



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

Surveys for Desmoulin's Whorl Snail *Vertigo moulinsiana* on Cors Geirch NNR/SSSI and the Afon Penrhos floodplain & for Geyer's Whorl Snail *Vertigo geyeri* on Cors Geirch NNR in 2017

Martin Willing

NRW Evidence Report No. 258



Figure1. Newly discovered *Vertigo moulinsiana* habitat at Afon Penrhos.

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: 258
 Publication date: April 2018
 Contract number:
 Contractor: Dr. M.J. Willing
 Contract Manager: Dr M.A. Howe
 Title: **Surveys for Desmoulin’s Whorl Snail *Vertigo moulinsiana* on Cors Geirch NNR/SSSI and the Afon Penrhos floodplain & for Geyer’s Whorl Snail *Vertigo geyeri* on Cors Geirch NNR in 2017**
 Author: Martin Willing
 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)

Mike Howe, NRW Invertebrate Ecologist
 Jo Clark, NRW Senior Conservation Officer
 Emyr Humphreys, NRW Senior Manager, Anglesey & Llŷn wetlands

Recommended citation for this volume:

Willing, M.J. 2018. Surveys for Desmoulin’s Whorl Snail *Vertigo moulinsiana* on Cors Geirch NNR/SSSI and the Afon Penrhos floodplain & for Geyer’s Whorl Snail *Vertigo geyeri* on Cors Geirch NNR in 2017. NRW Evidence Report No. 258, 23pp, Natural Resources Wales, Bangor.

Contents

1.	Crynodeb Gweithredol	1
2.	Executive Summary	2
3.	Introduction	3
	3.1. <i>Vertigo moulinsiana</i>	3
	3.1.1. Background information.....	3
	3.1.2. Objectives of 2017 survey.....	4
	3.2. <i>Vertigo geyeri</i>	4
	3.2.1. Background information.....	4
	3.2.2. Objectives of 2017 survey.....	5
4.	Methods	6
	4.1. <i>Vertigo moulinsiana</i>	6
	4.2. <i>Vertigo geyeri</i>	8
5.	Results	9
	5.1. <i>Vertigo moulinsiana</i> at Afon Penrhos.....	9
	5.2. <i>Vertigo moulinsiana</i> at Cors Geirch	12
	5.3. <i>Vertigo geyeri</i> at Cors Geirch.....	12
6.	Discussion.....	12
	6.1. <i>Vertigo moulinsiana</i> at Afon Penrhos.....	12
	6.2. <i>Vertigo moulinsiana</i> at Cors Geirch.....	13
	6.3. <i>Vertigo geyeri</i> at Cors Geirch.....	13
7.	Conclusions & Recommendations.....	13
	7.1. <i>Vertigo moulinsiana</i>	13
	7.2. <i>Vertigo geyeri</i>	14
8.	Acknowledgements.....	14
9.	References.....	14
10.	Appendix 1. Site locations, brief habitat descriptions, molluscan presence (Tables 3-5).....	17
11.	Appendix 2. Site images for Afon Penrhos and Cors Geirch (Figures 6-25).....	19
12.	Appendix 3. Data Archive Appendix.....	23

List of Figures

Figure 1.	Newly discovered <i>Vertigo moulinsiana</i> habitat at Afon Penrhos	frontispiece
Figure 2.	Survey blocks on Afon Penrhos floodplain for <i>Vertigo moulinsiana</i>	7
Figure 3.	Survey location for <i>Vertigo moulinsiana</i> on Cors Geirch	7
Figure 4.	Survey location on Cors Geirch for <i>Vertigo geyeri</i>	8
Figure 5a.	<i>Vertigo moulinsiana</i> distribution on the Afon Penrhos floodplain.....	11
Figure 5b.	<i>Vertigo moulinsiana</i> distribution on the Afon Penrhos floodplain.....	11

List of Tables

Table 1.	<i>Vertigo moulinsiana</i> on Afon Penrhos, October 2017	10
Table 2.	<i>Vertigo moulinsiana</i> records from Afon Penrhos, 2016-17.....	10

1. Crynodeb Gweithredol

Cynhaliwyd arolwg ym mis Hydref 2017 i bennu terfynau dwyreiniol cynefin malwen droellog Desmoulin *Vertigo moulinsiana* ar orlifdir Afon Penrhos yn dilyn arolwg blaenorol ar ran orllewinol y safle yn 2016. Cynhaliwyd arolwg ar bron pob cynefin addas. Er na ddarganfuwyd y falwen yn y rhan fwyaf o ardaloedd newydd lle gwnaed arolwg, nodwyd 0.5ha o gynefin *V. moulinsiana* ychwanegol, ac mae hwn yn cydgyffwrdd â'r bloc o gynefin lle mae'r falwen yn bresennol sydd yn uniongyrchol i'r gorllewin, lle gwnaed arolwg yn 2016. Ystyriwyd bod ardaloedd o gynefin nad oeddent yn cynnal y falwen yn rhy sych a/neu'n rhy asidig i gynnal y falwen. Cyfrifir mai isafswm cyfanswm arwynebedd gorlifdir Afon Penrhos lle mae *V. moulinsiana* yn bresennol yw 11.07ha, gydag uchafswm posibl o 13.2ha os yw nifer o'r ardaloedd cyfagos sydd efallai yn addas ond nad ydynt wedi bod yn destun arolwg eto yn cynnal y falwen hefyd. Poblogaeth Afon Penrhos yw nid yn unig y mwyaf o'r tair poblogaeth yng Nghymru, ond yn ôl pob tebyg un o'r mwyaf ar dir mawr Prydain. Mae arwyddocâd y boblogaeth sy'n byw yma yn fwy byth yn sgil gostyngiadau sylweddol yn ddiweddar ym mhoblogaethau nifer o ardaloedd cadwraeth arbennig yn ne Lloegr ac yn yr ardal cadwraeth arbennig gyfagos Corsydd Llŷn (Gwarchodfa Natur Genedlaethol / Safle o Ddiddordeb Gwyddonol Arbennig Cors Geirch). Gan fod holl gynefin tebygol y boblogaeth ar safle Afon Penrhos yn hysbys erbyn hyn, argymhellir y dylid dynodi'r safle yn Safle o Ddiddordeb Gwyddonol Arbennig er mwyn lleihau'r perygl o golled neu ddifrod o ganlyniad i newidiadau i'r modd y caiff y safle ei reoli.

Datgelodd arolygon a wnaed ar Safle o Ddiddordeb Gwyddonol Arbennig Cors Geirch rhwng 1999 a 2008 bresenoldeb poblogaeth fawr a helaeth o *V. moulinsiana*, ond dangosodd gwaith ymchwil yn 2016 ddirywiad sylweddol, heb unrhyw gregyn i'w cael yn un o'r priif ardaloedd yn rhan ogleddol y safle. Yn 2017, ymwelwyd â'r ardal hon unwaith eto a chanfuwyd pedair malwen fyw yn unig, ar ôl ymchwiliad estynedig gan ddau o bobl, mewn llystyfiant ffen byrrach yn yr hen gadarnle hwn, gan ddangos bod gan y falwen bresenoldeb gweddilliol. Yn 2016, ystyriwyd mai lledaeniad llystyfiant ffen rhy drwchus heb ei bori na'i dorri oedd yn debygol o fod yn gyfrifol am ddirywiad y falwen, wedi'i gyfuno â choed bedw a phrysg helyg yn ennill tir. Mae cyngor rheoli a roddwyd yn 2017 (yn ailadrodd yr hyn a gafwyd yn 2016) yn awgrymu camau adfer er mwyn ceisio adfer y falwen drwy dorri prysg sy'n ennill tir a chlystyrau mwy trwchus o lymfrwynen *Cladium mariscus* a chorsen cyrs *Phragmites australis* yn ôl er mwyn annog datblygiad ffen lle mae brwyn yn goruchafu.

Cadarnhawyd niferoedd isel o falwen droellog Geyer *Vertigo geyeri* ar hyd nifer fechan o leoliadau yng Nghors Geirch rhwng 1996 a 2005. Ailsamplodd arolygon yn 2016 yr holl leoliadau a gadarnhawyd yn y gorffennol a lle amheuwyd presenoldeb y falwen, ond ni ddaethpwyd o hyd iddi. Ailymwelodd arolwg 2017 ag un ardal o 'lawnt hesg' a borwyd gan geffylau lle'r oedd *V. geyeri* wedi cael ei adrodd yn 1998 ac yr ystyriwyd mai dyma oedd yr ardal fwyaf tebygol yn y warchodfa i gynnal niferoedd isel o'r falwen o hyd. Er gwaethaf tynnu samplau mawr o tua 0.5ha, ni chanfuwyd unrhyw sbesimenau. Mae'n ymddangos yn debygol fod *V. geyeri* wedi diflannu o Gors Geirch ac, oherwydd hyn, o ACA Corsydd Llŷn.

2. Executive Summary

A survey was undertaken in October 2017 to determine the eastern distribution limits of Desmoulin's Whorl Snail *Vertigo moulinsiana* on the Afon Penrhos floodplain following a previous survey covering the western part of the site in 2016. Virtually all potentially suitable habitat was surveyed. Although most new survey areas proved negative, an additional 0.5ha of *V. moulinsiana* habitat was identified, this being contiguous with the occupied habitat block lying to the immediate west surveyed in 2016. Areas of habitat not supporting the snail were judged to be too dry and/or too acidic to support it. It is calculated that the minimum total area of the Afon Penrhos floodplain occupied by *V. moulinsiana* is 11.07ha, with a possible maximum of 13.2ha if a number of adjoining but potentially suitable un-surveyed areas also support the snail. The Afon Penrhos population is not only the largest of three in Wales, but also probably one of the largest in mainland Britain. The significance of the population here is further enhanced by recent considerable population losses at several SACs in southern England and on the nearby Corsydd Llŷn SAC (Cors Geirch NNR/SSSI). Now that the probable full extent of the population on Afon Penrhos is known, it is recommended that the site should be notified as a SSSI to reduce any risk of loss or damage due to changes in site management.

Survey on Cors Geirch SSSI between 1999 and 2008 had shown the presence of a large and extensive population of *V. moulinsiana*, but work in 2016 demonstrated a considerable decline with no shells found in one of the key areas toward the north of the site. In 2017, this area was revisited and an extended search by two people located just four live snails in shorter fen vegetation in this former stronghold demonstrating a residual presence of the snail. In 2016, it was considered that the decline of the snail was likely to be the result of the spread of uncut and un-grazed rank, fen vegetation combined with encroaching birch and willow scrub. Management advice in 2017 (repeating that from 2016) suggests remedial action to attempt a recovery of the snail by the cutting back of encroaching scrub and denser stands of Saw-sedge *Cladium mariscus* and Common Reed *Phragmites australis* in favour of shorter *Juncus*-dominated fen.

Low numbers of Geyer's Whorl Snail *Vertigo geyeri* were confirmed in a scattering of locations at Cors Geirch between 1996 and 2005. Surveys in 2016 re-sampled all previously confirmed and suspected locations but failed to find the snail. The 2017 survey revisited one area of horse-grazed 'Carex-lawn' where *V. geyeri* had been reported in 1998 and which was considered the most likely area on the reserve to still support low numbers of the snail. Despite the removal of large samples from across about 0.5ha, no specimens were found. It seems likely that *V. geyeri* has been lost from Cors Geirch and, as a consequence, from Corsydd Llŷn SAC.

3. Introduction

3.1. *Vertigo moulinsiana*

3.1.1. Background information

Desmoulin's Whorl Snail *Vertigo moulinsiana* (Dupuy, 1849) is a small snail found mostly in old or semi-natural open, calcareous fen and wetlands, usually adjacent or close to rivers, streams, lakes and ponds. In the UK, it is chiefly distributed in a broad band of country from central-southern England to East Anglia (Kerney, 1999). Outlying populations also exist in north and mid-Wales, the north-west English Midlands and north Cornwall. It was categorised as Rare (category 3) in the UK Red Data Books (Bratton, 1991), and more recently as Vulnerable on the IUCN-based UK red list status review (Seddon *et al.*, 2014). The snail is listed on Annex IIa of the European Community Habitats and Species Directive (92/43/EEC) and is also a Welsh Section 7 'Species of Principal Importance'.

V. moulinsiana is known from just three localities in Wales; Cors Geirch NNR/SSSI and the Afon Penrhos floodplain near Pwllheli on the Llŷn peninsula, and Rhos Goch National Nature Reserve near Hay-on-Wye in Radnorshire, where a recent survey has highlighted a strong population (Willing, 2016). It is a feature of Corsydd Llŷn – Lleyn Fens SAC of which Cors Geirch is a part, but there is currently no statutory protection for the site on the Afon Penrhos floodplain. All of the Welsh *V. moulinsiana* sites are isolated and do not closely resemble the lake and river-side, base-rich fens which the snail is typically associated with at most of its English sites. The nearest English *V. moulinsiana* sites to Afon Penrhos and Cors Geirch lie in the north-west Midlands (meres in Shropshire & Cheshire) (Cousins, 2015; Kerney, 1999). Although they have very different habitats, the Afon Penrhos and Cors Geirch sites only lie about 2.5 km apart.

V. moulinsiana was first found on the Afon Penrhos floodplain by Dylan Lloyd in October 2002, who recorded it again in June 2003 when it was associated with emergent Meadowsweet *Filipendula ulmaria* and Yellow Flag *Iris pseudacorus* along a ditch-line. It was recorded in abundance at the same location in an area of open fen in 2008, although a wider search failed to find additional populations and the population boundaries were not delineated (Willing, 2008). It was recorded again in 2010 by John Bratton. A brief visit in October 2015 by Dylan Lloyd and Mike Howe of NRW failed to find the snail but highlighted major land management changes to the previously-occupied area, including drainage, ditch clearance, scrub removal and sheep grazing. In October 2016, a large area at the western end of the Afon Penrhos floodplain was surveyed (including all areas previously found supporting the snail) and the snail was found in large numbers in short, mechanically-cut and lightly horse-grazed 'fen-meadow'; tall uncut fen supported significantly lower numbers (Willing, 2017c). Elsewhere in the UK, the snail is typically associated with tall fen. *V. moulinsiana* was recorded on about 19 acres (8 hectares) of the site, but population boundaries were not established on the eastern and south-east borders of the surveyed area. The Afon Penrhos population is not only the largest in Wales, but also probably one of the largest in mainland Britain.

Following the discovery of *V. moulinsiana* on Cors Geirch by Barry Colville in 1998, a survey in October 1999 highlighted that the population was confined to the south-east

section of the site where more than 700 shells were associated with three permanently-wet ditches and an area of fen vegetation (Killeen, 2000). A survey in November 2003 led to the development of a 'common standards' condition assessment protocol for the site (Killeen, 2004; Killeen & Moorkens, 2003) and the snail population was assessed as being in Favourable Condition, although some scrub encroachment was noted (Killeen, 2004). A repeat assessment in 2008, but with some methodology modifications, found habitat in good condition and an increase in *V. moulinsiana* area of occupancy, but a decline in total snail numbers from an average of 16 per sample in 2003 to five per sample in 2008, although the population was assessed to be in Favourable Condition (Lloyd, 2008a). A survey of all previously *V. moulinsiana* sites was undertaken in October 2016 (Willing, 2017c) and the population was found to have declined considerably, with a complete loss of the snail from former stronghold areas; just 17 snails were recorded from two small areas at the southern end of the site. With an eight-year monitoring hiatus, the causes of the sharp decline were unclear, but were likely to include the spread of uncut and un-grazed rank, fen vegetation combined with encroaching birch and willow. Dense vegetation growth at the site was such that the former ditch-lines, used as features for site monitoring, were almost completely obscured and difficult to reach.

3.1.2. Objectives of 2017 survey

Following the 2016 Afon Penrhos survey, it was estimated that a further 75 acres (30 hectares) of potentially-suitable habitat exists which should be surveyed to determine if it supports the snail. This project was undertaken to continue the *V. moulinsiana* surveys to determine if these potentially-suitable areas of fen lying to the east of the 2016 survey area support further populations of the snail.

The 2016 survey of Cors Geirch found no *V. moulinsiana* in the northern area formerly used as the location of a monitoring transect and where the snail had previously been found in abundance. Further survey work was required to determine if this earlier survey coincided with a population trough. As a result, a further visit to this area was planned to see if the snail losses were permanent or if a recovery had occurred.

3.2. *Vertigo geyeri*

3.2.1. Background information

Geyer's Whorl Snail *Vertigo geyeri* is a rare, boreal species that was widespread in Britain in the pre-wooded Late-glacial and early Post-glacial (Kerney, 1999). It is only known from one small site in lowland southern Britain (Holyoak *et al.*, 2006, Willing, 2011) and exhibits a relict distribution pattern elsewhere in upland regions of the British mainland where it is present at nine known centres of distribution (Kerney, 1999, Conchological Society database)¹. The conservation importance of the species has resulted in its inclusion in various schedules and red data lists. Categorised as Endangered (category 1) in the UK Invertebrate Red Data Book (Bratton, 1991), it has recently classed as Near Threatened/Nationally Scarce (Seddon *et al.*, 2014). The species is listed in Annex IIa of the European Community Habitats and Species

¹ UK mainland areas and number of 10km squares occupied (bracketed): England: central Norfolk (1), central Pennines (3), North York Moors (2); Wales: Anglesey (2), Llŷn Peninsula (1); Scotland: Perthshire (5), Deeside (2), Black Isle (1), Islay (5). *V. geyeri* reported from the Brecon Beacons were mis-identifications (Willing, 2012).

Directive (92/43/EEC) and is also a Welsh Section 7 ‘Species of Principal Importance’. In Britain, *V. geyeri* lives in open, un-shaded, permanently wet calcareous flushes and fens. Sites are dominated by small sedges, rushes and mosses. Examples of typical associate plants include *Carex viridula* and subsp. *brachyrrhyncha*, *Pinguicula vulgaris*, *Briza media*, *Equisetum palustre*, *Juncus articulatus* and the mosses *Drepanocladus revolvens* and *Campylium stellatum*, with scattered tussocks of *Schoenus nigricans*. The snail requires surface water levels to be mostly close to the ground surface for most of the year (Cameron *et al.*, 2003; Kuczyńska & Moorkens, 2010).

V. geyeri is known from just three localities in Wales; it was first reported in the country in 1985 with a find at Cors Erddreiniog NNR on Anglesey in 1985 when the author of this report recorded a fossil shell in postglacial tufa whilst live specimens were found there in 1988 (Boyce *et al.*, 1992; Holmes *et al.*, 1995). *V. geyeri* was later found at a second Anglesey site, Waun Eurad SSSI, by Adrian Fowles in 1996 (record from NRW Welsh Invertebrate Database). A third Welsh *V. geyeri* population was found on Cors Geirch SSSI (part of Corsydd Llŷn/Lleyn Fens SAC) by Adrian Fowles in 1996 “from tussocks in wet valley fen with *Schoenus* but no tufa” (Adrian Fowles, pers. comm.). A contract was let by the Countryside Council for Wales to Barry Colville to undertake a wider search on Cors Geirch in 1998 and on other sites on the Llŷn peninsula (Colville, 1999). The snail was found close to the original location and in an atypical area on the adjacent Cors Geirch NNR dominated by Bog Myrtle *Myrica gale* and Purple Moor-grass *Molinia caerulea*. Searches on Cors Edern SSSI and Aber Geirch SSSI failed to locate the snail. Habitat and population condition assessments on Cors Geirch in 2005 and 2008 included a wider search of suitable habitat and of past locations and found two shells and four shells (the identification of latter four shells still to be confirmed) respectively at single, but different locations, one in the SSSI (2005) and one in the NNR (2008) (Lloyd, 2005, 2008b). Dylan Lloyd and Mike Howe visited the 2008 location on Cors Geirch NNR on 19th October 2015 but failed to record any *V. geyeri* in the four vegetation samples collected, the only *Vertigo* being a single *V. pygmaea*. Voucher specimens from 2005 have been confirmed by the author of this report but no vouchers of the four specimens recorded in 2008 have been seen.

In October 2016, all previous reported *V. geyeri* sites on Cors Geirch (1996 to 2008) were re-surveyed (Willing, 2017b) but these failed to locate the snail despite the removal and laboratory processing of numerous, large bulk samples. *V. geyeri* losses from known locations on Cors Geirch appear to be due to the development of a rank ‘tussocky’ sward that has reduced or eliminated the lightly-grazed ‘*Carex*-lawn’ habitat because of under-grazing.

3.2.2. Objectives of 2017 survey

As small populations of *V. geyeri* can be easily overlooked, it was considered premature to declare the snail as extinct on Cors Geirch. The 2017 survey resampled an area of closely horse-cropped ‘*Carex* lawn’ spring-fed fen, near to where B. Colville had recorded the snail in 1998. This area was considered, by the author, to be at least superficially like areas of *V. geyeri* habitat on the island of Islay in western Scotland (Willing, 2013). Although a single negative sample was removed from this area in 2016, the further survey was considered appropriate because of the potential suitability and extent of the habitat (estimated at >0.5ha).

4. Methods

4.1. *Vertigo moulinsiana*

Surveys on the Afon Penrhos floodplain were completed on 16th and 17th October 2017, with Cors Geirch visited on 17th October 2017. Survey days were selected to ensure the dry conditions needed to undertake sampling. Survey locations at Afon Penrhos are displayed in Figure 2 and for Cors Geirch on Figure 3, with descriptions given in Tables 3 and 4 in Appendix 1.

Survey methodology broadly followed the 'level 1' survey techniques detailed in Killeen & Moorkens (2003). Consequently, searches for *V. moulinsiana* climbing upon wetland vegetation were carried out by the well-established technique of beating herbaceous fen vegetation onto a gridded white plastic tray.

1. Tray beating was undertaken in dry weather conditions. A gridded white beating tray measuring approximately 25cm x 33cm was used. At selected locations, this allowed approximate *V. moulinsiana* numbers per unit area to be estimated (6 trays being approximately equivalent to 0.5 m²). Each beating tray went at the base of a fresh and undisturbed plot of vegetation, all within approximately 2m of a single sampling point. Material on the trays was counted in the field to record numbers of adult and juvenile *V. moulinsiana*. Survey stations were selected as those judged most likely to produce *V. moulinsiana*. Tray beating was difficult in cut fen areas at Afon Penrhos because of the low vegetation height which prevented the estimation of snail area density.
2. Approximate area of occupancy was assessed with the use of a tray beating.
3. Degree of ground moisture (using a version of the '5 Point Wetness scale' of Killeen & Moorkens, 2003) was recorded at all survey sites;
 1. Ground dry: Possibly with cracks, and no evidence of surface moisture.
 2. Ground damp: Moisture observed on the surface but water does not rise under light pressure.
 3. Ground wet: No surface veneer, but water rises under light (foot) pressure.
 4. Ground wet: Surface veneer of water less than 1-2cm deep
 5. Ground very wet: Water depth greater than 2cm which may cover the sward and tussocks.
4. Dominant vegetation presence was recorded, noting particularly '+' and '-' *V. moulinsiana* 'suitability indicators' (e.g. *Carex* sp, *Glyceria maxima* as '+' indicators and *Epilobium* sp and *Urtica dioica* as '-').
5. Degree of site shading by overhead or over-hanging trees and bushes was recorded as a simple % canopy cover where appropriate (as shading can negatively affect the suitability of sites for *V. moulinsiana*).
6. Other potentially important site environmental and management details were recorded e.g. (i) grazing and/or ground poaching, (ii) recent cutting, (iii) human trampling;
7. Where *V. moulinsiana* was located (and vegetation height permitted), numbers were counted per 6-tray samples and then converted into approximate numbers m² with numbers of adult and juvenile snails recorded;

GPS 12 figure grid references and digital images were recorded for each 'main' sample point. In addition to these, tray beating was carried out as the surveyor walked around the site to try and locate *V. moulinsiana* 'pockets' that might otherwise be over looked.

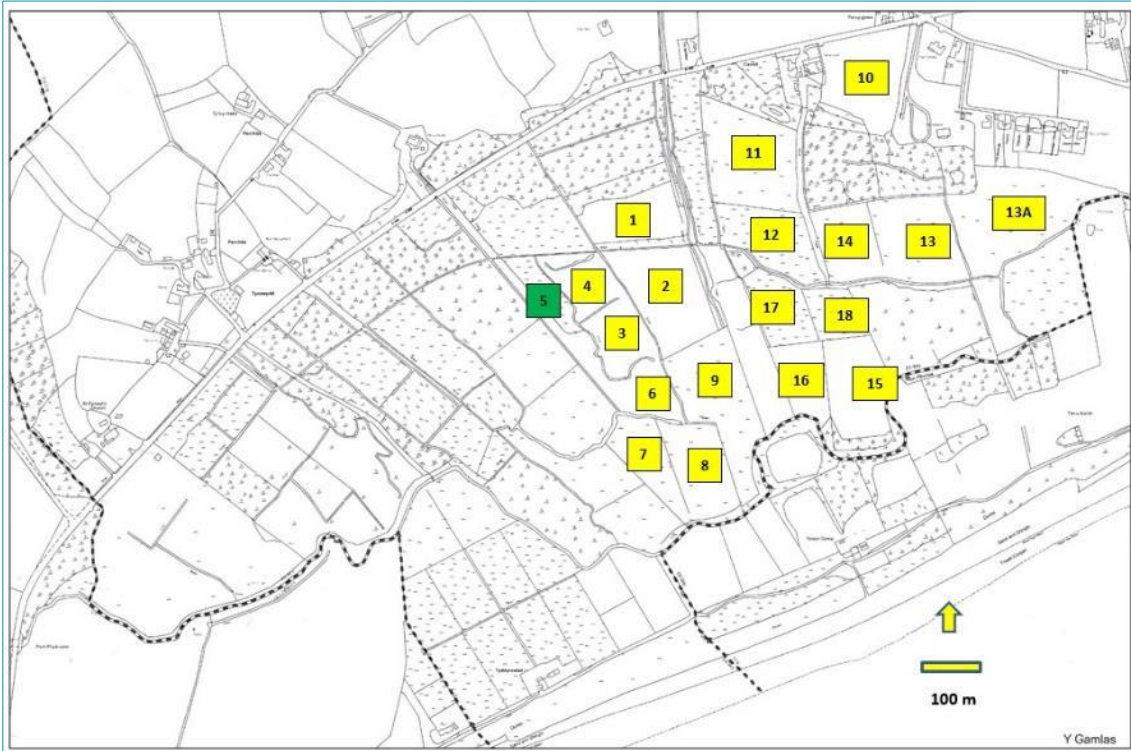


Figure 2. Survey blocks on Afon Penrhos floodplain for *Vertigo moulinsiana*. green = present; yellow = absent.



Figure 3. Survey location for *Vertigo moulinsiana* on Cors Geirch.

4.2. *Vertigo geyeri*

A survey of the *Carex*-lawn' habitat on Cors Geirch NNR (see Figure 4) was completed on 17th October 2017.



Figure 4. Survey location on Cors Geirch for *Vertigo geyeri* (lying between A & B).

Sampling relied primarily upon the well-established technique of selecting potentially-suitable habitat and then removing sample material for later laboratory processing (as this tiny snail is typically very difficult to locate in the field). *Vertigo geyeri*, is usually found living in damp moss and sedges/rushes which cannot be readily sieved in the field as water tends to block sieve holes.

To make the surveillance results directly comparable with those of similar surveys, techniques involved the refinement of those used previously (e.g. Willing, 1997, 1999, 2004, 2012, 2013, 2017b), and also described by Killeen & Colville (1999):

- At sampling points, vegetation (mosses, sedges and bryophytes collected near springs and seepages) were cut down to about 5 cm (if initially higher) and then cut just below ground level over a series of small areas (approx. 15 cm x 15 cm max) using a serrated kitchen knife. Collected material was then amalgamated into one bag (typically resulting in about 3 to 4 litres of sample material). To avoid significant damage at any one point and to sample from several points within a flush, material

was collected from a total area measuring 0.5 m x 0.5 m (0.25 m²) and combined from a series of points over about a 5 m x 5 m.

- The collected material was retained in polythene bags until returned to the laboratory where samples were placed in fine muslin bags and then air-dried to constant mass.
- Dried material was then shaken through series of sieves with 5 mm, 2 mm and 0.5 mm meshes (with most *Vertigo* spp. accumulating in the 0.5 mm fraction).
- Counts of adult and juvenile *Vertigo* sp were made using a x7 to x50 binocular microscope.
- Other molluscan species were recorded.

At each survey site (or sub-site for larger locations), the following information was also gathered:

Ground moisture levels: (adopting the 5-point scale widely used for assessing *V. moulinsiana* habitat); at each of the survey sites, ground moisture levels were recorded on the 5-point scale as detailed in Killeen & Moorkens (2003):

1. DRY – no visible moisture on ground surface or detected if touched;
 2. DAMP – ground visibly damp but water does not rise if pressed;
 3. WET – water appears under light pressure;
 4. VERY WET – pools of water present but < 5 cm in depth;
 5. SUBMERGED – whole sample site under water > 5 cm in depth
- GPS locations (at 10 figure level);
 - Site descriptions in terms of major vegetational type, and level of grazing, trampling and % of bare ground;
 - Digital photographs to display (a) site location in relation to surrounding landscape features (to assist later site relocation) and (b) site structure in closer detail.

Site survey and assessment for *V. geyeri* at Cors Geirch was undertaken together with the NRW Invertebrate Ecologist, Dr Mike Howe.

5. Results

5.1. *Vertigo moulinsiana* at Afon Penrhos

The extensive survey of potential *Vertigo moulinsiana* habitat in the eastern areas of the Afon Penrhos floodplain located further specimens in about 0.52ha of lightly grazed fen lying immediately east of and adjacent to an area found to support the snail during the 2016 survey (block 5, Figure 2; Table 1). *V. moulinsiana* distribution is displayed in Figures 5a & b. Almost all other areas surveyed were considered to be too dry and/or too acidic to support *V. moulinsiana* populations (see Figures 6 to 20). Table 2 provides all locations of *V. moulinsiana* recorded during the 2016 and 2017 surveys, and includes a correction to Table 2 in Willing (2017a).

Table 1. *Vertigo moulinsiana* on Afon Penrhos, October 2017.

<i>Vertigo moulinsiana</i> site locations in this report	Approx. <i>V. moulinsiana</i> m ⁻²
<p style="text-align: center;">Site 5</p> <p style="text-align: center;">SH 34771 33925 - south to about SH 34822 33834</p>	Tray beating between the grid refs produced low levels of the snail with numbers ranging between 10 – 20 m ⁻² with a juvenile: adult ratio range of 1:6 / 1:8

Table 2. *Vertigo moulinsiana* records from Afon Penrhos, 2016-17, fifteen records in 2016 and one in 2017. This corrects Table 2 in Willing (2017) which included 14 rather than 15 locations and gave some incorrect Grid References.

Grid Reference	Date	Recorder	Abundance
SH3430133659	5.10.2016	Martin Willing	several shells
SH3432733631	5.10.2016	Martin Willing	several shells
SH3435333742	5.10.2016	Martin Willing	several shells
SH3436133620	5.10.2016	Martin Willing	several shells
SH3438333655	5.10.2016	Martin Willing	several shells
SH3441333565	5.10.2016	Martin Willing	several shells
SH3441533706	5.10.2016	Martin Willing	several shells
SH3445133653	5.10.2016	Martin Willing	several shells
SH3446433590	5.10.2016	Martin Willing	several shells
SH3447433634	5.10.2016	Martin Willing	1 shell
SH3450533590	5.10.2016	Martin Willing	several shells
SH3453733649	5.10.2016	Martin Willing	several shells
SH3454933781	5.10.2016	Martin Willing	1 shell
SH3464533849	5.10.2016	Martin Willing	several shells
SH3473033912	5.10.2016	Martin Willing	several shells
SH3477133925	16.10.2017	Martin Willing; Mike Howe	6 shells

Locations for *Vertigo moulinsiana* in 2016 & 2017

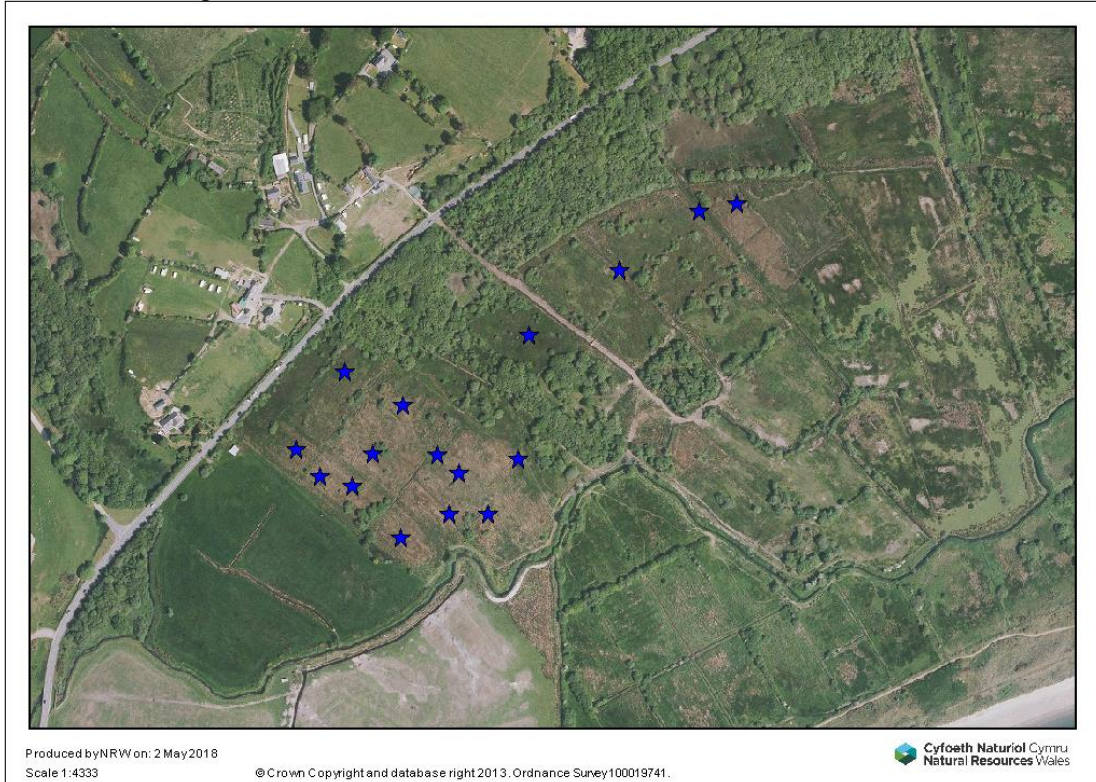


Figure 5a. *Vertigo moulinsiana* (Vm) distribution on the Afon Penrhos floodplain. Blue stars indicate where specimens were recorded in 2016 and 2017.

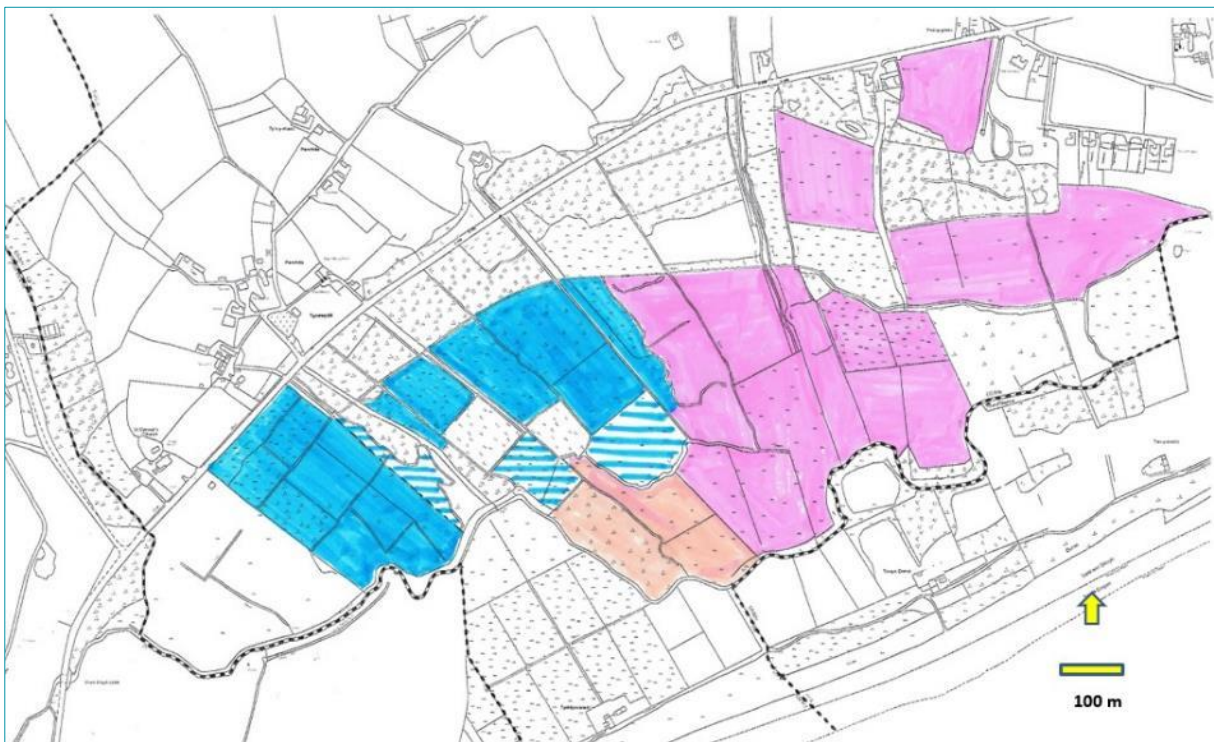


Figure 5b. *Vertigo moulinsiana* (Vm) distribution on the Afon Penrhos floodplain. Key: blue: Vm present; blue hatched: Vm probable; orange: not surveyed but Vm possible; pink: Vm absent

5.2. *Vertigo moulinsiana* at Cors Geirch

A single area of the site was surveyed on the immediate margins of an overgrown ditch-line used as a monitoring feature on previous *V. moulinsiana* surveys (Killeen, 2004; Lloyd 2008) but where no *V. moulinsiana* were found in 2016 (Willing, 2017c). Tray beating by two people for a 35-minute period (70-minute total search) produced 4 *V. moulinsiana* specimens (3 adults, 1 juvenile). These were all collected from *Juncus acutifloris* and other *Juncus* spp., with none found in areas of taller *Cladium mariscus* and *Phragmites australis* which previously supported a large population (Figures 21 to 22).

5.3. *Vertigo geyeri* at Cors Geirch

Three large bulk samples were removed from across the selected survey area (Figures 23 to 25). Although appearing potentially suitable for *V. geyeri*, the species was not found although large numbers of other *Vertigo* species were recovered (see Table 5 in Appendix 1 for full molluscan results from the samples).

6. Discussion

6.1. *Vertigo moulinsiana* at Afon Penrhos

Survey of the eastern areas of the Afon Penrhos floodplain in 2017 located a further 0.52 ha (1.3 acres) of additional *Vertigo moulinsiana* habitat. This was a block of fen meadow lying to the immediate east of and immediately adjacent to a large block of habitat (separated by a boundary ditch) supporting large numbers of the snail in 2016 (Willing, 2017c). The flora in these two areas is similar with abundant *Festuca ovina*, *Filipendula ulmaria*, *Potentilla palustris*, *Lycopus europaeus*, *Hydrocotyle vulgaris* and *Lotus corniculatus*. This particular suite of plants was closely associated with areas supporting *V. moulinsiana* at Afon Penrhos (western sector) in 2016. With the exception of a very small area in the north-west corner of survey 'Site 11' (Figures 2 & 13), this plant suite was not seen at the other sites surveyed in 2017. Other areas surveyed in 2017 were judged to be either too dry and/or too acidic to support the snail. A total area of actual and probable *V. moulinsiana* habitat at Afon Penrhos (in Figure 5 as blue or hatched blue) is calculated (using Grid Reference Finder) at 11.07 ha (27.3 acres). This is the largest area occupied by the snail in Wales and might equal or exceed the largest *V. moulinsiana* areas in England. Most of the snail's English sites are quite different in that they occupy habitat in relatively narrow strips of base-rich fen lying alongside rivers, in abandoned water-meadow channels or around the margins of ponds, meres, broads or lakes; the overall occupied areas may be relatively small. An unusual feature of the Afon Penrhos site is that *V. moulinsiana* habitat is not a linear feature running in narrow bands but occurs in large blocks. The area occupied by the snail might be as much as 13.2ha if it is also living in an area lying immediately to the south of the occupied block in the western area of Afon Penrhos (coloured orange in Figure 5); lack of access permission prevented survey of this area in 2017.

It is of considerable concern that this nationally important site has no statutory protection; SSSI status would seem to be urgently required. The significance of the Afon Penrhos population is further enhanced by the declines in *V. moulinsiana* populations elsewhere in Britain. Studies over the last 18 years have demonstrated at least an 85% decline in the formerly numerous populations of the snail in the Hampshire/Wiltshire River Avon SAC (Willing, 2015, 2017a). Similar extensive losses

have been recorded in another SAC, that of the Rivers Kennet and Lambourn (Tattersfield & Killeen, 2006; Killeen, pers. comm.). It is suggested that any proposed SSSI boundary should include a continuous block of all the areas actually or probably supporting the snail - these being displayed in solid blue, hatched blue or orange in Figure 5.

6.2. *Vertigo moulinsiana* at Cors Geirch

Resurvey of a single area situated at the north of the Cors Geirch survey area on the west margin of a ditch-line used as a monitoring feature by Killeen (2004). *V. moulinsiana* was found in abundance in this area in 1999, 2003 and 2008 (Killeen, 2000, 2004; Lloyd, 2008a) but was not recorded there in 2016 (Willing, 2017c). An extensive tray-beat search by two people for a total of 70 minutes located only four live *V. moulinsiana* (Table 1) close to the 2016 sample location 'Cw' (see Figure 6 on p.11 in Willing, 2017c). As suggested in the previous report (p.13 in Willing, 2017c), given the large *V. moulinsiana* population present in the short-cut fen at Afon Penrhos, a trial habitat clearance could be undertaken at a number of localities on Cors Geirch to create some 'short fen' habitat. This would encourage the remnant *V. moulinsiana* population located in the relatively shorter *Juncus* spp habitat to increase. The scrub and rank fen that is currently largely obscuring the monitoring ditch-line could be reduced in a staggered way to leave a mosaic of different fen heights.

6.3. *Vertigo geyeri* at Cors Geirch

The three large bulk samples removed from the close-cropped, horse-grazed fen did not produce any *Vertigo geyeri* although three other *Vertigo* species were found in abundance. This area was chosen for resurvey in 2017 as it was judged by the surveyor to most closely match the deer-grazed, base-rich flush sites supporting the snail on the island of Islay in Scotland (Willing, 2013). If *V. geyeri* was still present at Cors Geirch, then this area was considered the most likely to still support the snail and it is to the site that Colville reported the presence of specimens in 1998. Reasons for *V. geyeri* absence at Cors Geirch are unknown and it is puzzling that the area still supports the three other *Vertigo* species, all frequently found living in association with *V. geyeri* at other sites.

7. Conclusions and Recommendations

7.1. *Vertigo moulinsiana*

The rediscovery of very low numbers of *V. moulinsiana* from the northern survey compartment of Cors Geirch in 2017 (where the snail was not recorded in 2016) demonstrates that the species remains there in very low numbers. An attempt to restore the population it is suggested (following similar recommendations outlined in Willing, 2017c) with remedial habitat management to reduce encroaching scrub and dense *Cladium* / *Phragmites* beds to encourage the development of a lower, lightly-grazed, *Juncus*/*Festuca*/*Agrostis* sward.

Survey work in the Afon Penrhos floodplain in 2017 further increases the extent of habitat known to support the snail such that *V. moulinsiana* is now known to be present in at least 11.07ha, and maybe in as much 13.2ha if snail populations extend slightly southwards into adjoining areas that could not be surveyed due to a lack of access permissions. The Afon Penrhos population of *V. moulinsiana* is not only the largest in

Wales, but probably also in mainland Britain. The significance of the population here is further enhanced by recent considerable population losses at several SACs in southern England. Now that the full extent of the population on Afon Penrhos has been determined, **it is recommended that the site should be notified as a SSSI** to reduce any risk of loss or damage due to changes in site management, and to acknowledge its importance as a key site in the UK and in Europe.

7.2. *Vertigo geyeri*

V. geyeri was not found at any of its previously reported sites on Cors Geirch in 2016. A re-survey took place in 2017 of an extensive area of unshaded horse-grazed 'Carex-lawn' habitat (with water table at or very close to the ground surface) that was considered the most likely location to still support *V. geyeri* on the reserve. Despite the removal of large samples from across about 0.5ha, no *V. geyeri* were located (although numerous specimens of three other *Vertigo* species were recovered). It is considered likely that *V. geyeri* has been lost from Cors Geirch and thus from Corsydd Llŷn SAC.

8. Acknowledgements

Natural Resources Wales are thanked for funding this project, which was managed by Dr. Mike Howe. Mike is also thanked for his help with all of the field survey at Cors Geirch and Afon Penrhos and for making valued comments that have improved the final report. Additionally, I am particularly grateful to Mr. Williams (Tyddyn Llywellyn) and Mrs. Williams (owner) & Mr. Thomas (tenant) for allowing me to undertake surveys on their land. Mags Cousins (Natural England, Telford) is thanked for identifying several plant specimens.

9. References

Boyce, D.C., Holmes, P.R. & Reed, D.K. 1992. *Vertigo lilljeborgi* Westerlund on Anglesey. *Journal of Conchology* **34**: 185-186.

Bratton, J.H. 1991. *British Red Data Books: 3. Invertebrates other than insects*. Joint Nature Conservation Committee, Peterborough.

Cameron, R.A.D., Colville, B., Falkner, G., Holyoak, G.A.E., Horung, E., Killeen, I.J., Moorkens, E.A., Pokryszko, B.M., Proschwitz, T. von, Tattersfield, P. & Valovirta, I. 2003. Species accounts for snails of the genus *Vertigo* listed in Annex II of the Habitats Directive: *V. angustior*, *V. genesii*, *V. geyeri* and *V. moulinsiana* (Gastropoda, Pulmonata: Vertiginidae). *Heldia*: 5 Sonderheft. 151 - 170. Munchen.

Colville, B. 1999. Survey for Geyer's whorl snail *Vertigo geyeri* on base-rich wetlands on the Llŷn peninsula. Unpublished report for the Countryside Council for Wales, Bangor supplied in the form of BRC record cards.

Cousins, M. 2015. Molluscs of the Midland Meres. *Mollusc World* **39**: 15-17.

Holmes, P.R., Boyce, D.C. & Reed, D.K. 1995. The Welsh Peatland Invertebrate Survey - Anglesey. CCW Biological Science Report No. **95/1/1**. Countryside Council for Wales, Bangor.

Holyoak, G., Howlett, D. & Baker, R. 2006. *Vertigo geyeri* Lindholm in Norfolk: A survey of small calcareous valley fens. *Wheatfen Partnership* (Norfolk Biodiversity Partnership; Broads Authority; Environment Agency), unpublished report.

Kerney, M.P. 1999. *Atlas of the Land and Freshwater Molluscs of Britain and Ireland*. Harley Books, Colchester.

Killeen, I.J. 2000. Status and distribution of Desmoulin's whorl snail *Vertigo moulinsiana* on Cors Geirch SSSI. CCW Contract Science Report No. **373**. Countryside Council for Wales, Bangor.

Killeen, I.J. 2004. Condition monitoring of *Vertigo moulinsiana* on Cors Geirch, Corsydd Lleyrn/Lleyrn Fens Candidate Special Area of Conservation, Wales. CCW Contract Science Report No. **624**. Countryside Council for Wales, Bangor.

Killeen, I.J. & Colville B. 1999. A survey of the Deeside area, Scotland for the terrestrial molluscs *Vertigo geyeri* and *Vertigo genesii*. Scottish Natural Heritage Commissioned Report **F99AC332**.

Killeen, I.J. & Moorkens, E.A. 2003. *Monitoring Desmoulin's Whorl Snail, Vertigo moulinsiana*. Conserving Natura 2000 Rivers Monitoring Series No. **6**. English Nature, Peterborough.

Kuczyńska, A. & Moorkens, E. 2010. Micro-hydrological and micro-meteorological controls on survival and population growth of the whorl snail *Vertigo geyeri* Lindholm, 1925 in groundwater fed wetlands. *Biological Conservation*, 143, 1868-1875.

Lloyd, D. 2005. The condition of *Vertigo geyeri* on Corsydd Llŷn/Lleyrn Fens SAC. CCW unpublished report. Countryside Council for Wales, Bangor.

Lloyd, D. 2008a. The condition of *Vertigo moulinsiana* on Corsydd Llŷn/Lleyrn Fens SAC. Unpublished notes for the Countryside Council for Wales, Bangor.

Lloyd, D. 2008b. The condition of *Vertigo geyeri* on Corsydd Llŷn/Lleyrn Fens SAC. CCW unpublished report. Countryside Council for Wales, Bangor

Seddon, M.B., Killeen, I.J. & Fowles, A.P. 2014. A Review of the Non-Marine Mollusca of Great Britain: Species Status No. **17**. NRW Evidence Report No: **14**, 84pp. Natural Resources Wales, Bangor.

Tattersfield, P. & Killeen, I.J. 2006. Major declines in populations of the wetland snail *Vertigo moulinsiana* in a UK protected wetland site. *Tentacle* **14**: 17-18.

Willing, M.J. 1997. A Molluscan Survey of Calcareous Flushes on Islay, July 1996. Scottish Natural Heritage Commissioned **F96AC301** (unpublished report).

Willing, M.J. 1999. A Molluscan survey for *Vertigo geyeri* and *Vertigo genesii* on Islay, Tayvallich, Lismore and Loch Awe, July – August 1998. Scottish Natural Heritage Commissioned **F99AC608** (unpublished report).

Willing, M.J. 2004. Molluscan surveys of the RSPB Oa Reserve and other sites on the island of Islay, Scotland, July 2004. Unpublished report to the RSPB, Sandy, Beds.

Willing, M. 2008. Field notes of a site visit to the Afon Penrhos floodplain: a field survey of open fen sites potentially suitable for *Vertigo moulinsiana* lying to the west of Pwllheli (July 2008). Unpublished notes & site images sent to the Countryside Council for Wales.

Willing, M.J. 2011. Monitoring populations of *Vertigo angustior* and *Vertigo geyeri* in Norfolk, 2010. Natural England Article 17 Reporting on *Vertigo* snails in England **SAE03-02-362**.

Willing, M.J. 2012. The status and distribution of Geyer's Whorl Snail *Vertigo geyeri* at Craig y Cilau National Nature Reserve in 2011, with a wider search of other sites in south-east Wales supporting base-rich seepages. CCW Contract Science Report No. **1018**. Countryside Council for Wales, Bangor.

Willing, M.J. 2013. Geyer's Whorl Snail (*Vertigo geyeri*) surveillance on Islay 2012. Scottish Natural Heritage Report No. **617**.

Willing, M. 2015. SAC Status reporting on *Vertigo moulinsiana* in England: monitoring at selected sites on the Hampshire / Wiltshire River Avon and tributary rivers Wylfe and Bourne. Unpublished report to Natural England. IPENS programme (LIFE11NAT/UK/000384IPENS).

Willing, M. 2016. The status of Desmoulin's Whorl Snail *Vertigo moulinsiana* at Rhos Goch NNR in 2015. NRW Evidence Report No: **157**, 20pp. Natural Resources Wales, Bangor.

Willing, M. 2017a. Surveys for Desmoulin's Whorl Snail *Vertigo moulinsiana* on the rivers Avon and Till (in areas immediately north and south of the A303 in the Amesbury & Winterbourne Stoke areas, Wiltshire) October–December 2016. Unpublished report to AtkinsGlobal / Highways Agency.

Willing, M. 2017b. A survey for Geyer's Whorl Snail *Vertigo geyeri* Cors Erddreiniog SSSI and Cors Geirch SSSI in 2016. NRW Evidence Report No: **209**, 40pp. Natural Resources Wales, Bangor.

Willing, M. 2017c. A survey for Desmoulin's Whorl Snail *Vertigo moulinsiana* on Cors Geirch NNR/SSSI and the Afon Penrhos floodplain in 2016. NRW Evidence Report No: **210**, 36pp. Natural Resources Wales, Bangor.

10. Appendix 1. Site locations, brief habitat details, molluscan presence.

Table 3. Site Locations and habitat descriptions at Afon Penrhos.

Location point (LP): with Grid Ref	Site wetness (1 – molluscan presence5)	Shading	General vegetation/ dominant species / site management	Figs.
1 SH 34933 34004	4 – 5	Nil	Close cut <i>Juncus</i> spp; water at or above ground surface. Site seemed neutral - acidic	Fig. 6
2 SH 34953 33909	3 – 5	Nil	As site 1	Fig. 7
3 SH 3485733866	3 – 4	Nil	As site 1 & 2	Fig. 8
4 SH 34835 33897	3 – 4	Nil	As sites 1 – 3 (plant sample taken & included: <i>Juncus acutiflorus</i> , <i>Agrostis canina</i> .)	Fig. 9
5 SH 34771 33925 Extending south to about SH34822 33834	3 – 5	Nil	Rank <i>Juncus</i> spp dominated very lightly ?cattle-grazed fen closely similar to the field lying immediately to the west (west of boundary ditch) surveyed in October 2016 also supporting <i>Vertigo moulinsiana</i> . <i>Juncus acutiflorus</i> , <i>J. effusus</i> , <i>Agrostis canina</i> , <i>Lotus corniculatus</i> , <i>Iris</i> sp, <i>Filipendula ulmaria</i> , <i>Potentilla palustris</i> , <i>Lycopus europaeus</i> , <i>Hydrocotyle vulgaris</i>	Fig. 1
6 SH 34912 33746	3 – 4	Nil	Close-cropped <i>Juncus</i> spp, <i>Festuca</i> sward	Fig. 10
7 SH 34934 33653	3 – 4	Nil	As site 6	Fig. 11
8 SH 34978 33667	3 - 4	Nil	As site 6	Fig. 12
9 SH 35009 33746	3 - 4	Nil	As site 6	No image but similar to 8
10 SH 35229 34212	2	Nil	Dry improved sheep-grazed field	No image
11 SH 35082 34096	3 - 4	Nil	Most of field rank <i>Juncus</i> spp / <i>Iris pseudacorus</i> ; extreme NW corner an area of seemingly more base-rich vegetation with <i>Filipendula ulmaria</i> , <i>Potentilla palustris</i> , <i>Lycopus europaeus</i> , <i>Hydrocotyle vulgaris</i> (as S5)	Fig. 13
12 SH 35078 33968	2 (3 in few places)	Nil	Most of field lightly grazed rank <i>Juncus</i> spp / <i>Iris pseudacorus</i> Quite unsuitable for <i>Vertigo mouliniana</i>	Fig. 14
13 SH 35303 33943	2 (3 in few places)	Nil	As Site 12	Fig. 15
13A	2	Nil	Viewed over low hedge; dry and unsuitable for <i>Vertigo mouliniana</i>	No image
14 SH35212 33944	2	Nil	A site 12	Fig. 16

15 SH 35238 33743	2	Nil	<i>Juncus</i> tussocks with close-cropped grasses between; site too dry for <i>Vertigo mouliniana</i> .	Fig. 17
16 SH 35149 33770	2	Nil	As site 15	Fig. 18
17 SH 35155 33834	2	Nil	As site 15	Fig. 19
18 SH 35199 33871	2	Nil	As site 15	Fig. 20

Table 4. Site Locations and habitat descriptions at Cors Geirch.

Location point (LP): with Grid Ref	Site wetness (1 – 5)	Shading	General vegetation/ dominant species / site management	Figs.
<i>Vertigo geyeri</i> survey area: SH 32916 35253 south to SH 32887 35165	3 - 5	Nil	Very close horse-grazed ' <i>Carex viridula</i> agg / <i>Carex</i> spp/ moss' lawn. Area of similar habitat calculated at approx. 0.5ha	Figs.. 23 - 25
<i>Vertigo moulinsiana</i> survey area: SH 33006 35662	3 - 4	Variable – greater in areas of <i>Phragmites</i> and <i>Cladium mariscus</i>	Lightly cattle-grazed and poached rank fen with an outer area of <i>Juncus</i> spp, <i>J.acutifloris</i> merging into <i>Cladium mariscus</i> and <i>Phragmites australis</i> partly over shaded by <i>Salix capraea</i>	Figs: 21 - 22

Table 5. Bulk sample results from Cors Geirch. Each bulk sample approximately 3 litres compressed.

Species	Samples		
	S1	S2	S3
Terrestrial			
<i>Carychium minimum</i>	8	15	36
<i>Oxyloma elegans</i>	X(dead)		
<i>Cochlicopa lubrica</i>	5		8
<i>Vertigo antivertigo</i>	37	39	38
<i>Vertigo substriata</i>	5	2	1
<i>Vertigo pygmaea</i>	24	11	14
<i>Nesovitrea hammonis</i>	2		2
Aquatic			
<i>Potamopyrgus antipodarum</i>	1		1
<i>Galba truncatula</i>	6	11	11
<i>Pisidium personatum</i>	1	6	2

11. Appendix 2. Site images for Afon Penrhos and Cors Geirch.



Figure 6. Afon Penrhos survey block 1.



Figure 7. Afon Penrhos survey block 2.



Figure 8. Afon Penrhos survey block 3.



Figure 9. Afon Penrhos survey block 4.



Figure 10. Afon Penrhos survey block 6.



Figure 11. Afon Penrhos survey block 7.



Figure 12. Afon Penrhos survey block 8.



Figure 13. Afon Penrhos survey block 11.



Figure 14. Afon Penrhos survey block 12.



Figure 15. Afon Penrhos survey block 13.



Figure 16. Afon Penrhos survey block 14.



Figure 17. Afon Penrhos survey block 15.



Figure 18. Afon Penrhos survey block 16.



Figure 19. Afon Penrhos survey block 17.



Figure 20. Afon Penrhos survey block 18.



Figure 21. Cors Geirch – *Vertigo moulinsiana* survey block.



Figure 22. Cors Geirch – *Vertigo moulinsiana* survey block.



Figures 23 & 24. Cors Geirch – *Vertigo geyeri* survey block



Figure 25. Cors Geirch – *Vertigo geyeri* survey block.

12. Appendix 3. Data Archive Appendix

The data archive contains:

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

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

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <http://libcat.naturalresources.wales> or <http://catllyfr.cyfoethnaturiol.cymru> by searching 'Dataset Titles'. The metadata is held as record no. 121548.



**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 2018

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