



Assessing the status of the Large Scabious bee (*Andrena hatterfiana*) in North Cornwall

*Penhale Sands SSSI and Kelsey Head SSSI
– June to August 2016*

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Saving the small things that run the planet

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Executive Summary

The Large scabious bee (*Andrena hattorfiana*) is a declining species of solitary bee largely reliant on the pollen of Field Scabious (*Knautia arvensis*). *A.hattorfiana* is threatened in the UK and across its European range by the decline of wildflower-rich grassland. In a joint Internship project with the People's Trust for Endangered Species (PTES) and Buglife, surveys were carried out from June to August 2015 to assess the status of the Large scabious bee in north Cornwall, a county where it was thought to be facing local extinction. Surveys involved recording bee sightings, mapping potential foraging areas and mapping the connectivity of habitat for the Large scabious bee in the area based on the species' known foraging range.

The surveys revealed mixed fortunes for the Large Scabious bee in North Cornwall. A new stronghold was identified on Kelsey Head SSSI but this appears to be an isolated population. The species was not found on its historical range at the nearby Penhale Dunes SSSI, possibly due to changes in grassland management. These results indicate that urgent action is required to conserve the large scabious bee in Cornwall.

The new maps generated from these surveys have been used to identify opportunities for restoring and creating wildflower-rich habitat. Management recommendations have been made to inform habitat creation and restoration efforts to prevent the county extinction of the Large scabious bee and to increase its range in North Cornwall.

Introduction

The Large scabious bee (*Andrena hattorfiana*) (Fabricius, 1775) is listed provisionally as a Nationally Rare Species (pRDB3) and is included in Buglife's South West Bees Project (Horsley *et al*, 2013) as a species in need of regional conservation action. Although widespread in southern England, it has declined across most of its UK and European range due to habitat loss. In Cornwall, *A.hattorfiana* is restricted to the north coast, with a former stronghold at Penhale Dunes SSSI, alongside a population of Small scabious bees (*Andrena marginata*) (E.C.M.Haes 2004). However, a survey in 2014 revealed that suitable habitat for *A.hattorfiana* and *A.marginata* has been lost from the location of previous records in Penhale. There is an urgent need to confirm the current status of the population of both bees at Penhale.

The project aims to confirm the current status and distribution of *Andrena hattorfiana* and assess habitat suitability in and around Penhale Dunes SSSI, with a view towards instigating appropriate habitat management by landowners and land managers to aid conservation of this species in the local area. *Andrena marginata* was also sought as part of this project, since it depends on the same habitat as *A.hattorfiana*.

Species Description

The Large scabious bee (*Andrena hattorfiana*) (Plate 1) is a solitary bee, widespread in the Western Palearctic from southern Fennoscandia to North Africa and the Caucasus. In the UK, it occurs in southern England from Cornwall to Norfolk.



Plate 1-Male (Left) and female *Andrena hattorfiana*. Photos by author.

A.hattorfiana is a specialist pollen forager (oligolectic) on Field scabious (*Knautia arvensis*) and Small scabious (*Scabiosa columbaria*). The female bees stock these pollens in their nest as provisions for the developing larvae. As a result this bee is restricted to Scabious-rich habitats such as calcareous grassland, coastal dune and cliff-top grassland, traditional agricultural land (e.g. hay-meadows), moorland edges and road verges. It is the UK's largest mining bee (Andrenidae) at 13-16mm long. Like other *Andrena*, *A.hattorfiana* is a ground-nester, digging burrows into soft soil, though it is less reliant on bare (unvegetated) ground than other species.

As well as specialist foraging habits, *A.hattorfiana* has a slow reproductive rate (Larsson and Franzén 2007), small range-size and generally low population density (Franzén et al 2009, Else 2001) making this bee species vulnerable to environmental change (Biesmeijer et al 2006). The species has declined in many western-European countries due to the loss of Scabious-rich habitats to agricultural intensification, inappropriate grassland cutting regimes, overgrazing by livestock or rabbits, scrub encroachment and development. As a result, *A.hattorfiana* is provisionally listed as a Nationally Rare Species (pRDB3) in the UK (Falk 1991) and is included in Buglife's South West Bees Project (Horsely et al 2013) and Friends of the Earth's Iconic Bees Report (Evans and Potts 2013) as a species in need of regional conservation action.

Methods

Site selection

Sites were selected based on a combination of historic records for *Andrena hattorfiana* -using the Bees, Wasps and Ants Recording Society (BWARS) and Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) databases, satellite imagery (Google maps), and preliminary site visits to observe the distribution and availability of Field scabious (the main foodplant in this area). Preliminary site visits narrowed the search area down to Penhale Dunes SSSI, Kelsey Head SSSI and adjacent golf courses and road verges.

Field surveys

Field surveys were conducted from late June to late August 2015, during the flight period of *A.hattorfiana*. Areas of Field Scabious were logged with a handheld GPS (Garmin GPS 60) on the first visit to each site. These areas were classified either as 'Patches' (areas over 1m² with plants separated no more than 1m) or as 'Stepping Stones' (areas less than 1m² with at least 5 florets). Areas smaller than stepping stones were not recorded.

Each site was visited fortnightly to count the number of sightings of *A.hattorfiana* and to measure changes in the mean floret density of each scabious patch through the season. Scabious bee sightings were made incidentally as part of the floret density measurements and/or by staking out patches of scabious for 15 minutes. Incidental presence records of other pollinator species visiting the Field scabious were also made where these could be recognised in the field.

Mean floret density was measured as the number of open florets/m² by counting the florets within two to three randomly placed 1mx1m quadrats (Plate 2). An 'open floret' was defined as a floret with at least the outer ring of flowers open and available to pollinators before seed-set had begun.



Plate 2-measuring floret density within a patch of Field scabious.

Spatial analysis

Information from the GPS was analysed using QGIS software. In order to assess habitat connectivity for *A.hattorfiana*, buffers of 50m and 900m were applied to scabious patches, corresponding to the mean and maximum recorded foraging range of *A.hattorfiana* respectively (Franzen et al 2009). Where gaps were identified in the resulting connectivity map, locations for habitat restoration are suggested based on the mean foraging range of *A.hattorfiana*.

Results

Large scabious bee records

Just seven sightings of *Andrena hattorfiana* were made during the surveys. One male and four females were seen at Kelsey Head SSSI and the nearest sightings to Penhale Dunes SSSI were two isolated records of single females from a road verge and driveway at Gear Farm (Table 1). The locations are shown in Figure 2. No *A.hattorfiana* were seen on Penhale Dunes SSSI, Perranporth Golf Course or Holywell Bay Golf Course. One late female was found on August 28th at Kelsey Head.

Table 1- Details of *Andrena hattorfiana* sightings

Date	Site	Location	Details
19/07/2015	Kelsey Head SSSI	SW 77737 59514	1 Male, 1 Female
02/08/2015	Kelsey Head SSSI	SW 77737 59514	1 Female
02/08/2015	Kelsey Head SSSI	SW 78383 59420	1 Female
11/08/2015	Gear Farm	SW 77652 55465	1 Female
18/08/2015	Gear Farm	SW 77652 55465	1 Female
28/08/2015	Kelsey Head SSSI	SW 78383 59420	1 Female

Individuals were only observed on larger scabious patches with comparatively dense florets. None were observed on 'stepping stones'. No nests were located, but an individual sighted at Gear farm had substrate from the driveway deposited on its thorax, suggesting it was nesting in the driveway (Plate 3).

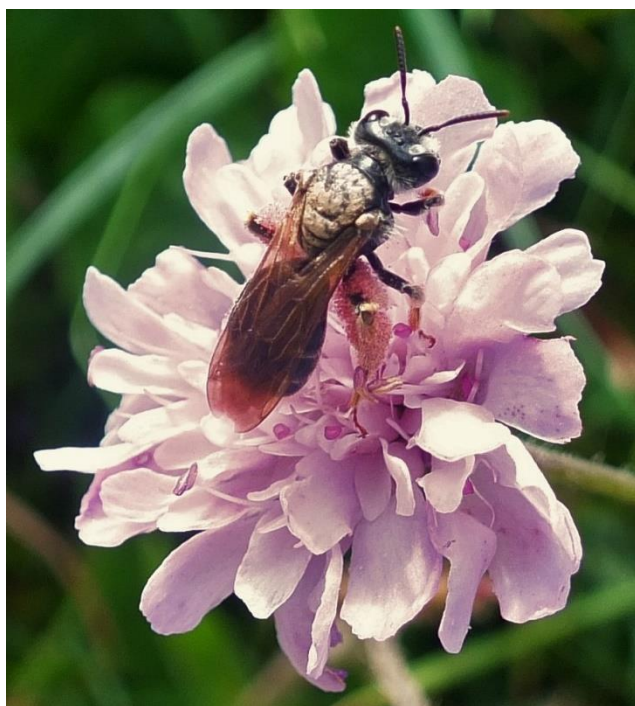


Plate 3. Female *Andrena hattorfiana* from Gear farm with substrate deposits on thorax, resulting from nesting in a driveway. Photo by author.

Spatial analysis

Survey site	Number of Patches
Penhale Dunes SSSI	4
Penhale Road verges	10
Kelsey Head SSSI	16
Holywell Bay Golf Course	2
Perranporth Golf Course	1
Gear Farm	8
TOTAL:	41

41 Field scabious patches were recorded in total. The number of patches on each survey site is recorded in Table 2 and are represented in Figures 1 and 2. Kelsey Head SSSI included the most Field scabious patches, with Perranporth golf course including the least with just one patch. Most scabious patches were found on less-accessible areas such as banks, ditches and Cornish hedges. In addition, another field with scabious patches was found on the outskirts of Cubert, could not be surveyed since the area was private land.

Table 2-Number of Field scabious (*Knautia arvensis*) patches on the survey sites.

When buffers corresponding to the mean foraging range are applied, there is a lack of both between-site and within-site habitat continuity. Applying buffers corresponding to the maximum foraging range in QGIS results in two distinct areas (Figures 1 and 2); The Penhale Sands SSSI-Gear Farm-Penhale road verges in the South and the Kelsey Head-Holywell Bay Golf course to the North. When buffers are applied around scabious patches, the Northern area extends to nearby towns, South of Cubert and South East to Holywell, almost bordering Penhale Dunes SSSI to the east, as well as to the coast on the North-West border. The distance between the closest known foraging patches of the two areas is around 4.7km. The maximum foraging range from bee sightings is more limited (Figure 2). The distance between bee sightings in the two areas is over 6.4km.

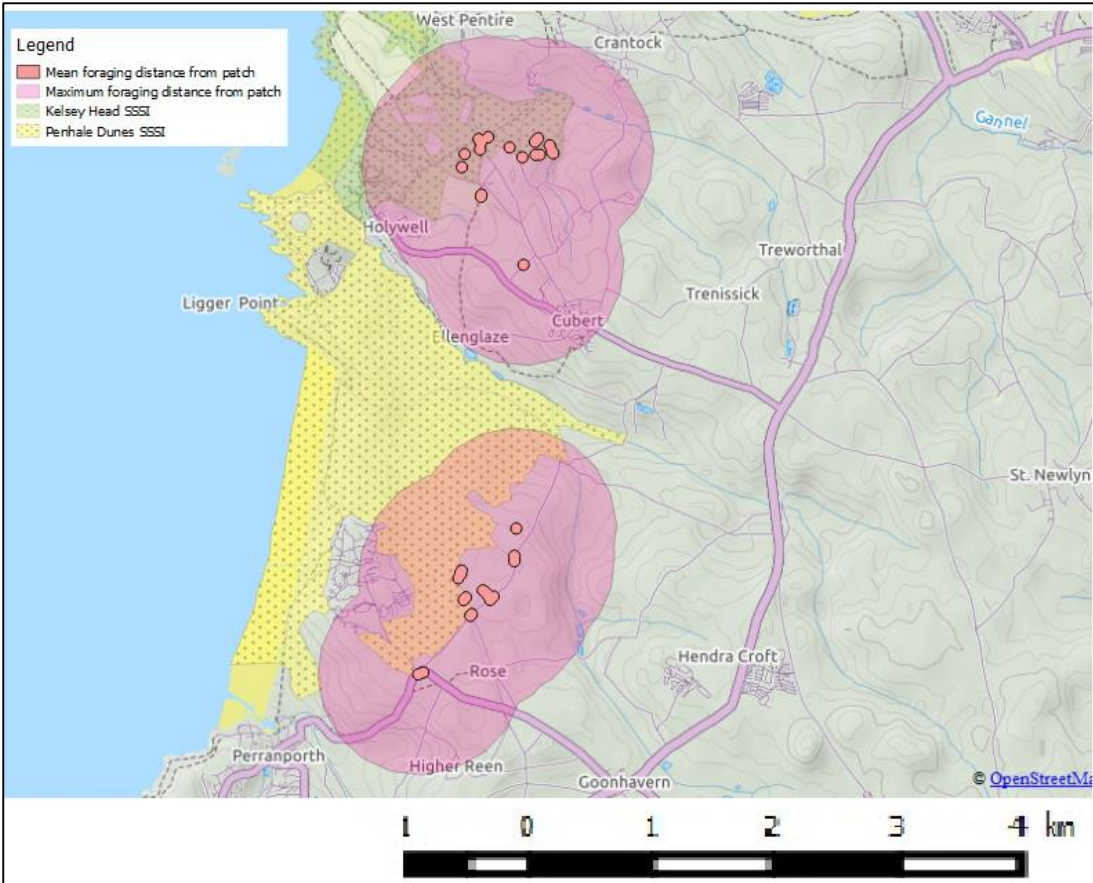


Figure 1- Projected foraging ranges of *Andrena hattorfiana* around recorded Field scabious patches in the survey area.

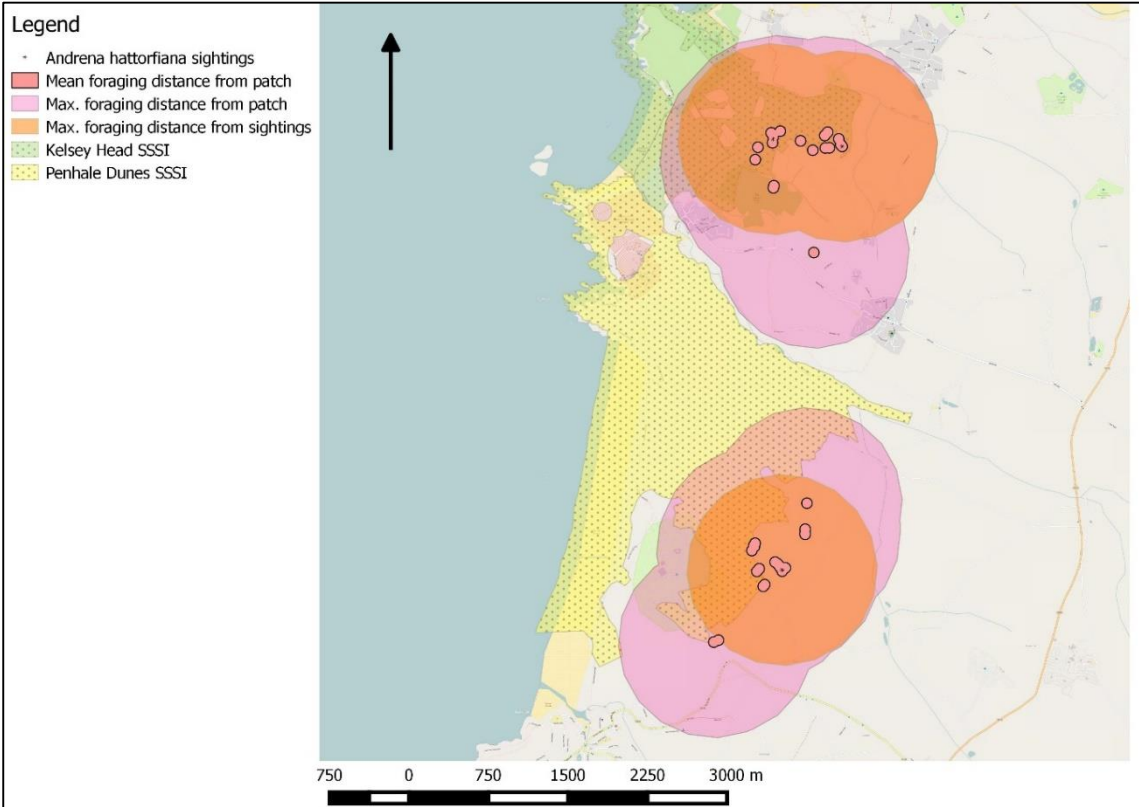


Figure 2. Projected foraging ranges of *Andrena hattorfiana* from recorded patches of Field scabious and *A. hattorfiana* sightings in the survey area.

Average floret density

The average floret density for each patch is recorded in Appendix 1. There was a temporal variation in floret density within patches. Following an apparent early seed set in late June, a second flowering peak was observed in Early August (Figure 3). At any one point during the survey, average floret density/m² ranged from 0 to 88 with the estimated number of florets in a patch reaching up to 1536 (Both these highest values being at Kelsey Head on the 2nd of August). None of the scabious was cut or grazed on the survey sites during the field season.

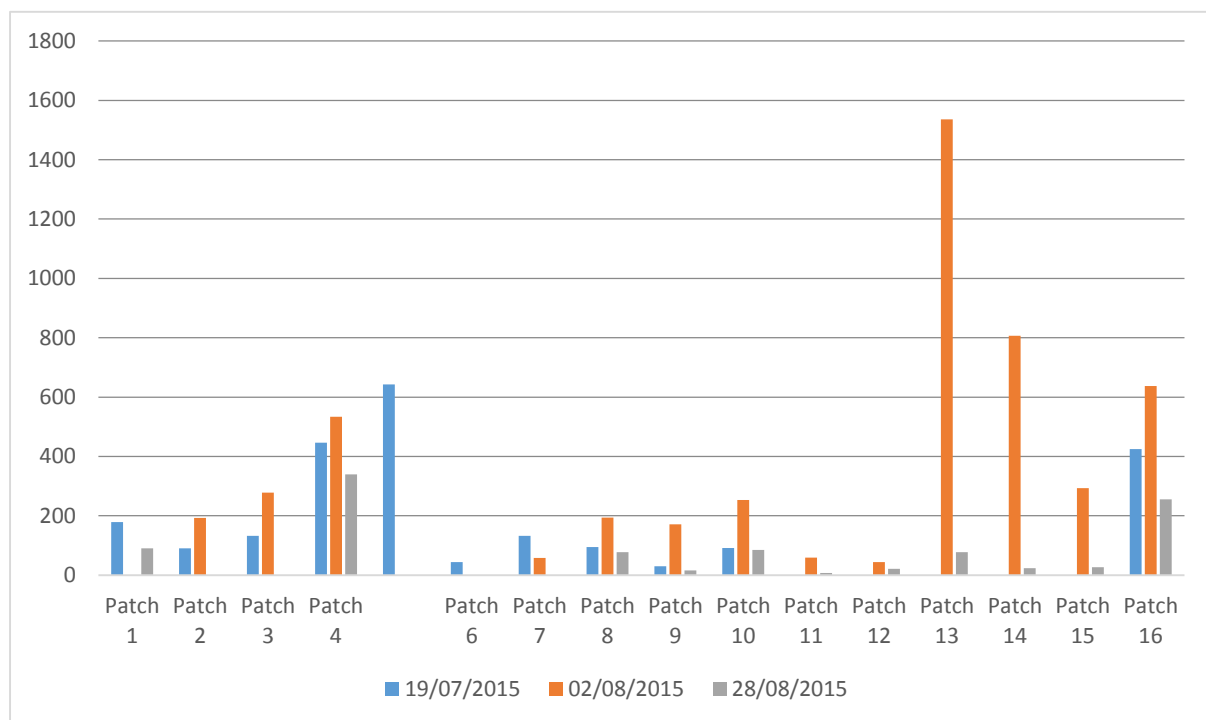


Figure 3—Changes in the density of florets within patches of Field scabious (*Knautia arvensis*) at Kelsey Head during the survey season.

Incidental species records

A wide range of pollinators were observed on Field scabious (Table 3). Field observations indicated that Field scabious was an important forage species for the Rare (RDB3) and Section 41 Bumblebee species; the Brown-banded carder bee (*Bombus humilis*) and Moss carder bee (*B. muscorum*) as well as the Section 41 Wall butterfly (*Lasiomata megera*) on the survey sites. The Small scabious bee (*Andrena marginata*) was not seen.

In addition to pollinators, the Great-green bush cricket (*Tettigonia viridissima*) and Bordered orb weaver spider (*Neoscona adianta*), appeared to show a preference for the habitat structure provided by the tall scabious plants within open grassland.

Table 3 -Incidental species records from Field scabious (*Knautia arvensis*)

Order	Species name	Common name	Location
Lepidoptera	<i>Mythimna litoralis</i>	Shore Wainscoat	Kelsey Head
	<i>Zygaena trifolii</i>	Five-spot burnet	Kelsey Head
	<i>Zygaena filipendulae</i>	Six-spot burnet	Penhale Sands, Kelsey Head
	<i>Callimorpha dominula</i>	Scarlet tiger	Kelsey Head
	<i>Thymelicus sylestris</i>	Small skipper	Penhale Sands, Kelsey Head
	<i>Ochlodes sylvanus</i>	Large skipper	Penhale Sands, Kelsey Head
	<i>Pieris brassicae</i>	Large white	Penhale Sands, Kelsey Head
	<i>Pieris rapae</i>	Small white	Penhale Sands, Kelsey Head
	<i>Argynnis aglaja</i>	Dark green fritillary	Holywell Bay Golf Course Penhale Sands, Holywell Bay
	<i>Lasiomata megera</i>	Wall	Golf Course
	<i>Pyronia tithonus</i>	Gatekeeper	Penhale Sands, Kelsey Head
	<i>Maniola jurtina</i>	Meadow brown	Penhale Sands, Kelsey Head
	Diptera	<i>Episyrphus balteatus</i>	Marmalade hoverfly
<i>Syrphus spp.</i>		A hoverfly	Penhale Sands, Kelsey Head
<i>Baccha elongata</i>			Penhale Sands, Kelsey Head
<i>Helophilus spp.</i>		Tiger hoverfly	Penhale Sands, Kelsey Head
<i>Eristalis spp.</i>		Drone fly	Penhale Sands, Kelsey Head
<i>Syritta pipiens</i>		Thick-legged Hoverfly	Penhale Sands, Kelsey Head
<i>Sicus ferrugineus</i>		Thick-headed fly	Penhale Sands, Kelsey Head
<i>Nowickia ferox</i>		A Tachinid fly	Kelsey Head
<i>Eriothrix rufomaculata</i>		A Tachinid fly	Penhale Sands, Kelsey Head
<i>Sarcophaga sp.</i>		Flesh fly	Penhale Sands, Kelsey Head
<i>Calliphora spp.</i>		Blowflies	Penhale Sands, Kelsey Head
Hymenoptera	<i>Halictus rubicundus</i>	Orange-legged Furrow-bee	Penhale Sands, Kelsey Head
	<i>Lasioglossum cf. calceatum</i>	Slender mining bee Vestal cuckoo	Penhale Sands, Kelsey Head
	<i>Bombus vestalis</i>	bumblebee	Penhale Sands, Kelsey Head
	<i>Bombus muscorum</i>	Moss carder bee Brown-banded carder bee	Kelsey Head
	<i>Bombus humilis</i>	bee	Penhale Sands, Kelsey Head
	<i>Bombus pascuorum</i>	Common carder bee	Penhale Sands, Kelsey Head
	<i>Bombus terrestris</i>	Buff-tailed bumblebee White-tailed	Penhale Sands, Kelsey Head
	<i>Bombus lucorum</i>	bumblebee	Penhale Sands, Kelsey Head
	<i>Bombus lapidarius</i>	Red-tailed bumblebee	Penhale Sands, Kelsey Head
	<i>Bombus hortorum</i>	Garden bumblebee	Penhale Road verge
	<i>Apis mellifera</i>	Honeybee	Penhale Sands, Kelsey Head

Coleoptera	<i>Rhagonycha fulva</i>	Red soldier beetle	Penhale Sands, Kelsey Head
	<i>Cteniopus sulphureus</i>	Sulphur beetle	Penhale Sands, Kelsey Head
Non-pollinator species			
Orthoptera	<i>Tettigonia viridissima</i>	Great-green bush cricket	Penhale Sands, Kelsey Head
	<i>Conocephalus discolor</i>	Long-winged conehead	Penhale Sands, Kelsey Head
Araneae	<i>Neoscona adianta</i>	Bordered orb weaver	Penhale Sands, Kelsey Head

Discussion

Scabious bee sightings

The low number of sightings of Large scabious bees from the survey sites is usual for this species. *Andrena hattorfiana* largely persists in small populations and at low population densities, especially in the UK (Franzen et al 2009, Larsson and Franzen 2007, Else 2001). Hence, the few sightings do not necessarily reflect an unsustainable population. This is exemplified by the opinion that Kelsey Head is a local stronghold based on these records and a finding of 9 individuals by county bee recorder Patrick Saunders in July (P.Saunders pers comms). However, the complete lack of finds from the former stronghold location of Penhale Dunes shows that it is still pertinent to consider the vulnerability of the population and include *A.hattorfiana* in conservation management targets for Kelsey head.

In addition, the rate of *A. hattorfiana* emergence varies through the active season. The County bee recorder, Patrick Saunders recorded 9 individuals from Kelsey Head on the 7th of July (P.Saunders pers. comms), suggesting that the total population could be larger than observations would suggest and that the peak emergence time may have been missed on this survey.

Weather conditions also affect the activity of solitary bees, since they require warm, sunny conditions to fly. Though ambient temperature was favourable and insolation was generally high on all site visits, the survey period was also a wet summer in general and the coastal locations were subject to buffeting winds which would create difficult flight conditions. Sweeping the vegetation around scabious patches for grounded individuals yielded no results. *A.hattorfiana* emergence can vary annually depending on the reproductive success of previous generations (Larsson and Franzen 2007). Repeated surveys over several years are recommended to gain a more accurate measure of the populations.

Most observations of *A.hattorfiana* were made whilst measuring or otherwise observing the patches rather than on arrival. This suggests that the methods employed in this survey confer a greater recording success for this species than a transect survey method.

Floret density

Measures of floret density revealed the continuity of the foraging resource for *A.hattorfiana*. None of the Scabious was cut or grazed on the survey sites, so forage was available to *A.hattorfiana* throughout their active season. Crucially, this also allowed seed-set, ensuring this floral resource is available for the next generation of *A.hattorfiana*.

Defining a patch by average floret density was a surrogate to the critical 20 florets per foraging area required by *A.hattorfiana* as defined by Franzen et al (2009). Franzen's measure was not used in this study since the change in floret density was being measured over time, with 'patch' being a fixed spatial reference. Only six 'patches' did not reach an estimate of 20 florets during the survey period, one at Penhale Sands SSSI, one at Penhale Golf course and 3 at Gear Farm (three of which were less than 2m²). Therefore by this measure all of the survey areas except Penhale Golf Course had sufficient forage resources to support *A.hattorfiana*.

Variations in floret density through time meant that the number of florets in a further 13 patches fell below the threshold required by *A.hattorfiana* at some point during the survey period. This variation in Scabious flowering through time emphasises the need for quantifying the number of available flowers at different points during the active season. More importantly, this temporal change in forage availability emphasises the need for large numbers of better connected patches to ensure sufficient forage is available for *A.hattorfiana* populations throughout the flight season.

A limitation of the method of the density measurement used in this study is that the distribution of florets within patches was uneven. In addition, counting florets from different random sampling points within the patches made the measures less comparable through time. The most accurate alternative measure would be to count the total number of florets in each patch, but this would be demanding and time consuming, especially for the larger and denser patches. However, regardless of the method of data collection, the changes in floret density were observable in the field.

Other pollinator species

Incidental records of other pollinators using Field scabious illustrate the importance of this plant for general pollinator diversity, including priority species. Field scabious is a particularly favourable plant for pollinators since each floret consists of several, nectar-rich flowers, offering a productive, clustered food resource.

The Section 41 priority bumblebees; Moss carder (*Bombus muscorum*) and Brown-banded carder (*B.humilis*) showed a clear preference for Field scabious. The section 41 Wall butterfly (*Lasiomatta megera*) also showed a preference for Field scabious on the survey sites.

The competition posed by these other pollinators is also an important factor to consider for *A.hattorfiana*, since they reduce the availability of scabious pollen for nesting females and their foraging success (Larsson and Franzen 2007). Assessing the intensity of competition on the survey sites was beyond the scope of this study, but was exemplified by an observation of 69 Six-spot burnet moths simultaneously nectaring on a single scabious patch in Penhale Dunes. Promoting the coverage of flowering Scabious to increase the floral resource will both benefit the wide range of

pollinators observed, and reduce the intensity of competition with *A.hattorfiana*.

The complete lack of *A.marginata* records indicate this bee has already become locally extinct. The pollen requirements for this species are unknown, though its smaller body size means it possibly has a more restricted foraging range (Gathmann and Tschardt 2002), explaining why *A.hattorfiana* has persisted whilst *A.marginata* has not. Surveys on the other two known sites in Cornwall (Woon gumpus common and Gwitihian Towans) in 2013 have failed to find this species, so it is likely to be extinct in the county (P.Saunders pers comms).

Spatial analysis

The buffer analysis revealed that there is no remaining connectivity between Penhale Dunes SSSI and Kelsey Head SSSI, effectively isolating the population at Kelsey head from those observed at Gear farm. Though it is possible that patches on private land adjacent to the road verges were missed, these are likely to be small patches restricted to Cornish hedges, which will support few, if any Large Scabious bees.

The mean foraging range is a more realistic measure of connectivity, since it is closer to the normal daily movements of the bee. There is no between-site connectivity at this finer scale, and there is a lack of contiguous habitat within sites. Even at Kelsey head, which supported the greater number of patches of Field scabious, foraging areas are largely divided between the two areas where *A.hattorfiana* were sighted. This means that individual female bees are reliant on a few patches or must forage further than normal, reducing their foraging efficiency. More crucially at the landscape scale, this means there is potentially a lack of gene flow between populations, with the potential for inbreeding depression making the populations less sustainable (although the dispersal behaviour of males is not known).

The insights provided by these buffer maps illustrate the need to improve habitat connectivity for *A.hattorfiana* in the area in order to a) conserve existing populations and b) restore *A.hattorfiana* to its former local range, namely Penhale Dunes SSSI.

Habitat management recommendations

The species records and habitat mapping from the surveys illustrate that action is imperative if the Large scabious bee is to be conserved in North Cornwall. Based on the results of these surveys, four main priorities have been identified:

1- Prevent the extinction of *Andrena hattorfiana* in North Cornwall by safeguarding the known population at Kelsey Head.

2-Restore the historical population of *Andrena hattorfiana* at Penhale Dunes SSSI by restoring and creating a habitat corridor from Kelsey Head to enable their return and form a meta-population between the two sites.

Priority 1 is essential for preventing the extinction of *A.hattorfiana* in the local area, and potentially

across Cornwall. Priority 2 focuses on restoring *A.hattorfiana* to some of the species historical range and most importantly, establishing a more robust population less vulnerable to environmental change.

In order to fulfil these priorities, the limiting factors on *A.hattorfiana* populations in the area need to be understood and alleviated. Bee populations are mostly dependant on the availability of forage and nesting habitat.

Unlike most other other mining bees which require bare substrates for nesting, *A.hattorfiana* nests in a variety of situations (Larsson and Franzen 2007), so the major limiting factor on their populations in the survey area is the availability of Field scabious. The decline of *A.hattorfiana* in Western Europe has been linked to declines in this host plant (Abrol 2011). To increase the available habitat, land within the foraging range of existing populations should be restored to Scabious-rich grassland where there is potential to do so.

Field scabious growth can be promoted by avoiding cutting and grazing from mid-April to mid-September to allow the plants to flower and set seed, and removing the arisings to reduce the growth of rank vegetation (Buglife 2013). Later cutting times or a complete lack of cutting (providing scrub encroachment is controlled) is the most beneficial (Franzen and Nilsson 2004). This management may also benefit other late-flowering species important to pollinators, including common fleabane (*Pulicaria dysenterica*), Viper's Bugloss (*Echium vulgare*) and Knapweeds (*Centurea sp.*). For more detail see Appendix 2.

Scabious cover can also be increased by planting or seeding. Care should be taken to use plants or seeds with local provenance. Planting can achieve faster results (flowering time) without the need to disturb the ground to create a seedbed.

Within site management

On all sites, connectivity between scabious patches needs to be improved at the scale of the median foraging range of *A.hattorfiana*. Actions vary depending on the nature of the sites, such as size, designations and pressures. For example, planting or seeding Field scabious on SSSI's may not be possible due to issues of local provenance of the plants. Due to issues of local provenance. Proposed actions for each site are detailed below.

Kelsey Head SSSI

The current management regime should continue in order to promote the growth of scabious at Kelsey Head. This site provides a good example for the management of late-flowering calcareous grassland. However, the within-site connectivity could be improved for *A.hattorfiana*. A focus on planting or seeding areas with Field scabious between known foraging patches will improve the viability of the bee's population on this site.

Holywell Bay Golf course

The path-side banks are already favourable habitat for *A.hattorfiana*, so current management should continue. Some targeted management of scrub may be necessary to prevent its spread.

There is potential to plant the grass-dominated roughs of the golf courses with Field Scabious and manage them sympathetically as wildflower patches. The 'island' formation of the roughs may provide suitable foraging patches. Furthermore, the site is in an ideal location for extending the available habitat for *A.hattorfiana* and other pollinators since it is adjacent to Kelsey head and

includes a central strip of suitable habitat. The possibility of planting in this area is currently being explored.

Penhale Dunes SSSI

The major factor in maintaining the early-successional grassland and suppressing taller vegetation growth at Penhale Dunes SSSI is rabbit grazing, and to a lesser extent public disturbance and conservation grazing with ponies (The latter causing the loss of a former *A.hattorfiana* habitat area on the site).

The early-successional grassland is a desirable habitat, supporting several target plant and invertebrate species and allowing public access across the site. Therefore, any management to increase Scabious growth at Penhale Dunes should occur at a small scale. This may be achieved by creating grazing exclusion zones with rabbit-proof fencing, either planted or seeded with Field scabious. If these are implemented they should be small enough so as to not significantly restrict access on the site, but close enough to form a connected foraging habitat for *A.hattorfiana* (at most 50m apart).

The planting of *Knautia* cultivars has also been suggested as part of bee-friendly landscaping initiatives at Perran Sands Holiday Park (J. Cripps and P. Saunders pers comms.) However, it is not known if *A.hattorfiana* will forage from these.

Road verges

A key component towards increasing the local range of the Large scabious bee would be sympathetic management of road verges, providing linear habitat which can connect larger habitat patches. The grass verges in the survey area are well-managed for Scabious, since they are left uncut. However, although Field scabious is widespread along these verges, there are few large patches, which are poorly connected at the landscape scale. Increasing the number of patches by planting clusters of Field scabious in at least 50m intervals will provide a potential highway for *A. hattorfiana*, providing a refuge from the adjacent agricultural land and contributing to a potential connection between Panhale Dunes and Kelsey Head. The value of road verges may still be limited by pesticide spray drift from agricultural land.

Between-site connectivity

It is reasonable to assume that the entire survey area (Perranporth Golf Course to Kelsey Head) formerly supported a metapopulation of Large scabious bees, before land-use change decreased the availability of Field scabious. Large scabious bees could potentially benefit from restoring Scabious-rich habitats anywhere within the 900m foraging ranges marked in Figure 2, but to be successful in the long term, habitat restoration and creation efforts should be focussed in areas where they are most achievable and more likely to be maintained.

Any efforts to expand the available habitat for *A.hattorfiana* and improve landscape connectivity are restricted by the surrounding habitats and land-use. Aside from the Nature Reserves, the surrounding use is mainly arable (Brassica and Asparagus fields) or pasture (equestrian and cattle). Both land uses remove Field scabious, restricting it to Cornish hedges and road verges (although medium horse-grazing adjacent to scabious patches can offer suitable nesting habitat (Larsson and

Franzen 2007)). Therefore the creation of Scabious-rich foraging habitat will have to make use of these linear border features or circumvent this agricultural land entirely.

In addition, much of the land immediately surrounding the sites is Leisure Park (e.g. Holiday Parks and Golf courses) which mainly feature close-cut amenity grasslands. There is the potential to provide corridors or stepping stones through these grounds by promoting the creation of wildflower meadow areas in the holiday parks and by utilising the roughs of the golf courses.

The major natural barrier to Field scabious growth is the maritime grassland to the West which has soils that are too infertile and saline to support the plant. Therefore the coastline does not offer a potential corridor for *A.hattorfiana*.

Accounting for these restrictions, there are two ways to connect Kelsey Head SSSI to Penhale SSSI; To increase the growth of Field scabious on road verges and to promote the growth of Field scabious on Penhale Dunes SSSI itself.

Surveys revealed that the road verges did not support *Andrena hattorfiana* (except at Gear Farm) and that scabious patches along the verges didn't form a contiguous foraging area. More scabious is needed. Road verges cannot be solely relied upon to connect the two areas, since much of the stretch between Penhale Dunes SSSI and Kelsey Head SSSI is wooded, preventing scabious growth and presenting a barrier to dispersal of *A.hattorfiana*. Therefore, the formation of a corridor between Kelsey Head and Gear farm will also require sympathetic management on Penhale Dunes SSSI (Figure 4).

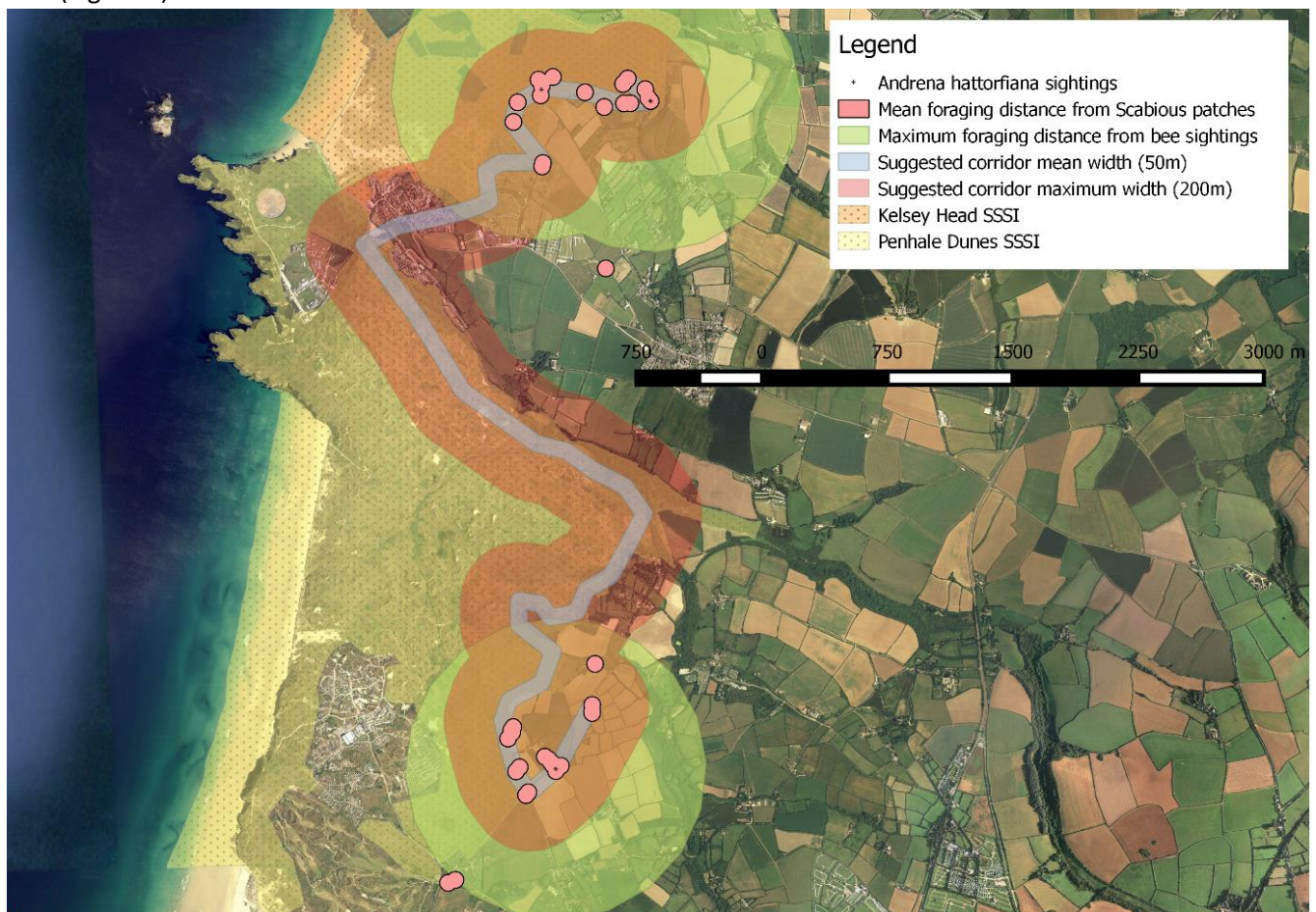


Figure 4-Proposed corridor for the restoration and creation of Field scabious-rich grassland for *Andrena hattorfiana* between Kelsey Head SSSI and Penhale Dunes SSSI.

Where possible, the suggested corridor passes through SSSI land, since these areas are managed for conservation. Woodland, thick scrub and farmland have been generally avoided by the central line. However, the sympathetic management of Cornish hedges and pasture on a landscape scale could offer ideal connecting habitat if land owners and land managers are willing to maintain them for Scabious growth. The suggested corridor also skirts around a caravan site-part of Holywell Bay Holiday park. This site could also be incorporated with appropriate management (e.g. growing Field scabious in beds and borders.).

A potential barrier to this corridor is the dune grassland where the two SSSI's border each other around Holywell Bay (SW767591) which is unsuitable for Field scabious growth (Figure 5). One option to avoid this is to include Holywell Bay Holiday Park as a shorter route into the Golf course. This alternative route will encompass some rough grassland fields which could also be restored into Scabious-rich habitat.

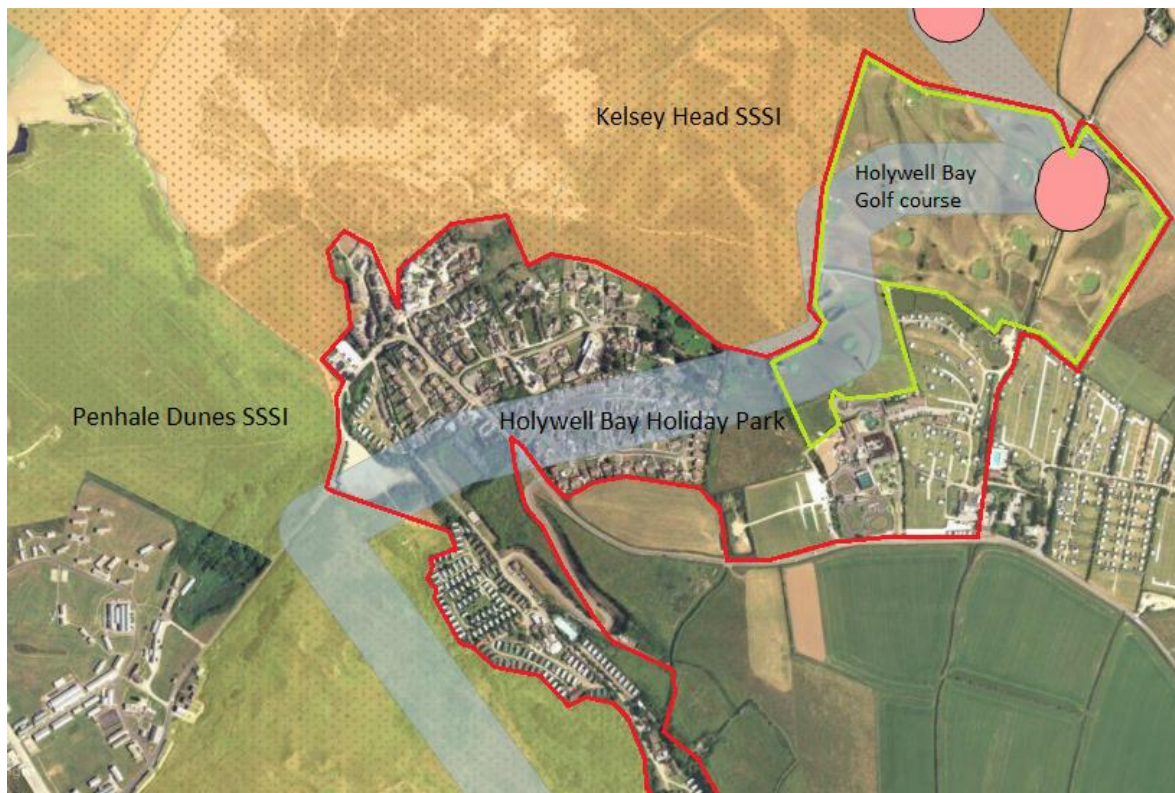


Figure 5- Aerial map of Holywell Bay showing proposed corridor (blue) and potential barriers. The pale pink spots show Field scabious patches with the median foraging range buffer.

Monitoring

To prevent the extinction of *Andrena hattorfiana* at Kelsey Head, it is important that they continue to be monitored to evaluate the health of the population and identify any downward trends which would indicate that action is needed. *A.hattorfiana's* relatively distinctive appearance makes it suitable for monitoring by non-experts with some prior training, for example via a training day for the land managers and volunteers. Monitoring could be extended to encompass the suggested habitat corridor.

The population should be monitored annually during the active period (June to August) by walking

transects of the reserve and stopping at patches of Field scabious to record visiting individuals. Records should be submitted to BWARS and ERCCIS.

Conclusion

This 2015 survey for *Andrena hattorfiana* has revealed both positive and negative results for the species in Cornwall. It is reassuring to identify a stronghold population in Cornwall, living on an appropriately managed nature reserve when the species was thought possibly extinct in the county. However, this appears to be a small, isolated population and confirmation of the species loss from a former site illustrates that care must be taken to conserve *A.hattorfiana* in the local area. Local action is essential to conserve *Andrena hattorfiana* in Cornwall and help reduce the species' national decline. Fortunately an understanding of the species ecology and the relative ease of restoring suitable habitat makes implementing such conservation action readily achievable by working with local landowners and land managers. This report presents information that should be helpful to planning both immediate and long-term conservation efforts for *Andrena hattorfiana* in North Cornwall.

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Appendix

Appendix 1- Field Scabious Patch data

Kelsey Head							
Patch	Area (m ²)	Floret count (1m ²)	Total calculated florets	Floret count (1m ²)	Total calculated florets	Floret count (1m ²)	Total calculated florets
		19/07/2015	19/07/2015	02/08/2015	02/08/2015	28/08/2015	28/08/2015
Patch 1	6.2	29.0	178.6	0.0	0.0	14.7	90.3
Patch 2	6.8	13.3	90.1	28.5	192.7	0.0	0.0
Patch 3	9.9	13.3	132.3	28.0	277.8	0.0	0.0
Patch 4	9.1	49.0	445.9	58.7	533.9	37.3	339.8
Patch 5	9.0	71.7	642.1	0.0	0.0	0.0	0.0
Patch 6	1.4	31.3	43.9	0.0	0.0	0.0	0.0
Patch 7	5.3	25.0	132.0	11.0	58.1	0.0	0.0
Patch 8	3.3	29.0	94.3	59.5	193.4	0.0	0.0
Patch 9	2.0	15.5	30.2	88.0	171.6	8.0	15.6
Patch 10	5.3	17.3	91.5	48.0	253.4	16.0	84.5
Patch 11	21.6	19.7	424.8	0.0	0.0	0.0	0.0
Patch 12	1.5	NA	NA	39.0	58.5	4.5	6.8
Patch 13	2.6	NA	NA	17.0	44.2	8.0	20.8
Patch 14	48.5	NA	NA	31.7	1536.2	0.0	0.0
Patch 15	29.2	NA	NA	27.7	806.5	0.0	0.0
Patch 16	7.4	NA	NA	39.3	292.6	0.0	0.0

Gear Farm					
Patch	Area (m ²)	Floret count (1m ²)	Total calculated florets	Floret count (1m ²)	Total calculated florets
		19/07/2015	18/07/2015	11/08/2015	11/08/2015
Patch 1	7.3	1.3	9.5	0.0	0.0
Patch 2	11.0	10.26	112.9	3.4	37.4
Patch 3	12.0	3.36	40.3	5.6	67.2
Patch 4	13.0	1	13.0	0	0.0
Patch 5	2.0	42.9	85.8	24.3	48.7
Patch 6	2.7	3.6	9.6	1.2	3.2
Patch 7	10.5	1.6	16.8	0.0	0.0
Patch 8	2.7	2.5	6.7	0.0	0.0

Penhale							
Patch	Area (m ²)	Floret count (1m ²)	Total calculated florets	Floret count (1m ²)	Total calculated florets	Floret count (1m ²)	Total calculated florets
		19/07/2015	19/07/2015	02/08/2015	02/08/2015	28/08/2015	28/08/2015
Patch 1	2.1	7.5	15.8	37.0	77.7	5.0	10.5
Patch 2	1.8	35.0	63.0	10.0	18.0	3.0	5.4
Patch 3	31.9	14.0	446.9	38.0	1213.0	11.0	351.1
Patch 4	22.3	0.0	0.0	9.7	215.8	4.7	104.2
Patch 5	7.9	0.0	0.0	6.0	47.5	6.3	50.2

SPECIES MANAGEMENT SHEET

Armed nomad bee

(*Nomada armata*)



The Armed nomad bee is a 'cuckoo' (cleptoparasite) on the Large scabious mining bee (*Andrena hattorfiana*), its 'host'. Both bees have declined substantially, and because the Armed nomad bee is so rare it is a Section 41 Conservation Priority Species. The Large scabious mining bee forages almost exclusively on Field scabious and Small scabious, and so these plants are critical to the survival of both species.

Life cycle

Adult Armed nomad bees fly from late June till early August, which coincides with the peak of activity of its host the Large scabious mining bee, and the flowering of scabioues. Females seek out nests of the host, enter and lay an egg in a nest. The resulting larva then uses the host's food to grow. The larva eventually pupates and overwinters within the host's nest, emerging as an adult the following summer.

Distribution map

The Armed nomad bee has always been much more restricted than its host, which has a long

history in areas like the South Downs, North Downs and East Anglia where the Armed nomad has had little if any historical presence. Today it is almost entirely restricted to Salisbury Plain which offers a vast quantity of scabious-rich calcareous grassland. There are also more isolated recent records from North Hampshire and it may still survive in Oxfordshire.

Habitat

The preferred habitat is calcareous grassland that is not intensively grazed in summer, or cut for hay, and has an abundance of scabioues. Both the Armed nomad bee and its host have also occurred on less calcareous coastal grassland and coastal heathland in southern England and Wales in the past.

Reasons for decline

The loss, fragmentation and deterioration of scabious-rich habitats through agricultural improvement, development and inappropriate management. Scabioues are particularly vulnerable to overgrazing.



Post 1980 Dark green, pre1980 light green



Scabious-rich chalk grassland on Salisbury Plain where a strong Armed nomad bee population is present (left). Chalk grassland of the South Downs where the host still persists at low levels (right).

Habitat management

- Maximise the abundance of flowering scabiouses between June and August by avoiding grazing and cutting between 15 April and 15 September
- In species-rich grassland, avoid applying fertilizers and herbicides and remove arisings that result from any cutting
- Known or potential nesting areas should be kept free of encroaching vegetation such as coarse grasses, bramble or scrub
- Create new scabious-rich areas on former species-poor grassland, or through arable reversion and seeding and planting of scabious
- A well-designed Farm Environment Plan could be crucial in providing stepping stones and corridors to link suitable sites

Environmental Stewardship options (with promotion of scabiouses as a primary target)

Note other options may also be suitable depending on individual sites. These options are available in England, although Wales and Scotland have similar schemes in place.

HLS options

- HE10** - Floristically enhanced grass buffer strips
- HE11** - Enhanced strips for target species on intensive grassland
- HF1** - Management of field corners
- HF4** - Nectar flower mixture

- HF9** - Unfertilised cereal headlands within arable fields
- HF14** - Unharvested, fertiliser-free conservation headland
- HF20** - Cultivated fallow plots or margins for arable plants
- HJ3** - Arable reversion to unfertilised grassland to prevent erosion or run-off
- HK6/7/8** - Maintenance/restoration/creation of species-rich, semi-natural grassland
- HK15/16/17** - Maintenance/restoration/grassland for target features

HLS capital item

- GS** - Native seed mix

ELS options

- EE1-6/OEE1-6** - Buffer strips on cultivated land/intensive grassland
- EF1** - Management of field corners
- EF4/EG3** - Nectar flower mixture on arable land or grassland areas
- EF9** - Unfertilised cereal headlands
- EK3** - Permanent grassland with very low inputs
- EF2/EG2** - Wild bird seed mixture on arable land or grassland areas (with the addition of Field Scabious and Small Scabious)

References and further information

This sheet can also be accessed on the web at www.buglife.org.uk
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