



**Cyfoeth  
Naturiol**  
Cymru  
**Natural  
Resources**  
Wales

# Surveillance of the narrow-mouthed whorl snail *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC

John Harper

Evidence Report No. 10

## About Natural Resources Wales

Natural Resources Wales is the organisation responsible for the work carried out by the three former organisations, the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales. It is also responsible for some functions previously undertaken by Welsh Government.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, used and enhanced, now and in the future.

We work for the communities of Wales to protect people and their homes as much as possible from environmental incidents like flooding and pollution. We provide opportunities for people to learn, use and benefit from Wales' natural resources.

We work to support Wales' economy by enabling the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions.

We work to maintain and improve the quality of the environment for everyone and we work towards making the environment and our natural resources more resilient to climate change and other pressures.

## Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

This Evidence Report series serves as a record of work carried out or commissioned by Natural Resources Wales. It also helps us to share and promote use of our evidence by others and develop future collaborations. However, the views and recommendations presented in this report are not necessarily those of NRW and should, therefore, not be attributed to NRW.

Report series: NRW Evidence Report  
Report number: 10  
Publication date: September 2014  
Contract number: EAS0677  
Contractor: J. Harper  
Contract Manager: A.P. Fowles  
Title: Surveillance of the narrow-mouthed whorl snail *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC  
Author(s): **J. Harper**  
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)**

Ruth Harding, Senior Conservation Officer, Carmarthenshire District, NRW  
Adrian Fowles, Senior Invertebrate Ecologist, NRW  
Karen Wilkinson, SAC Monitoring Ecologist

**Recommended citation for this volume:**

Harper, J. 2014. Surveillance of the narrow-mouthed whorl snail *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC. NRW Evidence Report No: 10, 54pp, Natural Resources Wales, Bangor

## Contents

1.	Crynodeb Gweithredol .....	1
2.	Executive Summary .....	2
3.	Introduction.....	3
4.	Methodology.....	3
5.	Site descriptions .....	4
5.1.	Pembrey Forest.....	4
5.2.	Local Nature Reserve .....	5
5.3.	RAF Pembrey Sands .....	5
5.4.	Maps .....	5
6.	Results.....	7
6.1.	Sampling locations.....	7
6.2.	Summary.....	17
7.	Conclusions .....	18
8.	Recommendations .....	21
9.	Acknowledgements .....	21
10.	References .....	22
11.	APPENDICES .....	23
11.1.	Site Photographs.....	23
11.2.	Sample details.....	30
11.3.	Mollusc species found during survey for <i>Vertigo angustior</i> , 2013-14.....	54

## List of Figures

Map 1:	Map of Pembrey Area with boundaries of SAC, SSSI, LNR.....	6
Map 2:	Pembrey Area .....	7
Map 3:	Sites 1-3, Pembrey Forest .....	9
Map 4:	Site 8 - detail around sampling spots .....	12
Fig. 1:	Site 1J, 17.12.2013 - Trackside (looking NNW) .....	23
Fig. 2:	Site 1L, 17.12.2013 - Bank (looking NW) .....	23
Fig. 3:	Site 6E, 13.11.2013 - Pond Edge (looking SE) .....	24
Fig. 4:	Site 8D & 8E, 11.1.2014 - Bomb Alley, range side of fence (looking NE) .....	24
Fig. 5:	Site 8F, 11.1.2014 - Bomb Alley, forest side of fence (looking NE).....	24
Fig. 6:	Site 8, 11.1.2014 - Bomb Alley, fen willow carr near "target" (looking SE).....	25
Fig. 7:	Site 8, 11.1.2014 - Bomb Alley, bulldozed 2013 (looking SSE from near 'target') .....	25
Fig. 8:	Sites 08-1-AB in 2006 - Bomb Alley, low growth of carr/scrub (looking SE) .....	25
Fig. 9:	Site 08-3-B in 2006 - rich fen vegetation (looking S); target on left .....	26
Fig 10:	Site 9, 9.1.2014 - Grazed top of saltmarsh (looking WNW).....	26
Fig. 11:	Site 11B, 13.11.2013 - Flooded marshy path in forested slack (looking NW).....	26
Fig. 12:	Site 14A, 22.11.2013 - Country Park, Ski Slope Pond (looking SW).....	27

Fig. 13: Site 24A, 9.1.2014 - Flotsam deposited near top of Banc y Lord (looking NE) ..... 27  
 Fig. 14: Site 25 B, 30.11.2013 - LNR, back of saltmarsh/freshwater seepage (looking W) ... 27  
 Fig. 15: Site 25 C, 17.12.2013 - LNR, dense grassland behind saltmarsh (looking SW)..... 28  
 Fig. 16: Site 27A, 13.11.2013 - Forest Clearing, NE side (looking S)..... 28  
 Fig. 17: Site 27B, 13.11.2013 - Forest Clearing, NE side (looking S)..... 28  
 Fig. 18: Site 28A, 17.12.2013 - Rough Grazing on NE side of forest (looking NE) ..... 29

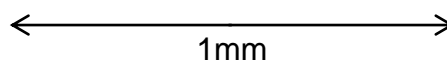
List of Tables

Table 1: Summary of Field Visits ..... 3  
 Table 2: Density of *Vertigo* species in samples where *Vertigo* spp. were recorded..... 18  
 Table 3: Comparison of *Vertigo* numbers between the two years 2012 & 2013 at Site 27 .... 19  
 Table 4: *Vertigo angustior* numbers in samples at Site 8 in 2006 and 2014 ..... 20



*Vertigo angustior*

*Vertigo substriata*



## 1. Crynodeb Gweithredol

Wedi darganfod y boblogaeth o'r falwen droellog geg gul *Vertigo angustior* yng Nghoedwig Pen-bre yn 2005 cynyddodd nifer y safleoedd ar gyfer y rhywogaeth hon yng Nghymru i dri. Yn flaenorol cafwyd hyd iddo yn Whiteford a Oxwich Burrows, y ddau ohonynt ar benrhyn Gŵyr. Cadarnhaodd yr arolwg yn 2006 (Harper 2007) presenoldeb y falwen brin mewn tri lleoliad yn y Goedwig a thir corsiog cyfagos a hefyd cofnodwyd nifer fechan o unigolion ymhellach i'r gogledd-orllewin ar draeth yr Awyrlu Brenhinol ym Mhen-bre.

Fe gynhaliwyd yr arolwg presennol yng nghanol y gaeaf a, er yn gymharol fwyn, fe fu yna lawiad trwm a hir cyn llawer o'r gwaith maes. Byddai hyn wedi effeithio ar y canlyniadau, yn enwedig gan fod ardaloedd mawr a allai fod yn gynefin addas wedi cael ei effeithio gan lifogydd, ar y pryd. Roedd sampl o froc môr o bwynt gogledd-orllewin traeth yr Awyrlu Brenhinol ym Mhen-bre yn cynnwys nifer eithriadol o falwod, a oedd yn ôl pob tebyg wedi cael eu golchi o'u cynefin addas rhywle arall ar y safle gan y llifogydd. Roedd y rhan fwyaf wedi cael eu llosgi, credir ei fod o ganlyniad i danau achoswyd gan fomiau ymarfer ar y Maes Tanio.

Fe ddarganfuwyd *V. angustior* mewn pum lleoliad gwahanol yn ystod yr arolygon yn 2013-14, pob un ohonynt wedi cael eu cofnodi o'r blaen. Datgelwyd nifer fechan unwaith eto bob ochr i'r ffens derfyn yng nghornel dde-ddwyreiniol Goedwig Pen-bre, ond dim ond dwy gragen wag a welwyd mewn trydedd ardal tuag at ben gogleddol y Goedwig. O'r wybodaeth bresennol, mae dwy ardal yn cynnal y rhan fwyaf o'r boblogaeth *angustior* ym Mhen-bre - llecyn llaith bach yng nghanol y Goedwig ger yr ymyl mewndirol a'r corstir a sefydlwyd mewn llaciai twyni hen, sy'n croesi'r rhan ogleddol o ffin y Goedwig a thraeth yr Awyrlu Brenhinol ym Mhen-bre. Dangosodd ymchwiliadau ar y ddau safle hyn, pa mor lleol gall crynhoad o falwod fod, gyda samplau a gymerwyd yn agos at ei gilydd yn cynhyrchu canlyniadau gwahanol iawn. Fodd bynnag, roedd arwyddion, fod y dwysedd uchaf yn digwydd mewn llystyfiant tal, trwchus. Daethpwyd o hyd i amrywiad yn y gymhareb o oedolion i'r ieuanc, yn y samplau. Gall hyn adlewyrchu deinameg y boblogaeth leol neu effaith llifogydd. Fodd bynnag, mae maint rhywogaethau poblogaeth *Vertigo* yn amrywio'n fawr yn flynyddol ac mae'r prif gyfnod magu yn newid yn sylweddol o flwyddyn i flwyddyn (Pokryszko 1990).

## 2. Executive Summary

The discovery of a population of the narrow-mouthed whorl snail *Vertigo angustior* in Pembrey Forest in 2005 increased the number of sites for this species in Wales to three. Previously it had been known from Whiteford and Oxwich Burrows, both of which are on the Gower peninsula. A survey in 2006 (Harper, 2007) confirmed the presence of this rare snail in three locations in the Forest and adjacent marshland and also recorded a small number of individuals further north-west on RAF Pembrey Sands.

The current survey was undertaken in mid-winter and, although relatively mild, there had been heavy and prolonged rainfall prior to much of the fieldwork. This will have had an affect on results, especially as large areas of potentially suitable habitat were flooded at this time. A flotsam sample from the north-western tip of RAF Pembrey Sands contained exceptional numbers of snails, presumably having been flooded out from suitable habitat elsewhere on the site. The majority of these had been burnt; thought to be the result of fires caused by practice bombs on the Range.

*V. angustior* was found at five separate locations during the surveys in 2013-14, all of which had been recorded previously. Small numbers of individuals were again detected either side of the boundary fence at the south-eastern corner of Pembrey Forest, but only two empty shells were found at a third locality towards the northern end of the Forest. On current knowledge, two areas support the majority of the *angustior* population at Pembrey – a small damp clearing in the middle of the Forest near the inland edge and the established fen in old dune slacks that straddles the northern Forest boundary and RAF Pembrey Sands. Investigations at both of these sites demonstrated how localised concentrations of the snail can be, with samples taken near to each other producing very different results. There were indications, however, that the highest densities occurred in tall, dense vegetation. Variation was also found in the ratio of adults to juveniles in the samples. This may reflect local population dynamics or the impact of flooding. However, *Vertigo* species are known to undergo large annual fluctuations in population size and the peak breeding period varies considerably from year to year (Pokryszko 1990).

### 3. Introduction

*Vertigo angustior* was originally discovered in Pembrey Forest on 18.8.2005 while using a G-vac, to sample for spiders primarily, along a 200m section of forest track at SN 406 013. A CCW contract in 2006 investigated the original site to assess the ecology of *V. angustior* there, and extended the search to identify other parts of Pembrey Forest and surrounding areas where the species existed or may exist. Where found the numbers and densities of the species were assessed. (Harper, 2007). In 2012 a spider sampling session by John Harper in a previously unexplored part of Pembrey Forest was found to contain a substantial density of *V. angustior* - matching that at Whiteford Burrows on the Gower - approx 500 per sq.m. at their densest.

Initially in 2013 the previously identified sites were sampled to re-assess presence or absence, numbers, and habitat condition. The new site identified in 2012, and two more sites nearby, were investigated further. A number of sites, previously identified in 2006 but not surveyed at the time because of bad weather, were also surveyed. Access to the RAF range was not possible until early January 2014.

Table 1: Summary of Field Visits

Date	Sites investigated (no sample)	Sites sampled	Other activity
13.11.2013	28	11, 6, 27	
22.11.2013	15	14, 27, 28	
30.11.2013		1, 25	
17.12.2013	12, 8 (bomb alley) from SE	25, 1	
9.1.2014	9 from Banc y Lord	24	RAF range briefing
11.1.2014		8, 10	B&B Pembrey
12.1.2014		2, 1, 29	

As the survey contract was arranged late in the year, during the winter months, weather was an all-important factor in the success of the survey; the vagaries of the weather had to be allowed for and conditions exploited when opportunities were presented.

### 4. Methodology

Whether initially finding *angustior* sites, or assessing their numbers and density, the method of choice was the G-vac suction sampler (a garden vacuum machine with a net in the intake tube) and it was used for most sampling as it is very suitable for sucking tiny invertebrates from a wide variety of dry habitats in a short time, whether it be very short grassland with herbs, long grassland or almost impenetrable low bramble cover with coarse grass. In practice, many of the habitats in the Forest were difficult (thick tangled grass and herbs, sometimes with fine interwoven bramble). The technique used was to poke the tube into the herbage and circle it around as far as the tangle would allow; the process was repeated as many as 16 times; then the area of each subsample was multiplied by the number to give a sampled area. Either: a) by moving to a different spot for each subsample a wide-ranging sample was taken



overall; or: b) an intense suck of a smaller measured area would give the density more thoroughly. The G-vac is much less effective in wet weather when minute invertebrates, such as *Vertigo* species, are held tightly by surface tension to the substrate. In addition vegetation litter is sucked up and forms a dense mat in the collecting tube, inhibiting suction (ref. Section 4.2.2 List of Sites - Site 27 description for discussion). These conditions were infuriatingly common during the field work period and strategies had to be adapted to cope - all of which prolonged the data collection phase considerably. One method was to empty the collecting tube frequently into a pillow case and take the sample home for drying and sorting.

From experience in 2006, it was found essential to vigorously shake and brush the collecting equipment and all creases in the fabric thoroughly. Essentially, if only one tiny juvenile *V. angustior* appeared in a sample it would be virtually impossible to be sure that it hadn't slipped through any but the most extreme cleansing, which is hardly possible in the field with any certainty.

At the first sampling session in 2013, at Site 27 (the productive site discovered in 2012), the initial results were very surprisingly poor. To investigate whether the snails were very low in the herbage mat or even in the top soil layer, a variety of methods was used such as cutting the dense foliage off with shears and bagging it, and digging out the top 2.5cm of soil. The resulting samples required considerable extra time and effort to process and were not repeated, except once at Site 1.

On one occasion on the bombing range on 11.1.2014, the sample site was flooded - up to a depth of nearly a metre; this was a site sampled in 2006 so a repeat sample was of value. The only way to do this was with a pond sieve (kitchen sieve on a long pole) that is usually carried as a back-up sampling method when required in flooded conditions. At two sites, 30L samples of flotsam were collected, dried and sorted. It was found in 2006 that a smaller sample volume (8L) contained too few shells to constitute a worthwhile sample; this proved to be the case with the first 30L sample from Banc y Lord in which there were few molluscs. Unfortunately, in the second case from Site 10, the opposite was true and much time was expended sorting out hundreds of shells; a much smaller sample would have sufficed.

The samples of small molluscs have been retained and will be deposited at the National Museum of Wales.

## 5. Site descriptions

### 5.1. Pembrey Forest

Most of the surveying in 2013 was taken up with assessing the snail's numbers and status at sites identified in 2006; the exception was Site 27 which was identified in 2012. The forest is mostly not designated as a statutorily protected area except the seaward fringe of the dunes (SSSI) and the tongue of SAC down "bomb alley" in the north-west of the forest. See Map 1.

## 5.2. Local Nature Reserve

While small areas were previously identified as potential *angustior* habitat, they were not surveyed until 2013, and then only a very small area was investigated where suitable habitat conditions were thought to exist. Elsewhere on the LNR it is not known if there is a juxtaposition of fresh water seepage and long grass mats. The two sites positive for *Vertigo antivertigo* and *V. pygmaea* are just on the boundaries of the statutorily protected areas which are indicated on Map 1. Since *Vertigo angustior* can be very locally distributed because of its habitat requirements, it is possible that it might be found nearby. The habitat has similarities to suitable sites on Oxwich Burrows.

## 5.3. RAF Pembrey Sands

The fen area, a north to south strip on the Range extending south into the forest area, has proved to be the most likely habitat for *angustior* and monitoring there was most important. Flotsam samples collected here help to understand the movement of snails - carried by circulating flood water during very high spring tides, aided by storm surges (as occurred on 3<sup>rd</sup> January 2014). It appears that the incoming tidal surge creates two circulations: a) one anticlockwise around the eastern half of the saltmarsh, depositing flotsam on Banc y Lord; and b) the other, probably incorporating fresh water, clockwise around the fen area, depositing flotsam on the spur of low dunes at Site 10.

## 5.4. Maps

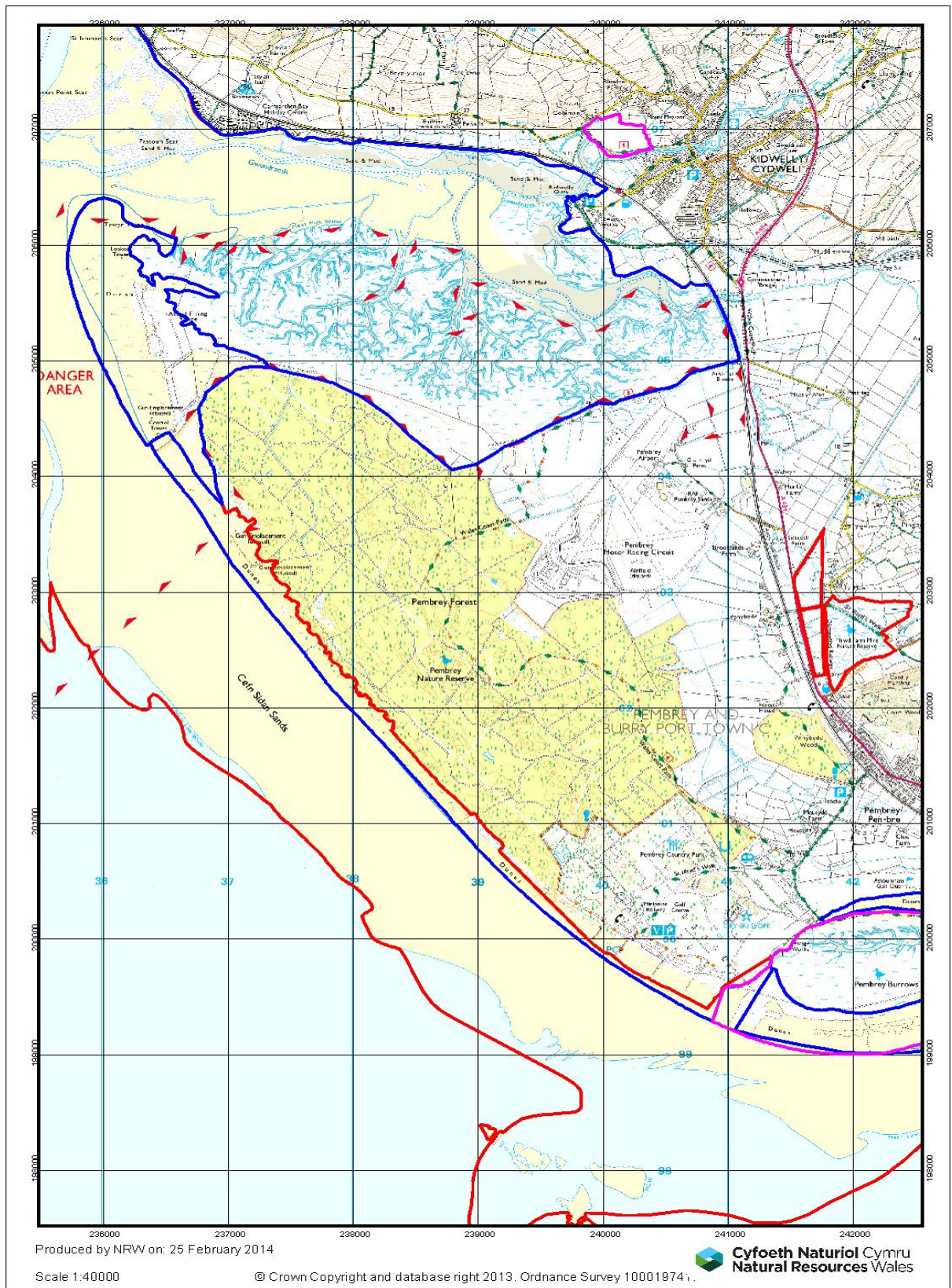
All the sites that were investigated or considered in 2006 are marked in red on Map 2 of the whole Pembrey Dunes area so that they can be located and their positions put into context in relation to each other, to the fen / marshy fields inland, to the saltmarshes, and to the RAF Pembrey Sands bombing range. Additional sites investigated in 2012/2013/2014 are also marked.

Since Sites 1 and 2 received concentrated attention and sampling, Map 3 details those sampling spots and their relationship. Site 3 was nearby so it was included on this map. The GPS used was a Garmin eTrex which, when it had stabilised, indicated an accuracy of plus or minus 5m. Map 3 gives the relative positions for sites that are close together.

Similarly, the sampling spots in Site 8, either side of the boundary fence between the forest and the range, are shown in Map 4. They are close together yet produced very different results so that their relationship, together with vegetation and edaphic factors, may help to explain the complex habitat preferences of *V. angustior*.

Map 1 shows the positions of statutory conservation areas that are relevant to the occurrence of *V. angustior* in the area.

Map 1: Map of Pembrey Area with boundaries of SAC, SSSI, LNR



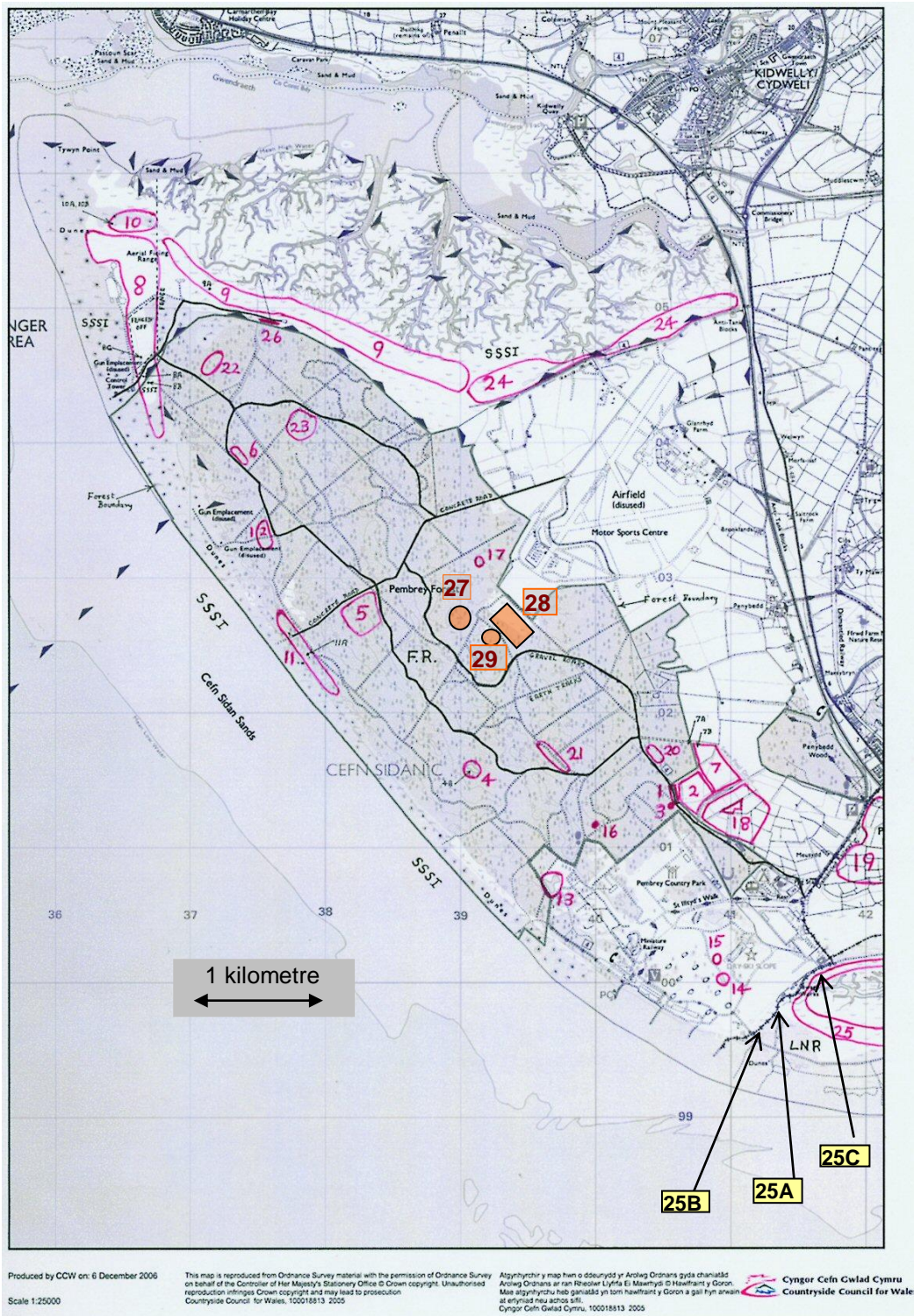
Boundaries: Blue = SAC (within the boundaries and seawards)  
 Red = SSSI (within the boundary, but the red line is obscured by blue)  
 Purple = LNR

## 6. Results

### 6.1. Sampling locations

Only those sites which are relevant to the monitoring of *V. angustior* in 2013/14 are described below; for details of other sites investigated in 2006, refer to Harper (2007).

Map 2: Pembrey Area



Site 01: Grassy Bank between Forest road and Marshy Fields (SN40610134 to SN40570147)

This site is a grassy bank alongside the forest road and dropping into a ditch in the marshy field / fen below. It was part of the 200m length of verge sampled in August 2005 when the first *Vertigo angustior* were found; since this particular section was next to marsh it seemed the most obvious place to start. On the road side, the bank is about 40cm high and 100cm wide; this is surmounted by the boundary fence before the bank drops steeply 1.8m into the ditch bottom. The grass and herbs on the forest side are generally 30cm high with *Rubus* and other coarse plants to 60cm. The general features can be seen in Fig. 2. On the steep slope on the field side the 1m grass and herbs droop and overhang the ditch.

In 2006 samples 1A, 1B, 1G provided the highest densities (17.5, 25.0 and 8.3 per sq.m.) of *V. angustior* of any found in the Forest, or anywhere in the Pembrey area for that matter. Six of the seven samples on the east bank (1A to 1G) in 2006 were positive for the species - densities ranging from 1.3 to 25.0 per square metre, the majority being live or fresh shells. However, in 2013 only three shells were found - all dead. This feature was observed in other sites and is discussed in the Conclusions.

A characteristic that this site has in common with Site 6 is that *V. angustior* was found in the very marginal grassy bank squeezed between the forest track and the marshy field or pond. Road grading in 2006 had restricted the narrow habitat and although the verge has grown wider again, a new problem seen in 2013 is that regular mowing of verges throughout the forest renders the sward too short for most invertebrates. *2006 photos: see Harper (2007). 2013 photos: Figs. 1 & 2 01J and 01L*

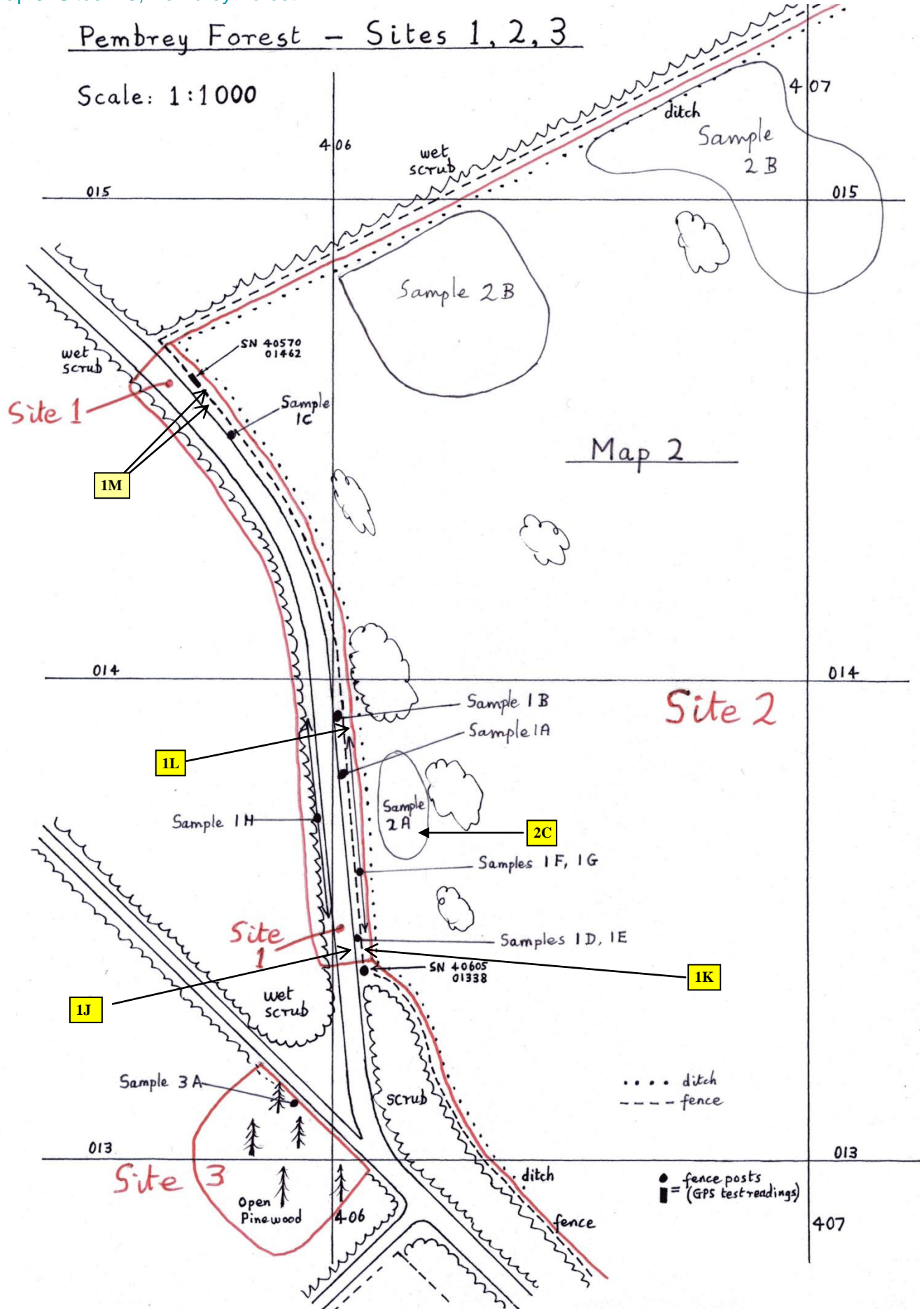
Site 02: Marshy Field outside the Forest boundary and to the East of Pembrey Forest (SN 40650150)

Site 2 is immediately adjacent to Site 1, the separation being taken as the ditch at the foot of the road bank. The ditch is an ecological boundary since the field is marshy with fen-like patches and grazed by cattle in the drier months, while the bank is higher, well-drained and relatively dry with long grass and brambles that the cattle do not seem to reach on the other side of the ditch. The marshy field produced very few *Vertigo angustior* compared to the bank in 2006 - sample densities of only 1.0 and 1.3 per sq. m. The 2013 sample produced only one dead shell - a general result similar to that in Site 1.

The appearance of the habitat seemed not to have changed much since seven years ago. Some minor drainage work has taken place, including recasting the ditch leading away from Sites 1 and 2, but apparently on a fairly minor scale so far. *2006 photos: see Harper (2007). None taken in 2013*

Site 03: Open Pine Forest, Eastern Corner of Pembrey Forest (SN40590132) (see Harper 2007)

Map 3: Sites 1-3, Pembrey Forest



Site 04: Water Lily Pond in the South of Pembrey Forest (SN391016) (see Harper, 2007)

Site 05: Large Slack by Concrete Road, Centre of Pembrey Forest (SN383029) (see Harper, 2007)

Site 06: *Phragmites*-filled Depression in NW of Pembrey Forest (SN373039)

On the north side of the forest road this 1.0m deep depression is entirely filled with *Phragmites*; it presumably provided material to build up the road through this swampy area as the depression is linear (approx. 80m x 25m) and parallel to the road. In the autumn of 2006 the depression was water-free, but it was deeply flooded in the 2013 winter.

Small numbers of *V. angustior*, all live, were found in 2006. A few were among roots and rhizomes on the floor of the pond, but about six were among sparse vegetation on the bank, although this had been narrowed by the recent passing of a grader. In 2013 the grassy verge had regrown but, in common with the rest of the forest roads, the edge was now mown regularly. The only *V. angustior* shells found were both dead, which mirrors the findings at other sites.

2006 photos: see Harper (2007).      2013 photo: Fig. 3. 06 E

Site 07: Old Reen and Marshy Field on edge of East Boundary of Forest (SN410013) (see Harper, 2007)

Site 08: Marshy Tract in RAF Pembrey and NW end of Forest (SN3604)

For some unaccountable reason, possibly a large mass of buried metal affecting the GPS, the grid reference of sample 8C in 2006 (Harper 2007) was wrongly recorded as SN32320463 - it should have been SN36630463, inside the fenced area, shown on Map 4.

In this survey, access to the bombing range could not be arranged until early January 2014, after the unprecedented flooding and tidal surge had inundated almost all the range. The effect of this upon the populations and distribution of *V. angustior* and other species of *Vertigo* was likely to be of great interest. It is now possible to drive to the disused gun emplacements, south of Site 8, and northwards; there is a newly reopened track running from the forest road through Site 12 on the map, thence northwards to bomb alley. However access is still easier from the range - with permission of course. Details of Site 8 areas and sampling spots can be seen on Map 4 below.

The tarmac road in the range is built on an embankment where it crosses low marshy areas (from range gate to western obs. tower). This effectively creates a barrier to tidal / storm surge flood water moving from the tidal marshes southwards down the SAC tongue along "bomb alley" or vice versa; thus these two areas would be isolated in respect of water dispersal of snails. However, due to a rising water table in winter, flooding lasts far longer on the tongue compared to the relatively swift flood surge on the north side of the road.

The fen area where samples 8A and 8B were taken (by G-vac) in 2006 was under water on 11.1.2014 so resort was made to a pond sieve to skim the water surface and vegetation for sample 8D. Similar numbers of *V. angustior* were obtained (compared to 2006) but the water was too deep near the fence and on the forest side for a full comparison; the totally different methods of sampling preclude a proper comparison anyway. Sample 8E from rough cut vegetation on the Range side of the fence similarly produced only one *V. angustior*, which accords with results from 2006 - ie. that *angustior* does not favour short vegetation. Conversely, 8F just over the fence on the forest side, from an area of long grass and herbs, produced 210 specimens from 1.0 sq.m. The proximity and similarity of the habitat, apart from the treatment of the vegetation, drives home the effect of condition and management of the herb layer. *V. angustior* seems overwhelmingly to favour long, dense, mixed vegetation for a thriving population to exist.

To extend sampling coverage to the north, the G-vac was used to obtain sample 8G in fairly long matted vegetation. A healthy population of 139 *angustior* per sq.m. was found - this is significant because it may suggest that there is a far larger area (only hinted at in 2006) where considerable numbers of *V. angustior* may be present. The significance starts to be appreciated when considering where the large number of dead shells of the species originate from in Sample 10C. Clearly, more extensive sampling in this habitat and area needs to be done to assess the overall importance of the range as an important site in Wales.

Compared to the comments on vegetation management in the 2007 report, there have been few changes on the Range apparently. The fenced area, north-east of the western obs. tower, appears not to have been grazed recently, as originally planned in 2006. Cattle appear to graze only to the east of the fence running north from near the Range gate. Generally, grassland near to the main bombing targets is managed by cutting or mowing to try to reduce the incidence and severity of fires; these areas are generally kept free from most scrub. This management extends southwards to the boundary fence and there has been little change here. However, there have been considerable changes in vegetation in the forest areas adjacent to the range fence and further south down bomb alley. Whereas in 2006 a large swathe of trees and scrub had been cleared on the forest side of the boundary fence for sighting purposes (perhaps as far as the eastern observation tower) and down the SAC tongue / "bomb alley" to the south (Fig. 8), by 2014 the scrub on the drier ground and willow carr on the wetter ground had regrown to be almost impenetrable (Figs. 5 & 6). This had shaded out much of the rich fen vegetation present in 2006 (Fig. 9) except for the persistent *Iris pseudacorus*. In autumn 2013 heavy machinery was used to clear an area (about 250m long by 100m wide) to the south of the guiding "target" in bomb alley / the SAC tongue (Fig. 7) so that pilots could now see it when approaching from the south.

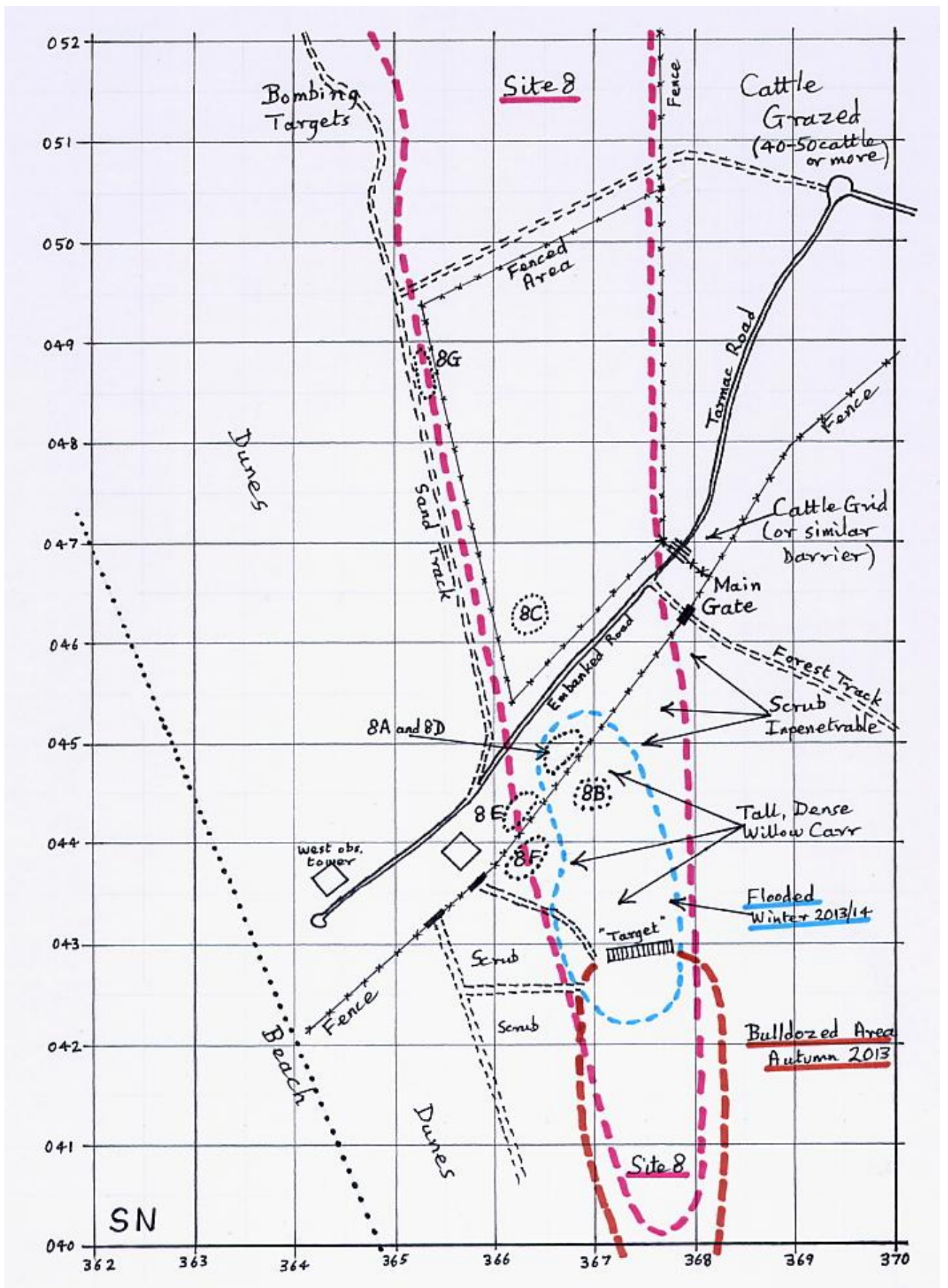
The rich fen vegetation to the south of the boundary fence, apart from closely adjacent to it, down bomb alley / the SAC tongue, was not investigated in 2006. In 2014 the presence of the thick scrub would have made sampling difficult; alternatively the decimation of the vegetation in the area bulldozed in 2013 would have made sampling pointless. However, investigation of the habitat during the next two or three years, as the fen regrows, would be valuable.

2006 photos: see Harper (2007) and Figs. 8 & 9.

2014 photos: Figs 4-7.



Map 4: Site 8 - detail around sampling spots



Site 09: Top Edge of Saltmarsh, RAF Pembrey Sands (SN380048)

Two fresh adult shells of *Vertigo angustior* were found in Sample Site 9A in 2006 but it is now considered most likely they were transported by very high tides from the nearby fen to the west. This extensive linear feature, about 100m wide, to the southeast consists mostly of sparse *Juncus* clumps in maritime grazing at the top edge of the saltmarsh, which appear quite unsuitable to harbour *Vertigo* species. To the northwest the strip includes the top edge of the saltmarsh and the grassland just above until it reaches a spur of sand dunes (Site 10). *Vertigo* species might occur here but it is likely they will have been translocated by extra high tides. The virtual lack of terrestrial molluscs in the flotsam sample from Banc y Lord supports this view - but see comments on Site 24.

No photos in 2006

2014 photo: Fig. 10

Site 10: Spur of Dune Hummocks in the NW of RAF Pembrey (SN36470563)

At the NW end of Site 8 a spur of dune hummocks extends NE into the saltmarsh from Cefn Sidan - the main dune system. At exceptionally high tides, water flooding the marshy area (Site 8) ebbs and deposits flotsam, including non-marine snails, on the projecting dune hummocks. There may be times when the marsh is already flooded with rainwater, which dilutes any salt water allowing non-marine snails to survive.

The survey occurred not long after the very high tide and storm surge of 3<sup>rd</sup> January 2014, when the fen area was flooded and draining water carried much flotsam away, leaving small deposits on the low sand dunes at Site 10. The 11.1.2014 sample of 30L of flotsam included incredible numbers of mollusc shells. What was startling was the numbers and proportions and condition of the three *Vertigo* species: the vast majority of *V. antivertigo* shells (174) were mature with only one juvenile - the majority in good condition. Of the 868 *V. angustior* shells the majority were dead white shells with the majority burnt - some flecked with a brown chemical; only 40 were live adults in good condition. The *V. pygmaea* were in similar condition. This observation was explained by the RAF staff in that practice missiles, throwing out burning phosphorus, often cause vegetation fires - though the result of this was not at all apparent on the ground on the day of the visit. The different species were presumably floated out from different areas of the fen.

The 30L sample may perhaps represent 1% of the flotsam deposited on the dune hummocks; implying that perhaps a minimum of 80,000 individual *V. angustior* were involved. What is probably impossible to estimate is how much flotsam gets carried out to sea. Overall the number of *Vertigo* individuals involved must be very large. From the topography and flotsam positions they must come from the Site 8 fen area which suggests that there might be a very large population there. The results from sample 8G on the same day (11.1.2014) show that many live (130 per m<sup>2</sup>) *V. angustior* remain and presumably it is the dead shells, full of air, that are more prone to float away.

2006 photos: see Harper (2007).

2014 photos: none

Site 11: Damp Dune Slack under Pines behind Fore Dunes (SN37870247)

In 2006 one juvenile *V. angustior* was recorded at this site but it is now considered to have been contamination from another site, however thoroughly the equipment was cleaned; the damp weather increased the chance of a tiny snail sticking in a fold in the net. With the benefit of subsequent experience the habitat is now considered unsuitable; the site was sampled once in 2013 but no snails at all were found.

*No photos in 2006*                      *2014 photo: Fig. 11*

Site 12: A Scrubby and Wooded Damp Area with *Salix repens* (SN375033)

Rather similar to Sites 5, 11 and 21 and recommended for investigation in 2006. Much of the area is fairly densely wooded and it is very unlikely that *Vertigo* spp. exist here, except possibly on the edge near the forest road. The area was looked at again in 2013 and the same conclusion made. A track through it has been bulldozed giving vehicular access northwards to the grasslands and fen of “bomb alley” up to the boundary fence of RAF Pembrey Sands. *No photos*

Site 13: Conservation Pond, Pembrey Country Park (SN396007) (see Harper, 2007)Site 14: Pit / Pond just SW of Ski Slope, Pembrey Country Park (SN409000)

Visited on 28.10.2006 when it was too wet to sample effectively. This approx 80m by 40m pit contains a pond up to a metre deep. There is marginal vegetation but it seems too sparse or scrubby; G-vac sampling produced few mollusc species and no *Vertigos*.

*2006: no photos*                      *2013 photo: Fig. 12*

Site 15: Depression / Fen W of Ski Slope, Pembrey Country Park (SN40860011)

This 100m diameter, 2.0m deep, ungrazed, flat-bottomed depression has sedge fen, invading *Salix cinerea* and hybrids, *Betula pubescens*, *B. pendula*, *Crataegus monogyna*. The depression is surrounded on three sides by *Pinus* forest with a mixed scrub understory. Experience of other sites suggests that it is too shaded and the sparse vegetation is unsuitable for *Vertigo* spp. *No photos*

Site 16: Pond “with Broken Oak” in SE of Pembrey Forest (SN40010115) (see Harper, 2007)Site 17: Pond on NE side of Pembrey Forest (SN39100310) (see Harper, 2007)Site 18: Marshy Field and Fen outside Eastern Corner of Pembrey Forest (SN410013)

This once botanically rich site used to be of much better quality fen, even until the early 1990s, and the area was considered as a pSSSI. The triangle of rank vegetation in the middle of the site has now been mown and the fields more heavily grazed. It is now most unlikely that *V. angustior* occurs in the fields but it might just exist in the long grass on the ditch edges. *No photos*

Site 19: Marshy Farmland just south of Pembrey Village (SN421010) (see Harper, 2007)

Site 20: Reedy Depression to NE of Main Track (SN404017) (see Harper, 2007)

Site 21: "Butterfly Glade" in the SE of Pembrey Forest (SN397017)

One of several large flat-bottomed "plains" between the dune series parallel to the coast. This one is sheltered by good stands of pine forest and is warm and well vegetated and is known as the best area for butterflies in the region. It is fairly open as forest operations have harvested swathes of timber and further thinning has taken place recently. A wide glade is retained, in addition to the track, though it seems to be mown regularly so is probably unsuitable for *Vertigo* spp. The ground flora is characterised by *Salix repens* and other wetland plants but these may have established when the area was generally wetter. It is possible there are damp spots to the sides. *No photos.*

Site 22: Dry *Salix repens* Fen in Pembrey Forest near North RAF Gate (SN371046) (see Harper, 2007)

Site 23: Dry *Salix repens* Fen in North Centre of Pembrey Forest (SN379042) (see Harper, 2007)

Site 24: Banc y Lord, East Side of RAF Bombing Range (SN400046)

Despite the encouraging comments in the earlier report (Harper, 2007), when the SE end of Site 9 and Site 24 were surveyed on 9.1.2014 they were found to be fairly heavily grazed short grassland, and heavily poached by cattle in places along Banc y Lord. The very high tides and storm surge, six days previously, had deposited a large quantity of flotsam very near the top of the flood bank, the position of which suggested that flood water had circulated anti-clockwise around the saltmarsh. The relatively small number of terrestrial mollusc shells in the 30L flotsam sample, but preponderance of saltmarsh species, suggests that fresh-water marsh species do not live in or at the upper fringes of the vast area of the saltmarsh to the east of the bomb target zone with its dunes and fen zones.

*No photos in 2006*                      *2014 photo: Fig. 13*

Site 25: Top Edge of Saltmarsh East of Pembrey Country Park (SN415000)

Parts of the extensive saltmarsh southeast of Pembrey Burrows has three conservation designations as shown on Map 1. It is enclosed and sheltered by a 2km stretch of dunes continuous with Cefn Sidan and has its outlet near Burry Port harbour. The upper edge of the saltmarsh, grading into *Phragmites* beds and dune grassland, stretches around the north and south sides of the saltmarsh for about 3km and may offer similar opportunities for *Vertigo* habitat as demonstrated at Oxwich Bay in 2006 (Harper 2007). The western end of the enclosed saltmarsh is remote from the sea and there is a fresh water seepage and small fen (running SW to NE) to the southwest of the sewage works. G-vac samples 25A and 25B produced totals of 4 live (+2 dead) *Vertigo pygmaea* and 20 live *V. antivertigo*. Experience elsewhere

suggests that *V. angustior* can exist with these two species, but in very localised pockets, so that it is possible that it occurs nearby. Just 400m to the NE was a patch of very dense grassland (often favoured by *V. angustior*) between the *Phragmites* bed and the road bank but sample 25C produced no trace of small snails; however this site had no fen or seepage adjacent - just drains from the road and perhaps the sewage works.

2013 photos: Figs. 14 & 15

Site 26: new ponds by the Inland Observation Tower, RAF Pembrey Sands (SN376049)

Ponds had been excavated beside the easterly observation tower prior to 2006 between the road and Forest boundary. They are largely unvegetated but look potentially very interesting as they present an unusual habitat of fresh water just above the upper limit of the saltmarsh. As the water table was quite high at this site in autumn 2006 and it was completely flooded in winter 2013 this suggests that there may be fresh-water surface (or subsurface) seepages in the vicinity or even along the northern edge of the Forest. This possibility suggests that further surveys along the forest edge may be rewarding. *No photos*

Site 27: damp patch beside a horse ride on the north side of Pembrey Forest (SN391027)

A G-vac sample aimed at spiders on 12.8.2012 (included in this report and designated as sample 27X) incidentally produced a large number of small molluscs. Included were three species of *Vertigo* - *V. angustior*, *V. pygmaea* and *V. substriata* - the last found nowhere else at Pembrey by the surveyor (except for one subsequently at the nearby Site 28). What was amazing were the numbers of *Vertigos* found in the 0.5m<sup>2</sup> sample: 241 *V. angustior*, 80 *V. pygmaea* and 53 *V. substriata*. The *V. angustior* showed a density of nearly 500/m<sup>2</sup> which is close to the high densities found at the prime Welsh site at Whiteford Burrows on Gower.

What is also striking about the 2012 sample is that the majority of the snails of all species were live or were fresh shells; out of 241 *V. angustior* only 9 were dead or old shells and the ratio of adult to juvenile live shells was 82:150. This sort of ratio was similar for *V. pygmaea*, but the ratio for *V. substriata* was 36 adult to 16 juvenile. These figures (standardised to a square metre) are summarised in Table 3 together with results from 2013.

However, subsequent sampling has indicated that the 2012 spider sample chanced upon a small area with a high density of *angustior*. The clearing in which the site sits is itself fairly small - roughly circular with a diameter of about 30m. As with all the forest tracks, the horse ride and edges are now mown, so reducing the habitat in which the snails may be found - not seriously at the moment, but the area affected by mowing could increase.

Considering Sample 27A, on the first day in the field on 13.11.2013, overnight rain had left the standing vegetation, vegetation thatch, and litter layer, damp. Sieving and examining the G-vac sample in the field produced incredibly few specimens. Loose damp vegetation, sucked up, formed a very effective block to air flow in the collecting tube (tested by a hand over the mouth of the tube). Clearly sampling under these

conditions required adaptation of existing procedures or alternative methods. Thus, as a comparison, Sample 27B used the laborious method of a) cutting off and bagging the vegetation, b) digging up the top layer of soil. Samples were dried in the lab and sieved progressively - altogether a very laborious time-consuming task. Subsequently a modified method of cutting off the vegetation and sucking the soil surface with the G-vac with frequent emptying into a pillowcase for drying later was used (Sample 27C).

Making any comparison between the samples from Site 27 is fraught with interpretive difficulties since the methods were so different. The G-vac works best in dry weather when the snails are active in the vegetation and can be knocked off by the tube's agitation and effectively sucked up. In addition it is likely that not many were aestivating low in the litter layer or in the soil. Whether *V.angustior* was genuinely at very low concentration (Sample 27A) over the wider area of Site 27 in 2013 is not known; clearly using an intensive sampling method (Sample 27B) in a chosen small area, previously shown (by sample 27X) to be rich, was much more productive. Thus the comparison of results in Tables 3 and 4 must be treated with great caution. The intention in Table 4 is to demonstrate the change in proportions of the different ages of the species, the breeding success and the survival rates - not the relative spatial distribution of the species. The totally different methods that had to be used, to get comparative numbers of specimens were a reflection of the seasonal weather controlling the field conditions for sampling.

2013 photos: Figs. 16 & 17

#### Site 28: Large Grazed Field on the North Side of Forest near the End of the Airport Runway (SN393026)

This is a large area that is fenced off from the forest and is contiguous with the grazing land of Brooklands Farm to the NE. It retains many of the characteristics of the dune system of which it is part edaphically and the flora resembles that found in the forest. However it is grazed by 20 - 30 cattle at times and, from experience elsewhere, *V. angustior* does not exist well with cattle. The vegetation is varied with mixed grasses and herbs, lightly grazed, with longer grass and herbs in among scrub. Interestingly, apart from *Vertigo pygmaea* found here there was also a specimen of *V. substriata*, which has only been found otherwise at Site 27 close by.

2013 photo: Fig. 18

#### Site 29 Small Glade at Edge of Forest (close to sites 27 and 28) (SN39200264)

This site was sampled because it is close to Site 27. The habitat looked similar, was damp and had some long grass. However there were no *Vertigo* species - indeed few molluscs of any sort despite being very close to Site 28 the other side of the horse ride. *No photos.*

## 6.2. Summary

The detailed results for each site investigated and sampled are to be found in Appendix 10.2. Table 2 summarises the results for all of the *Vertigo* species recorded. The area for each sample is given. Densities are rounded to the nearest whole number per square metre.

Table 2: Density of *Vertigo* species in samples where *Vertigo* spp. were recorded

Site Sample	Area m <sup>2</sup>	<i>angustior</i>			<i>substriata</i>	<i>pygmaea</i>	<i>antivertigo</i>	Habitat
		Live	Dead	Total/m <sup>2</sup>	no./m <sup>2</sup>	no./m <sup>2</sup>	no./m <sup>2</sup>	
1J	1.0	-	1	1	-	3	-	grassy verge
1L	1.0	-	4	4	-	2	-	grassy bank
1M	1.0	-	-	-	-	4	-	grassy bank and verge
2C	0.5	-	1	2	-	-	-	marshy field
6E	0.75	-	2	3	-	1	-	grassy verge by pond
8D	4.0	3	1	1	-	2	6	fen (winter flooded)
8E	1.0	1	-	1	-	9	-	rough grassland
8F	1.0	203	7	210	-	5	-	thick rough grassland
8G	1.0	130	9	139	-	5	-	grassland/fen
# 10C	30L	46	822	# - - - #	-	230	173	flotsam at flood level
25A	1.0	-	-	-	-	4	3	fen / marsh
25B	1.0	-	-	-	-	2	17	fen / marsh
*27X*	0.5	232	9	482	106	160	-	marshy fen vegetation
27A	1.0	-	1	1	3	3	-	marshy fen vegetation
27B	0.5	36	42	156	130	108	-	marshy fen vegetation
27C	0.25	4	11	60	96	60	-	marshy fen vegetation
28A	1.0	-	-	-	1	2	-	lightly grazed dune grassland

Notes on above table:

# Not comparable for a density value

\*\* Incidental to a spider sample on 12.8.2012

## 7. Conclusions

a) Three of the sites (1, 2, 6) investigated in or adjacent to the Forest in 2006 were found to harbour very low densities of *V. angustior*, but in 2013 only a few dead shells could be found. It could be that these sites are increasingly unsuitable or, as found at Site 27 in the comparative years of 2012 and 2013, it seems likely that the population has undergone a periodic crash, perhaps due to poor 2012/13 winter survival and/or poor breeding in 2013.

Table 3: Comparison of *Vertigo* numbers between the two years 2012 & 2013 at Site 27

Species	Date	Alive - fresh / m <sup>2</sup>			Dead - old / m <sup>2</sup>		
		Adult	Juv	Total	Adult	Juv	Total
<i>V. angustior</i>	12.8.2012	164	300	<b>464</b>	16	2	<b>18</b>
	13.11.2013	54	18	<b>72</b>	64	20	<b>84</b>
<i>V. substriata</i>	12.8.2012	72	32	<b>104</b>	2	-	<b>2</b>
	13.11.2013	70	20	<b>90</b>	32	8	<b>40</b>
<i>V. pygmaea</i>	12.8.2012	48	108	<b>156</b>	4	-	<b>4</b>
	13.11.2013	14	20	<b>34</b>	56	18	<b>74</b>

The samples in the two years were taken differently in respect of distribution over the site, the methods, and the vegetation / soil strata.

b) *V. angustior* was found in 2014 in good numbers in suitable habitat within Site 8, the SAC/SSSI tongue of fen known locally as “Bomb Alley” - both on the RAF bombing range and in the adjacent Forest. Thus sample 8G, which may represent a wide area, had 139/m<sup>2</sup> while 8F from a smaller area provided 210/m<sup>2</sup>.

c) *V. angustior* was found in 2012 in high numbers (482/m<sup>2</sup>) in suitable habitat at Site 27 within the Forest. However sampling in 2013 showed a lower population, that it was very localised, and the proportion of dead shells was much higher as though there had been a population crash. The data are summarised in Table 3 together with results from 2013.

d) It is again demonstrated that *V. angustior* exists most successfully in dense, rather than sparse, vegetation such as tall and dense fen or long, thick grassland adjacent to fen. Examples are: Pembrey Site 27, Site 8 on the Forest side of the fence (sample 8F), and in the fen grassland (sample 8G) near the fenced enclosure. This finding agrees with Sharland’s data from Whiteford Burrows (Cameron 2003, Table 2).

e) The fen that used to surround Pembrey Dune system and Forest may have been important to the presence of *Vertigo angustior* in the area, while the adjacent banks (with a thick grass thatch) may be a secondary habitat as a consequence of flooding. Subsequently land drainage, lowered water table, increased grazing and fen deterioration may have impacted upon the population. The result may be the observed absence of live specimens in Sites 1, 2 and 6 in 2013/14.

f) During the occasional, extensive but short-lived, storm/tidal surge flooding of the Pembrey saltmarshes and fen areas (eg. January 2014), a few of the live *V. angustior* are transported (sample 10C) by the flotsam but many still remain in situ (sample 8G) - probably attached to the vegetation bases. Dry banks with long



vegetation, just above exceptionally high tide level or winter flooding, seem important refuges for snails.

g) On the other hand, prolonged flooding (high winter water table) of the fen, south of the tarmac road, and either side of the Range/Forest boundary fence in Site 8, is perhaps not conducive to the survival of *V. angustior*, or else it floats and is blown to the water's edge where it thrives if the vegetation is long enough; see Table 4. Thus Samples 8A and 8B of 2006, and Samples 8D and 8E of 2014, from the area of the winter fresh water flooding, show low densities, but the long grassland, close by just above the flooding (sample 8F), showed a significant 210 snails per square metre.

Table 4: *Vertigo angustior* numbers in samples at Site 8 in 2006 and 2014

	Alive		Dead		Notes
	adult	juvenile	adult	juvenile	
2006					
8A	2	1	-	-	G-vac sample of fen - but flooded in winter
8B	3	2	-	-	G-vac sample of fen - but flooded in winter
8C	16	3	-	-	fenced; possibly lightly grazed in 2006
2014					
8D	3	-	1	-	sieve samples as area flooded on sampling in winter
8E	-	1	-	-	rough cut vegetation, grass and herbs (not flooded)
8F	110	93	6	1	thick, matted vegetation close to 8D & 8E
8G	94	36	9	-	long, matted vegetation

h) *V. angustior* seems not to co-exist successfully with heavy cattle grazing, perhaps much less so than other species of *Vertigo* - for example *V. pygmaea* exists at up to 200 animals per square metre in the marshy field (sample 2B in 2006), compared to two *V. angustior*. The noted degradation of the fen habitat in Sites 2 and 7 may be related to drainage operations and lowering of the water table and thus the availability of the sward for more prolonged grazing leading to shorter vegetation and conversion to marsh grazing.

i) *V. angustior* seems subject to population crashes as exemplified by the results from 2012 and 2013 at Site 27 - see Table 3. While the overall totals for the two years may represent sampling variation at what seems a very localised site, the relative changes in the numbers of adults and the juveniles from year to year, and the proportions of adults to young are harder to explain except by invoking a poor survival and/or breeding season. If indeed the 2012 / 2013 seasons were poor for survival and breeding, this may explain the dearth of live *V. angustior* at Sites 1, 2 and 6, in addition to grass mowing activities. In contrast however, results from suitable habitat in Site 8 illustrate the opposite scenario, comparing numbers of *V. angustior* found in 2006 and 2014. As Cameron (2003) says "the evidence suggests that the timing and success of reproduction of *V. angustior* varies considerably between years and sites within Great Britain". Perhaps this also occurs in sites that are not so far apart; annual monitoring of the main populations (Whiteford and Pembrey) either side of Carmarthen Bay in April, June, August, October would be interesting.

## 8. Recommendations

- a) Consideration could be given to a regular (annual) monitoring of selected *V. angustior* sites to assess the population dynamics in relation to weather and vegetation management. Ideal sampling criteria would have to be validated and adhered to if the results are to be at all meaningful and comparative.
- b) Further survey of suitable sites in the wider Pembrey area would be desirable - particularly as the Forest itself possesses few ideal habitats; they are marginal or of limited area and they are under threat from perceived lowering of the water table, amenity verge grading and mowing.
- c) Grader maintenance of gravel roads in the Forest and verge mowing should be reviewed to reduce damage to habitats - particularly within glades in the Forest (particularly at Site 27).
- d) On the basis of these results, the present management of the RAF Range seems ideal and should be maintained.
- e) Heavy grazing by cattle (as opposed to sheep) seems not to bode well for the survival of *V. angustior*. Further assessment of *V. angustior* survival or presence in relation to heaviness of cattle grazing could be instigated where possible. Thus it would not be desirable to commence grazing in the fen area of the RAF Ranges, as may have been planned in 2006.
- f) The regeneration of scrub and willow carr south of the boundary fence (between the RAF Range and the Forest) in "Bomb Alley" (Site 8) between 2006 and 2013 is most worrying. One can gauge the scrub changes by looking at the photos of Site 8 in 2006 and 2014 (Figs. 4-9). If allowed to continue unchecked (apart from the area bulldozed in 2013) a valuable part of the significantly valuable fen flora and fauna will be lost. If regular mechanical clearing is not possible, then alternatives need to be found - such as fencing and a programme of suitable grazing installed.

## 9. Acknowledgements

I gratefully thank the following for their help:

Adrian Fowles (NRW) has been a constant source of encouragement, information, guidance and references.

Jonathan Saville, of NRW Abergavenny, provided the map of Pembrey with statutory conservation areas. Ruth Harding of the local NRW office gave advice on access in the area.

Landowners: the Davies Family of Penybedd, Lyn Jones of Brooklands Farm, and Paul Jones very kindly provided access and collecting opportunities on their marshy fields NE of Pembrey Forest.

Gavin Hall, Ranger of Pembrey Country Park, provided convenient access and encouragement to survey parts of the Park; and Simeon L. D. Jones, LNR Ranger Carmarthenshire County Council, gave permission to access the Local Nature Reserve.

I am specially indebted to various staff of RAF Pembrey Sands, at various times, for access to the bombing range on the weekend of 11<sup>th</sup> and 12<sup>th</sup> January 2014; they include Major (rtd) Martyn Alexandre, Major John Nicholl, Mark Evans, Ian Gower and Ann Davies.

## 10. References

Anderson, R. 2005. An annotated list of the non-marine molluscs of Britain and Ireland. *Journal of Conchology*, London **38**: 607-637.

[updated <http://www.conchsoc.org/resources/Anderson.pdf> ]

Cameron, R. A. D. 2003. Life cycles, molluscan and botanical associations of *Vertigo angustior* and *Vertigo geyeri* (Gastropoda, Pulmonata: Vertiginidae). *Heldia* **5**: 95-110

Harper, J. 2007. Survey of Pembrey Forest, Carmarthenshire, for the narrow-mouthed whorl snail *Vertigo angustior*. Unpublished report. Countryside Council for Wales, Bangor.

Pokryszko, B.M. 1990. The Vertiginidae of Poland (Gastropoda: Pulmonata: Pupiloidea) - a systematic monograph. *Annales Zoologici*, **43**: 133-257.

## 11. APPENDICES

[2006 photos listed in Appendix 10.5 of Harper (2007)]

### 11.1. Site Photographs



Fig. 1: Site 1J, 17.12.2013 - Trackside (looking NNW)



Fig. 2: Site 1L, 17.12.2013 - Bank (looking NW)



Fig. 3: Site 6E, 13.11.2013 - Pond Edge (looking SE)



Fig. 4: Site 8D & 8E, 11.1.2014 - Bomb Alley, range side of fence (looking NE)



Fig. 5: Site 8F, 11.1.2014 - Bomb Alley, forest side of fence (looking NE)



Fig. 6: Site 8, 11.1.2014 - Bomb Alley, fen willow carr near "target" (looking SE)



Fig. 7: Site 8, 11.1.2014 - Bomb Alley, bulldozed 2013 (looking SSE from near 'target')



Fig. 8: Sites 08-1-AB in 2006 - Bomb Alley, low growth of carr/scrub (looking SE)  
Note fence at break in vegetation type and "target" on right



Fig. 9: Site 08-3-B in 2006 - rich fen vegetation (looking S); target on left



Fig 10: Site 9, 9.1.2014 - Grazed top of saltmarsh (looking WNW)



Fig. 11: Site 11B, 13.11.2013 - Flooded marshy path in forested slack (looking NW)



Fig. 12: Site 14A, 22.11.2013 - Country Park, Ski Slope Pond (looking SW)



Fig. 13: Site 24A, 9.1.2014 - Flotsam deposited near top of Banc y Lord (looking NE)



Fig. 14: Site 25 B, 30.11.2013 - LNR, back of saltmarsh/freshwater seepage (looking W)





Fig. 15: Site 25 C, 17.12.2013 - LNR, dense grassland behind saltmarsh (looking SW)



Fig. 16: Site 27A, 13.11.2013 - Forest Clearing, NE side (looking S)



Fig. 17: Site 27B, 13.11.2013 - Forest Clearing, NE side (looking S)



Fig. 18: Site 28A, 17.12.2013 - Rough Grazing on NE side of forest (looking NE)

11.2. Sample details

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>1 J</b>	Grid ref: <b>SN 4060 0135</b>	Date: 30 <sup>th</sup> November 2013
------------------------------	-------------------------------	--------------------------------------

Weather: fine, sunny, cool 8°C, calm

Characteristics of the Sample Location: Dry grassy 1m wide trackside verge on the forest side of the fence - the same sample site as 1D and 1E of 2006; the verge rises to a low bank on which the fence sits. [Outside the fence a 1m wide grassy bank - see sample 1K - slopes 1.8m down on the east side into a ditch (60cm deep) in an unimproved marshy field]. Soil - sandy, well drained. See Map 3.

Vegetation Structure: Mixed grasses and herbs mostly to 60cm supported by the wire fence, but away from the fence the grass verge was mown short.

Subsample size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 8min
Layer sampled: Herb and ground surface	Method: G-vac	Time: 1330h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	-	-	5	2
<i>Clausilia bidentata</i>	-	1	-	-
<i>Cochlicopa sp.</i>	-	2	-	1
<i>Ena obscura</i>	-	5	-	1
<i>Cecilioides acicula</i>	-	-	1	-
<i>Trochulus hispidus</i>	-	12	-	-
<i>Lauria cylindracea</i>	-	-	1	2
<i>Aegopinella nitidula</i>	-	13	-	5
<i>Oxychilus navarricus</i>	-	16	-	2
<i>Vitrea contracta</i>	2	5	1	6
<i>Punctum pygmaeum</i>	-	-	2	1
<i>Vallonia costata</i>	-	-	6	2
<i>Columella edentula</i>	6	2	-	4
<i>Vertigo pygmaea</i>	-	-	3	-
<i>Vertigo angustior</i>	-	-	1	-

Plants recorded:
Dominants:
<i>Arrhenatherum elatius</i>
<i>Agrostis sp</i>
<i>Dactylis glomerata</i>
<i>Rubus fruticosus</i>
Others:
<i>Filipendula ulmaria</i>
<i>Heracleum sphondylium</i>
<i>Plantago lanceolata</i>
<i>Equisetum arvense</i>
<i>Rumex acetosa</i>
moss
<i>Taraxacum officinale</i>

Comments: The site is clearly vulnerable to damage by grader while clearing and resurfacing the track - as happens every few years and was happening during the sampling. Since 2006 this verge, like so many in the forest, has been mown short so the dense grass mat and tussocks are very narrow - against and through the fence. Effective sampling was consequently difficult and the reduced cover provided less useful habitat for the target species.

Photographic Images: 2006 - Site 01 photos 1 - 9 ( Harper, 2007);  
2013 - Fig. 1 01J shows the narrow, mown verge

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **1K**    Grid ref: **SN 4060 0135 (10m each way)**    Date: 30<sup>th</sup> November 2013

Weather: Fine day, sunny, cool 8°C, calm

Characteristics of the Sample Location: Steep east-facing bank 1.2m high from forest boundary fence on top to marshy field level below (or 1.8m to bottom of ditch). 1K samples taken along the same 20m stretch of the bank just outside forest boundary as 1F and 1G in 2006. Soil - sandy, well drained. This 200m section of track appears to have built up over the marsh, probably decades ago while much of the area was being used for a munitions factory. Marshy field damp in summer - boggy in winter. See Map 3.

Vegetation Structure: Coarse grasses and herbs among bramble and willow bush supported by the fence and leaning out from the steep bank, overhanging field and ditch.

Subsample size & no: 25cm x 25cm x 8	Hence area sampled: 0.5m <sup>2</sup>	Sampling time: 10 min
Layer sampled: ground layer mostly	Method: G-vac	Time: 1430h

<b>Molluscs recorded:</b>	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	2	-	3	1
<i>Cochlicopa cf. lubrica</i>	-	-	1	4
<i>Cecilioides acicula</i>	-	-	-	2
<i>Cepaea nemoralis</i>	-	-	-	2
<i>Trochulus hispidus</i>	-	5	-	-
<i>Aegopinella nitidula</i>	-	7	-	-
<i>Oxychilus navarricus</i>	-	9	-	2
<i>Vitrea contracta</i>	-	-	-	2
<i>Vitrea crystallina</i>	-	-	1	1
<i>Vallonia costata</i>	-	-	-	4
<i>Vallonia cf. excentrica</i>	-	-	-	2

<b>Plants recorded:</b>
<b>Dominants:</b>
<i>Dactylus glomerata</i>
<i>Rubus fruticosus</i>
<i>Salix cinerea</i>
<i>Juncus inflexus</i> (ditch level)
<b>Others:</b>
<i>Juncus conglomeratus</i>
<i>Equisetum arvense</i>
<i>Filipendula ulmaria</i>
<i>Arrhenatherum elatius</i>
<i>Heracleum sphondylium</i>
<i>Agrostis</i> sp.
<i>Epilobium</i> sp.
<i>Holcus</i> sp.
<i>Angelica sylvestris</i>

Comments: Brambles and tall vegetation on the bank, above the ditch, had grown more strongly since 2006 and now overhang the ditch in most places along a 50m stretch - encompassing Sites 1F and 1G of 2006. Thus grass mats and clumps were suppressed leaving a rather bare soil surface - hardly suitable for snails of thick vegetation

Photographic Images: 2006 - Site 01 photos 1 - 9 ( Harper, 2007);  
2013 - no photo of 1K, but Fig. 2 01L is similar and shows the bank

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **1 L**    Grid ref: **SN 4059 0138 (5m each way)**    Date: 17<sup>th</sup> December 2013

Weather: Fine day, cool 9°C, high cloud, thin sun, calm, vegetation wet

Characteristics of the Sample Location: Steep 40° east-facing bank 1.2m high from forest boundary fence on top to marshy field level below (or 1.8m to bottom of ditch). 1L samples taken along the same 10m stretch of the bank as 1A and 1B in 2006, but just outside forest boundary. Soil - sandy, well drained. Marshy field damp in summer - boggy in winter. See Map 3.

Vegetation Structure: Fairly thick mat of grass and herbs on 40° east facing bank, with Grey Willow bush at ditch level. Some Gorse

Subsample size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 10 min
Layer sampled: vegetation and soil surface	Method: G-vac	Time: 1400h

Molluscs recorded:	live / fresh				dead / old			
	Adult		Juv		Adult		Juv	
	va c	soil	va c	soil	va c	soil	va c	soil
<i>Carychium tridentatum</i>	-	-	-	-	3	4	1	1
<i>Cochlicopa cf. lubrica</i>	1	-	2	1	1	1	7	2
<i>Cochlicopa cf. lubricella</i>	-	-	-	-	1	1	-	-
<i>Ceciliooides acicula</i>	-	-	-	-	1	1	-	5
<i>Cepaea nemoralis</i>	-	-	8	-	1	-	10	3
<i>Candidula intersecta</i>	-	-	-	-	3	2	-	1
<i>Trochulus hispidus</i>	-	-	4	-	1	-	-	1
<i>Lauria cylindracea</i>	-	-	-	-	-	-	1	-
<i>Aegopinella nitidula</i>	4	-	14	1	-	2	7	-
<i>Oxychilus draparnaudi</i>	1	-	-	-	-	-	-	-
<i>Oxychilus navarricus</i>	3	1	28	4	-	-	-	7
<i>Vitrea contracta</i>	2	-	2	2	-	2	-	6
<i>Punctum pygmaeum</i>	-	-	-	-	-	-	1	4
<i>Succinea cf. putris</i>	-	-	-	-	-	-	1	-
<i>Vallonia costata</i>	-	-	-	-	-	5	2	4
<i>Vallonia cf. excentrica</i>	-	-	-	-	12	11	4	9
<i>Collumella edentula</i>	9	-	2	-	-	-	-	-
<i>Vertigo pygmaea</i>	-	-	-	-	1	2	1	-
<i>Vertigo angustior</i>	-	-	-	-	1	-	1	-
<i>Vitrina pellucida</i>	1	-	-	-	-	-	-	-

Plants recorded:
Dominants:
<i>Festuca sp.</i>
<i>Agrostis sp.</i>
<i>Arrhenatherum elatius</i>
Others:
<i>Plantago lanceolata</i>
<i>Equisetum arvense</i>
<i>Filipendula ulmaria</i>
<i>Dactylis glomerata</i>
<i>Heracleum sphondylium</i>
<i>Achillea millefolium</i>
<i>Achillea ptarmica</i>
<i>Holcus sp.</i>
<i>Salix cinerea</i>
<i>Cirsium palustre</i>
<i>Chaerophyllum temulum</i>
<i>Scrophularia nodosa</i>
<i>Potentilla repens</i>
<i>Juncus inflexus</i>
<i>Rubus fruticosus</i>

Comments: With the same intention as Sample 27B, a 20cm x 20cm x 2.5cm = 1L soil sample was taken to investigate whether live snails aestivated in the soil during the winter.

Photographic Images: 2006 - Site 01 photos 1 - 9 (Harper, 2007);  
2013 - Fig. 2 01L Bank outside fence - east-facing

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>1 M</b>	Grid ref: <b>SN 40575 01455</b>	Date: 12 <sup>th</sup> January 2014
------------------------------	---------------------------------	-------------------------------------

Weather: Dull, cold 8°C, breeze from SW

Characteristics of the Sample Location: Dry grassy 1m trackside verge plus 1m wide grassy bank that slopes 1.8m on east side into a ditch (60cm deep) in an unimproved marshy field. Verge and bank are longitudinally bisected by a wire fence that provides some vegetation support and protection. NE-facing and exposed. Soil - sandy, well drained. The 200m section of track appears to have been built up over the marsh, probably long ago when much of the area was being used for a munitions factory. Marshy field damp in summer - wet in winter; however the ditch has been recently cleaned out, improving drainage. See Map 3.

Vegetation Structure: Mixed fine grasses and herbs mostly 10 - 30cm with taller vegetation to 60cm where supported by the fence wires or shrubs. Some patches of bramble *Rubus fruticosus* and a gorse *Ulex* sp and willow *Salix* sp are developing.

Subsample size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 5 min
Layer sampled: herb to ground layers	Method: G-vac	Time: 1100h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	1	-	-	-
<i>Cochlicopa lubrica</i>	-	-	1	-
<i>Cepaea nemoralis</i>	-	10	1	13
<i>Trochulus hispidus</i>	-	15	4	6
<i>Trochulus striolata</i>	-	11	-	-
<i>Aegopinella nitidula</i>	1	4	-	1
<i>Oxychilus alliarius</i>	-	1	-	2
<i>Oxychilus navarricus</i>	-	11	-	-
<i>Vitrea contracta</i>	-	1	-	-
<i>Succinea cf. putris</i>	-	3	-	2
<i>Vallonia costata</i>	-	-	2	3
<i>Vallonia cf. excentrica</i>	-	-	3	-
<i>Vertigo pygmaea</i>	-	-	3	1

Plants recorded:
Dominants:
<i>Festuca</i> sp
<i>Agrostis</i> sp
<i>Equisetum arvense</i>
Others:
<i>Plantago lanceolata</i>
moss
<i>Rubus fruticosus</i>
<i>Leontodon autumnalis</i>
<i>Linum bienne</i>
<i>Achillea millefolium</i>
<i>Phragmites australis</i>
<i>Pastinaca sativa</i>
<i>Arrhenatherum elatius</i>
<i>Cerastium fontanum</i>
<i>Ammophila arenaria</i>
<i>Ranunculus repens</i>

Comments: The site is vulnerable to damage by grader while clearing and resurfacing the track - as happens every few years and was happening during the sampling in 2006. More recently the trackside verge has been regularly mown, reducing the cover available for molluscs.

Photographic Images: 2006 - Site 01 photos 1 - 9 ( Harper, 2007);  
2013 - Figs. 1 & 2 are similar for either side of fence at 01M

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>2 C</b>	Grid ref: <b>SN 4061 0137</b>	Date: 12 <sup>th</sup> January 2014
------------------------------	-------------------------------	-------------------------------------

Weather: Very dull, cold 8°C, south-west breeze

Characteristics of the Sample Location: marshy unimproved field with uneven surface from past excavation / ditching / banking. Drainage ditch on edge, adjacent to forest boundary. See Map 3.

Vegetation Structure: Very mixed - tussocks of *Juncus* and *Molinia* to 100cm and thickets of scrubby *Salix cinerea*. Varied herb flora in between. Grazed mostly in summer.

Subsample size & no: 25cm x 25cm x 8	Hence area sampled: 0.5m <sup>2</sup>	Sampling time: 5 min
Layer sampled: herb layer to ground level	Method: G-vac	Time: 1200h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cepaea nemoralis</i>	1	1	-	5
<i>Trochulus striolatus</i>	-	7	-	-
<i>Nesovitrea hammonis</i>	-	-	-	1
<i>Oxychilus alliarius</i>	-	8	-	2
<i>Vitrea contracta</i>	-	1	-	-
<i>Succinea cf. putris</i>	-	4	-	-
<i>Vallonia cf. excentrica</i>	-	-	3	-
<i>Columella aspera</i>	4	2	-	-
<i>Vertigo angustior</i>	-	-	1	-

Plants recorded:
Dominants:
<i>Juncus conglomeratus</i>
<i>Juncus effusus</i>
<i>Molinia caerulea</i>
<i>Filipendula ulmaria</i>
<i>Salix cinerea</i>
Others:
<i>Holcus mollis</i>
<i>Mentha aquatica</i>
<i>Equisetum arvense</i>
<i>Cirsium arvense</i>
<i>Lythrum salicaria</i>
<i>Lotus uliginosus</i>
<i>Rubus fruticosus</i>
<i>Scrophularia nodosa</i>
<i>Ulex sp.</i>
<i>Iris pseudacorus</i>
moss
<i>Angelica sylvestris</i>
<i>Achillea millefolium</i>
<i>Achillea ptarmica</i>
<i>Plantago lanceolata</i>
<i>Arrhenatherum elatior</i>

Comments: Moderate grazing pressure in summer by cattle - little during winter as it is very wet. However new grazier is "improving pasture by draining and cutting - limited so far.

Photographic Images: 2006 - Site 02 photos 1 - 8 (Harper, 2007);  
2013/14 - none

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>6 E</b>	Grid ref: <b>SN 373 040</b>	Date: 13 <sup>th</sup> November 2013
------------------------------	-----------------------------	--------------------------------------

Weather: overcast, cool 9°C, light SW wind; vegetation wet from overnight rain

Characteristics of the Sample Location: Grassy and shrubby rim of excavation / pond, dry in the summer but flooded in the winter. Rim with long vegetation very narrow, 0.5m - 1.0m, about 60m long. It was disturbed in 2006 by road grading and since has been mown regularly for amenity purposes. The excavation is 1m deep. On the date of the sample the pond was 25cm deep at the edge and 50cm deep in the middle; on 9.1.2014 this depth had increased to 90cm.

Vegetation Structure: Narrow (half metre wide) band of sparse grass and herbs under open Grey Willow between mown verge and full pond. While the verge had regrown to 3m width after the grading in 2006, it is now mostly mown regularly leaving very little cover for invertebrates.

Subsample size & no: 25cm x 25cm x 12	Hence area sampled: 0.75m <sup>2</sup>	Sampling time: 4 min
Layer sampled: herb and soil surface	Method: G-vac	Time: 1330h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cochlicopa cf. lubrica</i>	-	-	1	1
<i>Cepaea</i> sp.	-	1	-	-
<i>Trochulus hispidus</i>	1	2	2	-
<i>Aegopinella pura</i>	1	-	-	-
<i>Aegopinella nitidula</i>	-	-	-	2
<i>Nesovitrea hammonis</i>	1	-	1	-
<i>Punctum pygmaeum</i>	-	-	-	3
<i>Vallonia cf. excentrica</i>	1	-	-	-
<i>Vertigo pygmaea</i>	-	1	-	-
<i>Vertigo angustior</i>	-	-	1	1

Plants recorded:
Dominants:
<i>Agrostis</i> sp.
<i>Eupatorium cannabinum</i>
<i>Salix cinerea</i>
Others:
<i>Alnus glutinosa</i>
<i>Epilobium hirsutum</i>
<i>Chamaenerion angustifolium</i>
<i>Potentilla anserina</i>
<i>Phragmites australis</i>
<i>Geranium robertianum</i>
<i>Melilotus</i> sp.

Comments: Sampling was limited to the grassy rim of the excavation (cf. 6C of 2006); the pond was flooded. The site is vulnerable to damage by grader while clearing and resurfacing the track - as happens occasionally eg. during the sampling in 2006. In more recent years the grass verge is being mown regularly, as it is throughout the forest for amenity purposes, leaving only a very narrow strip of longer vegetation under the willows.

Photographic Images: 2006 - Site 06 - photos 1 - 5 (Harper, 2007)  
2013 – Fig. 3 06E





**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **8 E**      Grid ref: **SN 3661 0441**      Date: 11<sup>th</sup> January 2014

Weather: fine, sunny, warm 12°C, light wind variable

Characteristics of the Sample Location: relatively dry fen area in the summer - not flooded in the winter - on RAF Pembrey Sands side of boundary fence, and between that and the tarmac road near the western observation tower. Above the flooded fen area just to the NE. Vegetation on the other side of the fence (sample 8B of 2006 in Pembrey Forest) was similar in 2006 but has grown up appreciably with scrub, shading out most fen herbs.

Vegetation Structure: Open grass / *Carex* layer with a dead mat under. Varied herbs and occasional small shrubs. Not mown but cut occasionally to control scrub.

Sweeps - size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 8 min
Layer sampled: vegetation to ground	Method: G-vac	Time: 1100h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	37	14	1	-
<i>Cochlicopa cf. lubrica</i>	-	2	-	-
<i>Euconulus cf. alderi</i>	-	3	-	-
<i>Cepaea nemoralis</i>	-	2	1	-
<i>Trochulus hispidus</i>	1	12	-	-
<i>Punctum pygmaeum</i>	-	-	1	1
<i>Succinea cf. putris</i>	-	-	1	-
<i>Vertigo pygmaea</i>	2	6	1	-
<i>Vertigo angustior</i>	-	1	-	-
<i>Vitrina pellucida</i>	-	-	1	-

Plants recorded:
Dominants:
<i>Agrostis</i> spp
<i>Carex arenaria</i>
<i>Festuca</i> sp.
<i>Rubus fruticosus</i>
<i>Salix repens</i>
Others:
<i>Holcus lanatus</i>
<i>Dactylis glomerata</i>
<i>Juncus effusus</i>
moss
<i>Plantago lanceolata</i>
<i>Chamaenerion angustifolium</i>
<i>Eupatorium cannabinum</i>
<i>Pulicaria dysenterica</i>
<i>Heracleum sphondylium</i>
<i>Hippophae rhamnoides</i>
<i>Prunus spinosa</i>

Comments: No grazing though the fen area has been cut occasionally to control scrub and maintain the fen Adjacent to area 8A sampled in 2006 and 8D “pond-sieved” just prior to this sample. The embanked tarmac road isolates the southern part of the fen area (Site 8) from flooding to the north, though general water table rises cause the inundation observed during the winter.

Photographic Images: 2006 - Site 08 photos 1, 2 & 4 (Harper, 2007);  
2014 - Fig. 4 8E scrub controlled on range side of fence

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>8 F</b>	Grid ref: <b>SN 3661 0436</b>	Date: 11 <sup>th</sup> January 2014
------------------------------	-------------------------------	-------------------------------------

Weather: fine, sunny, warm 12°C, light wind variable

Characteristics of the Sample Location: on Pembrey Forest side of boundary fence with RAF Pembrey Sands; above the flooded fen area to the NE. Not really fen but rough grassland, more like dune slack grassland with a dense dead mat. On a slope up from the fen to dry grassland. A small area that hasn't been encroached upon yet by the surrounding thick scrub.

Vegetation Structure: dense grass cover over a thick dead mat - hummocky - with some herbs. Many shrubs.

Sweeps - size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 8 min
Layer sampled: vegetation to ground	Method: G-vac	Time: 1130h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	1	-	-	-
<i>Cochlicopa cf. lubrica</i>	-	9	-	1
<i>Euconulus cf. alderi</i>	-	1	-	-
<i>Cepaea nemoralis</i>	-	6	-	-
<i>Trochulus hispidus</i>	2	9	1	2
<i>Oxychilus alliarius</i>	1	3	1	-
<i>Punctum pygmaeum</i>	7	4	1	-
<i>Acanthinula aculeata</i>	-	-	-	1
<i>Columella aspera</i>	1	1	-	-
<i>Vertigo pygmaea</i>	1	4	-	-
<i>Vertigo angustior</i>	110	93	6	1
<i>Vitrina pellucida</i>	1	1	-	4

Plants recorded:
Dominants:
<i>Agrostis</i> spp
<i>Festuca</i> sp.
<i>Hippophae rhamnoides</i>
<i>Rubus fruticosus</i>
<i>Salix repens</i>
<i>Prunus spinosa</i>
Others:
<i>Holcus lanatus</i>
<i>Dactylis glomerata</i>
<i>Carex arenaria</i>
moss
<i>Plantago lanceolata</i>
<i>Chamaenerion angustifolium</i>
<i>Eupatorium cannabinum</i>
<i>Pulicaria dysenterica</i>
<i>Heracleum sphondylium</i>
<i>Sambucus nigra</i>

Comments: No grazing, no cutting, no mowing. Closely adjacent to the lower fen area.

Photographic Images: 2006 - Site 08 photos 1, 2 & 3 ( Harper, 2007);  
2014 - Fig. 5 8F - scrub invading area of forest side of fence

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>8 G</b>	Grid ref: <b>SN 3654 0488</b>	Date: 11 <sup>th</sup> January 2014
------------------------------	-------------------------------	-------------------------------------

Weather: fine, sunny, warm 12°C, light wind variable

Characteristics of the Sample Location: grassland just above fenland perhaps, with few shrubs - not grazed, nor mown (though may be cut occasionally to control scrub). Next to a fenced area (which was intended to be grazed from 2006, but probably not in the last few years) in which sample 8C of 2006 was taken.

Vegetation Structure: grassland with sedges and a few *Juncus* clumps; occasional shrubs. There is a fairly dense herb cover with a thick dead mat of grass / sedge leaves.

Sweeps - size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 8 min
Layer sampled: vegetation to ground	Method: G-vac	Time: 1500h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cochlicopa cf. lubrica</i>	2	12	-	2
<i>Euconulus cf. alderi</i>	1	3	-	-
<i>Cepaea nemoralis</i>	2	3	-	-
<i>Trochulus hispidus</i>	-	3	-	-
<i>Nesovitrea hammonis</i>	-	7	-	-
<i>Oxychilus alliarius</i>	-	11	-	-
<i>Punctum pygmaeum</i>	2	2	-	-
<i>Succinea cf. putris</i>	-	2	-	-
<i>Columella aspera</i>	54	124	-	-
<i>Columella edentula</i>	1	-	-	-
<i>Vertigo antivertigo</i>	1	-	-	-
<i>Vertigo pygmaea</i>	2	2	-	-
<i>Vertigo angustior</i>	94	36	9	-
<i>Vitrina pellucida</i>	-	15	-	9

Plants recorded:
Dominants:
<i>Agrostis</i> spp
<i>Festuca</i> sp.
<i>Carex arenaria</i>
<i>Salix repens</i>
Others:
<i>Dactylis glomerata</i>
<i>Juncus effusus</i>
<i>Juncus maritimus</i>
<i>Juncus acutus</i>
moss
<i>Plantago lanceolata</i>
<i>Centaurea nigra</i>
<i>Agrimonia eupatorium</i>
<i>Heracleum sphondylium</i>

Comments: No grazing, no cutting, no mowing. Closely adjacent to the lower fen area. Results from sample 10C of 2014 show that fires, resulting from missile practice, can burn areas around the target zones - this results in large numbers of obviously burnt mollusc shells that are floated out in exceptional flood tides and left as flotsam on low dunes - for example near the "convoy".

Photographic Images: 2006 - Site 08 - 5, 6, 7 (Harper, 2007) are of similar habitat  
2014 - no photos

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>10 C</b>	Grid ref: <b>SN 3645 0564</b>	Date: 11 <sup>th</sup> January 2014
-------------------------------	-------------------------------	-------------------------------------

Weather: fine, warm 12°C, dry, calm

Characteristics of the Sample Location: A promontory of low fixed dunes sticks out into the saltmarsh creating a restriction to the flow of flood tides. As the waters ebb, floating material from the fresh-water marsh is caught as flotsam on the low dunes, including mollusc shells.

Vegetation Structure: Short grass on low dunes at edge of saltmarsh and fresh-water marsh.

Subsample size & no: 1.5L handfuls x 20	Hence sample: 30L	Sampling time: 4min
Layer sampled: Flotsam at highest tide level	Method: sieving dried flotsam	Time: 1400h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Potamopyrgus antipodarum</i>	-	-	1	2
<i>Cochlicopa cf. lubrica</i>	3	17	57	51
<i>Myosotella myosotis</i>	-	4	3	5
<i>Euconulus cf. alderi</i>	-	1	-	-
<i>Cepaea nemoralis</i>	2	9	2	5
<i>Candidula intersecta</i>	7	44	26	190
<i>Trochulus hispidus</i>	-	-	2	2
<i>Trochulus sericeus</i>	-	-	-	6
<i>Oxychilus sp.</i>	-	1	1	3
<i>Punctum pygmaeum</i>	1	4	4	10
<i>Pupilla muscorum</i>	25	13	213	67
<i>Vallonia cf. excentrica</i>	6	5	19	5
<i>Vertigo antivertigo</i>	127	1	45	-
<i>Vertigo pygmaea</i>	39	8	167	17
<i>Vertigo angustior</i>	40	6	803	19
<i>Vitrina pellucida</i>	1	3	-	8

Plants recorded:
Dominants: -----
Others: -----

Comments: There were exceptionally high spring tides on 3<sup>rd</sup> January 2014 in addition to a storm surge, causing flooding in the saltmarsh on the north side of RAF Pembrey Sands and inundation of most of the fresh water fen area on the SW side. In addition, the generally very wet conditions caused a high water table in the Site 8 “fen” area in the range and bomb alley. The embanked tarmac road from the range gate to the western obs tower acts as a barrier to tidal flood water, so the section of “bomb alley” to the south would not be affected by salt water, even if diluted. Flood water swirled clockwise around the fen area and deposited flotsam on the projecting low sand dunes by the “convoy”. The 30L sample was a tiny fraction of the total of flotsam spread around the tops of the low dunes. Many of the dead shells were burnt or blackened, particularly a very high proportion of the *V. angustior* shells as though they had suffered a hit by chemicals from phosphorus training missiles and fire.

Photographic Images: 2006 - Site 10 - 1, 10 - 2 (Harper, 2007)  
2014 - none



**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>14 A</b>	Grid ref: <b>SN 409 000</b>	Date: 22 <sup>nd</sup> November 2013
-------------------------------	-----------------------------	--------------------------------------

Weather: overcast, cool 9°C, calm, fairly dry vegetation

Characteristics of the Sample Location: an excavation with a pool at the bottom and, like the nearby site 15, may result from sand being removed to cover bunkers when the site was used as a munitions facility. The pool dries up partially in the summer and may separate into two shallow pools. The banks are steep in parts. About half the edge is dominated by *Salix cinerea* but there are thin grassy banks as well.

Vegetation Structure: Apart from the *Salix* scrub, the grassy edges are sparse, particularly in winter, with no suitable mats of thick vegetation to support small molluscs.

Subsample size & no: 30cm x 30cm x 11	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 10 min
Layer sampled: herb layer to soil surface	Method: G-vac	Time: 1030h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cepaea nemoralis</i>	1	-	-	1
<i>Lymnaea fuscus</i> * <sup>1</sup>	-	1	-	-
<i>Radix balthica</i> * <sup>2</sup>	-	24	-	-
NO SMALL TERRESTRIAL SNAILS				
* <sup>1</sup> = the common split of <i>Lymnaea palustris</i> s.l.				
* <sup>2</sup> = <i>Lymnaea peregra</i>				

Plants recorded:
Dominants:
<i>Agrostis</i> sp.
<i>Fescue</i> sp.
<i>Phragmites australis</i>
<i>Salix cinerea</i>
Others:
<i>Typha latifolia</i>

Comments: the pond is isolated on a dry grass plain, with no thick grassy reservoir for molluscs to shelter from the fluctuating water level.

Photographic Images: 2006 - None  
2013 - Fig. 12 14A

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>24 A</b>	Grid ref: <b>SN 3997 0465</b>	Date: 9 <sup>th</sup> January 2014
-------------------------------	-------------------------------	------------------------------------

Weather: overcast, cool 8°C, light variable wind

Characteristics of the Sample Location: Banc y Lord - flood bank along the SE boundary of the bombing range and saltmarsh; highest in the middle or NE end - peters out at the SW end as the ground rises gradually; only just high enough to contain the exceptionally high spring tide and storm surge of 3<sup>rd</sup> January 2014.

Vegetation Structure: grazed short turf on saltmarsh, and top and saltmarsh side of the flood bank Banc y Lord. Grazing and poaching extends over to the inside of the bank in some places where there is no scrub.

Subsample size & no: 3L handfuls x 10	Hence sample: 30L	Sampling time: 5 min
Layer sampled: flotsam	Method: hand	Time: 1530h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Potamopyrgus antipodarum</i>	-	-	-	1
<i>Peringia ulvae</i>	-	-	-	2
<i>Cochlicopa cf. lubrica</i>	-	1	-	-
<i>Myosotella myosotis</i>	4	55	-	2
<i>Cepaea nemoralis</i>	-	-	1	-
<i>Trochulus hispidus</i>	-	-	-	2
<i>Pupilla muscorum</i>	-	-	2	1
<i>Vallonia excentrica</i>	-	-	4	1

Plants recorded:
Dominants:
short poached grazing
Others:

Comments: flotsam within 50cm of the top of the flood bank on the saltmarsh side. It would appear from the position of the flotsam on the flood bank and the snail species sampled that the flood tide swirls in across the saltings and the grazing in an anticlockwise direction; thus it probably does not float out molluscs from the fen areas on the SW side of the bombing range.

Photographic Images: 2014 - Fig. 13 24A Banc y Lord with flotsam bands, looking NE



**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>25 A</b>	Grid ref: <b>SS 414 998</b>	Date: 30 <sup>th</sup> November 2013
-------------------------------	-----------------------------	--------------------------------------

Weather: fine, thin cloud but sunny, cool 8°C, calm

Characteristics of the Sample Location: grading from low dune grassland down to semi-saltmarsh, above the saltmarsh *Phragmites* zone of the Pembrey LNR - perhaps influenced by some fresh water seepage from the adjacent sample area 25B; a transect from dry grassland of the dune edge down across a semi-saltmarsh rushy zone behind the *Phragmites* bed (looking from the land side) - perhaps rarely flooded by very high tides.

Vegetation Structure: Mixed grass, sedge and rushes to 50cm with occasional taller herbs and shrubs

Subsample size & no: 30cm x 30cm x 11	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 10 min
Layer sampled: herb layer to soil surface	Method: G-vac	Time: 1030h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Discus rotundatus</i>	-	-	1	-
<i>Cepaea nemoralis</i>	2	2	1	6
<i>Discus rotundatus</i>	-	-	1	-
<i>Trochulus striolatus</i>	-	1	-	-
<i>Aegopinella nitidula</i>	-	1	1	-
<i>Oxychilus navarricus</i>	-	1	1	1
<i>Columella aspersa</i>	1	3	-	-
<i>Vertigo antivertigo</i>	3	-	-	-
<i>Vertigo pygmaea</i>	2	-	2	-

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Agrostis</i> sp.
<i>Holcus</i> sp.
<i>Carex arenaria</i>
<i>Juncus inflexus</i>
Others:
<i>Agropyron pungens</i>
<i>Phragmites australis</i>
<i>Juncus maritimus</i>
<i>Daucus carota</i>
moss
<i>Rubus fruticosus</i>
<i>Salix cinerea</i>
<i>Crataegus monogyna</i>

Notes and Comments: the rationale for investigating this site was the occurrence of *V. angustior* at the interface of saltmarsh / fen / thick matted grass bank at Oxwich Nature Reserve. The presence of two species of *Vertigo* does bear this out - it's just that *V. angustior* wasn't present but still might be found nearby as it was found in apparently a rather localised situation at site 27.

Photographic Images: 2006 - none;  
2013 - as Fig. 14 25B - fen vegetation

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>25 B</b>	Grid ref: <b>SS 413 997</b>	Date: 30 <sup>th</sup> November 2013
-------------------------------	-----------------------------	--------------------------------------

Weather: fine, thin cloud but sunny, cool 8°C, calm

Characteristics of the Sample Location: grading from low dune grassland down to what appears to be fresh water seepages from the dunes and adjacent country park; site 27B is just above the saltmarsh *Phragmites* zone of the Pembrey LNR; a transect from dry grassland of the dune edge down across the fresh water marsh rushy zone behind the *Phragmites* bed (looking from the land side) - perhaps rarely flooded by very high tides, if ever.

Vegetation Structure: Mixed grass, sedge and rushes to 50cm with occasional taller herbs and shrubs

Subsample size & no: 30cm x 30cm x 11	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 8 min
Layer sampled: herb layer to soil surface	Method: G-vac	Time: 1130h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Discus rotundatus</i>	-	-	-	3
<i>Cepaea nemoralis</i>	-	-	-	1
<i>Trochulus hispidus</i>	-	3	-	-
<i>Trochulus striolatus</i>	3	3	-	-
<i>Lymnaea truncatula</i>	-	1	-	-
<i>Aegopinella nitidula</i>	-	1	-	1
<i>Oxychilus navarricus</i>	-	1	1	-
<i>Columella aspersa</i>	3	17	3	1
<i>Vertigo antivertigo</i>	16	1	-	-
<i>Vertigo pygmaea</i>	2	-	-	-

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Agropyron pungens</i>
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
Others:
<i>Phragmites australis</i>
<i>Juncus maritimus</i>
moss
<i>Daucus carota</i>
<i>Rubus fruticosus</i>
<i>Salix cinerea</i>

Notes and Comments: the rationale for investigating this site was the occurrence of *V. angustior* at the interface of saltmarsh / fen / thick matted grass bank at Oxwich Nature Reserve. The presence of two species of *Vertigo* does bear this out - it's just that *V. angustior* wasn't present but still might be found nearby as it was found in apparently a rather localised situation at site 27.

Photographic Images: 2006 - none;  
2013 - Fig. 14 25B - fen vegetation

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>25 C</b>	Grid ref: <b>SN 4165 0008</b>	Date: 17 <sup>th</sup> December 2013
-------------------------------	-------------------------------	--------------------------------------

Weather: fine, cool 9°C, high cloud layer with a little sun, light SW cool wind, vegetation damp

Characteristics of the Sample Location: a flat shelf of thick matted grassland just above the Phragmites belt of the upper saltmarsh, and below the road bank. No adjacent fresh water marsh - as nearby at sites 25A and 25B.

Vegetation Structure: A thick, densely matted monoculture of few grass species.

Subsample size & no: 25cm x 25cm x 16	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 20 min
Layer sampled: herb layer to soil surface	Method: G-vac - see Notes	Time: 1100h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cepaea nemoralis</i>	2	-	-	1
No other snails collected				

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Agropyron pungens</i>
Others:
None recognised

Notes and Comments: The G-vac was used to take 11 separate subsamples around an area 25m in diameter - the approx. size of the matted grass on the flat. The grass layer was densely felted so penetrating it and forming a working space was slow, and each sample was limited in area.

The area is bordered by the upper saltmarsh on one side and by a road bank on the other. The paucity of snails may be due to the very limited dicotyledenous flora. The rationale for investigating this site was the occurrence of *V. angustior* at the interface of saltmarsh / fen / thick matted grass bank at Oxwich Nature Reserve. The presence of two species of *Vertigo* nearby in 25A and 25B does bear this out; *V. angustior* wasn't present but still might be found above this corner of the saltmarsh, just as it was found in rather a localised situation at site 27. Missing at 25C is freshwater marsh, compared to 25B and perhaps 25A.

Photographic Images: 2006 - none;  
2013 - Fig. 15 25C - LNR, dense grassland behind saltmarsh

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **27 A**      Grid ref: **SN 3914 0270**      Date: 13<sup>th</sup> November 2013

Weather: dull, cool 8°C, NW brisk cold wind, dense vegetation mat damp from overnight rain

Characteristics of the Sample Location: a small damp clearing within the forest with a very uneven surface as though rutted by heavy forestry machinery; to one side of a ride designated for horse riding and mown regularly; possibly an area with subsurface water although the site is on slightly higher ground than some adjacent areas; wet woodland lower to east and north.

Vegetation Structure: mostly a herb layer of grasses and moss, with a thick mat, with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens* and *Rosa pimpinellifolia*. Vegetation suggests a permanently damp area.

Subsample size & no: 30cm x 30cm x 11	Hence area sampled: 1.0m <sup>2</sup>	Sampling time: 5 min
Layer sampled: herb layer to soil surface	Method: G-vac - see Notes	Time: 1400h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cochlicopa cf. lubrica</i>	-	2	-	1
<i>Cochlicopa cf. lubricella</i>	-	1	1	-
<i>Nesovitrea hammonis</i>	-	1	-	-
<i>Oxychilus alliarius</i>	1	-	-	-
<i>Acanthinula aculeata</i>	1	-	-	1
<i>Vertigo pygmaea</i>	-	-	3	-
<i>Vertigo substriata</i>	1	2	-	-
<i>Vertigo angustior</i>	-	-	-	1

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Holcus</i> sp.
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
moss
<i>Salix repens</i>
<i>Rosa pimpinellifolia</i>
Others:
<i>Dactylis glomerata</i>
<i>Festuca gigantea</i>
<i>Geranium</i> sp.
<i>Ranunculus repens</i>
<i>Centaurea nigra</i>
<i>Plantago lanceolata</i>
<i>Heracleum sphondylium</i>
<i>Veronica chamaedrys</i>
<i>Galium</i> sp.
<i>Achillea millefolium</i>
<i>Chamaenerion angustifolium</i>
<i>Rumex acetosa</i>
<i>Cytisus scoparius</i>
<i>Rubus fruticosus</i>
<i>Quercus</i> sp. sapling
<i>Pinus</i> sp. sapling

Notes and Comments: 11 subsamples taken around an area 25m in diameter - the approx. size of the clearing. Very close to NW end of the grazed field (Site 28), but separated by a fence. Site 27 is damp although 2-3m higher than the field - suggesting an underground water source close to the surface.

Photographic Images: 2013 - Fig. 16 27A - Forest Clearing, NE side (looking S)

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **27 B**      Grid ref: **SN 3914 0270**      Date: 13<sup>th</sup> November 2013

Weather: dull, cool 8°C, NW brisk cold wind, dense vegetation mat damp from overnight rain

Characteristics of the Sample Location: a small damp clearing within the forest with a very uneven surface as though rutted by heavy forestry machinery; to one side of a ride designated for horse riding and mown regularly; possibly an area with subsurface water although the site is on slightly higher ground than some adjacent areas; wet woodland lower to east and north.

Vegetation Structure: mostly a herb layer of grasses and moss, with a thick mat, with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens* and *Rosa pimpinellifolia*. Vegetation suggests a permanently damp area.

Subsample size & no: 70cm x 70cm x 1	Hence area sampled: 0.5m <sup>2</sup>	Sampling time: 30 min
Layer sampled: herb + 2.5cm soil layer	Method: cut + soil - see notes	Time: 1430h

Molluscs recorded:	alive / fresh				dead / old			
	adult		juv.		adult		juv.	
	cut	soil	cut	soil	cut	soil	cut	soil
<i>Carychium tridentatum</i>	5	13	3	3	-	12	1	3
<i>Cochlicopa cf. lubricella</i>	4	3	19	12	2	12	3	86
<i>Discus rotundatus</i>	-	1	-	1	-	-	-	1
<i>Cepaea nemoralis</i>	2	-	1	-	1	-	2	-
<i>Candidula intersecta</i>	-	-	-	1	-	3	-	17
<i>Trochulus hispidus</i>	-	-	-	2	2	1	6	9
<i>Lauria cylindracea</i>	-	-	-	-	-	2	-	-
<i>Nesovitrea hammonis</i>	-	-	-	9	-	-	-	7
<i>Oxychilus</i> sp.	-	-	-	9	-	-	1	10
<i>Punctum pygmaeum</i>	-	-	-	-	-	5	3	16
<i>Acanthinula aculeata</i>	-	11	-	4	-	20	3	10
<i>Vallonia excentrica</i>	11	-	22	-	5	-	21	-
<i>Vertigo pygmaea</i>	2	5	3	7	5	23	3	6
<i>Vertigo substriata</i>	13	22	8	2	3	13	1	3
<i>Vertigo angustior</i>	9	18	2	7	9	23	3	7
<i>Vitrina pellucida</i>	-	-	-	-	-	-	-	2
Two tubes of specimens								
- one for cut vegetation								
- one for soil sample								

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Holcus</i> sp.
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
moss
<i>Salix repens</i>
<i>Rosa pimpinellifolia</i>
Others:
<i>Dactylis glomerata</i>
<i>Festuca gigantea</i>
<i>Geranium</i> sp.
<i>Ranunculus repens</i>
<i>Centaurea nigra</i>
<i>Plantago lanceolata</i>
<i>Heracleum sphondylium</i>
<i>Veronica chamaedrys</i>
<i>Galium</i> sp.
<i>Achillea millefolium</i>
<i>Chamaenerion angust.</i>
<i>Rumex acetosa</i>
<i>Cytisus scoparius</i>
<i>Rubus fruticosus</i>
<i>Quercus</i> sp. sapling
<i>Pinus</i> sp. sapling

Notes and Comments: a) 70cm x 70cm herbage cut off, bagged, dried and progressively sieved in lab.

b) 70cm x 70cm x 2.5cm top soil layer removed, dried and progressively sieved in lab. Reason - to investigate apparently poor field result of sample 27A. 27B was the productive spot sampled in 2012

Photographic Images: 2013 - Fig. 17 27B - Forest Clearing, NE side (looking S)

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **27 C**      Grid ref: **SN 3914 0270**      Date: 22<sup>nd</sup> November 2013

Weather: dull, cool 9°C, calm, fairly dry

Characteristics of the Sample Location: a small damp clearing within the forest with a very uneven surface as though rutted by heavy forestry machinery; to one side of a ride designated for horse riding and mown regularly; possibly an area with subsurface water although the site is on slightly higher ground than some adjacent areas; wet woodland lower to east and north.

Vegetation Structure: mostly a herb layer of grasses and moss, with a thick mat, with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens* and *Rosa pimpinellifolia*. Vegetation suggests a permanently damp area.

Subsample size & no: 50cm x 50cm x 1	Hence area sampled: 0.25m <sup>2</sup>	Sampling time: 15 min
Layer sampled: herb + soil surface	Method: cut + vac - see Notes	Time: 1500h

Molluscs recorded:	alive / fresh				dead / old			
	adult		juv.		adult		juv.	
	cut	vac	cut	vac	cut	vac	cut	vac
<i>Carychium tridentatum</i>	8	7	-	1	3	23	-	6
<i>Cochlicopa</i> sp.	-	-	4	-	-	-	5	-
<i>Cochlicopa</i> cf. <i>lubricella</i>	4	5	-	17	-	3	-	20
<i>Discus rotundatus</i>	-	-	-	-	-	-	-	4
<i>Cepaea nemoralis</i>	7	-	2	1	-	-	2	-
<i>Trochulus hispidus</i>	-	-	-	-	-	2	-	3
<i>Trochulus striolatus</i>	-	-	-	1	-	-	-	-
<i>Lauria cylindracea</i>	-	-	-	-	1	-	-	-
<i>Nesovitrea hammonis</i>	-	1	1	14	-	2	1	5
<i>Oxychilus</i> sp.	-	-	8	2	-	-	1	3
<i>Punctum pygmaeum</i>	-	-	-	-	-	-	-	1
<i>Acanthinula aculeata</i>	-	1	-	1	-	4	-	-
<i>Vallonia excentrica</i>	2	5	4	4	6	17	3	36
<i>Vertigo pygmaea</i>	-	3	-	1	-	11	-	-
<i>Vertigo substriata</i>	-	4	1	4	2	8	3	2
<i>Vertigo angustior</i>	-	2	-	2	-	11	-	-
One tube of specimens								

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Holcus</i> sp.
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
moss
<i>Salix repens</i>
<i>Rosa pimpinellifolia</i>
Others:
<i>Dactylis glomerata</i>
<i>Festuca gigantea</i>
<i>Geranium</i> sp.
<i>Ranunculus repens</i>
<i>Centaurea nigra</i>
<i>Plantago lanceolata</i>
<i>Heracleum sphondylium</i>
<i>Veronica chamaedrys</i>
<i>Galium</i> sp.
<i>Achillea millefolium</i>
<i>Chamaenerion angust.</i>
<i>Rumex acetosa</i>


<i>Cytisus scoparius</i>
<i>Rubus fruticosus</i>
<i>Quercus</i> sp. sapling
<i>Pinus</i> sp. sapling

Notes and Comments: a) 50cm x 50cm herbage cut off, bagged, dried and progressively sieved in lab.  
 b) 50cm x 50cm soil surface G-vacced thoroughly. Reason - to investigate apparently poor field result of sample 27A. 27C was close to the productive spot sampled in 2012

Photographic Images: 2013 - as for Fig. 17 27B

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>27 X</b>	Grid ref: <b>SN 3914 0270</b>	Date: 12 <sup>th</sup> August 2012
-------------------------------	-------------------------------	------------------------------------

Weather: dry, warm, cloudy with bright periods, light variable breeze

Characteristics of the Sample Location: a small damp clearing (even in summer) within the forest with a very uneven surface as though rutted by heavy forestry machinery; to one side of a ride designated for horse riding and mown regularly; possibly an area with subsurface water although the site is on slightly higher ground than some adjacent areas; wet woodland lower to east and north.

Vegetation Structure: mostly a herb layer of grasses and moss, with a thick mat, with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens* and *Rosa pimpinellifolia*. Vegetation suggests a permanently damp area.

Subsample size & no: 20cm circles x 12	Hence area sampled: 0.5m <sup>2</sup>	Sampling time: 15 min
Layer sampled: herb and soil surface	Method: G-vac - see Notes	Time: 1500h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium tridentatum</i>	17	-	2	-
<i>Cochlicopa</i> sp.	-	2	-	-
<i>Trochulus hispidus</i>	-	13	-	-
<i>Punctum pygmaeum</i>	30	40	11	-
<i>Acanthinula aculeata</i>	4	8	-	-
<i>Vallonia costata</i>	1	2	-	-
<i>Vallonia</i> cf. <i>excentrica</i>	7	-	-	-
<i>Collumella aspera</i>	3	12	-	-
<i>Vertigo pygmaea</i>	24	54	2	-
<i>Vertigo substriata</i>	36	16	1	-
<i>Vertigo angustior</i>	82	150	8	1

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Holcus</i> sp.
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
moss
<i>Salix repens</i>
<i>Rosa pimpinellifolia</i>
Others:
<i>Dactylis glomerata</i>
<i>Festuca gigantea</i>
<i>Geranium</i> sp.
<i>Ranunculus repens</i>
<i>Centaurea nigra</i>
<i>Plantago lanceolata</i>
<i>Heracleum sphondylium</i>


<i>Veronica chamaedrys</i>
<i>Galium</i> sp.
<i>Achillea millefolium</i>
<i>Chamaenerion angustifolium</i>
<i>Rumex acetosa</i>
<i>Cytisus scoparius</i>
<i>Rubus fruticosus</i>
<i>Quercus</i> sp. sapling
<i>Pinus</i> sp. sapling

Notes and Comments: grass / herb layer was densely felted so penetrating it and forming a working space was slow, and each sample was limited in area. What is striking about this sample is the dearth of dead juveniles, and the very few dead adult snails - as though the site has been "colonised" and populated only recently. This compares with the following year when samples 27B and 27C seem to show the reverse - with large numbers of dead snails.

Photographic Images: 2012 - none;  
2013 - as for Fig. 17 27B



**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: **28 A**Grid ref: **SN 393 026**Date: 22<sup>nd</sup> November 2013

Weather: dull, cool 8°C, calm, slight rain showers

Characteristics of the Sample Location: agricultural rough grazing with scattered scrub fenced off from the forest, but surrounded by the forest or woodland on all sides - at the rear of the dune system. Relatively dry soil on old dunes, but wet at the NW end where there are scrub thickets - very closely adjacent to the productive site 27.

Vegetation Structure: mostly a herb layer of grasses and moss with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens*, *Rosa pimpinellifolia* and *Prunus spinosa*.

Subsample size &amp; no: 25cm x 25cm x 16

Hence area sampled: 1.0m<sup>2</sup>

Sampling time: 10 min

Layer sampled: herb layer to soil surface

Method: G-vac

Time: 1600h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Carychium minimum</i>	-	1	-	-
<i>Cochlicopa</i> sp.	-	3	-	2
<i>Trochulus hispidus</i>	-	-	-	1
<i>Nesovitrea hammonis</i>	-	1	-	-
<i>Acanthinula aculeata</i>	-	-	1	-
<i>Vallonia excentrica</i>	1	-	2	1
<i>Columella aspera</i>	-	-	1	-
<i>Vertigo pygmaea</i>	2	-	-	-
<i>Vertigo substriata</i>	-	-	1	-

Plants recorded:
Dominants:
<i>Festuca</i> sp.
<i>Holcus</i> sp.
<i>Agrostis</i> sp.
<i>Carex arenaria</i>
moss
Others:
<i>Dactylis glomerata</i>
<i>Rumex acetosa</i>
<i>Geranium</i> sp.
<i>Ranunculus repens</i>
<i>Centaurea nigra</i>
<i>Betula pubescens</i>
<i>Crataegus monogyna</i>
<i>Rosa pimpinellifolia</i>
<i>Rubus fruticosus</i>
<i>Salix repens</i>
<i>Ulex</i> sp.
<i>Cytisus scoparius</i>
<i>Prunus spinosa</i>
<i>Hippophae rhamnoides</i>

Comments: The NW end of the field is very close to the productive site 27 in the forest, but separated from it by a fence. Both areas are damp, despite this end of the field being 2 - 3m lower - suggesting an underground water source close to the surface. G-vac sampling was concentrated in the longer herb vegetation protected from grazing within the scrub patches.

Photographic Images: 2013 – Fig. 18 28A - Rough Grazing on NE side of forest (looking NE)

**Surveillance of *Vertigo angustior* at Pembrey, Carmarthen Bay Dunes SAC**

Site / Sample No: <b>29 A</b>	Grid ref: <b>SN 39203 02644</b>	Date: 12 <sup>th</sup> January 2014
-------------------------------	---------------------------------	-------------------------------------

Weather: Very grey and dull, cold 8°C, cold south-west breeze, but sheltered in the forest

Characteristics of the Sample Location: Small clearing at the edge of NE side of forest next to a designated horse ride, and closely adjacent to a fenced rough grazing. Damp with lots of moss and marsh plants but dry underfoot in summer.

Vegetation Structure: mostly a herb layer of moss and grasses with taller vegetation in patches. Dispersed young shrubs and trees. Patches of *Salix repens*.

Subsample size & no: 25cm x 25cm x 8	Hence area sampled: 0.5m <sup>2</sup>	Sampling time: 5 min
Layer sampled: herb layer to soil surface	Method: G-vac	Time: 1300h

Molluscs recorded:	alive / fresh		dead / old	
	adult	juv.	adult	juv.
<i>Cochlicopa cf. lubrica</i>	-	1	-	1
<i>Cepaea nemoralis</i>	-	1	-	2
<i>Aegopinella nitidula</i>	-	4	-	1
<i>Oxychilus alliarius</i>	-	1	-	-
<i>Punctum pygmaeum</i>	1	-	-	-
<i>Acanthinula aculeata</i>	1	-	-	-

Plants recorded:
Dominants:
moss
<i>Salix repens</i>
<i>Carex arenaria</i>
<i>Festuca</i> sp.
<i>Holcus</i> sp.
Others:
<i>Molinia caerulea</i>
<i>Dactylis glomerata</i>
<i>Deschampsia caespitosa</i>
<i>Rosa pimpinellifolia</i>
<i>Heracleum sphondylium</i>
<i>Betula pubescens</i>
<i>Crataegus monogyna</i>
<i>Pinus</i> sp.
<i>Rubus fruticosus</i>
<i>Centaurea nigra</i>

Comments: It is close to the productive site 27 but separated from it by a low ridge. Despite being near the top of higher ground in the forest the area is damp - suggesting an underground water source close to the surface.

Photographic Images: 2013 - no photo

11.3. Mollusc species found during survey for *Vertigo angustior*, 2013-14

	frequently used synonyms
<i>Potamopyrgus antipodarum</i>	
<i>Peringia ulvae</i>	<i>Hydrobia ulvae</i>
<i>Deroceras laeve</i>	
<i>Carychium minimum</i>	
<i>Carychium tridentatum</i>	
<i>Clausilia bidentata</i>	
<i>Cochlicopa cf. lubrica</i>	<i>Cochlicopa lubrica</i>
<i>Cochlicopa cf. lubricella</i>	<i>Cochlicopa lubricella</i>
<i>Discus rotundatus</i>	
<i>Myosotella myosotis</i>	<i>Ovatella myosotis</i>
<i>Ena obscura</i>	
<i>Euconulus cf. alderi</i>	<i>Euconulus alderi</i>
<i>Euconulus cf. fulvus</i>	<i>Euconulus fulvus</i>
<i>Cecilioides acicula</i>	
<i>Cepaea nemoralis</i>	
<i>Ashfordia granulata</i>	
<i>Candidula intersecta</i>	
<i>Trochulus hispidus*</i>	
<i>Trochulus sericeus*</i>	
<i>Trochulus striolatus</i>	<i>Trichia striolata</i>
<i>Lauria cylindracea</i>	
<i>Galba truncatula</i>	<i>Lymnaea truncatula</i>
<i>Lymnaea fuscus</i>	<i>Lymnaea palustris s.l.</i>
<i>Radix balthica</i>	<i>Lymnaea peregra</i>
<i>Aegopinella pura</i>	
<i>Aegopinella nitidula</i>	
<i>Nesovitrea hammonis</i>	
<i>Oxychilus alliarius</i>	
<i>Oxychilus cellarius</i>	
<i>Oxychilus draparnaudi</i>	
<i>Oxychilus navarricus helveticus</i>	<i>Oxychilus helveticus</i>
<i>Aplexa hypnorum</i>	
<i>Physa fontinalis</i>	
<i>Vitrea contracta</i>	
<i>Vitrea crystallina</i>	
<i>Punctum pygmaeum</i>	
<i>Pupilla muscorum</i>	
<i>Succinea cf. putris*</i>	
<i>Acanthinula aculeata</i>	
<i>Vallonia costata</i>	
<i>Vallonia cf. excentrica</i>	<i>Vallonia excentrica</i>
<i>Vallonia pulchella</i>	
<i>Columella aspera</i>	
<i>Columella edentula</i>	
<i>Vertigo antivertigo</i>	
<i>Vertigo pygmaea</i>	
<i>Vertigo substriata</i>	
<i>Vertigo angustior</i>	
<i>Vitrina pellucida</i>	

Nomenclature from Anderson (2005, updated)

\* these species require dissection to be certain of identification



**Cyfoeth  
Naturiol**  
Cymru  
**Natural  
Resources**  
Wales

Published by:  
Natural Resources Wales  
Maes-y-ffynnon  
Penrhosgarnedd  
Bangor  
Gwynedd  
LL57 2DW

0300 065 3000 (Mon-Fri, 8am - 6pm)

© Natural Resources Wales 2014

All rights reserved. This document may be reproduced with prior permission of  
Natural Resources Wales

Further copies of this report are available from:

Email: [library@cyfoethnaturiolcymru.gov.uk](mailto:library@cyfoethnaturiolcymru.gov.uk)