Further studies to assess the distribution of the Narrow-mouthed Whorl Snail *Vertigo angustior* on Oxwich Burrows, Nicholaston Burrows, Whiteford Burrows, Three Cliffs Bay & Swansea Dunes in September 2023

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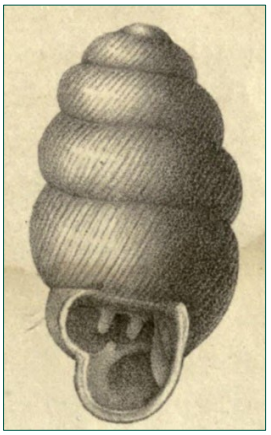

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Crynodeb gweithredol

Mae'r adroddiad hwn yn disgrifio arolygon ar y falwen *Vertigo angustior* a gynhaliwyd dros gyfnod o 6 diwrnod rhwng 16 a 21 Medi 2023 ar Benrhyn Gŵyr yn ne Cymru fel rhan o brosiect Natur am Byth! Arolygwyd pum ardal: Twyni Oxwich (2 ddiwrnod), Twyni Nicholaston (1 diwrnod) a Thwyni Whiteford (1 diwrnod), Bae'r Tri Chlogwyn (1 diwrnod) a Thwyni Abertawe (1 diwrnod). Nid yw'n hysbys bod unrhyw arolygon blaenorol o *V. angustior* wedi'u cynnal ar Dwyni Nicholaston, ym Mae'r Tri Chlogwyn nac ar Dwyni Abertawe, ac ym mhob un o'r safleoedd hyn samplwyd ystod o gynefinoedd a allai fod yn addas.

Yn Nhwyni Oxwich, canolbwyntiodd yr arolygon yn bennaf ar safleoedd twyni sych sefydlog a lled-sefydlog ar ôl darganfod poblogaeth sylweddol o'r falwen ar safle twyni sych yn Oxwich yn 2022. Yn ogystal, arolygwyd holl safleoedd Oxwich trwy ddulliau samplu swmp a samplu drwy wactod (sugno) er mwyn gallu cymharu'r ddwy dechneg hon.

Cynhaliwyd arolygon pellach o laciau twyni nad ymwelwyd â hwy o'r blaen yn Nhwyni Whiteford tua'r gogledd a'r gorllewin o system y twyni. Yn ogystal, cymerwyd samplau ar hyd dau drawslun byr yn rhedeg o waelod un o laciau'r twyni ac i fyny ymylon twyni sych gogleddol a deheuol y twyni o'i amgylch.

Ni chafwyd unrhyw achosion *V. angustior* yn y samplau a gasglwyd o Dwyni Abertawe a Bae'r Tri Chlogwyn. Fodd bynnag, gwnaed darganfyddiad nodedig ar y cyntaf o'r safleoedd hyn, sef presenoldeb y falwen estron o Awstralasia, *Paralaoma servilis.* Y rhain ydy'r cofnodion cyntaf (ynghyd â rhai o Dwyni Oxwich) o'r rhywogaeth ar y Gŵyr a'r boblogaeth fwyaf helaeth sydd wedi'i chanfod yng Nghymru hyd yma. **Daethpwyd o hyd i *V. angustior* ar un safle twyni sych sefydlog ar Dwyni Nicholaston, y cofnod cyntaf ar gyfer y system hon o dwyni**, ond sylwer na chofnodwyd y falwen yno'n ehangach mewn cynefin tebyg.

Ar Dwyni Oxwich, cofnodwyd y falwen mewn pedwar safle twyni sych gan gynnwys tri lleoliad newydd ac un ble cafodd ei chofnodi hefyd yn 2022. Fodd bynnag, dim ond mewn dau o'r lleoliadau hyn y cofnodwyd niferoedd sylweddol o'r falwen. Roedd y safleoedd positif hyn i gyd yn gymharol agos at ei gilydd, yng nghornel ogledd-ddwyreiniol Twyni Oxwich, sy'n dangos dosbarthiad cyfyngedig *V. angustior* ar y twyni. Dangosodd y gymhariaeth o'r dulliau samplu swmp / drwy wactod yn Oxwich fod y technegau ill dau yn fwyaf addas ar gyfer casglu rhannau penodol o'r gymuned o folysgiaid, gyda'r dull samplu drwy wactod yn ffafrio rhywogaethau mwy a'r rhai sy'n dringo uwchlaw lefel y ddaear. Yn achos *V. angustior*, casglodd y dull samplu swmp niferoedd sylweddol uwch o'r falwen ac mewn mwy o safleoedd nag a wnaeth y dull samplu drwy wactod. I raddau, rhoddodd y ddau ddull wybodaeth a oedd yn ategu ei gilydd. Fodd bynnag, gan fod yr un gymhariaeth hon wedi'i chynnal o dan amodau gwlyb anffafriol, gallai hynny fod wedi peri anfantais i'r dull samplu drwy wactod.

Yn Nhwyni Whiteford darganfuwyd *V. angustior* mewn saith arall o laciau'r twyni, a hynny'n ymestyn amrediad hysbys y falwen ymhellach yn y cynefin hwn ar system y twyni i gynnwys safleoedd newydd ar ymylon gorllewinol a gogleddol eithaf y warchodfa.

Dangosodd canlyniadau'r ddau drawslun fod poblogaethau *V. angustior* yn byw mewn cynefin twyni sych ar lethr sy'n wynebu'r gogledd, ond nid ar un cyfagos sy'n wynebu'r de ble gallai amodau poethach a sychach greu amodau anaddas i'r falwen. Fe wnaeth arolwg Whiteford 2023 hefyd leoli *V. angustior* am y tro cyntaf mewn pum safle twyni sych.

Nid oes angen arolygon pellach ar gyfer *V. angustior* o Dwyni Abertawe a Bae'r Tri Chlogwyn, ac erbyn hyn mae darlun gweddol dda o ddosbarthiad y falwen ar Dwyni Oxwich. Argymhellir arolwg mwy trylwyr o Dwyni Nicholaston i weld a yw'r falwen i'w chael yn ehangach ar system y twyni. Ymddengys fod cyfiawnhad dros gynnal arolygon pellach o gynefinoedd twyni sych yn Nhwyni Whiteford yn dilyn arolwg 2023 a ddangosodd am y tro cyntaf ac yn annisgwyl fod y falwen yn bresennol yn y cynefin hwn.

Er mwyn asesu 'iechyd' poblogaethau *V. angustior* ar Dwyni Oxwich a Thwyni Whiteford, awgrymir y dylid sefydlu nifer o safleoedd monitro lleoliad sefydlog. Ym mhob un o'r rhain, argymhellir y dylid asesu statws cadwraeth y falwen yn wrthrychol yn rheolaidd gan ddefnyddio protocolau monitro diwygiedig ac Amcanion Cadwraeth.

Executive summary

This report describes surveys for the Narrow-mouthed Whorl Snail *Vertigo angustior* undertaken over a 6-day period from 16th to 21st September 2023 on the Gower Peninsula in south Wales as part of the Natur am Byth! project. Five areas were surveyed: Oxwich Burrows (2 days), Nicholaston Burrows (1 day) and Whiteford Burrows (1 day), Three Cliffs Bay (1 day) and Swansea Dunes (1 day). No previous *V. angustior* surveys are known to have taken place on Nicholaston Burrows, Three Cliffs Bay and Swansea Dunes and at each of these sites a range of potentially suitable habitats were sampled.

At Oxwich Burrows, surveys focussed primarily upon fixed and semi-fixed dry dune sites following the discovery of a substantial population of the snail from an Oxwich dry dune site in 2022. Additionally, all Oxwich sites were surveyed by both bulk and vacuum (suction) sampling to allow a comparison of these two techniques.

Further surveys of dune slacks not previously visited were undertaken at Whiteford Burrows towards the north and west of the dune system. Additionally, samples were taken along two short transects running from the base of a dune slack and up the northern and southern dry dune margins of enclosing dunes.

No *V. angustior* were found in the dune samples collected on Swansea Dunes and Three Cliffs Bay. A notable discovery at the former site was, however, the presence of the non-native Australasian snail *Paralaoma servilis,* these being the first records (together with those from Oxwich Burrows) of the species from Gower and the most extensive population yet discovered in Wales. ***V. angustior* was found at a single fixed dry dune site on Nicholaston Burrows, a first record for this dune system**, although it was not found more widely in similar habitat there.

On Oxwich Burrows, the snail was recorded at four dry dune sites including three new locations and one where it was also recorded in 2022. However, significant numbers of the snail were found at only two of these locations. These positive sites were all situated relatively close together at the north-eastern corner of Oxwich Burrows, demonstrating the restricted distribution of *V. angustior* on the dunes. The Oxwich bulk / vacuum sample comparison trial demonstrated that each technique was best suited to recovering particular parts of the molluscan community, the vacuum sampling favouring larger species and those that climb above ground level. For *V. angustior*, bulk sampling recovered significantly larger numbers of the snail and at more sites than from the vacuum sampling. To a degree, the two methods gave complementary information although as this single comparative trial was conducted under unfavourable wet conditions it may have disadvantaged the vacuum sampling.

On Whiteford Burrows *V. angustior* was found in a further seven dune slacks, further extending the snail's known range in this habitat on the dune system to include new sites at western and extreme northern margins of the reserve. Results from the two transects showed *V. angustior* populations living in dry dune habitat on a north-facing slope, but not on an adjacent south-facing one where hotter and drier conditions may create unsuitable

conditions for the snail. The 2023 Whiteford survey also located *V. angustior* for the first time at five dry dune sites.

Further surveys for *V. angustior* of Swansea Dunes and Three Cliffs Bay are not required, and there is now a reasonably good picture of the snail's distribution on Oxwich Burrows. A more thorough survey of Nicholaston Burrows is recommended to determine if the snail occurs more widely on the dune system. Further surveys on Whiteford Burrows of dry dune habitats seem justified following the 2023 survey which demonstrated for the first time the snail's previously unsuspected presence in this habitat.

To assess the 'health' of the *V. angustior* populations on Oxwich Burrows and Whiteford Burrows, it is suggested that several fixed location monitoring sites are established. At each of these, it is recommended that the snail's conservation status should be objectively assessed on a regular basis using revised monitoring protocols and Conservation Objectives.

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'.

The first records of *V. angustior* in Wales were all of 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 (Harper, 2007, 2014). Thus, in Wales, the Narrow-mouthed Whorl Snail *Vertigo 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) and Oxwich Burrows, with historical records from Swansea (its type locality) and Tenby in Pembrokeshire.

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.

1.2 Oxwich Burrows

Oxwich Burrows is a dune system lying on the central south coast of the Gower Peninsula. It is part of Oxwich Bay SSSI and is mostly within Oxwich National Nature Reserve. *Vertigo angustior* shells were first found here in 1924 and 1925 (Quick 1924, 1926) but no live animals were recorded. Live specimens were first found in 1983 (Preece & Willing, 1984), with further surveys and monitoring occurring in 1993 (Killeen, 1993), 1994, 1995, 1996 (Fowles & Hurford, 1995, 1996; Fowles *et al*., 1997), 2006 (Harper, 2007) and with a short unpublished NRW visit in 2016 (Karen Wilkinson & Mike Howe, pers. comm.). All these surveys focussed exclusively on a narrow band of dunes lying as a ‘transition zone’ immediately parallel to saltmarsh on the northern margins of the dunes. *V. angustior* is not believed to have been surveyed previously in other Oxwich dune locations. In 1995, *V. angustior* was considered to be on the verge of extinction at Oxwich (Fowles & Hurford, 1996) but the following year the snail was recorded at a number of locations at the eastern end of the ‘transition zone’ (Fowles *et al*., 1997).

Despite these encouraging finds, no further surveys were undertaken by NRW until a short visit in 2016 when a few snails were found on dune hummocks close to where the snail was first found in 1983. In 2006 a trial vacuum sampling visit (Harper, 2007) also found live populations in the vicinity of the first finds. A survey in October 2022 (Willing, 2024) was the first to survey *V. angustior* more widely across the Oxwich dunes system since Quick in 1925. This survey not only focussed upon an extensive survey of the saltmarsh – dune edge ‘transition zone’ on the northern edge of the dunes, but also sampled a wide range of *Salix repens* dune slacks across the reserve. This survey focus followed the discovery of many *V. angustior* populations living in dune slacks on Whiteford Burrows in 2021 and 2022 (Willing, 2023, 2024). The 2022 Oxwich survey revealed depletion of populations of the snail in the transition zone, chiefly due to the advance of trees and scrub, and also its presence in only low numbers at one of the eight slacks surveyed. An unexpected find however was the presence of large numbers of the snail living in a semi-fixed dry dune site lying away from the transition zone (see Willing, 2024).

More detailed notes on all previous Oxwich surveys are given in Appendix 13 in Willing (2024).

1.3 Whiteford Burrows

Whiteford Burrows is a dune system lying on the north-west coast of the Gower Peninsula and is part of the much larger Carmarthen Bay Dunes/Twyni Bae Caerfyrddin SAC. Following the initial discovery of *V. angustior* at Whiteford Burrows in 1983 (Preece & Willing, 1984), a more detailed survey was undertaken there in 1993 (Killeen, 1993) confirming the presence of the snail along a narrow length of salt marsh/sand dune 'transition zone' extending for nearly 1km. Following this survey, regular monitoring and condition assessment has been undertaken of the southern area of the transition zone in 1994 (Fowles & Hurford, 1995), 1995 (Fowles, 1998; Fowles & Hurford, 1996), 1996 (Fowles *et al*., 1997), 1997 (Fowles, Painter & Woodman, unpublished), 2001 (Fowles & Guest, 2006), 2006 (Wilkinson, 2007), 2012 (Wilkinson, 2012) and 2016 (Wilkinson, in prep.). In 2006, two areas were sampled to trial a vacuum sampler (Harper, 2007). In addition to this monitoring, a survey of Cwm Ivy Marsh was undertaken in 1998 (Holyoak & Willing, 1999) and an autecological study of *V. angustior* was undertaken in the southern area of the transition zone from 1998 to 1999 (Cameron, 2003; Sharland, 2000a&b).

The *V. angustior* monitoring results from 1994 to 2012 all broadly concluded that the snail and its associated *Iris pseudacorus* habitat were mainly in **favourable condition**. However, a series of four monitoring visits to these previously studied monitoring sites between February and September 2016 recorded very few snails, even in the central core area, suggesting that the population of the snail had declined significantly. The 'crashed' population in the Whiteford transition zone was then assessed as **unfavourable** with a decreasing trend (Karen Wilkinson, pers. comm.). This formed the basis of NRW Article 17 reporting for the snail in 2018 – a stable range but all populations under threat (Howe, 2018). In response to this apparent decline, a single day assessment visit was undertaken in October 2018 (Willing, 2020). This allowed an overview site-survey, combined with off-site bulk sample analysis, to assess most of the sand dune/salt marsh transition zone and allowing the field assessment of the snail at 11 sites, which also involved the removal of bulk vegetation samples for off-site determination of snail presence. The results revealed *V. angustior* to be present at seven sites including several in the northern transition zone, an area in which the snail had not been recorded previously and which had been overlooked for study since the 1993 survey.

The 2018 results demonstrated the presence of the snail over a linear distance of 1.9km along the eastern saltmarsh / sand dune transition zone extending the previously recorded range by 1.2 km, a 171% increase. A survey in 2021 (Willing, 2023) was the first to undertake wide-ranging *V. angustior* surveys within the main body of the dunes. As a result, the snail was found in 32% of the *Salix repens* dominated slacks surveyed, living in different vegetational communities than those present in the sand dune / salt marsh transition zone where the snail had previously been recorded. The 2022 survey (Willing, 2024) further investigated dune slacks at the northern end of the dunes, discovering the snail in a further 4 sites (50% of those investigated).

More detailed notes on all previous Whiteford surveys are given in Appendix 14 in Willing (2024).

1.4 Nicholaston Burrows, Three Cliffs Bay & Swansea Dunes

Nicholaston Burrows lies to the immediate east of the north-western edge of Oxwich Burrows (separated from them by Oxwich Pill - a small stream flowing out from Oxwich marsh) where the recent *V. angustior* finds have been made. Three Cliffs Bay lies a short distance to the east of Nicholaston Burrows but they are not directly connected. A small number of sand dunes are present there including some lying on the margins of a small area of saltmarsh. Swansea Dunes, also known as Black Pill Burrows, lie as a relatively narrow strip to the immediate east of Swansea University campus. These dunes, which extended further inland before the University was built, are believed to lie close to where Jeffreys found freshly dead *V. angustior* in 1830, the area becoming the type locality for this then newly described species (Jeffreys, 1830, 1862).

No systematic surveys are known to have been undertaken for any of these three dune systems.

1.5 Survey objectives

1.5.1 Oxwich Burrows & Nicholaston Burrows

Both the salt marsh/sand dune transition zone and *Salix repens* dominated dune slacks were adequately surveyed at Oxwich in 2022 making surveys of these habitats a low priority in 2023. As *Vertigo angustior* were found in 2022 in 'good numbers' in a fixed Oxwich fore dune community, then this habitat (prior to 2022 not suspected as supporting the snail there) should be more extensively surveyed at Oxwich in 2023. Additionally, as Nicholaston Burrows lies immediately to the east of Oxwich Burrows, then a survey of a selection of dune habitats was planned for 2023. The western end of Nicholaston Burrows also lies relatively close to the Oxwich locality (Site OB1) which produced a large number of *V. angustior* in 2022.

1.5.2 Whiteford Burrows

The further discovery of 'good' populations of *V. angustior* in dune slacks at Whiteford Burrows in 2022 suggested that this habitat should be more extensively surveyed in 2023, focussing upon areas toward the north and north-west of the dunes that had not yet been visited. Additionally, two short transects were planned to collect a series of samples from the south and north facing slopes of dunes bordering a known *V. angustior* occupied dune

slack (WB7 in Slack 27 from the 2022 survey) to assess the extent to which the snail occupies the drier habitat on the dune slopes bordering a slack.

1.5.3 Three Cliffs Bay & Swansea Dunes

Surveys of both these sites were planned for 2023.

1.5.4 Vacuum sampling trial

John Harper successfully recovered *V. angustior* using a vacuum sampler at Whiteford and Oxwich Burrows and subsequently in Pembrey Forest (Harper, 2007, 2014). A comparative assessment of bulk and vacuum sampling was planned to compare these two sampling techniques at Oxwich in 2023.

Surveys of *V. angustior* at Whiteford Burrows and Oxwich Burrows have aimed to determine its (a) presence and (b) abundance on these reserves. These use the well-established methods of field searching and bulk sampling (see Willing, 2020, 2023, 2024). Field searching can require considerable field experience and takes a long time in the field (especially when the number of observers is low), while bulk samples can take several weeks to dry, sieve and process. Both methods have their unique advantages and disadvantages. For example, field searching can allow rapid confirmation of the presence of *V. angustior* by scanning a relatively large area. Meanwhile, bulk sampling is known to be effective at finding *V. angustior* at sites where it has simultaneously been overlooked by field searching.

Vacuum (suction) samplers (including a modified garden leaf blower or “G-vac”, as discussed below) offer a potential alternative or complement to these methods. A vacuum sampler can be used freely in the manner of a general field search, or to take a standard quantified effort sample. Under certain circumstances, suction sampling can be carried out by fewer experienced personnel and can require less time to be spent in either the field or during sample processing. It almost always captures a wide range of invertebrate taxa other than molluscs which may be of interest in other studies. Disadvantages include the much-reduced effectiveness in wet weather or on wet ground, and the need to carry and then operate the sampler.

It is well-established that suction samplers are effective at finding live terrestrial molluscs, including *Vertigo* spp., in grassland habitats. Standardised samples taken in various grassland types across South Wales including meadows and pastures near Monmouth (Cavadino & Rowson, 2017, 2018) show that a very wide range of grassland species (probably the whole site fauna) is captured, and that results are repeatable and comparable. Moreover, suction sampling has been shown to capture large numbers of live *Vertigo angustior* at Whiteford Burrows, Oxwich Burrows and Pembrey Forest, even during the winter months when moisture hampers its performance (Harper, 2007, 2014).

However, no direct comparison has been made between the effectiveness of suction sampling and the other methods at determining the (a) presence and (b) abundance of *V. angustior*. This requires using the three methods simultaneously at a range of likely *V. angustior* sites and comparing the results. The extent to which the three methods yield similar results is used here to judge whether suction sampling might form an effective complement to, or replacement for, other survey methods in the future.

2. Methods

Survey work was undertaken during a 6-day period from 16th to 21st September 2023 in five areas, namely (1) Oxwich Burrows, (2) Nicholaston Burrows, (3) Whiteford Burrows, (4) Three Cliffs Bay and (5) Swansea Dunes (Figure 1).

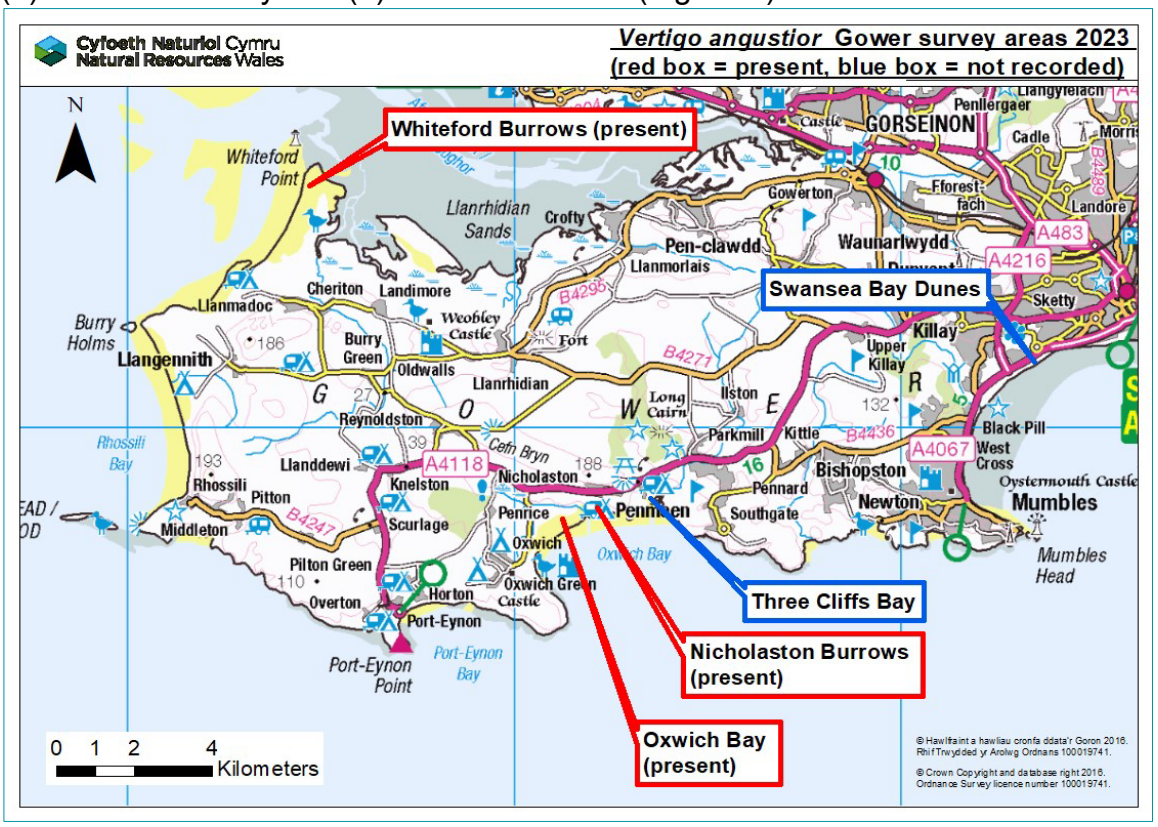

Figure 1. The location of survey areas in 2023.

Three Cliffs Bay and Nicholaston Burrows were visited by the author (MJW) on 16th & 17th September 2023 respectively. Three stations were surveyed at the former site and seven at the latter.

Whiteford Burrows was visited on 18th September 2023 with MJW being accompanied by Dan Guest and Catherine Hammond (both from NRW). The work continued surveys started in 2021 and 2022 of dune slacks in the central and north-western parts of the

reserve and additionally, for the first time, at several dry fixed-dune sites. A total of 15 samples were collected. In one dune slack, two short transects were used to collect a sequence of samples from the flat dune slack floor and then up the enclosing north and south facing dry dune slopes (Figure 2 & 3).

Swansea Dunes were visited on 19th September 2023 when MJW was again accompanied by Dan Guest and Catherine Hammond and seven sites were surveyed.

Oxwich Burrows was visited on 20th & 21st September 2023. On the first day, MJW was joined by Ben Rowson and additionally on the second day by Laura Brooks, Catherine Hammond and Karen Wilkinson (all from NRW). On both days, Ben undertook vacuum sampling at survey sites.

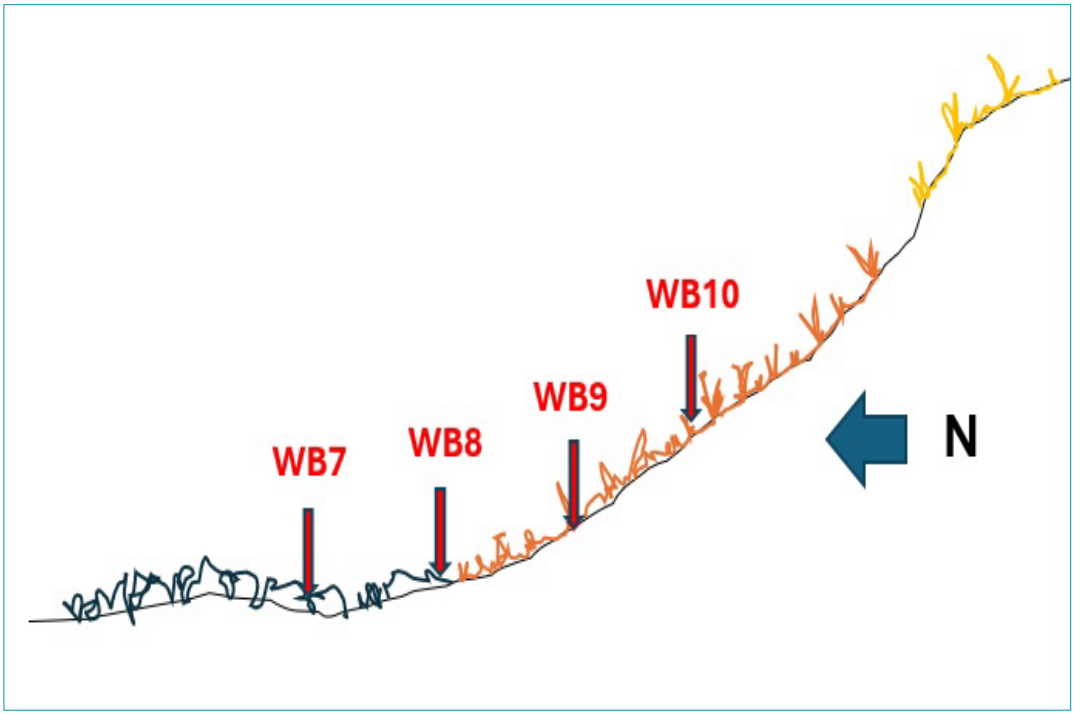

Figure 2. Whiteford Burrows transect 1 with samples collected from dune slack to north-facing dry dunes.

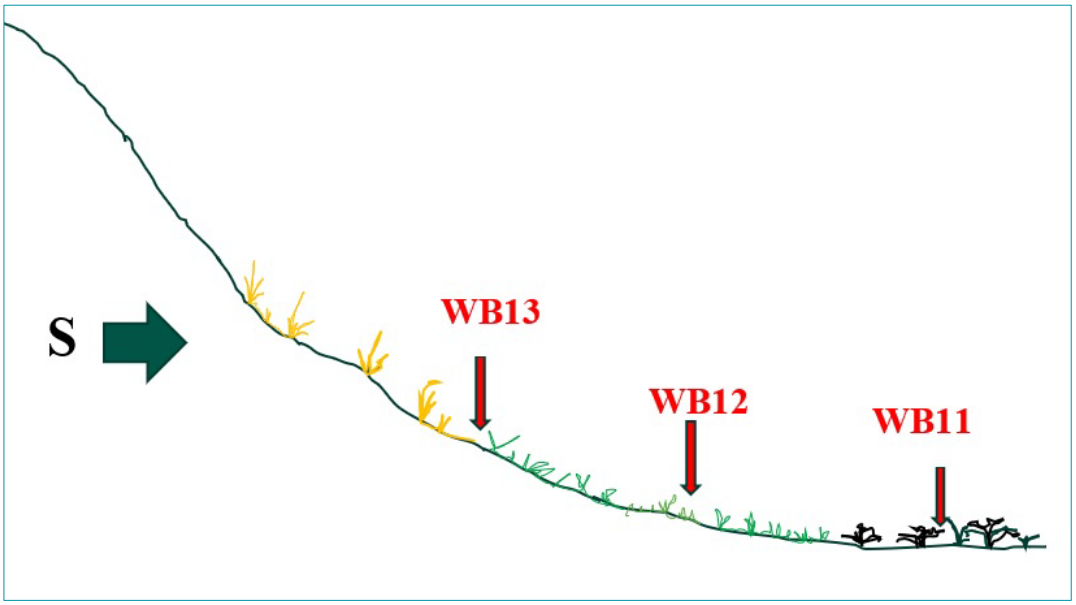

Figure 3. Whiteford Burrows transect 2 with samples collected from dune slack to south-facing dry dunes.

Site surveys involved:
1. The close ('hands and knees') visual examination of vegetation and ground litter;
2. 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.

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 $1m^2$ and probably amounted to what might approximately have been obtained from a 0.25m x 0.25m [$0.0625m^2$] 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.

Open ground & site shading: The approximate percentage of bare ground was noted at each survey site as was the degree of ground shading resulting from rank herbaceous vegetation and over-shading by bushes and trees.

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

Vacuum (suction) sampling: The weather on the first day was dry but had been preceded overnight by a period of heavy rain. The weather on the second was very wet with frequent heavy showers creating sub-optimal conditions for suction sampling.



Figure 4. Vacuum sampling in progress on Oxwich Burrows, September 2023.

A standard suction sample consisted of a 30-second powered suction of the vegetation. The 30 seconds was either continuous or spread over separate favourable patches within the approx. 2m 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. In dry conditions, molluscs can be picked out in the field.

These 30-second standard samples are of the same nature used by Cavadino & Rowson (2017, 2018) across a wide variety of grassland habitats throughout South Wales, providing the potential for later comparisons.

At each site, either one or two 30-second samples (hereafter called “replicates”) were taken. In one case (Site OB13), a third 30-second sample was taken immediately around the area in which a *V. angustior* shell was found in the field. This was to guarantee that at least one positive *V. angustior* sample was taken, and to allow the numbers caught to be directly compared with the associated bulk sample. The results of this third, biased replicate were excluded from the reported results and subsequent analysis.

Each bagged suction-sample was frozen at the end of the day’s fieldwork. The moisture and large biomass of live snails in most of the samples from the wet day meant that the contents had to be preserved in 70% industrial alcohol. All samples were then dried,

sieved through a 10 mm, 5 mm and 0.5 mm sieve nest before being picked under magnification. All molluscs in each sample were identified and counted.

3. Results

Molluscan results from the 2023 surveys of Nicholaston, Whiteford and Oxwich Burrows, Three Cliffs Bay and Swansea Dunes are displayed in Appendices 1 to 5, 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 samples. Plant records appear in Appendix 9A to 9D and are preceded by an explanation of (A) National Vegetational Categories (NVC) of communities recorded during the 2023 surveys (Appendix 6 & 7) and (B) dominance assessments (Appendix 8). Survey site locations, summarised habitat descriptions and site images are given in Appendices 10 to 14.

3.1 Oxwich Burrows

A further 17 sites were surveyed at Oxwich, two in a small dune slack (OB1 & OB2) and all others in dry dunes (Figure 5). Eighteen mollusc species were recovered and, except for the non-native *Paralaoma servilis,* all had been previously recorded at Oxwich (Willing, 2024). *V. angustior* was located at four sites, two in both bulk and suction samples (NB13 and NB16) and a further two (NB8 and NB9) only from bulk samples. *V. angustior* was only recorded in the field from NB13, all other sites only being confirmed from analysis of removed samples in the lab. All the *V. angustior* sites were found in dry dune sites at the northern end of the dunes.

3.2 Nicholaston Burrows

Six sites were surveyed along the southern dune margins of the dunes (Figure 5). Twelve species of mollusc were recorded, all also present on the adjacent Oxwich Burrows. A single live juvenile *V. angustior* was recovered from site NB2 lying towards the eastern end of the dune complex and living in NVC SD8 *Festuca rubra-Galium verum* fixed dune grassland (Appendices 6 & 7). As such, **this is a new site for *V. angustior***.

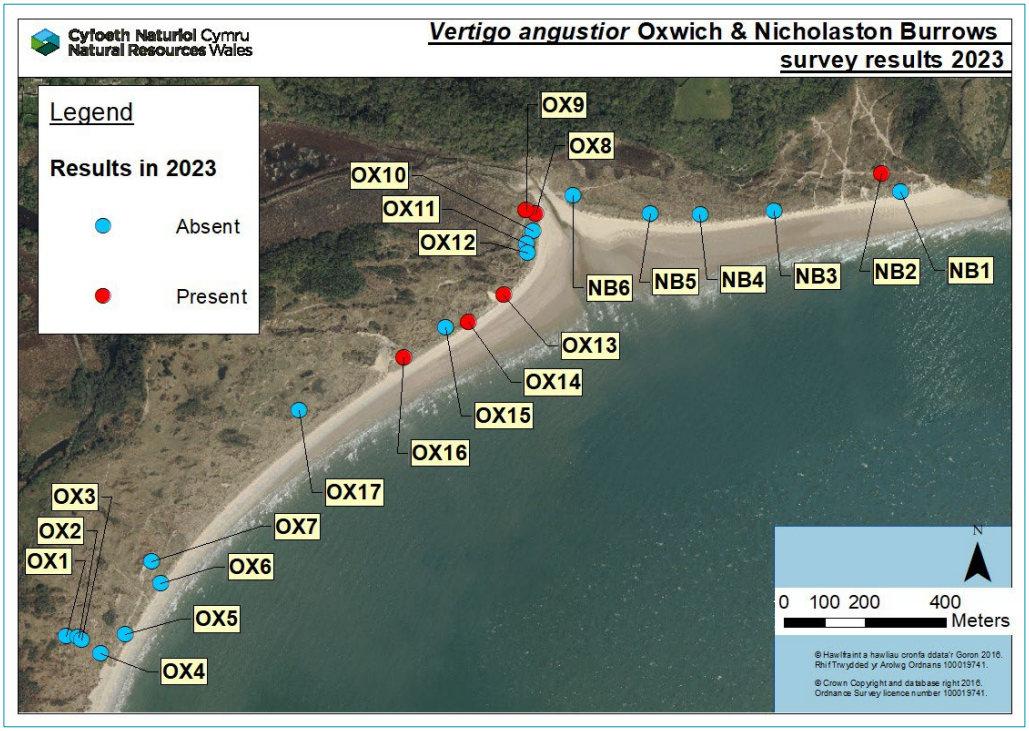

Figure 5. The distribution of survey sites on Oxwich and Nicholaston Burrows (indicating where *Vertigo angustior* was recorded).

3.3 Whiteford Burrows

A further 15 sites were surveyed at Whiteford, all towards the north or north-west of the dunes (Figure 6). Eighteen mollusc species were recorded, all of which had been recorded in recent Whiteford surveys (Willing 2023, 2024). *V. angustior* was recovered at 12 sites, 7 of which (NB1, NB2, NB3, NB4, NB5, NB6 and NB14) were new dune slack sites in 2023 with 5 sites (WB2, WB4, WB8, WB9 and WB10) situated in dry dunes. The presence of the snail at NB7 reconfirmed a record there first made in 2022 (WB7 in Willing [2024]). Two short transects (Figures 2 & 3) were undertaken in one slack with a sequence of samples taken from the slack base and running upwards on a north facing slope (WB7 to WB10) and on a south facing slope (WB11 to WB13). *V. angustior* was present in all north-facing samples but absent from the south-facing samples (see Discussion section).

3.4 Three Cliffs Bay

Three sites were surveyed (Figure 7), two from one dune ridge at the western end of the bay and a third from an isolated dune 'island' surrounded by tidal sand or mud. A total of 10 mollusc species was recorded, all known from the nearby Oxwich Burrows. No *Vertigo angustior* were recorded.

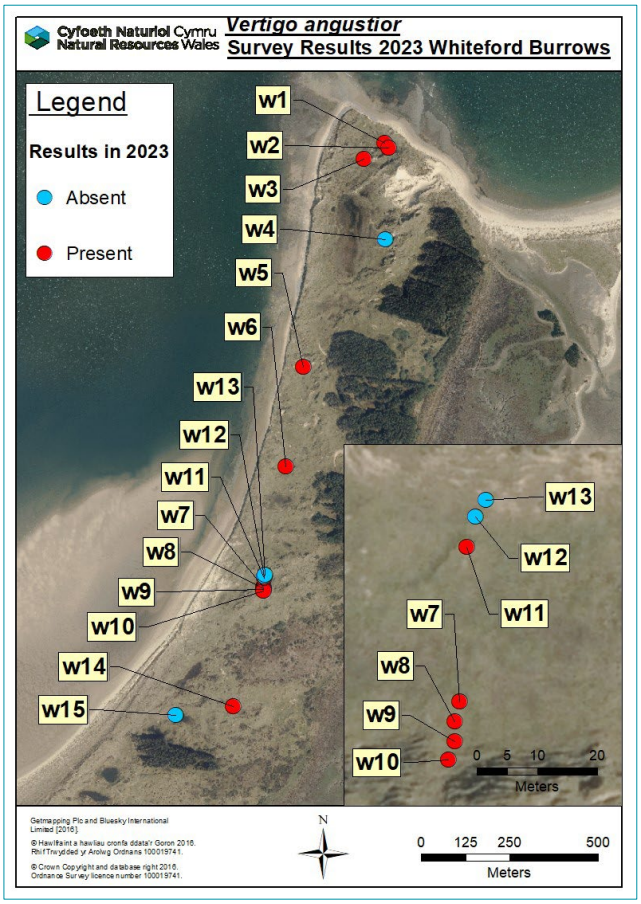

Figure 6. The distribution of survey sites on Whiteford Burrows in 2023 showing presence and absence of live *Vertigo angustior* (inset box: the two transect samples).

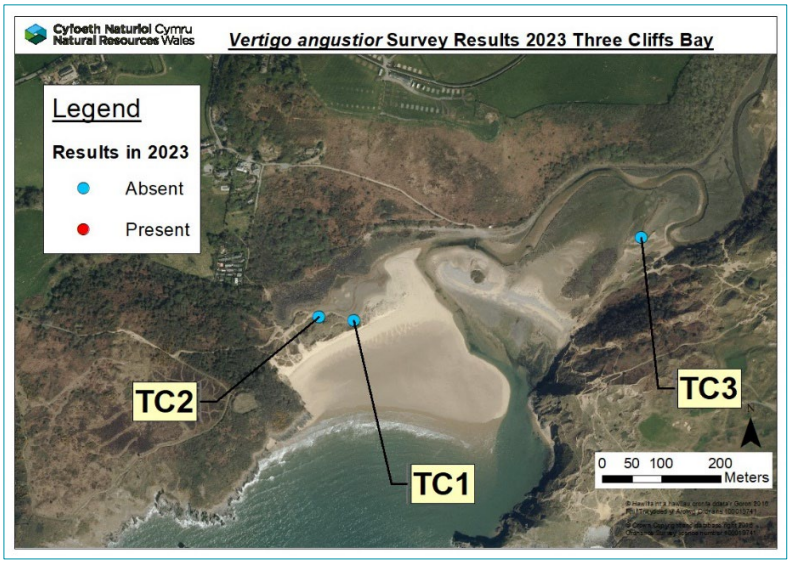

Figure 7. The distribution of survey sites at Three Cliffs Bay. *Vertigo angustior* was not found.

3.5 Swansea Dunes

Seven sites were surveyed along a narrow, eastward facing line of dunes (Figure 8). 12 mollusc species were recorded including the two non-natives - *Hygromia cinctella* and *Paralaoma servilis*, the former species at a single site but the latter from 6 of the 7 sites. *P. servilis* was also recorded from two Oxwich sites and these are the first records of the species from the Gower Peninsula. No *V. angustior* specimens were recovered.

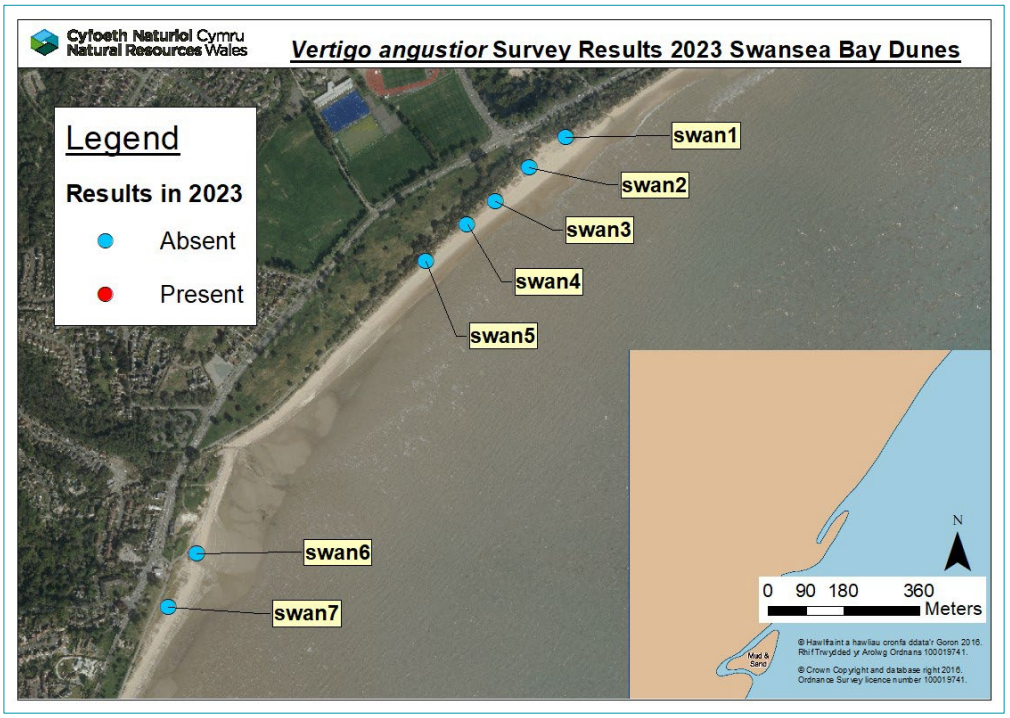

Figure 8. The distribution of survey sites on Swansea Dunes (indicating *Vertigo angustior* absence).

4. Discussion

4.1 Oxwich Burrows

The 2023 survey of 17 sites follows up on the survey of 2022 which focussed upon two objectives; (1) a comprehensive survey of the sand dune/ saltmarsh transition zone lying on the northern margin of the dunes which had been the focus of all previous Oxwich *V. angustior* surveys between 1983 and 2016 (Willing, 2024) and (2) following the widespread discovery of the snail in dune slacks on Whiteford Burrows in 2021 and 2022 (Willing, 2023, 2024), numerous Oxwich dune slacks were surveyed in 2022, but they were found to be mostly be devoid of the snail and so this habitat was not further surveyed in 2023. Following the unexpected find of large numbers of *V. angustior* in a dry semi-fixed dune sample (NVC 7) in 2022 (Oxwich sample 1 in Willing [2024]), the 2023 survey focussed on this habitat type - 15 of the 17 survey sites were situated in dry dunes. *V. angustior* was

recovered from just 4 of these sites, appearing only as single individuals in two. It is therefore evident that the snail is not widespread in dry dunes at Oxwich and that the few occupied sites are all concentrated towards the north-east of the reserve (Figures 9 & 10) despite the presence elsewhere at Oxwich of much other seemingly potentially suitable habitats there. *V. angustior* was not found from any sites in the southern areas of the dunes and so, unlike at Whiteford Burrows, the snail displays a very localised presence at Oxwich.

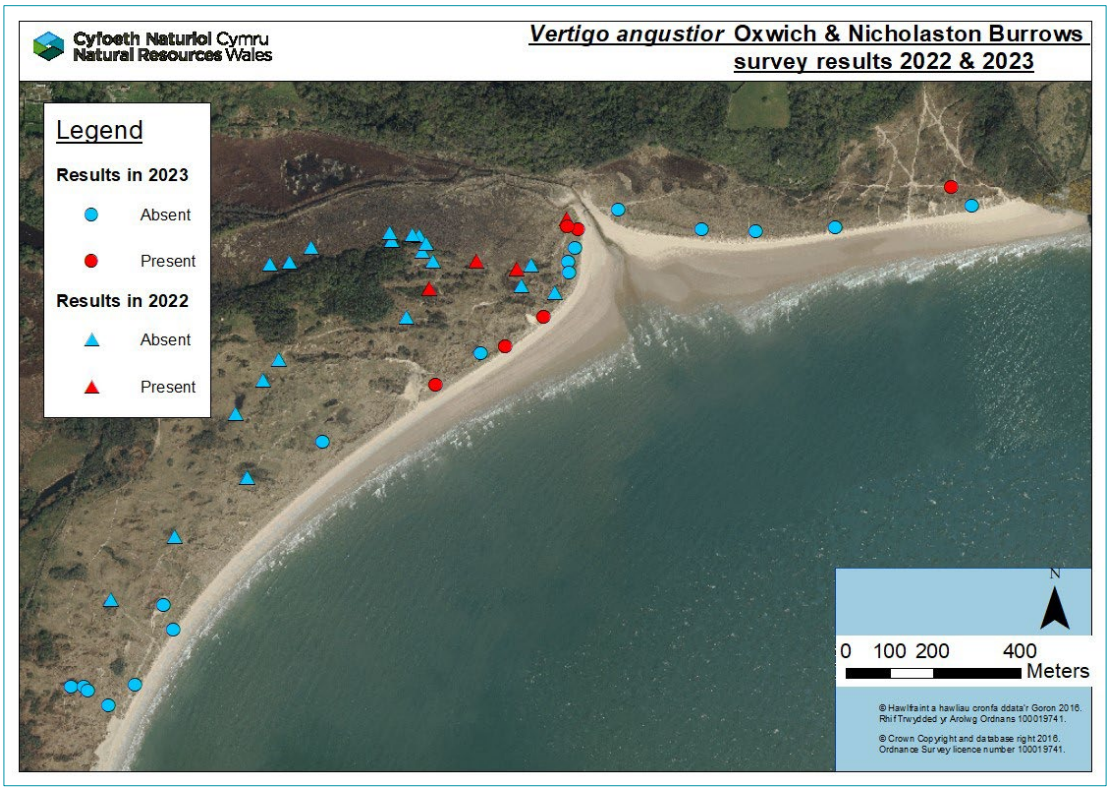

Figure 9. A summary overview map showing results of 2022 and 2023 surveys of Oxwich Burrows and Nicholaston Burrows.

4.1.1 Vacuum sampling trial

In addition to the bulk sampling and direct field searches employed during most previous Oxwich surveys, vacuum (suction) sampling was also undertaken at all survey sites in 2023. A comparison of the relative effectiveness of each technique the combined species and site presence scores are summarised in Table 1. A comparison of (1) the total number of species recovered and (2) the total number of each species found at the 17 Oxwich sample sites allows the relative effectiveness of vacuum and bulk sampling to be considered.

A total of 18 species were recorded, with each sampling technique recording 15 species but missing three that were recorded only by the other technique. Bulk sampling produced three species not recovered by the vacuum technique - *Oxychilus alliarius* (3 specimens from 2 sites), *Vallonia excentrica* and *Columella edentula*, each represented by single

specimens from single sites. The vacuum sampling recovered three species not found in any bulk sample, these being *Pupilla muscorum* (1 specimen from 1 site), *Trochulus hispidus* (10 specimens from 2 sites) and *Vitrea contracta* (2 specimen from 1 site). The total number of each species collected by each method also differs widely in most cases.

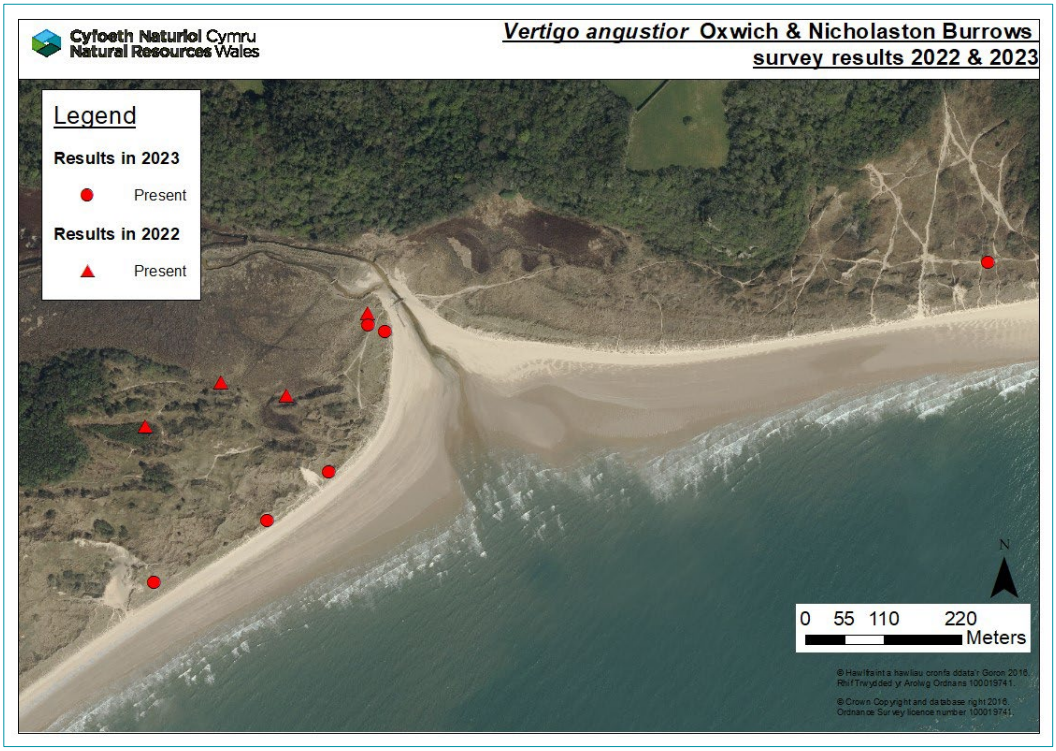

Figure 10. A summary overview map of Oxwich Burrows and Nicholaston Burrows.

Table 1. The total number of each species recorded from 17 Oxwich Burrows survey sites in 2023 and the total number of sites where the species was 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)
Vertigo angustior	**167 (4)**	**5 (3)**
Acanthinula aculeata	3 (1)	4 (2)
Cepaea nemoralis & Cepaea sp	2 (2)	65 (10)
Clausilia bidentata	15 (6)	22 (6)
Cochlicopa lubrica	114 (14)	37 (11)
Columella edentula	1 (1)	0 (0)
Cornu aspersum	2 (1)	257 (15)
Lauria cylindracea	11 (3)	15 (3)
Oxychilus alliarius	3 (2)	0 (0)
Paralaoma servilis	34 (2)	26 (1)
Punctum pygmaeum	46 (6)	46 (12)
Pupilla muscorum	0 (0)	1 (1)
Trochulus hispidus	0 (0)	10 (2)
Vallonia excentrica	1 (1)	0 (0)

Sites situated in dry dunes	Bulk samples	Vacuum samples
Species	No. recorded (& no. of sites with species)	No. recorded (& no. of sites with species)
Vertigo pygmaea	341 (14)	273 (13)
Vitrea contracta	0 (0)	2 (1)
Vitrina pellucida	73 (12)	282 (14)
Xeroplexa intersecta	118 (15)	1,089 (15)

With regard to *V. angustior,* bulk sampling found the snail (including a dead shell at one site) from four sites (OB8, OB9, OB13 & OB16) with a combined total of 167 (fresh dead and living) specimens. By contrast, vacuum sampling recovered only five specimens from three sites (OB13, OB14 & OB16), two of which (OB13 & OB16) were also sites at which it was found in bulk samples. Vacuum sampling did not produce the snail at sites OB8 and OB9. The single specimen found at site OB14 is suspected as being a sample contaminant (from the vacuum bag) perhaps from the *V. angustior*-rich previous site OB13. This suspicion is reinforced by the absence of the snail in the bulk sample from site OB14. An additional third vacuum sample from site OB13 (not listed in the results table) produced a further ten *V. angustior* (double the number from all other vacuum samples). This probably reflects a very localised distribution of the snail and may suggest that vacuum sampling is more prone to missing occupied patches than bulk sampling.

In the case of the similarly sized and shaped *Vertigo pygmaea*, the results of the two methods were much more similar, both in overall numbers of snails and the number of sites recorded. This might be expected if the presumably more tolerant *V. pygmaea* was less patchily distributed within sites than *V. angustior*. It may also reflect microhabitat differences relating to their height locations within the vegetation. Only 3% of the collected *V. angustior*, a species found close to, or slightly buried in the ground were found in the vacuum samples. By contrast *V. pygmaea*, a species that climbs up vegetation and, unlike *V. angustior*, is often recovered when 'beating' vegetation onto a sample tray, was represented by a 44% presence in the vacuum samples.

Survey results show that each technique is better suited to recover particular components of the molluscan community. Larger species that are present attached to vegetation or are active higher in the sward are represented in much higher numbers in the vacuum samples. Examples include *Xeroplexa intersecta*, *Cepaea* sp. and *Cornu aspersum* where 90%, 97% and 99% respectively of the total finds were recovered by vacuum sampling. Many of the individuals were juvenile snails, but full-sized and heavy adults are also readily sucked up. However, there were also several small species at which vacuum sampling found larger numbers than bulk sampling including *Clausilia bidentata*, *Pupilla muscorum*, *Trochulus hispidus* and *Vitrina pellucida*. *Cochlicopa lubrica*, another species that lives low down in the vegetation close to ground level, presumably to remain in shaded, humid conditions, was also recovered predominantly from the bulk samples - 75% of the total collected. To an extent, the two methods thus give complementary information.

The small, non-native *Paralaoma servilis* was recovered from two sites (sites OB5 & OB14). These are the first records of this Australasian snail from Oxwich Burrows. The

numbers recovered reveal the difficulty of generalising about these two survey methods. At site 5, the bulk sampling gave three specimens whilst the vacuum produced 26 specimens, whereas at site 14 the bulk sample produced 31 specimens with none from the vacuum. Such inconsistent results perhaps reveal the extremely patchy presence of this species at each location.

The 2-day vacuum / bulk sample comparative trial undertaken on Oxwich Burrows was probably conducted in unfavourable conditions, especially for vacuum sampling. Work on the first day followed a period of heavy rain whilst the second day experienced a series of heavy downpours. Under such conditions smaller snails, particularly those living further down in the vegetation, adhere to surfaces making suction removal more difficult. The results may have been different in dry conditions, possibly resulting in higher numbers of snails such as *V. angustior*. The likelihood of contamination between vacuum samples, as may have happened here, is probably higher when the net bag remains wet between samples.

Finally, one other potential advantage of the vacuum method is that the smaller samples can be processed more quickly. They can be checked immediately in dry conditions (analogous to field sieving), allowing a surveyor to cover more ground, or preserved and sorted later following a survey in wet weather. This can often be done within hours or days, without requiring the complete desiccation and sieving of bulk samples which can take several weeks, especially if wet. The volume and weight of net-collected samples is also smaller, potentially important on more extensive surveys.

The key question is whether bulk or vacuum sampling is better at detecting *V. angustior* at a site. The number of sites at which presence was detected by bulk sampling (4) was twice that detected by vacuum sampling (2), if the single snail at site 14 is considered a contaminant. Moreover, at both sites the species was detected by both methods. The likelihood of detecting *V. angustior* is almost certainly correlated with its abundance at a site, so this may be partly explained by the larger numbers recorded by bulk sampling. However, it is clear that both methods are susceptible to missing other species of snail that are present at a site, sometimes in large numbers.

Although this single trial suggests that vacuum sampling is less successful than bulk in surveying for the target species, it did nevertheless record some species not recorded in bulk samples and collected much higher numbers of certain components of the molluscan community. Larger vacuum samples could quite readily be collected if desired, by increasing the time spent collecting, while still taking only roughly as long as bulk sampling. It is suggested that, ideally in drier field conditions where the vacuum sampling may work more effectively, the two sampling techniques could be run in parallel for comprehensive molluscan surveys. However, if only one method were available for a *V. angustior* survey, bulk sampling must be considered preferable, at least in these conditions.

4.2 Nicholaston Burrows

The extensive Nicholaston Burrows (NB) dune system, which lies immediately to the east of Oxwich Burrows and supports a similar range of fixed and semi-fixed sand dune communities, is **a new locality for *V. angustior***. The main concentration of Oxwich *V. angustior* populations currently lie immediately adjacent to the western end of NB (Figures 9 & 10) and so one might have expected the snail to be present there. The single live *V. angustior* found at Nicholaston Burrows (sample NB2) was found in NVC SD8 *Festuca rubra-Galium verum* fixed dune grassland which is also present at the western end of these dunes, although seemingly not supporting the snail there. It is possible that *V. angustior* is living elsewhere on these dunes but may be similarly locally distributed as is the case on Oxwich Burrows. A further survey of the mature fixed dunes, lying immediately to the north of the 2023 survey sites, is recommended.

4.3 Whiteford Burrows

The 2023 surveys resulted in *V. angustior* being recorded from 12 of the 15 sites surveyed, of which 11 were from previously unrecorded locations (although sites WB8 to WB10 lay close to WB7 where the snail was first recorded in 2022 (S7 from Whiteford in Willing [2024]). In 2023, *V. angustior* was located in a further seven dune slacks (WB1, WB3, WB5, WB6, WB7, WB11 & WB14). Additionally, the snail was recorded at Whiteford in dry dunes being present at WB2, WB4, WB8, WB9 and WB10. This habitat was not previously sampled at Whiteford as it was considered unsuitable for the snail but was included in the 2023 schedule following the unexpected discovery of large numbers of the snail in a dry, semi-fixed dune site on Oxwich Burrows in 2022 (Willing, 2024). The two short transects (Figures 2 & 3) extending from the base of a dune slack onto the north and south facing dune slopes provided contrasting results. Thus, samples on the north facing slope (WB8, WB9 & WB10) found *V. angustior* in fixed dry dunes (NVC SD8) a habitat not previously surveyed for the snail at Whiteford. By contrast, *V. angustior* was not found in the two south-facing dune slope samples (WB12 & WB13) again in NVC SD8 and additionally in NVC SD19 *Phleum arenarium-Arenaria serpyllifolia* dune annual community. *V. angustior* is a species that requires permanently humid, although not flooded conditions (Cameron, 2003; Kerney, 1999; Moorkens & Gaynor, 2003) and these requirements may be present on the steeper north-facing dune slopes not subject to direct insolation.
The discovery of *V. angustior* in dry dune habitats, possibly there with an avoidance of southerly facing slopes, suggests that further surveys of this previously overlooked habitat at Whiteford may reveal an even wider presence of the snail here. The 2023 survey also found ‘good numbers’ of *V. angustior* in slack habitat at the extreme northern end of the dunes (WB1) in a location covered with strandline flotsam (Appendix 12) indicating occasional inundation of the site by saline waters. Figures 11 and 12 indicate the considerable increase in the known range of *V. angustior* occupation of Whiteford Burrows following the series of surveys from 2018 to 2023 showing that the snail is widespread in the main body of the dunes occupying dune slack and dry fixed and semi-fixed plant communities.

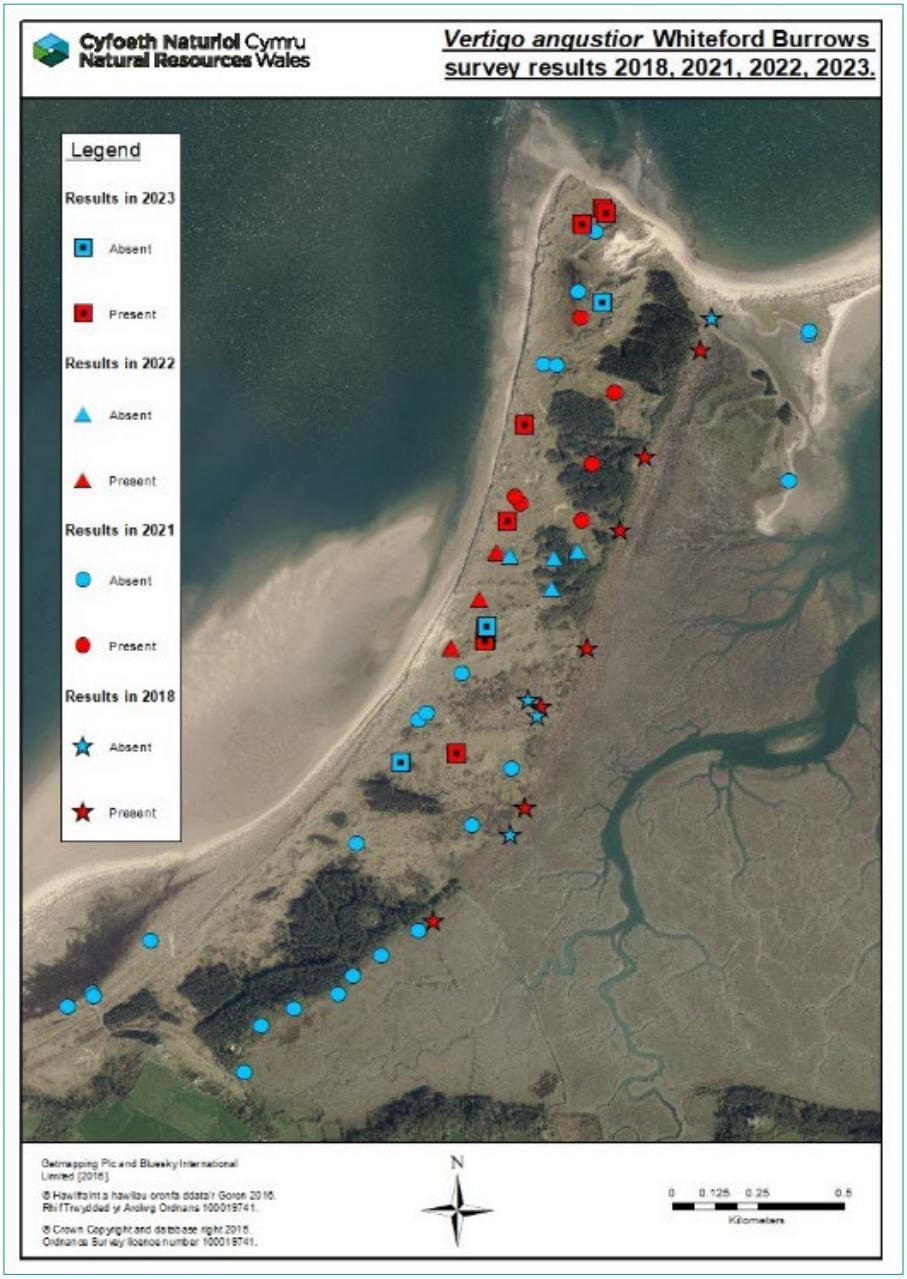

Figure 11. The distribution of survey sites on Whiteford Burrows from 2018 to 2023, indicating where *V. angustior* was recorded.

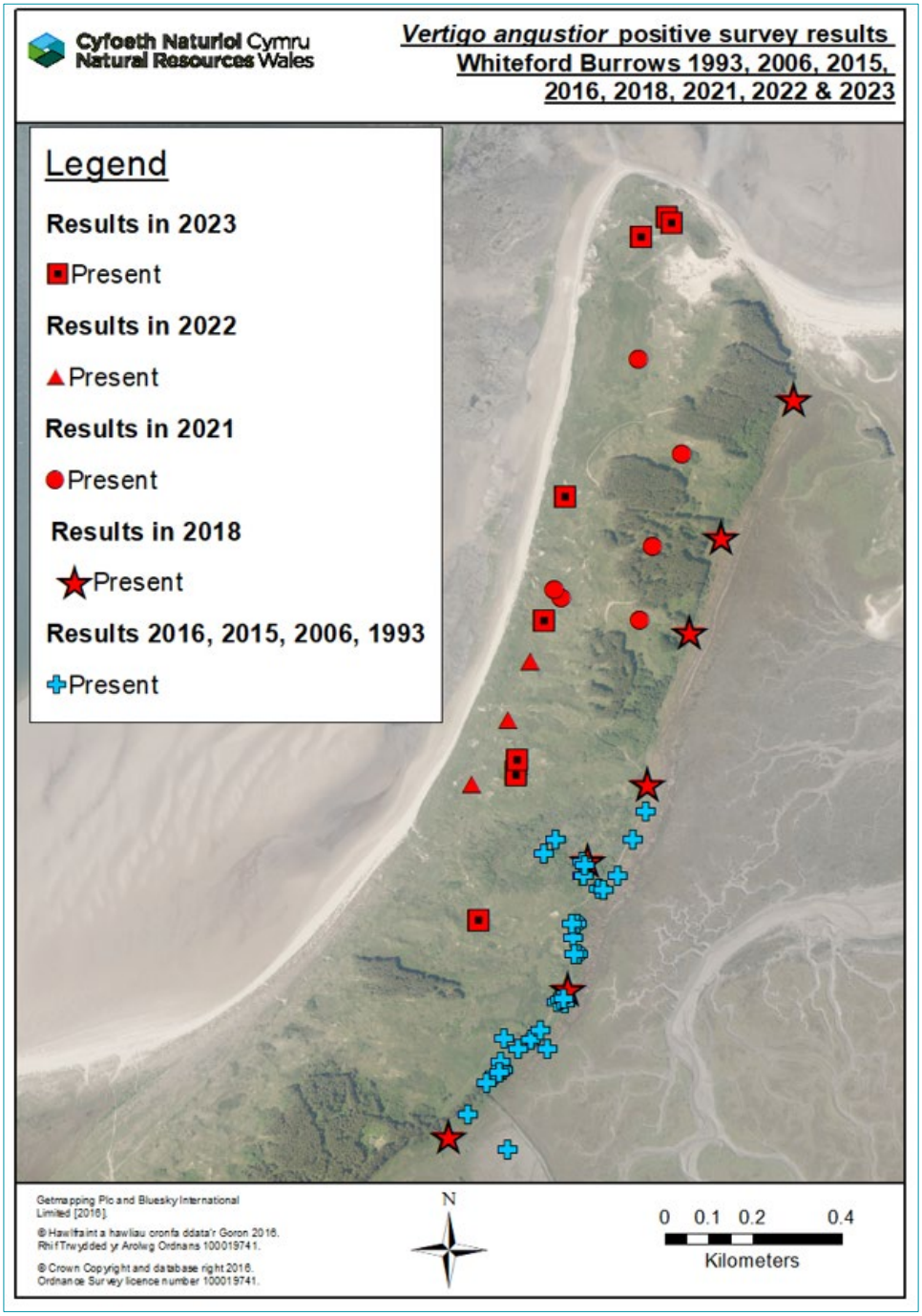

Figure 12. The distribution of *V. angustior* sites on Whiteford Burrows (1993 to 2023), indicating the considerably wider presence of the snail there resulting from the recent series of surveys (2018 to 2023).

4.4 Three Cliffs Bay

No *V. angustior* were recovered from the Three Cliffs Bay samples although they all supported the NVC SD7 dune community that supports the snail at Oxwich Burrows 2023 survey sites (e.g. OB8, OB9, OB13). Only three sites were sampled and so *V. angustior* may be present elsewhere in the dune ridge lying at the western margins of the bay, a

possibility considering the very localised presence of the snail on neighbouring Oxwich Burrows and Nicholaston Burrows.

4.5 Swansea Dunes

No *V. angustior* were recovered from the Swansea Dunes complex thought to lie at, or close to, the type locality of the species. Even when originally found at the site in 1830, it was only of dead shells; clearly numerous changes have affected this dune system in the period since including the construction of the Swansea University buildings. A notable find was the presence of the '*Punctum pygmaeum* look-alike' snail *Paralaoma servilis* which was found at six of the seven Swansea sites. This non-native Australasian species has been widely distributed by human agency in the Mediterranean region. The snail was first found in the UK in 1985 (Kerney, 1999) and in Wales from a site in Cardiff in 2008, with subsequent records from disturbed ground at Merthyr Tydfil in 2016 and Merthyr Mawr Warren in 2020 (Aderyn, accessed 11th November 2024). *P. servilis* was also found at two of the 2023 Oxwich Burrows sites and together with the Swansea finds mark the first records of this species from Gower.

5. Conclusions

The 2022 and 2023 Oxwich Burrows and Whiteford Burrows results further demonstrate that *V. angustior* lives in a wider range of dune habitats than previously appreciated. Prior to this, it was believed that the snail was largely confined to saltmarsh / sand dune transition zone habitats, typically in a narrow range of mostly *Iris* dominated plant communities (e.g. NVC M28 [*Iris pseudacorus-Filipendula ulmaria* mire*, Juncus* spp. sub-community] and MG11 [*Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland]) as described by Fowles (1998) and Fowles & Guest (2006). Surveys in 2021 and 2022 surveys found the snail in numerous dune slack habitats on Whiteford Burrows, with yet further new sites identified there during these 2023 surveys. NVC dune slack communities found to be occupied during these years include SD14b, SD15, SD15b, SD16 & SD16b. In 2022, *V. angustior* was unexpectedly found in large numbers in a semi-fixed dune community on Oxwich Burrows (Willing, 2024) and in 2023 similar dry fixed and semi-fixed dune habitats were explored more widely. As a result, additional *V. angustior* populations were found in this general habitat type (including NVC SD7, SD8 and SD19 communities) on Nicholaston Burrows, Oxwich Burrows and Whiteford Burrows, with the snail being found in 1, 3 and 5 new sites respectively. It should be noted, however, that although the snail was found in these dry dune sites its presence in this habitat type on all three systems was very localised with many seemingly similar sites not occupied. Two short dune slack to dry dune habitat transects undertaken at Whiteford demonstrated (at least in this case) that *V. angustior* appeared to favour north-facing rather than south-facing dry dune slopes.

The snail is very locally distributed on Oxwich Burrows and Nicholaston Burrows, with a cluster of sites at the extreme north-east of the former and at a single site at the far eastern end of the latter (Figures 9 & 10). By contrast, the 2023 surveys further confirmed the very widespread presence of *V. angustior* on Whiteford Burrows, with the snail living in 'good numbers' in a wide variety of habitats including dry fixed and semi-fixed dunes, dune slacks and damp mire habitats. Apart from populations at Oxwich Burrows and Nicholaston Burrows, *V. angustior* has only been recorded recently in Wales on Pembrey Aerial Firing Range, within Pembrey Forest and adjacent areas of Pembrey grazing marsh where it is present in low numbers in a wide scattering of relatively small sites (Harper, 2007, 2014). With the recent loss of the only known *V. angustior* population living in western Scotland (Killeen *et al*., 2019), it seems that the Whiteford Burrows *V. angustior* populations are the most important not only in Wales but also western Britain and so of high conservation importance.

6. Further work

On the Gower Peninsula, the results obtained from Swansea Dunes and Three Cliffs Bay do not currently seem to justify further surveys there although, due to the extremely localised presence of *V. angustior* on Oxwich Burrows and Whiteford Burrows, the snail's presence elsewhere in these two areas cannot be ruled out. The discovery of the snail from a single site on Nicholaston Burrows may suggest its wider presence there, especially further north in the area of fixed dunes which were not surveyed in 2023. The 2022 and 2023 Oxwich Burrows surveys may have provided a sufficient range of results to demonstrate the distribution and range of habitats currently occupied by the snail there. Nevertheless, it seems important to maintain regular monitoring of the populations here and so a programme of periodic visits should be planned to assess the status of the populations present in the vicinity of the 2023 survey sites OB9, OB13 and OB16. To make objective judgements, a Common Standards Monitoring protocol and Conservation Objective should be produced before the first monitoring visit.

The surveys of Whiteford Burrows in 2021, 2022 and 2023 have demonstrated the widespread presence of *V. angustior* within the main body of the dunes (away from the eastern fringing saltmarsh – sand dune 'transition zone') especially in *Salix repens* dominated dune slacks. The 2023 survey was the first to investigate a limited number of dry dune habitats and, as it demonstrated the presence of the snail in this habitat, further, more wide-ranging dry dune surveys in the Whiteford complex are justified. Additionally, as the 2023 survey suggested that *V. angustior* seemingly avoids south-facing dry dune slopes, then this microhabitat preference might be further studied. Finally, as with Oxwich Burrows, to understand the possibly changing status of the Whiteford *V. angustior* populations, a selection of sites should be selected across the reserve including representatives from all habitat types known to support the snail. Once these sites have been selected, then a revised Conservation Objective should be produced before the first monitoring visits.

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Appendix 1A. Mollusca recorded at Oxwich Burrows on 20th & 21st September 2023

B = bulk sample, V = vacuum sample, X1 or X2 = 'standard' samples.

Species	OB1 (B)	OB1 (V) X1	OB2 (B)	OB2 (V) X1	OB3 (B)	OB3 (V) X1	OB4 (B)	OB4 (V) X1
Vertigo angustior (live)	-	-	-	-	-	-	-	-
Adult (live)	-	-	-	-	-	-	-	-
Juvenile (live)	-	-	-	-	-	-	-	-
Fresh dead	-	-	-	-	-	-	-	-
Weathered dead	-	-	-	-	-	-	-	-
Acanthinula aculeata	-	-	-	-	-	-	-	-
Cepaea nemoralis	-	-	-	-	-	-	-	-
Cepaea sp.	-	1	-	-	-	-	-	-
Clausilia bidentata	-	-	-	-	-	-	-	-
Cochlicopa lubrica	2	1	4	2	7	2	5	7
Columella edentula	-	-	-	-	-	-	-	-
Cornu aspersum	-	-	-	5	-	1	-	-
Lauria cylindracea	-	-	-	-	-	-	-	-
Oxychilus alliarius	-	-	-	-	-	-	-	-
Paralaoma servilis	-	-	-	-	-	-	-	-
Punctum pygmaeum	-	-	3	12	-	-	-	1
Pupilla muscorum	-	-	-	-	-	-	-	-
Trochulus hispidus	-	3	-	7	-	-	-	-
Vallonia excentrica	-	-	-	-	-	-	1	-
Vertigo pygmaea	1	-	1	4	-	-	5	6
Vitrea contracta	-	-	-	-	-	-	-	2
Vitrina pellucida	-	-	-	1	-	-	-	-
Xeroplexa intersecta	-	2	-	-	1	12	3	42

Appendix 1B. Mollusca recorded at Oxwich Burrows on 20th & 21st September 2023

B = bulk sample, V = vacuum sample, X1 or X2 = 'standard' samples.

Species	OB5 (B)	OB5 (V) X1	OB6 (B)	OB6 (V) X1	OB7 (B)	OB7 (V) X1	OB8 (B)	OB8 (V) X2
Vertigo angustior (live)	-	-	-	-	-	-	-	-
Adult (live)	-	-	-	-	-	-	-	-
Juvenile (live)	-	-	-	-	-	-	-	-
Fresh dead	-	-	-	-	-	-	1	-
Weathered dead	-	-	-	-	-	-	-	-
Acanthinula aculeata	-	-	3	3	-	-	-	-
Cepaea nemoralis	-	-	-	-	-	-	-	-
Cepaea sp.	-	-	1	5	-	4	-	2
Clausilia bidentata	-	-	-	-	-	-	2	5
Cochlicopa lubrica	3	1	6	1	-	-	15	2
Columella edentula	-	-	-	-	-	-	-	-
Cornu aspersum	-	15	-	7	-	4	-	60
Lauria cylindracea	2	1	2	4	-	-	-	-
Oxychilus alliarius	-	-	-	-	-	-	-	-
Paralaoma servilis	3	26	-	-	-	-	-	-
Punctum pygmaeum	-	5	-	8	-	8	4	2
Pupilla muscorum	-	-	-	-	-	1	-	-
Trochulus hispidus	-	-	-	-	-	-	-	-
Vallonia excentrica	-	-	-	-	-	-	-	-
Vertigo pygmaea	49	13	32	24	13	40	69	69
Vitrea contracta	-	-	-	-	-	-	-	-
Vitrina pellucida	5	1	2	3	-	2	8	26
Xeroplexa intersecta	5	50	x	28	5	86	12	92

Appendix 1C. Mollusca recorded at Oxwich Burrows on 20th & 21st September 2023

B = bulk sample, V = vacuum sample, X1 or X2 = 'standard' samples.

Species	OB9 (B)	OB9 (V) X2	OB10 (B)	OB10 (V) X2	OB11 (B)	OB11 (V) X2
Vertigo angustior (live)	1	-	-	-	-	-
Adult (live)	1	-	-	-	-	-
Juvenile (live)	-	-	-	-	-	-
Fresh dead	-	-	-	-	-	-
Weathered dead	1	-	-	-	-	-
Acanthinula aculeata	-	-	-	-	-	-
Cepaea nemoralis	-	-	-	-	-	-
Cepaea sp.	-	14	-	-	-	1
Clausilia bidentata	-	-	1	3	1	1
Cochlicopa lubrica	10	12	-	-	-	-
Columella edentula	1	-	-	-	-	-
Cornu aspersum	-	43	-	13	-	32
Lauria cylindracea	-	-	-	-	-	-
Oxychilus alliarius	-	-	2	-	-	-
Paralaoma servilis	-	-	-	-	-	-
Punctum pygmaeum	-	-	-	-	-	-
Pupilla muscorum	-	-	-	-	-	-
Trochulus hispidus	-	-	-	-	-	-
Vallonia excentrica	-	-	-	-	-	-
Vertigo pygmaea	12	6	47	74	6	9
Vitrea contracta	-	-	-	-	-	-
Vitrina pellucida	1	8	7	158	3	19
Xeroplexa intersecta	2	21	14	143	22	220

Appendix 1D. Mollusca recorded at Oxwich Burrows on 20th & 21st September 2023

B = bulk sample, V = vacuum sample, X1 or X2 = 'standard' samples. V. angustior 1* may represent a contaminant.

Species	OB12 (B)	OB12 (V) X1	OB13 (B)	OB13 (V) X2	OB14 (B)	OB14 (V) X2
Vertigo angustior (live)	-	-	155	3	-	1*
Adult (live)	-	-	103	-	-	-
Juvenile (live)	-	-	52	-	-	-
Fresh dead	-	-	3	-	-	-
Weathered dead	-	-	-	-	-	-
Acanthinula aculeata	-	-	-	-	-	-
Cepaea nemoralis	-	-	-	-	-	-
Cepaea sp.	1	5	-	1	-	-
Clausilia bidentata	8	7	-	5	1	-
Cochlicopa lubrica	2	-	29	2	1	1
Columella edentula	-	-	-	-	-	-
Cornu aspersum	-	22	-	1	-	25
Lauria cylindracea	-	-	-	-	-	-
Oxychilus alliarius	-	-	1	-	-	-
Paralaoma servilis	-	-	-	-	31	-
Punctum pygmaeum	6	7	19	1	-	2
Pupilla muscorum	-	-	-	-	-	-
Trochulus hispidus	-	-	-	-	-	-
Vallonia excentrica	-	-	-	-	-	-
Vertigo pygmaea	60	9	-	-	2	1
Vitrea contracta	-	-	-	-	-	-
Vitrina pellucida	13	51	7	11	1	2
Xeroplexa intersecta	1	30	28	17	1	85

Appendix 1E. Mollusca recorded at Oxwich Burrows on 20th & 21st September 2023.

B = bulk sample, V = vacuum sample, X1 or X2 = 'standard' samples.

Species	OB15 (B)	OB15 (V) X2	OB16 (B)	OB16 (V) X2	OB17 (B)	OB17 (V) X2
Vertigo angustior (live)	-	-	7	1	-	-
Adult (live)	-	-	5	-	-	-
Juvenile (live)	-	-	2	-	-	-
Fresh dead	-	-	-	-	-	-
Weathered dead	-	-	-	-	-	-
Acanthinula aculeata	-	-	-	-	-	1
Cepaea nemoralis	-	-	-	-	-	-
Cepaea sp.	-	-	-	12	-	20
Clausilia bidentata	-	-	2	1	-	-
Cochlicopa lubrica	5	-	7	-	18	6
Columella edentula	-	-	-	-	-	-
Cornu aspersum	-	8	2	8	-	13
Lauria cylindracea	-	-	7	10	-	-
Oxychilus alliarius	-	-	-	-	-	-
Paralaoma servilis	-	-	-	-	-	-
Punctum pygmaeum	-	2	3	1	11	16
Pupilla muscorum	-	-	-	-	-	-
Trochulus hispidus	-	-	-	-	-	-
Vallonia excentrica	-	-	-	-	-	-
Vertigo pygmaea	-	-	16	10	28	8
Vitrea contracta	-	-	-	-	-	-
Vitrina pellucida	5	2	5	10	16	50
Xeroplexa intersecta	10	95	7	154	5	14

Appendix 2. Mollusca recorded at Nicholaston Burrows on 17th September 2023.

Species	NB1	NB2	NB3	NB4	NB5	NB6
Vertigo angustior (live)	-	1	-	-	-	-
Adult (L)	-	-	-	-	-	-
Juvenile (L)	-	1	-	-	-	-
Fresh dead	-	-	-	-	-	-
Weathered dead	-	-	-	-	-	-
Acanthinula aculeata	-	-	2	-	-	-
Aegopinella nitidula	-	-	-	1	-	-
Cepaea nemoralis	1	-	-	-	-	-
Cepaea sp.	-	-	-	-	1	-
Clausilia bidentata	4	-	9	-	7	-
Cochlicopa lubrica	6	4	19	8	4	-
Cornu aspersum	-	-	-	1	-	-
Lauria cylindracea	-	-	3	-	-	-
Punctum pygmaeum	-	1	-	-	-	-
Vertigo pygmaea	37	7	10	10	12	37
Vitrina pellucida	-	1	-	-	-	-
Xeroplexa intersecta	3	1	-	3	6	4

Appendix 3A. Mollusca recorded at Whiteford Burrows on 18th September 2023.

Species	WB1	WB2	WB3	WB4	WB5	WB6	WB7
Vertigo angustior (live)	14	12	16	-	38	2	58
Adult (L)	9	4	5	-	25	2	31
Juvenile (L)	5	8	11	-	13	-	27
Fresh dead	4	3	-	1	19	-	3
Weathered dead	-	5	3	-	3	-	-
Carychium minimum	-	-	-	-	-	-	-
Cochlicopa lubrica	4	7	17	1	17	4	6
Monacha cantina	-	-	-	-	1	-	-
Columella edentula	1	4	-	-	-	-	-
Cornu aspersum	-	-	-	1	-	-	-
Lauria cylindracea	20	16	13	-	1	-	-
Oxychilus alliarius	-	-	-	-	-	-	1
Punctum pygmaeum	1	1	-	-	1	1	-
Pupilla muscorum	-	-	2	-	1	-	-
Trochulus hispidus	-	-	-	-	1	-	1
Vallonia costata	15	17	-	-	2	-	-
Vallonia pulchella	-	-	-	-	-	-	-
Vallonia excentrica	3	-	-	-	-	4	2
Vallonia sp.	-	1	-	-	1	-	-
Vertigo pygmaea	4	3	2	-	2	16	4
Vitrina pellucida	-	2	-	-	-	-	-
Xeroplexa intersecta	x	-	x	10	-	-	1

Appendix 3B. Mollusca recorded at Whiteford Burrows on 18th September 2023.

**Euglesa personatum* is an aquatic species.

Species	WB8	WB9	WB10	WB11	WB12	WB13	WB14	WB15
Vertigo angustior (live)	8	35	100	7	-	-	5	-
Adult (L)	3	17	31	-	-	-	2	-
Juvenile (L)	5	18	69	7	-	-	3	-
Fresh dead	2	4	7	6	-	-	-	-
Weathered dead	1	-	-	-	-	-	-	-
Carychium minimum	-	-	-	-	-	-	-	1
Cochlicopa lubrica	31	12	20	4	x	x	-	-
Monacha cantina	-	-	-	-	-	-	-	-
Columella edentula	-	-	-	-	-	-	-	-
Cornu aspersum	-	-	-	-	-	-	-	-
Lauria cylindracea	-	9	2	-	-	-	-	-
Oxychilus alliarius	-	1	-	-	-	-	-	-
Punctum pygmaeum	1	5	3	4	-	x	1	-
Pupilla muscorum	-	-	-	-	-	-	-	-
Trochulus hispidus	-	-	-	-	-	-	-	-
Vallonia costata	-	-	-	-	-	-	-	-
Vallonia pulchella	-	-	-	-	-	-	-	1
Vallonia excentrica	-	-	-	-	x	-	-	-
Vallonia sp.	-	-	-	-	-	-	-	-
Vertigo pygmaea	7	13	4	-	-	-	4	-
Vitrina pellucida	-	-	-	-	-	-	-	-
Xeroplexa intersecta	-	-	-	1	x	8	2	1
**Euglesa personatum*	-	-	-	-	-	1	-	-

Appendix 4. Mollusca recorded at Three Cliffs Bay on 16th September 2023

Species	TC1	TC2	TC3
Acanthinula aculeata	5	6	-
Cochlicopa lubrica	8	9	7
Cornu aspersum	-	1	-
Lauria cylindracea	28	59	-
Pupilla muscorum	-	-	1
Trochulus hispidus	-	2	-
Vallonia pulchella	-	-	2
Vertigo pygmaea	11	5	-
Vitrina pellucida	-	-	1
Xeroplexa intersecta	24	2	9

Appendix 5. Mollusca recorded on Swansea Dunes on 19th September 2023

Species	SD1	SD2	SD3	SD4	SD5	SD6	SD7
Cepaea sp.	1	-	-	-	-	-	1
Cernuella virgata	-	-	-	-	-	-	4
Cochlicopa lubrica	1	3	-	39	22	-	1
Cornu aspersum	-	-	1	-	-	-	-
Hygromia cinctella	-	-	-	-	-	4	-
Oxychilus alliarius	-	-	-	-	-	1	-
Paralaoma servilis	14	2	-	2	2	1	13
Trochulus hispidus	-	2	4	-	3	-	1
Vallonia costata	-	-	4	-	-	-	-
Vertigo pygmaea	-	-	3	7	26	-	-
Vitrina pellucida	1	-	-	1		-	1
Xeroplexa intersecta	3	2	14	2	1	2	5

Appendix 6. National Vegetational Classification (NVC) communities recorded at Gower survey sites in September 2023

NVC	NVC description
SD6	*Ammophila arenaria* mobile dune community
SD7	*Ammophila arenaria-Festuca rubra* semi-fixed dune community
SD8	*Festuca rubra-Galium verum* fixed dune community
SD8c	*Festuca rubra-Galium verum* fixed dune (*Tortula ruraliformis* subcommunity)
SD15	*Salix repens-Calliergon cuspidatum* dune-slack community
SD15b	*Salix repens-Calliergon cuspidatum* dune-slack (*Equisetum variegatum* subcommunity)
SD16	*Salix repens-Holcus lanatus* dune-slack community
SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
SD19	*Phleum arenarium-Arenaria serpyllifolia* dune annual community

Appendix 7. NVC communities associated with *Vertigo angustior* in September 2023

Site	NVC	NVC description
Nicholaston Burrows NB2	SD8	*Festuca rubra-Galium verum* fixed dune community
Whiteford WB1	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Whiteford WB2	SD8c	*Festuca rubra-Galium verum* fixed dune community (*Tortula ruraliformis* subcommunity)
Whiteford WB3	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Whiteford WB4	SD8c & SD19	*Festuca rubra-Galium verum* fixed dune community (*Tortula ruraliformis* subcommunity) & *Phleum arenarium-Arenaria serpyllifolia* dune annual community
Whiteford WB5	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Whiteford WB6	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Whiteford WB7	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Whiteford WB8	SD8	*Festuca rubra-Galium verum* fixed dune community
Whiteford WB9	SD8	*Festuca rubra-Galium verum* fixed dune community
Whiteford WB10	SD8	*Festuca rubra-Galium verum* fixed dune community
Whiteford WB11	SD15	*Salix repens-Calliergon cuspidatum* dune-slack community
Whiteford WB14	SD16b	*Salix repens-Holcus lanatus dune*-slack (*Rubus caesius* subcommunity)
Oxwich OB8	SD7	*Ammophila arenaria-Festuca rubra* semi-fixed dune community
Oxwich OB9	SD7	*Ammophila arenaria-Festuca rubra* semi-fixed dune community
Oxwich OB13	SD7	*Ammophila arenaria-Festuca rubra* semi-fixed dune community
Oxwich OB16	SD8	*Festuca rubra-Galium verum* fixed dune community

Appendix 8. 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 9A. Plant records from Oxwich Burrows Sites (OB8 to OB17) - prominent plant species in mobile and semi-fixed dune habitats at Oxwich Burrows in 2023

D = Dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare.

Sample number	OB8	OB9	OB10	OB11	OB12	OB13	OB14	OB15	OB16	OB17
Festuca rubra	D	F/A	A/D	O	D	D	F	D	D	A/D
Ononis repens	-	F	F	F/A	F	F	F	F	F	F
Rubus caesius	-	-	-	-	-	A	O	A	A/D	D
Ammophila arenaria	D	F	A	O	A	F	D	A	F	F
Carex arenaria	-	-	-	F	O	F	-	-	F	F
Pseudoscleropodium purum	-	A	-	-	-	-	-	-	-	-
Hypochaeris radicata	-	F	O	-	F	F	F	-	F	-
Pilosella officinarum	-	F	F	F	F	-	-	-	O	-
Poa humilis	-	F	-	-	-	-	-	-	-	O
Syntrichia ruraliformis	F	-	A	F/ A	F	-	A	-	-	-
Thymus praecox	-	-	-	R	-	A	-	-	-	-
Homalothecium lutescens	-	-	-	F	A	A	-	-	-	-
Hypnum lacunosum	-	F/A	-	-	-	-	-	-	-	-
Oenothera spp.	O	O	O	O	F	-	F	-	-	-
Holcus lanatus	F	F	F	-	F	F	-	F	F	F
Jacobaea vulgaris	-	F	O	-	F	F	F	F	F	-
Avenula pubescens	F	F	F	-	-	F	O	F	F	F
Brachythecium rutabulum	F	A	-	A	-	A	-	F	F	F
Kindbergia praelongum	O	-	-	-	-	-	-	F	-	F
Taraxacum officinale agg.	-	R	O	O	-	O	O	F	F	O
Elymus sp.	F	F	F	-	-	F	-	-	-	-
Sward height range cm	20 - 25	20 - 25	25 - 30	< 5	25 - 50	25 - 50	0 - 30	30 - 50	n/r	20 - 35
Main NVC community	SD7	SD7	SD7	SD7	SD7	SD7	SD7	SD8	SD8	SD8

Appendix 9B. Plant records from Whiteford Burrows in 2023 - prominent plant species from dune slack habitats at Whiteford Burrows in 2023

D = Dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare.

Sample number	WB1	WB3	WB5	WB6	WB7	WB11	WB14	WB15
Festuca rubra	F	A	F	F	F	F	F, A	F
Rubus caesius	D	A	A	F	F	A	A	A
Salix repens	D	A	A	D	D	D	D	D
Lotus corniculatus	-	F	F	F	F	F	F	-
Pseudoscleropodium purum	F	-	A, D	F	F, A	A	F, A	-
Galium verum	F	O, F	-	-	F	F	F	-
Agrimonia sp.	F	F	-	F	F	-	F	-
Trifolium pratense	F	-	F	F	F	F	-	-
Poa humilis	F	-	F	F	-	F	-	-
Holcus lanatus	F	-	F	F	-	-	F, A	-
Trifolium repens	F	-	F	F	-	F	-	-
Ononis repens	-	O, F	-	-	F	-	F	-
Carex flacca	F	F	-	-	-	-	-	F
Avenula pubescens	-	-	-	-	F	F	O, A	-
Calliergonella cuspidata	-	-	A, D	F	-	-	-	D
Ranunculus acris	-	-	F	F	-	F	-	-
Homalothecium lutescens	-	O, A	-	-	F, A	-	-	-
Briza media	-	-	-	-	F	-	O, F	-
Ranunculus bulbosus	-	-	-	-	F	F	-	-
Taraxacum officinale agg.	-	F	-	F	-	-	-	-
Hydrocotyle vulgaris	-	-	F	-	-	-	-	F
Juncus maritimus	-	-	R, D	-	-	-	-	O, D
Mentha aquatica	-	-	-	F	-	-	-	F
Plantago lanceolata	-	F	F	-	-	-	-	-
Polygala vulgaris	-	F	-	-	F	-	-	-
Potentilla anserina	-	-	A	-	-	-	-	A
	-	-	-	-	-	-	-	-
Sward height range cm	(5)20-45	10-20	25-45	25-50	5-15	10-40	40-70	20-30
Main NVC community	SD16b	SD16b	SD16b	SD16b	SD16b	SD15	SD16b	SD15b
Associated NVC types/other mosaic components	-	SD8	-	SD8	-	-	SD8	-

Appendix 9C. Plant records from Whiteford Burrows in 2023 - prominent plant species from fixed dune habitats at Whiteford Burrows in 2023

D = Dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare.

Sample number	WB2	WB4	WB8	WB9	WB10	WB12	WB13
Galium verum	F	F	F	F	F	F	F
Ononis repens	F	F	F	F	F	F	F
Thymus praecox	F.A	F	A	A	A	A	A
Festuca rubra	F	-	F	F	F	F	F
Lotus corniculatus	F	-	F	F	F	A	F
Pilosella officinarum	-	F	F	F	F	F	F
Hypochaeris radicata	-	F	F	F	F	F	F
Rubus caesius	F	F	F	A	A	-	-
Hypnum lacunosum	-	-	A	A	A	A/D	A/D
Rosa spinosissima	-	-	F	A	A	A	F/A
Poa humilis	F	-	-	-	-	F	F
Carex flacca	-	-	F	F	F	-	-
Homalothecium lutescens	-	-	A	A	A	-	-
Briza media	-	-	F	F	F	-	-
Ranunculus bulbosus	-	-	F	F	F	-	-
Anthoxanthum odoratum	-	-	F	F	F	-	-
Rhinanthus minor	-	-	F	F	F	-	-
Rhytidiadelphus triquetrus	-	-	A	A	A	-	-
Veronica chamaedrys	-	-	F	F	F	-	-
Anthylis vulneraria	-	F	-	-	-	A	A
Arenaria serpyllifolia	-	F	-	-	-	-	F
Catapodium rigidum	-	F	-	-	-	-	F
Echium vulgare	-	-	-	-	-	F	F
Luzula cf. *campestris*	-	-	-	-	-	F	F
Phleum arenarium	-	F	-	-	-	-	F
Pseudoscleropodium purum	D	-	-	-	-	-	-
Syntrichia ruraliformis	-	F/A	-	-	-	-	-
Sward height range cm	5-10	2-5(40)	1-5	5-10	8-12	2-8	3-5(8)
Main NVC community	SD8c	SD8c	SD8	SD8	SD8	SD8	SD19
Associated NVC types/other mosaic components	-	SD19	-	-	-	-	SD8

Appendix 9D. Plant records from Swansea Dunes - prominent plant species in mobile and semi-fixed dune habitats on Swansea Dunes in 2023

D = Dominant; A = Abundant; F = Frequent; O = Occasional; R = Rare.

Sample number	SD1	SD2	SD3	SD4	SD5	SD6	SD7
Ammophila arenaria	A/D	A/D	A	A	O/A	A	O/A
Carex arenaria	F	F	F	F	F	F	F
Festuca rubra	F	F	F	F/A	F/A	F	-
Syntrichia ruraliformis	D	D	D	F	F	F	-
Oenothera spp.	F	A	F	F	F	-	F
Arenaria serpyllifolia	F	F	F	F	F	-	-
Calystegia soldanella	F	F	F	F	F	-	-
Clemetis vitalba	F	A	F	F	F	-	-
Cynodon dactylon	-	O/A	O	O	O	-	F
Jacobaea vulgaris	F	F	F	F	F	-	-
Quercus ilex (sapling)	F	F	F	F	O/D	-	-
Ononis repens	-	-	O/D	D	D	F	-
Cerastium semi-decandrum	F	F	F	F	-	-	-
Brachythecium cf. *rutabulum*	-	-	-	F/A	F	F	-
Kindbergia praelongum	-	-	-	F	F	F	-
Lotus corniculatus	-	-	-	-	F	-	F
Eryngium maritimum	-	-	-	-	-	F	F
Pseudoscleropodium purum	-	-	-	-	A	-	-
Homalothecium lutescens	-	F/A	-	-	-	-	-
Rhytidiadelphus squarrosus	-	F/A	-	-	-	-	-
Sward height range cm	5-60	5-60	15-60	12-15	12-15	15-60	2-15
Main NVC community	SD7	SD7	SD7	SD8	SD8	SD7	SD7
Associated NVC types/other mosaic components	-	-	SD8	-	SD7	-	-

Appendix 10. Site locations and summary habitat descriptions at Oxwich Burrows (OB)



Site OB1. SS5025186728

Site OB1. Mature humid dune slack vegetation (NVC SD15?) – wet slack vegetation dominated by *Salix repens* with prominent *Rubus caesius* and *Hydrocotyle*. *Phragmites* is frequent at low cover and there are scattered tussocks of *Juncus acutus*, and bushes of *Betula* and *Salix*.



Site OB2. SS5028086727

Site OB2. Grassy, mature humid dune slack (NVC SD15?) – closed sward vegetation co-dominated by *Salix repens* and a range of grasses including *Molinia caerulea*. There are scattered bushes of *Betula*.



Site OB3. SS5028886720

Site OB3. Fixed dune grassland (NVC SD8) with scattered bracken and open sandy areas probably assignable to SD19 although the annual species characteristic of that community are not visible in the image used to assess the NVC community.



Site OB4. SS5033586686

Site OB4. Fixed or semi-fixed dune grassland (NVC SD7/SD8) featuring abundant *Ammophila* and prominent *Hypochaeris radicata* and *Ononis repens* in an open sward in which pleurocarpous mosses form a patchy carpet interspersed by areas of bare sand.



Site OB5. SS5039786733

Site OB5. Semi-fixed dune grassland (NVC SD7) mostly dominated by *Ammophila* but including open areas with higher cover of fine-leaved grasses (probably mainly *Festuca rubra*), pleurocarpous mosses and patches of bare sand. *Taraxacum officinale* is one of the few frequent herbs.



Site OB6. SS5048486859

Site OB6. Semi-fixed dune grassland (NVC SD7) with abundant *Ammophila* and *Rubus caesius* and prominent *Festuca rubra* and *Ononis repens.*



Site OB7. SS5046286914

Site OB7. Fixed or semi-fixed dune grassland (NVC SD7/SD8) with abundant, but not dominant *Ammophila* in an open grassy sward.



Site OB8. SS5143487761

Site OB8. Sample taken from more-or-less level ground just behind the frontal dune ridge (NVC SD7). *Vertigo angustior* was picked up by Ben Rowson using the suction sampler. The vegetation is closed, and co-dominated by *Festuca rubra* and *Ammophila arenaria* with Frequent *Elymus*, *Holcus lanatus* and *Avenula pubescens*, along with occasional *Hedera hibernica*, *Eryngium maritimum*, and *Oenothera* sp. The bulk of the vegetation is 20-25cm tall excluding infloresences with taller tussocks of *Ammophila* (30-40cm) frequent through the sward. Underneath the living vegetation is a thick thatch of damp, leaf litter. *Vertigo angustior* present.



Site OB9. SS5139387788

Site OB9. Closed grassland, close to sample 8, but with less but still frequent to locally abundant *Festuca rubra* and a higher cover of bryophytes, particularly *Pseudoscleropodium purum* (NVC SD7). *Ammophila* tussocks continue to be frequent. A high frequency of *Polypodium interjectum* is a key difference from sample 8. Other associated species include frequent *Ononis repens, Calystegia soldanella*, *Hypochaeris radicata*, *Pilosella officinarum*, J*acobaea vulgaris,*and *Polygala vulgaris*,and occasional *Oenothera* sp., and other grasses include *Holcus lanatus*, *Dactylis glomerata*, *Elytrigia* sp., *Avenula pubescens* and *Poa subcaerulea*. The bulk of the vegetation is 20-25cm tall excluding inflorescences with taller tussocks of *Ammophila* (30-40cm) frequent through the sward.
Vertigo angustior present.



Site OB10. SS5140887738

Site OB10. This is the original positive location from 2023. A closed *Festuca rubra* (abundant to dominant) and *Ammophila* (frequent to abundant) sward with frequent *Ononis repens* and *Pilosella officinarum*, and occasional *Hypochaeris radicata*, *Taraxacum, Oenothera* sp. and *Hieracium* sp. (NVC SD7). Other frequent grass species include *Elytrigia* sp., *Holcus lanatus*, *Anthoxanthum odoratum* and *Avenula pubescens*.

Bryophytes are scattered at a low cover (<10%). The bulk of the vegetation is 25 to 30cm tall with the *Ammophila* tussocks around 40cm tall. The leaf litter cover is high (>50%).



Site OB11. SS5131287703

Site OB11. A short bryophyte-dominated sward on level ground (an exploratory sample!) with scattered *Ammophila*, a high cover of *Ononis repens* (frequent to abundant) and scattered *Eryngium maritimum* (frequent). Most of the bryophyte cover is provided by *Brachythecium* and *Syntrichia ruraliformis* (in combination c. 50% cover). Other associates include *Oenothera* sp., *Ammophila arenaria*, *Pilosella officinarum*, *Carex arenaria*, *Taraxacum* sp., *Thymus polytrichus* (rare), *Phleum arenarium* (rare) and *Peltigera* (occasional). Leaf litter is very low and vegetation height is generally <5cm.



Site OB12. SS5138587684

Site OB12. A generally closed *Ammophila* and *Festuca rubra* grassland, but with some small amounts of open ground (NVC SD7). *Ammophila* is abundant, *Festuca rubra* is dominant and other common associated include *Honkenya peploides* (frequent), *Oenothera* sp. (frequent) *Jacobaea vulgaris* (frequent), *Hieracium* sp. (occasional), *Eryngium maritimum* (occasional). Bryophyte cover is high (c. 50%) and the cover of leaf

litter is above 50%. The bulk of the vegetation is between 25 cm and 50cm, although small tracks are present which support bare ground.



Site OB13. SS5134087581

Site OB13. This location was confirmed as positive in the field with 5 specimens found through hand sieving and additional specimens through using the suction sampler. This location is probably the highest (vertically) positive location recorded to date and occurs on sloping ground on the landward side of steep foredunes. The sward is closed with a high cover of *Festuca rubra* and *Ammophila* (frequent) but this time is joined by abundant *Rubus caesius* (NVC SD7). Other associates include *Ononis repens* (frequent), *Jacobaea vulgaris* (frequent), *Hypochaeris radicata*, *Carex arenaria*, *Teucrium scolopendrium* and *Thymus polytrichus* (LA). The bryophyte layer is scattered and principally made up of *Brachythecium* cf *.rutabulum* and the litter layer is typically above 50%. The bulk of the vegetation is between 25 and 50cm.
Vertigo angustior present.



Site OB14. SS5124787509

Site OB14. On the seaward side of the frontal dune ridge, this sample is dominated by *Ammophila* but *Festuca rubra* continues to be frequent (NVC SD7). The sward is more-or-

less closed but when the *Ammophila* tussocks are pulled apart bare ground is frequent (at around 5%) at the base; the soil is very sandy and free-draining so is likely to be quite droughted. Other associates include *Oenothera* sp. (frequent), *Hypochaeris radicata* (frequent), *Jacobaea vulgaris* (frequent), *Ononis repens* (frequent), *Rumex acetosa* (occasional), *Leontodon saxatilis* (occasional) and *Rubus caesius* (occasional). *Syntrichia* cover is around 25% and cover of leaf litter is above 50%. Vegetation height various from 0 to 30cm.
Vertigo angustior present? (suspected to be a vacuum sample contaminant)



Site OB15. SS5119187498

Site OB15. A closed sward *Festuca rubra* grassland with *Ammophila* and abundant *Rubus caesius* (NVC SD8). The vegetation is taller and ranker here, with no bare ground and a thick thatch of leaf litter (over 50% cover). Vegetation height is typically between 30 and 50 cm. Associates include frequent *Ononis repens*, *Jacobaea vulgaris*, *Taraxacum*, *Avenula pubescens* and *Holcus lanatus* (F), and rare *Ranunculus acris*. Bryophyte cover is generally low and includes *Brachythecium rutabulum* and *Kindbergia praelogum*.



Site OB16. SS5108087420

Site OB16. A rank seaward facing, closed sward principally made up of *Festuca rubra*, *Rubus caesius* (abundant to dominant) and *Ammophila* (frequent) (NVC SD8). Bryophyte cover (primarily *Brachythecium rutabulum*) is very low (1%) and the leaf litter cover is lower here than in previous samples (25 to 50%). Other frequent associates are *Ononis repens*, *Hypochaeris radicata*, *Holcus lanatus*, *Avenula pubescens* and *Carex arenaria*.
Vertigo angustior present.



Site OB17. SS5082787289

Site OB17. A rankish, closed sward of *Festuca rubra* (abundant) and *Rubus caesius* (dominant) and scattered *Ammophila* (less here than in previous samples) (NVC SD8). No bare ground present. The bryophyte cover is typically around 20% and the bulk of the vegetation between 20 and 35cm tall, although shorter areas, around 15cm were also included in the sample. *Ononis repens*, *Holcus lanatus*, *Avenula pubescens*, *Carex arenaria*, *Brachythecium rutabulum* and *Kindbergia* are Frequent. *Teucrium*, *Poa subcaerulea* and *Taraxacum* are occasional.

Appendix 11. Site locations and summary habitat descriptions at Nicholaston Burrows (NB)



Site NB1. SS5231387828

Site NB1. Semi-fixed dune grassland. *Ammophila* is abundant to dominant alongside high covers of *Ononis repens* and *Geranium sanguineum* (NVC SD7).



Site NB2. SS5226587871

Site NB2. Closed sward, fixed dune grassland (NVC SD8). *Geranium sanguineum* dominated vegetation in which *Ammophila* is frequent, but not abundant.
Vertigo angustior present.



Site NB3. SS5200087779

Site NB3. Mobile/semi-fixed dune grassland (NVC SD6/SD7) – strongly dominated by *Ammophila* with scattered *Jacobaea vulgaris.*



Site NB4. SS5181787770.

Site NB4. Mobile dune vegetation (SD6) – strongly dominated by *Ammophila* with few prominent associates (NVC SD6).

Site NB5. SS5169487774**.** Vegetation similar to NB4. No site image available.



Site NB6. SS5150387818

Site NB6. Semi-fixed dune grassland (SD8) – closed sward vegetation dominated by *Ammophila* with frequent to abundant *Ononis repens* and prominent *Polypodium interjectum* (NVC SD8).

Appendix 12. Site locations and summary habitat descriptions at Whiteford Burrows (WB)



Site WB1. SS4481996490

Site WB1. A mature dune slack at the northern end of the sand dune system. *Salix repens* and *Rubus caesius* co-dominate the vegetation here forming a closed sward roughly 20-45cm tall (NVC SD16b). Frequent associates include *Galium verum*, *Agrimonia* spp., *Carex arenaria*, *C. flacca*, *Trifolium repens* and *T. pratense* and the grasses *Holcus lanatus*, *Festuca rubra* and *Poa humilis*. Bryophytes are only weakly represented with a patchy cover of *Brachythecium cf. rutabulum* and *Scleropodium purum*. The frontal dune ridge, at the northern end of the slack, appears to have been recently eroded by the sea and the vegetation here is shorter (5-15cm) with large volumes of woody debris and scattered plants of *Ammophila arenaria* and *Euphorbia paralias*.
Vertigo angustior present.



Site WB2. 40m north of SS4481996490

Site WB2. This sample was collected from the lower, north-facing flank of a dune ridge adjacent to slack. Grasses including *Festuca rubra*, *Avenula pubescens*, *Poa humilis* and *Holcus lanatus* and herbs and chamaephytes among them *Thymus praecox*, *Galium verum*, *Ononis repens*, *Lotus corniculatus*, *Leontodon autumnalis* and *Rubus caesius* form the main fabric of a closed and ankle high (5-10cm) sward in which no one species is dominant (NVC SD8c). There is a relatively lush bryophyte layer dominated by *Scleropodium purum*.
Vertigo angustior present.



Site WB3. SS4477296459

Site WB3. The bulk sample was collected from the sloping north- and west-facing margins of a mature dune slack and includes material collected from underneath a tall *Salix cinerea* bush. *Salix repens*, *Rubus caesius* and *Festuca rubra* are the most prominent species in a closed sward around 10-20cm tall (NVC SD16b). The more prominent associates include *Carex flacca*, *Polygala vulgaris*, *Lotus corniculatus*, *Plantago lanceolata*, *Taraxacum officinale* agg. and *Agrimonia* spp. The sample includes material collected from more transitional vegetation in which *Salix repens* declines in frequency and *Galium verum*,

Ononis repens and the mosses *Homalothecium lutescens* and *Hypnum lacunosum* become more prominent marking a transition to fixed dune grassland (NVC SD8). *Vertigo angustior* present.



Site WB4. SS4482196230

Site WB4. Steep west-facing dune supporting short (mostly 2-5cm tall) open vegetation with scattered clumps of taller *Ammophilla arenaria* (c. 40cm) particularly on the upper slopes. Prominent species in a species-rich turf include *Rubus caesius*, *Galium verum*, *Thymus praecox*, *Carex arenaria*, *Ononis repens*, *Pilosella officinarum*, *Hypochaeris radicata*, and *Anthylis vulneraria* (NVC SD8c). Annuals including Aira praecox, Catapodium rigidum, Phleum arenarium and *Arenaria serypyllifolium* are frequent particularly in the more open areas with higher covers of bare sand and *Syntrichia ruraliformis* marking transitions to NVC SD19. Bare sand accounts for up to 50% of the ground cover on the upper slope but is limited on the lower parts of the dune.
Dead shell of *Vertigo angustior* present.



Site WB5. SS4460695847

Site WB5. This sample was taken from an area of mature slack co-dominated by *Salix repens*, *Rubus caesius* and *Potentilla anserina* which from a relatively closed canopy at

around calf to ankle height (25-45cm). Frequent associates include *Trifolium pratense*, *T. repens*, *Hydrocotyle vulgaris*, *Lotus corniculatus*, *Plantago lanceolata*, *Ranunculus acris* and the grasses *Festuca rubra*, *Holcus lanatus* and *Poa humilis* (NVC SD16b). Robust pleurocarpous mosses, notably *Scleropodium purum* and to a lesser extent *Calliergonella cuspidata* are prominent in a well-developed bryophyte layer. The sample also includes material collected from patches of otherwise similar slack vegetation in which *Juncus maritimus* is dominant.
Vertigo angustior present.



Site WB 6. SS4454995580

Site WB6. Another sample collected from an area of closed, mature *Salix repens*-dominated slack vegetation in which *Festuca rubra* and *Rubus caesius* are among the most consistently prominent associates (NVC SD16b). *Filipendula ulmaria* is locally abundant and even in places dominant. Other frequent species include *Ranunculus acris*, *Trifolium pratense*, *Trifolium repens*, *Mentha aquatica*, *Taraxacum officinale* agg., *Lotus corniculatus*, *Holcus lanatus*, *Poa humilis* and *Agrimonia fragrans*. The bryophyte layer is poorly developed, but *Pseudoscleropdium purum* and *Calliergonella cuspidata* remain moderately frequent. The bulk sample also includes material collected from the drier margins to the slack where the vegetation grades into shorter stands of fixed dune grassland NVC SD8.
Vertigo angustior present.



Sites WB7 to WB13 (two transects) - View across slack from south facing ridge to north facing ridge.

Transect 1 (samples WB7 to WB10)

This includes four samples collected at c 3.5m intervals along a transect starting in *Salix repens*-dominated vegetation occupying level ground at the base of the dune slack and extending up into more droughted areas of fixed dune grassland on the lower half of the adjacent, north-facing dune ridge.



Image showing transect line positions of WB7 to WB10

Site WB 7. SS4446895259
This sample was taken from an area of relatively low growing (5-15) dune slack in which *Salix repens* is the principle dominant (NVC SD16b). The turf is relatively species-rich with *Lotus corniculatus*, *Ononis repens*, *Ranunculus bulbosus*, *Polygala vulgaris*, *Rubus caesius*, *Trifolium pratense*, *Agrimonia* spp, *Galium verum*, *Avenula pubescens*, *Festuca rubra* and *Briza media* among the more frequent vascular associates. Areas of bare ground are absent and there is a well-developed bryophyte carpet in which *Pseudosclerpodium purum*, *Homalothecium lutescens* and *Rhytidiadelphus triquetrus* are prominent.
Vertigo angustior present.

Site WB8. SS4447895237
Fixed dune vegetation on gently sloping ground with north-facing aspect. The sward here is short (1-5cm) and species and forb-rich with no one species consistently dominant. Prominent species include *Thymus praecox*, *Ononis repens*, *Galium verum*, *Pilosella officinarum*, *Ranunculus bulbosus*, *Lotus corniculatus*, *Veronica chamaedrys*, *Carex flacca*, *Rhinanthus minor*, *Hypochaeris radicata*. *Festuca rubra*, *Anthoxanthum odoratum* and *Briza media* (NVC SD8). Bulkier plants of *Rubus caesius* and *Rosa spinosissima* are scattered but for the most part at low cover. There is a well-developed moss layer in which *Hypnum lacunosum*, *Rhytidiadelphus triquetrus* and *Homalothecium lutescens* are prominent, and little or no bare ground. *Vertigo angustior* present.

Site WB9. SS4447895230
This sample was taken on more moderately sloping ground somewhat higher up on the dune ridge than WB8. The vegetation here (NVC SD8) is floristically like that sampled in WB8, the main difference being that the sward is somewhat taller ((5-10cm) and denser with higher covers of *Rosa spinosissima* and *Rubus caesius*.
Vertigo angustior present.

Site WB10. SS4447795227
This sample is again from floristically similar vegetation to WB9. The sward here is slightly taller (8-12cm) and represents vegetation on more sloping ground higher up on the dune face (NVC SD8).
Vertigo angustior present.



Image showing transect line positions of WB11 to WB13.

Transect 2 (samples WB11 to WB13)

This includes three samples taken from vegetation grading from level ground within the floor of the dune slack (W11) through to droughted dune grassland on the lower south-facing slope of the adjacent dune ridge (WB13).

Site WB 11. SS4448395266
Sample from area of slack in which *Salix repens* and to a lesser extent *Rubus caesius* forms an open canopy at around 10-40cm tall (NVC SD15). *Ranunculus acris*, *R. bulbosus, Lotus corniculatus*, *Galium verum*, *Trifolium pratensis*, *T. repens*, *Rhinanthus minor*, *Pilosella officinalis* and *Veronica chamaedrys* are among the more frequent herbaceaous associates, while *Festuca rubra*, *Poa humilis* and *Avenula pubescens* are among the most common grasses. There is a patchy bryophyte layer in which *Pseudocleropodium purum* is the dominant species.
Vertigo angustior present.

Site WB12. SS4448395268
Short (2-8 cm tall) fixed dune grassland co-dominated by mixtures of *Rosa spinosissima*, *Lotus corniculatus*, *Thymus praecox* and *Anthyllis vulneraria* (NVC SD8). Frequent associates include, *Galium verum*, *Ononis repens*, *Pilosella officinalis*, *Luzula campestris*, *Hypochaeris radicata* and *Echium vulgare* alongside a range of grasses among the most prominent of which are *Festuca rubra* and *Poa humilis*. The sward is general closed with little or no bare ground but a lush moss carpet (mostly *Hypnum lacunosum*).

Site WB13. SS4448395227
This sample was taken from more moderately sloping ground on the lower edge of a south-facing dune ridge. The sward here is generally short (3-5 cm tall) and includes more closed areas that are similar in floristic composition to WB12 and more open droughted patches with high covers of *Syntrichia ruraliformis* and patches of bare sand. Dune annuals including *Phleum arenarium*, *Catapodium rigidum*, *Bromus ferronii* and *Arenaria serpyllifolia* are prominent particularly in the more open areas (NVC SD19 & SD8).


Site WB14. SS4439294910

Site WB14. Mature dune slack in which *Salix repens* and to a lesser extent *Rubus caesius* forms a closed canopy at knee to thigh height (40-70 cm) (NVC SD16b). Frequent vascular associates include *Festuca rubra*, *Galium verum*, *Holcus lanatus*, *Ononis repens*, *Agrimonia eupatoria*, *A. fragrans*, *Rosa spinosissima* and *Lotus corniculatus*. *Pseudoscleropodium purum* and *Kindbergia praelonga* are the most prominent species in a patchy moss layer. The sample also includes material collected from grassier areas in which *Festuca rubra*, *Avenula pubescens*, *Holcus lanatus* and to a lesser extent *Briza media* and *Anthoxanthum odoratum* are prominent and a patch of shorter fixed dune grassland (NVC SD8) on a low tump within the slack.
Vertigo angustior present.



Site WB15. SS4423594879

Site WB15. Sample collected from an area of slack vegetation in which *Salix repens*, *Rubus caesius* and *Potentilla anserina* form a closed canopy at ankle to calf height (NVC SD15b). Frequent associates include a range of grasses (notably *Agrostis stolonifera* and *Festuca rubra*), sedges (*Carex flacca* and *C. nigra*) rushes (principally *Juncus articulatus*) and poor-fen forbs (including *Hydrocotyle*, *Galium palustre* and *Mentha aquatica*). *Calliergonella cuspidata* is dominant in a well-developed moss layer. The sample also includes material collected from patches variously dominated by *Juncus maritimus*, *Carex nigra* and *Iris pseudacorus*.

Appendix 13. Site locations and summary habitat descriptions at Three Cliffs Bay (TC)



The location of sites TC1 & TC2.


Site TC1. SS5360088176

Site TC1. Semi-fixed dune grassland with *Ammophila arenaria*, *Hypochaeris radicata*, *Eryngium maritimum*, and *Jacobaea vulgaris* all prominent (NVC SD7). There is a high cover of bryophytes, including *Syntrichia ruraliformis*.



Site TC2. SS5354088181

Site TC2. Semi-fixed dune grassland. Short, open, fixed-dune grassland with high covers of mosses (primarily *Syntrichia ruraliformis*) and bare sand (NVC SD19 & SD7). Vascular plants are less prominent with *Rubus caesius*, *Jacobaea vulgaris* and *Thymus praecox* among the more frequent species alongside scattered tussocks of *Ammophila*.



Site TC 3. SS5408788316

Site TC3. Semi-fixed dune grassland occupying high ground just above the saltmarsh/sand dune interface (NVC SD7). *Ammophila* is present at moderate to high covers alongside frequent *Hypochaeris radicata* in an open mossy sward which includes localised patches of bare sand a strandline of woody debris.

Appendix 14. Site locations and summary habitat descriptions at Swansea Dunes (SD)



Site SD1. SS6285391509

Site SD1. Open yellow dune with abundant *Ammophila* (NVC SD7). Frequent associates include a mix of taller herbs (*Oenothera* sp., *Jacobaea vulgaris*, *Clematis vitalba*, *Reseda lutea*), sprawlers (*Clemetis vitalba*, *Calystegia soldanella*) and other grasses and sedges (Carex arenaria and *Festuca rubra*). Between the tussocks of *Ammophila*, *Syntrichia ruraliformis* is dominant in a near continuous moss carpet which is interspersed with patches of bare sand in which dimunative annuals including *Arenaria serpyllifolia* and *Cerastium semi-decandrum* are common. Saplings of the invasive *Quercus ilex* are scattered throughout.



Site SD2. SS6276491440

Site SD2. This sample is like SD1, but with rather more abundant *Clemetis* and *Oenothera* and a more diverse bryophyte layer, in which *Rhytidiadelphus squarrosus* and *Homalothecium lutescens* are prominent alongside *Syntrichia ruraliformis* (NVC SD7). The

sample also includes shorter grassier areas with prominent *Cynodon dactylon* and *Achillea millefolium* and more closed vegetation dominated by mixtures of *Clemetis*, *A. millefolium* and *Arrhenathermum elatius*.



Site SD3. SS6268591359

Site SD3. Floristically similar vegetation to SD1 and SD2, although featuring rather more closed dune grassland (mostly 15-60cm tall) in which *Ononis repens* is locally dominant and *Ammophilla* is frequent but rather less prominent (NVC SD7/SD8). *Syntrichia ruraliformis* is again the most abundant bryophyte in a well-formed moss layer.



Site SD4. SS6261791306

Site SD4. This sample is again taken from vegetation which is floristically like SD3. *Ononis repens* dominates in a mostly calf high (12-15cm) sward which is punctuated by taller tussocks of *Ammophilla*. *Festuca rubra* is locally prominent and the bryophyte layer is less well-developed with *Brachythecium* cf. *rutablulum* and *Kindbergia praelongum* largely replacing *Syntrichia* as the most prominent mosses (NVC SB8?).



Site SD 5. SS6252391213

Site SD5. This sample is from a more mixed area of dune grassland, including mostly closed sward vegetation assignable to NVC SD8, more open areas with abundant bare sand and prominent *Ammophila* (NVC SD7) and areas of *Quercus ilex* and *Hippophaea rhamnoides* scrub. The bulk of the grassland is between calf and knee high (20-25 cm) and shares a similar floristic composition to SD3 and SD4, although *Rubus caesius* and *Lotus corniculatus* are perhaps more prominent here. *Pseudoscleropodium purum* and to a lesser extent *Brachythecium* cf. *rutablum* and *Kindbergia* are the most prominent bryophytes.



Site SD6. SS6197590521

Site SD6. This sample was taken from an area of yellow dune adjacent to a small stream. *Ammophilla* is abundant but not dominant in a sward that is mostly between calf and thigh high (15-60cm), but which also includes shorter areas of bare sand, mosses and patches of *Alnus glutinosa* scrub (NVC SD7). Frequent associates here include *Carex arenaria*, *Hypochaeris radicata*, *Leontodon saxatilis, Festuca rubra, Reseda lutea* and *Sonchus* sp, with *Euphorbia paralias*, *Eryngium maritimum* and *Ononis repens* prominent in more open areas. *Brachythecium rutabulum* and *Kindbergia* are the most frequent mosses in a patchy bryophyte layer which also includes clumps of *Syntrichia ruralis*.



Site SD7. SS6190890394

Site SD7. Mostly short (2-15cm), open dune grassland on level ground (NVC SD7). *Lotus corniculatus*, *Carex arenaria*, *Crepis capillaris*, *Taraxacum officinale* agg., *Cynodon dactylon* and *Euringuim maritimum* are frequent alongside more bulky herbs including *Raphnus rapistrum* and *Oenothera* spp. *Ammophilla* is scattered along the front edge of the sample and *Rosa rugosa* is locally prominent.

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] format~~.

[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_DS161319**.

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