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# The status and distribution of the ground beetle *Harpalus melancholicus* at Stackpole Warren in 2017

Mark G. Telfer

NRW Evidence Report No. 247



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Report series: NRW Evidence Report  
 Report number: 247  
 Publication date: March 2018  
 Contract number:  
 Contractor: Dr M.G. Telfer  
 Contract Manager: Dr M.A. Howe  
 Title: **The status and distribution of the ground beetle *Harpalus melancholicus* at Stackpole Warren in 2017**  
 Author(s): **Mark G. Telfer**  
 Restrictions: None

**Distribution List (core)**

NRW Library, Bangor	2
National Library of Wales	1
British Library	1
Welsh Government Library	1
Scottish Natural Heritage Library	1
Natural England Library (Electronic Only)	1

**Distribution List (others)**

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**Recommended citation for this volume:**

Telfer, M.G. 2018. The status and distribution of the ground beetle *Harpalus melancholicus* at Stackpole Warren in 2017. NRW Evidence Report No: 247, 26 pp, Natural Resources Wales, Bangor.

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## 1. Crynodeb Gweithredol

Mae Cwningar Ystafbwl yn cynnal yr unig boblogaeth hysbys ym Mhrydain o'r chwilen ddaear mewn perygl *Harpalus melancholicus*, bwytawr-hadau Ystafbwl. Comisiynwyd yr arolwg hwn er mwyn ceisio pennu ei statws a'i dosbarthiad cyfredol ar Gwningar Ystafbwl. Cynhaliwyd archwiliadau daear yn ystod y dydd a'r nos rhwng 22 a 23 Awst 2017. Arsylwyd ar wyth i ddeg *H. melancholicus* unigol, i gyd yn ystod y nos. Mae hyn yn nodedig ar gyfer rhywogaeth nad yw ond yn hysbys yng Nghwningar Ystafbwl o bedwar unigolyn a gofnodwyd rhwng 1992 a 2015. Mae'r arolwg hwn wedi gwneud llawer er mwyn nodi nodweddion y cynefin lle mae'r *H. melancholicus*, yn byw, gydag oedolion ond wedi'u cofnodi ar ddwy lain fach o gynefin lle mae troed twyn tywod â llystyfiant yn ymestyn dros galchfaen sy'n brigo. Mae'r arolwg hwn hefyd wedi cadarnhau bod *H. melancholicus* yn bwyta hadau, gyda'r Peradyl Blewog *Leontodon saxatilis* ac yn fwy na thebyg teim *Thymus* sp. yn eitemau bwyd. Y ddamcaniaeth yw bod *H. melancholicus* yn arbenigol iawn yn ecolegol, gyda phresenoldeb ysbeidiol yng Nghwningar Ystafbwl, ond bod lleiniau ychwanegol o gynefinoedd lle maent yn byw yn parhau i fod heb eu darganfod eto. Cyflwynir damcaniaethau eraill hefyd.

Gwneir argymhellion ar gyfer monitro rheolaidd o'r boblogaeth hysbys, ac arolwg pellach i ddarganfod poblogaethau eraill mewn mannau eraill yn Ystafbwl ac ar faes Castellmartin. Gwneir argymhellion hefyd ar gyfer defnyddio dulliau archwilio'r ddaear yn ystod y nos a monitro ar gyfer *H. melancholicus*, gan adeiladu ar wybodaeth newydd am batrymau gweithgarwch dyddiol a thymhorol. Mae dal mewn magl a dal â golau yn cael eu trafod fel dulliau amgen neu ychwanegol ar gyfer arolygu.

## 2. Executive Summary

Stackpole Warren supports the only known British population of the Endangered ground beetle *Harpalus melancholicus*, the Stackpole Seed-eater. This survey was commissioned to attempt to determine its current status and distribution on Stackpole Warren. Diurnal and nocturnal ground-searching was carried out on 22<sup>nd</sup> to 23<sup>rd</sup> August 2017. Eight to ten individuals of *H. melancholicus* were observed, all at night. This is noteworthy for a species otherwise known at Stackpole Warren from only four individuals recorded between 1992 and 2015. This survey has done much to characterise the habitat occupied by *H. melancholicus*, with adults recorded only from two small patches of habitat where the toe of a vegetated sand-dune encroaches over outcropping limestone. The survey has also confirmed that *H. melancholicus* is a seed-eater, with Lesser Hawkbit *Leontodon saxatilis* and probably thyme *Thymus* sp. as food items. It is hypothesised that *H. melancholicus* is ecologically highly specialised, with a patchy occurrence at Stackpole Warren, but that additional occupied habitat patches remain to be discovered. Alternative hypotheses are also presented.

Recommendations are made for regular monitoring of the known population, and further survey to discover other populations elsewhere at Stackpole and on Castlemartin Range. Recommendations are also made for the use of nocturnal ground-searching in survey and monitoring for *H. melancholicus*, building on new information on diurnal and seasonal activity patterns. Pitfall-trapping and light-trapping are discussed as potential alternative or supplementary survey methods.



### 3. Introduction

Prior to 1980, the Endangered ground beetle *Harpalus melancholicus* was known from a scattering of mostly coastal localities in southern England and South Wales. In Wales, it was found at Conwy in 1857 and at Tenby in 1894. There were no records from anywhere in Britain between 1964 and July 1992, when *H. melancholicus* was discovered on Stackpole Warren “under stones on more or less bare sand with *Thymus* sp., in an area of sand dunes where the limestone bedrock formed an exposed outcrop” (Harrison, 1994). A male and female were recorded at the same locality on 16<sup>th</sup> August 1999, and a single adult (Figure 1) was found at night close to here and in similar habitat on 28<sup>th</sup> May 2015 (Hodgkins & Telfer, 2015; Telfer, 2016) (Table 1). The only other recent British record is from Bewl Water Sussex Wildlife Trust reserve when a single adult was found in a light trap on the night of 12<sup>th</sup> - 13<sup>th</sup> August 2003 (Telfer, 2016). Nothing is known of the species’ ecological requirements although other members of the genus feed on plant seeds.



Figure 1. *Harpalus melancholicus* Dejean, 1829 is a beetle in the family Carabidae known as carabids or ground beetles.

Table 1: Records of *Harpalus melancholicus* from Stackpole Warren.

Site	Grid Reference	Date	Recorder	Abundance
Stackpole Warren	SR978943	5 <sup>th</sup> July 1992	Tom Harrison	1
Stackpole Warren	SR978943	16 <sup>th</sup> August 1999	Tony Allen & John Owen	1♂ + 1♀
Stackpole Warren	SR9799994235	28 <sup>th</sup> May 2015	Mark Telfer	1♀

The conservation statuses of British ground beetles were reviewed by Telfer (2016) who assessed *Harpalus melancholicus* as Endangered (EN) on the basis of its substantial decline and very small and much contracted area of occupancy. The Bewl Water singleton may have been a migrant or dispersing individual, and efforts to locate a population of *H. melancholicus* at this site have gone unrewarded. Stackpole Warren thus supports the only known British population. Understanding the status, distribution and ecological requirements of *H. melancholicus* at Stackpole is essential for the conservation of this species in Wales and in Britain.

### 3.1. Survey timing

Work on a different but congeneric ground beetle, *Harpalus froelichii* (a Biodiversity Action Plan species), discovered that early- to mid-August was the season of greatest abundance for this species (Telfer, 2004), despite that most records of the species were from May and June when coleopterists tend to be at their most active. In *H. froelichii*, many fresh adults emerge from the pupal stage in August which means the population is then at its densest, whereas by the spring and early summer of the following year, dispersal and mortality has reduced the population density, and any further recruitment of freshly-emerged adults is more limited.

The timing of this survey work, on 22<sup>nd</sup> and 23<sup>rd</sup> August 2017, was based on an expectation that *H. melancholicus* would have a similar phenology to *H. froelichii*. The records on 12<sup>th</sup> to 13<sup>th</sup> August (Bewl Water) and 16<sup>th</sup> August (Stackpole Warren - Tony Allen and John Owen) lend support to this.

### 3.2. Vernacular name

*H. melancholicus* does not yet have a vernacular name in English or Welsh. The author has been gradually devising and introducing English names for carabids and the name 'seed-eater' for members of the genus *Harpalus* is reasonably well-established. Melancholy Seed-eater would be a possible name for *H. melancholicus* but I propose that Stackpole Seed-eater becomes the English name for this species. It has the advantage of being alliterative and euphonious. Although it accurately describes the current known range of this species, it is to be hoped that further populations of *H. melancholicus* will be discovered elsewhere, and the name may come to seem out of date.

### 3.3. Survey requirements

A survey is required to attempt to determine the current status and distribution of *H. melancholicus* on Stackpole Warren. The initial target will be to re-find the species in the area where it has been recorded previously, then to widen the search to cover other areas of suitable habitat. The search area, and the distribution of *H. melancholicus*, will be mapped with GPS. Where *H. melancholicus* is found, notes and photographs of the habitat structure and vegetation will be taken.

## 4. Methods

Most species of carabid are more active in the dark and experience in May 2015 had shown that *H. melancholicus* was easier to find by torchlight searching than in the daytime. Thus, the survey methodology in August 2017 was to spend some time

ground-searching by day but also to use this time as a reconnaissance of areas to be re-visited after dark for torchlight searching.

Daytime ground-searching was largely carried out on hands and knee-pads, looking under any loose stones, looking under leaf-rosettes and around the roots of plants, scuffing through the surface vegetation and attempting to find carabids in their resting places. Torchlight searching was also carried out on hands and knees using a very bright headtorch, scanning for surface-active beetles out in the open.

#### 4.1. Taxonomic coverage

*Harpalus melancholicus* was the main target of survey effort but other invertebrates were recorded as appropriate, including all other beetles. Such records of other invertebrates may help to clarify, by association, the habitat requirements of *H. melancholicus*.

#### 4.2. Identification

Where practical, invertebrates were identified in the field but wherever the slightest doubt existed, one or more specimens were collected, or photographs taken, for more detailed scrutiny. To achieve rigorously accurate identifications, specimens were identified using the surveyor's own library and entomological collection. Selected specimens have been retained in the surveyor's personal collection as vouchers.

## 5. Results

### 5.1. Fieldwork diary

A daytime survey and reconnaissance visit to Stackpole Warren was made from 15.45 to 19.30 on Tuesday 22<sup>nd</sup> August 2017 on a warm, dry, sunny day with 2/8 cover of cirrus cloud and a fresh onshore breeze (F5). The key area for *H. melancholicus* is a linear exposure of limestone at the top of a shallow, south-facing valley slope (Figure 2 & 3). This is where I had found a single *H. melancholicus* on 28<sup>th</sup> May 2015, and also it seems (from descriptions) where Tom Harrison and Tony Allen recorded *H. melancholicus* in 1992 and 1999 respectively. A 47-minute ground-search along the limestone exposure yielded only three carabids: 2 adults of *Harpalus anxius* and 1 adult *Calathus fuscipes*. The rest of the daylight time was spent reconnoitring for other areas of potentially suitable habitat in the vicinity of the limestone exposure and in areas to east and west (Figure 4).

A nocturnal search was conducted from 21.05 on 22<sup>nd</sup> August to 03.45 on 23<sup>rd</sup> August. Between 21.32 and 22.32, I crawled on hands and knees along most of the length of the exposed limestone. This yielded carabids in much greater numbers than the earlier daytime searching of the same ground. The torchlight search yielded the following (daytime counts in brackets): 22 (2) *H. anxius*, 48 (1) *Calathus erratus* and *C. fuscipes* (both species present in approximately equal numbers but only a sample were identified to species), 4 (0) *Calathus cinctus* and 5 (0) *Amara tibialis*. These results vindicated the tactic of torchlight survey but it was disappointing not to have found *H. melancholicus*.





Figure 2. The linear exposure of limestone above a shallow valley slope.



Figure 3. View eastwards along the linear exposure of limestone.

I decided next to survey the areas to the west of the limestone exposure in the hope of discovering a new area for *H. melancholicus*. But as I walked back westwards along the flat ground above the limestone exposure, I spotted a larger *Harpalus* and on closer examination it was clear that this was a female *H. melancholicus*. While observing this female walking along, I found a male just 20cm away. I spent over half an hour watching and photographing these two individuals. Widening the search area away from this spot, I soon found three more.

It was now past midnight, with the weather remaining mild, and I was keen to see if I could find *H. melancholicus* in new areas rather than just spend time counting them at [www.naturalresourceswales.gov.uk](http://www.naturalresourceswales.gov.uk)

this known patch. The GPS track (Figure 5 and Appendix 2) shows which areas were covered, targeting areas identified during daylight as providing potentially suitable habitat for *H. melancholicus*. I first covered some of the grassy slope below the limestone exposure, then some sandy, south-facing slopes to the south and seaward of the limestone exposure. Here the vegetation also included lots of thyme, moss and bare ground but was rather taller and later-successional. I covered a smaller but very similar area, inland and north-west of the limestone exposure where there is an exposed ridge of shattered limestone. I then moved round the head of the inlet to the dry, east-west valley and surveyed an area of south-facing slope. None of these areas yielded any further individuals of *H. melancholicus*.

Having failed to find *H. melancholicus* in any of these other potentially suitable habitat patches, as well as torching all the areas in between *en route*, I wondered if it had become too cold or too late for *H. melancholicus* to be still active on the surface. Hence, I returned to check the original area where I found two more *H. melancholicus* within two minutes (02.27 and 02.28). Clearly, *H. melancholicus* can remain active into the early hours. With the little remaining time in the field, I made less ambitious attempts to extend the known range of *H. melancholicus*, moving out beyond the easternmost and westernmost points where I'd already found the beetle. One further individual was found, at 02.56, but this exercise seemed to indicate that *H. melancholicus* is extremely restricted in its distribution at Stackpole Warren. Figure 6 (see also Appendix 2) shows a detail of the author's track around the limestone exposure with pins marking the positions of all 10 observed *H. melancholicus*, and revealing that the beetles occurred in two small clusters.

On 23<sup>rd</sup> August, the weather was similar to the previous day but a little warmer and less windy. I returned to the areas where I had seen *H. melancholicus* during the night and took some photographs and a series of suction samples but no *H. melancholicus* were recorded.



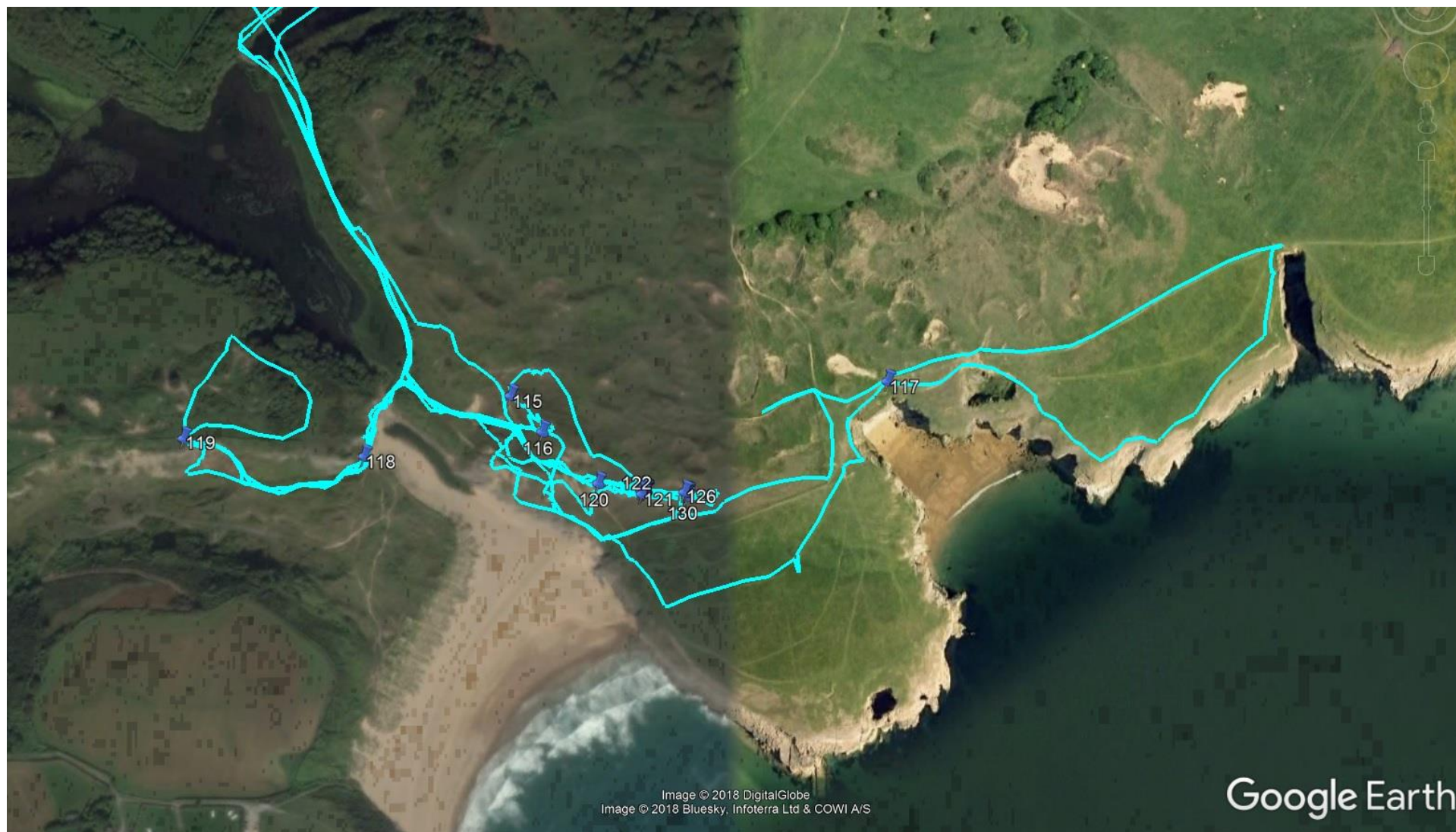


Figure 4. The author's GPS track on 22<sup>nd</sup> August and overnight 22<sup>nd</sup> – 23<sup>rd</sup> August 2017. Image from Google Earth © 2018 DigitalGlobe, © 2018 Bluesky, Infoterra Ltd & COWI A/S.

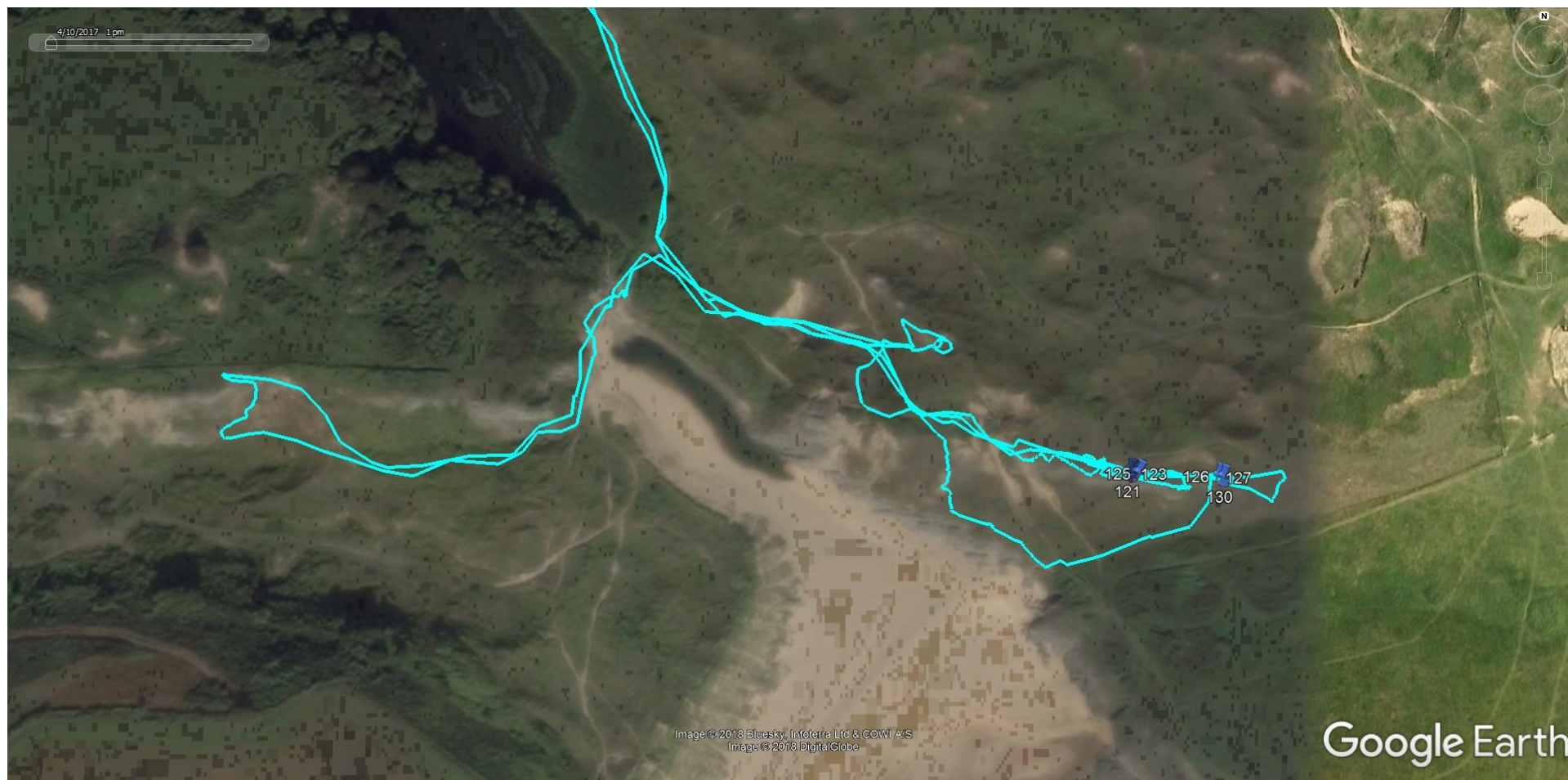


Figure 5. The author's GPS track during the night of 22<sup>nd</sup> – 23<sup>rd</sup> August 2017. Image from Google Earth © 2018 DigitalGlobe, © 2018 Bluesky, Infoterra Ltd & COWI A/S.



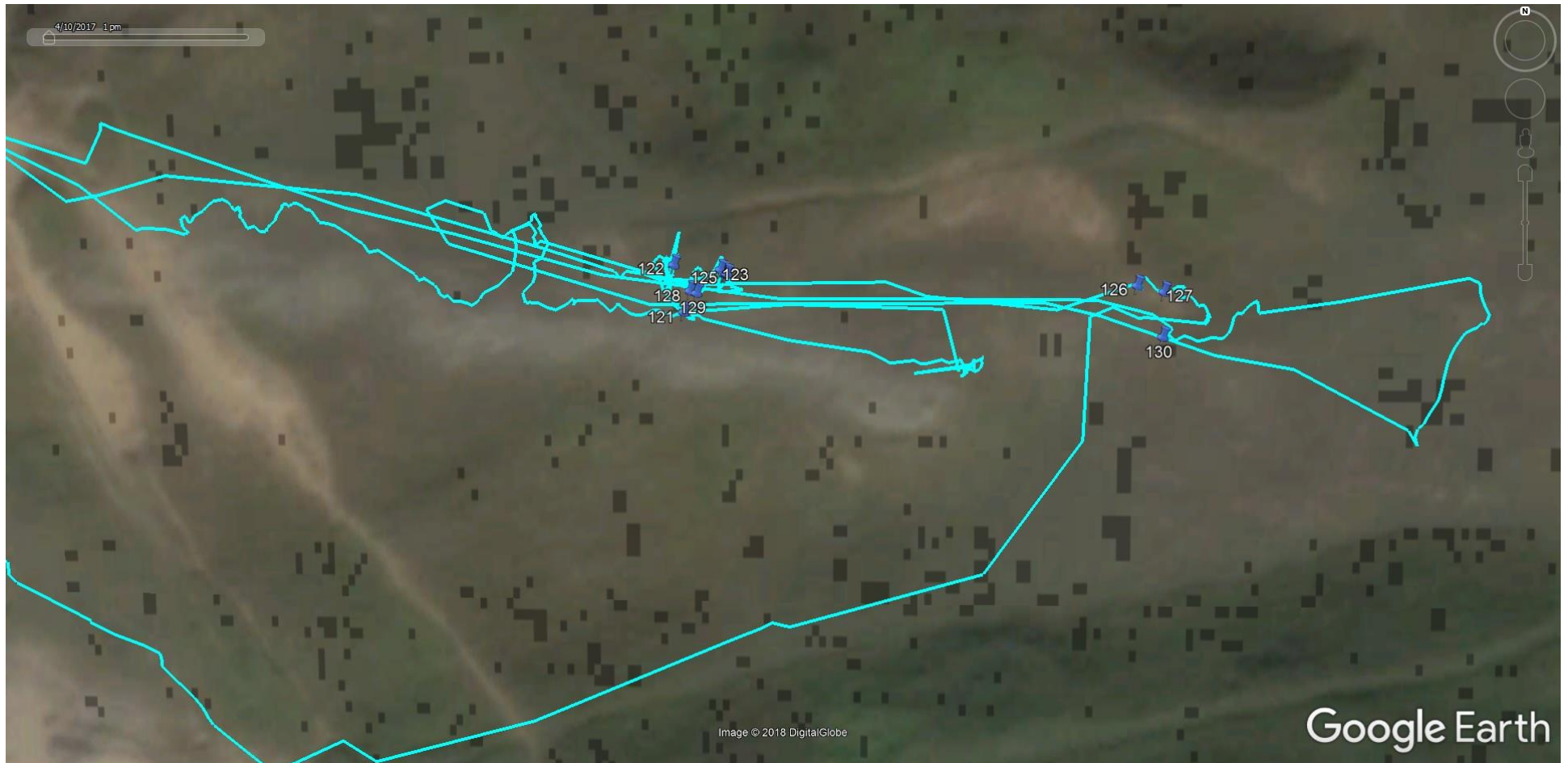


Figure 6: Detail of the author's GPS track during the night of 22<sup>nd</sup> – 23<sup>rd</sup> August 2017. Each of pins 121 to 130 marks the position of an individual *H. melancholicus* (pin 124 is obscured by pin 125). Image from Google Earth © 2018 DigitalGlobe.

### 5.2. Records of *Harpalus melancholicus*

No *H. melancholicus* were seen during the daytime survey work. During the torchlight search, ten individuals were recorded (Figure 6 & Appendix 2; Table 2). It is possible that there could be some duplication (males 128 and 129 may already have been recorded as males 123 - 125) but it is certain that at least eight different individuals were recorded in total.

### 5.3. Observations of *Harpalus melancholicus* in captivity

Males 122 and 130 (Table 2) were taken into captivity for further observations. They were kept together in a lunchbox lined with a turf taken from the point of capture. The box was placed on the kitchen worktop where it could conveniently be observed at frequent intervals. It was hoped that this might enable additional observations of feeding, under less disruptive conditions than are possible in the field, where sudden illumination by the headtorch tends to immediately disrupt natural behaviour. However, the occupants were rarely observed. Most sightings were made early in the morning, especially between 05.00 and 06.00, and only once were both beetles on the surface at the same time. This suggests a strongly nocturnal species.

Already by 3<sup>rd</sup> September, one of the males had died. The survivor was despatched by post to be photographed by John Walters but did not survive much longer. These unusually rapid deaths suggest this may be a difficult species to keep and breed in captivity. Both specimens have been retained in the author's collection.

Table 2. Records of *H. melancholicus* during the night of 22<sup>nd</sup> – 23<sup>rd</sup> August 2017.

Sex	Pin number	GPS reading	Time of observation	Comments
Female	121	SR 98005 94240	22.56	Photographed - see front cover. Seen to pick up, chew and carry a seed of Lesser Hawkbit <i>Leontodon saxatilis</i> (collected) until disturbed by excessive light.
Male	122	SR 98004 94245	23.14	Observed for 12 minutes in which time it remained completely static, while the nearby foraging female covered 1 m in the same duration. Taken into captivity.
Male	123	SR 98009 94244	23.49	Very light shy individual.
Male	124	SR 98009 94243	23.55	
Male	125	SR 98010 94243	23.56	Very close to 124. All individuals so far in proximity to thyme seeds - a potential food item.
Female	126	SR 98053 94240	00.10	
Female	127	SR 98055 94239	00.15	
Male	128	SR 98006 94242	02.27	Appeared to be chewing a thyme seed-case.
Male	129	SR 98006 94242	02.28	
Male	130	SR 98055 94235	02.56	Taken into captivity.

#### 5.4. Feeding observations

Seed-feeding can now be confirmed for *H. melancholicus* with adults observed, under field conditions, to feed on a seed of Lesser Hawkbit *Leontodon saxatilis* and probably to feed on a seed-case of thyme *Thymus* sp. (Table 2).

#### 5.5. Habitat observations

The limestone exposure has a flat, fairly level top (Figure 7) supporting a thin, sandy soil over limestone. This strip of flat ground forms something of a natural pathway, and though not heavily trampled, the very short vegetation shows some influence of footfall. This flat area is bounded on the northern, inland edge by vegetated sand dunes, one of which encroaches over the flat limestone more than the others (outlined in red in Figure 7 & 8). The key area for *H. melancholicus* is specifically here at the interface between this encroaching dune and the flat limestone area. The cluster of sightings further east (126, 127 and 130; Table 2) are from a very similar situation (Figure 9).



Figure 7. The flat, fairly level top of the limestone exposure, viewing eastwards. Outlined in red is an area where a sand dune encroaches over the limestone.





Figure 8. Sand-dune (outlined in red) encroaching over the flat limestone area.



Figure 9. The eastern cluster of *H. melancholicus* records were from this spot, also where a sand-dune encroaches over flat limestone.



Looking at occupied habitat on a finer scale, the sward is typically closely rabbit-grazed, with substantial moss cover and bare ground, without or with very little cover of grasses, with abundant thyme, on shallow sandy soil over limestone, with a slight southerly aspect, and not trampled or compacted by footfall unlike the adjacent flat turf.

The habitat occupied by *H. melancholicus* appears to correspond to the 'Fulgensia vegetation' of Sutton's (2012) National Vegetation Classification (NVC) survey of Stackpole Warren, described as follows:

"A rather different type of short calcareous vegetation occurs ... most extensively in front of the dune ridge in Compartment 41b where exposure and thin soils combine with trampling pressure and presumably rabbit grazing to suppress the sward. This was mapped as 'Fulgensia vegetation', as NVC placement is somewhat equivocal. It retains the constant *Thymus polytrichus* and *Pilosella officinarum* of the CG7, although the latter is at much lower cover here. *Agrostis stolonifera* replaces *Festuca ovina* as the dominant grass. *Sanguisorba minor* and *Asperula cynanchica* are also constant here, together with *Linum catharticum*, *Euphrasia officinalis*, *Leontodon saxatilis*, *Lotus corniculatus*, *Centaureum erythraea*, *Anagallis arvensis*, *Plantago lanceolata* and *Plantago coronopus*. Much of the distinctive character of this vegetation comes from the lower plants, with acrocarpous mosses often accounting for over 50% of the cover. *Trichostomum crispulum* dominates, but *Ditrichum flexicaule* is also constant, *Gymnostomum viridulum* is frequent, and further enrichment is provided by species such as *Trichostomum brachydontium*, *Pleurochaete squarrosa*, *Encalypta streptocarpa* and the Nationally Scarce *Didymodon acutus*. The eye-catching feature though is the sparse but constant occurrence of the scrambled egg lichen *Fulgensia fulgens*, which appears sufficiently associated with this vegetation type to be used as the primary indicator species for mapping purposes. *Cladonia pocillum* is another constant, and a further seventeen lichen species were recorded in our samples. This vegetation bears some resemblance to descriptions of the *Ditrichum flexicaule* – *Diploschistes scruposus* var. *bryophilus* sub-community of CG7, CG7c, which is known to feature *Fulgensia fulgens* in the few Breckland stands. However, the Stackpole examples are perhaps closer to a form of CG1, and for monitoring purposes could be classed as a CG1 'Fulgensia' sub-community".

The following images (Figure 10a-h) are provided to illustrate the actual occupied patches of ground. Each image was taken with flash, centred on an individual *H. melancholicus* (mostly the beetles are visible in the photographs though some are concealed within the vegetation).

Figure 10a-h. Patches of ground occupied by *Harpalus melancholicus*.



















### 5.6. Associated invertebrate species

The survey identified 68 species of invertebrates (Appendix 1). The precise habitat occupied by *H. melancholicus* was also occupied by the scarce beetles *Meligethes exilis* (a Nationally Scarce pollen beetle specialising on *Thymus polytrichus*), *Squamapion atomarium* (a weevil which develops in a stem-gall on *Thymus*), *Xanthomus pallidus* (a Nationally Scarce (NS) darkling beetle of sandy coastal habitat) and *Trichosirocalus dawsoni* (a Nationally Scarce (Nb) weevil feeding on *Plantago coronopus* and *P. maritima*). The occurrence of this suite of species elsewhere could be indicative of suitable habitat for *H. melancholicus*.

Including *H. melancholicus*, the survey recorded eight species which may be said to have a conservation designation (Table 3). These include the Moss Carder-bee *Bombus muscorum* and Wall butterfly *Lasiommata megera* which are both Section 7 species (species listed in Section 7 of the Environment (Wales) Act 2016). Wall butterfly is also regarded as Near Threatened (NT). The remaining species are Nationally Scarce.

Table 3. Insects recorded by this survey with a conservation designation. The table is in taxonomic order.

Order	Family	Species (scientific name)	Species (English name)	Conservation Status
Coleoptera	Carabidae	<i>Harpalus anxius</i>	a ground beetle	LC, Nationally Scarce
Coleoptera	Carabidae	<i>Harpalus melancholicus</i>	a ground beetle	IUCN Endangered, Nationally Rare
Coleoptera	Nitidulidae	<i>Meligethes exilis</i>	a pollen beetle	Nationally Scarce
Coleoptera	Tenebrionidae	<i>Xanthomus pallidus</i>	a darkling beetle	LC, Nationally Scarce
Coleoptera	Curculionidae	<i>Orthochaetes setiger</i>	a weevil	Nationally Scarce (Nb)
Coleoptera	Curculionidae	<i>Trichosirocalus dawsoni</i>	a weevil	Nationally Scarce (Nb)
Hymenoptera: Aculeata	Apidae	<i>Bombus muscorum</i>	Moss Carder-bee	Section 7
Lepidoptera	Satyridae	<i>Lasiommata megera</i>	Wall	Near Threatened, Section 7

## 6. Discussion & Conclusions

The survey succeeded in finding *Harpalus melancholicus* again, two years after the previous sighting. The survey recorded eight to ten individuals of *H. melancholicus* which is noteworthy for a species otherwise known at Stackpole Warren from only four individuals recorded in three different months from 1992 to 2015. By observing *H. melancholicus* and observing it in numbers, the survey has confirmed that late August is a suitable season for survey. None of the individuals observed was noticeably teneral so they had probably all been adult for at least a week. Likewise, the survey has confirmed that nocturnal torchlight survey is the most efficient survey technique, and is much more efficient than daytime ground-searching or suction-sampling. Although Tom Harrison, Tony Allen and John Owen have each succeeded in finding single *H.*

*melancholicus* by day, the author has yet to do so on three visits to Stackpole Warren. The efficiency of daytime searching for *H. melancholicus* is too poor for it to be used in survey and monitoring for this species.

The survey has confirmed that *H. melancholicus* is a seed-eater and noted Lesser Hawkbit *Leontodon saxatilis* and probably thyme *Thymus* sp. as food items, although much more work remains to be done on the feeding preferences of this beetle. If it does specialise in its choice of seeds, thyme seeds were abundant in the swards occupied by the beetle and a specialism on thyme seeds may go some way to explaining its rarity and restricted range.

This survey has done much to characterise the habitat occupied by *H. melancholicus* at Stackpole Warren. It appears to be restricted to two small patches of habitat where the toe of a vegetated sand-dune encroaches over outcropping limestone. There are many other areas at Stackpole Warren where sandy soils overlie limestone and support very similar swards, so the apparent absence of *H. melancholicus* from other suitable habitat patches is a conundrum. Three hypotheses are proposed here to explain these observations:

- 1 *H. melancholicus* is ecologically highly specialised and thereby restricted to the two small patches of habitat where it was found by this survey. It has survived as a tiny, isolated population here since at least 1992 but is nonetheless highly vulnerable to successional habitat change and chance events and should be regarded as Critically Endangered.
- 2 *H. melancholicus* is ecologically highly specialised but occupies numerous additional patches of habitat at Stackpole Warren which were not detected by this survey. It may be closely linked to the distribution of 'Fulgensia vegetation', as mapped by Sutton (2012). *H. melancholicus* has a patchy occurrence at Stackpole Warren, but is not restricted to just the two small patches of habitat where it was found by this survey.
- 3 *H. melancholicus* is a particularly difficult beetle to find and actually occurs quite widely at Stackpole Warren but is most easily detected in two small patches of optimum habitat where the population density is much higher.

If hypothesis 1 is correct, then it is extraordinary that such a tiny population can persist. Hypothesis 2 seems most likely to be correct and should drive additional survey work to seek out additional occupied habitat patches, but hypothesis 3 cannot be discounted and should drive efforts to test and refine survey methods.

## 7. Recommendations

### 7.1. Further survey and monitoring

In view of the possibility that *H. melancholicus* is restricted to the two small patches of habitat where it was found by this survey, and hence highly vulnerable to extinction, the population should be monitored frequently.

In the hope and expectation that there are other occupied patches of habitat at Stackpole Warren which have not yet been detected, additional survey work should be carried out. The habitat information provided by this survey should firstly be used to



identify other potentially suitable patches of habitat. Additional survey work may then be targeted at those patches of habitat. The Castlemartin Range to the west is also likely to support suitable habitat for *H. melancholicus* and should be surveyed.

### 7.2. Recommended survey methods

On current evidence, the best survey method for *H. melancholicus* is to look for surface-active adults by torchlight. A very bright headtorch is needed and even then, they are difficult to spot from a stooped position, so survey should be carried out on hands and knee-pads. It is known that 22<sup>nd</sup> – 23<sup>rd</sup> August is a suitable time of year for torchlight survey and the survey window can probably be safely extended for up to two weeks either side. Some nocturnal ground beetles are not active until well after dusk and *H. melancholicus* may be in this category, with no sightings prior to 22.56 during this survey. Hence, survey should take this into account. If weather remains suitable, survey may be continued until at least 03.00. Field identification of *H. melancholicus* by torchlight should only be attempted by an experienced or well-trained surveyor.

Extreme care should be taken when carrying out nocturnal survey work and the risk assessment should recognise that there is no mobile phone signal in much of the survey area.

### 7.3. Testing and refining survey methods

It would be desirable to have a quicker, easier and safer method of surveying for *H. melancholicus*, especially for the purpose of surveying other potentially suitable habitat patches elsewhere at Stackpole and beyond. Pitfall-trapping and light-trapping are discussed here as potential alternative or supplementary survey methods.

Pitfall-trapping could be used, primarily to avoid any need for nocturnal work. Though pitfalls are most convenient when operated as kill-traps with a preservative and left for up to three or four weeks, they could best be used here as live traps and checked after one or a few days. The rapid deaths of captive specimens indicates that trapped adults should be released as soon as possible. It should be noted that *Harpalus* species are relatively slow movers and do not move as much as predatory and scavenging carabids, so pitfall traps may be a relatively inefficient way of catching them.

Light-trapping for moths at Bewl Water in 2003 yielded *H. melancholicus* in the by-catch. This could be an effective method for surveying for *H. melancholicus* at Stackpole Warren and Castlemartin Range. Few such beetles that are attracted to light are caught and retained within the trap, so by far the best approach is to run a naked, mercury-vapour bulb suspended over a sheet and vigilantly watch for beetles landing on the sheet. Unlike moths which forage every night on the wing, flights by beetles are more likely to be once-in-a-lifetime dispersal events and most carabids at light are freshly emerged adults. Thus, this technique is likely to work best for *H. melancholicus* in early- to mid-August but some experimentation will be required to find the best time of year.

## 8. Acknowledgements

I would like to thank the following: Mike Howe and Paul Culyer for arranging this survey; Paul also for hosting my visit and arranging accommodation at the Stackpole Centre; and Tom Harrison and Tony Allen for sharing information about their records of *Harpalus melancholicus*.

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## 10. Appendix 1. List of invertebrates recorded at Stackpole in 2017 by Mark G. Telfer.

Species with a conservation designation are listed in **red text**. The table is in taxonomic sequence. Full details of all records generated by this project are held in a MapMate database by the author that may be consulted if required to provide further information such as precise localities, grid references, quantity, sex and life-stage.

Class	Order	Family	Species (scientific name)	Species (English name)	Conservation Status
Malacostraca	Isopoda	Philosciidae	<i>Philoscia affinis/muscorum</i> <sup>1</sup>	Common Striped Woodlouse	Least Concern (LC)
Malacostraca	Isopoda	Armadillidiidae	<i>Armadillidium depressum</i>	a woodlouse	LC
Malacostraca	Isopoda	Armadillidiidae	<i>Armadillidium vulgare</i>	Common Pill-woodlouse	LC
Malacostraca	Isopoda	Porcellionidae	<i>Porcellio scaber</i>	Common Rough Woodlouse	LC
Malacostraca	Amphipoda	Talitridae	<i>Arcitalitrus dorrieni</i>	Landhopper	None
Insecta	Dermaptera	Forficulidae	<i>Forficula auricularia</i>	Common Earwig	LC
Insecta	Orthoptera	Tettigoniidae	<i>Tettigonia viridissima</i>	Great Green Bush-cricket	LC
Insecta	Orthoptera	Acrididae	<i>Chorthippus brunneus</i>	Field Grasshopper	LC
Insecta	Orthoptera	Acrididae	<i>Myrmeleotettix maculatus</i>	Mottled Grasshopper	LC
Insecta	Hemiptera: Heteroptera	Tingidae	<i>Acalypta parvula</i>	a lacebug	None
Insecta	Hemiptera: Heteroptera	Tingidae	<i>Agramma laetum</i>	a lacebug	None
Insecta	Hemiptera: Heteroptera	Miridae	<i>Dicyphus annulatus</i>	a mirid bug	None

<sup>1</sup> *Philoscia affinis* was discovered in Britain during 2017, a similar species to *P. muscorum* and hitherto overlooked. I have no adult male voucher specimen with which to determine which of the pair was observed at Stackpole.

Class	Order	Family	Species (scientific name)	Species (English name)	Conservation Status
Insecta	Hemiptera: Heteroptera	Berytidae	<i>Gampsocoris punctipes</i>	a stiltbug	None
Insecta	Coleoptera	Carabidae	<i>Nebria salina</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Cicindela campestris</i>	Green Tiger-beetle	LC
Insecta	Coleoptera	Carabidae	<i>Broscus cephalotes</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Pterostichus madidus</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Calathus cinctus</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Calathus erratus</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Calathus fuscipes</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Calathus mollis</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Amara aenea</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Amara tibialis</i>	a ground beetle	LC
Insecta	Coleoptera	Carabidae	<i>Harpalus anxius</i>	a ground beetle	LC, Nationally Scarce
Insecta	Coleoptera	Carabidae	<i>Harpalus melancholicus</i>	Stackpole Seed-eater	Endangered, Nationally Rare
Insecta	Coleoptera	Leiodidae	<i>Leiodes rufipennis</i>	a beetle	None
Insecta	Coleoptera	Silphidae	<i>Nicrophorus vespillo</i>	a sexton beetle	None
Insecta	Coleoptera	Staphylinidae	<i>Tasgius ater</i>	a rove-beetle	None
Insecta	Coleoptera	Scarabaeidae	<i>Aphodius rufipes</i>	a dung beetle	LC
Insecta	Coleoptera	Elateridae	<i>Agrypnus murinus</i>	a click-beetle	None
Insecta	Coleoptera	Nitidulidae	<i>Meligethes exilis</i>	a pollen beetle	Nationally Scarce
Insecta	Coleoptera	Tenebrionidae	<i>Lagria hirta</i>	a darkling beetle	LC
Insecta	Coleoptera	Tenebrionidae	<i>Phylan gibbus</i>	a darkling beetle	LC
Insecta	Coleoptera	Tenebrionidae	<i>Xanthomus pallidus</i>	a darkling beetle	LC, Nationally Scarce
Insecta	Coleoptera	Chrysomelidae	<i>Timarcha tenebricosa</i>	Great Bloody-nosed Beetle	None



Class	Order	Family	Species (scientific name)	Species (English name)	Conservation Status
Insecta	Coleoptera	Chrysomelidae	<i>Aphthona euphorbiae</i>	a flea-beetle	LC
Insecta	Coleoptera	Chrysomelidae	<i>Longitarsus pratensis</i>	a flea-beetle	LC
Insecta	Coleoptera	Chrysomelidae	<i>Cryptocephalus fulvus</i>	a leaf-beetle	LC
Insecta	Coleoptera	Apionidae	<i>Squamapion atomarium</i>	a weevil	None
Insecta	Coleoptera	Apionidae	<i>Ischnopterapion loti</i>	a weevil	None
Insecta	Coleoptera	Curculionidae	<i>Otiorhynchus ligneus</i>	a weevil	None
Insecta	Coleoptera	Curculionidae	<i>Charagmus griseus</i>	a weevil	None
Insecta	Coleoptera	Curculionidae	<i>Sitona lineatus</i>	a weevil	None
Insecta	Coleoptera	Curculionidae	<i>Orthochaetes setiger</i>	a weevil	Nationally Scarce (Nb)
Insecta	Coleoptera	Curculionidae	<i>Trichosirocalus dawsoni</i>	a weevil	Nationally Scarce (Nb)
Insecta	Coleoptera	Curculionidae	<i>Trichosirocalus troglodytes</i>	a weevil	None
Insecta	Hymenoptera: Aculeata	Apidae	<i>Bombus lapidarius</i>	Large Red-tailed Bumblebee	None
Insecta	Hymenoptera: Aculeata	Apidae	<i>Bombus muscorum</i>	Moss Carder-bee	Section 7
Insecta	Hymenoptera: Aculeata	Apidae	<i>Bombus pascuorum</i>	Common Carder-bee	None
Insecta	Hymenoptera: Aculeata	Apidae	<i>Bombus terrestris</i>	Buff-tailed Bumblebee	None
Insecta	Hymenoptera: Aculeata	Apidae	<i>Panurgus banksianus</i>	Large Shaggy Bee	None
Insecta	Lepidoptera	Zygaenidae	<i>Zygaena filipendulae</i>	Six-spot Burnet	None
Insecta	Lepidoptera	Pyralidae	<i>Agriphila geniculea</i>	Elbow-stripe Grass- vener	None
Insecta	Lepidoptera	Satyridae	<i>Lasiommata megera</i>	Wall	Near Threatened, Section 7

Class	Order	Family	Species (scientific name)	Species (English name)	Conservation Status
Insecta	Lepidoptera	Satyridae	<i>Maniola jurtina</i>	Meadow Brown	LC
Insecta	Lepidoptera	Notodontidae	<i>Ptilodon capucina</i>	Coxcomb Prominent	None
Insecta	Lepidoptera	Arctiidae	<i>Lithosia quadra</i>	Four-spotted Footman	None
Insecta	Lepidoptera	Noctuidae	<i>Agrotis vestigialis</i>	Archer's Dart	None
Gastropoda	Neotaenioglossa	Pomatiasidae	<i>Pomatias elegans</i>	Round-mouthed Snail	LC
Gastropoda	Pulmonata	Clausiliidae	<i>Clausilia bidentata</i>	Common Door-snail	LC
Gastropoda	Pulmonata	Cochlicopidae	<i>Cochlicopa lubricella</i>	a moss-snail	LC
Gastropoda	Pulmonata	Helicidae	<i>Cochlicella acuta</i>	Pointed Snail	LC
Gastropoda	Pulmonata	Helicidae	<i>Cornu aspersum</i>	Garden Snail	LC
Gastropoda	Pulmonata	Helicidae	<i>Theba pisana</i>	White Snail	NA
Gastropoda	Pulmonata	Helicidae	<i>Candidula intersecta</i>	Wrinkled Snail	LC
Gastropoda	Pulmonata	Helicidae	<i>Helicella itala</i>	Heath Snail	LC
Gastropoda	Pulmonata	Pupillidae	<i>Lauria cylindracea</i>	Common Chrysalis-snail	LC
Gastropoda	Pulmonata	Pyramidulidae	<i>Pyramidula pusilla</i>	Rock Snail	LC



## 11. Appendix 2: Data Archive Appendix

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] Species records, which are held on the NRW Recorder 6 database.

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <http://libcat.naturalresources.wales> or <http://catllyfr.cyfoethnaturiol.cymru> by searching 'Dataset Titles'. The metadata is held as record no. 121121.



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Natural Resources Wales  
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