & Ashmole, 2006). Both groups, the tineids and wolf spiders, are significant elements and have key roles in the desert ecology of Prosperous Bay Plain. Yet we know little about them.

- Extent of the study area

Mapping all the habitats in Dry Gut was not practical under the circumstances already described. The primary areas of study were chosen because they presented identifiably distinct habitats and held populations of native plants. One area not surveyed, which would perhaps have been good to take a closer look at, was the cliff immediately below DG6 (Earwig Gully _mouthflat – 265 m) into which the water channel drains. The cliffs are covered in lichens and have good populations of **Ceterach haughtonii* and bryophytes. However, these cliffs are only accessible working with ropes and were not included in the survey. They are steep with a shaded southerly aspect at the neck of the valley. They are likely to be impacted by the construction but may not be completely lost. It would be good, if the site is to be lost if bryophyte species and **Ceterach haughtonii* could be rescued.

During the course of the study, the two main gullies draining the Southern Ridge (called here Terminal Samphire Gully and Crescent Gully) into Dry Gut were identified as providing valuable habitats for native flora and fauna. They were not originally included as survey sites which on reflection would have been good to include. These areas are described in Appendix 2 Survey Site Descriptions but not to the same level of detail as the plateau study sites. They are however valuable sites and will be important to protect and enhance as part of mitigation measures. As these natural drainage channels may be used to discharge water arising from the construction site works, a more detailed assessment of the vegetation will be needed prior to construction works as a baseline for monitoring change.

6. Study area and methodology

Habitat surveying took place between 23/6/12 and 6/07/12 and was undertaken by Rebecca Cairns-Wicks and Phil Lambdon. Maps 1, 2 and 3 forming Appendix 1 illustrate the areas surveyed.

6.1 Dry Gut

Dry Gut is an arid sparsely vegetated valley, through which an ephemeral stream flows after heavy or prolonged rains. Water flows in from the large catchment of the upper valley from below Woody Ridge. Small catchments and water channels drain into Dry Gut on both the north and south slopes. Rock faces also precipitate moisture. The prevailing south easterlies, coming straight off the sea are moisture laden and create ideal conditions for lichens. Sea mist regularly descends to 300 m in this area, particularly during the winter. This regular source of moisture has given rise to a diverse and biologically rich valley for species adapted to arid habitats.

The study area within Dry Gut fell between the western and eastern extents of the footprint of the runway embankment (marked on the ground by a series of painted white rocks). A detailed habitat study across the whole site was not possible given the time constraints for the study (construction work was expected to begin within two weeks). We chose to focus our attention on a subset of habitat types that we considered from our experience were likely to be of biological interest and represented a range of habitats found within the construction area. The whole area was initially subdivided into 21 sites that were considered to hold homogenous habitat through visual observation from a distance followed by walk-over, and included the valley slopes, rocky terraces, valley bottom, summit plateaux, cliffs and ridges. Of these, 12 sites were chosen for detailed habitat assessment. Two sites, Earwig Gully and the rocky slope above Gill Waterfall had previously been studied by the Ashmoles from their descriptions of sites PBP4 and PBP7 (Ashmole and Ashmole, 2004) and therefore add to the existing body of knowledge of the flora and fauna in these areas and possibly providing some indication of the changes which have taken place over the past decade. These two sites were further subdivided resulting in 19 sites and sub-sites surveyed.

Earwig Gully, Ashmole site reference PBP4, was so named by the Ashmoles (Ashmole and Ashmole, 2004). They found it to be a rich site for invertebrates including a variety of habitats. This is the site where the access road into Dry Gut begins. It will be lost to the construction for the road and thereafter the runway apron. Gullies provide a very different set of environmental conditions to those of the Prosperous Bay Plain (PBP) or Dry Gut and thus can support quite distinct communities. The area as described by the Ashmoles included the whole gully from its upper catchment. This study broadly covers the same area (with the exception of the dusty basin in the northern edge of the upper catchment where the Mole Spider is to still be found) that has been subdivided into smaller areas of observable similar characteristic habitat types for more detailed study.

6.2 Southern Ridge

A detailed description of the topography, geology and habitats of PBP is given in Ashmole & Ashmole (2004).

The Southern Ridge forms part of the raised plateau, making up three sides of the depression called the Central Basin. The slopes of Dry Gut bound the southern ridge to the south and it extends westwards to Bone Gully, the main catchment draining into the Central Basin and eastwards to the southeast rim of the Central Basin at Widow Slope (Ashmoles, 2004a site WS12)

The area was initially quartered on foot to define the survey area and identify similar habitat types. Seven areas were initially identified for surveying. The two main gullies draining the Southern Ridge (called here Terminal Samphire Gully and Crescent Gully) into Dry Gut were later identified as providing valuable habitats for native flora and fauna.

6.3 Methodology

The approach to the habitat survey was based on the general framework outlined in JNCC's National Vegetation Classification (Rodwell, 2006). Habitat descriptions followed the nomenclature devised by Lambdon and Darlow (2008) for St Helena.

In each of the survey areas the Domin Scale of cover/abundance was used to record the quantitative contribution that the different species made to the vegetation structure.

In this arid area bare ground and rocky substrates form significant proportions of the ground cover. They are key elements in the ecology of the desert environment supporting native flora and fauna. The different substrate types were divided into 8 types: fine dust (fine dust which in undisturbed areas is often crusted and where algal crusts were obvious they were described as such; fine grit and dust (a combination of fine dust with consolidated weathered rounded dust which creates a more open loose soil structure); grit and small stones (1-15cm); rocks and boulders (15cm-1m); exposed weathered outcrop, vertical cliff, alluvial silt and open water.

In each of the survey areas, data was collected on slope, aspect, altitude, ground cover composition and abundance and substrate type. Factors influencing the distribution and composition, including for example threats from invasive species were also recorded.

Five random 2m x 2m quadrats were surveyed across the 7 sites on the southern ridge. The southern ridge will be subject to habitat restoration post construction and this supplementary information was gathered as an aid to interpreting the current status of the area. Additional data recorded included plant heights of those species contributing to the vegetation layers, soil analysis for pH, mineral composition including sodium and phosphorous, electrical conductivity, organic carbon and particle size analysis. Chemical composition of the soils will influence which species can become established and thereafter plant species composition and soil quality will be influenced by each other. In desert soils organic carbon and nitrogen levels are low. Phosphorus levels on the southern ridge may be influenced by the presence of seabird guano from former seabird colonies. Soil surface horizons are not well developed and soil nutrients will primarily be in the thin (first few cms) surface layer. Disturbance by vehicles, development, water or wind erosion easily removes this surface layer together with its important soil biota (lichens, cryptobionts, fungi) seed and litter.

Where obvious significant differences were observed, percentage cover occupied by live and dead plant material was recorded separately. Litter is a very important part of the ecology, providing shelter and food for detritivores at the bottom of the food chain. The type of litter is also important, creeper litter provides a very different environment compared to natives such as *Eragrostis cilianensis* (*i*). This species was observed more often as dead plants, with fewer young plants occupying less ground. Dead material takes time to decompose and regeneration may be in small flushes during wet weather, rather than a single flush.

6.4 Invertebrate surveying

Invertebrate sampling was carried out at six of the sample sites within Dry Gut chosen because of the presence of native plant species, previous study, or habitats of potential interest. Earwig Gully sites DG01, DG02, DG04, DG05 were combined into one area for the invertebrate study, so that the study site included, east and west facing slopes and dry water channel. Four sites were sampled on southern ridge supplemented by a night search and observations during detailed habitat survey work. Surveying was carried out with timed physical searches (equivalent to 3 man hours) and randomly placed pitfall traps. The night search was carried out on PBP_SR19 Southern Ridge Terminal Samphire and PBP_SR21 Southern Ridge Quarry Samphire to look specifically for wolf spiders.

The Ashmoles carried out an intensive study of Prosperous Bay Plain between September and December 2003. Their study provides the most comprehensive description of the species present on Prosperous Bay Plain and sites with similar characteristics within the Eastern Arid Area, and the habitats in which they are found. They did not survey Dry Gut in detail, not being aware at the time of the extent to which it would be impacted. The Ashmoles did however include Site PBP 7 Gill Waterfall and PBP 4 Earwig Gully.

Searching and trapping methods were based on Ashmole and Ashmole (2004a) with additional advice taken from Richard Smith at Buglife. Trapping was through a combination of direct timed searching (3 man hours/area), and included searching under stone, searching plants, including bashing *Suaeda* fruticosa (i), *Carpobrotus edulis* and *Attriplex semibaccata*, when they were present, with a $1m^2$ fine mesh underneath to catch what falls out, digging and pitfall trapping. Searches were carried out during the day. A night search of PBP_SR19 Southern Ridge Terminal Samphire and PBP_SR21 Southern Ridge Quarry Samphire was also carried out. Specimens were collected except where their identity was definitely known. We attempted to rear moth caterpillars and *Mellissius* grubs for identification with mixed success.

8 pitfall traps containing 50:50 anti-freeze and water were randomly placed within sample sites for four days.

Collections have been sorted, identified, counted and recorded.

7. Results

7.1 Habitat Descriptions

Full descriptions of the areas surveyed are available as Appendix 2 to this document.

The habitat definitions used by Lambdon and Darlow (2008) were adopted for this study, where habitat types are synonymous with those described by the Ashmoles (2004a) these have been illustrated. The habitat types described in the survey area included:

7.1.1 Creeper waste; examples DG07, SR23, SR27

Arid areas dominated by *Carpobrotus edulis* and *Atriplex semibaccata*. Deep fine gritty substrate interspersed with small stones and rocks and generally few large surface boulders, the exception is the upper northern rim of Dry Gut (as example DG_07) which have a greater presence of many large rocks and boulders. Exposure to the incoming mists on the higher outcrops of the southern ridge and northern rim of Dry Gut support lichen communities, particularly *Ramalina* species. There are still moderately good communities of lichens in the open areas, but where the boulders have been smothered by *Carpobrotus edulis* the lichens have disappeared. Native plants have been almost entirely suppressed in these areas.

Creeper dominated areas support low plant and animal diversity. Endemic invertebrates associated with this habitat include *Mellissius adumbratus*, salticid spiders and tineid moths. Wirebirds will forage in creeper-dominated areas.

Creeper waste described here is synonymous to the creeper-dominated areas described by the Ashmoles (2004a).

7.1.2 Semi desert; examples DG09, SR19 (best example), SR22, SR24, SR26
These are semi-barren areas dominated by *Suaeda fruticosa* and supporting good populations of other annuals: *Eragrostis cilianensis* (i), **Hydrodea cryptantha* and *Mesembryanthemum crystallinum*.

Substrate can vary from sandy to sandy/loam and varying proportions of surface stones and rocks and vegetation cover. Where there are good numbers of surface stones and rocks these support good populations of lichens – boulder field and soil crusts, particularly in more exposed sites.

SR19 shares characteristics with the exposed stony area Site 17 (Ashmoles, 2004a). It has a good stand of Suaeda for shelter, as well as surface stones and rocks combined with open gritty areas, which makes this a rich site for invertebrates.

Those sites which are least disturbed support the most diverse communities of endemic plants and animals. Wirebird were frequently observed in the semi-desert sites, notably DG09, SR19, and SR22 where a nesting attempt was made during the study. Wirebirds enjoy soaring on the ridges of these areas.

7.1.3 Sparsely vegetated rocky hillsides or slopes, examples DG01, DG13
Barren hillsides with some soil and not dominated by recognized community type, (i) *Atriplex* and *Carpobrotus* most likely to be present together with annuals such as (i) **Eragrostis*, **Osteospermum sanctae-helenae*, (i) *Portulaca oleracea* and (i) *Chenopodium helenense*.

Slopes have loose and unstable substrate with medium to large size rocks/boulders with pockets of shallow soil in between. More stable rocks and boulders provide a variety of habitats for lichens including overhangs and crevices for invertebrates.

Native tenebrionid beetles *Gonacephallum* and the alien *Hemasodes*, together with the alien Salticid spiders were common at DG01 whilst Oecobid spiders were found at DG13.

This habitat shares characteristics with the rocky slopes described by the Ashmoles (2004a), with site 12 as the cited example.

7.1.4 Erosion slope, examples DG08, DG10, SR30
Barren slopes with loose substrate smaller than scree formed as a result of weathering and human disturbance (quarrying activity). These are unstable dry and dusty sites with loose rocks, and surprisingly diverse, primarily with non-native species that are able to quickly colonise disturbed

areas*: Atriplex* and *Mesembryanthemum*. Rockier areas with soil pockets also support a range of native annual species, notably **Osteospermum sanctae-helenae*, **Hydrodea cryptantha*, (i) *Amaranthus thunbergii*, (i) *Portulaca oleracea* and (i) *Chenopodium helenense*.

7.1.5 Scree slope, examples DG10, DG13
Accumulated broken rock fragments at the base of cliffs or valley shoulders. These slopes are subject to frequent disturbance from rock fall from cliffs above as well as water run-off down slope. Slopes have shallow soils between rocks, and on gentle sloping benches soils pockets can accumulate. These can support a range of annual species, notably **Osteospermum sanctae-helenae*, **Hydrodea cryptantha*, (i) *Amaranthus thunbergii* and (i) *Portulaca oleracea* and (i) *Chenopodium helenense*. Supports only a low number of animals and diversity is also low, but surprising numbers of spiders, both native and non-native are present.

7.1.6 Inland cliffs & rocky areas, examples DG03, DG14, DG15, DG19
Exposed to the moisture laden prevailing winds and sea mists and providing a variety of micro-habitats from areas of exposed rock weathered rocky outcrops, vertical cliffs, overhangs, and steep weathered rocky slopes sometimes with benches of gentler slope where soil collects. These sites can support large and diverse communities of lichens. Bryophytes are also important, though often scarce, elements of this habitat, providing conditions for ferns and plants to become established. Invertebrate numbers and diversity is low, however moths that graze on lichens are a feature of this habitat. Other herbivores and scavengers will be present supported by lichens and annual flush of seed together with their predators.

At higher elevations (above 260m) annual endemic **Ceterach haughtonii*, Barn fern grows in crevices between rocks where water is channelled. **Eragrostis cilianensis*, **Osteospermum sanctae-helenae*, **Hydrodea cryptantha*, (i) *Portulaca oleracea,* (i) *Amaranthus thunbergii* and (i) *Cotula coronopifolia* can be found growing in the shallow soils on gently sloping benches. Alien species such as *Carpobrotus edulis* and woody weeds like *Acacia cyclops* are becoming established in these habitats.

7.1.7 Dry gullies, examples DG05, DG12, Crescent Gully and Terminal Gully
These are watercourses that run dry for most of the year and their margins influenced by water seepage. Ephemeral watercourses are a scarce habitat on St Helena and very little is known about them and their associated invertebrates. Dry Gut watercourse DG05 is probably the best example of this type of habitat on the island. Water is retained in temporary pools that could provide an important water source for invertebrates. The gullies running off Prosperous Bay Plain are steeper and water is unlikely to pool.

7.1.8 Stony heath, examples DG06, DG11, DG18
These are barren areas, often exposed, of level stony and compact ground with some soil between rocks.

Eragrostis cilianensis (i) is often the dominant vascular plant with endemic **Hydrodea cryptantha* and indigenous *Portulaca oleracea* (i) and *Cotula coronopifolia* (i) present in small numbers.

Low numbers and low diversity of invertebrates with little soil and shelter. Some scavengers and herbivores (tineid moths, *Thysanura* and psocids) and predatory species like *Xeropigo* and the scorpion *Isometrus maculatus*. Other species whose food webs are based around flushes of plant growth following wet periods may also be present.

DG11 shares characteristics with the Ashmoles (2004a) cliff tops, crags and rocky gullies, of which sites 3 and 7 are examples.

7.2. Flora
See Appendix 2 for site descriptions and species lists. Findings in relation to key species are summarized here.

7.2.1 **Ceterach haughtonii*, Barn fern

Pictures above: Barn fern growing in damp mossy rock crevices and areas of water drip amongst lichen covered fog capturing ridge line rocks (*Ramalina* dominated). Alien species, in particular Carpobrotus edulis which smothers the rocks and also species like *Sonchus sp.*, *Ageratum conyzoides*, *Atriplex semibaccata*, which are competing for the same space are spreading into and threatening this habitat.

The upper ledges of the northern cliff slopes of Dry Gut support an extensive and very large population of barn fern, **Ceterach haughtonii*. It is estimated that the population that stretches from the ridgeline cliffs and rocky outcrops and ledges immediately west of Earwig Gully to the rocky rim of terminal gully, was over 1,000 plants. This community is specific to a very narrow microhabitat in which a shaded southerly aspect is important. Patches of **Ceterach haughtonii* are often associated with *Trichostomum* and *Weissia* moss patches in soil-filled crevices at the foot of cliffs and boulder overhangs where water is trapped after running through rock crevices and seams or drips from rock faces. The presence of mosses may create a better microhabitat for fern gametophytes.

Elsewhere on the island, the Barn fern grows in rock crevices in dry areas between 250 and 600m above sea level (Lambdon, 2012). It is rare and vulnerable to competition and habitat modification (due to spread of invasive species like creeper & climate change). It is usually found in small numbers in scattered sites (13) and mostly in the south of the island. The Dry Gut population is estimated to contain over 50% of the known world population and could be as much as 75%. Nearly all of the Dry Gut population is likely to be lost. The loss of this site therefore constitutes a significant loss to the island wide population and a potential threat to the survival of the species. The Environmental Conservation Section (ECS) has removed the majority of plants that were growing within the construction footprint and now have them at their nursery at Scotland. Reinstatement post construction should aim to increase the population (enhancement), and at the least recover the population to pre-construction numbers.

7.2.2 **Bulbostylis neglecta*, neglected sedge

Two small populations of the Neglected Sedge, **Bulbostylis neglecta*, have been found, one during the survey, growing amongst boulders and rocky ridges and one prior to it by Andrew Darlow. One site is expected to be lost to the development and soil collected from underneath dried plants by the ECS has within a few months resulted in over 70 plants being raised and the first flush of seed collected. The speed with which regeneration has been achieved in cultivation is exciting and bodes well for multiplying seed stocks.

7.2.3 *Amaranthus thunbergii* (i?), candlestick amaranth

Amaranthus is considered as probably native (Lambdon, 2012) and possible endemic sub-species, who found that its main population appears to be centred on Prosperous Bay Plain, where it is thinly scattered. It is also found in small pockets along the south coast (Cox's Battery, White Rocks, Lot's Wife and Castle Rock Plain, with a few plants on the cliffs of High Knoll) between 300-500m.

We found it well distributed across the survey area in rocky areas of Dry Gut (DG08, DG10, DG14) and semi-desert areas of the southern ridge (SR19 & SR24) associated with rocky reefs and stony areas and one tiny stony pocket amongst creeper waste in SR23, but only in very small numbers and was the rarest native species found during the survey. It was flowering and seeding at the time of this study (July).

Amaranthus thunbergii is the only probable native species to be seriously threatened on the island. Loss of several sites around the ADA will have a significant impact on the St Helena population (and assuming it is a local sub-species), on the global population. This is a potentially valuable component of the natural desert ecology and increases the number of species that can be used in habitat restoration and enhancement. Fortunately it seeds prolifically and soon after germination so it has the potential to be a species which can be multiplied quickly.

7.2.4 **Osteospermum sanctae-helenae*, boneseed

Pictured above right, boneseed germinating amongst *Atriplex semibaccata* (died back), *Digitaria ciliaris* and *Cyperus polystachyos*.
Pictures above left, boneseed is able to recruit into bare ground where rocks provide shelter and reduce water loss from the soil (in these tiny damp soil patches mosses may also be present). It possibly provides conditions for other plants to become established. Possibly also having the advantage over species like Atriplex because during the hottest driest period it is in seed form quickly taking advantage of available moisture to grow and seed quickly.

Found frequently across the steep (≥45°) often unstable rocky and scree northern slopes (south facing) of Dry Gut (examples DG10, DG15, DG16) in small numbers (but likely to be larger because of the time of survey). Slopes are sheltered and dry, shaded for part of the day. Boneseed benefits from water run off or where dampness is retained in the shallow sandy loam soils that have collected between rocks. Germinates after winter rains and seeds quickly. Plants were beginning to flower in July and new recruits were still germinating into August. Grows in association with *Portulaca oleracea* (i), *Digitaria ciliaris* (i?), *Sonchus oleraceus*, *Atriplex semibaccata, *Hydrodea cryptantha*, and *Amaranthus thunbergii* (i?)

A large population grows below the Gill Point Waterfall and there are other scattered but quite robust populations in other coastal areas (Flagstaff, Sandy Bay, Manti Bay). The loss of this population will not impact upon the conservation status of the species as a whole. The Environmental Conservation Section has rescued seed and plants from the site and these can be used as part of the restoration programme. Boneseed seeds prolifically in cultivation so there is the potential to multiply seed stocks. Some success has been had with direct seeding into conservation sites. It will be one of the important species to re-establish in Dry Gut.

7.2.5 **Chenopodium helenense,* St Helena Goosefoot

Chenopodium helenense is an annual herb germinating in autumn and flowering rather late in winter. It can grow up to 70 and rarely 1.3m. It is associated with semi-desert habitats and rocky slopes. In the drier and open sandy semi-desert sites of the Central Basin and southern ridge it is more often found as growing much smaller, flowering and seeding from very young (>5cm). On cooler rocky slopes where moisture is available plants can grow for much longer (almost behaving as a perennial) becoming much larger and bushier.

It is very rare, and only re-recorded recently from Prosperous Bay Plain, slopes of Bencoolen, Cox's Battery, Great Stone Top, cliff near Horse Pasture and Asses' Ears.

A large population (50+), and the only one found in Dry Gut, was found growing in dry shaded and sheltered ground immediately under the cliffs at DG13. This site will be lost to the construction. Substrate was sandy loam with small stones and few rocks. Growing in association with *Mesembryanthemum crystallinum*, *Coronopus didymus*, **Osteospermum sanctae-helenae* and *Carpobrotus edulis*. A small number of the non-native *Chenopodium murale* were also found growing alongside **C. helenense* and it is possible that hybridisation between the two species takes place. Some individuals looked like putative hybrids. Care needs to be taken in the treatment of seed at this site and it would be better if seeds were grown on to confirm their status as pure *C. helenense* before using them in restoration programmes.

On the southern ridge it was found at site SR19 as a few scattered plants, associated with **Hydrodea cryptantha*, and *Mesembryanthemum crystallinum*. A small population extends from here across the plateau and rocky slope into the Central Basin.

Chenopodium helenense is a valuable species and as such will form an important part of the ecological restoration programme.

7.2.6 *Suaeda fruticosa,* samphire

Samphire is the major component of the vegetation of Prosperous Bay Plain. It is very salt tolerant, which it accumulates in its tissues. It's well adapted to the exposed windy conditions on the ridge plateau of Prosperous Bay Plain. Growing prostrate (just a few cms high in very exposed sites) and capable of producing adventitious roots from the stems it produces a thick and sturdy frame that is excellent at accreting sand which over time results in raised mounds. With the roots of *Suaeda* penetrating to a metre or more in depth it is very good at stabilising soils. It also provides essential habitat, shelter and food for native species and will be the key species to reinstate post construction. Together with the reinstatement of appropriate surface substrate, suitable conditions for native invertebrates to re-colonise could be established.

7.2.7 Lichens and Cryptobionts

The most important habitats for lichens in Dry Gut were vertical cliffs, rocky slopes with water run-off, and cliff overhangs. On the southern ridge there are fragile soil crusts and boulder fields with good examples found in SR19, SR21 and SR22.

DG15 was the most diverse site for lichens in the survey area, and probably represents one of the finest examples of saxicolous (living on or among rocks) lichen communities on the island. As well as having a good diversity of habitats, the site appeared to occupy the narrow transitional zone between high-moisture capture (supporting abundant but species-poor communities of dominant *Ramalina* species) and the arid lowlands (again with few species). This transitional zone is characterised by a high diversity of rarer species. Such sites are scarce. Rarer species of note at this site included good numbers of the endemic **Dermatiscum pusillum*, and *Enterographa anguinella*, *Pannaria fulvescens*, *Psora cerebriformis*, *Opegrapha subelevata*, *Roccellina jamesii (near endemic)*, *Endocarpon pallidum*, **Dimelaena triseptata* and an unidentified soil crust species which appears not to have been recorded on the island previously.

DG19 also proved to be an important site for lichens in the Dry Gut area, not only containing a rich community of rare species, but also a very different community from the hotspot on the other side of the valley, Site DG 15. The two locations combined represent lichen assemblages of considerable conservation value. As with Site DG15, the principle interest comes from the presence of south-facing cliffs with overhangs, which are not dominated by *Ramalina* species. Amongst the most notable species of this site are good populations of *Buellia stellulata*, and *Ochrolechia africana* (some of which had very misshapen fruiting bodies and could conceivably be a different, previously unrecorded species), together with the moderately rare endemic, **Roccella sanctae-helenae*. Other species not globally threatened but probably moderately scarce on St Helena are *Diploschistes caesoplumbaeus*, *Enterographa anguinella*, *Opegrapha saxigena*, *Peterjamesia circumscripta*, and *Pyxine petricola*. The overhanging cliffs contain other non-fruiting crustose species that could not be identified. Aside from these sheltered microhabitats, the open flats form a strange and interesting landscape of low terraces, which contain abundant *Ramalina* species on the rocks, but between them are flat, soil-filled areas with excellent populations of the scarce endemic **Dimelaena triseptata*.

The exposed rock and boulders of SR21 Creeper Hill hold a surprisingly rich diversity of lichens and bryophytes, including an unidentified white crusting lichen, an isidiate *Parmotrema* species, *Lecanographa farinentula*, a *Graphis* sp., *Dirinia insularis*, *Cladonia marioni* and the liverwort *Frullania depressa*, which wasn't recorded from any other site in the study and is rare in dryland parts of St Helena.

SR22 was not a rich site for lichens but there is a small, undisturbed area with abundant lichen soil crusts formed from at least 3 species (2 *Endocarpon* and one or more *Caloplaca sp*.). Such habitat is extremely rare across the survey area as a whole, but indicates that much more extensive soil crusting communities may have existed previously in the absence of human disturbance and the spread of invasive creeper. Saxicolous species are thinly distributed on the larger rocks, and include **Dimelaena triseptata*.

Ground crusting lichens and algal crusts (cryptobionts) were a frequent feature of level areas of dusty substrate in samphire, *(i) Suaeda* fruticosa, dominated areas of the southern ridge. They form an important component of the desert ecology, protecting the desert soils and providing conditions for succession and in wet periods (perhaps after prolonged periods of high condensation) algae could sustain ephemeral communities of small grazing invertebrates which lie at the bottom of a food chain. Soil crusts are also very fragile, as the soil is soft and dusty and once the surface crust is disturbed, they are easily lost. Once lost it is not known how long it will take for them to become re-established.

7.2.8 Bryophytes (mosses and liverworts)

Bryophytes were sparse and low in diversity across the study sites. They form an important function in the dryland and desert ecosystem holding down and stabilising soils, retaining moisture, creating conditions that support the germination and growth of higher plants and ferns and providing shelter for invertebrates. Three species were most commonly recorded (*Weissia sp*, *Bryum argenteum* and *Trichostomum brachydontium*).There were also two mosses *Campylopus flexuousa* and *Bryum subapiculatum* which have not previously been recorded from such extreme dryland sites on the island. Three other species were recorded *Trichostomum crispulum*, *Exormotheca pustulosa* and *Frullania depressa*). Moss tussocks at the base of the rocks appear to provide important habitat for some invertebrates which burrow amongst the rhizoids. Patches of **Ceterach haughtonii* were often associated with *Trichostomum* and *Weissia* moss patches in soil-filled crevices at the foot of cliffs and boulder overhangs. The presence of mosses may create a better microhabitat for fern gametophytes.

7.2.9 Alien species

Many of the island's top ranked invasive species on St Helena are now present on Prosperous Bay Plain and Dry Gut (see Lambdon& Darlow, 2008). If left unchecked they present a serious threat to the native flora and fauna. Some species like *Carpobrotus edulus*, creeper, present in all sites surveyed for this study, now forms a major component of the vegetation. Others are present in low numbers but have the capacity to quickly become well established. Without control aggressive alien species that can out-compete native species will become community dominants and change the whole ecology of the area. The Ashmoles (2004a) highlighted the threat to native species from the spread of aggressive aliens species and recommended immediate action be taken to halt their advance.

Creeper is the dominant vegetation in SR23 (where it forms a near complete cover) and SR27 (probably checked by the presence of eroded dusty soils) and it is the main species actively recruiting into all other sites on the southern ridge. It is dominant along the upper strip of rocky hillside between Crescent Gully and Earwig Gully. Where the substrate has deep gritty soils with lots of small rocks and larger boulders as found in SR23 and the southern and western slopes of the Central Basin. And is spreading within many sites within Dry Gut.

Once established creeper spreads to form extensive (>90% of ground cover), smothering mats. Creeper often has die back and dead mats often make up a significant proportion of the creeper ground cover. These dead mats form a thin layer of poorly decayed, salt-rich litter, and provide a very hostile environment for other species, inhibiting secondary colonisation. Dense populations, out-compete native plants and change the nature of the semi-desert ecosystem, giving rise to a low diversity, low quality habitat.

Annual weeds such as *Conyza bonariensis*, fleabane and *Ageratum conyzoides*, blue weed, *Sonchus oleraceus*, smooth sow-thistle have spread rapidly across a wide range of habitats on St Helena from semi-desert to the central ridges. These are present in low numbers across the southern ridge and Dry Gut but have the capacity to spread and become more common due to disturbance from development. Their control during and post construction will be essential. *Tetragonia microptera*, is also spreading quickly across the southern ridge, it is a newly recorded species for St Helena (Lambdon and Darlow, 2008).

All alien woody weeds will need to be controlled if they are not to become more widely established. Some species are spread by birds (Myna and canaries). Species for control include: *Acacia cyclops, Nicotiana gluaca, Olea europaea ssp africana*, *Schinus terebinthifolius*, *Lantana camara*, and *Chrysanthemoides monilifera.*

7.3 Fauna

7.3.1 Results of invertebrate survey

The following tables summarize the species found during the survey of Dry Gut and the southern ridge.

Table 1. **Species recorded at Dry Gut**
PS = timed physical search, CO = Casual observations and P = pitfall trapping

Species	**DG01- (+ 02, 04, 05)**	**DG07**	**DG09**	**DG10**	**DG11**	**DG12**	**DG13**	**DG14**	**DG15**	**DG16**
* endemic species ** endemic genus *i* indigenous	**PS+P**	**PS**	**PS**	**CO**	**PS**	**PS+P**	**PS+P**	**CO**	**CO**	**CO**
GASTROPODA										
Helicidae *Helix asper*	X				X	X	X			
Subulinidae										
***Chilonopsis sp.*		X								
Succineidae										
**Succinea sanctaehelenae*	X						X			
SCORPIONES										
Buthidae *Isometrus maculatus*					X		X			
ARANAE										
Corinnidae *Xeropigo tridentiger*	X	X	X	X	X		X			X
Dictynidae										
[i]*Archaeodictyna condocta*							X			
Dysderidae *Dysdera crocata*	X	X					X			
Linyphiidae *Unidentified species*						X				
Lycosidae										
**Hogna nefasta*										
**?Lycosidae sp.*										
**?Trochosippa sp.*										
Oecobiidae										
?Oecobius sp a	X						X			
?Oecobius sp b navus?				X			X			
Oonopidae										
Gamasomorpha insularis			X			X	X			
Salticidae										
Hasarius adansoni	X	X	X		X	X		X	x	
Menemerus bivittatus	X									
Unitdentified species a	X				X	X	X		x	
Unidentified species b								X		
Scytodidae										
Scytodes veluntina?							X			
Sicariidae										
Loxosceles rufescens	X					X	X	x		
Theridiidae										
Latrodectus geometricus										
Steatoda capensis										
Steatoda grossa										
Steatoda sp.							X			
Thomisidae										
**Philodromus signatus*	X			X	X	X	X			
ACARI										
Cryptostigmata										
Orobatidae unknown	X									
Bdellidae **Bdellodes sp.*										
ISOPODA Porcellionidae										
Porcellio laevis	X	X	X	X	X	X	X			
DIPLOPODA Julida										
Omnatoiulus moreleti	X			X		X				X

Species	**DG01- (+ 02, 04, 05)**	**DG07**	**DG09**	**DG10**	**DG11**	**DG12**	**DG13**	**DG14**	**DG15**	**DG16**
* endemic species ** endemic genus *i* indigenous	**PS+P**	**PS**	**PS**	**CO**	**PS**	**PS+P**	**PS+P**	**CO**	**CO**	**CO**
CHILOPODA										
Scolopendromorpha										
Scolopendra mortisans	X	X	X	X		X				
Scutigeromorpha										
Scutigera coleoptrata				X						
THYSANURA										
Lepismatidae										
Lepisma saccharina	X				X	X	X		X	X
Lepisma unknown	X						X			
ORTHOPTERA										
Acrididae										
***Primnia sanctaehelenae*	X	x	X					x		
Gryllidae										
Gryllus bimaculatus										
Mogoplistidae										
Mogoplistid sp										
BLATTODEA										
Euthyrrhaphidae										
Euthyrrhapha pacifica	X	X	X		X			X		
Blattidae										
Periplaneta australasiae	X	X	X		X		X			
Blattellidae										
Afrobalta decellei										
HETEROPTERA										
Cydnidae										
[i]*Aethus pallidipennis*		X			x	X				
Miridae										
[i]*Creontiades pallidus*	X	X				X	X			
***Hirtopsallus suedae*	X									
Unidentified sp. (brown 1mm)						X				
HOMOPTERA										
Coccoidea										
Icerya purchasi										
Pseudcoccidae										
Pseudococcus viburni										
PSCOPTERA										
Unidentified species	X	X	X		X					
COLEOPTERA										
Anthicidae										
***Anthicodes fragilis*										
Carabidae										
Campalita chlorostictum				X						
Coccinellidae										
Cheilomenes lunata				X			X			
Exochomus flavipes										
**Scymnus helenae*										
Curculionidae										
***Isotornus proximus*							X			
***Microxylobius westwoodii*	X				X	X				
Phylctinus callosus	X						X	X		

Species	DG01- (+ 02, 04, 05)	DG07	DG09	DG10	DG11	DG12	DG13	DG14	DG15	DG16
* endemic species ** endemic genus *i* indigenous	**PS+P**	**PS**	**PS**	**CO**	**PS**	**PS+P**	**PS+P**	**CO**	**CO**	**CO**
Scarabaeidae										
***Mellissius adumbratus*		X	X							
***Mellissius oryctoides*	X				X					
Tenebrionidae										
[i]Gonacephalum simplex hadroides (endemic subsp?)	X		X							
Hemasodes batesi	X		X							
HYMENOPTERA										
Apidae										
Apis mellifera	X									
Formicidae										
Pheidole megacephala	X				X	X	X			X
Sphecidae										
[i]Podalonia canescens										
LEPIDOPTERA										
Geometridae										
**Scopula separata*										
Noctuidae										
Agrotis ipsilon			X							
**Cardepia subvelata*	X		X			X				
Pyralidae										
***Helenoscoparia nigritalis*	X								X	
Spodolea recurvalis						X				
Tineidae										
**?Opogona 3mm jumping*				x	X		X			
**?Opogona (reduced wing)*	X						X			X
**?Opogona 2.5mm*	X									
**?Opogona 5mm*							X			
**?Opogona 5.5mm*			X							
**?Opogona sp*	X	X				X	X	x		
DIPTERA										
Drosophilidae										
Drosophila repleta	X									
Muscidae										
**Limnophora helenae*	X	X			X					

Table 2. **Species recorded on the Southern Ridge, PBP**

PS = timed physical search, CO = Casual observations and P = pitfall trapping

Species	SR19	SR21	SR23	SR22	SR24	SR26	SR25
* endemic species ** endemic genus *i* indigenous	**PS night**	**CO**	**PS+P**	**PS +P**	**PS +P**	**PS +P**	**PS**
GASTROPODA							
Helicidae *Helix asper*			x		x	x	
Subulinidae							
***Chilonopsis sp.*							
Succineidae					X	X	
**Succinea sanctaehelenae*							
ARANAE							
Corinnidae							

Species	SR19	SR21	SR23	SR22	SR24	SR26	SR25
* endemic species ** endemic genus *i* indigenous	**PS night**	**CO**	**PS+P**	**PS +P**	**PS +P**	**PS +P**	**PS**
***Xeropigo tridentiger*	X		X	X	X	X	X
Dictynidae							
[i]*Archaeodictyna condocta*				X			
Dysderidae							
Dysdera crocata							X
Linyphiidae							
Unidentified species				X			X
Lycosidae							
**Hogna nefasta*	X						
**?Lycosidae sp.*	X	X					
**?Trochosippa sp.*	X						
Oecobiidae							
[i]*?Oecobius sp.*							
Oonopidae							
Gamasomorpha insularis				X			
Salticidae							
Hasarius adansoni			X	X		X	X
Menemerus bivittatus				X			X
Unknown species a							
Unknown species b							x
Sicariidae							
Loxosceles rufescens							X
Theridiidae							
Latrodectus geometricus	X						X
Steatoda capensis	X	X		X			X
Steatoda grossa	X						X
Steatoda unidentified							
Thomisidae							
**Philodromus signatus*	X			X		X	
ACARI							
Bdellidae							
**Bdellodes sp*			X	X		X	
ISOPODA							
Porcellionidae							
Porcellio laevis	X		X	X	X		X
DIPLOPODA Julida							
Omnatoiulus moreleti				X	X		X
CHILOPODA							
Scolopendromorpha							
Scolopendra mortisans	X		X	X	X		X
THYSANURA							
Lepismatidae							
Lepisma saccharina					X		
ORTHOPTERA							
Acrididae							
***Primnia sanctaehelenae*	X			X	X		
Gryllidae							
Gryllus bimaculatus				X	X		X
Mogoblastidae							
Unidentified species			X	X			
BLATTODEA							

Species	SR19	SR21	SR23	SR22	SR24	SR26	SR25
* endemic species ** endemic genus *i* indigenous	**PS night**	**CO**	**PS+P**	**PS +P**	**PS +P**	**PS +P**	**PS**
Euthyrrhaphidae							
Euthyrrhapha pacifica			X	X	X	x	X
Blattidae							
Periplaneta australasiae	X		X	X	X		X
Blattellidae							
Afrobalta decellei			X	X			
HETEROPTERA							
Anthocoridae							
Cardiastethus sp?				X			X
Cydnidae							
[i]*Aethus pallidipennis*							
Miridae							
[i]*Creontiades pallidus*	X			X			X
***Hirtopsallus suedae*	X			X		X	x
Unidentified sp (brown 1mm)	X			X			X
HOMOPTERA							
Coccoidea							
Icerya purchasi			X				
Pseudcoccidae							
Pseudococcus viburni	X						
PSCOPTERA							
Unidentified sp.							
COLEOPTERA							
Anthicidae							
***Anthicodes fragilis*	X						x
Carabidae							
Campalita chlorostictum							
Coccinellidae							
Cheilomenes lunata					X		
Exochomus flavipes							
**Scymnus helenae*			X				
Curculionidae							
***Isotornus proximus*							
***Microxylobius westwoodii*					x	x	x
Phylctinus callosus				x		X	
Scarabaeidae							
***Mellissius adumbratus*	X			X	X		X
***Mellissius oryctoides*							
Tenebrionidae							
[i]*Gonacephalum simplex hadroides (endemic subsp?)*	X		X	X	X	x	
Hemasodes batesi	X		X	X	X	X	
HYMENOPTERA							
Apidae							
Apis mellifera							
Formicidae							
Pheidole megacephala	X		X	X	X		
Sphecidae							
[i]*Podalonia canescens*				X	X		
LEPIDOPTERA							
Geometridae							
**Scopula separata*	X						X

Species	SR19	SR21	SR23	SR22	SR24	SR26	SR25
* endemic species ** endemic genus *i* indigenous	**PS night**	**CO**	**PS+P**	**PS +P**	**PS +P**	**PS +P**	**PS**
Noctuidae							
Agrotis ipsilon							X
**Cardepia subvelata*	X			X			
Pyralidae							
***Helenoscoparia nigritalis*							
Spodolea recurvalis							X
Tineidae							
**?Opogona 3mm jumping*			X				
**?Opogona (reduced wing)*			X				
**?Opogona 2.5mm*							
**?Opogona 5mm*				X			
**?Opogona 5.5mm*							X
**?Opogona sp*	X						
DIPTERA							
Drosophilidae							
Drosophila repleta							x
Muscidae							
**Limnophora helenae*				X	x	x	

7.3.2 Moth search

DG15 proved to be a rich site for lichens but it was also a site were the micro-moth ***Helenoscoparia nigritalis* was locally abundant. This was considered a potentially interesting site for moths and as this was a group that was under-represented in our collections, a supplementary search for moths using a light trap during one night was carried out at site DG15 at the end of August. Light trapping had previously not been used as a search method because we were interested in what was living within our study sites, a light trap could potentially traps species drawn to the light trap from outsider our study areas.

The overall catch was low, possibly because it was a moonlit night, or because it was the wrong time of year, or perhaps the local species aren't attracted to light. The following species were caught and identified:

2 *Hellula undalis* (Geometridae) - introduced pest species
2 *Mythimna loreyi* (Noctuidae) - probably introduced
1 *Condica pauperata* (Noctuidae) - an African species, perhaps native
1 *Cardepia subvelata* (Noctuidae) - endemic (on samphire)
2 *Trichoplusia ni* (Noctuidae) - introduced pest species
3 *Opogona bicolor* (Tineidae) - endemic
4 Unidentified *Noctuidae sp*.

It is interesting to note that the species found by visual searches (***Heleonscoparia nigritalis*) wasn't represented at all in the collection.

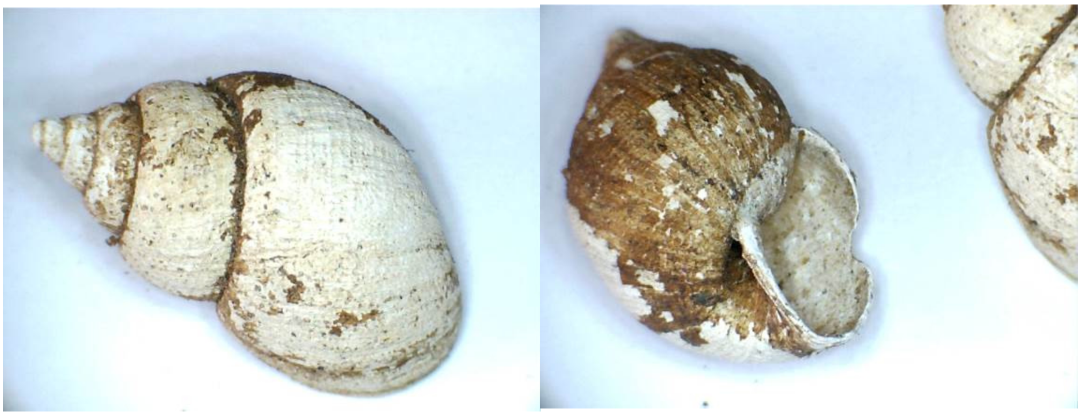
The *Opogona* is particularly interesting. It is one of the most boldly marked of the Opogonas, fully winged and with an unmistakeable black and white pattern. This species was not recorded otherwise, yet there is clearly a local population. It was identified by Mrs Wollaston and other than her original description, virtually nothing is known about it.

The unidentified species was an unspectacular, drab, brown Noctuidae. The patterning doesn't match any of the species known from St Helena. However, all 4 specimens are in poor condition and have lost a lot of scales, so it is impossible to tell whether the marking are quite what they are supposed to look like. It could just be one of the common pests (e.g. an Agrotis like the turnip moth) but doesn't look right and may be more interesting than that.

7.3.3 Invertebrates of note

This section provides information on those species found considered to be of conservation significance, because of their contribution to the ecology of the areas, their rarity, or their impact on natives (aliens). Key groups are described where this study adds to and provides comparative data, with the existing body of knowledge described by the Ashmoles (2004a & b). For full species descriptions or further information on other species listed in the survey see Ashmoles (2004a & b).

Mollusca - Gastropoda (snails and slugs)
Gastropoda: Subulinidae, **Chilonopsis species



Two sub-fossil shells found at site DG07_stony creeper slope.

Snail	1	2
Length	20mm	22mm
Aperture length	10mm	9mm
Aperture width	6.5mm	6mm

Five species of *Chilonopsis* are recognised plus a subspecies of *C. nonpareil* (Ashmole & Ashmole, 2000). They were associated with former native forests from the cabbage tree woodland of the Peaks to the dry gumwood woodland. The two fossilised specimens found resemble *Chilonopsis nonpareil* that grew up to 50mm by 32mm. The Ashmoles thought it was associated with the former dry gumwood woodland (Ashmole & Ashmole, 2004). Specimens of this species have been found by the Ashmoles at Dry Gut and more recently by Kevin George near Fisher’s Valley. It is possible that the snail found in this survey could have been associated with former scrubwood scrub growing in the mist zone on the ridge above Dry Gut.
[*Reference specimens*: EG2230]

Corinnidae - corinnids
Xeropigo tridentiger (O. P.- Cambridge, 1869)

Found at all sites in Dry Gut and the southern ridge that were subject to dedicated physical searches or pitfall trapping with the exception of site DG12. Confirmed at sites: DG01, DG07, DG10, DG11, DG13, DG16, SR19, SR21, SR23, SR24, SR25, & SR26, it is almost ubiquitous.

This is a surface living hunting spider that is found under rocks. It had been considered to be a generic endemic but this has proved not to be the case. Mendel and Ashmole (2006) note that following revision of the subfamily Corinninae and genus Xeropigo*, Xeropigo tridentiger*, has been found in Brazil, northwest South America, Central America and Florida and it probably reached St Helena in the mid 19th Century on a slave ship.

This was the most commonly found spider at the study sites. It was found frequently under rocks, which it requires for shelter and reproduction (Ashmole & Ashmole, 2004a). It has flat circular papery egg cases that are attached to the undersides of rocks. It's presence in the majority of study sites, across a range of habitat types surveyed, suggests that it could present a serious threat to other rock dwelling invertebrates as well as a serious predator.
[*Reference specimens*: SR1934 2 sub-adult females & juvenile; SR1936 adult female; SR1945 sub-adult female; SR1946 juvenile female or possible Linyphiid; DG1991 juvenile female]; DG2000 sub-adult female & juvenile; SR2226 1 sub-adult female, 2 juveniles & very small juvenile or possible Linyphiid; DG2001 1 juvenile; DG2002 adult male, 2 sub-adults; SR2227 very small juvenile or possible Linyphiid; BV1951 2 juveniles; SR2236 2 juveniles]

Dictynidae- hackled-web spiders
Archaeodictyna condocta (O.P. Cambridge, 1876)
Two species have been previously described from St Helena under an endemic genus *Helenactyna vicina* and *H. crucifera*. These are now considered to be members of a single species. *A. condocta* is a widespread species of north and east Africa and the Middle East. It is very possibly native and likely to be an ecologically important species.

[*Reference specimens*: DG2007. Noting that the head and carapace shape are right for *Dictyna*, as is the forward-pointing central band of white hairs on the carapace and the patches of white hairs scattered amongst the mottled abdomen. However, no definite signs of a cribellum (although it could be there), the legs are longer than in any of the UK *Dictyna* species and the carapace and legs are rather pale. The Ashmoles state "a stumpy brown spider of variable size with more or less annulated legs". This species isn't stumpy and the legs are barely annulated. However, the photo accompanying the description in the Ashmoles' suggests a species with long, pale, plain legs; SR2226 Adult male - subject to the same uncertainty over identification as described above]

Dysderidae - dysderids

Dysdera crocata Koch.
Found at sites: DG01, DG07, DG13 and SR25 (Crescent Gully)

This introduced species has become successfully established in all habitats on St Helena. It is a nocturnal spider that shelters under stones during the day. It eats woodlice. The Belgians felt that its arrival probably had a serious effect on the endemic invertebrates that also live under stones (Ashmole, 2000a). The Ashmoles only found it at one site in the EAA, at the waterfall on the path to Gill Point (Ashmoles, 2004a). This study found it at 4 sites, rocky slopes of Dry Gut and gullies running into it. The species is now on the southern edge of Prosperous Bay Plain but it was not found on the southern ridge. It is possible that this species is spreading. There is no shortage of prey. The Ashmoles (2004) suggested that the abundance of *Xeropigo tridentiger* and *Latrodectus geometricus* on PBP may be preventing its spread onto the Plain. *Latrodectus* was rarely observed in this study and was not found in Dry Gut, with the exception of Crescent Gully. This study found an abundance of *Xeropigo* and *Steatoda* on the southern ridge both of which shelter under rocks that could be preventing its spread onto the Plain. These introduced species are also likely to have a serious impact on endemic invertebrates, as predators as well as competitors for shelter.
[*Reference specimens*: EG2238; DG1997; tube labelled Crescent Gully]

Gnaphosidae- mouse spiders

***Benoitodes caheni* (ex *Actaeodes caheni*) (Benoit) – This generic endemic mouse spider was found to be common on PBP in the 1960s by the Belgians and not found elsewhere. The Ashmoles did not find it in 2003 and suggested it might be extinct or much reduced. It was not found during this study. The Ashmoles pointed to the arrival of *Latrodectus geometricus* since 1967 as a possible causal factor in its decline. Whether *X. tridentiger* or *Steatoda sp.* have also had an impact is uncertain, or other alien predatory species.

Linyphiidae – sheetweb weavers
The linyphiids are small spiders that make sheet-like webs close to the ground.

Three unidentified specimens of Linyphiidae were found at sites: DG12, SR22 and SR25.

[*Reference specimens*: SR2227 Probably a Lepthyphantes or Bathyphantes species, with white dots on the abdomen. Sub-adult male. Trichobothria not seen on the legs. 1 juvenile female unidentifiable and 2 female sub-adults. DG1975 1 juvenile Quite possibly a Leptophantes or a Bathyphantes species, with white spots on the upper surface of the abdomen.]

Lycosidae – wolf spiders
The Lycosids are a key element of the desert ecosystem of PBP and in particular within the Central Basin. The Ashmoles (2004a) identified 5 species associated with and limited to the Eastern Arid area (EAA) and in considering the impact of airport construction on the group considered them a high priority for conservation: *Hogna nefasta* (prowling wolf spider); a species provisionally placed in the genus *Trochosippa* (lurking wolf spider); a species provisionally placed in the genus *Lycosidae sp.* (mole spider) and two probable *Brevalibus* species.

The wolf spiders of PPB are nocturnal species, and are primarily burrow dwelling, spending the day in burrows or in the case of the male mole spider, under rocks. *Brevalibus* hides under pieces of debris but this has not been identified during this study. They have extremely localised distributions and have only been found in areas of dry dusty and gritty substrate that are particularly friable, primarily un-vegetated areas or with low-density ground cover. *Hogna nefasta* has the widest range occurring at several sites across the EAA. *Trochosippa* the most restricted, with almost its entire population within the Central Basin. *Trochosippa* was found at a second site, SR19, but its observed presence here was low and as this site will be lost to the construction they may not remain. *Lycosidae sp.* is also extremely restricted in distribution, they have been found at three sites, two Ashmole study sites, SBS22 and PBP4 and a third SR19. A potential fourth site, near Bradley's is within the Airport Development Area close to the contractor's construction camp, but this has not been confirmed.

**Hogna nefasta* at night, SR19

Mole spider, **Lycosidae sp?*

Male spider as seen from above (left) and below (right) found at site SR19, mounds noted at SR19 and SR21.

Very little is known about this spider. Two males and a juvenile were found in 2003 at sites SBS22 and PBP4 (Ashmole & Ashmole, 2004b). Two females and a male were found in the Central Basin at SBS22 in 2006 (Mendel, Ashmole & Ashmole, 2008). Efforts to find a specialist to identify this spider or provide some clues as to its ecology have been unsuccessful (Philip Ashmole, pers. com.). It is something of a mystery.

It is associated with gritty mounds. The male and female, thought to be of the same species, have very different morphology adapted to suit their apparently very different life-styles. The males have been found on the surface, whilst females are associated with the mounds (page 29 Mendel, Ashmole and Ashmole, 2008).

Over 350 small gritty mounds or 'mole-hills' were counted across Site SR19 Southern Ridge Terminal Samphire, with a small number extending into PBP_SR21 Creeper Hill.

These mounds are formed from an extensively subterranean species – considered the equivalent of molehills. There is no obvious opening, to allow something to come in and out; they are piles of expelled dirt. They often appear in groups, some being fresher (soil colouration darker indicating higher moisture content) than others (lighter colour, flattened). Five mounds were excavated in SR19 but no spiders found. Tunnels are easily lost in the friable substrate and it is possible that holes were not excavated deep enough.

A single adult male specimen was found during this study under a stone during the day at site SR19. This specimen (illustrated above) has dark chelicerae with white hairs whereas the Ashmoles described pale chelicerae with black hairs. The eyes are unusual, very small and close together, for a wolf spider. The palps, which fit the family morphology, are also very small.

The reduced eyes in the male are unusual. However, they are not reduced enough to suggest it is a fully subterranean species. The very striking coloration, the presence of easily-rubbed hairs all over the body and spines on the legs, and long legs adapted for running all indicate that this is not suited to a subterranean lifestyle. The specimen had lots of fine dust grains attached to the underside, but none on the upper side, which indicates that it had been aboveground for some time.
It is suspected that females may carry out their foraging underground. Could it be that the female of the mole spider is completely subterranean?

The conservation of the wolf spiders is a major concern because of the three confirmed sites on PBP, Ashmole site PBP 4 will be lost to the construction of the runway, Ashmole site SBS22 is likely to be impacted by the change of landform for the runway construction to the east of the Central Basin and site PBP_SR19 will be significantly impacted by the construction of the access road, terminal and parking area – with a significant proportion to be lost to the construction. A fourth site was found during the baseline ecology/vegetation survey for the Airport and supporting infrastructure project EIA close to the remote obstacle lighting site at Bradley's and is also impacted by development there (Faber Maunsell-AECOM 20011a). Protection for the site was identified prior to the start of construction camp works and the relocation of the weather station from the eastern plateau of PBP.

The status of area SR19 was discussed at a meeting, held with members of the PMU team and Basil Read's Environmental Co-ordinator, to present immediate observations following the completion of the fieldwork (10/07/12). At the end of that meeting, Basil Read engineers described a possible variation from the reference design that was being developed that would minimise the cut to Widow Slope thereby maximising wind shielding to the Central Basin, improve functionality of the terminal area and provide space for the Fire Training Rig. This involved bringing the access road to the south, instead of north, of the terminal, extending the cut to the road to make space for the Fire Training Rig that would also reduce the slope of the cut that drops from 325 to 306m. It had also been suggested that Creeper Hill might be required for rock infill. These changes would extend the area of cut, from that originally proposed, into the area of *Suaeda* dominated semi-desert SR19. Under the reference design a large part of the area will be lost to the construction of the terminal, terminal parking areas and access road. If in the detailed designing it is possible to limit the extent of cut necessary, reducing land take, minimising disturbance and retaining as much intact and continuous (that is not separated by the access road) habitat this will be a benefit. Creeper Hill (site SR21) proved to be a rich site for lichens and was the only site surveyed where the liverwort *Frullania erisotonum*, was found. As the highest landform on the ridge it is also an important feature of the landscape. It was agreed that the area should be visited to determine the extent of burrows and their position in relation to the proposed development, which was done the following day. It was agreed that the area should be fenced off to prevent any unnecessary damage whilst there was no need to access the site.
Basil Read staff provided field support. Seven observers were position across the site (north to south) at 5-10 metre intervals and walked in a line from east to west counting mounds observed along their transect. Approximately 280 were counted which covered the full length of the site, a further 60 were

observed on the eastern lower flank of Creeper Hill. A smaller number (about 12) were observed north of the existing track. Basil Read produced a map of the survey area, with geo-references to mole spider mounds found along one transect. A small area (0.1ha) of identified mounds on that transect and within the cut for the terminal building and car park was later taped off.

The status of the SR19 and SR21 and the mole spider was discussed further at a meeting summarising the survey findings, following submission of the interim report and appendices, on 6th September with the Airport PMU and the Basil Read Environmental Co-ordinator. At that meeting it was indicated that permission would not be given for the removal of rock from the landform Creeper Hill. Basil Read Environmental Co-ordinator proposed to study the taped off area before it was stripped.

The authors made a visit to Ashmoles site PBP4 after field work had been completed (9th September 2012) in an attempt to see whether any more light could be shed on the species. This was a larger and less disturbed site than the taped off area within SR19 and might be more productive. The equivalent of 9 man-hours was spent searching the PBP4 mounds. The majority of mounds at the site had been lost but we found a less disturbed area of mounds further north. We found very few mounds that appeared to be fresh - or likely to have been thrown up within the last 24 hours. We chose the freshest mounds we could see and excavated by means of blowing, through a tube or directly, and hand/small instrument excavation. We found that we couldn't really track tunnels much beyond a depth of about 15cm. Although it wasn't obvious it is possible that they begin to run on a more horizontal plane at around this depth. Wider excavations were carried out with a trowel or hand but also failed to reveal any spiders.

We suspect that spiders can move long distances underground along a network of their silk lined tunnels. A single spider could form several mounds and because we don't know how the number of mounds relates to spiders we have no idea about the population size. When Philip and Myrtle Ashmole were looking at them at the end of their research in 2003, they tried blowing in a hole and found particulate movement on a mound about 1m away (Philip Ashmole, pers. com). They will be sensitive to vibrations and quite likely to have escape responses.

We concluded that excavating potentially active burrows wasn't a very successful approach to finding spiders or learning much more about them - other than gaining some knowledge of tunnelling and that they are extremely scarce and very adept at moving around underground. We felt that more time spent observing sites would be more productive - and a much more systematic approach was needed. Observing one or more areas where there was a good number of mounds would help reveal where there was active tunnelling, by mapping and counting mounds and or disturbing the top of a mound, which if actively being maintained would reveal a new replacement mound over the tunnel. This type of study will take several days if not weeks to execute and is perhaps best suited to less disturbed areas as part of a longer term ecological study. This information was shared with the Basil Read Environmental Co-ordinator.

We are of the opinion that a wider and more thorough study of the ecology of the mole spider (and other wolf spiders, including **Trochosippa?*) is needed. This is possibly a study that could be commissioned locally with the support of the SHNT and Darwin invertebrate project. A study of the ecology of the wolf spiders combined with a study of their status post construction would also make a fitting PhD, again which could be developed in collaboration with the Darwin Invertebrate project. A rigorous scientific approach to a study would be required if meaningful information is to be generated to support conservation efforts.

Extending the current known range of the mole spider is a key finding of this study. This is a rare species we know very little about however from what we do know, it will be significantly impacted by the construction of the airport and associated structures because of the loss of a significant proportion of the known habitat of this species. It is possible that this species has had an even wider range in the past and has been detrimentally affected by the spread of creeper into areas of samphire dominated semi-desert that have deep gritty or dusty friable substrates.

[*Reference specimen*: SR2224].

Lurking wolf spider*, *?Trochosippa*

The discovery of the lurking wolf spider was considered by the Ashmoles (2004a) to be one of the most important results of their 2003 study. It was restricted to the Central Basin where it burrowed in the least vegetated areas, with a fine substrate turned to mud by rain. Site PBP_SR19 held small dispersed dusty bowls of compacted un-vegetated ground. The dusty basin immediately east of PBP_SR19, the site of the terminal building was also reminiscent of lurking wolf spider habitat. Two *Hogna nefasta* were observed on the western edge of the dust bowl (immediately adjacent to PBP_SR19) during a night search, hiding in dried out babies toes **Hydrodea cryptantha*. This area has held good populations of babies' toes. It is completely criss-crossed with vehicle tracks and it is possible that this site has become a less suitable habitat.

Only one spider was identified in its burrow during the night search, but more holes, typical of this species were observed. There was little evidence of **?Trochosippa* activity and it is likely that it is rare at this site.

The lurking wolf spider was previously only described from two sites within the Central Basin: BYD24 and SBS22. At site SBS22 it is associated with the predominantly un-vegetated ground extending to the raised saddle marking the eastern extent of the Central Basin, the ADA extends into this area.

This is an extremely rare species we know very little about. It will be important to retain as much habitat associated with the lurking wolf spider as possible and limit indirect or accidental damage when construction works take place adjacent to lurking wolf habitat. Mitigation and protection measures recommended for the mole spider are also pertinent to the lurking wolf spider. However it is possible that its preferred habitat will be lost in its entirety to the construction because it was rare at this site and its presence across the whole site was not determined.

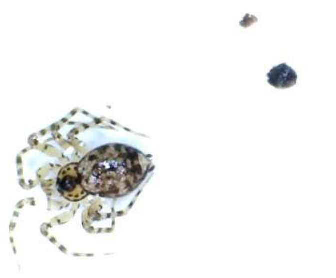
From their 2003 study, the Ashmoles (2004a) suggested that the world population of the lurking wolf spider could number in the hundreds and it's extremely restricted distribution means that this species must be considered severely endangered. At the time of their study detailed designs were not available and there was no indication of construction impact within the known range of the spider. They concluded that in addition to environmental risks, the construction of the airport and associated structures will significantly increase the risk of extinction of this species and called for special efforts to "ensure that the risk to its survival is minimized"(Ashmole & Ashmole, 2004a).

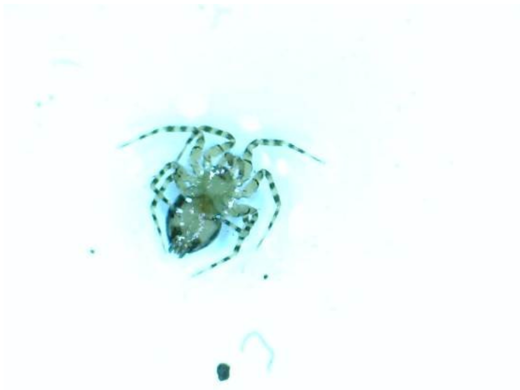
It is worth noting here that wolf spider activity in the Central Basin, observed during infrequent 'spiders at night' guided walks (about one per year) led by Rebecca Cairns-Wicks, appears to have reduced since 2005. This anecdotal evidence may not reflect the actual situation and there could be

many reasons why year-to-year differences have been observed, including seasonality and weather conditions. However, it does raise the question, could the species be in decline?
Vehicle movement outside of the existing tracks in the Central Basin has been a repeated cause for concern because of the damage it causes to fragile invertebrate habitats. Since 2005 vehicle movement in the Central Basin has been restricted. Whilst enforcement wasn't always successful, repeated effort by the St Helena Government did result in a noticeable reduction in vehicle tracks. With airport construction underway, public notices on site and published articles have reinforced the restriction amongst the public quite successfully. Furthermore, the Air Access Project Environmental Management Plan prohibits construction traffic through the Central Basin (EMP ref) and is enforced by Project Management Unit's Environmental Monitor. Signage, demarcation, restricting access with fencing and strict enforcement of protocols is essential if the Central Basin is to be protected.

Oecobiidae
This is a group of small (3mm) ground-living spiders that build webs in crevices. The Oecobids found in this study were associated with rocky and scree slopes.

Oecobius sp.
At least two species (3mm) were found in this study: species a collected from DG01 & DG13 and species b from DG09 and DG13. The specimen illustrated here is probably *O. navus*. The Ashmoles (2004b) suggest that oecobiids could have reached St Helena naturally. This is a group that requires further study.





[*Reference specimens*: Species a, DG2005 1 adult male; DG1980 1 juvenile damaged; DG 1962 1 adult male damaged but palps ok. *Species b O. navus?* - DG1974 1 adult female; DG2007 1 adult female, 1 damaged juvenile, 1 shed exoskeleton].

Oonopidae – oonopids
Gamasomorpha insularis Simon
Ashmoles found it typical of rocky sites on the fringes of PBP and this study indicates the same (DG09, DG13, although we also found it at SR22, a mixed site.

Body length 4mm

[*Reference specimens*: DG2006 1 adult female; SR1941, 1]

Salticidae – jumping spiders

Menemerus bivitattus

Unknown species – same as specimen collected from Crescent Gully (tube labeled Crescent gully mixed with Steatoda) but different to DG1972 and DG1980

Menemerus bivittatus and *Hasarius adansoni* were the most common salticids of Dry Gut and the southern ridge of PBP. These were also the common salticids of the low, dry parts of the island in the Belgian study. Both are worldwide and introduced species to St Helena, adapted to feeding during the day. In the more exposed northeastern parts of the island, the Belgians found (which the Ashmoles suggest is probably coincident with the EAA), there were two to three endemic species that in contrast lived under rocks or the shelter of samphire.

The Ashmoles recorded *Hasarius adansoni* and *Pellenes inexcultus* as abundant in 2003. The Ashmoles did not record *M. bivittatus*. We found two or three other as yet unidentified species (DG1972 and DG1980, which appears to be the same as Roger Key's specimen from Peak Dale. From Internet drawings it looks similar to *Dendryphanthes purcelli* in the swollen front femora and the very conspicuous brush-like hair cufts around the claws. However, that species looks to have pale markings which the current specimen does not (it has pale hairs but scattered, making an overall mousy pattern). Roger photographed a very different specimen that he determined to be *D. purcelli*. Adult female, but it wouldn't be easy to determine from the epigyne, which lies over a dark background and is very indistinct and Crescent Gully with a pale, marked abdomen. It is the same as Roger Keys unidentified jumping spider from Sandy Bay Beach, 22/04/2011). These species were found in the more sheltered Earwig Gully, Dry Gut Watercourse and Crescent Gully. We did not find *Pellenes inexcultus*. *Hasarius* is the most abundant salticid*, Menemerus* was largely confined to the fringe of PBP, Earwig Gully and Crescent Gully but it was also found southern ridge, Site 22 Southern Ridge Samphire Quarry, which could indicate that has already become established on the Plain.

Salticids are considered to be an important element in the ecology of PBP (Ashmole, 2004b). It would be good have a better understanding of the status and ecology of this group considering it is a significant element of the ecology of the area.

[*Reference specimens*: *Hasarius adansoni* SR1932 sub adult male & 2 juveniles; SR1935 adult female, sub-adult male & juvenile; SR22 2004 adult female; EG2228 2 adult females; DG1988 adult female & sub-adult female; DG1971 juvenile female; DG1984 sub adult female; DG1975 1 juvenile; DG1982 adult female, BV1949 1 adult female

Menemerus bivittatus SR22 2004 1 adult male & 1 adult female; CG1958 1 adult male; DG1988 1 adult female]

Scytodidae
Scytodes velutina?
1 sub-adult female found at DG13. The genus looks right but the identification of the species is only a guess. However, the Belgians apparently recorded this species (at an unspecified locality on the island) and it looks very similar from Internet photos.

[Reference specimen: DG2005].

Sicariidae – six eyed crab spiders
Loxosceles rufescens Dufour

6mm body length

Found at sites DG01, DG12, DG13, DG14 and Crescent Gully.

Common in drier sheltered and rocky areas, primarily slopes but also the watercourse margins in Dry Gut. It was not found on the southern ridge. It is thought to have been introduced to St Helena.

[*Reference specimens*: DG1970 1 sub-adult female, DG1983 1 sub-adult female, DG1987 1 sub adult female, DG1988 1 juvenile, DG2000, DG2006 1 sub-adult male 1 sub adult female]

Theridiidae – comb-footed spiders
Latrodectus geometricus Koch. Brown Widow

Only found at Crescent Gully. Its absence from other sites on the southern ridge is perhaps surprising. It was not found at Earwig Gully or Terminal Samphire, adjacent to Ashmoles Site 17 where it was found in 2003. The predominance of *X. tridentiger* and *Steatoda sp* (mostly *S. capensis*) on the southern ridge might contribute to its absence. The Ashmoles (2004b) note that *Steatoda grossa* has been reported as preying on black widows. *L. geometricus* was present at sites with *S.capensis* in the 2003 study.

The Ashmoles study of 2003 found *Latrodectus geometricus* to be abundant at many sites in and around PBP. The Belgians did not previously record it and the Ashmoles considered it likely to have arrived on St Helena since the 1960s and then spread quickly. Large females are normally found under cavities in larger rocks, under overhangs and in rabbit burrows. At night they can be found hanging upside down. Since 2005 annual night walks have been led through the Central Basin to observe the wolf spiders and brown widows. In the last two to three years there has been an observable decline in female brown widows observed on the rocky north-facing slope forming the southeast corner of the rim of the Central Basin. Nicknamed Widow Slope because of its relative abundance of female brown widows none were observed on a night time search this year. Similarly the abundance of wolf spiders in the Central Basin, visible from the reflection of their eyes in torchlight has also appeared to have declined. A potential reduction in the abundance of brown widows considered to be a potential threat to native species could be positive if this were the only change. These are only casual observations but might indicate an underlying and potentially worrying change. Environmental and ecological changes within the Central Basin and PBP, due to a combination of factors (including the spread of alien species, and damage due compaction from vehicles). What role the climate has would also be interesting to investigate.
[*Reference specimens*: Tube marked Crescent gully spiders mixed 1 adult female]

Steatoda
Steatoda capensis (*ex S. lepida*) Hann.
Steatoda capensis and possible *S. capensis*, was recorded at 13 sites across PBP in 2003. *S. grossa* was restricted to two sites to the east of the Plain, Ashmoles site 3 and 7. *S. capensis* was only recorded from Horse Point and Bryan's rock by the Belgians in the 1960s, whilst *S. grossa* was found to the east of the Plain and in many other parts of the island. This study also found S*. capensis* to be common and found it at sites SR19, SR21, SR22, SR25.

Steatoda capensis - adult male

[*Reference specimens*: SR2225 1 adult male; SR2236 1 adult male; tube marked Crescent gully 1 adult female & 1 sub adult male; tube marked Crescent gully spiders mixed 1 adult male].

Steatoda grossa C.L Koch
We found possible *S. grossa*, but cannot be certain of the identification, at two sites on the southern ridge SR19 Terminal Samphire and Crescent Gully.
[Reference specimens: tube marked Crescent Gully spiders mixed; SR2236 sub adult male abdomen missing].

Steatoda sp.
A third 3 species [reference specimen DG2005] found at site DG13, which from initial study does not appear to match either species or S. triangulosa, is possibly a new species.

Thomisidae – small crab spiders
Thomisids are distinguished by their flattened crab-like shape. They typically catch prey by ambush, often on flowers.

***Bonapruncinia sanctaehelenae*
Not seen since the Belgians study in the south of PBP at around 260m and then only represented in collections by two juvenile females 3mm. The Ashmoles thought that this might be near Gill Waterfall and searched the potential site in 2003 and did not find it. It was not found during this study.

This is thought to be a species adapted to a substrate of sand and gravel. The Ashmoles suspected its range maybe wider than previously described by the Belgians, suggesting that it might exist on the gravelly terraces on the slopes of Bencoolen, but this has not been proven. The lower most easterly terraces of Bencoolen will be directly and indirectly impacted by the construction of the emergency end runway. Site DG 19 DGlichenrunway end was not surveyed for invertebrates, but proved to be very important for lichens. It is a very exposed site with little plant cover, except for lichens. *Bonapruncinia* is possibly threatened by filling in of Dry Gut.

Further searching is recommended below Gill Waterfall, on the sheltered south facing rocky scree slope that holds a large population of the endemic *Osteospermum*, boneseed. Rocky slope site DG13 with similar characteristics proved to be rich site for spiders.

Philodromus signatus

This is a very distinctive and charismatic spider and the only endemic spider that appears to be common and is found within a range of habitats across the study sites.

[*Reference specimens*: DG1976 1 sub adult female; DG1973 1 juvenile; DG1975 1 juvenile; DG1982 1 female; BV1958 1 adult male; DG1995 juvenile]

Acari – mites
Specialist's identification is needed for mites.
*Bdellodes sp?

We found *Bdellodes* on the southern ridge sites SR22, SR23 and SR26. It is a tiny yet conspicuous red species of long snouted mite. The Belgians only found *B. parvisetosa* on PBP and the Ashmoles tentatively assigned their specimens to this species but specialist assistance is needed to determine whether it is *B. parvisetosa* or a relative.
[*Reference specimens*: SR1937 (1), SR1941 (2), BV1948 (2)].

Isopoda – woodlice and their relatives

Porcellionidae
Porcellio laevis Latreille

Abundant and found at all sites. Often in large colonies under rocks. *Gonacephalum simplex hadroides* observed associated with colonies.

Chilopoda – centipedes
Scolopendromorpha
Scolopendra mortisans Linnaeus


Photo: Ed Thorpe

The Ashmoles found it to be common on PBP (16 out of the 24 sites). We found this at all invertebrate survey sites except DG11, DG13 and SR26 (9 out of 12 sites). This must be considered a serious predator of native invertebrates.

Scutigeromorpha
Scutigera coleoptrata Linnaeus
Occurs in warm dry parts of the island, including Jamestown. Belgians found it at low and middle levels including Horse Point Plain and Prosperous Bay Plain. Ashmoles found it at site 3. We found it during a search of the rocky slope of Dry Gut (Boneseed outwash) DG10

Thysanura – bristletails
Lepismatidae
Lepisma saccharina – DG1985 (1)

This is a group that we have under collected. We found mainly *Lepisma saccharina*, other specimens were collected but these were nymphs or badly damaged so not able to identify. Surprising no *Ctenolepisma sanctaehelenae* Wygodinsky as this was found at majority of Ashmole sites.

Orthoptera – grasshoppers and crickets

Acrididae – grasshoppers
*******Primnia sanctaehelenae* Stål– under represented in collections because it is difficult to catch, but observed frequently. Very common at most sites.

Gryllidae – crickets
Gryllis abnormis Chopard
Non found. Ashmoles raised suspicion that it might hybridise with the widespread *G. bimaculatus*, which is considered to have arrived here naturally. This would make a good study.

Mogoplistidae – scaly cricket

3mm body length

Mogoplistid crickets were not recorded on the island until 1995. As they were not previously recorded and could be a recent introduction to St Helena although the Ashmoles considered they could have been overlooked and likely to have arrived as result of transportation by ship. Two small nymphs were found in pitfalls SR22 and SR23. One specimen was lost and the second is in poor condition making identification difficult. However the nymph is dark bodied quite distinct from that described by the Ashmoles (2004b) and is possible a new species. Considered to spend much of their time underground emerging at night. Both sites have deep friable sandy soils with good vegetation cover.

Blattodea- cockroaches

Afrobalta decellei Princis Ghost cockroach
Only seen during the night search. Very common on Atriplex and Creeper SR22 Quarry Samphire.

Heteroptera – true bugs
Poorly represented in our collections, possibly due to time of year of study.

Cydnidae- **burrower bugs**

Aethus pallidipennis Reuter
The Ashmoles consider this to be a native species and expected to find it more widespread in the EAA then their records indicated. This study confirms their suspicion, having found it in the deep silt and sandy deposits of Dry Gut watercourse. Size 3.5-4mm
[Reference specimens DG1964 (8), DG1966 (2 but lacking legs and antennae), DG2002 (1).]

Lygaeidae - seed bugs or ground bugs
Notable by their absence. Too early in the season.

Miridae – plant bugs
Creontiades pallidus Rambur

Probably native to St Helena. Adults and nymphs found locally abundant at several sites DG01, DG07, DG12, DG13 and SR19, SRr22 and SR25 on *Atriplex* and *Suaeda.* Very easily recognizable, the largest mirid known on St Helena.
[*Reference specimens*: DG1981 & DG1987]

**Hirtopsallus suedae* Schmitz
As its name suggests, found on Suaeda. Very common. Found at sites DG01, SR19, SR22, Sr25, and SR26.
[*Reference specimens*: SR1942, BV1953 & CG1955.]

Homoptera – **hoppers, aphids and scale insects**
Pseudococcidae *Pseudococcus viburni*. Common on the roots of *Carpobrotus* and also *Sonchus oleraceus*. Possibly the cause of yellowing and die back observed in patches of creeper on the southern side of SR23. This pest is ubiquitous and could have a detrimental impact on restoration efforts.

Pscoptera – psocids (booklice and barklice)
We have been unable to identify the booklice locally. Described species have a pale coloration, whereas the current specimens are dark brown.
[Reference specimens: DG1991, DG2009, DG1993]

Coleoptera - beetles
Very few beetles were collected in this study. This could be due to the limited collection techniques (physical search and pitfalls) used; it may also be a seasonal effect. However it is also likely that many beetles are declining, a trend that the Ashmoles study suggested.

Anthicidae-antlike flower beetles
***Anthicodes fragilis* Wollaston

***Anthicodes fragilis* is considered to be one of the most important endemic species of the deserts of St Helena (Ashmole & Ashmole, 2004b). It was found at SR19 and Crescent Gully. In 2003 the Ashmoles found it at 5 study sites outside of the Central Basin and within the EAA. Two of the sites frame the west and eastern extent of the southern ridge (PBP5 and PTP17). It likes open stony habitats.

It is likely that this species is in decline. The Ashmoles (2004b) report that the Belgians described it from Horse Point Plain, Holdfast Tom and the PBP area and that they refer to old records from Sane Valley and Flagstaff and suggested it might be in decline. The Ashmoles failed to find any at Horse Point Plain, but did find it at Holdfast Tom and PBP. Loss of habitat to the construction is likely to have an impact but it is not considered threatening. Loss of habitat through habitat modification due to the spread of alien plants is considered to present the greatest threat to its survival. It will be important to protect existing habitat and control the spread of alien invasive species during the construction and operational phase of the airport.
[*Reference specimens*:

Anthribids- fungus weevils
The Ashmoles (2004b) found ***Homoeodera scolytoides* at site 17, although there was some uncertainty over its identification. This species was discovered by the Belgians who only found 5 specimens on PBP. It is a very rare species that must be of conservation concern.

Site 17, is an exposed area immediately adjacent and with similar characteristics to Site PBP_SR19. Similar habitat extends between Site 17, SR19 and the Central Basin and a search in this area might be worthwhile. Half of SR19 has been lost to the construction and more will be affected by road construction. However the change in design to move the access road from the north of the terminal to the south could be of benefit, enabling the creation of a swathe of undisturbed ground up to the Central Basin.

Curculionidae – weevils
Few weevils found, perhaps not surprising as few scrubs to bash in Dry Gut, main species from Suaeda was Microxylobius.

****** *Microxylobius westwoodi* Chevrolat.

Length 2.2-3mm

Phylctinus callosus

8mm body length

Identified with similarity to examples from the Internet, but the distinctive diamond-shaped flat patch at the end of the rostrum looks to be fairly distinctive. This is an invasive pest species in some countries and one to watch out for. It was found at sites DG01, DG13, DG14, SR22 and SR26. [*Reference specimens*: DG1990, DG1984]

Scarabaeidae- scarab beetles
***Mellissius adumbratus* Wollaston Hogworm & ***M. oryctoides* Decelle


Mellissius adumbratus (left) and much the smaller *M. oryctoides (right)* with pronounced dimple.

Mellissius species were found either as grubs or dead individuals. No live adults were observed. *Mellissius* grubs feed on roots and were found in good numbers in creeper-dominated areas and are one of the few endemic species that apparently survive well within this unnatural habitat. Gradual removal of creeper, alongside the establishment of native species will be an important part of future restoration efforts.

Tenebrionidae – darkling beetles
Gonacephalum simplex hadroides Wollaston.

Indigenous *Gonacephalum simplex hadroides* is a species of the semi-desert, found to be common at all the study areas of the southern ridge (SR19, SR22, SR23, SR24 and SR26) and Dry Gut sites DG01 (Earwig Gully with similar characteristics to the PBP) and DG09 (a site on the eastern plateau) many of the study areas. It was not found elsewhere in Dry Gut. Introduced alien species *Hemasodes batesi* occupies the same habitats and was found at all the same sites.
[*Reference specimens*: DG1990 1; EG2232 1; DG1999 1, SR1962 2].

Hemasodes batesi Waterhouse.

Large numbers of the introduced *Hemasodes batesi* at many of the study areas attest to it being one of the most abundant beetles of the area. It was found at PBP sites (SR19, SR22, SR23, SR24 and SR26) and at Dry Gut sites DG01 (Earwig Gully with similar characteristics to the PBP) and DG09 (a site on the eastern plateau). Whether its presence and relative abundance has had an impact on native species is not known. Size and shape variation noted between sexes, the females have a more shovel-shaped head and are larger.
[Reference specimens: EG2231, SR19622 adult males; EG1963 1 adult male DG1965 2, DG1990 3]

Hymenoptera – ants, bees and wasps

Bethylidae – bethylids
Small wasps that parasitize the larva of moths and beetles. Samples mislaid but could be this group.

Formicidae – ants

Pheidole megacephala Fabricius.
Common. Recorded as predator on Wirebird eggs.

Sphecidae- sphecid wasps
Podalonia canescens Dahlbohm.
This species was active at samphire dominated semi-desert sites SR22 and SR24, possibly because of the presence of caterpillars.

The anthropogenic spread of species into the PBP (both the introduction via the airport and the internal spread from other parts of the island of known pest species) is a serious concern because of its potential impact on native species. Biosecurity measures will need to be very strict and early warning systems in place. One species not currently recorded from PBP is the introduced species *Vespula vulgaris*. Its spread is closely associated with people and its predatory behavior could make it a pest of native invertebrates. Elsewhere its impact has also been reported on bird species that feed on insects.

Lepidoptera – moths and butterflies

Geometridae – geometrids
Scopula separata Walker

Caterpillar found on *Suaeda* and adults observed in semi-desert site (SR19) and SR25 (Crescent Gully) caterpillar on samphire. The caterpillar is very well camouflaged and looks like a dry samphire twig.

Noctuidae – noctuids
Cardepia subvelata Walker.
Found on rocky and semi-desert habitats (SR19, SR22, DG01, DG09, DG12). Found as caterpillars at reared in the lab. Also found on Suaeda. Like *Scopula* shelters amongst rocks to avoid being blown away in exposed sites. Well camouflaged.

Pyralidae- pyralids
***Helenoscoparia nigritalis*

Helenoscoparia is an endemic genus of five species that have evolved on the island from a single colonising group. They are mainly associated with cabbage trees and gumwoods and are primarily moss and lichen grazers. This species was pupated from caterpillars found in Dry Gut and Earwig

Gully. The larva of caterpillars found at Dry Gut site 15 Boneseed triangle and DG05 Earwig Gully water channel. They were collected from silk 'galleries' on the rock face in Dry Gut and at the base of *Eragrostis cilianensis* (*i*). From Earwig Gully a caterpillar was found in soil/litter beneath *Attriplex semibaccata*. The caterpillars are black with gold spots. The moths that emerged are about 9mm in length, with bold patternation: black, grey and golden buff bar with deep yellow/gold patches.

This is an interesting find as *Helenoscoparia* species have been more closely associated with damper mid altitude habitats. It is not restricted to Dry Gut and thus not threatened by the development.

Tineidae – tineids
Thought to be at least four species or forms in the collection. Ubiquitous, species found at almost all sites surveyed, its absence from a collection probably more of an omission than an indication of it a species not being present. More work needed to determine how many species are present.

These are some of of the few endemic species that seem to enjoy creeper waste. Micro-moth pupal cases were found in soil under moss tussocks at the base of the rocks in Dry Gut, and in soil caught in rock crevices, a different type (as illustrated in Ashmoles, 2004b) were found on the undersides of rocks and boulders.

The Ashmoles conceded that this is the most important animal group in the EAA in which they had been unable to make much progress with (Ashmoles, 2004b). This is a group for which further study is needed.

[Reference specimens: SR1962 – 40 5 large, 35 smaller all reduced wings, possibly same species different sex; EG1963 1 female @5mm; DG2237 13, 1 large 12 small similar to SR1962; 2233, 11 all reduced wings].

Diptera – flies
Not well represented because we didn't use nets, light or baited traps apart from in Earwig Gully, which we then abandoned because it was too successful!

Muscidae – house flies
*Limnophora helenae Pont.
Abundant and seen at all sites
[Reference specimens: DG1979 37]

Tachinidae – tachinids
**Atlantomyia nitidia Crosskey.
This is an ancient endemic associated with the flightless grasshoppers, probably a parasite of *Primnia sanctaehelenae*. It has only been seen once since the Belgians recorded it, in March 2004 at site 12 - Widow Slope. This species must be considered a conservation priority.

7. 4 Vertebrates
7.4.1 Wirebird (*Charadrius sanctaehelenae*)
During the course of the study observations of Wirebirds in the study sites was made. Pairs were observed within the areas of DG09 Earwig Gully catchment, PBP_SR19 Southern Ridge Terminal Samphire and PBP SR22 Southern Ridge Quarry Samphire. At these sites the birds were observed on

several occasions to use the strong updrafts to display. One pair attempted to nest in SR22 during the time of the study, but the nest failed. Two birds were also observed in PBP_SR 23 Southern Ridge Creeper foraging and a further two were noted in PBP_SR27 where they were foraging.

A detailed study of Wirebird territories within the survey areas was not attempted because that work has been carried out by others. Detailed surveying of Wirebird territories and nesting had been carried out by the SHNT Wirebird team as part of the Defra/RSPB Wirebird Predator Control Project prior to construction works commencing. In 2011 and 2012, nest sites have been recorded in the area of the terminal building within survey site PBP_SR19, within PBP_SR22 and in the area of Bone Gully, close to SR_27.

The pattern is very similar to that described for 2006 (Faber Maunsell-AECOM, 2011b)

The construction work site is expected to have at least a direct impact on the territories of two Wirebird pairs with a third pair directly impacted by the construction of the terminal building and haul road through PBP_SR19. This is a similar status to that predicted and planned for under the Wirebird Mitigation Project (DFID, 2008). There is an increase in the loss of habitat on the southern ridge with the establishment of the construction works as compared to the loss predicted from the construction of a haul road only and as such a small negative increase in the impact on Wirebirds is expected.

7.4.2 **Gecko** (*Hemidactylus frenatus*, Java gecko)

Geckos were recorded at 4 sites within Dry Gut and DG01, DG09, DG07 (eggs) and DG10 sites and two sites on the southern ridge SR22 and SR23. It is likely that they are more widely distributed then the study implies. There is no baseline with regards the presence of geckos on PBP. The Ashmoles recorded them in 2003. It is possible that they are increasing in number. As geckos are insectivorous they are no doubt a significant predator of native invertebrates.

The assumption on the island seems to be that the specimens in wild areas are a dark morph of the Java house gecko, presumably induced by the conditions found at PBP. The Ashmoles don’t mention a dark morph, and the species recorded as part of this study look longer snouted and more scaly-backed. Reptiles have been poorly studied locally and we are not sure anyone has ever scientifically confirmed their identity. This would be good to follow up. There is apparently a third, as yet undetermined species living relatively commonly on Ascension that has never been studied, so it is possible that we have another species established here. Geckos will potentially prosper with the introduction of concrete and stone structures, providing shelter and warmth, and will also take advantage of the provision of external lighting that will inevitably attract prey at night. These must be a controlled species as part of environmental management and habitat reinstatement programmes.

7.4.3 House mouse (*Mus musculus*) and Rat (*Rattus rattus*)
Mice were seen at all the sites surveyed on the southern ridge and are also present in Dry Gut. The National Trust Defra/OTEP Wirebird Predator Control programme has recorded mice and rat presence across Prosperous Bay Plain over the last year using tracking tunnels located on random transects. Mice are recorded at 1 in 10 of all tracking tunnels and their relative abundance is greater than any of the other monitored sites (Man and Horse and Deadwood). Mice will be predators of native invertebrates and eat seed of native plants. They are very likely to have an impact on habitat recovery. Rats are rare on the Plain but are recorded in Dry Gut close to the watercourse (Chris Hillman, pers. com.). There is a potential for rat numbers to increase if more surface water becomes available and this should be monitored and controlled.

7.4.4 Mynas (*Acridotheres tristis*) **and Feral Pigeons** (*Columba livia*)
Casual observations of presence were made during the survey. Both species appear more obvious by their presence then they were in when the baseline survey for the airport was carried out in 2005. Mynas use tall shrubs such as *Nicotiana* and also structures (e.g. fences posts) and mounds (e.g. rocky mounds created by cut for detonators) to rest and take advantage of the better view. Chris and Sheila Hillman, National Trust, have been carrying out surveys of mynas and pigeons as part of an assessment of the risk of bird strike. The data provided for that study would also be very useful in establishing a baseline for the status of the habitat on PBP. Chris Hillman has observed pigeons feeding on *Atriplex semibaccata*. Mynas are omnivorous and will eat seed, insects and are also considered a predator of Wirebirds. Both species will spread seed of non-native species such as *Opuntia*, *Carpobrotus* and *Atriplex* (although this isn’t seen as a species requiring control) and are scavengers in urban areas. Construction works and subsequent operation of an airport is likely to attract increasing numbers of these species if they are not controlled.

8. Conclusions

8.1 Habitats
Dry Gut is a diverse and biologically rich valley for species adapted to arid habitats. The underlying geology and easterly aspect have given rise to a wide range of habitats (rocky and scree slopes, vertical cliffs, cliff overhangs, ledges with run-off, ephemeral watercourse, and stony heath). Those areas exposed to the prevailing winds carrying sea mists in particular support large and sometime diverse populations of lichens. Seventy different species were identified, this approximates to one third of the total number of species found on St Helena (note all lichens on St Helena are indigenous, a few are endemic and these are all found within the arid coastal zone). Dry Gut also supports the largest population of the rare endemic barn fern, ***Ceterach haughtonii* on the island. The ephemeral stream, which runs through the base of the valley, is also a rare habitat on St Helena, and one that we know very little about. Considering the diversity of habitats Dry Gut supports, including rare examples on St Helena, species diversity and the presence of rare species this site could potentially meet the selection criteria for a Site of Special Scientific Interest (DoE, Scientific Survey – Primary Selection Criteria).

The southern ridge is part of Prosperous Bay Plain. PBP's ecological value to St Helena and the world has been established through the work of Philip and Myrtle Ashmole (Ashmoles, 2004a). It is a site of international importance. The southern ridge sites are part of PBP and as such share characteristics and values with other similar areas across PBP. We found them to be ecologically rich and valuable habitats.

The habitats surveyed in Dry Gut and on the southern ridge will be significantly adversely directly and indirectly impacted by land take for the embankment, site construction compound and associated drainage. The key habitats impacted include:

8.1.1 Semi-desert

This habitat type is extremely threatened by the development. Of the sites surveyed PBP_SR19 Southern Ridge Terminal Samphire held the best example of this type of habitat on the southern ridge. It is the only site outside of the Central Basin where the lurking wolf spider *?*Trochosippa* has been recorded and one of two sites recorded outside of the Central Basin where the mole spider *?*Lycosidae*' has been recorded. The other site (Ashmoles site PBP4) will be lost to the construction of the runway and its apron. This site is considered to be internationally important. Habitat with similar characteristics to PBP_SR19 extend northwards towards Widow Slope and the Central Basin and north-eastwards towards the exposed stony area Site 17 (Ashmoles, 2004a). Protecting these areas together with satellites within PBP_SR21 and PBP_SR24 will be very important. The protection and enhancement of these areas will not only be important for potentially providing refuga for rare invertebrates and mitigating for the loss of habitat but also has the potential to provide a reservoir of native species to support re-colonisation of the adjacent southern ridge post construction.

8.1.2 Inland cliffs and rocky areas

The rocky boulders, ridgeline cliffs and crags of Dry Gut support rich communities of lichens and the largest recorded population of **Ceterach haughtonii*, Barn fern on the island. Bryophytes are also important, though often scarce, elements of this habitat. Providing suitable conditions for ferns and plants to become established. These could be propagated and reintroduced on their own and with Barn fern as part of the reinstatement programmes.

Neglected sedge **Bulbostylis neglecta* was also found associated with this habitat. Andrew Darlow found the first recorded population in the PBP area, growing amongst boulders on the rocky ridge adjacent to site PBP_SR19. A second site was found during the study in Terminal Gully.

DG 15 is a mid- valley site on the north slope (predominantly south west facing) and is composed of exposed weathered rock with a diversity of habitats: steep slope, vertical cliff and benches of gentle slope where soil collects. This was the most diverse site for lichens in the survey area, and probably represents one of the finest examples of saxicolous (living on or among rocks) lichen communities on the island. DG 19 is amongst the most important for lichens in the Dry Gut area, containing a rich community of rare species, very different community from the hotspot on the other side of the valley Site DG15. The two locations combined represent lichen assemblages of considerable conservation value. Whilst several microhabitats host rare and endemic lichens both sites, the most important of these is the underside of overhanging rock ledges, which tend to host a high diversity of species thought to be rare on St Helena (and often globally). This niche is likely to be particularly difficult to recreate and the species present are slow growing due to the deep shade.

8.1.3 Creeper waste – a degraded habitat
A large proportion of the southern ridge and upper northern slope of Dry Gut are dominated by creeper and this represents severely degraded semi-desert habitat. Creeper has spread to cover over 90% of the ground in some areas and must have caused substantial reduction in biodiversity (species composition and abundance) where it forms a near monoculture. In some areas, where the encroachment is not complete, some important flora and fauna still hold on.

Creeper Hill (PBP_SR 21) is a raised rocky landform, the highest point, on the southern ridge. At first glance this area appears to be of little interest. It is highly degraded due to the encroachment of creeper and disturbance from quarrying activity on its west-facing slope. However the gritty east facing slope provide conditions still suitable for the mole spider and the exposed rocky slopes, cliff and boulder areas still support a surprising rich lichen and bryophyte communities, including species rarely recorded or not previously recorded within this study (e.g. bryophyte *Frullania erisotonum* and lichens *Cladonia marioni*, *Dirinia sp* and *Endocarpon pallidium*). This is an important site to conserve and one where mitigation to protect the site during construction and thereafter enhance habitat conditions should be carried out.

The invertebrate search at DG07_Earwig Gully stony creeper slope uncovered two snail sub-fossils of the generic endemic species (Subulinidae, *Chilonopsis** sp*.) thought to be extinct. Species in this group are considered to have been formerly associated with gumwood forests (Ashmole and Ashmole, 2000). It is possible they would have been part of a fauna associated with scrubwood.

Creeper-dominated areas do support some important communities of native invertebrate species (e.g. tineid moths, *Mellissius* beetles and spiders - Salticidae). Although, except for the *Mellissius*, which feed on creeper roots, many of the species are probably not feeding or using the plants directly but are able to survive in the gaps between the vegetation cover.

This habitat also presents an opportunity, as it covers a substrate type that could once again sustain more diverse communities with the carefully planned removal and replacement of creeper. The enhancement of this habitat will not only be important in mitigating for the loss of habitat on PBP but also has the potential to provide a reservoir of native species to support re-colonisation of the adjacent southern ridge post construction.

8.1.5 Dry gullies
The ephemeral watercourse of Dry Gut is particularly important. Ephemeral watercourses are a scarce habitat on St Helena and very little is known about them and their associated invertebrates. The loss of the ephemeral watercourse habitat in Dry Gut to the construction of the culvert and embankment is significant and warrants mitigation.

The two main gullies draining from the southern ridge into Dry Gut (PBP_SR20_Terminal Samphire Gully and PBP_SR25_Crescent Gully) are rich and valuable habitats quite different to the more exposed plateau. They are damper then the upper plateau and as well as providing conditions for rare natives also support invasive species that are not yet well established on PBP. They will be important sites to focus habitat enhancement activities.

It is possible that surface water and grey water may be drained into these natural water channels and if this proves to be the case, management of pollution control protocols, control of invasive species and monitoring will be required.

The gully west of Bencoolen View is quite different. This is a much drier gully that is dominated by a number of non- native annuals, including *Ageratum conyzoides* and *Leonotis sp.*, the first time this species has been recorded on PBP. If these species are not removed they could become significant weeds of PBP and early control and eradication is recommended.

8.2 Species of conservation significance

The loss of habitats supporting rare species is a concern, particularly when the species are restricted in range. There are several species of conservation significance that will be impacted by the construction of the embankment in Dry Gut and the construction of the access road, construction works site, the terminal building car parking and associated infrastructure on the southern ridge. Tentative comparison with previous studies, considering differences in the time of year of study and range of techniques used, based on the presence (or implied absence) of species, supports previous observations in the continued absence of species from the collections and the increasing frequency within which non-native and aggressive alien species are appearing. This trend is echoed in the vascular flora. The increasing encroachment of *Carpobrotus edulis*, is cause for serious concern, but also the number and abundance of alien annual and woody weeds.

- Vascular Plants

Barn Fern, **Ceterach haughtonii* and Candlestick amaranth, *Amaranthus thunbergii* (i?)
Due to their island wide rarity and the size of the local populations in Dry Gut and the southern ridge of PBP, it is concluded that Barn fern **Ceterach haughtonii* and *Amaranthus thunbergii* (i?) will become more threatened as a result of development in Dry Gut and the southern ridge of PBP if no mitigatory action is taken.

The Environmental Conservation Section of ANRD has already been active in collecting and re-locating Barn fern to their nursery at Scotland. Most of the population is already in cultivation and will need to be maintained and multiplied. In part because of the field collecting and also through deliberate collecting, Bryophytes associated with the Barn fern have also been brought into cultivation. The numbers however are tiny and could be multiplied as part of the Barn fern programme.

Amaranthus thunbergii (i?) is a species from which seed should also be collected and propagated to be replied in the reinstatement programme. The ECS has been collecting seed of *Amaranthus thunbergii* and other natives including: boneseed, *Osteospermum sanctae-helenae*, purslane, *Portulaca oleracea* and *Eragrostis cilianensis*. These will need to be used as part of air access mitigation to form the basis of gene banks to produce seed for reinstatement programmes. The impact of the development on these species could be negligible, even positive in the long term, if enhanced populations are established and maintained. However the risks are high because up until now Barn fern has not been maintained in long-term cultivation, the development of techniques to multiply these species through field and nursery gene banks are in their early stages and re-introduction and re-seeding into the wild is unproven. Securing the resources required to maintain consistent and committed long-term conservation programmes will be crucial to achieve success. .

Neglected Sedge, **Bulbostylis neglecta*
Two sites have now been identified on PPB, amongst the rocky outcrops of the upper slope and northern rim of Dry Gut which also forms the southern boundary of PBP. One site is expected to be

lost to the development. Early efforts to reinforce and enhance the second site should be carried out as part of habitat mitigation and managed under a site management plan.

- Lichens and Cryptobionts

There will be a direct impact on the lichen communities of PBP and Dry Gut. A number of endemic and rare lichens occur in Dry Gut and on the southern ridge of PBP. However as they are also found elsewhere on the island, in sites outside of the development it is not expected that any lichen will become more threatened as a result of the development. Dry Gut holds rich and diverse lichen communities that are considered of conservation interest and that will be lost or impacted by the construction of the embankment in Dry Gut. The physical structure of the embankment will change the topography, air movement, and moisture re-charge of the valley. Lichens will only establish where the conditions are suitable. Not all habitats may be re-instated (for example cliff overhangs) following the construction and consequently species composition may be different, species diversity and community richness may be reduced.

On the southern ridge Plain plateau soil crusts are particularly important in protecting soils and are also very fragile, as the soil is soft and dusty and once the surface crust is disturbed, they are easily lost. Soil crusts established by lichens and algae and even where there are no lichens - through damping and then drying of the soil surface are all important in stabilizing soils and enabling ecological succession.

Boulders across the ridge support good populations of lichens. Where they are going to be lost, surface rocks, large and small, should be salvaged and used as part of the post construction reinstatement works to help re-colonisation and recovery. This will require adopting appropriate locations for storage and re-positioning in areas of habitat restoration and reinstatement.

As well as long term direct impacts on lichens there are likely to be long term indirect impacts because lichens are very sensitive to air pollution. Aptroot (2006) notes that pollution from aircraft may have an adverse impact, at least within the narrow zone around the airport. A reduction in lichen growth around the airport due to air pollution can be expected and he suggests that impacts could be monitored once a year. The data from this survey should be used as well as that of Aptroot as a baseline. Aptroot (2006) also recognized trampling as an indirect impact of increased tourism numbers. Any unnecessary encroachment whether or not it is associated with leisure pursuits or construction activity, where there are no dedicated tracks or footpaths, into undisturbed and ecologically sensitive areas during the construction and post construction whether on foot or by vehicle must be prevented.

- Invertebrates

The survey picked up many of the top predators but with notable gaps lower down in the food web.

We only recorded 3 of the endemic beetles (*Mellissius adumbratus* and *M. oryctoides* and *Anthicodes fragilis*). This might be due to the time of the year of surveying. All live *Mellissius* were found as grubs in the soil. We recorded a prevalence of the introduced alien Hemasodes batesi. However we also think it is likely that many beetles are declining, a trend that was indicated in the Ashmoles study (Ashmoles, 2004a). One of the species considered by the Ashmoles (Ashmoles, 2004b) to be of conservation concern was *******Homoeodera scolytoides*, which they found at site 17, although there was some uncertainty over its identification. This species was discovered by the Belgians who only found 5 specimens on PBP. Site 17, is an exposed area immediately adjacent and with similar characteristics to Site PBP_SR19. As beetles were under represented in our collections, it is quite possible that we have underestimated the value of this habitat for this group. Similar habitat extends between Site 17, SR19 and the Central Basin and a search in this area might be worthwhile. Half of SR19 has been lost to the construction and more will be affected by road construction. However the change in design to move the access road from the north of the terminal to the south could be of benefit, enabling the creation of a swathe of undisturbed ground up to the Central Basin.

We also failed to find many of the endemic Salticid spiders. This might be because we under-sampled in places where they were more likely to be found (e.g. samphire bashing). It seems likely, with the prevalence of non-native species that we are witnessing a declining trend for some endemics.

Less disturbed areas that supported good populations of native plants are also better quality habitats for native invertebrates e.g. PBP_SR19. Non-native species are often prevalent in disturbed sites. The loss of habitat and disturbance associated with the airport construction has the potential to contribute to an increasing prevalence of non-natives.

With the permanent loss of most of the eastern and southern ridges and their associated habitats to the construction of the runway and supporting infrastructure (permanent and temporary) protection of the Central Basin and its borders (out with the construction footprint) must be the principal focus of conservation efforts. The aim should be to protect and conserve as much habitat as possible.

The main priority must be on actively protecting the remaining sites which are out with the construction footprint but within or adjacent to the ADA from inadvertent construction damage. Protecting the Central Basin is critical but it will also be important to keep the construction footprint to a minimum within the area described as SR19 and to enforce this during construction. Suitable physical measures and protocols should be put in place. Mitigation will need to consider how best sites will be managed during and post construction to ensure ecological integrity is maintained. Physical protection of the site alone may well not go far enough to ensure that suitable habitat for the mole spiders and other associated native species persists and other measures such as monitoring for impacts of dust and alien plant control etc. could be applicable. Although it will be much reduced - habitat enhancement adjacent to the area (towards the Central Basin side) could provide suitable conditions for the wolf spiders and habitat reinstatement on the southern ridge west of Creeper Hill (and beyond!) could also provide future potential habitat in the long term.

To create enhanced areas of restored habitat as part of the mitigation it will be important to establish conditions suitable for native species. Soil substrate, surface rocks and plant cover (Suaeda) will all be critical elements. Forward planning will be important with regards landscaping (reinstatement and creation of new landform) post construction to make sure that there will be sufficient and appropriate volumes of material for re-application post construction if suitable habitat for wolf spiders and other native species is to be created. This will also require that the re-applied material remain in good condition having been well protected and treated during the construction period.

To increase chances of success this will require further investigation of the distribution and ecology of the mole spider and lurking wolf spider (and taxonomy – but this will take time). This will not be an easy task given the time constraints and the specialist subject. One possible option would be to work with the St Helena National Trust (St Helena lead) and Environmental Management Division of St

Helena Government. Together they are working with Buglife (UK lead) on a Darwin Initiative project 'laying the foundations for invertebrate conservation on St Helena'. This project is currently seeking to employ an invertebrate conservation co-ordinator who will be supported by a UK based 'trainer' with St Helena experience. Given that it is difficult to find specialists in this group, St Helena would be best placed to 'grow' its own specialists. With the right support a local study could be commissioned and successfully executed.

The study found an abundance of introduced and aggressive invertebrates to be well established on the southern ridge and Dry Gut that are likely to have a serious impact on endemic invertebrates, as predators as well as competitors for shelter (e.g. *Xeropigo*, *Steatoda*, *Scolopendra*, *Hemasodes*). Understanding their ecology and impact will be valuable in developing conservation strategies and restoration targets and plans.

- Invasive species

Habitat modifying invasive species pose a current and future threat to native plants and animals of the southern ridge of PBP and Dry Gut.

Invasive species are leading to reduced habitat quality for native species and could lead to species extinctions. It is possible some invertebrate species may have already been lost from PBP.

The scale of disturbance and habitat loss to the construction alone is significant and will be not be easy, or even possible, to reinstate or enhance in the medium to long term. This is further complicated by the presence of invasive species, that are more likely to spread quickly taking advantage of the disturbance. If left unchecked they will add considerably to the challenges and risks in achieving reinstatement of enhanced habitat. If they become community dominants they will change the ecology of the area.

The increased traffic associated with the construction and permanent establishment of an airport on PBP also increases the potential for the establishment of new species, whether introduced through the airport terminal or spread from other parts of the island (internal), which could have a detrimental impact on native species.

- Vertebrates

Geckos
Geckos will potentially prosper with the introduction of concrete and stone structures, providing shelter and warmth, and will also take advantage of the provision of external lighting that will inevitably attract prey at night. These must be a controlled species as part of environmental management and habitat reinstatement programmes.

House Mouse and Rat
Control of the mice population as part of rodent control will be required. There is a potential for rat numbers to increase if more surface water becomes available and this should be monitored and controlled.

Wirebirds
This study concludes that similar numbers of territories will be impacted to those originally identified (DFID, 2008), however the airport design deviates from the reference design with the intention to

establish the construction site works on the southern ridge, in addition to the construction of the haul road. This study concludes that the development will result in the permanent loss of the habitat because the impacts are considered to be long term. Mitigation proposals (Annex 8 of DFID, 2008) excluded "the semi-desert, including both the stony ridges and the more sandy Central Basin" of PBP from the mitigation proposals because "Although substantial works are planned to improve habitats for endemic and globally important invertebrates, especially in the Central Basin, these works are unlikely to provide for an increase in the Wirebird numbers using this area".

The Wirebird mitigation project which, was successful in improving habitat conditions within identified mitigation sites for Wirebirds and livestock, concluded in October 2011 prior to the commencement of construction works. As of July 2011 counts of Wirebird territories showed that the project had resulted in the number of Wirebirds increasing, in all the mitigation sites, with an overall average across the sites of about 10 territories. Although the results are encouraging this fell short of the original target number which "at the most optimistic timescale that is not for another 3-4 years time". The end of project report (Reporting Period: 1st July 2008 – 31 October 2011) concluded "It is vitally important that both the Wirebird and pasture gains achieved through this project are sustained into the future and followed with a set of recommendations to achieve that. These recommendations should be pursued vigorously." Of particularly relevance to this study are:

"8.1 (9) The greatest threats to pasture or semi-desert habitats should be identified and treated as priorities (perhaps presently Furze and Bull Grass to pasture and spread of invasives such as Opuntia and Wild Mango into the semi desert). DFID, SHNT, ANRD, SHG (Environment Directorate) and SHG (Access/Infrastructure) should form a review group to ensure that appropriate monitoring and actions based on the monitoring take place. The RSPB have advised that they would be pleased to be a member of such a review group.

8.1 (12) SHG should ensure long term monitoring of the sites takes place to check and report on responses of Wirebirds to mitigation measures once Access work starts (perhaps trying to define the timing that is needed i.e. Jan for full census for context and December/February to provide additional mitigation work impact i.e. 3 months a year for construction period and 5/10 years of operation).

8.1 (14) The process towards ensuring legal protection that is recognised nationally, should be continued as part of the NCA's system to protect the key mitigation sites in perpetuity. Mitigation sites proposed as NCA's should be included as part of the priority list of sites that Management Plans are established for in the short-medium term. This will support the availability of management guidelines for their development and provide a protective framework that largely ensures that only appropriate and complimentary access and developments occur on these sites.

8.2 (5) Where other issues emerge (i.e. predation) that are shown to be critical to long term success of work, there should be a mechanism whereby they can be dealt with as part of mitigation packages".

The impact of development on the southern ridge should be considered as part of the potential cumulative impacts of the air access project on Wirebirds that have come about as a result of changes to the reference design and against the on-going achievements of the mitigation project. An earlier variation in the reference design was the establishment in May 2012 (Access Office, 2012) of the temporary access route for Deadwood. This was to be used over a four month period until the haul road was in operation, however the road is still in regular use now. Monitoring the response of

Wirebirds to the air access project as well as to the mitigation measures with review and response is required. These measures, reflecting the recommendations notes above and made in the mitigation project report, should be in place and if not already done so, will need to be “pursued vigorously”.

9. Assessment of significance

9.1 Dry Gut

The ecological interest of Dry Gut is considered High Value and at least of National Importance.

The construction of the embankment will have a significant impact on the whole ecology of Dry Gut. It will lead to the loss of those habitats within the footprint and significant modification of the remaining habitats within Dry Gut. The embankment will lead to the creation of a new range of environmental conditions. Some may be similar to existing which in time could support the range of species which currently exist in the Gut, but rare habitats and any rare species associated with them may not be and the new set of environmental variables may support different floristic compositions. As the dominant organisms in Dry Gut are lichens colonisation of new substrate will years, and decades to recover. The type of rock used on the outer face of the embankment, the angle it is placed at, the amount of compaction etc. will all have bearing on what species are able to colonise and establish. Detailed planning with the design engineer and work on the ground with an ecologist will be needed if a range of habitats are to be created.

Land take for the construction will result in:

1) The loss of valuable habitats supporting communities of endemic and indigenous plants, lichens and invertebrates

2) Impact on valuable habitats supporting communities of endemic and indigenous plants, lichens and invertebrates adjacent to the construction from change in landform.

3) Pollution risk - drainage - pollution of downstream watercourse from the construction and dust emissions and sediment from construction and damping down.

9.2 Southern Ridge

The southern ridge holds rare endemic invertebrates of restricted range that are considered to be a very significant risk of global extinction (A&A, 2004) from the construction, including the mole and lurking wolf spiders. Key ecologically sensitive areas are: PBP_SR19 Terminal Samphire, SR21 Creeper Hill, SR22 Quarry samphire and gullies draining into Dry Gut and the CB. It also provides habitat for the Wirebird.

The ecological interest of the southern ridge is considered Very High Value and of International Importance.

Levelling and excavation for works is considered to effectively constitute a permanent impact.

Land take for the construction will result in:

1) Damage (disturbance & compaction) to and loss of valuable habitat for specialised endemic & indigenous invertebrates, plants and Wirebird, including rare species of limited range.

2) Risk of pollutants during construction effecting sensitive ecological habitats: pollutants include dust emissions, contaminants from road and site works, spillages, contaminated water & sewage to existing watercourses and run off areas into the Central Basin and Dry Gut.

3) Risk of erosion – exposure of fine dust and grit, gullying and run off from dust suppression

4) Potential change in landform that is conducive to sustaining valuable habitats for invertebrates and plants.

5) Creating a challenging environment for reinstatement – it is potentially very difficult to recreate specific habitat requirements particularly for burrow dwellers (dust and gritty habitats which include un-vegetated areas).

10. Recommendations: proposed mitigation measures

10.1 Dry Gut

10.1.1 Mitigation for loss and damage to habitat important for endemic and indigenous invertebrates, plants particularly lichens

- Set up an appropriate data management programme to record what is present and establish a long term monitoring programme for lichens, plants and invertebrates.
- Collection of endemic and indigenous seed and plant material (this has begun with support from the ECS and will need to continue to be supported. The removal of the barn fern population is one of the most important conservation measures of the mitigation programme. The resources required to support this will need to be made available.
- Creation of new landform. Profile the embankment to support the creation of a diversity of niches – working with ecologists for the detailed design of the embankment could help offset (in the long term) habitat lost but unlikely to re-create all habitat types.
- Salvage as many lichen covered rocks and boulders for re-application in to areas of reinstatement as possible.
- Commission a study with support from the National Trust and Environment Management Division (see comment below in relation to wolf spider studies) of ephemeral surface water on St Helena. The watercourse, which eventually drains into Dry Gut just above Gill Point Waterfall, is potentially valuable. It is also possible that water will be diverted into it from the Emergency End Runway, as long as there are measures in place to prevent pollutants entering into the stream, this could be a benefit. Provided that alien invasive species like *Schinus terrebinthifolius*, *Acacia cyclops* and *Olea europea sub sp africana* are removed conditions that favour moisture loving native species might be established.
- Implement a programme of alien species control. The control of alien invasive species will be key to the long-term success of restoration efforts. The approach to invasive species control as proposed by Lambdon and Darlow (2008) provides a good guide for PBP and Dry Gut. Management approaches to will need to include, but not be limited to:

  - *Control existing problem species*

Early action to remove those weedy species, which currently only have small populations, will avoid more costly control efforts later when the species become better established and removes sources of weed for potential re-colonisation. Maintain vigilance to detect new patches of weed establishment. For example annual weeds like *Sonchus oleraceus* will quickly colonise disturbed areas and take advantage of unmanaged water run-off (e.g. from structures without guttering). Actions will be required that will help reduce the problem; avoid unnecessary disturbance and clearance to open ground, adoption of suitable practises for regular weed control, pre-emptive or early establishment of native species through planting and sowing direct. Woody weeds like *Schinus terebinthifolius*, *Nicotiana glauca*, *Acacia cyclops* and *Olea europaea subspecies africana*, *Lantana camara* only occur in low numbers in Dry Gut and PBP and these can be removed as part of a control programme. Creeper should be removed from areas where it is still not frequent but may be actively recruiting into. Longer term approaches for control and gradual restoration will be needed for those areas (creeper waste) where it is the dominant vegetation type. All this should be carried out within appropriately planned programmes, using appropriate techniques and treatment of waste.

- *Maintenance of effective control of introduced animal pests (e.g. mynas, rats and mice), which may be responsible for seed dispersal of a number of invasive plant species*.

- *Prevention of new introductions*

Adoption of an appropriate early detection (monitoring) programme and biosecurity policies.

10.2 Southern Ridge

10.2.1 Mitigation for damage and loss of habitats important for endemic and indigenous invertebrates, plants and the Wirebird

- Set up an appropriate data management programme to record what is present and set up a long term monitoring programme to determine trends in species composition and abundance for lichens, plants and invertebrates. This study, together with Ashmoles (2004a) and Aptroot (2006) should be used as a baseline. A more stratified approach to sampling with permanent monitoring plots might be used (e.g. pitfalls and fixed plots – e.g. under purposefully located stones or other shelter). Mole spider mounds should be counted at SR19 and monitored periodically for change. A separate study of the status and the ecology of the wolf spiders is recommended and could be facilitated through the Darwin Invertebrates project.

- The emphasis must be on preserving as much intact habitat as possible.
- Minimise land take/restrict working area to minimum required and only excavating substrate to that which is necessary for construction. Wherever possible structures should be laid on top of undisturbed ground and separated by a semi-permeable membrane.
- Designate SR19 Terminal Samphire as an ecological sensitive area and limit development there to a minimum. Produce site and species (e.g. wolf spiders) (recovery) management plans to be agreed with the relevant authorities. It is recommended that advice is taken from a suitably qualified ecologist to develop plans, with clear goals and targets, for the mole and lurking wolf spiders, to re-instate and restore habitat as mitigation for habitat lost or damaged by the construction. Firstly however, it is important to retain as much intact habitat as possible as habitat re-instatement and restoration are unproven and therefore must carry some risk. To be successful this will require further investigation of the distribution and ecology of the mole spider or spiders and lurking wolf spider (and taxonomy – but this will take time). This will not be an easy task given the time constraints and the specialist subject. One possible option would be to work with the St Helena National Trust (St Helena lead) and Environmental Management Division of St Helena Government. Together they are working with Buglife (UK lead) on a Darwin Initiative

project ‘laying the foundations for invertebrate conservation on St Helena’. This project is currently seeking to employ an invertebrate conservation co-ordinator who will be supported by a UK based ‘trainer’ with St Helena experience. Given that it is difficult to find specialists in this group, St Helena would be best placed to ‘grow’ its own specialists. With the right support a local study could be commissioned and successfully executed.

- As far as possible, concentrate construction works to creeper-dominated areas.
- Take immediate action to reinforce & enhance adjacent ecologically sensitive areas based on agreed management plans and maintain satellites of undisturbed area wherever possible. The area of plateau north of SR19 on the border of the Central Basin is important.
- Salvage as many lichen covered rocks and boulders for re-application in to areas of reinstatement as possible, as numbers are so few on the southern plateau, every bit will help.
- Collection of endemic and indigenous seed and plant material (this has begun with support from the ECS and will need to continue. The resources required to support this will need to be made available.
- The control of alien invasive species of plants and animals will be a key to the long-term success of restoration efforts. Develop and implement appropriate alien species control programmes, as described above. Target species for control should include: geckos, mice, rats, myna, pigeons, *Carpobrotus edulis*, *Schinus terebinthifolius*, *Nicotiana glauca*, *Acacia cyclops*, *Olea europaea subspecies africana*, *Lantana camara, Sonchus oleraceus, Ageratum conyzoides and Leonotis nepetifolia*
- Monitor the response of Wirebirds to the air access project as well as to the mitigation measures with review and respond to the outcomes.

10.2.2 Mitigation for pollution risk

- Apply and rigorously enforce British Standards for pollution (surface water and dust) control. Careful consideration required as to route, treatment, length of filtering, construction of bunds around water, concrete and diesel storage areas, risk management and alien species control.
- Monitor for impacts of dust on plant communities.

10.2.3 Mitigation for erosion risk

- Apply and enforce British Standards for earthworks, soil stripping and storage and surface water, but see note below. These are desert soils of variable substrate and modifications of approach will be required to stripping. See appended notes produced as an addendum to the meeting held on the 6th September.

10.2.4 Mitigation for change in landform

- Creation of new landform. Where impacted, re-profile landform to re-instate gradients and apply substrates conducive to sustaining valuable habitats for invertebrates and plants.

10.2.5 Challenging environment for reinstatement

- Clearly demarcate vehicle and pedestrian tracks and access routes for staff and the public and ensure these are adhered to throughout construction period.
- Restrict working area to a minimum and ensure suitable protocols and protection measures in place to avoid damage to sensitive areas adjacent to the construction. Delicate algal crusts (cryptobionts) and soil crusting lichens protect desert soils, they can take many years to re-cover after disturbance.
- Strip substrate from identified areas of cut for later re-application. In some areas collection of seed in the soil seed bank should be carried out which could be achieved by collecting soil from

the immediate surface by brushing with a stiff broom. An initial strip of topsoil (5-10cm) should be piled separately from subsoil.

- Prior to stripping take cuttings of *Suaeda* as, this is not a species in regular cultivation and is one that will form an essential component of restoration.
- Avoid mixing stripped vegetation with topsoil. Remove creeper from the site, samphire can be used to cover soil heaps and seed with native annuals (*Eragrostis cilianensis, Amaranthus thunbergii*, *Portulaca oleracea, Chenopodium helenense* & *Hydrodea cryptantha*).
- All topsoils and subsoil should be stripped and moved directly to storage location, where they should be given adequate protection and labelling and recording from where they originated.
- In areas to be stripped, no part of the site should be excavated or traversed by heavy vehicles or plant or used as a road or stationing of plant or buildings until area stripped. Activity during wet periods will need to be avoided to prevent damage to soils.
- Control weed species that germinate within the construction area and on soil heaps.
- Implement a programme of seed collection and bulking up of native for reinstatement as described in the LEMP.
- Monitoring of the above and early response essential.

With due care in planning and implementation of mitigation and with continuity in management, secured through long term funding, the establishment of favourable conditions for native flora and fauna should be possible.

10.2.5 Further studies

Observations suggest that the composition of invertebrate communities is undergoing change and that this is primarily due to the spread of alien invasive invertebrates. To help guide conservation planning, further studies are needed to get a better understanding of the impact of alien invertebrates on native invertebrates.

Several key groups are considered to make up a significant element of the ecology of the area and as such study of them is encouraged to inform conservation efforts. Studies into the status and ecology of the following key ecological groups are recommended wolf spiders, Tineids, salticid spiders and beetles.

Further study of *Oecobius sp*., and ***Bonapruncinia sanctaehelenae* is also encouraged.

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Addendum: Soil Stripping and Storage Recommendations

Addendum to meeting held with PMU and Basil Read at the Access Office, 6th September 2012
Rebecca Cairns-Wicks & Phil Lambdon, 8th September 2012

These notes have been prepared following a meeting held between PMU, Basil and Rebecca Cairns-Wicks and Phil Lambdon at which we discussed the key findings and recommendations of the habitat and invertebrate survey of Dry Gut and the southern ridge. They were presented to Andreas Huber and Annina Van Neel.

The purpose of soil stripping is to salvage soils for re-application in the clear and graded areas, areas of habitat reinstatement and habitat creation (potential embankment terraces).
PBP has a mosiac of different substrate types, formed as a result of the geology, topographic and prevailing environmental conditions, that support a variety of habitats for plants and animals. Deep fine gritty soils provide habitat for burrowing animals whilst exposed stony areas support species which hide under what small stones they can find during the day and come out to feed at night.
The restoration works will be required to re-instate and re-create the range of existing habitat types and (excluding the clear and graded areas) avoid create homogenous habitat. Because substrates are locally and habitat specific this will create challenges for the construction/restoration process if it is to be done well.
This requires some knowledge of the existing conditions prior to soil stripping. The ES provides a basic baseline description but more detail will need to be recorded.

Soil stripping to salvage top layer and subsequent sub-surface horizons.
The upper layer is going to be most crucial.

It will be important to collect sufficient volumes of material to be able to re-apply over re-graded landforms and areas of habitat reinstatement/creation. This requires an idea of how much material is needed. It should be assumed that there will be loss of material during the storage period, so a proportional increase in estimates should be collected. The proportion of usable material lost could be quite high depending on the conditions under which it is stored.

From the brief overview from a collection visit to PBP on the 6th September it looks like different approaches to soil stripping will be required depending on the substrate. In the current areas of cut, the soils are deep fine gritty and the machinery used for soil stripping and transportation is causing deep rutting. An initial removal of plant material is also likely to be causing some mixing prior to collection. Large partially buried surface rocks are also likely causing challenges of cutting the upper layer.

Because of the variability of terrain, it appears from our casual observation that a singular approach to soil stripping applied across PBP may not be satisfactory. It won't be fine grained enough to capture important soil seed banks and soil quality for key habitats and might be overkill for others. Focusing detailed effort on the more complex and important areas would be a more efficient way of working, and beneficial for the environment.

Collecting, and then managing, the upper layer well is really important. Depending on the site different approaches to stripping may need to be adopted.

For example in areas such as found on the site of the terminal area and taxiway, which was a rich site for plants and animals – an exposed, relatively level area with deep gritty/dusty soils dominated by indigenous samphire with a good mix of endemic and indigenous annual species, relatively abundant surface rocks with good lichen communities. An approach is need that maximises the opportunity for salvage of the soil seed bank, which is likely to be within the first centimetre or so and lichen covered rocks. This would be better collected separately, and may not be achievable with machinery, from the upper sub-surface layer. Intensive, focused collection may only be needed in areas where there are good populations of samphire and desert annuals. Collection of seed bank material from areas dominated by creeper for example would be counter-productive and a waste of effort. Hand collection of the top few cms (e.g. by brushing) could be done. This doesn't have to be the whole site and doesn't need to take long if focused in the best areas, but it could provide a very valuable source of seed that can be applied to the topsoil in its storage location or used for multiplication of plants for re-application as part of restoration efforts. This could be far more successful in salvaging seed from the site based on a later cut of 10cm because of the mixing and dilution effect.
The hand collection of samphire for propagation or application to the topsoil in its storage location would also be beneficial as this is not a species that is in large-scale cultivation and will be one of the prime species for restoration works. Its potential for ameliorating salinity from damping down was discussed at the meeting, it is also excellent at accreting desert sands so an important component of erosion control and wind breaking.

As mentioned in the meeting, an initial surface pass should also include removal of surface rocks and boulders, where practical, to preserve the best examples of lichen communities. The methodology should not just sample the common, shrubby *Ramalina* species, but should be designed to capture a range of different growth forms and both common and rarer species. The last category is sometimes the most important in conservation terms. Lichen rock storage is also going to be critical to successful re-application post construction and we understand from the meeting that Basil Read will need to update their protocols.

Collecting and retaining horizons in storage did look to be undertaken carefully and effectively, but consideration should perhaps be given to collect to a far greater depth in areas where there are deep gritty soils. Roots of samphire have been observed at depths of a metre and possibly more. Desert subterranean invertebrates could also be burrowing to a depth of 1m. If areas of habitat are to be re-created suitable for these burrowing species then material will need to be available to do this. The amounts required will depend on the potential areas of reinstatement and the amount available to do so will depend on the requirements for construction.

In rockier areas the approach might be slightly different. We could see that rocks on the surface, or partially buried will make it difficult for specific cut depths. Depending on the quality of the site, hand stripping might be useful to take off the soil seed bank and a deeper depth of the first layer might be acceptable (or practically feasible). Areas of creeper-dominated habitat are unlikely to have a soil seed bank of native species, except where residual open areas (islands) still support small communities.

Our brief observations of the soil heaps collected so far showed clearly that a large proportion of the rocks from the area of cut are concentrated quite close to the surface. Even though buried, these are probably critically important for some burrowing invertebrates as they create a structure, which supports a matrix of interstitial holes, suitable as tunnels and lairs. Therefore, collection of the upper soil horizon, complete with rocks, is critical in recreating conditions post-construction. Hopefully, when the rock – soil mix is reapplied, it would eventually settle and air pockets would develop naturally.

Excuse us if these comment relate to existing practice, but we thought they are important to mention. The appropriate and wise use of machinery needs to be considered, particularly in areas of deep fine grit. An adaptive approach should be used, as the vehicles cause damage each time they drive over the area an approach to stripping and collection which avoids multiply passes could be adopted. The use of machinery to take out samphire and creeper is damaging. Hand collection of samphire for propagation and re-application would be better. In areas where creeper is invading good quality habitat at low density, hand removal would be appropriate so that the seed bank can be recovered, as for example has been done at the mole spider site at the head of Earwig Gully. In creeper-dominated areas mechanical removal will be the only practical solution.
Maps should be produced to describe where soil has been collected from, these will relate to the documentation and labelling of the stockpiled substrate that will ensure they can be correctly identified and put back. Different areas have markedly different particle size. Re-applying coarse soil on top of finer dust will not work.

Soil storage
Identifying where substrate can be stockpiled is challenging given the volume of material likely to require stockpiling.

It is really important that any material is only handled once, taken from site to storage only and then re-applied post construction.

Protecting soil heaps is absolutely vital. Very sturdy windbreaks could work. As soil stockpiles are required to be held for a substantial period of time, having them as vegetated heaps is recommended. However this might be difficult to achieve immediately because of the lack of available material. Samphire is one of the only perennial species that could be used, desert annuals will only provide cover for part of the year. But a mixed suite of native species could provide sufficient cover if managed well. A two- pronged approach might be required - covering to provide short-term protections - a very light teram to cover the material until the samphire has established to bind it together. A very light teram would be permeable so allowing light and moisture through, anything thicker would not allow light or water through and wouldn’t in the long term be a good approach.

We should also anticipate a high loss of usable material. This loss will be higher where the piles are exposed to strong winds, and could create a significant dust issue, even if covered with vegetation. Ideally, a sheltered storage location would avoid this risk, but if this is not possible then heavier duty wind breaking (perhaps with rocks) may be needed along the perimeter.
Lighter surface horizons will need greater protection than heavier underlying substrate. These could be stored in a different more protected location to the underlying substrates as long as they are well labelled.

The uppermost horizon, containing the seed bank, is the most problematic. If the above suggestions for collection are adopted, this will comprise a relatively low volume, but it is particularly important and erosion should be minimised. Covering with samphire or even dead vegetation is not an option, as this will affect the germinability of the seed bank. Also, we do not yet know how long the seed of many native species can remain dormant. Rather than let the piles remain inert for 4 years, it may be better to allow germination near the surface, so that the annuals present can re-seed into the mixture, enriching it further. This would require keeping the soil open, in a very sheltered location. Removing to a nursery situation could be one answer; perhaps some kind of specially prepared beds could be created near the site buildings even?

Mapping stockpiles, good documentation and labelling will be needed to ensure that soils horizons and soil types are not mixed and the correct soils re-applied.