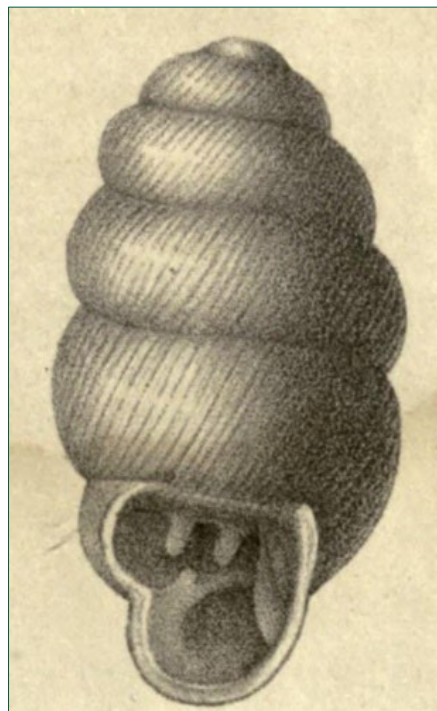




A survey for Narrow-mouthed Whorl Snail *Vertigo angustior* at MoD Pendine in September 2024

Natur am Byth! Evidence Report No. 016

Author name: M.J. Willing



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Report series: Natur am Byth! Evidence Report
 Report number: 016
 Publication date: June 2025
 Contract number:
 Contractor: Dr. Martin Willing
 Contract manager: Clare Dinham
 Title: **A survey for Narrow-mouthed Whorl Snail *Vertigo angustior* at MoD Pendine in September 2024**
 Author: **M.J. Willing**
 Technical editor: Dr. Mike Howe
 Quality assurance: 2
 Peer reviewer(s): Dr. Mike Howe
 Approved by: Clare Dinham
 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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 MoD Pendine
 Sally Campbell, QinetiQ, MoD Pendine
 John Black, DIO Ecologist
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Recommended citation for this volume:

Willing, M.J. 2025. A survey for Narrow-mouthed Whorl Snail *Vertigo angustior* at MoD Pendine in September 2024. Natur am Byth! Evidence Report No. **016**. 55pp. Buglife Cymru & Natural Resources Wales, Bangor.

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Crynodeb gweithredol

Mae'r adroddiad hwn yn disgrifio arolygon o'r falwen *Vertigo angustior* a gynhaliwyd dros gyfnod o 3 diwrnod rhwng 13 a 15 Medi 2024 ar safle'r Weinyddiaeth Amddiffyn ym Mhentywyn yn Sir Gaerfyrddin, de Cymru, fel rhan o brosiect Natur am Byth! Nid yw'n hysbys bod unrhyw arolygon blaenorol o *V. angustior*, nac arolygon cyffredinol o folysgiaid anforol, wedi'u gwneud ar system twyni tywod Pentywyn.

Arolygwyd 33 o safleoedd i gyd ar draws yr ardal gan dargedu cymunedau o blanhigion y gwyddys eu bod yn cynnal y falwen ar Benrhyn Gŵyr gerllaw. Twyni sefydlog a lled-sefydlog oedd y safleoedd hyn, ynghyd â llaciau twyni. Arolygwyd yr holl safleoedd drwy gyfrwng arsylwadau maes uniongyrchol, ynghyd â dulliau samplu swmp a samplu drwy wactod, er mwyn gallu cymharu'r ddwy dechneg hon ymhellach. Yn ogystal, gwnaed asesiadau botanegol manwl ar holl safleoedd yr arolwg.

Ni chanfuwyd *V. angustior* yn ystod yr arolwg, a oedd yn syndod o ystyried bod cymunedau o blanhigion sy'n cynnal y falwen ar Dwyni Whiteford i'w cael ar safle'r Weinyddiaeth Amddiffyn ym Mhentywyn, sef twyni sefydlog a lled-sefydlog (NVC SD7 ac SD8) a llaciau twyni (NVC SD14 ac SD15). Mae'n bosibl ei bod yn absennol yn sgil prinder cymharol o ardaloedd helaeth o frithwaith o gynefinoedd llaciau twyni / twyni sych.

O'r 43 rhywogaeth a gofnodwyd, canfuwyd 35 drwy ddull samplu swmp a 40 drwy ddull samplu â gwactod. Cofnodwyd wyth rhywogaeth dim ond yn y samplau gwactod, a thair rhywogaeth dim ond yn y samplau swmp. Cofnodwyd 5,871 o folysgiaid i gyd yn y samplau gwactod, a 965 yn y samplau swmp. Cesglir bod y ddwy dechneg arolygu yn ategu ei gilydd am eu bod yn galluogi darlun cyflawn o gymuned o folysgiaid.

Un darganfyddiad gwerth ei nodi oedd bod y falwen anfrodorol o Awstralasia *Paralaoma servilis* yn bresennol, wedi'i chofnodi ar ddau safle. Mae'r rhain yn gofnodion newydd ar gyfer Sir Gaerfyrddin (VC 44).

Executive summary

This report describes surveys for the Narrow-mouthed Whorl Snail *Vertigo angustior* undertaken over a 3-day period from 13th to 15th September 2024 on the MoD Pendine dune site in Carmarthenshire, south Wales as part of the Natur am Byth! project. No previous *V. angustior* or general non-marine molluscan surveys are known to have taken place on the Pendine dunes complex.

A total of 33 sites were surveyed across the area targeting plant communities known to support the snail on nearby Gower, these being fixed and semi-fixed dunes and dune slacks. All sites were surveyed by direct field observations, and bulk and vacuum sampling to allow a further comparison of these two techniques. Additionally detailed botanical assessments were undertaken at each survey site.

V. angustior was not found during the survey which was surprising given that plant communities which support the snail on Whiteford Burrows occur on MoD Pendine, namely fixed and semi-fixed dunes (NVC SD7 and SD8) and dune slack (NVC SD14 and SD15). It is possible that its absence is due to a relative scarcity of extensive areas of dune slack / dry dune habitat mosaics.

Of the 43 species recorded, 35 were detected by bulk sampling and 40 by vacuum sampling. Eight species were only recorded in the vacuum samples with three only present in the bulk samples. The vacuum sampling recorded a total of 5,871 molluscs, with the bulk sample total of 965. It is concluded that the two survey techniques complement each other in obtaining a complete picture of a molluscan community.

A notable discovery was the presence of the non-native Australasian snail *Paralaoma servilis*, recorded at two sites, these being new records for Carmarthenshire (VC 44).

1. Introduction

1.1 Background

The Narrow-mouthed Whorl Snail *Vertigo angustior* (Jeffreys, 1830) is a small species restricted to base-rich, free-draining moist places which are rarely affected by periodic desiccation or flooding. It lives in open, short vegetation of grasses, mosses and low herbs which are typically quickly warmed by the sun. In Britain, it occurs in a variety of habitats ranging from salt-marsh transition zones (Killeen, 1983; Preece & Willing, 1984), limestone pavements (Marriott & Marriott, 1982), inland marshy grassland (Killeen, 1997; Norris & Colville, 1974) and sand dune maritime grassland (Colville, 1994; Moorkens & Gaynor, 2003). Due to its rarity, it was categorised as Endangered (RDB category 1) in the UK Red Data Books (Bratton, 1991) and more recently as Vulnerable on the IUCN-based UK status review (Seddon *et al.*, 2014). The snail is listed on Annex IIa of the European Community Habitats and Species Directive (92/43/EEC) and is also a Welsh Section 7 'Species of Principal Importance'.

In England, *V. angustior* specimens found at Aldeburgh, Suffolk by J.E. Cooper in 1903 have been confirmed to have been living when collected following examination of museum specimens (Killeen, 1992). More recently, live shells were first found in Norfolk at Flordon Common in 1972 (Norris & Colville, 1974) and in Suffolk at Martlesham Creek and Fritton by I. Killeen in 1982 (Killeen, 1983) and 1988 (Killeen, 1991, 1992, 2001) respectively. Since those initial discoveries, at least a further six populations have been located at coastal and inland sites in Norfolk (Howlett & Baker, 2004, 2006; Willing, 2011). Since the first two confirmed live populations, numerous additional ones have been reported in Suffolk. In 2003, an extensive study of the Blyth Estuary (Killeen & Moorkens, 2011) demonstrated the presence of the snail at numerous sites there, with an estimation that a linear 25km of occupied habitat (mostly 'grassy' artificial sea defence embankments) may have supported about 156 million *V. angustior*, making this the most significant area for the snail in the UK and also of international importance. This study also noted the presence of the snail elsewhere in Suffolk associated with other estuary embankments of the rivers Deben, Alde and Waveney. In 2008, a further study (Abrehart, 2008) surveyed existing and some new sites in the county, reporting the presence of the snail from 43 1km squares (32 tetrads), a further confirmation of the importance of Suffolk for the species.

The first live *V. angustior* in Scotland were found at a sand dune site on the Solway coast in the south-west of the country by B. Colville in 1992 (Colville, 1994); dead shells had previously been reported from the site by Chris Paul. In 2000, *V. angustior* was found in the north-east of the country at Garron Point near Aberdeen (Marriott, 2004). A study in 2017 (Killeen *et al.*, 2019) undertook monitoring of all these Scottish *V. angustior* populations, reporting the loss of the population previously living on sand dune margins at Whiteport on the Solway coast, this being the first documented loss of a population due to maritime coastal erosion.

The first records of *V. angustior* in Wales were all dead shells. Thus, in 1830, Jeffreys found shells in flood debris near Swansea (Jeffreys, 1830) with further shells reported by him found near Tenby (Jeffreys, 1862). On the Gower peninsula in 1924, Quick reported fresh dead shells from sand dunes at Oxwich Bay (Quick, 1924) but, despite extensive surveys in following years (Quick, 1926, 1927), he failed to locate live specimens. The first live *V. angustior* in Wales (and indeed in western Britain) were found on a single day in May 1983 when populations were located at both Oxwich and Whiteford Burrows on the southern and northwestern Gower coastlines respectively (Preece & Willing, 1984). A third live Welsh population was discovered in Pembrey Forest,

Carmarthenshire (lying immediately north of the Gower Peninsula) by John Harper in 2005 and subsequent surveys by him revealed a total of 20 discrete populations (Harper, 2007, 2014). Following the initial discovery of *V. angustior* at Whiteford Burrows in 1983, a series of further surveys were undertaken there in 1993, 1994, 1995, 1996, 1997, 2001, 2006 (two), 2012 and 2016. (with full details and associated references given in Willing, 2020, 2024a & b). All these surveys were focussed upon a narrow saltmarsh / sand dune 'transition zone' lying on the eastern margins of the Burrows. In 2016 a series of surveys of previously studied monitoring sites recorded very few snails, and it was concluded that the population had 'crashed' and was in a decreasing and unfavourable condition (further discussed in Willing, 2020). In October 2018 a single day visit surveyed the whole transition zone and unexpectedly reconfirmed the snail's continued presence in the transition zone, additionally extending the previously recorded range northwards by 60%. Further studies in 2021, 2023 and 2024 (Willing, 2023, 2024a & b) extended the surveys into the main body of the dunes. These revealed widespread *V. angustior* presence in the centre and northern areas in both dune slacks and fixed and semi-fixed dunes. They also revealed that that *V. angustior* may show a pattern of local distribution within the dunes favouring more shaded sites and avoiding those with a more exposed and so drier, southerly facing aspect.

At Oxwich Burrows, the first confirmation of live snails in 1983 was also followed by further surveys in 1993, 1994, 1995, 1996, 2006 and 2016 (full details and associated references are given in Willing, 2024a). All these surveys were undertaken (as at Whiteford Burrows between 1983 and 2016) along a sand dune / salt marsh transition zone lying on the northern margins of the Burrows. Following a six-year hiatus from the previous brief single-site visit in 2016, a detailed survey of the whole transition zone was undertaken in 2022 (Willing, 2024a). This revealed that *V. angustior* had disappeared from the central transition zone area where the first finds had been made and most of the subsequent monitoring had taken place. This loss was considered probably due to the northward spread of scrub and trees causing shading of the open dunes and so unsuitable conditions for *V. angustior*. Only low numbers of the snail were still present in a few sites on the eastern margins of the transition zone. Following the discovery of the widespread *V. angustior* presence in dune slacks at Whiteford Burrows, this habitat was, for the first time, also surveyed widely at Oxwich in 2022. In contrast to Whiteford, the snail was not found widely in this habitat but was unexpectedly found in large numbers in a fixed dune habitat. A further Oxwich survey in 2023 (Willing, 2024b) now focussed upon a wider survey of fixed and semi-fixed dunes, finding a few additional snail populations there although all confined to the north-east of the dune complex. Elsewhere on Gower, in 2022 the extensive Llangennith Burrows dune complex (lying immediately south of Whiteford Burrows) were surveyed (Willing, 2024a) whilst in 2023 dunes at Three Cliffs Bay and Swansea Bay were also visited (Willing, 2024b) - *V. angustior* was not found at any of these three sites. Also, in 2023 Nicholaston Burrows was surveyed and the snail found at one site making this the first *V. angustior* record from this dune complex, perhaps a not unexpected find due to the proximity of the site of the northern section of Oxwich Burrows which support some large *V. angustior* populations.

Thus, in Wales, the *V. angustior* is confined to a relatively small area of coastline in Carmarthenshire and West Glamorgan, incorporating the Pembrey dune system (Pembrey Aerial Firing Range & Pembrey Forest), Whiteford Burrows (including Cwm Ivy Marsh), Oxwich Burrows and most recently Nicholaston Burrows, with historical records from Swansea (its type locality) and Tenby in Pembrokeshire.

1.2 Pendine

Laugharne and Pendine Burrows SSSI comprises the largest spit and sand dune system in west Wales, lying on the west side of Carmarthen Bay. It is of outstanding importance for its rare coastal plants and extensive dune slacks which merge into fen and swamp near Witchett Pool, a 9-hectare calcareous freshwater lake. At least 350 species of flowering plants have been recorded from the site. The extensive dune system has ridges up to 20m in heights, separated by deep, damp hollows rich in rare or uncommon plants.

The SSSI notified habitat features include sand dune, swamp and coastal dune woodland, and a large standing water body, the Witchett Pool. Notified / qualifying species include water vole *Arvicola terrestris*, wintering golden plover *Pluvialis apricaria*, fen orchid *Liparis loeselii*, dune gentian *Gentianella uliginosa*, small blue *Cupido minimus* and strandline beetle *Eurynebria complanata*. There is also a nationally important breeding bird assemblage and a dune invertebrate assemblage. Also of importance are associated habitats comprising intertidal communities, saltmarsh, scrub, marshy grassland, semi-improved grassland and open water/river channel.

Details of the SAC designation are available on the JNCC website [Carmarthen Bay Dunes/ Twyni Bae Caerfyrddin - Special Areas of Conservation](#).

Much of the SSSI lies within the MOD Pendine boundary, an area managed by QinetiQ.

1.3 Survey objectives

The Pendine dune complex is situated a relatively short distance west of Tenby where the dunes are believed to have supported *V. angustior* because shells were recorded there in the mid-1800s (Jeffreys, 1862). East of Pendine lies Pembrey Forest and dunes, an extensive area where numerous *V. angustior* populations were recorded between 2005 and 2014 (Harper 2007, 2014). The extensive *V. angustior* populations living at Whiteford Burrows also lie a relatively short distance to the south.

It was therefore possible that the extensive Pendine dune system might support a *V. angustior* population (or populations). This project was planned to undertake a wide-ranging survey across the area, targeting those plant communities known to support the snail on Gower, these including fixed and semi-fixed dunes and dune slacks. To maximise the chances of detecting the snail, survey techniques were planned to embrace (1) field observation (chiefly using 'beating trays'), (2) the removal of bulk samples for off-site processing and (3) the simultaneous removal of vacuum samples. The use of this latter technique was trialled at Oxwich Burrows in 2023 but undertaken in sub-optimal, damp conditions (Willing, 2024b). It was hoped that the Pendine surveys might be undertaken in dry weather which is better suited to the removal of vacuum samples and so allow a better assessment of the technique.

2. Methods

Survey work was undertaken during a 3-day period from 13th to 15th September 2024 at 33 sites covering Pendine (Figure 1).

Site surveys involved:

1. The close ('hands and knees') visual examination of vegetation and ground litter;
2. the beating vegetation onto a white gridded tray and examining debris with a x6 magnifier;
3. shaking dry moss and low growing fresh and dead plant material through a two-tier 2mm and 0.5mm sieve stack.

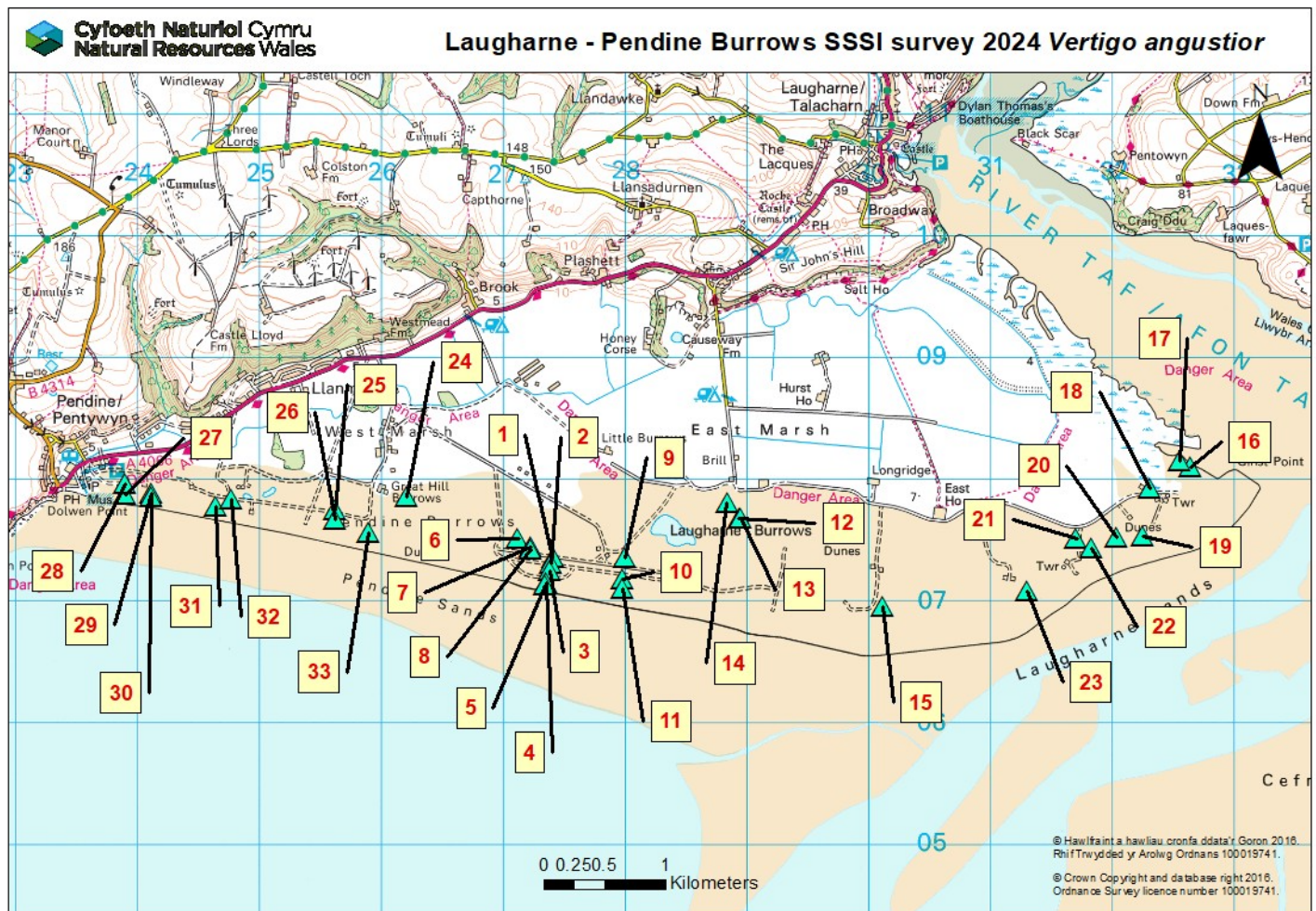


Figure 1. The location of survey areas on Laugharne-Pendine Burrows SSSI in 2024.

At all survey sites, samples were also removed for later laboratory processing. These bulk samples consisted of approximately 2-3 litres of lightly compressed material consisting of ground litter, moss and low plants (living and dead) cut at or just below ground level using a serrated 'Kitchen Devil' knife. Material was gathered over an area of about 1m² and probably amounted to what might approximately have been obtained from a 0.25m x 0.25m [0.0625m²] quadrat frame as employed by Sharland (2000a & b). Removed samples were later air-dried (in suspended muslin bags in an open but roofed outdoor space) to constant mass. Material was then sieved through a 2mm/0.5mm sieve nest and sievings examined on a lipped, gridded white tray with finer fractions examined using a x10 – x60 binocular microscope.

Plant associates: At most sites the plant species were identified, their frequency recorded and National Vegetation Classification (NVC) assessed by Matt Sutton. All sites were digitally photographed, and GPS 10-fig. OS grid references recorded.

Vacuum (suction) sampling:

Suction samples were also taken using the same method as employed at Oxwich Burrows in September 2023 (Willing, 2024b), with minor differences as explained below. Samples were again taken using a hand-held petrol garden vacuum (McCulloch GB345) with an entomological net fitted over the mouth of the intake tube.

A standard suction sample consisted of two separate 30-second sessions of powered suction of the vegetation. Each 30 seconds was either continuous or spread over separate favorable patches within the approx. 2 m radius that can be reached without the surveyor substantially changing their position. At the end of the period, the contents of the net bag were tipped out, either on to a white gridded tray or placed directly into a plastic bag. Experience has shown that after 30 seconds, the bag tends to fill with loose vegetation, sometimes with an apparent loss of suction, so two 30-second sessions are considered preferable to one 60-second session.



Figure 2. Vacuum sampling technique (image taken on Oxwich Burrows, September 2023).

The two 30-second samples from each site were combined in one bag. In Willing (2024b), the two samples from each site were analysed and presented as separate replicates. The samples from each site in the present study are therefore directly equivalent to the combined data for each site obtained at Oxwich Burrows in 2023 (Willing, 2024b).

All bagged suction samples were frozen at the end of the fieldwork, before being dried and sieved through a 10 mm, 5 mm and 0.5 mm sieve nest. The small number of large, live snails and slugs were labelled and preserved separately. The sieved fractions were picked under magnification, and all molluscs in each sample were identified and counted. Dry conditions throughout the fieldwork, and a relatively low biomass of large, live snails, meant that there was no need to preserve the samples in alcohol, in contrast to the samples recovered at Oxwich in September 2023 (Willing, 2024b).

3. Results

Molluscan results from the 2024 surveys of Pendine are displayed in Appendix 1, with species naming throughout following that of Anderson & Rowson (2020). Absolute counts of each species equate to numbers recovered from each of the approximately comparable sized bulk and vacuum samples. A total of 43 species of Mollusca were recorded (44 if the marine *Peringia ulvae* is included - this was only found as dead shells washed or blown into a few samples taken close to the upper tide level). Of the 43 species, 35 were recorded by bulk sampling and 40 by vacuum sampling. Eight species were only recorded in the vacuum samples, with three only present in the bulk samples (see Table 1). The vacuum sampling recorded a total of 5,871 snails, with a bulk sample total of 965. **The target species of the survey, *V. angustior*, was not found at any of the sites.**

In providing his vacuum results, Ben Rowson noted that, “smaller juveniles of the hairy species (*Ashfordia granulata*, *Trochulus hispidus* and *Monacha cantiana*) are difficult to attribute. At sites where adults were not present, some co-occurrences could thus have been overlooked”.

Plant records appear in Appendix 4 and are preceded in Appendix 2 by an explanation of National Vegetational Categories (NVC) of communities recorded during the 2024 surveys, and in Appendix 3 plant dominance assessments are explained. Survey site locations, brief habitat descriptions and site images are given in Appendix 5.

Table 1. The total number of each mollusc species recorded from 33 Pendine survey sites in 2024 and the total number of sites where the species were present.

Sites situated in dry dunes	Bulk samples	Vacuum samples
Species	No. recorded (& no. of sites with species)	No. recorded (& no. of sites with species)
TERRESTRIAL SPECIES	-	-
<i>Acanthinula aculeata</i>	12 (5)	17 (7)
<i>Aegopinella nitidula</i>	5 (5)	8 (5)
<i>Arion (Arion) ater</i>	0 (0)	2 (2)
<i>Ashfordia granulata</i>	30 (12)	114 (14)
<i>Carychium minimum</i>	4 (2)	12 (2)
<i>Cecilioides acicula</i>	1 (1)	1 (1)
<i>Cepaea nemoralis</i> & <i>Cepaea</i> sp.	26 (14)	188 (30)
<i>Cernuella virgata</i>	0 (0)	9 (2)
<i>Clausilia bidentata</i>	19 (3)	31 (6)
<i>Cochlicella acuta</i>	118 (12)	1,737 (13)
<i>Cochlicopa lubrica</i>	126 (27)	63 (23)
<i>Columella edentula / aspera</i>	9 (4)	527 (13)
<i>Cornu aspersum</i>	6 (4)	69 (16)
<i>Deroceras reticulatum</i>	0 (0)	1 (1)
<i>Euconulus alderi</i>	0 (0)	9 (1)
<i>Lauria cylindracea</i>	24 (6)	4 (4)
<i>Monacha cantiana</i>	4 (2)	126 (9)
<i>Nesovitrea hammonis</i>	2 (2)	3 (2)
<i>Oxychilus alliarius</i>	5 (5)	4 (3)
<i>Oxychilus cellarius</i>	18 (6)	4 (3)

Sites situated in dry dunes	Bulk samples	Vacuum samples
Species	No. recorded (& no. of sites with species)	No. recorded (& no. of sites with species)
<i>Paralaoma servilis</i>	2 (1)	3 (1)
<i>Punctum pygmaeum</i>	0 (0)	50 (9)
<i>Pupilla muscorum</i>	75 (3)	214 (2)
<i>Succinea putris</i>	5 (2)	133 (8)
<i>Trochulus hispidus</i>	33 (11)	634 (23)
<i>Trochulus striolatus</i>	3 (1)	9 (2)
<i>Vallonia costata</i>	4 (2)	19 (5)
<i>Vallonia excentrica</i>	2 (2)	0 (0)
<i>Vallonia pulchella</i>	0 (0)	5 (4)
<i>Vertigo antivertigo</i>	3 (2)	38 (2)
<i>Vertigo pygmaea</i>	113 (19)	980 (19)
<i>Vitrea contracta</i>	1 (1)	2 (2)
<i>Vitrina pellucida</i>	63 (8)	52 (17)
<i>Xeroplexa intersecta</i>	100 (21)	803 (20)
<i>Zonitoides nitidus</i>	3 (1)	0 (0)
AQUATIC SPECIES	-	-
<i>Ampullaceana balthica</i>	5 (2)	19 (1)
<i>Anisus leucostoma</i>	1 (1)	1 (1)
<i>Aplexa hypnorum</i>	17 (2)	3 (1)
<i>Euglesa casertana</i>	5 (1)	0 (0)
<i>Galba truncatula</i>	62 (4)	790 (5)
<i>Gyraulus crista</i>	9 (1)	15 (1)
<i>Gyraulus parvus</i> (=laevis)	0 (0)	2 (1)
<i>Lymnaea stagnalis</i>	0 (0)	16 (1)
<i>Peringia ulvae</i>	50+ (all dead)	1 (1) (dead)

4. Discussion

It is difficult to explain why *V. angustior* does not seem to be living within the extensive Pendine sand dune system. The area lies of east of the formerly recorded Tenby site/s and west of currently occupied Pembrey dunes and forest. Plant communities supporting the snail at Whiteford and Oxwich Burrows on the Gower (Willing 2023, 2024a & b) were located and surveyed at Pendine, including fixed and semi-fixed dunes (NVC SD7 and SD8) and dune slack (NVC SD14 and SD15). There are, of course, other large dune systems such as Llangennith Burrows on Gower that, although lying close to the extensively populated Whiteford Burrows, were not found to support the snail. One possible explanation for the abundant presence of *V. angustior* at Whiteford but its apparent absence at Pendine may lie in the relative absence at Pendine of the extensive dune slack / dry dune mosaic present at Whiteford. This was discussed in Willing (2024a). In that report, this statement was included:

“Moorkens & Gaynor (2003) suggest that for the successful conservation of *V. angustior* it is important, where possible, to maintain a mosaic of habitats. They state that “*Experiences in this dune system (in western Ireland) suggest that the wetland areas may be critical to V. angustior, such that in dry years, the snail may find refuge in the wetland areas. Conversely, in very wet years, when the wetland areas are too wet for this species, the dune element becomes essential habitat. Thus, both habitat types may be required to ensure long-term survival of a population in*

this climate" (= western, oceanic). The possibly widespread presence of *V. angustior* at Whiteford may, at least in part, be due to the habitat mosaic that exists there including numerous dune slacks, some that regularly flood in winter and steep dry dunes. The dune sides are oriented in different directions; the slopes facing east and north possibly maintaining cooler, more humid conditions (and so better suited to maintain *V. angustior* populations) than on the drier and warmer southerly and westerly facing slopes".

Although there are some dune slacks at Pendine, they are not as regularly dispersed as in the Whiteford system. It is also suggested (Dan Guest, pers. comm.) that the water table lies relatively close to the surface in the northern half of Whiteford Burrows, the very area that supports numerous *V. angustior* populations.

The parallel comparative use of bulk and vacuum sampling was first trialled during the *V. angustior* surveys of Oxwich Burrows in 2023 (Willing, 2024b). During that work, although the vacuum sampling collected significantly more snails overall, both techniques missed 3 species only recorded by the other technique. In terms of the *V. angustior* target species, the 2023 bulk sampling collected x33 more of the snail and located it at more sites. The 2023 comparative trial was conducted in unfavourable conditions following heavy rainfall which meant that snails tended to adhere to the sward making vacuum removal more difficult. Under these conditions, it was concluded that, in terms of the target species, bulk was better vacuum sampling but that neither technique had an overall advantage when considering the sampling of the whole molluscan community.

Neither technique found all of the 44 recorded species. Thus, the bulk sampling only recorded the three species *Vallonia excentrica*, *Zonitoides nitidus* and *Euglesa casertana* not detected by the vacuum technique. By contrast, vacuum sampling recorded the eight species - *Arion ater*, *Ceruella virgata*, *Deroceras reticulatum*, *Euconulus alderi*, *Punctum pygmaeum*, *Vallonia pulcella*, *Gyraulus parvus* (= *laevis*) and *Lymnea stagnalis* - not found in the bulk samples. The 2024 sampling was undertaken in dry conditions with no rainfall immediately preceding or during the survey creating ideal conditions for vacuum sampling. As in 2023, the vacuum sampling produced significantly more snails with a total count of 5,871 compared to 965 as a bulk sample total. The much higher vacuum sample mollusc numbers (snails but a few slugs) is probably due to the technique collecting species occurring higher in the sampled vegetation. Thus, species that climb within the sward are those that are often also recovered by 'beating' vegetation onto a sample tray. Typical of these species are *Cochlicella acuta*, *Columella edentula*, *Vertigo pygmaea* and *Xeroplexa intersecta* which together made up a sample total of 4,047 snails, 69% of the vacuum total collected. Ben Rowson notes that in relation to the vacuum sampled snails, "Counts for larger species are strongly skewed towards juveniles. Most conspicuously, at Site 23 hatchlings of *Cochlicella acuta* and *Xeroplexa intersecta* each outnumbered the adults by a factor of almost 100". By contrast, some species that live low in the vegetation or close to or slightly below ground level (presumably to remain in shaded humid conditions and so minimise desiccation) were chiefly recorded from the bulk samples. Thus, 66% of the *Cochlicopa lubrica* recorded were collected by bulk sampling which also detected the snail more sites than by the vacuum technique. A similar situation for this species was noted in the Gower 2023 surveys when bulk sampling recovered 75% of the *Cochlicopa lubrica* records. Similarly both in 2023 and 2024, *Oychilus alliarius* was recorded in slightly higher numbers and at more bulk sample than vacuum sites.

Although this second comparative trial of vacuum versus bulk sampling may suggest that the former is the more successful technique, it is suggested that the two techniques complement each other and are usefully combined to survey species such as *V. angustior*. Each technique is better suited to recover particular components of the molluscan community, bulk sampling favouring

those species such as *V. angustior* that live close to or below the ground surface and do not climb into the sward. As *V. angustior* was not recorded at Pendine, it is not possible to compare the relative effectiveness of the two survey techniques in recoding it. If, as on Gower in 2023, the species is restricted to a microhabitat at or just below the ground surface like *Cochlicopa lubrica* then one might have expected the bulk sampling technique to have resulted in slightly better results than the vacuum even under dry conditions.

The small non-native *Paralaoma servilis* was recorded at two Pendine sites (S19 bulk and S20 vacuum). These are the first records of this Australasian snail from Carmarthenshire (vice-county 44). At the two sites where it was found, it was only located by one of the two survey techniques which may suggest the snail is very locally distributed. *P. servilis* was also recorded in Gower 2023, at two sites on Oxwich Burrows and along an extensive stretch of Swansea dunes (Willing, 2024b).

5. Conclusions & further work

The thorough and wide-ranging (Figure1) 2024 Pendine surveys targeted potentially suitable *V. angustior* plant communities throughout the Pendine dunes adopting a range of survey techniques at each site. An absence of both living or dead shells of the species suggests that it is unlikely to be extant in the area or that it may have been formerly present. As a result, no further *V. angustior* focussed surveys of the area are suggested.

6. Acknowledgements

Natur am Byth! supported by the Heritage Lottery Fund is thanked for funding this project, which was commissioned and managed by Clare Dinham (Buglife Cymru). Dr. Mike Howe (Natural Resources Wales) is thanked for making valued comments and structural improvements that have, through his skilled editorial role, improved the final report.

Ruth Harding (Senior Environment Officer [Conservation], Carmarthenshire Environmental Team, Natural Resources Wales) is thanked for providing help and guidance during the initial planning stages of this project.

Natural Resources Wales is thanked for granting an assent under Section 28H of the Wildlife & Countryside Act 1981 to undertake surveys (adopting the survey methodologies as described in this report) on the Twyni Lacharn - Pentywyn / Laugharne - Pendine Burrows SSSI. The assent notices were issued to Mr. John Black, DIO Ecologist (Tilleshall, Salisbury, Wiltshire) and he is thanked for allowing the surveys to operate under this permission.

Sally Campbell (Senior Administrator, QinetiQ, MoD Pendine) is thanked for arranging access permission to visit MOD Pendine and for arranging for Dave Tennor to act as the QinetiQ host.

Matt Sutton (Wyndrush Wild, Tenby) is thanked for acting as the MoD escort and site guide during the MoD Pendine visits. Additionally, Matt undertook botanical surveys of the survey sites providing the plant lists and the NVC assessments used in the report.

Ben Rowson (National Museum Wales, Cardiff) is thanked for undertaking vacuum sampling at all sample sites and for processing and tabulating results from the collected samples.

Finally, I am indebted to Cat Hammond (Natural Resources Wales) for assistance in constructing the survey location map.

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Appendix 1A. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	1B	1V	2B	2V	3B	3V
<i>Acanthinula aculeata</i>	-	-	-	-	-	-
<i>Aegopinella nitidula</i>	-	-	-	1	-	-
<i>Arion (Arion) ater</i>	-	-	-	1	-	-
<i>Ashfordia granulata</i>	-	-	-	-	1	-
<i>Carychium minimum</i>	3	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	1	-	-	-
<i>Cepaea nemoralis</i>	4	22	-	8	4	9
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	-	-	-	-	-	-
<i>Cochlicopa lubrica</i>	2	-	2	1	3	1
<i>Columella aspera / edentula</i>	-	-	-	-	-	-
<i>Cornu aspersum</i>	-	2	-	-	-	-
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	-	-
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	-	-	-
<i>Oxychilus cellarius</i>	-	-	-	-	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	1	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	-
<i>Trochulus hispidus</i>	-	-	1	-	-	22
<i>Trochulus striolatus</i>	-	-	-	10	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-
<i>Vallonia excentrica</i>						
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	1B	1V	2B	2V	3B	3V
<i>Vertigo pygmaea</i>	-	-	2	6	-	-
<i>Vitrea contracta</i>	-	-	-	-	1	-
<i>Vitrina pellucida</i>	-	1	-	-	-	-
<i>Xeroplexa intersecta</i>	-	-	1	11	3	3
<i>Zonitoides nitidus</i>						
AQUATIC SPECIES	1B	1V	2B	2V	3B	3V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	7	4	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1B. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	4B	4V	5B	5V	6B	6V
<i>Acanthinula aculeata</i>	7	5	-	-	-	-
<i>Aegopinella nitidula</i>	1	3	-	-	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	5	13	2	11	-	6
<i>Carychium minimum</i>	-	-	-	-	-	2
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	1	5	-	12	-	2
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	13	21	-	5	-	-
<i>Cochlicella acuta</i>	2	-	44	15	-	-
<i>Cochlicopa lubrica</i>	8	2	-	-	-	1
<i>Columella aspera / edentula</i>	-	-	-	-	-	31
<i>Cornu aspersum</i>	-	-	-	-	-	-
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	10	-	-	-	-	-
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	4B	4V	5B	5V	6B	6V
<i>Oxychilus cellarius</i>	6	-	-	1	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	-	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	15
<i>Trochulus hispidus</i>	1	2	3	1	1	1
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	2
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	23	5	-	-	-	-
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	1	-	1	19	-	-
<i>Xeroplexa intersecta</i>	-	-	2	-	-	-
<i>Zonitoides nitidus</i>						
AQUATIC SPECIES	4B	4V	5B	5V	6B	6V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1C. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	7B	7V	8B	8V	9B	9V
<i>Acanthinula aculeata</i>	-	-	-	-	-	-
<i>Aegopinella nitidula</i>	-	-	-	-	-	-
<i>Arion (Arion) ater</i>	-	1	-	-	-	-
<i>Ashfordia granulata</i>	-	26	-	-	4	16
<i>Carychium minimum</i>	-	-	-	-	1	10
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	-	-	-	8	1	16
<i>Cernuella virgata</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	7B	7V	8B	8V	9B	9V
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	-	1	-	-	-	-
<i>Cochlicopa lubrica</i>	4	2	3	8	2	8
<i>Columella aspera</i>	-	57	-	-	-	-
<i>Cornu aspersum / edentula</i>	-	4	-	16	-	-
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	9
<i>Lauria cylindracea</i>	-	-	-	-	-	-
<i>Monacha cantiana</i>	-	2	-	59	-	1
<i>Nesovitrea hammonis</i>	-	-	-	-	-	2
<i>Oxychilus alliarius</i>	1	-	-	-	-	-
<i>Oxychilus cellarius</i>	-	1	-	-	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	6	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	1	-	-	2	36
<i>Trochulus hispidus</i>	-	1	-	-	-	-
<i>Trochulus striolatus</i>	-	2	-	-	-	-
<i>Vallonia costata</i>	-	-	-	1	-	-
<i>Vallonia excentrica</i>	1	-	1	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	2	33
<i>Vertigo pygmaea</i>	2	3	11	155	-	-
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	1	3	-	1	-	-
<i>Xeroplexa intersecta</i>	4	-	2	1	-	-
<i>Zonitoides nitidus</i>	-	-	-	-	3	-
AQUATIC SPECIES	7B	7V	8B	8V	9B	9V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	11	-
<i>Euglesa casertana</i>	-	-	-	-	5	-
<i>Galba truncatula</i>	-	-	-	-	7	18
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1D. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	10B	10V	11B	11V	12B	12V
<i>Acanthinula aculeata</i>	-	-	-	-	-	-
<i>Aegopinella nitidula</i>	1	-	-	-	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	3	-	-	8	-	-
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	1	5	1	2	-	-
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	-	-	1	-	-	-
<i>Cochlicopa lubrica</i>	8	2	3	1	-	-
<i>Columella aspera / edentula</i>	-	-	-	-	-	-
<i>Cornu aspersum</i>	-	1	-	-	-	-
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	-	-
<i>Monacha cantiana</i>	-	52	-	4	-	-
<i>Nesovitrea hammonis</i>	-	1	-	-	-	-
<i>Oxychilus alliarius</i>	1	-	1	-	-	-
<i>Oxychilus cellarius</i>	-	-	-	-	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	6	-	-	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	2	-	6
<i>Trochulus hispidus</i>	-	2	1	9	-	-
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	6	34	2	4	-	-
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	-	-	-	-	-	-
<i>Xeroplexa intersecta</i>	3	3	1	3	-	-
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	10B	10V	11B	11V	12B	12V
<i>Ampullaceana balthica</i>	-	-	-	-	4	19
<i>Anisus leucostoma</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	10B	10V	11B	11V	12B	12V
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	4	117
<i>Gyraulus crista</i>	-	-	-	-	9	15
<i>Gyraulus parvus</i> (=laevis)	-	-	-	-	-	2
<i>Lymnaea stagnalis</i>	-	-	-	-	-	16
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1E. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	13B	13V	14B	14V	15B	15V
<i>Acanthinula aculeata</i>	1	4	-	-	-	-
<i>Aegopinella nitidula</i>	-	-	-	-	-	-
<i>Arion</i> (<i>Arion</i>) <i>ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	-	-	-	-	8	2
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	-	-	-	16	-	8
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	5	2
<i>Cochlicella acuta</i>	-	-	-	-	3	-
<i>Cochlicopa lubrica</i>	4	3	-	-	-	-
<i>Columella aspera</i> / <i>edentula</i>	-	-	-	-	-	-
<i>Cornu aspersum</i>	-	-	-	-	1	7
<i>Deroceas reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	1	-	-	2	1
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	1	-	-	-
<i>Oxychilus alliarius</i>	1	-	-	-	-	-
<i>Oxychilus cellarius</i>	-	2	-	-	2	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	-	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	15	-	-
<i>Trochulus hispidus</i>	-	-	-	31	4	-
<i>Trochulus striolatus</i>	-	-	-	-	3	7
<i>Vallonia costata</i>	2	9	-	-	2	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	13B	13V	14B	14V	15B	15V
<i>Vallonia pulchella</i>	-	1	-	1	-	-
<i>Vertigo antivertigo</i>	-	-	1	5	-	-
<i>Vertigo pygmaea</i>	2	4	-	-	-	-
<i>Vitrea contracta</i>	-	1	-	-	-	-
<i>Vitrina pellucida</i>	-	2	-	-	-	-
<i>Xeroplexa intersecta</i>	6	21	-	-	-	-
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	13B	13V	14B	14V	15B	15V
<i>Ampullaceana balthica</i>	-	-	1	-	-	-
<i>Anisus leucostoma</i>	-	-	1	1	-	-
<i>Aplexa hypnorum</i>	-	-	6	3	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	22	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1F. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	16B	16V	17B	17V	17iiB	17iiV
<i>Acanthinula aculeata</i>	-	-	-	-	-	not
<i>Aegopinella nitidula</i>	-	-	-	-	-	Recorded*
<i>Arion (Arion) ater</i>	-	-	-	-	-	*
<i>Ashfordia granulata</i>	-	-	-	-	-	*
<i>Carychium minimum</i>	-	-	-	-	-	*
<i>Cecilioides acicula</i>	-	-	-	-	-	*
<i>Cepaea nemoralis</i>	3	12	2	11	-	*
<i>Cernuella virgata</i>	-	-	-	-	-	*
<i>Clausilia bidentata</i>	-	-	-	-	-	*
<i>Cochlicella acuta</i>	3	138	20	65	-	*
<i>Cochlicopa lubrica</i>	10	2	3	-	-	*
<i>Columella aspera / edentula</i>	-	-	-	-	-	*
<i>Cornu aspersum</i>	3	9	-	10	-	*
<i>Deroceras reticulatum</i>	-	-	-	-	-	*
<i>Euconulus alderi</i>	-	-	-	-	-	*
<i>Lauria cylindracea</i>	6	-	-	-	-	*
<i>Monacha cantiana</i>	-	-	-	-	-	*
<i>Nesovitrea hammonis</i>	-	-	-	-	-	*
<i>Oxychilus alliarius</i>	-	-	-	-	-	*

TERRESTRIAL SPECIES	16B	16V	17B	17V	17iiB	17iiV
<i>Oxychilus cellarius</i>	-	-	-	-	-	*
<i>Paralaoma servilis</i>	-	-	-	-	-	*
<i>Punctum pygmaeum</i>	-	-	-	-	-	*
<i>Pupilla muscorum</i>	49	163	15	51	4	*
<i>Succinea putris</i>	-	-	-	-	-	*
<i>Trochulus hispidus</i>	-	-	-	-	-	*
<i>Trochulus striolatus</i>	-	-	-	-	-	*
<i>Vallonia costata</i>	-	-	-	-	-	*
<i>Vallonia excentrica</i>	-	-	-	-	-	*
<i>Vallonia pulchella</i>	-	-	-	-	-	*
<i>Vertigo antivertigo</i>	-	-	-	-	-	*
<i>Vertigo pygmaea</i>	11	4	-	-	1	*
<i>Vitrea contracta</i>	-	-	-	-	-	*
<i>Vitrina pellucida</i>	55	5	2	2	-	*
<i>Xeroplexa intersecta</i>	24	19	1	5	-	*
<i>Zonitoides nitidus</i>	-	-	-	-	-	*
AQUATIC SPECIES	16B	16V	17B	17V	17iiB	17iiV
<i>Ampullaceana balthica</i>	-	-	-	-	-	*
<i>Anisus leucostoma</i>	-	-	-	-	-	*
<i>Aplexa hypnorum</i>	-	-	-	-	-	*
<i>Euglesa casertana</i>	-	-	-	-	-	*
<i>Galba truncatula</i>	-	-	-	-	-	*
<i>Gyraulus crista</i>	-	-	-	-	-	*
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	*
<i>Lymnaea stagnalis</i>	-	-	-	-	-	*
<i>Peringia ulvae</i>	-	-	3-4	1	50+	*

Appendix 1G. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	18B	18S	19B	19S	20B	20S
<i>Acanthinula aculeata</i>	1	1	-	-	-	-
<i>Aegopinella nitidula</i>	-	2	-	-	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	-	-	-	1	-	-
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	3	13	-	1	-	3
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	1	1	-	1
<i>Cochlicella acuta</i>	1	-	3	17	1	48

TERRESTRIAL SPECIES	18B	18S	19B	19S	20B	20S
<i>Cochlicopa lubrica</i>	3	2	1	2	4	1
<i>Columella aspera / edentula</i>	-	5	-	-	-	2
<i>Cornu aspersum</i>	-	4	1	-	-	2
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	2	1
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	-	-	-
<i>Oxychilus cellarius</i>	-	-	-	-	-	-
<i>Paralaoma servilis</i>	-	-	2	-	-	3
<i>Punctum pygmaeum</i>	-	-	-	-	-	1
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	-
<i>Trochulus hispidus</i>	3	63	12	25	1	48
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	2
<i>Vallonia excentrica</i>	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	-	-	1	2	12	123
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	-	-	-	-	-	2
<i>Xeroplexa intersecta</i>	2	4	11	18	4	3
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	18B	18S	19B	19S	20B	20S
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1H. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	21B	21V	22B	22V	23B	23V
<i>Acanthinula aculeata</i>	-	-	-	-	-	-
<i>Aegopinella nitidula</i>	-	-	-	-	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	2	19	-	3	-	-
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	-	8	-	2	-	1
<i>Cernuella virgata</i>	-	-	-	-	-	1
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	-	-	-	1	23	1,419
<i>Cochlicopa lubrica</i>	10	-	5	2	7	-
<i>Columella aspera /edentula</i>	-	-	-	2	-	-
<i>Cornu aspersum</i>	-	-	-	1	-	15
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	3	1	-	-
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	1	-	-
<i>Oxychilus cellarius</i>	-	-	-	-	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	3	-	2	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	-
<i>Trochulus hispidus</i>	-	-	1	34	-	4
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	5	-	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	3	13	9	77	-	-
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	-	-	1	1	-	-
<i>Xeroplexa intersecta</i>	-	-	6	21	7	594
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	21B	21V	22B	22V	23B	23V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	21B	21V	22B	22V	23B	23V
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus</i> (=laevis)	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1I. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	24B	24V	25B	25V	26B	26V
<i>Acanthinula aculeata</i>	-	-	1	3	-	-
<i>Aegopinella nitidula</i>	-	-	-	-	-	-
<i>Arion</i> (<i>Arion</i>) <i>ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	-	-	-	-	1	-
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	2	2	-	5	1	3
<i>Cernuella virgata</i>	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	15	27	-	-	-	-
<i>Cochlicopa lubrica</i>	7	1	1	2	7	3
<i>Columella aspera</i> / <i>edentula</i>	-	-	-	105	5	161
<i>Cornu aspersum</i>	-	-	-	-	-	6
<i>Deroceras reticulatum</i>	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	-	-
<i>Monacha cantiana</i>	3	4	-	-	-	-
<i>Nesovitrea hammonis</i>	1	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	2	-	1
<i>Oxychilus cellarius</i>	-	-	-	-	2	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	-	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	3	57	-	-	-	1
<i>Trochulus hispidus</i>	-	31	-	1	2	53
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	24B	24V	25B	25V	26B	26V
<i>Vallonia pulchella</i>	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	-	1	-	-	4	-
<i>Vitrea contracta</i>	-	-	-	-	-	-
<i>Vitrina pellucida</i>	-	-	-	-	-	2
<i>Xeroplexa intersecta</i>	3	-	-	-	-	-
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	24B	24V	25B	25V	26B	26V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	44	629	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1J. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	27B	27V	28B	28V	29B	29V
<i>Acanthinula aculeata</i>	2	1	-	-	-	-
<i>Aegopinella nitidula</i>	1	-	1	-	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-
<i>Ashfordia granulata</i>	2	-	-	5	3	2
<i>Carychium minimum</i>	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-
<i>Cepaea nemoralis</i>	-	2	-	3	1	1
<i>Cernuella virgata</i>	-	8	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	-	-
<i>Cochlicella acuta</i>	-	2	-	1	-	-
<i>Cochlicopa lubrica</i>	5	1	-	5	7	5
<i>Columella aspera / edentula</i>	-	-	1	4	1	15
<i>Cornu aspersum</i>	-	3	-	1	-	1
<i>Deroceras reticulatum</i>	-	-	-	1	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	1	-
<i>Monacha cantiana</i>	-	-	-	-	-	-
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	-	-	-	-

TERRESTRIAL SPECIES	27B	27V	28B	28V	29B	29V
<i>Oxychilus cellarius</i>	-	-	4	-	3	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	-	-	25	-	-
<i>Pupilla muscorum</i>	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	-
<i>Trochulus hispidus</i>	-	2	-	51	-	47
<i>Trochulus striolatus</i>	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-
<i>Vallonia excentrica</i>	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	1	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	-	1	4	189	4	126
<i>Vitrea contracta</i>	-	-	-	1	-	-
<i>Vitrina pellucida</i>	-	2	-	4	1	1
<i>Xeroplexa intersecta</i>	2	8	1	14	9	14
<i>Zonitoides nitidus</i>	-	-	-	-	-	-
AQUATIC SPECIES	27B	27V	28B	28V	29B	29V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-

Appendix 1K. Mollusca recorded at Pendine, 13th to 15th September 2024

Columns labelled 'B' represent bulk samples and those labelled 'V' vacuum samples)

TERRESTRIAL SPECIES	30B	30V	31B	31V	32B	32V	33B	33V
<i>Acanthinula aculeata</i>	-	-	-	1	-	2	-	-
<i>Aegopinella nitidula</i>	-	1	1	-	-	1	-	-
<i>Arion (Arion) ater</i>	-	-	-	-	-	-	-	-
<i>Ashfordia granulata</i>	5	1	-	-	-	-	2	1
<i>Carychium minimum</i>	-	-	-	-	-	-	-	-
<i>Cecilioides acicula</i>	-	-	-	-	-	-	-	1
<i>Cepaea nemoralis</i>	1	3	1	2	-	2	-	1
<i>Cernuella virgata</i>	-	-	-	-	-	-	-	-
<i>Clausilia bidentata</i>	-	-	-	-	-	1	-	-
<i>Cochlicella acuta</i>	2	-	-	-	-	2	-	1

TERRESTRIAL SPECIES	30B	30V	31B	31V	32B	32V	33B	33V
<i>Cochlicopa lubrica</i>	9	3	3	-	1	-	4	5
<i>Columella aspera / edentula</i>	2	97	-	26	-	6	-	-
<i>Cornu aspersum</i>	1	1	-	-	-	-	-	2
<i>Deroceas reticulatum</i>	-	-	-	-	-	-	-	-
<i>Euconulus alderi</i>	-	-	-	-	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	-	-	-	-
<i>Monacha cantiana</i>	-	1	-	-	-	1	1	2
<i>Nesovitrea hammonis</i>	-	-	-	-	-	-	-	-
<i>Oxychilus alliarius</i>	-	-	1	-	-	-	-	-
<i>Oxychilus cellarius</i>	1	-	-	-	-	-	-	-
<i>Paralaoma servilis</i>	-	-	-	-	-	-	-	-
<i>Punctum pygmaeum</i>	-	1	-	-	-	-	-	5
<i>Pupilla muscorum</i>	-	-	-	-	-	-	-	-
<i>Succinea putris</i>	-	-	-	-	-	-	-	-
<i>Trochulus hispidus</i>	-	58	-	-	-	49	3	89
<i>Trochulus striolatus</i>	-	-	-	-	-	-	-	-
<i>Vallonia costata</i>	-	-	-	-	-	-	-	2
<i>Vallonia excentrica</i>	-	-	-	-	-	-	-	-
<i>Vallonia pulchella</i>	-	-	-	-	-	-	-	-
<i>Vertigo antivertigo</i>	-	-	-	-	-	-	-	-
<i>Vertigo pygmaea</i>	2	20	-	-	4	9	10	204
<i>Vitrea contracta</i>	-	-	-	-	-	-	-	-
<i>Vitrina pellucida</i>	-	1	-	-	-	1	1	3
<i>Xeroplexa intersecta</i>	1	3	-	19	-	9	7	30
<i>Zonitoides nitidus</i>	-	-	-	-	-	-	-	-
AQUATIC SPECIES	30B	30V	31B	31V	32B	32V	33B	33V
<i>Ampullaceana balthica</i>	-	-	-	-	-	-	-	-
<i>Anisus leucostoma</i>	-	-	-	-	-	-	-	-
<i>Aplexa hypnorum</i>	-	-	-	-	-	-	-	-
<i>Euglesa casertana</i>	-	-	-	-	-	-	-	-
<i>Galba truncatula</i>	-	-	-	-	-	-	-	-
<i>Gyraulus crista</i>	-	-	-	-	-	-	-	-
<i>Gyraulus parvus (=laevis)</i>	-	-	-	-	-	-	-	-
<i>Lymnaea stagnalis</i>	-	-	-	-	-	-	-	-
<i>Peringia ulvae</i>	-	-	-	-	-	-	-	-

Appendix 2. Classification (NVC) communities recorded at Pendine survey sites in September 2024

NVC	NVC description
SD6d	<i>Ammophila arenaria</i> mobile dune community
SD6e	<i>Ammophila arenaria</i> mobile dune community (<i>Festuca rubra</i> subcommunity)
SD7	<i>Ammophila arenaria</i> - <i>Festuca rubra</i> semi-fixed dune community
SD7c	<i>Ammophila arenaria</i> - <i>Festuca rubra</i> semi-fixed dune community (<i>Ononis repens</i> subcommunity)
SD8	<i>Festuca rubra</i> - <i>Galium verum</i> fixed dune community
SD8a	<i>Festuca rubra</i> - <i>Galium verum</i> fixed dune community (typical subcommunity)
SD8b	<i>Festuca rubra</i> - <i>Galium verum</i> fixed dune (<i>Luzula campestris</i> subcommunity)
SD9	<i>Ammophila arenaria</i> - <i>Arrhenatherum elatius</i> dune grassland
SD14	<i>Salix repens</i> - <i>Campylium stellatum</i> dune-slack
SD15	<i>Salix repens</i> - <i>Calliargon cuspidatum</i> dune-slack community
SD15a	<i>Salix repens</i> - <i>Calliargon cuspidatum</i> dune-slack (<i>Carex nigra</i> subcommunity)
SD17d	<i>Potentilla anserina</i> - <i>Carex nigra</i> dune-slack (<i>Hydrocotyle vulgaris</i> - <i>Ranunculus flammula</i> subcommunity)

Appendix 3. Assessment of plant frequencies and abundance

Plant frequency and abundance ratings are based upon an approximate DAFOR scale where:

1. Species listed as **Rare** are likely to be present in less than 20% of samples (2m x 2m) but are not included in the summary plant tables as their presence is not believed to be significant.
2. Species listed as **Occasional** are likely to be present in 20-59% of samples within the stand.
3. Species listed as **Frequent** are likely to be present in at least 60% of samples but are not typically at high covers (above 20%).
4. Species listed as **Abundant** make up more than 20% of the cover at, at least, 60% of sample locations but are not prominent enough to be considered **Dominant**.
5. Species listed as **Dominant** make up more than 50% of the cover at least 60% of locations within the stand.

Where a taxon has a particularly uneven distribution or abundance within an otherwise homogeneous stand of vegetation, a second local DAFOR value has been provided after a /.

Appendix 4. Plant records from Pendine sites in September 2023

Site 1:

NVC: SD15 (*Salix repens*-*Calliergon cuspidatum* dune-slack community)

Dominant: *Salix repens*, *Calliergon cuspidatum*

Locally Frequent > Abundant: *Rubus caesius*, *Equisetum palustre*, *Agrostis stolonifera*, *Epipactis palustris*, *Agrostis stolonifera*, *Potentilla anserina*, *Mentha aquatica*, *Hydrocotyle vulgaris*, *Festuca arundinacea*

Rare > Occasional: *Molinia caerulea*

Comments: winter-wet slack

Site 2:

NVC: SD8b (*Festuca rubra*-*Galium verum* fixed dune [*Luzula campestris* subcommunity])

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Dactylis glomerata*, *Carex flaca*, *Lotus corniculatus*, *Plantago lanceolata*, *Euphrasia officinalis*, *Rubus caesius*, *Ononis repens*, *Poa pratensis*, *Pseudoscleropodium purum*

Rare > Occasional: *Ammophila arenaria*, *Galium verum*, *Daucus carota*, *Blackstonia perfoliata*, *Carlina vulgaris*

Comments: None

Site 3:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Arrhenatherum elatius*, *Festuca rubra*

Locally Frequent > Abundant: *Holcus lanatus*, *Rubus caesius*, *Ononis repens*, *Valeriana officinalis*, *Ranunculus acris*

Rare > Occasional: *Ammophila arenaria*, *Galium verum*, *Soncus arvensis*, *Vicia cracca*, *Pseudoscleropodium purum*

Comments: None

Site 4:

NVC: SD7c (*Ammophila arenaria*-*Festuca rubra* semi-fixed dune community [*Ononis repens* subcommunity])

Dominant: *Ammophila arenaria*, *Festuca rubra*

Locally Frequent > Abundant: *Carex arenaria*, *Rubus caesius*, *Elytrigia atherica*, *Ononis repens*,

Rare > Occasional: -

Comments: Rank. Patches of *Hippophae rhamnoides* and *Rosa rugosa*.

Site 5:

NVC: SD6d (*Ammophila arenaria* mobile dune community)

Dominant: *Ammophila arenaria*

Locally Frequent > Abundant: Bare sand, *Hypochoeris radicata*, *Oenothera* sp., *Erigeron canadensis*, *Arenaria serpyllifolia*, *Bryum algovicum*

Rare > Occasional: *Euphorbia paralis*, *Festuca rubra*, *Bryum warneum*

Comments: Patches of *Hippophae rhamnoides*.

Site 6:

NVC: SD15 (*Salix repens*-*Calliergon cuspidatum* dune-slack community)

Dominant: *Salix repens*, *Calliergon cuspidatum*

Locally Frequent > Abundant: *Festuca arundinacea*, *Potentilla anserina*, *Rubus caesius*

Rare > Occasional: *Molinia caerulea*, *Hippophae rhamnoides*

Comments: Deer grazed; close to water trough.

Site 7:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Arrhenatherum elatius*, *Dactylis glomerata*

Locally Frequent > Abundant: *Ammophila arenaria*, *Eupatorium cannabinum*, *Jacobaea vulgaris*, *Festuca rubra*, *Daucus carota*, *Origanum vulgare*

Rare > Occasional: *Galium verum*, *Lithospermum officinale*, *Euphrasia officinalis*

Comments: On face of dune ridge

Site 8:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*

Locally Frequent > Abundant: *Jacobaea vulgaris*, *Origanum vulgare*, *Daucus carota*, *Poa pratensis*, *Rubus caesius*

Rare > Occasional: *Ammophila arenaria*, *Carex arenaria*, *Lotus corniculatus*, *Euphrasia officinalis*, *Lotus corniculatus*, *Lithospermum officinale*

Comments: Transitional to SD8b

Site 9:

NVC: SD15 (*Salix repens*-*Calliergon cuspidatum* dune-slack community)

Dominant: *Salix repens*, *Calliergon cuspidatum*, *Juncus maritimus*

Locally Frequent > Abundant: *Iris pseudacorus*, *Hydrocotyle vulgaris*, *Mentha aquatica*, *Carex nigra*

Rare > Occasional: *Juncus gerardii*, *Rumex hydrolapathum*

Comments: Transitional to SD8b

Site 10:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*

Locally Frequent > Abundant: *Holcus lanatus*, *Rubus caesius*, *Ammophila arenaria*

Rare > Occasional: *Ononis repens*

Comments: None

Site 11:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*

Locally Frequent > Abundant: *Holcus lanatus*, *Ammophila arenaria*

Rare > Occasional: *Rubus caesius*, *Daucus carota*, *Jacobaea vulgaris*

Comments: None

Site 12:

NVC: SD17d (*Potentilla anserina*-*Carex nigra* dune-slack [*Hydrocotyle vulgaris*-*Ranunculus flammula* subcommunity])

Dominant: *Eleocharis palustris*, *Potentilla anserina*

Locally Frequent > Abundant: *Mentha aquatica*, *Salix repens*

Rare > Occasional: *Carex hirta*

Comments: slack edge

Site 13:

NVC: SD8b > SD9 (*Festuca rubra*-*Galium verum* fixed dune (*Luzula campestris* subcommunity) > (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Dactylis glomerata*

Locally Frequent > Abundant: *Salix repens*, *Ammophila arenaria*, *Galium verum*, *Hippophae rhamnoides*, *Hylocomiadelphus triquetrus*

Rare > Occasional: *Arrhenatherum elatius*

Comments: north-west dune face by slack

Site 14:

NVC: SD15a (*Salix repens*-*Calliergon cuspidatum* dune-slack (*Carex nigra* subcommunity)

Dominant: *Salix repens*, *Carex nigra*

Locally Frequent > Abundant: *Carex arenaria*, *Rubus caesius*, *Mentha aquatica*, *Filipendula ulmaria*, *Festuca arundinacea*, *Potentilla anserina*, *Calliergon cuspidatum*

Rare > Occasional: -

Comments: None

Site 15:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Ammophila arenaria*, *Dactylis glomerata*, *Holcus lanatus*

Locally Frequent > Abundant: *Sonchus arvensis*, *Rubus caesius*, *Hippophae rhamnoides* (sprayed)

Rare > Occasional: -

Comments: Disturbed sea buckthorn clearance area

Site 16:

NVC: SD7 > SD8 (*Ammophila arenaria*-*Festuca rubra* semi-fixed dune community) > (*Festuca rubra*-*Galium verum* fixed dune community)

Dominant: *Ammophila arenaria*

Locally Frequent > Abundant: *Agrostis stolonifera*, *Festuca rubra*, *Lotus corniculatus*, *Carex arenaria*, *Arenaria serpyllifolia*, *Plantago lanceolata*, *Calystegia soldanella*, *Jacobaea vulgaris*, *Rumex crispus*

Rare > Occasional: *Raphanus maritimus*, *Sonchus arvensis*, *Tortella flavovirens*

Comments: transitional semifixed to fixed dune

Site 17:

NVC: SD6e (*Ammophila arenaria* mobile dune community [*Festuca rubra* subcommunity])

Dominant: *Ammophila arenaria*, *Carex arenaria*

Locally Frequent > Abundant: *Festuca rubra*, *Hippophae rhamnoides*, *Lotus corniculatus*, *Raphanus maritimus*, *Oenothera* sp, *Leontodon hispidus*, *Sonchus arvensis*, *Arenaria serpyllifolia*

Rare > Occasional: *Homalothecium lutescens*, *Syntrichia ruraliformis*, *Ceratodon purpureus*, *Anthyllus vulneraria*

Comments: semi-fixed dune with occasional bare sand patches

Site 18:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*

Locally Frequent > Abundant: *Daucus carota*, *Rubus fruticosus*, *Teucrium scorodonia*, *Plantago lanceolata*

Rare > Occasional: *Hypericum perforatum*, *Jacobaea vulgaris*, *Silene dioica*

Comments: Rank fixed dune

Site 19:

NVC: SD9 – SD8b (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland) > (*Festuca rubra* *Galium verum* fixed dune [*Luzula campestris* subcommunity])

Dominant: -

Locally Frequent > Abundant: *Dactylis glomerata*, *Rubus caesius*, *Poa pratensis*, *Festuca rubra*, *Galium verum*, *Ammophila arenaria*, *Ononis repens*, *Arrhenatherum elatius*, *Jacobaea vulgaris*, *Erigeron canadensis*, *Hippophae rhamnoides*

Rare > Occasional: *Raphanus maritimus*, *Sonchus arvensis*

Comments: transitional vegetation, rank but shorter patches

Site 20:

NVC: SD8b (*Festuca rubra*-*Galium verum* fixed dune [*Luzula campestris* subcommunity])

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ononis repens*, *Daucus carota*, *Pilosella officinalis*, *Linum catharticum*, *Rhinanthus minor*, *Hypochoeris radicata*, *Hippophae rhamnoides*, *Pseudoscleropodium purum*, *Rubus caesius*

Rare > Occasional: *Ammophila arenaria*, *Dactylis glomerata*, *Asplenium adiantum-nigrum*

Comments: North-east dune face

Site 21:

NVC: SD15 (*Salix repens*-*Calliargon cuspidatum* dune-slack community)

Dominant: *Salix repens*, *Prunus spinosa*

Locally Frequent > Abundant: *Festuca rubra*, *Agrostis capillaris*, *Dactylis glomerata*, *Rubus caesius*

Rare > Occasional: *Ammophila arenaria*, *Euphrasia officinalis*

Comments: tiny patch of species-poor *Salix repens* within rank SD8b - sample covered both

Site 22:

NVC: SD8b (*Festuca rubra*-*Galium verum* fixed dune [*Luzula campestris* subcommunity])

Dominant: -

Locally Frequent > Abundant: *Festuca rubra*, *Ammophila arenaria*, *Galium verum*, *Ononis repens*, *Leontodon hispidus*, *Plantago lanceolata*, *Anthoxanthum odoratum*, *Daucus carota*, *Veronica chamaedryfolia*, *Rubus caesius*, *Pseudoscleropodium purum*

Rare > Occasional: *Polypodium vulgare*, *Lithospermum officinale*, *Prunella vulgaris*, *Asplenium adiantum-nigrum*

Comments: north face of highest dune, sheep grazed at time of survey

Site 23:

NVC: SD8a (*Festuca rubra*-*Galium verum* fixed dune community [typical subcommunity])

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Ononis repens*, *Dactylis glomerata*, *Rubus caesius*, *Carex arenaria*

Rare > Occasional: *Hypochoeris radicata*, *Galium verum*

Comments: ungrazed north face of dune. Dead, sprayed *Hippophae rhamnoides*

Site 24:

NVC: SD14 (*Salix repens*-*Campylium stellatum* dune-slack)

Dominant: *Juncus articulatus*, *Carex flacca*, *Carex serotina*, *Agrostis stolonifera*

Locally Frequent > Abundant: *Salix repens*, *Calliargon cuspidatum*, *Equisetum palustre*, *Carex arenaria*, *Hippophae rhamnoides*

Rare > Occasional: *Ranunculus flammula*, *Mentha aquatica*, *Aneura pinguis*, *Bryum pseudotriquetrum*

Comments: level damp sandy ground in former rifle range

Site 25:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Ammophila arenaria*

Locally Frequent > Abundant: *Arrhenatherum elatius*, *Dactylis glomerata*, *Holcus lanatus*, *Jacobaea vulgaris*, *Rubus fruticosus*, *Ononis repens*, *Torilis japonica*, *Prunus spinosa*

Rare > Occasional: -

Comments: Crest of north face of dune

Site 26:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*, *Ammophila arenaria*

Locally Frequent > Abundant: *Rubus caesius*, *Glechoma hederacea*, *Teucrium scorodonia*, *Jacobaea vulgaris*, *Cirsium arvense*, *Prunus spinosa*

Rare > Occasional: *Galium verum*, *Heracleum sphondylium*, *Tragopogon pratensis*

Comments: None

Site 27:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*

Rare > Occasional: *Jacobaea vulgaris*

Comments: None

Site 28:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*

Rare > Occasional: *Centaurea nigra*, *Jacobaea vulgaris*

Comments: None

Site 29:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*

Rare > Occasional: *Centaurea nigra*, *Jacobaea vulgaris*

Comments: None

Site 30:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*

Rare > Occasional: *Galium verum*, *Jacobaea vulgaris*

Comments: None

Site 31:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*, *Prunus spinosa*

Rare > Occasional: *Galium verum*

Comments: None

Site 32:

NVC: SD9 (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: *Festuca rubra*

Locally Frequent > Abundant: *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*, *Rubus caesius*, *Daucus carota*, *Ononis repens*, *Plantago lanceolata*

Rare > Occasional: *Agrimonia eupatorium*

Comments: None

Site 33:

NVC: SD7 within SD9 (*Ammophila arenaria*-*Festuca rubra* semi-fixed dune community) within (*Ammophila arenaria*-*Arrhenatherum elatius* dune grassland)

Dominant: -

Locally Frequent > Abundant: *Ammophila arenaria*, *Festuca rubra*, *Ononis repens*, *Rubus caesius*, *Erigeron acer*, *Carex arenaria*, *Hypochoeris radicata*, *Poa pratensis*, *Galium verum*, *Thymus drucei*, *Arenaria serpyllifolia*

Rare > Occasional: -

Comments: semifixed dune on bank within SD9, bare sand patches frequent

Appendix 5. Site Locations and Summary Habitat Descriptions at Pendine

(including NVC community & dominant plants)



Site P1. SN 27406 07359

NVC: SD15. **Dominants:** *Salix repens*, *Calliergon cuspidatum*. **Elevation:** 7.882m



Site P2. SN 27394 07306

NVC: SD8b. **Dominants:** *Festuca rubra*. **Elevation:** 10.819m



Site P3. SN 27384 07247

NVC:SD9. **Dominants:** *Arrhenatherum elatius*, *Festuca rubra*. **Elevation:** 10.809m



Site P4. SN 27353 07157

NVC:SD7c. **Dominants:** *Ammophila arenaria*, *Festuca rubra*. **Elevation:** 10.723m



Site P5. SN 27342 07131

NVC:SD6d. **Dominants:** *Ammophila arenaria*. **Elevation:** 10.007m



Site P6. SN 27120 07512

NVC:SD15. **Dominants:** *Salix repens*, *Calliergon cuspidatum*. **Elevation:** 7.381m



Site P7. SN 27227 07447

NVC:SD9. **Dominants:** *Arrhenatherum elatius*, *Dactylis glomerata*. **Elevation:** 10.229m



Site P8. SN 27222 07429

NVC:SD9. **Dominants:** *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*. **Elevation:** 12.937m



Site P9. SN 28000 07356

NVC:SD15. **Dominants:** *Salix repens*, *Calliergon cuspidatum*, *Juncus maritimus* **Elevation:** 8.975m



Site P10. SN 27981 07186

NVC:SD9. **Dominants:** *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*. **Elevation:** 10.693m



Site P11. SN 27980 07109

NVC:SD9. **Dominants:** *Festuca rubra*, *Arrhenatherum elatius*, *Dactylis glomerata*. **Elevation:** 14.041



Site P12. SN 28933 07678

NVC:SD17d. **Dominants:** *Eleocharis palustris*, *Potentilla anserina*. **Elevation:** 9.023



Site P13. SN 28950 07679

NVC:SD8b - SD9. **Dominants:** *Festuca rubra*, *Dactylis glomerata*. **Elevation:**11.026



Site P14. SN 28836 07806

NVC:SD15a. **Dominants:** *Salix repens*, *Carex nigra*. **Elevation:** 7.064



Site P15. SN 30113 06958

NVC:SD9. **Dominants:** *Ammophila arenaria*, *Dactylis glomerata*, *Holcus lanatus*. **Elevation:** 10.64



Site P16. SN 23624 08073

NVC:SD7 – SD8. **Dominants:** *Ammophila arenaria*. **Elevation:** 9.15m



Site P17. SN 32548 08156

NVC:SD6e. **Dominants:** *Ammophila arenaria*, *Carex arenaria*. **Elevation:** 8.123m



Site P18. SN 32311 07926

NVC:SD9. **Dominants:** *Ammophila arenaria*, *Dactylis glomerata*, *Arrhenatherum elatius*.

Elevation: 9.912m



Site P19. SN 32248 07537

NVC:SD9 - SD8b. **Dominants:** *Ammophila arenaria*. **Elevation:** 10.271m



Site P20. SN 32032 07523

NVC:SD8b. **Dominants:** *Festuca rubra*. **Elevation:** 15.2m



Site P21. SN 31704 07517

NVC:SD15. **Dominants:** *Salix repens*, *Prunus spinosa*. **Elevation:** 7.918m



Site P22. SN 31823 07441

NVC:SD8b. **Dominants:** *Festuca rubra*. **Elevation:** 16.274m



Site P23. SN 31300 07080

NVC:SD8a. **Dominants:** *Festuca rubra*. **Elevation:** 9.81m



Site P24. SN 26210 07859

NVC:SD14. **Dominants:** *Juncus articulatus*, *Carex flacca*, *Carex serotina*, *Agrostis stolonifera*.
Elevation: 9.804m



Site P25. SN 25620 07751

NVC:SD9. Dominants: *Festuca rubra*, *Ammophila arenaria*. **Elevation:** 12.216m



Site P26. SN 25617 07671

NVC:SD9. Dominants: *Festuca rubra*, *Ammophila arenaria*. **Elevation:** 14.413m



Site P27. SN 23897 07879

NVC:SD9. Dominants: *Festuca rubra*. **Elevation:** 12.347m



Site P28. SN 23895 07964
NVC:SD9. **Dominants:** *Festuca rubra*. **Elevation:** 16.261m



Site P29. SN 24108 07889
NVC:SD9. **Dominants:** *Festuca rubra*. **Elevation:** 12.24m



Site P30. SN 24106 07860
NVC:SD9. **Dominants:** *Festuca rubra*. **Elevation:** 14.604m



Site P31. SN 24639 07780

NVC:SD9. **Dominants:** *Festuca rubra*. **Elevation:**10.895m



Site P32. SN 24770 07839

NVC:SD9. **Dominants:** *Festuca rubra*. **Elevation:** 13.304m



Site P33. SN 25889 07561

NVC:SD7 within SD9. **Dominants:** *Ammophila arenaria*. **Elevation:** 12.07m

Data Archive Appendix

The data archive contains:

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

~~[B] A full set of maps produced in JPEG format.~~

~~[C] A series of GIS layers on which the maps in the report are based with a series of word documents detailing the data processing and structure of the GIS layers.~~

~~[D] A set of raster files in ESRI and ASCII grid formats.~~

~~[E] A database named [name] in Microsoft Access 2000 format with metadata described in a Microsoft Word document [name.doc].~~

~~[F] A full set of images produced in [jpg/tiff].~~

[G] Species records held in Welsh Invertebrate Database (WID).

Metadata for this project is publicly accessible through Natural Resources Wales' Data Discovery Service <https://metadata.naturalresources.wales/geonetwork/srv> (English version) and <https://metadata.cyfoethnaturiol.cymru/geonetwork/cym/> (Welsh Version). The metadata is held as record no. NRW_DS161380.

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