Cyfoeth Naturiol Cymru
Natural Resources Wales

Surveys for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI & Cors Geirch SSSI and for Desmoulin's Whorl Snail *Vertigo moulinsiana* on Cors Geirch SSSI in 2019

M.J. Willing

NRW Evidence Report No. 404

Figure 1. Restored calcareous flush habitat S10 in Compartment 13C, Cors Erddreiniog SSSI.

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: 404
Publication date: February 2020
Contract number:
Contractor: Martin Willing
Contract manager: Mike Howe
Title: **Surveys for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI & Cors Geirch SSSI and for Desmoulin's Whorl Snail *Vertigo moulinsiana* on Cors Geirch SSSI in 2019**
Author(s): M.J. 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)

Dr Mike Howe, NRW Lead Specialist Advisor – Invertebrates
Emyr Humphreys, NRW Senior Officer Land Management
Ben Rowson, National Museums Wales

Recommended citation for this volume:

Willing, M.J. 2020. Surveys for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI & Cors Geirch SSSI and for Desmoulin's Whorl Snail *Vertigo moulinsiana* on Cors Geirch SSSI in 2019. NRW Evidence Report No: **404**, 40pp. Natural Resources Wales, Bangor.

Contents

List of tables

List of figures

1. Crynodeb gweithredol

Mae **malwen droellog Geyer *Vertigo geyeri*** wedi'i chofnodi ar dri safle yng Nghymru. Fodd bynnag, ni lwyddwyd i ganfod y falwen mewn arolygon o SoDdGA Cors Erddreiniog yn 2016 a SoDdGA Cors Geirch yn 2016 a 2017. Cafwyd pryderon fod *V. geyeri* wedi'i cholli ar y ddau safle ond, gan ei bod yn hawdd peidio â sylwi ar boblogaethau bach o'r falwen bitw hon, teimlwyd ei bod yn rhy gynnar i ddatgan bod y falwen wedi darfod ac felly cynhaliwyd arolygon ychwanegol ar y ddau safle ym mis Hydref 2019.

Ar SoDdGA Cors Erddreiniog, dangosodd arolygon rhwng 1995 a 2003 bresenoldeb eang *V. geyeri*, ond cofnododd arolygon yn 2007 fod nifer y malwod ar hen safleoedd yn dirywio'n sylweddol neu fod y malwod wedi diflannu. Yr hyn a oedd yn peri'r pryder mwyaf oedd dirywiad sydyn y falwen ar yr hen safle ‘poblogaidd’ o laciau llethrog yng nghae ffynnon Nant Isaf (adran 13C o’r SoDdGA). Mewn arolwg o lawer o hen safleoedd yn 2016, ni lwyddwyd i ddod o hyd i'r falwen ar un o'r rhain. Yn 2019, ymwelwyd â Chors Erddreiniog unwaith eto er mwyn ailarolygu rhai o'r safleoedd y tybiwyd eu bod yn fwyaf tebygol o gynnal y falwen o hyd, gan gynnwys cau ffynnon Nant Isaf, lle yr oedd dychwelyd at bori ceffylau ers arolygon 2016 wedi dechrau proses o adfer cynefinoedd. Yn ogystal, cafodd llawer o hen safleoedd *V. geyeri* yng ngogledd-orllewin y Warchodfa Natur Genedlaethol na chafodd eu samplu yn 2016 eu harolygu. Er gwaethaf amodau cynefin a ymddangosai'n addas yn y rhan fwyaf o safleoedd, yn cynnwys amodau gwell yn Nant Isaf, ni chofnodwyd y falwen.

Yng Nghors Geirch, canolbwyntiodd arolwg 2019 ar ddwy ardal o gynefin a allai fod yn addas a arolygwyd yn ddiweddar; (1) ardal o ‘lawnt hesg’ a borwyd gan geffylau yn y Warchodfa Natur Genedlaethol lle'r oedd *V. geyeri* wedi cael ei hadrodd yn 1998 ac yr ystyriwyd mai dyma oedd yr ardal fwyaf tebygol yn y warchodfa o gynnal niferoedd isel o'r falwen o hyd er gwaethaf absenoldeb a gofnodwyd yn 2016 a 2017, a (2) cyfres o laciau tra-fasig tuag at ben gorllewinol y Warchodfa Natur Genedlaethol a arolygwyd ddiwethaf yn 2016. Er gwaethaf addasrwydd tebygol y safleoedd, yn enwedig yr un cyntaf, ni chanfuwyd unrhyw sbesimenau o *V. geyeri*.

Mae'n debygol fod *V. geyeri* wedi'i cholli o Gors Erddreiniog a Chors Geirch a'i bod bellach wedi'i chyfyngu i SoDdGA Waun Eurad yn unig, lle y'i cofnodwyd ddiwethaf yn 2014.Gellid ystyried ailgyflwyno'r rhywogaeth i gae ffynnon Nant Isaf.

Roedd arolygon ar SoDdGA Cors Geirch rhwng 1999 a 2008 wedi dangos presenoldeb poblogaeth fawr a helaeth o **falwen droellog Desmoulin *V. moulinsiana***, ond dangosodd gwaith yn 2016 ddirywiad sylweddol ac ni chanfuwyd unrhyw gregyn yn un o'r ardaloedd allweddol tuag at ogledd yr ardal a feddiannwyd mewn ffen a oedd yn gyfoethog o ran gorsfrwynen lem *Cladium mariscus*. 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. 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 byrrach a oedd yn gyfoethog o ran *Juncus*, yn yr hen gadarnle hwn, gan ddangos bod gan y falwen bresenoldeb gweddilliol. Mae cyngor rheoli a roddwyd yn 2017 (yn ailadrodd yr hyn a gafwyd yn 2016) yn awgrymu camau adferol er mwyn ceisio adfer y falwen drwy dorri prysg sy'n ennill tir a chlystyrau mwy trwchus o gorsfrwynen lem *Cladium mariscus* a chorsen cyrs *Phragmites australis* yn ôl er mwyn annog datblygiad glastir *Juncus* byrrach. Canfu arolwg 2019 niferoedd bach o'r falwen mewn ffen byr a oedd yn gyfoethog o ran *Juncus*, dros bellter a oedd oddeutu 40 metr, nad oedd yn gysylltiedig â gwelyau *Cladium*. Gan nad oes unrhyw ran o'r gwaith adfer cynefinoedd wedi'i gwblhau, argymhellir bod **gwaith rheoli adferol yn cael ei wneud ar unwaith i atal y boblogaeth rhag dirywio ymhellach**.

2. Executive summary

Geyer's Whorl Snail *Vertigo geyeri* has been recorded from three sites in Wales. However, surveys of Cors Erddreiniog SSSI in 2016 and of Cors Geirch SSSI in 2016 and 2017 failed to locate the snail. It was feared that *V. geyeri* had been lost from both sites but, as small populations of this tiny snail can easily be overlooked, it was felt premature to declare the snail as extinct and additional surveys were therefore undertaken at both sites in October 2019.

At Cors Erddreiniog SSSI, surveys between 1995 and 2003 demonstrated the widespread presence of *V. geyeri,* but surveys in 2007 recorded the disappearance or large declines in snail numbers at former sites. Of most concern was the sharp decline of the snail at the former 'hotspot' hillside flush site at the Nant Isaf spring field (SSSI Compartment 13C). A survey of many former sites in 2016 failed to find the snail at any of these. In 2019, Cors Erddreiniog was revisited in order to re-survey some of the sites deemed most likely to still support the snail including the Nant Isaf spring field where a return to horse-grazing since the 2016 surveys had started a process of habitat restoration. Additionally, several former *V. geyeri* sites at the north-west of the NNR that were not sampled in 2016 were surveyed. Despite seemingly suitable habitat conditions at most sites, including improved conditions at Nant Isaf, the snail was not recorded.

At Cors Geirch, the 2019 survey focussed upon two areas of potentially suitable habitat that had been recently surveyed; (1) an area of horse-grazed '*Carex*-lawn' within the National Nature Reserve 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 adespite a recorded absence in 2016 and 2017 and (2) a series of base-rich flushes lying towards the western end of the National Nature Reserve last surveyed in 2016. Despite the seeming suitability of the sites, especially the former, no *V. geyeri* were found.

It is likely that *V. geyeri* has been lost from Cors Erddreiniog and Cors Geirch and is now restricted to just Waun Eurad SSSI where it was last recorded in 2014. A reintroduction to Nant Isaf spring field could be considered.

Surveys on Cors Geirch SSSI between 1999 and 2008 had shown the presence of a large and extensive population of **Desmoulin's Whorl Snail *V. moulinsiana*** but work in 2016 demonstrated a considerable decline with no shells found in one of the key areas towards the north of the occupied area in fen dominated by Saw-sedge *Cladium mariscus*. It was considered that the decline of the snail was due to the spread of uncut and un-grazed rank, fen vegetation combined with encroaching birch and sallow scrub. In 2017, this area was revisited and an extended search by two people located just four live snails in shorter *Juncus*-dominated vegetation in this former stronghold demonstrating a residual presence of the snail. Management advice in 2017 (repeating that from 2016) suggested remedial action to attempt a recovery of the snail by the cutting back of encroaching scrub and denser stands of *Cladium mariscus* and Common Reed *Phragmites australis* in favour of a shorter *Juncus* sward. The 2019 survey found low numbers of the snail in short *Juncus*-dominated fen over a distance of about 40m, with none associated with *Cladium* beds. As none of the habitat restoration work had been completed, it is recommended that **restorative management is undertaken urgently to prevent further population declines**.

3. Introduction

3.1. Geyer's Whorl Snail

Geyer's Whorl Snail *Vertigo geyeri* Lindholm, 1925 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 been classed as Near Threatened/Nationally Scarce in the IUCN-based UK Non-Marine Mollusc Status Review (Seddon *et al.*, 2014). The species is listed in Annex IIa of the European Community Habitats and Species Directive (92/43/EEC) and is also a Welsh Section 7 'Species of Principal Importance'. In 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* 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 when the author of this report recorded a fossil shell of uncertain age in a postglacial (possibly recent) 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.). *V. geyeri* is a Qualifying feature of Cors Erddreiniog SSSI, Cors Geirch SSSI and Waun Eurad SSSI, and a feature of Corsydd Môn/Anglesey Fens SAC and Corsydd Eifionydd/Eifionydd Fens SAC.

Cors Erddreiniog

V. geyeri was first reported in Wales from Cors Erddreiniog NNR on Anglesey in 1985 when the author of this report recorded a fossil shell in postglacial tufa (see Colville, 1994). It was subsequently taken in a pitfall sample in 1988 on Nant Isaf spring field, part of Cors Erddreiniog SSSI, during the Nature Conservancy Council's Welsh Peatland Invertebrate Survey (WPIS), although it was initially mistakenly identified as Lilljeborg's Whorl Snail *V. lilljeborgi* (Boyce *et al*., 1992; Holmes *et al*., 1995). It was re-found in Nant Isaf spring field in June 1994 by Barry Colville during a

[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).

Conchological Society field meeting, who returned in July 1994 with a team of local conchologists/entomologists and recorded eleven snails at three locations in the spring field and at an additional site within the NNR. Three snails were also found by Dr. Liz Howe in the spring field during the same visit (Colville, 1994). In correspondence with CCW's Chief Scientist (dated 14th July 1994), Adrian Fowles stated that "*V. geyeri* is established at low density throughout the flushes at Nant Isaf" and that the record from the NNR was from "amongst the fly orchid flushes in the old marlpit area" at SH476818. This area is actually at SH476820 (Mike Howe, pers. comm.). There are additional records from 1994, 1996 and 1997 made by M. & R. Marriott, Adrian Fowles and Matt Suttton respectively.

V. geyeri was later found at a second Anglesey site, Waun Eurad SSSI, by Adrian Fowles in 1996 (record from NRW Welsh Invertebrate Database), and Eva Sharland subsequently carried out a detailed study of the snail there (Cameron, 2003; Sharland, 2000). Further detailed studies of both Waun Eurad and Cors Erddreiniog were carried out in 2003 and 2007 (Killeen & Moorkens, 2004, 2008). Both sites are within the Corsydd Môn/Anglesey Fens SAC.

Killeen & Moorkens (2004) undertook the first baseline survey of *V. geyeri* on Cors Erddreiniog in autumn 2003, recording the snail in Nant Isaf spring field (Compartment 13C, nine locations), Compartment 15A (one location), Compartment 15B (three locations) and Compartment 20 (one location), mostly in small numbers. However, Killeen & Moorkens (2008) suggest that the record from Compartment 20 was more likely to be from Compartment 13A or Compartment 19A. They also recorded a juvenile shell in Compartment 11A (SH 4760881877) although they could not determine if this was *V. geyeri* or *V. pygmaea*. Regarding Nant Isaf spring field, they state that "while only a minority of the compartment has suitable habitat for the snail, the spread of the seepage in the south western corner of the compartment provides a much larger area for occupancy than the narrow seepage zones in 11, 13A, 15A, 15B and 20". At point 2 in Nant Isaf, the snail was described as "frequent".

Further survey work was carried out on Cors Erddreiniog in 2007 (Killeen & Moorkens, 2008). On Nant Isaf, *Vertigo geyeri* was found to be extremely rare having declined at the site since the earlier survey in 2002. Three individuals were found in just one sample. "The compartment had become much ranker over the intervening four-year period due to a lack of grazing, severely reducing the amount of suitable habitat for the snail". *V. geyeri* was found in Compartments 15B (6 shells), 19B (1 shell), 21 (175 shells), 22F (3 shells) and 22H (1 shell). Whilst the count of 175 shells in Compartment 21 is exceptional, suitable habitat was restricted to "small fragmented areas, many less than $1m^2$, where there is flushing along the eastern edge of the compartment along the spring line on the slopes of the ditch".

A survey for *Vertigo geyeri* on Cors Erddreiniog SSSI/NNR in October 2016 failed to locate the snail (Willing, 2017b). Survey locations were based upon previous records dating from 1985 to 2007. Losses from some former strongholds were probably due

to a lack of grazing, leading to the development of blanketing tussocks of Black Bog-rush *Schoenus nigricans* and Blunt-flowered Rush *Juncus subnodulosus* which have shaded out the open '*Carex*-lawn' habitat required by the snail. This was most pronounced on Nant Isaf spring field (Compartment 13c) which had not been grazed for over 20 months. In other compartments, snail losses may have been a consequence of over-grazing, or periods of under-grazing followed by cattle poaching of the remaining open areas.

Cors Geirch

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, both of Natural Resources Wales, 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 vouchers of the four specimens recorded in 2008 have not been seen and *V. geyeri* presence there cannot be confirmed.

In October 2016, all previously reported *V. geyeri* sites on Cors Geirch (1996 to 2008) were re-surveyed but these failed to locate the snail despite the removal and laboratory processing of numerous, large bulk samples (Willing, 2017b). *V. geyeri* losses from known locations on Cors Geirch appeared to be due to the development of a rank 'tussocky' sward that had reduced or eliminated the lightly-grazed '*Carex*-lawn' habitat because of under-grazing. In 2017 the area was revisited to re-sample an area of horse-grazed, unshaded '*Carex*-lawn' that had produced a diverse range of *Vertigo* species and seemed to offer moderately large area of potentially suitable *V. geyeri* habitat. The two samples did not produce the snail but again a range of *Vertigo* species suggesting that a gradient of ground moisture conditions was present at the site (Willing, 2018). This area was deemed worthy of further study in 2019 together with another small area of fen lying about 100m to the east.

3.2. 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 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 in the IUCN-based UK Non-Marine Mollusc 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. A survey of the Afon Penrhos site in 2016 and 2017 suggested that it supported one of the key populations in the UK (Willing, 2017c, 2018). All three Welsh *V. moulinsiana* sites are isolated and do not closely resemble the lake and riverside 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.

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-oocupied *V. moulinisiana* 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 sallow. 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. A further short survey of the stronghold area in 2017 located four snails at one location in relatively low *Juncus acutifloris* meadow with none found in adjacent taller *Cladium mariscus* areas, the previous hotspot for records (Willing, 2018).

3.3. Objectives of 2019 surveys

Geyer's Whorl Snail

Because small populations of *V. geyeri* can be easily overlooked, it was considered premature to declare the snail as extinct on Cors Erddreiniog following the 2016 survey and on Cors Geirch following surveys in 2016 and 2017. At Cors Erddreiniog, the 2019 survey looked at (1) a number of compartment blocks at the north-west that had either supported low numbers of *V. geyeri* in or before 2007 or supported habitat previously noted as suitable for the snail but not been visited in 2016, (2) a selection of compartments surveyed in 2016 that were negative for the snail but positive in previous years and (3) Nant Isaf spring field where a return to horse-grazing since

the 2016 surveys had resulted in habitat restoration. Sampling at the latter was undertaken to detect any small populations of the snail which may have survived the 8–9 year period where a lack of grazing had allowed the development of a blanket of *Schoenus nigricans* shading.

At Cors Geirch, 2019 survey effort focussed on an area of closely horse-cropped '*Carex* lawn' spring-fed fen within the NNR close to where the snail had been recorded in 1998 and considered to be at least superficially like areas of *V. geyeri* habitat on the island of Islay in western Scotland (Killeen *et al.*, 2019; Willing, 2013). Although samples were removed from this area in 2016 and 2017 failed to locate the snail, further survey was considered appropriate because of the potential suitability and extent of the habitat (estimated at >0.5ha). Additionally, another much smaller area of calcareous flush was surveyed that, although sampled in 2016 with negative results, has, nevertheless had unconfirmed reports of *V. geyeri* presence from 2008.

Desmoulin's Whorl Snail
A 2019 survey of the core *Cladium* area for *V. moulinsiana* on Cors Geirch was undertaken to determine if there had been any population recovery following a perceived population crash along the monitoring some time prior to 2016, given that surveys in 2016 and 2017 had found no or very few snails.

4. Methods

4.1. Geyer's Whorl Snail

Surveys for *Vertigo geyeri* were undertaken on Cors Erddreiniog on 14th and 16th October 2019 (Figures 2 & 3) and on Cors Geirch (Figure 4) on 15th October 2019.

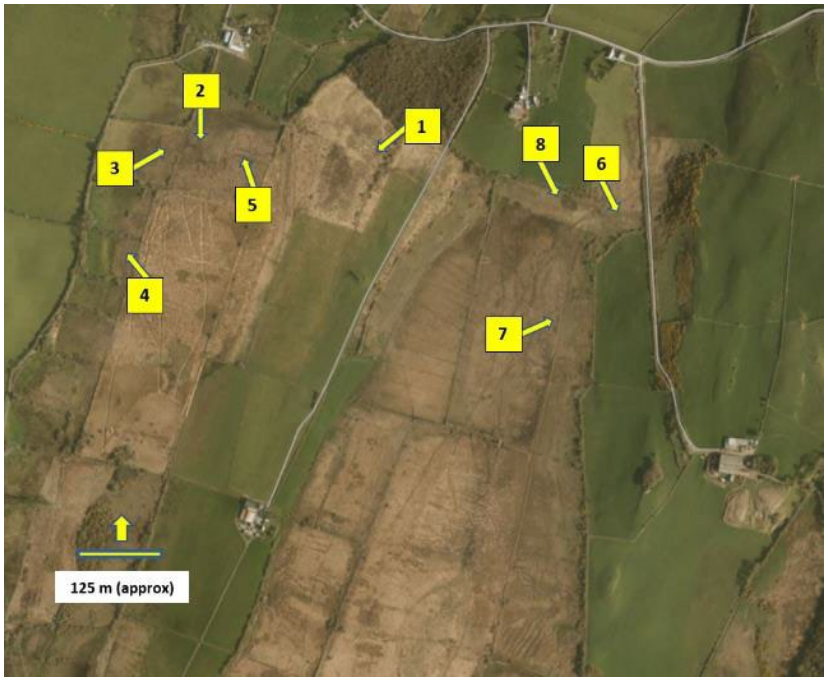

Figure 2. Survey points on Cors Erddreiniog (northern sector compartments) for *Vertigo geyeri.*

Figure 3. Survey points on Cors Erddreiniog (southern sector compartments) for *Vertigo geyeri.*

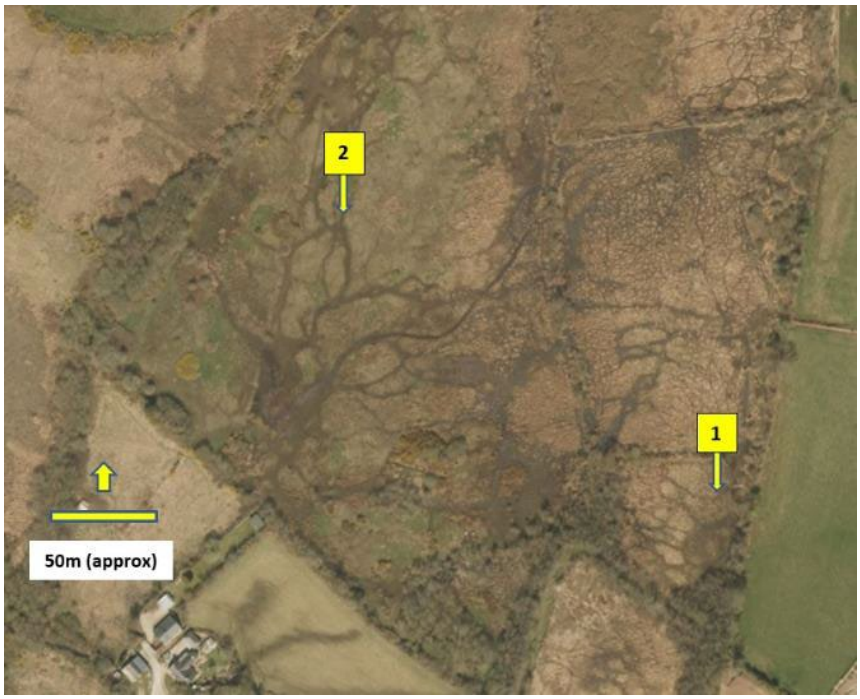

Figure 4. Survey points on Cors Geirch for *Vertigo geyeri.*

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. *V. 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, 2018) 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 m^2) 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 Erddreiniog and Cors Geirch was undertaken together with the NRW Invertebrate Ecologist, Dr. Mike Howe.

4.2. Desmoulin's Whorl Snail

Surveys at Cors Geirch was undertaken on visited on 15th October 2019 the day being selected to ensure the dry conditions needed to undertake sampling. Survey

locations are displayed in Figure 5 with descriptions and site images given in Appendix 7.

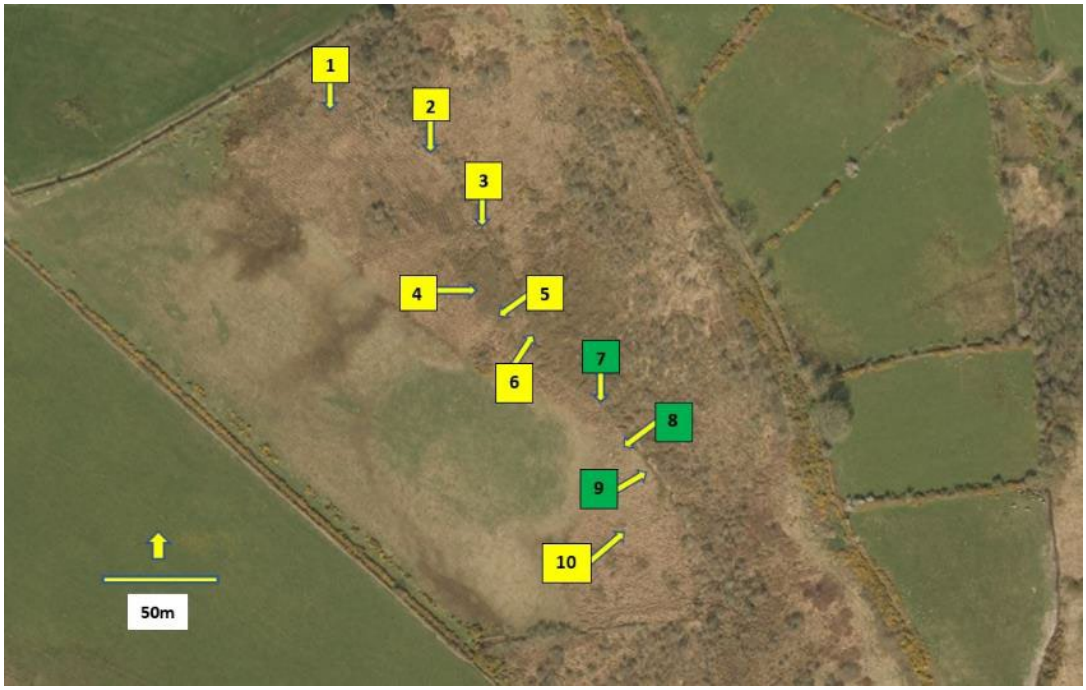

Figure 5. Survey points on Cors Geirch (yellow boxes indicated negative and green boxes positive for *Vertigo moulinsiana* in 2019).

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 m^2). 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*.
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 m^2 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 overlooked.

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

5. Results

5.1. Geyer's Whorl Snail

Four samples were collected from two different areas on Cors Geirch on 15th October 2019 (Figure 4), with nineteen samples from 13 sites (in 8 compartments) collected from Cors Erddreiniog on 14th and 16th October 2019 (Figures 2 & 3). None of the samples from either site contained *V. geyeri* (Table 1). Survey results for other Mollusca, including other *Vertigo* species, are given in Appendix 1,2 and 3 and site descriptions are given in Appendix 5 and 6. All sites were photographed and images appear in Appendix 8.

Cors Erddreiniog

Thirteen samples were removed from 8 reserve compartments. Seven of these were from compartments not surveyed in the previous 2016 survey, whilst the remaining six samples were from sites also surveyed in that year (Table 2).

Cors Geirch

Two sites were resurveyed but no *V. geyeri* were found.

5.2. Desmoulin's Whorl Snail

The northern sector of Cors Geirch was surveyed on 15th October 2019 with *V. moulinsiana* searches based upon a line of 10 reference points extending along about 300m (Figure 5). Low numbers of the snail were recorded in a narrow stretch of low *Juncus*-dominated fen extending for approximately 40m. The northern point of this band of *V. moulinsiana* presence started at approximately at the point where a

few *V. moulinsiana* were found in October 2017. Survey results are given in Appendix 4, and site descriptions are given in Appendix 7. All sites were photographed, and images appear in Appendix 8.

Table 1. Summary of status of *Vertigo geyeri* at Welsh localities.

Site	First record	Last record	Negative surveys	Comment
Cors Erddreiniog SSSI/NNR	1985	2007	2016, 2019	Presumed extinct
Cors Geirch SSSI/NNR	1996	2004/2008?	2015, 2016, 2017, 2019	No vouchers but presence confirmed in 2004. Presumed extinct
Waun Eurad SSSI	1996	2014	-	Not surveyed since

6. Discussion

6.1. Geyer's Whorl Snail

Cors Erddreiniog

The samples taken in Compartment 21 (S1A, 1B; Figure 16), as in 2016, failed to produce *V.geyeri*. The 2003 survey (Killeen & Moorkens, 2004) concluded that this compartment was "now an environment with no suitable habitat". However, four years later in 2007 a resurvey (Killeen & Moorkens, 2008) recovered many snails from a small patch of suitable habitat. It was noted that suitable *V.geyeri* habitat occurs in tiny pockets typically no more than 1m^2. The 2019 survey sampled in the precise area of this compartment recorded in the 2007 survey (SH4714383298) in pony grazed patches of '*Carex*-lawn' habitat. In 2019, the sampled area seemed relatively dry despite the heavy rain of the preceding days, which had left many other survey compartments saturated with pools of standing water. The two samples produced 44 *Vertigo pygmaea* but only a single *V. antivertigo*; the 2007 survey, by contrast, recorded no *V. pygmaea,* but numerous *V. antivertigo* suggesting wetter conditions at that time. It is possible that the likely drying of this site (reduction of flow at the spring line?) may explain the apparent loss of *V. geyeri* from the site.

The adjoining compartments 22F (samples 2a/2b & 5a/5b; Figures 17 & 20) and 22H (samples 3a/3b; Figure 18) lying at the NW margins of the reserve produced very low numbers of *V. geyeri* in 2007 (Killeen & Moorkens, 2008). As their described area of potentially suitable habitat seemed similar to that observed in 2019, it is difficult to suggest what habitat changes have occurred in these compartments in the intevening 12 years to the apparent loss of the snail.

The habitat in Compartment 22E (Figure 19) was described in the 2007 survey (Killeen & Moorkens, 2008) as including a narrow band of potentially suitable *V. geyeri* habitat although the snail was not recorded. Twelve years later, the habitat seems very similar and again the snail was not found (Samples 4a/4b).

A small area of potentially suitable *V. geyeri* habitat (Figure 21) was sampled in Compartment 19B (Sample 6) in the north-eastern corner of the reserve. A single *V. geyeri* was recorded here in 2007 (Killeen & Moorkens, 2008) but although the 2019 survey recorded three *Vertigo* species here, the target species was not found.

Compartment 19A had not been surveyed since 1997 when Matt Sutton (unpublished note to the former CCW) recorded *V. geyeri*. Sample 7 occurs towards the south of this block in an area of rank and very lightly cattle-grazed *Schoenus nigricans* tussocks (Figure 22). Pools between these had occasional small areas of *Carex*-lawn habitat. The presence of shade-loving snail species such as *Discus rotundatus* and *Aegopinella nitidula* indicates the unsuitability of this area for the un-shaded, short turf conditions necessary for *V. geyeri*. By contrast, the habitat at the north of 19A (Figure 23) consists of well-drained *Carex*-lawn that appeared well suited to *V. geyeri.* Although this species was not recorded here, Sample 8 produced one of the richest *Vertigo* assemblages including *V. antivertigo*, *V. pygmaea* and *V. substriata* suggesting a range of ground moisture levels and so the possibility of *V. geyeri* presence - further samples along this boundary slope between dry grazed slopes and saturated fen is recommended.

The habitat in Compartment 13C has changed considerably from the previous survey in October 2016. The dense, ungrazed *Schoenus nigricans* tussocks had been grazed down by a small number of ponies. This had removed the rank shading revealing areas of bare ground where shallow spring waters flowed in a dendritic pattern across the slope allowing areas of tufa to form (Figures 1 & 24). Between the grazed-down *S. nigricans* patches, small areas of *Carex*-lawn habitat were forming. Two samples were taken in the restoring *S. nigricans* area (S9a/9b; S10) in habitat considered suitable for *V. geyeri*. These revealed a low diversity molluscan fauna dominated by the marshy ground dwarf snail *Galba truncatula*. Only a single *Vertigo* specimen (*V. antivertigo*) was recovered from these samples. This suggests that the many years of dense ground shading of the site may have led not only to the loss of *V. geyeri* but also of other open-ground calcareous flush habitat species. Killeen and Moorkens recorded a sharp decline in *V. geyeri* presence between their surveys in 2003 and 2007 (Killeen & Moorkens, 2004, 2008). They commented upon the increase in shading of *S. nigricans* tussocks and noted that if grazing ceases at a *V. geyeri* site then the negative effects can be seen on the snail's numbers in only a year, whilst "*loss of function of a population due to shading can take place within 3 years of management change*". The sharp decline in *V. geyeri* numbers described for the 2007 survey (only three *V. geyeri* specimens were found in a single sample with a further 12 devoid of the snail) may mark at least the 1-year's decline stage suggesting that by 2009/2010 *V. geyeri* might have been expected to be lost from the site. With a further 6 to 7 years without grazing, it is not surprising that the 2016 survey of this compartment (Willing, 2017b) found the area blanketed in a rank *S. nigricans* blanket without detectable *V. geyeri* and few other Mollusca as well. In 2019, the Compartment 13C samples 11 and 12 (Figures 26 & 27) were collected from the north-western margins of the main tufaceous flush in shorter '*Carex*-lawn'

type habitat with S12 in particular closely resembling the habitat at Compartment 19A, sample 8 in similarly supporting good numbers of three *Vertigo* species and therefore seemingly providing potentially suitable habitat for *V. geyeri*.

The developing restoration 'recovery' of the unshaded *S. nigricans* dominated tufaceous spring habitat in 13C creates an opportunity for a re-introduction of the snail. It would appear that the habitat, if not yet fully restored to the grazed pre-2007 state, is certainly becoming more suitable for *V. geyeri*. Other than a short pulse of management to open up the tufaceous spring habitat during the Anglesey and Llŷn Fens LIFE project in 2013, when it was described as very open (Sutton, 2013), a decade with little or no grazing until ponies were introduced into the compartment in 2017, is likely to have resulted in the extirpation of the snail. Several actions are suggested.

- Firstly, a more detailed re-survey of the 13C compartment is recommended. In 2003 and 2007 (Killeen & Moorkens, 2004, 2008) surveyed 11 compartment segments or cells (9 of which are shown in maps in the two reports). Only 4 of the cells were considered to contain 'optimum' *V. geyeri* habitat and only one of these was found to support the snail in the 2007 survey. The 2019 survey only sampled 4 sites, but to confirm *V. geyeri* loss of the whole compartment will require a more systematic re-examination of at least some of the Killeen and Moorkens segments to see if any remnant population of the snail still survives.
- If, following this more rigorous re-survey, *V. geyeri* is confirmed lost then the option of re-introduction of the snail back to the restored habitat might be considered. A possible local source population, also living on the Anglesey, is that at Waun Eurad SSSI. Snails from this hopefully robust source are likely to be a genetically close match to the possibly extinct Cors Erddreiniog population. If this option was accepted then clearly it would need to be very carefully planned, closely following IUCN reintroduction guidelines and undertaken by Natural Resources Wales.

Compartment 11A (Figure 28) contained tiny amounts of '*Carex*-lawn' habitat on the fringes of steep tussocks topped with acid dominated flora (e.g. *Erica tetralix*). As in 2016 (Willing, 2017b), no *V. geyeri* were found. The only probable record of presence of the snail was from 1994 (Colville, 1994). In 2003, 11A was also surveyed when a single possible juvenile *V. geyeri* was found (Killeen & Moorkens, 2004) whilst the most recent survey in 2016 (Willing, 2017) proved negative.

Table 2. A summary of Cors Erddreiniog reserve compartments surveyed in 2019 and summarising survey results from previous years. X = absent.

2019 samples	Reserve compartments	2019 *Vertigo geyeri* result	2016 *Vertigo geyeri* result	Summary of key previous *Vertigo geyeri* (*Vg*) records at site
1	21	X	X	1997- 1 *Vg* [M. Sutton]; 2003 0 *Vg* [Killeen & Moorkens 2004]; 175 *Vg* in 2007 [Killeen & Moorkens 2008]
2 & 5	22F	X	Not surveyed	2007 – 3 *Vg* [Killeen & Moorkens 2008]
3	22H	X	Not surveyed	2007 – 1 *Vg* [Killeen & Moorkens 2008]
4	22E	X	Not surveyed	2007 – 0 *Vg* … but judged as suitable habitat for the snail [Killeen & Moorkens 2008]
6	19B	X	Not surveyed	2007 – 1 *Vg* [Killeen & Moorkens 2008]
7	19A [central]	X	Not surveyed	1997 – *Vg* recorded present [M. Sutton – unpublished]
8	19A [north]	X	Not surveyed	1997 – *Vg* recorded present [M. Sutton – unpublished]
9, 10, 11, 12	13C	X	X	Numerous records 1988 > 1996 [refs given in Willing 2017]; 2003 - numerous *Vg* recorded in 9/11 sub-compartments [Killeen & Moorkens 2004]; 2007 -3 *Vg* only recorded from a single sub-compartments [Killeen & Moorkens 2008] (huge *Vg* decline)
13	11A	X	X	1994 – 1 *Vg* [Colville 1994]; 2003 – 1? *Vg* [Killeen & Moorkens 2004]

Cors Geirch

The extensive horse-grazed '*Carex*-lawn' habitat at Site 2 (Figure 30) was previously surveyed in 2016 (Willing, 2017b) and 2017 (Willing, 2018) and conditions do not seem to have noticeably changed. As stated in 2018, the area was considered the most likely to support *V. geyeri* as it appears to closely resemble other *V. geyeri* habitats well known to the author in Scotland (Killeen *et al.*, 2019; Willing 1997, 2004, 2013), in Cumbria (Willing, 2015) and Norfolk (Willing, 2011). Equally puzzling is the frequent presence of three other *Vertigo* species, all *V. geyeri* associates at these other localities. The presence of both *Vertigo antivertigo* and *Vertigo pygmaea* suggests a gradient of ground moisture conditions, the former species found in rather wetter conditions and the latter in drier. This might suggest that there would be zones in this habitat with suitable ground moisture conditions to support *V. geyeri*.

Site 1 (Figure 29) by contrast seemed too wet for *V. geyeri* which was not found in either 2016 or 2019 (Willing, 2017b). The saturated ground-loving *Vertigo antivertigo* was found in abundance but *Vertigo pygmaea* was not recorded, although it was found in samples taken in 2016 (Willing, 2017b). Perhaps ground conditions have got wetter since the earlier survey.

6.2. Desmoulin's Whorl Snail

The 2019 survey of the north-eastern sector of Cors Geirch (Figures 6 to 15) reconfirmed the low-level presence of *Vertigo moulinsiana* there. The snail was found in very low numbers (a total of 11 individuals) in 3 adjoining areas on the south-western fringes of a now heavily overgrown drainage ditch (previously used as a reference point for *V. moulinsiana* monitoring of the site [Killeen 2000, 2004; Lloyd

2008a]). *V. moulinsiana* was present in a 40m strip of *Juncus acutifloris*/*Myrica gale* dominated habitat lying to the immediate west of dense *Cladium mariscus*/ *Phragmites australis* zone in many places infilled with encroaching *Betula pendula* and *Ulex* sp. The most northerly *V. moulinsiana* found in 2019 were collected at a point where a few individuals were located in 2017 (although none was found here in 2016; Willing, 2017c). In 2019, as in the previous 2016 and 2017 surveys, no *V. moulinsiana* were found by beating in *Cladium mariscus*-dominated fen. This is unusual as the earlier surveys in 1999, 2003 and 2008 all noted the collection of the snail by beating in tall fen dominated by this species. The 2016 *V. moulinsiana* survey of the Afon Penrhos floodplain (an area lying only a short distance to the south west of Cors Geirch) discovered large numbers of *V. moulinsiana* in very short, mechanically-cut and lightly horse-grazed fields with a *Festuca*-dominated sward, with lower numbers of the snail in taller *Carex riparia*-dominated fen areas (Willing, 2017c). It also seems that *V. moulinsiana* is also favouring (albeit in very low numbers) the rather shorter *Juncus*/*Myrica* areas of Cors Geirch rather than the taller *C. mariscus* fen. Although this area of Cors Geirch is lightly grazed by cattle (stock was present in 2016, 2017 and 2019), there are no other signs of habitat management. Noting the major decline in *V. moulinsiana* at Cors Geirch in 2016 and 2017 (since the snail was last considered to be in favourable condition there in 2008), habitat management recommendations were made in two reports. These state that "*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"*. Despite this advice appearing in two NRW reports, no restorative habitat management was noted in 2019.

7. Conclusions and recommendations

7.1. Geyer's Whorl Snail

Cors Erddreiniog

The 2019 surveys again failed to relocate *Vertigo geyeri* at sites formerly surveyed in 2016 (Willing, 2017b) or at those mostly lying at the north-west margins that were previously surveyed in 2007 and then found to support very low numbers of the snail (Killeen & Moorkens, 2007). Although these sites (2, 3 & 5) did not produce the snail in 2019 they did, nevertheless, support small areas of open habitat considered potentially suitable for it. A key area for *V. geyeri* in both 1994 and 2003 (Killeen & Moorkens, 2004), but showing major declines by 2007 (Killeen & Moorkens, 2007) is the hillside Nant Isaf spring field site (Compartment 13C). In 2016, this was found to have become heavily blanketed in un-grazed *Schoenus nigricans* tussocks, surveys

there failing to re-locate *V. geyeri* and finding only low numbers of other mollusc species (Willing, 2017b). The 2019 survey of this area found that an introduction of pony grazing in 2017 had led to the restoration of habitat with grazed down tussocks and the return of unshaded, open ground conditions (with tufa forming springs again evident) where patches of moss and '*Carex*-lawn' habitat seemingly suitable for *V. geyeri* were developing. Despite the improved habitat, *V. geyeri* was not recovered from samples taken from the restored flush areas and it is considered likely that the snail has been lost from the site at some point after 2007 (the last year that the snail was found here, albeit in greatly reduced numbers) due to the blanket shading. When previously surveyed and monitored in 2003 and 2007, this site was surveyed in a pattern of 11 'cells' only some of which supported the snail. It would be prudent to undertake a thorough and systematic survey of this compartment so that all the former cells are re-examined in case the snail has survived in small pockets of suitable habitat. If such a survey reconfirms a low-level presence of the snail, then plans will need to be developed to monitor its recovery at the site. If absent, then a re-introduction programme might be considered, possibly using *V. geyeri* stock from Waun Eurad SSSI.

Cors Geirch

As with surveys in 2016 and 2017 (Willing, 2017b, 2018), *V. geyeri* was not found at sites re-surveyed in 2019. One of these, Site 1, where *V. geyeri* presence has never been unambiguously confirmed, seemed to have become too wet to support the snail. By contract, Site 2 appeared to have extensive areas of grazed '*Carex*-lawn' habitat ideally suited to it and which was found to support large numbers of three other *Vertigo* species that are typically found in association with *V. geyeri* at sites elsewhere in Britain. Although it now seems increasingly likely that *V. geyeri* has been lost from Cors Geirch (and thus from Corsydd Llŷn SAC), more extensive surveys of the seemingly suitable Site 2 habitat may be worth considering. The removal of many more bulk samples, this time taken systematically from across the whole area, might detect a low-level presence of the snail, which was often previously detected only in very low numbers at positive sites at both Cors Geirch and Cors Erddreiniog.

7.2. Desmoulin's Whorl Snail

The 2019 survey of *Cladium mariscus*-dominated ditchline and fen, the stronghold of *V. moulinsiana* from 1999 to 2008 (Killeen, 2000, 2004; Lloyd, 2008a), confirmed the continued presence of the snail here, albeit it in very small numbers. The snail was not recorded in this area in 2016 (Willing, 2017b), but a few individuals were found at one spot in 2017 (Willing, 2018). The latest survey recorded a very modest increase as 11 individual snails were found in a band of *Juncus acutifloris*/*Myrica gale* habitat extending along a stretch of about 40m of habitat (out of a total 300m survey zone). As with the 2016 and 2017 surveys, these snails were not found in the extensive stands of *Cladium* but were associated with the much shorter, unshaded vegetation bordering it. It is unclear why there has been both a population crash and an apparent shift in habitat preference, although it possible that the former area has

become too shaded as a result of encroaching scrub and the development of a denser *Cladium* bed. The preference for a shorter *Juncus*-dominated sward mirrors the habitat association found on the nearby Afon Penrhos floodplain which supports arguably the strongest population in the UK in somewhat atypical habitat in a national contect (Willing, 2017c, 2018). It was suggested in Willing (2017b, 2018) that remedial habitat management be undertaken to remove scrub and open up the *Cladium* beds to encourage the spread of a lower, lightly grazed *Juncus/Festuca/ Agrostis* sward. Without this, the snail population is unlikely to recover.

It is also suggested that a more complete and systematic survey be undertaken of the occupied *Juncus/Festuca/Agrostis*/*Myrica gale* sward as the focus of surveys to date has been on the *Cladium mariscus* fen rather than these shorter areas.

8. Acknowledgements

Natural Resources Wales is thanked for funding this project, which was managed by Dr. Mike Howe. Mike is also thanked for his help during all the field survey at Cors Geirch and Cors Erddreiniog and for making valued comments that have improved the final report.

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. 2003. Life-cycles, molluscan and botanical associations of *Vertigo angustior* and *Vertigo geyeri* (Gastropoda, Pulmonata: Vertiginidae). *Heldia*: 5 Sonderheft. 95 – 110. Munchen.

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. 1994. A second site for *Vertigo geyeri* Lindholm living in mainland Britain. *Conchologists' Newsletter* **130**: 376 – 378.

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 Lleyn/Lleyn 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.

Killeen, I.J. & Moorkens, E.A. 2004. Condition monitoring of *Vertigo geyeri* on Cors Erddreiniog & Waun Eurad, Corsydd Môn/Angleysey Fens Candidate Special Area of Conservation, Wales. CCW Contract Science Report No. **625***.* Countryside Council for Wales, Bangor.

Killeen, I.J. & Moorkens, E.A. 2008. 2007 Condition Monitoring of *Vertigo geyeri* in Waun Eurad and Cors Erddreiniog SAC. CCW Environmental Monitoring Report No. **42***.* Countryside Council for Wales, Bangor.
Killeen, I., Willing, M. & Moorkens, E. 2019. Site Condition Monitoring of *Vertigo geyeri* and *Vertigo genesii* 2017. *Scottish Natural Heritage Research Report No. 1161.*

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/Lleyn Fens SAC. CCW unpublished report. Countryside Council for Wales, Bangor.

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

Lloyd, D. 2008b. The condition of *Vertigo geyeri* on Corsydd Llŷn/Lleyn 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.

Sharland, E.C. 2000. Autecology of *Vertigo angustior and Vertigo geyeri* in Wales. CCW Contract Science Report No. **392**. Countryside Council for Wales, Bangor.

Sutton, M. 2013. Southern damselfly *Coenagrion mercuriale* on the Anglesey fens. Survey and monitoring 2013. C.15: Action for Annex II species. Matt Sutton Ecology October 2013. LIFE 07 Nat UK. Natural Resources Wales, Bangor.

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.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.J. 2015. Surveillance of Populations of the Sandbowl Snail *Quickella* Arenaria in Cumbria – Autumn 2015. Unpublished Report to Natural England (Worcester) & Buglife.

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 floddplain in 2016. NRW Evidence Report No. **210**, 36pp. Natural Resources Wales, Bangor.

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.

10. Appendices

Appendix 1. Molluscs recorded on Cors Erddreiniog in 2019 – survey sites 1A to 6

Terrestrial species	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6
Carychium minimum	-	-	7	12	2	5	-	-	-	1	13
Carychium tridentatum	-	-	-	-	-	-	-	-	-	-	-
Oxyloma elegans	-	-	1	-	1	3	-	-	1	2	1
Cochlicopa lubrica	-	-	5	14	1	-	-	-	-	-	12
Vertigo antivertigo	-	1	14	13	2	5	-	-	1	3	3
Vertigo substriata	-	-	-	2	-	-	-	-	-	-	1
Vertigo pygmaea	36	8	-	2	-	-	-	-	-	-	2
Leiostyla anglica	-	-	-	-	-	-	-	-	-	-	2
Discus rotundatus	-	-	-	-	-	-	-	-	-	-	-
Punctum pygmaeum	-	-	-	-	-	-	-	-	-	-	-
Nesovitrea hammonis	2	-	6	4	11	2	-	-	2	-	-
Zonitoides nitidus	-	-	14	2	-	5	2	-	-	-	-
Aegopinella nitidula	1	-	-	-	-	-	-	-	-	-	-
Vitrea crystallina	1	-	-	-	-	-	-	-	-	-	-
Euconulus fulvus	-	-	-	-1	5	2	1	-	3	1	3
Trochulus hispidus	-	-	-	-	-	-	-	-	-	-	-
Cepaea nemoralis	-	-	-	-	-	-	-	-	-	-	-
Aquatic species	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6
Potamopyrgus antipodarum	-	-	-	-	-	1	-	-	-	-	-
Valvata cristata	-	-	-	-	-	-	-	-	-	-	-
Galba truncatula	-	-	2	-	-	2	-	1	6	-	-
Pisidium personatum	-	-	-	3	-	-	-	-	-	-	-
Pisidium casertanum	-	-	-	-	2	13	1	-	1	1	-
Pisidium obtusale	-	-	-	1	-	-	-	-	-	-	-
Pisidium sp.	-	-	-	1	-	3	-	-	1	-	-

Appendix 2. Molluscs recorded on Cors Erddreiniog in 2019 – survey sites 7 to 13

Terrestrial species	7	8	9A	9B	10	11	12	13
Carychium minimum	6	8	1	-	-	3	5	2
Carychium tridentatum	-	-	-	-	1	-	-	-
Oxyloma elegans	3	2	2	8	5	3	2	1
Cochlicopa lubrica	3	7	5	-	-	19	12	1
Vertigo antivertigo	3	31	1	-	-	-	17	3
Vertigo substriata	-	2	-	-	-	-	-	-
Vertigo pygmaea	-	7	1	-	-	-	6	-
Leiostyla anglica	-	-	-	1	-	-	-	-
Discus rotundatus	3	-	-	-	-	-	-	-
Punctum pygmaeum	1	-	-	-	-	-	-	-
Nesovitrea hammonis	1	2	-	6	3	-	3	3
Zonitoides nitidus	-	3	-	-	-	1	-	1
Aegopinella nitidula	1	-	-	-	-	-	-	-
Vitrea crystallina	-	-	1	1	-	-	-	-
Euconulus fulvus	1	1	4	1	1	3	-	-
Trochulus hispidus	-	-	-	-	-	-	1	-
Cepaea nemoralis (*dead shell)	2*	-	-	1	-	-	-	-
Aquatic species	**7**	**8**	**9A**	**9B**	**10**	**11**	**12**	**13**
Potamopyrgus antipodarum	-	-	-	-	-	-	3	-
Valvata cristata	1	-	-	-	-	-	-	-
Galba truncatula	3	-	20	19	2	5	19	1
Pisidium personatum	7	3	-	-	-	4	1	-
Pisidium casertanum	-	-	-	-	-	-	-	4
Pisidium obtusale	-	-	-	-	-	-	-	-

Appendix 3. Molluscs recorded on Cors Geirch during searches for *Vertigo geyeri* in 2019

Terrestrial species	1A	1B	2A	2B
Carychium minimum	-	-	29	12
Oxyloma elegans	-	2	-	1
Cochlicopa lubrica	-	-	2	2
Vertigo antivertigo	20	20	21	16
Vertigo substriata	-	-	-	1
Vertigo pygmaea	-	-	9	12
Aquatic species	**1A**	**1B**	**2A**	**2B**
Galba truncatula	3	5	8	8
Stagnicola palustris agg	-	-	5	-
Pisidium personatum	-	-	1	7

Appendix 4. Survey results for *Vertigo moulinsiana* on Cors Geirch in 2019

Survey locations	*Vertigo moulinsiana* (*Vm*) presence (surface area 6 sweep trays = 0.5m^2)	Approximate *Vm* m^{-2}
1	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
2	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
3	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
4	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
5	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
6	Tray beat for approximately 10m by 2 people (approximately 25 – 30 trays)	**0**
7	18 trays (approx. 1.5m^2) *Vm* produced: **5 adult; 4 juvenile = 9 live** Note: all Vm produced from beating *Juncus articulatus* and low grasses; none from taller *Cladium mariscus* & *Phragmites australis*	**6**
8	30 trays (approx. 2.5m^2) no *Vm* produced: **1 adult**	**0.4**
9	30 trays (approx. 2.5m^2) no *Vm* produced: **1 adult**	**0.4**
10	30 trays (approx. 2.5m^2) no *Vm* produced:	**0**

Appendix 5. Site locations and brief habitat descriptions on Cors Erddreiniog in 2019

Location point (LP): with Grid Ref	Site wetness (1 – 5)	Shading	General vegetation/ dominant species / site management	Figures
1 SH 47143 83303	3 - 4	Nil	Sloping ground quite closely pony-grazed sward with some hummocks. Hummock tops with cross-leaved heath *Erica tetralix*, bog asphodel *Narthecium* ossifagum and gorse *Ulex* sp; occasional *Schoenus nigricans*, grazed *Juncus* spp and grasses	Figure 16
2 SH 46806 83325	3 - 5	Nil	Very wet lightly cattle? Grazed fen with occasional clumps of *Myrica gale* other indictors of saturated ground included *Mentha aquatica*, numerous *Carex* spp & *Juncus* spp (NO *Schoenus nigricans)*	Figure 17
3 SH 46757 83321	3 - 5	Nil	Similar to Site 2 but also *Schoenus nigricans, Hydrocotyle vulgaris, Succisa pratensis*	Figure 18
4 SH 46677 83123	3 - 5	Nil	Similar to Site 3 but no *Hydrocotyle vulgaris.* Additionally, *Anagallis tenella*,	Figure 19
5 SH 46873 83305	3 - 5	Nil	Almost identical to Site 4 but NO *Anagallis tenella*,	Figure 20
6 SH 47544 83183	3 - 4	Nil	Close-grazed Carex spp sward, a single *Schoenus nigricans* tussock; site may dry in summer	Figure 21
7 SH 47420 82975	3 - 4	Nil	Carex sward on margins of depressions in a very large very lightly grazed block of *Schoenus nigricans*	Figure 22
8 SH 47432 83211	2 - 3	Nil	Closely grazed Carex rich damp grassland; site may dry in summer	Figure 23
9 SH 47808 82386	2 - 4	Nil	Closely grazed *Schoenus nigricans* tussocks, shallow water lying amongst numerous small trickles with creamy-white calcareous deposition; approximately 40% bare ground.	Figure 24
10 SH 47760 82295	2 - 4	Nil	As Site 9.	Figures 1 & 25
11 SH 47747 82339	2 - 3	Nil	Horse-grazed mossy *Carex* 'lawn' with little bare ground on slightly higher ground immediately grading into grazed *Schoenus nigricans* flush.	Figure 26
12 SH 47716 82337	2 - 3	Nil	Similar to Site 11	Figure 27
13 SH 47595 81829	2 - 4	Nil	Small areas of *Carex* lying on the margins of tussocks capped with acid-loving flora such as *Erica tetralix.* Tufa-deposing channels between tussocks.	Figure 28

Appendix 6. Site locations and brief habitat descriptions for the *Vertigo geyeri* survey on Cors Geirch in 2019

Location point (LP): with Grid Ref	Site wetness (1 – 5)	Shading	General vegetation/ dominant species / site management	Figure
1 SH 33084 35077	3 - 4	Slight lateral shading in morning and evening	Grazed *Carex* dominated sward with *Anagallis tenella* and *Pedicularis palustris* on margins of shallow marshy pools; site close by becoming invaded with *Alnus glutinosa* saplings.	Figure 29
2 SH 32912 35226	3- 4	Nil	Close-cropped horse-grazed *Carex* spp rich 'lawn' on margins of shallow flooded channels	Figure 30

Appendix 7. Site locations and brief habitat descriptions for the *Vertigo moulinsiana* survey on Cors Geirch in 2019

Location point (LP): with Grid Ref	Site wetness (1 – 5)	Shading	General vegetation/ dominant species / site management	Figure
1 SH 32879 35806	4 - 5	Nil	Dense *Cladium mariscus* fen with adjacent *Myrica gale* / *Juncus* spp	Figure 6
2 SH 32927 35782	5	Nil	Similar to Site 1 lying about 10 m to north	Figure 7
3 SH 32949 35746	4 - 5	Nil	Similar to Site 1 with some *Ulex* sp	Figure 8
4 SH 32941 35721	4 - 5	Slight lateral shading	*Cladium mariscus* fen with *Betula sp.,* occasional clumps of *Myrica gale, Ulex* sp	Figure 9
5 SH 32954 35705	4 - 5	Slight lateral shading	As Site 4	Figure 10
6 SH 32967 35697	4	Nil	Dense *Cladium mariscus* fen with occasional clumps of *Schoenus nigricans;* signs of light cattle grazing	Figure 11
7 SH 33002 35660	3 - 5	Nil	*Cladium mariscus* fen merging into lower *Juncus* sp & *Myrica gale;* signs of light cattle grazing	Figure 12
8 SH 33013 35641	3 - 5	Occasional slight	Similar to Site 7	Figure 13
9 SH 33019 35627	3 - 4	Occasional slight	Similar to Site 7	Figure 14
10 SH 33008 35605	3 - 4	Occasional slight	Similar to Site 7 plus occasional clumps of *Schoenus nigricans*, *Phragmites australis*	Figure 15

Appendix 8. Selected site images taken in October 2019 by the author

Figure 6. Cors Geirch *Vertigo moulinsiana* Site 1.

Figure 7. Cors Geirch *Vertigo moulinsiana* Site 2.

Figure 8. Cors Geirch *Vertigo moulinsiana* Site 3.

Figure 9. Cors Geirch *Vertigo moulinsiana* Site 4.

Figure 10. Cors Geirch *Vertigo moulinsiana* Site 5.

Figure 11. Cors Geirch *Vertigo moulinsiana* Site 6.

Figure 12. Cors Geirch *Vertigo moulinsiana* Site 7.

Figure 13. Cors Geirch *Vertigo moulinsiana* Site 8.

Figure 14. Cors Geirch *Vertigo moulinsiana* Site 9.

Figure 15. Cors Geirch *Vertigo moulinsiana* Site 10.

Figure 16. Cors Erddreiniog *Vertigo geyeri* Site 1 (Compartment 21).

Figure 17. Cors Erddreiniog *Vertigo geyeri* Site 2 (Compartment 22F).

Figure 18. Cors Erddreiniog *Vertigo geyeri* Site 3 (Compartment 22H).

Figure 19. Cors Erddreiniog *Vertigo geyeri* Site 4 (Compartment 22E).

Figure 20. Cors Erddreiniog *Vertigo geyeri* Site 5 (Compartment 2F).

Figure 21. Cors Erddreiniog *Vertigo geyeri* Site 6 (Compartment 19B).

Figure 22. Cors Erddreiniog *Vertigo geyeri* Site 7 (Compartment 19A).

Figure 23. Cors Erddreiniog *Vertigo geyeri* Site 8 (Compartment 19A).

Figure 24. Cors Erddreiniog *Vertigo geyeri* Site 9 (Compartment 13C).

Figure 25. Cors Erddreiniog *Vertigo geyeri* Site 10 (Compartment 13C).

Figure 26. Cors Erddreiniog *Vertigo geyeri* Site 11 (Compartment 13C).

Figure 27. Cors Erddreiniog *Vertigo geyeri* Site 12 (Compartment 13C).

Figure 28. Cors Erddreiniog *Vertigo geyeri* Site 13 (Compartment 11A).

Figure 29. Cors Geirch *Vertigo geyeri* Site 1.

Figure 30. Cors Geirch *Vertigo geyeri* Site 2.

11. 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. 124734.