A survey of the Narrow-mouthed Whorl Snail *Vertigo angustior* at Pembrey, Carmarthenshire in 2025

Natur am Byth! Evidence Report No: 019

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Cover image (clockwise from top right): Shell of *Vertigo angustior* (Amgueddfa Cymru - Museum Wales); map of 2025 survey sites at Pembrey; botanical surveying in *V. angustior* habitat.

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Report series: 'Natur am Byth!' Evidence Report
Report number: **019**
Publication date: October 2026
Contract number:
Contractor: Amgueddfa Cymru – Museum Wales
Contract managers: Tawny Clark & Clare Dinham
Title: **A survey of the Narrow-mouthed Whorl Snail *Vertigo angustior* at Pembrey, Carmarthenshire in 2025**
Author(s): B. Rowson
Technical editor: Clare Dinham
Quality assurance: 2
Peer reviewer(s) Dr. Mike Howe
Approved by: Dr. Mike Howe
Restrictions: None

Distribution list (core)

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

Distribution list (others)

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Paul Aubrey, Carmarthenshire County Council
MoD Pembrey Air Weapons Range
Clare Dinham, Buglife Cymru
Dr. Ben Rowson, Amgueddfa Cymru, Cardiff

Recommended citation for this volume:

Rowson, B. 2026. A survey of the Narrow-mouthed Whorl Snail *Vertigo angustior* at Pembrey, Carmarthenshire in 2025. Natur am Byth! Evidence Report No. **019**. 30pp. Buglife Cymru & Natural Resources Wales, Bangor.

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Crynodeb gweithredol

Mae'r adroddiad hwn yn cyflwyno canlyniadau arolwg maes a gynhaliwyd ar gyfer y falwen droellog *Vertigo angustior* yn ardal Pen-bre yn Sir Gaerfyrddin yn 2025. Cynhaliwyd yr arolwg cynhwysfawr diwethaf ar gyfer *V. angustior* ym Mhen-bre yn 2013-2014, ac mae'r cofnod mwyaf diweddar o 2016. Nod yr arolwg oedd:

- cynnig diweddariad o bresenoldeb a statws *V. angustior* ym Mhen-bre;
- cynnig argymhellion ar gyfer gwaith rheoli;
- cynghori ar ddulliau ar gyfer ei monitro yn y dyfodol.

Samplwyd 19 o safleoedd i gyd, gan gynnwys yr holl safleoedd y cofnodwyd *V. angustior* ynddynt yn 2013-2014. Arolygwyd yr holl safleoedd drwy gyfrwng dulliau samplu swmp a samplu drwy wactod, er mwyn gallu cymharu'r ddwy dechneg hon ymhellach. Cafodd safleoedd eu dosbarthu yn ôl categori NVC lle roedd modd, a rhestrwyd y rhywogaethau trechaf o blanhigion. Canfuwyd 1,995 sbesimen i gyd o folysgiaid y tir, a hynny'n cynrychioli 33 rhywogaeth gan gynnwys tair rhywogaeth o *Vertigo* a llawer o rywogaethau eraill o falwod pitw bach.

Dim ond mewn tri safle y canfuwyd *V. angustior*, y cyfan yn y rhan ogleddol o'r ardal ym Maes Arfau Awyr y Weinyddiaeth Amddiffyn. Mae'r tri safle hwn oll mewn glaswelltir tal sy'n gyforiog o blanhigion llysieuol, sydd heb ei gysgodi gan goed, a ble nad oes molysgiaid sy'n dynodi ei fod dan ddŵr ar adegau o'r flwyddyn. Ar ddau o'r safleoedd hyn roedd nifer o sbesimenau llawndwf ac ifanc byw o *V. angustior*. Cafwyd hyd i ddwy rywogaeth *Vertigo* arall, *V. antivertigo* a *V. pygmaea*, yn y rhan o'r ardal ar dir y Weinyddiaeth Amddiffyn. Ni ddarganfuwyd unrhyw enghreifftiau o *V. angustior* yn y safleoedd a arolygwyd yn y rhan ddeheuol o'r ardal yng Nghoedwig Pen-bre (CNC), ble mai *V. pygmaea* oedd yr unig rywogaeth *Vertigo* a welwyd. Er na ellir bod yn bendant na chafodd poblogaethau bach gweddillol eu methu, mae'r canlyniadau'n awgrymu crebachiad cryf tua'r gogledd ers 2013 o ran yr ardal a feddiannir gan *V. angustior*. Mae'r safleoedd a oedd wedi'u meddiannu yn y rhan o'r safle ar dir y Weinyddiaeth Amddiffyn mewn cynefin *V. angustior* confensiynol. Dylid atal gordyfiant prysgwydd yn y safleoedd hyn. Mae'r rhan fwyaf o'r safleoedd a feddianwyd gynt yn y rhan o'r safle sydd ar dir CNC bellach wedi'u cysgodi gan goed conwydd aeddfed neu dan dyfiant trwchus o brysgwydd, felly mae'n annhebygol eu bod yn dal i fod yn addas. Felly, ymddengys bod clirio llystyfiant i adfer a chynnal cynefinoedd agored, yn enwedig mewn un man agored bach, yn hanfodol er mwyn atal colli *V. angustior* o'r Goedwig os, yn wir, yw'n dal i oroesi yno.

Ni ddaethpwyd o hyd i *Vertigo substriata* yn arolwg 2025 – fe'i cofnodwyd ddiwethaf yn un o gyn safleoedd *V. angustior* yn y Goedwig. Mae'n bosib ei bod hithau wedi dirywio hefyd. Mae *Zonitoides nitidus*, malwen ysglyfaethus ar ymylon cyrff dŵr, a'r falwen anfrodorol *Paralaoma servilis,* yn newydd i'r casgliad o falwod sy'n byw ym Mhen-bre.

Mae cymhariaeth o ddulliau samplu swmp a samplu drwy wactod yn caniatáu cymhariaeth well ag arolygon blaenorol o *V. angustior* ym Mhen-bre, ac mewn safleoedd eraill yn Ne Cymru. Daethpwyd i'r casgliad bod y ddau ddull yn ffordd effeithiol o ganfod *V. angustior.* Ymddengys fod samplu swmp ychydig yn well ar gyfer y rhywogaeth hon. Fodd bynnag, mae manteision ymarferol i ddefnyddio dull samplu drwy wactod mewn arolygon cyflym neu reolaidd, felly argymhellir ei ddefnyddio mewn gwaith monitro *V. angustior* yn y dyfodol.

Executive Summary

This report presents the results of a field survey undertaken for the Narrow-mouthed Whorl Snail *Vertigo angustior* in the Pembrey area of Carmarthenshire in 2025. The last comprehensive survey for *V. angustior* at Pembrey was carried out in 2013-2014, with the most recent record being in 2016. The survey aimed to:

- provide an an update on the presence and status of *V. angustior* at Pembrey;
- provide management recommendations;
- advise on the methods for future monitoring.

A total of 19 sites were sampled, including all sites from which *V. angustior* was recorded in 2013-2014. All sites were surveyed by bulk and suction sampling methods to allow a further comparison of these two techniques. Sites were assigned to an NVC category where possible and dominant plant species listed. A total of 1,995 terrestrial mollusc specimens were found, representing 33 species including three species of *Vertigo* and many other tiny snail species.

V. angustior was found only at three sites, all in the northern, Pembrey Sands (MoD Air Weapons Range) part of the area. These are all in tall, herb-rich grassland unshaded by trees, and lack molluscs that indicate seasonal flooding. At two of these sites *V. angustior* was represented by numerous live adults and juveniles. Two other *Vertigo* species, *V. antivertigo* and *V. pygmaea*, were found in the Pembrey Sands (MoD) part of the area. No *V. angustior* were found at the sites surveyed in the southern, Pembrey Forest (NRW) part of the area, where *V. pygmaea* was the only *Vertigo* species found. While it cannot be ruled out that small, remnant populations were overlooked, the results suggest a strong northward contraction in the area occupied by *V. angustior* since 2013.

The occupied sites in the MoD part of the site are in conventional *V. angustior* habitat. The growth of scrub in these sites should be kept in check. Most of the formerly occupied sites in the NRW part of the site are now shaded by mature conifers or overgrown by scrub, so it is doubtful they are still suitable. Vegetation clearance to restore and maintain open habitats, particularly at one small clearing, therefore seems crucial to prevent the loss of *V. angustior* from the Forest if indeed it still survives there.

Vertigo substriata, last recorded at one of the former *V. angustior* sites in the Forest, was not found in the 2025 survey. It too may have declined. *Zonitoides nitidus*, a predatory snail of water margins, and the non-native snail *Paralaoma servilis*, are additions to the molluscan fauna of Pembrey.

A comparison of bulk and suction sampling methods allows better comparison with previous *V. angustior* surveys at Pembrey, and at other sites in South Wales. It is concluded that both methods are an effective way to detect *V. angustior*. Bulk sampling appears slightly superior for this species. However, suction sampling has practical advantages in rapid or regular surveys, so is recommended for use in future *V. angustior* monitoring.

1. Introduction

This report presents the results of a field survey undertaken for the Narrow-mouthed Whorl Snail *Vertigo angustior* (Jeffreys, 1830) in the Pembrey area of Carmarthenshire in 2025. The last comprehensive survey for *V. angustior* at Pembrey was carried out in 2013-2014, with the most recent record being in 2016.

1.1. The target species

The Narrow-mouthed Whorl Snail *Vertigo angustior* (Jeffreys, 1830) is a minute (1.5 – 2 mm long) but distinctive terrestrial snail. It is a habitat specialist species found in open, base-rich habitats including coastal dune slacks and marsh-dune transition zones. The snail requires humid habitats affected neither by desiccation nor by flooding (Kerney, 1999) and lives close to ground level, sheltered by low vegetation and plant litter. *Vertigo angustior* has been the target of several recent surveys that have helped refine its habitat range and preferences in coastal dune systems (Howe, 2020; Willing, 2023, 2024 & 2025).

In the UK, *V. angustior* is a rare and declining species that remains vulnerable to habitat loss through drainage, afforestation, and other changes in land use (Preece & Willing, 1984; Kerney, 1999). Population densities of this tiny species can be very high in optimal habitat, but are thought to fluctuate considerably from year to year (Moorkens & Killeen, 2011: p. 74). Its continued presence therefore requires periodic monitoring lest populations be lost undetected.

In Wales, *V. angustior* is known only from populations on Gower, last surveyed in 2023 (Willing, 2024) and from the Pembrey area, last surveyed in 2013-2014 (Harper, 2014). Attempts to find the species in Pembrokeshire based on an 1862 record from Tenby by J. G. Jeffreys have never been successful (Preece & Willing, 1984). A thorough survey of a large complex of apparently suitable habitats in the Pendine area in 2024 concluded that *V. angustior* was not present (Willing, 2025).

Vertigo angustior is listed on the EU Habitats Directive Annex II. In Wales, the species is a SAC Feature for Carmarthen Bay Dunes and a SSSI Qualifying Feature for Pembrey Coast SSSI as well as the SSSIs at Oxwich Bay and Whitford Burrows, Gower (Howe, 2020).

1.2. The Pembrey area

The Pembrey area is separated into four parts. The northern part, Pembrey Air Weapons Range, is managed by the Ministry of Defence (MoD) and consists of willow scrub and open habitat, much of it grazed or mown. It has almost no public access. The western edge is formed by dunes, while the eastern edge is a tidal saltmarsh grazed by cattle. The central strip of fen and dune habitats is a SSSI and is known locally as “Bomb Alley” (Harper, 2014).

The central and largest part, Pembrey Forest, is managed by Natural Resources Wales (NRW) and Pembrey Conservation Trust. It was planted with conifers between 1929 and 1954 and is managed primarily for forestry and recreation by walkers, horse riders and cyclists. There is little access for public vehicles. Much of the land is under mature conifers or mature willow scrub, with few open areas but many miles of gravel trackways and mown rides and some ponds. There is very little grazing. The western edge is formed by an

unbroken strip of dunes, while the eastern edge is abutted by Pembrey Airport, Pembrey Circuit motor racing track, and drained grazing levels.

The southern part, Pembrey Country Park, is managed by Carmarthenshire County Council and includes a campsite and vehicle access to Cefn Sidan beach. To the southeast of the Country Park lies Pembrey Burrows Local Nature Reserve, a set of dunes and saltmarsh that extends along the coast to Burry Port.

All four parts of Pembrey, and some of the adjoining areas, have been surveyed for *V. angustior*, mainly in the wide-ranging survey by Harper (2014). However, to date the species has been found only in the northern (MoD) and central (NRW) parts.

1.3. Aims & scope of survey

This survey aimed to:

- provide an update on the presence and status of *V. angustior* at Pembrey;
- provide management recommendations;
- advise on the methods for future monitoring.

The most recent record of *V. angustior* from Pembrey is an isolated observation by Mike Howe and Karen Wilkinson in a mature dune slack in the MoD range (SN366049, 28th September 2016) (Howe, 2020). Previously, the most recent records resulted from the extensive and very detailed survey by the late John Harper (Harper, 2014). This built on an earlier survey conducted in 2006 (Harper, 2007).

The present survey set out to reassess the species' presence and status by resampling each of the sites from which it was reported by Harper (2014). A small number of additional sites in areas not sampled by Harper (2014), but hosting apparently suitable habitats, were also sampled.

Throughout the present report, the prefix "H" is used to indicate the sites sampled by Harper (2014) and "R" for the new sites first sampled in 2025. The 19 sites surveyed are shown in Figure 1 and listed with details in Table 1.

The fieldwork reported on by Harper (2014) is difficult to replicate as it consists of many sites and subsites, surveyed by different methods, sometimes on multiple dates. Some of his subsites were very close together, while others were essentially repeat samples taken in the same place. Harper (2014) did not present a simple list of the sites at which *V. angustior* was found, though most details can be found in his Table 2 ("Density of *Vertigo* species…"; Harper, 2014: p.18). His Executive Summary (Harper, 2014: p.2) says *V. angustior* was found at "five separate locations", although Harper (2014) in fact reported *V. angustior* from 13 separate samples/subsites. It is here presumed that the "five separate locations" he referred to are sites (H 1 + H 2), H 6, (H 8 + H 10), H 11, and H 27, where closely adjacent sites are bracketed together as a single "location". It is worth noting that one of these five "locations" was in the northern, MoD part of the Pembrey area (sites H 8 + H 10), while the other four were spread across the southern, NRW part.

Despite variable sampling intensity, the geographical spread of sites by Harper (2014) was excellent, leaving only a few sections of the Pembrey area unsampled. It is likely that these unsampled areas have never previously been investigated for *V. angustior*. The present

survey aimed to address this by sampling additional sites in the north-western tip of the MoD range (sites R 5 and R 6), in the dune strip to the north (site R 3), and south (site R 4), and at the southern end of the Swan Pool Drain, the channel that drains the large area of pasture to the east of the NRW land (R 1 and R 2).

Tidal flotsam samples were also taken at the two sites at which flotsam was sampled by Harper (2014) (sites H 10C and H 24A), the former of which yielded many shells of *V. angustior* in 2014. Harper (2014) proposed that the presence of dead *V. angustior* in flotsam was to due to widespread flooding of the northern part of the Pembrey area in the winter of 2013-2014, and perhaps also to fires started in the MoD range.

The present survey made no attempt to sample the many other sites that Harper (2014) sampled but did not yield *V. angustior*. There is no evidence that the species occurs at these locations. However, a sample was taken at one site (H 11) at which *V. angustior* was reported in 2006 (Harper, 2007), even though this was later considered an error (Harper, 2014).

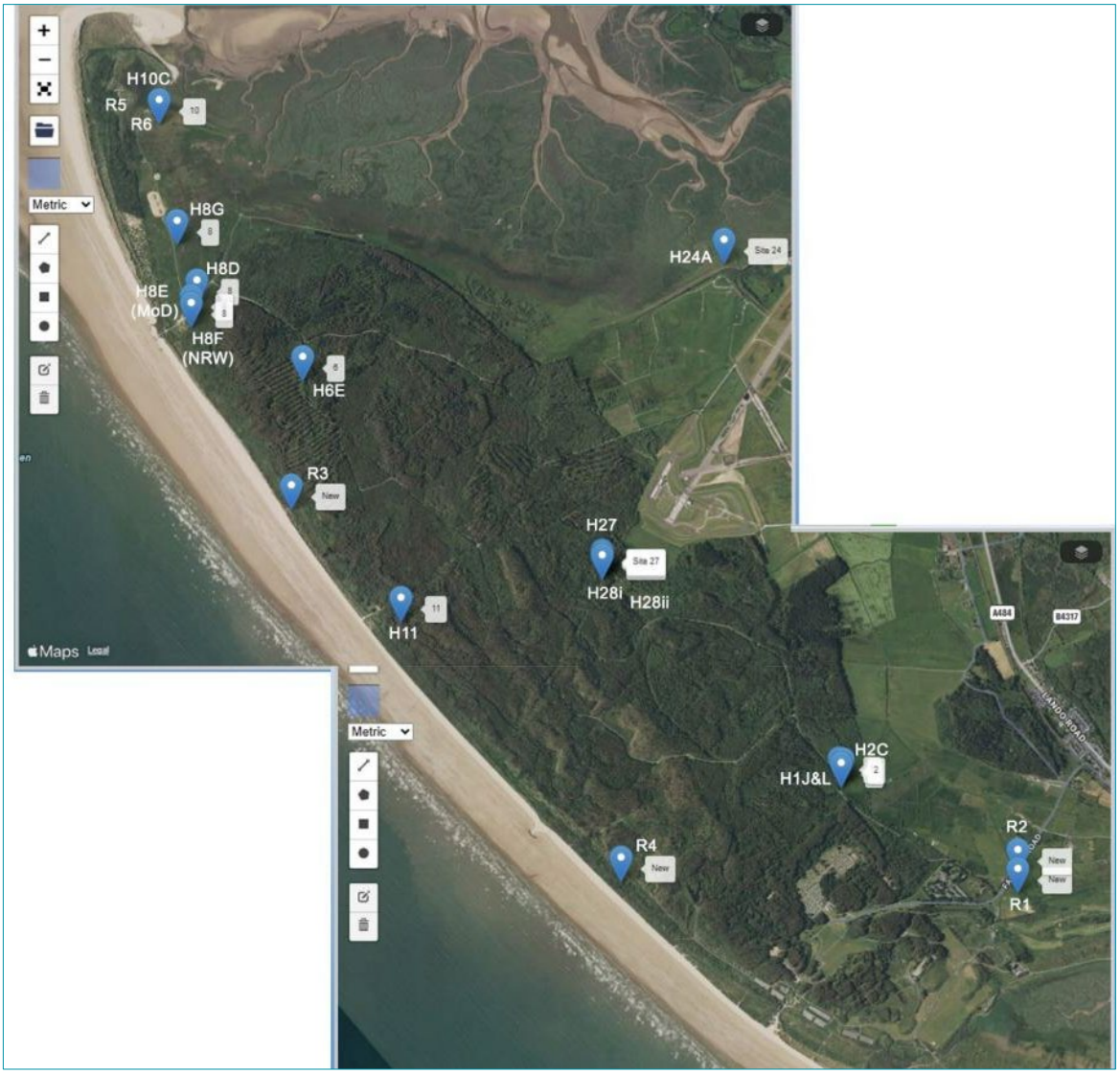


Figure 1. *Vertigo angustior* survey sites at Pembrey in 2025. The prefix “H” is used to indicate sites at which Harper (2014) found *V. angustior*, and “R” to indicate new sites first sampled in 2025.

Table 1. *Vertigo angustior* survey sites at Pembrey in 2025, arranged roughly from north to south. The 19 sites comprise all those at which Harper (2014) found *V. angustior* (9 sites / 13 subsites), plus 6 new sites. Those subsites that were in the same location (e.g. site H 27) or very closely adjacent (e.g. site H 1) were combined in 2025 as shown. Site H 28 was split into two in 2025.

2025 code	Date sampled	2025 samples taken	2025 samples taken	2025 samples taken	Harper subsite/ sample name	OSGR	*Vertigo angustior* density / m^2 (Harper, 2014)	Habitat (mostly verbatim Harper, 2014: Table 2)	*Vertigo angustior* presence (2025)
H 10C	29/09/2025	-	-	flotsam	H10C	SN36450564	100s	Flotsam at flood level	None
R 5	29/09/2025	bulk	suction	-	-	SN36250565	-	Marsh / saltmarsh transition	**Numerous live individuals**
R 6	29/09/2025	bulk	suction	-	-	SN36300562	-	Dune slack	**Numerous live individuals**
H 8G	29/09/2025	bulk	suction	-	H8G	SN36540488	139	Grassland/fen	**One empty shell**
H 24A	29/09/2025	-	-	flotsam	H24A	SN39970465	-	Flotsam on grazed turf at saltmarsh edge	None
H 8D	26/09/2025	bulk	suction	-	H8D	SN36650450	1	Fen (winter flooded)	None
H 8E	26/09/2025	bulk	suction	-	H8E	SN36610441	1	Rough grassland	None
H 8F	26/09/2025	bulk	suction	-	H8F	SN36610436	210	Thick rough grassland	None
H 6E	26/09/2025	bulk	suction	-	H6E	SN373040	3	grassy verge by pond	None
R 3	26/09/2025	bulk	suction	-	-	SN372032	-	Hollow in stable dunes, without tree cover	None
H 27	29/09/2025	bulk	suction	-	H27X	SN39120271	482	"marshy fen vegetation" but now overgrown	None

2025 code	Date sampled	2025 samples taken	2025 samples taken	2025 samples taken	Harper subsite/ sample name	OSGR	*Vertigo angustior* density / m^2 (Harper, 2014)	Habitat (mostly verbatim Harper, 2014: Table 2)	*Vertigo angustior* presence (2025)
H 27	29/09/2025	bulk	suction	-	H27A	SN39120271	1	"marshy fen vegetation" but now overgrown	None
H 27	29/09/2025	bulk	suction	-	H27B	SN39120271	156	"marshy fen vegetation" but now overgrown	None
H 27	29/09/2025	bulk	suction	-	H27C	SN39120271	60	"marshy fen vegetation" but now overgrown	None
H 28i	26/09/2025	bulk	suction	-	H28A	SN39220266	-	lightly grazed dune grassland	None
H 28ii	26/09/2025	bulk	suction	-	H28A	SN39240265	-	lightly grazed dune grassland	None
H 11B	07/08/2025	bulk	suction	-	H11B	SN37870247	-	hollow under pine cover, 100 m from foredunes	None
H 2C	26/09/2025	bulk	suction	-	H2C	SN40610137	2	Marshy field	None
H 1J+L	26/09/2025	bulk	suction	-	H1J	SN40600135	1	Grassy verge	None
H 1J+L	26/09/2025	bulk	suction	-	H1L	SN40590138	4	Grassy bank	None
R 4	26/09/2025	bulk	suction	-	-	SN392008	-	Hollow in stable dunes, scattered tree cover	None
R 1	07/08/2025	bulk	suction	-	-	SN41690065	-	Marshy grassland	None
R 2	07/08/2025	bulk	suction	-	-	SN41690077	-	Marshy grassland	None

2. Methods

Sampling was undertaken on three dates, 7th August, 26th September and 29th September 2025. In each case, the weather was dry and fine but humidity was still rather high and the ground surface was moist, particularly early in the morning.

At each site, suction samples were the product of 2 x 30 seconds of suction, and bulk samples consisted of 3 litres of vegetation cut into or very close to the ground. Further details of these methods are given in Willing (2025: p.10-11).

The survey by Harper (2014) was conducted primarily with a suction sampler, supplemented with other methods. The conventional method for surveying *V. angustior* in South Wales has been by bulk sampling, i.e. collecting, drying and sieving a set volume of vegetation. Both methods allow a basic quantification of sampling effort, as suction time or volume of vegetation sieved.

There has been no direct and quantified comparison of these methods until the recent surveys for *V. angustior* at Oxwich NNR (Willing, 2024) and at Pendine Burrows MoD (Willing, 2025). To maximise comparability, the present Pembrey survey was designed to use the same suction and bulk sampling methods as with the Oxwich and Pendine surveys, and was undertaken in September, the same time of year. It applies both methods consistently which may provide a more useful baseline for future monitoring than the highly variable sampling effort of Harper (2014).

Sites visited on 26th and 29th September 2025 were assigned, where possible, to a National Vegetation Classification (NVC) category, and the dominant plant species identified, by Matt Sutton (Wyndrush Wild) (Appendix 1). The habitat at all sites was photographed from two viewpoints (Appendix 2).

The tidal flotsam samples (sites H 10C and H 24A) consisted of large (8 litre) bags of loose vegetation gathered by hand over a length of shoreline around 50 metres long. This was dried, sieved and processed as for the other bulk vegetation samples.

3. Results

17 sites were sampled by bulk and suction methods, and two by taking flotsam samples, making 19 sites in all. A total of 1,995 terrestrial mollusc specimens were found, representing 33 terrestrial mollusc species (Table 2; full data in Appendix 3). A mean of 105 individuals per site (maximum = 345, minimum = 12) and of 8 species per site (maximum = 15, minimum = 1) were found when all methods were combined. The survey added five terrestrial mollusc species to the list in Harper (2014). Of these, *Zonitoides nitidus* (found at four sites) and *Paralaoma servilis* (one site) are notable. A total of five aquatic mollusc species was found, chiefly *Aplexa hypnorum* and *Galba truncatula*, which indicate seasonal flooding at some sites.

V. angustior was found at only three sites, all in the northern, Pembrey Aerial Weapons Range part of the area. These are all in tall, herb-rich grassland unshaded by trees, and lacking molluscs that indicate seasonal flooding. At two of these sites, *V. angustior* was

represented by numerous live adults and juveniles (R 5, 124 individuals; R 6, 27 individuals), while at the third it was represented only by an old, empty shell (H 8G, one individual).

No *V. angustior* were found at the sites surveyed in the southern, Pembrey Forest (NRW) part of the area, including the marshy grazing area to the east (H 2C). Nor was it found in the two flotsam samples (H10 C and H 24A) taken to replicate those of Harper (2014). As a result, *V. angustior* can be said to have been found only at one of the "five locations" from which it was reported by Harper (2014). This is site H 8G in the MoD area. While *V. angustior* is numerous at the nearby sites R 5 and R 6, it was not found at sites H 8D, H 8E, and H 8F along the border between the MoD and NRW parts of the land. The results therefore suggest a strong northward contraction in the area occupied by *V. angustior* relative to that found in Harper (2014).

Two of the three other *Vertigo* species recorded by Harper (2014) were found in large numbers. *Vertigo pygmaea* was widespread and occurred at seven sites, in both the MoD and NRW parts of the area. *Vertigo antivertigo* was present at four sites, two of which it shares with *V. angustior*. Harper (2014) reported very similar patterns for *V. pygmaea* and *V. antivertigo*. The final species, *Vertigo substriata*, was not found despite surveying both sites at which it was previously recorded (H 27 and H 28; Harper, 2014). It formerly shared site H 27 with *V. angustior*, which also appears to have been lost from this now very over-grown site.

The species found at each site by suction and bulk methods were broadly similar. In total, suction samples yielded nearly four times as many specimens as bulk sampling (1,586 : 397). Suction sampling found 32 species, while bulk sampling found 28; six species were found only by suction sampling and one by bulk sampling. Suction sampling yielded 0.7 times as many *V. angustior* specimens as did bulk sampling (64 : 88), but 5.7 times as many *V. antivertigo* (155 : 27) and 28.3 times as many *V. pygmaea* (85 : 3). The single *V. angustior* shell at site H 8G was found by bulk sampling. These results confirm that suction sampling is effective at finding *V. angustior*, but less so than it is for the other two *Vertigo* species (and many other snails).

4. Discussion

4.1. Present status of *V. angustior* at Pembrey

The survey succeeded in detecting *V. angustior* at three sites, all in the northern, Pembrey Sands (MoD) part of the area. These are all in tall, herb-rich marshy grassland unshaded by trees, and lacking molluscs that indicate seasonal flooding. These sites are near the point at which the most recent record of *V. angustior* at Pembrey was made (SN366049, 28 September 2016; Howe, 2020). The habitat at this site was described as a mature dune slack, which is very similar to that found at site R 6.

Suction and bulk sampling methods agreed closely, and small (<3mm) snails were recovered from all sites. They failed to detect *V. angustior* at all the remaining sites at which it was reported by Harper (2014), or other new sites added in this survey. It cannot be ruled out that seasonal or annual population fluctuations mean that *V. angustior* is still present at some or all of these, but at an undetectable level. Moorkens & Killeen (2011:

p.74) caution against false negatives of this kind. However, there is a strong possibility that it has died out at the formerly occupied sites, resulting in a strong northward contraction in the area occupied by *V. angustior* relative to that found in Harper (2014). Harper noted that the abundance of *V. angustior* had already fallen or "crashed" at most of its sites in the Forest between 2006 and 2014, with some sites in the later survey yielding only empty shells (Harper, 2014: p. 18-21). The failure to detect *V. angustior* at any site in the Forest in 2025 may therefore be symptomatic of a sustained decline over the last 20 years, regardless of annual fluctuations.

This is likely caused by an ongoing decline in the suitability of habitats in the Forest for *V. angustior*. The occupied sites in the MoD area are strikingly different to the formerly occupied sites in the NRW area. Most of those in the NRW area are now shaded or at least strongly influenced by mature Corsican Pine, and are either dry dunes or rather dense scrub. These habitats are unlike those usually cited as suitable for *V. angustior* (e.g. as summarised in Harper, 2014; Willing, 2025; Moorkens & Killeen, 2011 etc.). Comparing the photographs from 2012-2013 in Harper (2014) with those taken in 2025 (Appendix 2) suggests that the differences have become stronger over the years between surveys. It is possible that changes in the water table have also had an influence. The same factors may also account for the apparent loss of *V. substriata* from sites H 27 and H 28, the only sites from which this *Vertigo* species was reported by Harper (2014). *Vertigo substriata* is however considered slightly more tolerant of woodland than *V. angustior* and so is more likely still to occur elsewhere in the Forest.

4.2. Management recommendations

The long, herb-rich damp grassland at sites R 5 and R 6 in the MoD part of Pembrey is evidently highly suitable for *V. angustior*. The habitat resembles the classic vegetation type in which it is found at Whiteford Burrows NNR and Oxwich NNR (Willing, 2024). Occasional flooding of the area may aid local dispersal of the snail. These habitats are kept open while the area is used as an air weapons range. Other than ensuring that the growth of scrub in these areas is kept in check, no management recommendations are made.

As noted by Harper (2014), there are signs of scrub growth at Site H 8F, on the NRW side of the fence adjoining the MoD land. *V. angustior* was not found at this site or those on the MoD side of the fence (H 8D, H 8E), so may have been lost from the area. Harper (2014) recommended mechanical clearance or fencing and grazing on the NRW side to maintain open areas. However, scrub encroachment may not be the sole explanation, as there is less scrub on the MoD side. The extent of winter flooding, as indicated by amphibious and aquatic snail species, likely limits the area occupied by *V. angustior* in this part of Pembrey.

Harper (2014: p. 21) considered the sites at which he found *V. angustior* in the Pembrey Forest (NRW) part of the area to be marginal for this species. They appear to be even more marginal in 2025, and most would be considered unlikely places to find *V. angustior* if it were not for past records. The conversion of the land to conifer plantation has doubtless caused a long-term decline in the suitability of Pembrey's dunes for *V. angustior*. For example, site H 28 seems to be too dry and scrubby for *V. angustior*, whereas site H 6E is woodland almost to the edges of the track. Most of the bulk and suction samples gathered were dominated by Corsican Pine needles, even when not directly under trees

(as at site H 1 J+L). Drifts of decay-resistant needles are unlikely to favour *V. angustior*, or indeed most other British mollusc species. The clearing at Site H 27 is now very overgrown by bramble and is surrounded by tall trees (compare the photos in Harper, 2014: Figs. 16-17 with Appendix 2).

Table 2. Molluscs found at Pembrey in 2025 by bulk, suction and flotsam sampling (all methods combined). Sites are as listed in Figure 1 and Table 1 and arranged roughly from north to south. Full data are given in Appendix 3.

-	H 10C (flotsam)	R 5	R 6	H 8G	H 24A (flotsam)	H 8D	H 8E	H 8F	H 6E	R 3	H 27	H 28i	H 28ii	H 11B	H 2C	H 1J+L	R 4	R 1	R 2	No. samples	No. inds.	Species found by method
Terrestrial molluscs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acanthinula aculeata	-	-	-	-	-	-	-	1	1	-	-	-	-	2	-	-	-	-	-	3	4	-
Aegopinella nitidula	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	2	-	-	-	2	5	-
Arianta arbustorum	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	1	Bulk only
Arion flagellus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	Suction only
Ashfordia granulata	-	-	-	2	-	-	2	-	-	-	1	-	-	1	-	2	-	18	-	7	26	Suction only
Carychium minimum	-	-	-	-	-	11	1	-	-	-	-	-	-	-	-	-	-	-	-	2	12	-
Cepaea nemoralis	1	18	3	1	-	37	6	3	1	-	13	6	14	2	5	2	1	1	6	16	138	-
Cochlicella acuta	-	-	-	-	-	-	-	-	-	3	-	-	-	8	-	-	-	1	-	3	12	-
Cochlicopa lubrica	-	1	3	6	-	1	2	2	36	-	1	4	1	11	148	39	4	7	1	16	285	-
Columella aspera	-	-	-	4	-	-	-	16	167	-	-	-	1	1	-	7	-	-	-	7	232	-
Cornu aspersum	1	-	-	-	-	5	1	1	-	1	3	-	-	4	-	1	-	-	1	8	18	-
Deroceras sp. (slug plate)	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	4	-	-	-	3	6	Suction only
Euconulus alderi	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-	-	-	-	-	3	8	-
Lauria cylindracea	-	-	-	-	-	-	-	-	-	6	-	-	-	1	-	2	-	-	-	3	9	-
Monacha cantiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	6	3	11	Suction only
Nesovitrea hammonis	-	-	-	-	-	-	-	-	2	-	3	-	-	1	1	-	-	-	-	4	7	-
Oxychilus alliarius	-	1	-	2	-	-	-	-	1	2	-	1	-	1	-	5	1	-	1	7	15	-
Oxychilus cellarius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	2	8	-
Paralaoma servilis	-	-	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	54	Suction only
Punctum pygmaeum	-	-	-	-	-	-	1	-	2	-	-	-	-	1	-	-	-	-	-	3	4	-
Pupilla muscorum	8	-	49	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	59	-
Oxyloma elegans	-	1	14	4	-	22	3	-	-	-	-	-	-	23	-	1	-	1	136	9	214	-
Trochulus hispidus	-	-	-	2	-	-	-	-	1	-	8	2	-	-	11	22	-	3	5	8	54	-
Trochulus striolatus	-	-	-	-	-	-	96	-	-	-	-	-	-	-	-	-	-	-	-	2	96	-
Vallonia costata	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	2	13	-
Vallonia pulchella	-	8	17	2	1	-	6	-	-	-	4	1	-	-	2	-	-	-	-	6	41	-
Vertigo angustior	-	124	27	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	152	-
Vertigo antivertigo	-	93	89	-	-	13	1	-	-	-	-	-	-	-	-	-	-	-	-	4	196	-
Vertigo pygmaea	-	-	63	25	-	-	-	2	6	-	6	-	-	-	3	2	-	-	-	7	107	-
Vitrea contracta	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	1	Suction only
Vitrina pellucida	-	-	1	-	-	-	-	-	-	6	-	-	-	4	-	-	-	-	-	3	11	-
Xeroplexa intersecta	2	-	25	-	-	-	-	-	-	18	1	-	-	28	-	-	32	-	-	6	106	-
Zonitoides nitidus	-	-	-	1	-	77	1	1	-	-	-	-	-	-	-	-	-	-	-	3	89	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total individuals	**12**	**255**	**345**	**95**	**1**	**166**	**131**	**28**	**224**	**36**	**51**	**18**	**16**	**11**	**17**	**94**	**38**	**57**	**157**	105	**1,995**	-
Species richness	**4**	**7**	**11**	**11**	**1**	**7**	**12**	**8**	**11**	**6**	**11**	**8**	**3**	**15**	**6**	**13**	**4**	**7**	**8**	8	**33**	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquatic molluscs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aplexa hypnorum	-	-	-	-	-	**19**	**1**	**11**	-	-	-	-	-	-	-	-	-	-	-	8	62	-
Galba truncatula	-	-	-	-	-	**23**	**2**	-	-	-	-	-	-	-	-	-	-	-	**18**	7	68	-
Peringia ulvae	-	-	-	-	**1**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10	Flotsam only
Myostella myosotis	-	-	-	-	**11**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	101	Flotsam only
Pisidiidae (bivalve)	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total individuals	0	**0**	**0**	**0**	##	**44**	**3**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	-	**245**	-

Vegetation clearance to restore and maintain open sites would therefore seem vital to prevent the loss of *V. angustior* (and possibly *V. substriata*) from the Forest. Opportunities are already being taken at Pembrey to maintain open woodland rides in the forest that favour butterflies, their larval foodplants and nectar sources. Similar interventions could also be effective for *V. angustior*, especially if created at the edges of areas with a high water table. However, several such areas were investigated by Harper (2014) without yielding this species, so it may not be sufficiently widespread in the forest for all such efforts to have an impact. Perhaps the priority should be to attempt restoration of the known site H 27, which had large numbers of live *V. angustior* and *V. substriata* in 2012-2013 (Harper, 2014). Given the small size of the clearing at H 27, this action could be relatively easy to take and evaluate, and its restoration could even involve other users of the Forest.

4.3. Other mollusc species

The rest of the Pembrey mollusc fauna is similar to that reported by Harper (2014) with five additional species found (*Arianta arbustorum, Arion flagellus, Cornu aspersum, Paralaoma servilis* and *Zonitoides nitidus*). It is likely that the first three large and common species were encountered by Harper (2014) but simply not mentioned.

The tiny non-native snail *P. servilis* was newly detected in this survey at a single sandy site (R 6). A similar phenomenon was noted during the *V. angustior* surveys of Oxwich (Willing, 2024) and Pendine (Willing, 2025). At Swansea*, P. servilis* is more widespread, occurring at six of seven dune sites (Willing, 2024), a pattern likely to become more common as the species spreads.

The appearance of numerous live *Z. nitidus* at four sites near the border fence between MoD and NRW areas is noteworthy because this species did not appear in Harper's (2014) list, even among the aquatic molluscs. The sites in which it was found (H 8D, H8E and H8F) also have *Aplexa hypnorum* and *Galba truncatula*, likely indicating annual conditions too wet for *V. angustior*. In addition, *Z. nitidus* is a well-known predator of smaller snails, preying seasonally upon terrestrial species including *G. truncatula*, *Vallonia pulchella* and *Cochlicopa lubrica* as waterlines fluctuate (Barker & Efford, 2004: p.314-315). It is possible that *Z. nitidus* also preys upon *Vertigo* species and even presents a threat to them at a very local scale.

4.4. Considerations for future surveys

Future monitoring of *V. angustior* at Pembrey should involve checking for its continued presence in the MoD area and perhaps in areas from which it was formerly recorded in the NRW area. Revisiting former sites is clearly important if their management regime is changed, especially if this is intended to improve them for *V. angustior*.

Suction or bulk samples taken in September, using the present standardised effort (2 x 30 s suction / 3 L volume), and at the sites described here, will allow maximum comparability with the present survey and those done recently on Gower and Pendine (Willing, 2024, 2025).

The crucial metric for *V. angustior* monitoring is its presence at specified sites given a specified level of effort. The relative abundance of *V. angustior* influences the likelihood of detection, but in itself is difficult to interpret so is arguably far less important. Several

workers have suggested that populations of *V. angustior* may fluctuate markedly from year to year, in ways that could easily vary across large tracts of land like Pembrey (e.g. Moorkens & Kileen, 2011; Harper, 2014; Willing, 2023). Similarly the abundance of other mollusc species in the surveys is likely to fluctuate, especially for short-lived species with high reproductive potential. Abundance data are unlikely to influence decisions affecting management for *V. angustior*, yet obtaining them accounts for a substantial amount of the time spent in the field, processing samples, and preparing reports.

Likewise, detailed data for all the other terrestrial mollusc species in areas occupied by *V. angustior* in South Wales (and for Pendine) are now available (Willing, 2024, 2025; this report). These give a detailed indication of the dune mollusc communities present, and those most likely to include *V. angustior*. However they have not revealed any other mollusc to be a wholly reliable indicator or proxy for the presence of *V. angustior* itself. For instance, It was realised early on that while *V. antivertigo* is often found living within a metre of *V. angustior*, the two species have quite different requirements at a microhabitat scale (Preece & Willing, 1984) meaning each is able to live in habitats that would be intolerable for the other.

It was shown by Harper (2014) and during recent surveys (Willing, 2024, 2025) that suction sampling is an effective way of detecting the presence of *V. angustior*. While *V. angustior* appears to be harder to detect by suction sampling than *V. pygmaea* or *V. antivertigo*, a 2 x 30-second sample is only slightly less effective at detecting it than a 3 litre bulk sample (Table 2). Harper (2014: p. 17) discussed the problem of comparing inconsistently-sized suction and bulk samples and acknowledged that abundance or density estimates are of little use when this is the case. The 2025 results suggest that had Harper's survey used primarily bulk sampling rather than suction sampling, the results in terms of site presence / absence would have been similar. The present survey therefore offers a *V. angustior* dataset from Pembrey directly comparable to Harper (2014) and those conducted in other areas in South Wales (Willing, 2023, 2024, 2025).

Moreover, suction sampling has a number of practical advantages over bulk sampling. In dry weather, samples can readily be checked in the field to confirm the presence of *V. angustior*, potentially moving on as soon as at least one live individual is found. This is less intrusive than bulk sampling as no vegetation is removed and all live invertebrates (minus any voucher specimens) can be safely returned to the habitat. Alternatively, if samples need to be dealt with in full, the smaller volumes collected require less drying and sieving than bulk samples and can be processed more quickly.

As *V. angustior* is the only species needing to be identified in the sample residues, reporting all mollusc species (and especially their abundances) during monitoring is of secondary importance. Monitoring *V. angustior* using the suction sampling method is therefore potentially less intrusive, less labour-intensive, and less expensive, meaning it can potentially be applied at a) more sample sites and/or b) more frequent intervals.

5. Acknowledgements

I thank Matt Sutton (Wyndrush Wild) for the botanical work and transport, Elizabeth Pearce (MoD) and Hannah Shaw (NRW) for site access and background, and James Roseblade (NRW) for key hire. Tawny Clark and Clare Dinham (Buglife) and Matt Cooke (ARC Trust) provided further background on Pembrey. I thank Martin Willing for useful field training and experience during the *V. angustior* surveys at Whiteford, Oxwich and Pendine, 2021-2024.

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Appendix 1. Botanical details of sites, arranged roughly from North to South

Site R 5
NVC category: transitional brackish vegetation over varied topography - SM18 saltmarsh runnels (with M28? Tall-herb fen element), grading to dry *Festuca rubra* dominated grassland
Dominants: *Juncus maritimus*
Locally-Frequent to Abundant: *Mentha aquatica, Agrostis stolonifera, Potentilla anserina, Oenanthe crocata, Eupatorium cannabinum, Pulicaria dysenterica, Angelica sylvestris, Lycopus europaeus, Senecio aquaticus, Oenanthe lachenalii, Glaux maritima, Lychnis flos-cuculi, Carex otrubae, Iris pseudacorus*
Rare to Occasional: *Juncus acutus, Leymus arenarius, Lotus pedunculatus, Hippophae rhamnoides, Carex distans, Holcus lanatus, Festuca rubra*

Site R 6
NVC category: brackish 'slack' with no NVC equivalent - elements of MG11 and SM16, with SD8b edge
Dominants: *Juncus acutiflorus, Agrostis stolonifera, Potentilla anserina*
Locally-Frequent to Abundant: *Lythrum salicaria, Samolus valerandi, Juncus gerardiii, Salix repens, Glaux maritima, Eleocharis palustris*
Rare to Occasional: *Carex distans, Juncus maritimus, Trifolium fragiferum, Carex otrubae, Salix cinerea seedlings, Juncus articulatus, Bolboschoenus maritimus, Mentha aquatica, Elytrigia atherica, Senecio erucifolius. Festuca rubra, Carex arenaria, Didymodon tophaceus*

Site H 8G
NVC category: transitional vegetation with affinities to SD16 and M27
Dominants: *Agrostis stolonifera / Festuca rubra (mown strip); Filipendula ulmaria / Eupatorium cannabinum / Salix repens (unmown area)*
Locally-Frequent to Abundant: mown*: Juncus maritimus, Potentilla anserina, Succisa pratensis, Carex flacca;* unmown*: Pulicaria dysenterica, Rubus caesius, Equisetum arvense*
Rare to Occasional: *Lotus pedunculatus, Equisetum palustre, Senecio erucifolius, Dactylorhiza praetermissa, Juncus acutus, Holcus lanatus, Plantago lanceolata, Centaurea nigra, Angelica sylvestris, Carex arenaria, Lathyrus pratensis*
Comments: fence-side strip partly mown on an occasional basis

Site H 8D
NVC category: affinities to SD15
Dominants: *Phalaris arundinacea, Salix repens*
Locally-Frequent to Abundant: *Juncus subnodulosus, Filipendula ulmaria, Rubus caesius, Drepanocladus aduncus, Carex disticha, Hydrocotyle vulgaris, Lythrum salicaria*
Rare to Occasional: *Iris pseudacorus, Agrostis stolonifera, Potentilla anserina, Calystegia sepium, Kandea elodes, Calliergon cuspidatum*

Site H 8E
NVC category: SD15 / M27 - SD9 transition

Dominants: *Filipendula ulmaria, Iris pseudacorus, Rubus caesius*
Locally-Frequent to Abundant: *Calliergon cuspidatum*
Rare to Occasional: *Homalothecium lutescens, Carex arenaria, Dactylis glomerata, Arrhenatherum elatius, Festuca arundinacea, Cirsium arvense, Salix cinerea, Plantago lanceolata, Crataegus monogyna, Valeriana officinalis, Pulicaria dysenterica, Phalaris arundinacea*

Site H 8F
NVC category: cleared plantation with no NVC equivalent
Dominants:
Locally-Frequent to Abundant: *Crataegus monogyna, Salix cinerea, Calliergonella cuspidatum, Salix repens, Carex arenaria, Hydrocotyle vulgaris*
Rare to Occasional: *Rubus caesius, Carex flacca, Mentha aquatica, Eupatorium cannabinum, Jacobaea erucifolia, Prunella vulgaris, Galium palustre, Fragaria vesca, Kandea elodes*
Comments: some piles of rotten pine brash

Site R 3
NVC category: SD7
Dominants: *Festuca rubra*
Locally-Frequent to Abundant: *Thinopyrum junceum, Rubus caesius, Clematis vitalba, Plantago lanceolata, Jacobaea vulgaris, Carex arenaria*
Rare to Occasional: *Iris foetidissima, Achillea millefolium, Ammophila arenaria, Oenothera sp, Pastinaca sativa, Hypochoeris radicata, Hippophae rhamnoides*

Site H 6E
NVC category: track edge vegetation with no clear NVC equivalent
Dominants: *Phragmites australis, Agrostis stolonifera*
Locally-Frequent to Abundant: *Filipendula ulmaria*
Rare to Occasional: *Lathryus pratensis, Rubus caesius, Salix cinerea, Ranunuculus acris, Rhinanthus minor, Lythrum salicaria, Plantago lanceolata*
Comments: young *Salix cinerea* and *Alnus glutinosa*; winter-wet track section here has *Sagina nodosa*

Site H 27
NVC category: SD9a
Dominants: *Salix repens, Rubus caesius*
Locally-Frequent to Abundant: *Rosa pimpinellifolia*
Rare to Occasional: *Centaurea nigra, Arrhenatherum elatius, Heracleum sphondylium, Holcus lanatus*

Site H 28i
NVC category: SD9a
Dominants: *Salix repens, Rubus caesius, Rosa pimpinellifolia*
Locally-Frequent to Abundant: *Festuca rubra, Arrhenatherum elatius, Dactylis glomerata, Agrostis stolonifera, Poa pratensis, Pseudoscleropodium purum*
Rare to Occasional: *Plantago lanceolata, Galium verum, Vicia sativa, Urtica dioica, Ammophila arenaria, Cytisus scoparius, Silene dioica, Heracleum sphondylium*

Site H 28ii
NVC category: SD9a
Dominants: *Rubus caesius*
Locally-Frequent to Abundant: *Salix repens, Arrhenatherum elatius, Dactylis glomerata, Festuca rubra, Ervilia hirsuta , Pseudoscleropodium purum*
Rare to Occasional: *Carex disticha, Lotus corniculatus, Rosa pimpinellifolia, Poa pratensis, Agrostis capillaris, Agrimonia eupatoria, Carex flacca, Lathyrus pratensis, Pastinaca sativa*

Site H 2C
NVC category: MG10b/c and M23a
Dominants: *Trifolium repens, Holcus lanatus*
Locally-Frequent to Abundant: *Agrostis stolonifera, Carex leporina, Ranunculus repens, Juncus inflexus, Juncus effusus, Equisetum palustre, Cardamine pratensis, Persicaria hydropiper, Calliergonella cuspidata*
Rare to Occasional: *Festuca arundinacea, Lotus pedunculatus, Iris pseudacorus, Filipendula ulmaria, Carex disticha*
Comments: shallow wetter hollow is M23a with *Agrostis stolonifera, Ranuculus flammula, Mentha aquatica, Juncus cf acutiflorus, Lythrum salicarea, Senecio aquaticus, Juncus bulbosus*

Site H 1J+L
NVC category: MG1e
Dominants: *Arrhenatherum elatius, Dactylis glomerata, Agrostis stolonifera*
Locally-Frequent to Abundant: *Vicia cracca, Eupatorium cannabinum, Festuca arundinacea, Centaurea nigra, Melilotus officinalis, Festuca rubra, Lathyrus pratensis, Equisetum pratense, Rubus caesius, Plantago lanceolata, Achillea millefolium*
Rare to Occasional: *Heracleum sphondylium, Agrimonia eupatorium, Scrophularia nodosa, Juncus effusus, Odontites verna, Linum bienne, Oenothera cambrica, Equisetum x robertsii* (first record for VC44)

Site R4
NVC category: SD8b
Dominants: *Festuca rubra*
Locally-Frequent to Abundant: *Salix cinerea, Quercus sp. sapling, Ilex aquifolium sapling, Agrostis capillaris, Carex arenaria, Elytrigia arenaria, Ammophila arenaria, Pseudoscleropodium purum, Plantago lanceolata, Potentilla sterilis, Dactylis glomerata, Anthoxanthum odoratum, Lotus corniculatus, Vicia sativa, Rubus caesius, Ononis repens, Vicia sativa, Poa pratensis, Luzula campestris, Hypochoeris radicata, Rosa pimpinellifolia, Vicia cracca, Chamerion angustifolium*
Rare to Occasional: *Agrostis stolonifera, Calliergonella cuspidata, Lophocolea bidentata, Thuidium tamariscinum*

Appendix 2. Photographs of sites, arranged roughly from North to South




Site H 10C. “Flotsam at flood level” in Harper (2014). 29th September 2025




Site R 5. Marsh/saltmarsh transition. Numerous *Vertigo angustior* present. 29th September 2025




Site R 6. Dune slack. Numerous *Vertigo angustior* present. 29th September 2025




Site H 8G. “Grassland/fen” in Harper (2014). 1 empty shell of *Vertigo angustior* present. 29th September 2025




Site H 24A. “Flotsam on grazed turf at saltmarsh edge” in Harper (2014). 29th September 2025




Site H 8D. “Fen (winter flooded)” in Harper (2014). 29th September 2025




Site H 8E. “Rough grassland” in Harper (2014). 29th September 2025




Site H 8F. “Thick rough grassland” in Harper (2014). 26th September 2025




Site R 3. Hollow in stable dunes, without tree cover. 26th September 2025




Site H 6E. “Grassy verge by pond” in Harper (2014). 26th September 2025




Site H 27. “Marshy fen vegetation” in Harper (2014), but now overgrown. 29th September 2025




Site H 28i. “Lightly grazed dune grassland” in Harper (2014). 26th September 2025




Site H 28ii. “Lightly grazed dune grassland” in Harper (2014). 26th September 2025




Site H 11B. “Hollow under pine cover, 100 m from foredunes” in Harper (2014). The 2025 sample was taken to the west, beyond the tree cover. 7th August 2025




Site H 2C. “Marshy field” in Harper (2014). 26th September 2025




Site H 1J+L. “Grassy verge” and “grassy bank” in Harper (2014). 26th September 2025




Site R 4. Hollow in stable dunes, scattered tree cover. 26th September 2025




Site R 1. Marshy grassland. 7th August 2025




Site R 2. Marshy grassland. 7th August 2025

Appendix 3. Full mollusc data

-	H 10C	R 5	-	-	R 6	-	-	H 8G	-	-	H 24A	H 8D	-	-	H 8E	-	-	H 8F	-	-	H 6E	-	-	R 3	-	-	H 27	-	-	H 28i	-	-	H 28ii	-	-	H 11B	-	-	H 2C	-	-	H 1J +L	-	-	R 4	-	-	R 1	-	-	R 2	-	-	No. samples	No. inds.	Species found by method
-	flotsam	bulk	suction	total	bulk	suction	total	bulk	suction	total	flotsam	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	bulk	suction	total	-	-	-
Terrestrial molluscs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acanthinula aculeata	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	1	-	1	-	1	1	-	-	0	-	-	0	-	-	0	-	-	0	1	1	2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	4	-
Aegopinella nitidula	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	1	-	1	-	-	0	-	-	0	2	-	2	-	-	0	-	-	0	-	-	0	-	2	2	-	-	0	-	-	0	-	-	0	2	5	-
Arianta arbustorum	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1	1	Bulk only
Arion flagellus	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	1	1	2	1	Suction only
Ashfordia granulata	-	-	-	0	-	-	0	-	2	2	-	-	-	0	-	2	2	-	-	0	-	-	0	-	-	0	-	1	1	-	-	0	-	-	0	-	1	1	-	-	0	-	2	2	-	-	0	-	18	18	-	-	0	7	26	Suction only
Carychium minimum	-	-	-	0	-	-	0	-	-	0	-	5	6	11	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	12	-
Cepaea nemoralis	1	-	18	18	1	2	3	1	9	10	-	2	35	37	-	6	6	2	1	3	-	1	1	-	-	0	3	10	13	1	5	6	1	13	14	2	-	2	-	5	5	-	2	2	-	1	1	3	7	10	-	6	6	16	138	-
Cochlicella acuta	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	3	3	-	-	0	-	-	0	-	-	0	5	3	8	-	-	0	-	-	0	-	-	0	1	-	1	-	-	0	3	12	-
Cochlicopa lubrica	-	8	2	10	-	3	3	2	4	6	-	-	1	1	-	2	2	-	2	2	14	22	36	-	-	0	5	5	10	1	3	4	-	1	1	4	7	11	11	137	148	16	23	39	3	1	4	2	5	7	1	-	1	16	285	-
Columella aspera	-	-	-	0	-	-	0	3	37	40	-	-	-	0	-	-	0	1	15	16	5	162	167	-	-	0	-	-	0	-	-	0	-	1	1	-	1	1	-	-	0	-	7	7	-	-	0	-	-	0	-	-	0	7	232	-
Cornu aspersum	1	-	-	0	-	-	0	-	-	0	-	-	5	5	-	1	1	-	1	1	-	-	0	1	-	1	-	3	3	-	-	0	-	-	0	-	4	4	-	-	0	-	1	1	-	-	0	-	-	0	-	1	1	8	18	-
Deroceras sp. (slug plate)	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	2	2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	4	4	-	-	0	-	-	0	-	-	0	3	6	Suction only
Euconulus alderi	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	1	1	2	2	4	6	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	8	-
Lauria cylindracea	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	6	6	-	-	0	-	-	0	-	-	0	1	-	1	-	-	0	-	2	2	-	-	0	-	-	0	-	-	0	3	9	-
Monacha cantiana	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	5	5	-	-	0	-	-	0	-	6	6	3	11	Suction only
Nesovitrea hammonis	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	1	1	2	-	-	0	3	-	3	-	-	0	-	-	0	-	1	1	-	1	1	-	-	0	-	-	0	-	-	0	-	-	0	4	7	-
Oxychilus alliarius	-	1	-	1	-	-	0	1	1	2	-	-	-	0	-	-	0	-	-	0	1	-	1	1	1	2	-	-	0	-	1	1	-	-	0	-	1	1	-	-	0	1	4	5	-	1	1	-	-	0	1	-	1	7	15	-
Oxychilus cellarius	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	6	8	-	-	0	2	8	-
Paralaoma servilis	-	-	-	0	-	54	54	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	54	Suction only
Punctum pygmaeum	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	1	1	-	-	0	1	1	2	-	-	0	-	-	0	-	-	0	-	-	0	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	4	-
Pupilla muscorum	8	-	-	0	1	48	49	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1	-	1	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	59	-
Oxyloma elegans	-	-	1	1	2	12	14	-	4	4	-	1	21	22	-	3	3	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	23	23	-	-	0	1	-	1	-	-	0	1	9	10	8	128	136	9	214	-
Trochulus hispidus	-	-	-	0	-	-	0	-	2	2	-	-	-	0	-	-	0	-	-	0	-	1	1	-	-	0	2	6	8	2	-	2	-	-	0	-	-	0	-	11	11	2	20	22	-	-	0	2	1	3	-	5	5	8	54	-
Trochulus striolatus	-	-	-	0	-	-	0	-	-	0	-	-	-	0	13	83	96	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	96	-
Vallonia costata	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	5	8	13	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	13	-
Vallonia pulchella	-	6	2	8	5	12	17	2	-	2	1	-	-	0	4	2	6	-	-	0	-	-	0	-	-	0	2	2	4	1	-	1	-	-	0	-	-	0	1	1	2	-	-	0	-	-	0	-	-	0	-	-	0	6	41	-
Vertigo angustior	-	80	44	124	7	20	27	1	-	1	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	152	-
Vertigo antivertigo	-	16	77	93	11	78	89	-	-	0	-	3	10	13	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	4	196	-
Vertigo pygmaea	-	-	-	0	2	61	63	1	24	25	-	-	-	0	-	-	0	-	2	2	1	5	6	-	-	0	4	2	6	-	-	0	-	-	0	-	-	0	3	-	3	1	1	2	-	-	0	-	-	0	-	-	0	7	107	-
Vitrea contracta	-	-	-	0	-	-	0	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	1	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	2	1	Suction only
Vitrina pellucida	-	-	-	0	1	-	1	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	3	3	6	-	-	0	-	-	0	-	-	0	2	2	4	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	11	-
Xeroplexa intersecta	2	-	-	0	-	25	25	-	-	0	-	-	-	0	-	-	0	-	-	0	-	-	0	2	16	18	-	1	1	-	-	0	-	-	0	18	10	28	-	-	0	-	-	0	24	8	32	-	-	0	-	-	0	6	106	-
Zonitoides nitidus	-	-	-	0	-	-	0	1	-	1	-	15	62	77	7	3	10	1	-	1	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	89	-
Total individuals	12	111	144	255	30	315	345	12	83	95	1	26	140	166	26	105	131	6	22	28	26	198	224	7	29	36	21	30	51	8	10	18	1	15	16	39	62	101	15	155	170	21	73	94	27	11	38	11	46	57	10	147	157	105	1,995	-
Species richness	4	5	6	7	8	10	11	8	8	11	1	5	7	7	5	10	12	5	6	8	8	9	11	4	5	6	8	8	11	6	4	8	1	3	3	9	12	15	3	5	6	5	12	13	2	4	4	6	6	7	3	6	8	-	33	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquatic molluscs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aplexa hypnorum	-	-	-	0	-	-	0	-	-	0	-	15	4	19	-	1	1	10	1	11	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	8	62	-
Galba truncatula	-	-	-	0	-	-	0	-	-	0	-	8	15	23	1	1	2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	18	18	7	68	-
Peringia ulvae	-	-	-	0	-	-	0	-	-	0	10	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1	10	Flotsam only
Myostella myosotis	-	-	-	0	-	-	0	-	-	0	101	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	1	101	Flotsam only
Pisidiidae (bivalve)	-	-	-	0	-	-	0	-	-	0	-	1	1	2	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	-	-	0	3	4	-
Total individuals	0	0	0	0	0	0	0	0	0	0	111	24	20	44	1	2	3	10	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	-	245	-

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 are held in the Welsh Invertebrate Database (WID).

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no. **NRW_DS161647**.

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