Cyfoeth Naturiol Cymru
Natural Resources Wales

A survey for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI and Cors Geirch SSSI in 2016

MJ Willing

NRW Evidence Report No. 209

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Report series: NRW Evidence Report
Report number: 209
Publication date: March 2017
Contract number:
Contractor: Willing MJ
Contract Manager: Howe MA
Title: **A survey for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI and Cors Geirch SSSI in 2016**
Author(s): Willing MJ
Technical Editor: Howe MA
Restrictions: None

Distribution List (core)

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

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Recommended citation for this volume:

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

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Bu arolwg o Falwoden Droellog Geyer *Vertigo geyeri* ar SoDdGA (Safle o Ddiddordeb Gwyddonol Arbennig)/GNG (Gwarchodfa Natur Genedlaethol) Cors Erddreiniog ac SoDdGA/GNG Cors Geirch yn methu â lleoli'r falwoden. Cafodd lleoliadau'r arolwg eu seilio ar gofnodion blaenorol a oedd yn dyddio o 1985 i 2007 ar Gors Erddreiniog ac 1996 a 2008 ar Gors Geirch. Mae'n debyg bod colledion o rai cadarnleoedd blaenorol ar Gors Erddreiniog o ganlyniad i ddiffyg pori, gan arwain at ddatblygiad twmpathau gorchuddiol o gorsfrwyn du *Schoenus nigricans* a brwyn blaendon *Juncus subnodulosus* sydd wedi rhoi cysgod dros y cynefin '*Glaswellt Carex*' agored y mae ei angen ar y falwoden. Mae hyn yn amlycaf ar Faes Tarddell Nant Isaf (Llain 13c) nad yw wedi cael ei bori ers dros 20 mis. Mewn lleiniau eraill, mae'n bosibl bod llai o falwod o ganlyniad i or-bori, neu dan-bori wedi'i ddilyn gan wartheg yn sarnu'r rhannau agored sydd ar ôl. Mewn modd tebyg, yn ôl pob golwg mae colledion *V. geyeri* o leoliadau a adwaenir ar Gors Geirch o ganlyniad i ddatblygiad y tywarch drewllyd twmpathog sydd wedi lleihau neu wedi cael gwared ar y cynefin '*Glaswellt Carex*' sydd wedi cael ei bori'n ysgafn o ganlyniad i dan-bori. Mae'r sbesimenau enghreifftiol o 2005 wedi cael eu cadarnhau gan awdur yr adroddiad hwn ond ni welwyd enghreifftiau o'r pedwar sbesimen a gofnodwyd yn 2008.

Gan ei bod yn bosibl peidio â sylwi ar boblogaethau bach o *V. geyeri*, mae'n rhy gynnar i ddatgan bod y falwoden wedi diflannu o Gors Erddreiniog a Chors Geirch yn llwyr. Yn ogystal, mae angen cynnal arolwg o ardaloedd a oedd yn cynnal niferoedd bach iawn o falwod na chawsant eu harolygu yn 2016 yn fuan. Mae angen cynnal arolygon mwy rheolaidd er mwyn cynghori ynglŷn â chyfundrefn pori briodol os canfyddir bod *V. geyeri* yn 'hongian ymlaen' ar y naill safle neu'r llall. Os mai dyma'r achos, yna argymhellir datblygu cyfundrefnau gwylio fforddiadwy wedi'u symleiddio.

Hyd yn oed yn absenoldeb ymddangosiadol *V. geyeri*, mae'n hanfodol bod ardaloedd a oedd yn cynnal y falwoden yn flaenorol yn cael eu rheoli mewn modd priodol. Dylid ailddechrau pori ar Faes Tarddell Nant Isaf fel mater o'r brys mwyaf, a dylid cwtogi ar y gor-bori yn Llain 9 ar Gors Erddreiniog. Ar Gors Geirch, mae'r ardal lle y daethpwyd o hyd i *V. geyeri* gyntaf yn 1996 ac eto yn 1998 a 2005 yn rhy ddrewllyd, ac mae angen cynyddu'r lefel o bori er mwyn agor y diferiadau dŵr a'r tywarch yn gyffredinol.

2. Executive Summary

A survey for Geyer's Whorl Snail *Vertigo geyeri* on Cors Erddreiniog SSSI/NNR and Cors Geirch SSSI/NNR in October 2016 failed to locate the snail. Survey locations were based upon previous records dating from 1985 to 2007 on Cors Erddreiniog and 1996 and 2008 on Cors Geirch. Losses from some former strongholds on Cors Erddreiniog are 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 is most pronounced on Nant Isaf spring field (Compartment 13c) which has not been grazed for over 20 months. In other compartments, snail loss may be a consequence of over-grazing, or periods of under-grazing followed by cattle poaching of the remaining open areas. Similarly, *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 as a result of under-grazing. 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.

As small populations of *V. geyeri* can be easily overlooked, it is premature to declare the snail as extinct on Cors Erddreiniog and Cors Geirch. Additionally, areas which previously supported very small numbers of snails and not sampled in 2016 need to be surveyed soon. More regular surveys are required in order to advise on appropriate grazing regimes if *V. geyeri* is found to be 'hanging on' on either site. If this is the case, then the development of simplified and affordable surveillance routines is suggested.

Even in the apparent absence of *V. geyeri*, it is vital that areas which previously supported the snail are managed appropriately. Grazing should be re-instated on Nant Isaf spring field as a matter of great urgency, and the current over-grazing of Compartment 9 on Cors Erddreiniog should be relaxed. On Cors Geirch, the area where *V. geyeri* was first found in 1996 and again in 1998 and 2005 is too rank and grazing levels need to be increased to open up the seepages and the general sward.

3. Introduction

3.1. 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 meant 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 Directive (92/43/EEC) and is also an English and Welsh Section 41/42 'Species of Principal Importance' NERC Act 2006. 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*, *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).

3.2. Cors Erddreiniog NNR/SSSI

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 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 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

[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).

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 (SH4760881877) 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. Three individuals were found in just one sample, from 26m on Transect A." 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".

V. geyeri records for Cors Erddreiniog are given in Table 1 and mapped in Figure 1.

On 11th October 2015, Liz and Mike Howe sampled the small seepage in Compartment 20 on Cors Erddreiniog which had supported 175 shells in 2007, and found just a single *V. antivertigo*.

3.3. Cors Geirch NNR/SSSI

V. geyeri 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. Since then, two attempts have been made to establish a baseline survey and monitoring programme at Cors Geirch (Lloyd, 2005, 2008). Records for Cors Geirch are given in Table 1 and mapped in Figure 2.

Habitat and population condition assessments on Cors Geirch in 2005 and 2008, which included a wider search of suitable habitat and of past locations, found two shells and four shells respectively at single but different locations, one in the SSSI (2005) and one in the NNR (2008) (Lloyd, 2005, 2008).

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 singleton *V. pygmaea*.

3.4. Current Status

Whilst a good population is present on Waun Eurad (Lloyd, 2014), that at Cors Erddreiniog has probably declined over the last 10 to 15 years due to increasingly fragmented and deteriorating habitat conditions and is regarded as being in Unfavourable condition (Killeen & Moorkens, 2004, 2008). As a consequence, the population on Corsydd Môn SAC has been reported as Unfavourable in the last two reporting rounds (2001-06 and 2007-12) to Europe. The population at Cors Geirch has also been reported as Unfavourable over the last two reporting rounds as a consequence of the condition assessments (Lloyd, 2005, 2008).

3.5. Objectives

The 2016 *V. geyeri* surveys of Cors Erddreiniog and Cors Geirch follow a survey hiatus for the snail at these sites of nine and eight years respectively. This project was established to determine if the snail was still present on these sites following a number of unsuccessful recent surveys by NRW staff (see above). In the limited time available to undertake the fieldwork, site surveillance was undertaken rather than formal site monitoring. This entailed visits to all major locations where *V. geyeri* had been recorded during previous surveys.

Table 1. Records of *Vertigo geyeri* from Cors Erddreiniog SSSI/NNR and Cors Geirch SSSI/NNR. Note that some of the grid references from published sources are likely to be inaccurate.

Site	Compartment	Recorder	Date	Grid Reference	Abundance	Reference
Cors Erddreiniog NNR	9a	Martin Willing	July 1985	SH475815	1 shell	Colville 1994
Cors Erddreiniog NNR	11a	Barry Colville	02.07.1994	SH476818	1 shell	Colville 1994
Cors Erddreiniog NNR	13a/19a/20?	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH4747483259	1 shell	Killeen & Moorkens 2004
Cors Erddreiniog NNR	21	Matt Sutton	15.12.1997	SH47158325	1 shell	Sutton unpublished to CCW
Cors Erddreiniog NNR	21	Evelyn Moorkens & Ian Killeen	23.09.2007	SH4714383298	175 shells	Killeen & Moorkens 2008

Cors Erddreiniog NNR	22f	Evelyn Moorkens & Ian Killeen	23.09.2007	SH4691083303	3 shells	Killeen & Moorkens 2008
Cors Erddreiniog NNR	22h	Evelyn Moorkens & Ian Killeen	23.09.2007	SH4675083327	1 shell	Killeen & Moorkens 2008
Cors Erddreiniog NNR, Cors Nant Isaf	15a?	Adrian Fowles	29.09.1997	SH472824	1 shell	APF pers comm
Cors Erddreiniog NNR, Cors Nant Isaf	15a	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH4742782559	1 shell	Killeen & Moorkens 2004
Cors Erddreiniog NNR, Cors Nant Isaf	15b	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH4740082691	1 shell	Killeen & Moorkens 2004
Cors Erddreiniog NNR, Cors Nant Isaf	15b	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH4742182839	1 shell	Killeen & Moorkens 2004
Cors Erddreiniog NNR, Cors Nant Isaf	15b	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH4745382896	1 shell	Killeen & Moorkens 2004
Cors Erddreiniog NNR, Cors Nant Isaf	15b	Evelyn Moorkens & Ian Killeen	20-22.10.2007	SH47468307	6 shells	Killeen & Moorkens 2008
Cors Erddreiniog NNR, Cors Nant Isaf	19a	Matt Sutton	06-16.12.1997	SH47458310		Sutton unpublished to CCW
Cors Erddreiniog NNR, Cors Nant Isaf	19b	Evelyn Moorkens & Ian Killeen	20-22.10.2007	SH4757083173	1 shell	Killeen & Moorkens 2008
Cors Erddreniog SSSI, Nant Isaf spring field	13c	WPIS	06.10.1988	SH479823	1 shell	Boyce et al. 1992
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Barry Colville	24.06.1994	SH477823	1 shell	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Adrian Fowles	02.07.1994	SH477823	1 shell	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Liz Howe	02.07.1994	SH477823	3 shells	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Barry Colville	02.07.1994	SH478825	2 shells	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Barry Colville	02.07.1994	SH478824	3 shells	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Barry Colville	02.07.1994	SH477823	5 shells	Colville 1994
Cors Erddreniog SSSI, Nant Isaf spring field	13c	MED & RW Marriott	13-14.08.1994	SH477823		Marriott unpublished to CCW
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Adrian Fowles	27.06.1996	SH478823	2 shells	
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Evelyn Moorkens & Ian Killeen	Autumn 2003	SH478824	several shells	Killeen & Moorkens 2004
Cors Erddreniog SSSI, Nant Isaf spring field	13c	Evelyn Moorkens & Ian Killeen	20.10.2007	SH4778982302	3 shells	Killeen & Moorkens 2008
Cors Geirch SSSI		Adrian Fowles	20.09.1996	SH32863529	2 shells	APF pers comm
Cors Geirch SSSI		Barry Colville	16.09.1998	SH328353	3 shells	Colville unpublished to CCW
Cors Geirch SSSI		Dylan Lloyd	26.07.2005	SH3275935181	2 shells	Lloyd 2005
Cors Geirch NNR		Barry Colville	16.09.1998	SH329351	1 shell	Colville unpublished to CCW
Cors Geirch NNR		Dylan Lloyd	18.09.2008	SH33083507	4 shells (? ID to be confirmed)	Lloyd 2008

Figure 1: The distribution of *Vertigo geyeri* on Cors Erddreiniog SSSI/NNR. Note that some of the grid references from published sources are likely to be inaccurate.

Figure 2: The distribution of *Vertigo geyeri* on Cors Geirch SSSI/NNR.(A - Fowles site; B & C - Colville sites; D & E Lloyd sites) Note: *V. geyeri* specimens from E require confirmation.

4. Methods

4.1 Introduction

As only one day was available to undertake work at each site it was considered impractical to follow the detailed **monitoring** condition assessment ('performance indicators') as described by Killeen & Moorkens (2008) and Lloyd (2008) for Cors Erddreiniog and Cors Geirch respectively. In any event, habitat conditions at the sites were likely to have changed making the accurate and meaningful placement of transects and polygons problematic. It was therefore decided to adopt a more pragmatic **surveillance** approach. This entailed visits to all localities reported as supporting the snail on both Cors Erddreiniog and Cors Geirch – it was impossible to visit the exact localities but any suitable habitat close to the grid references was investigated. At each location, sample material was removed from the remaining habitat deemed most likely to still support *V. geyeri*.

4.2 Method Procedures

Sampling relied primarily upon the well-established technique of selecting the best potentially-suitable habitat present and then removing sample material for later laboratory processing (as this tiny snail is typically very difficult to locate in the field).

Survey for *Vertigo* species (except for *V. moulinsiana*) is difficult to achieve solely by reliance upon field data collection. This is because:

- Visual field searches, although often revealing the presence of *Vertigo* snails, typically significantly under-estimate snail numbers or even fail to locate the presence of the snail;
- The target species of this study, *Vertigo geyeri,* is usually found living in damp moss and sedges/rushes. This 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), and also described by Killeen & Colville (1999a):

- Selection of suitable areas for material collection. This relied upon studies of previous surveys of Cors Erddreiniog and Cors Geirch (chiefly Killeen & Moorkens 2004, 2008; Lloyd 2008) to locate areas where the species had been previously recorded (often in low and unshaded sedge *Carex* and/or Black Bog-rush *Schoenus* sward and associated moss carpets).
- 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 a number of 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. Depending upon the size of the site, additional samples may also have been taken.

- 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 both Cors Geirch and Cors Erddreiniog was undertaken together with the NRW Invertebrate Officer, Dr Mike Howe.

5. Results

Eleven samples were collected from five different areas on Cors Geirch on 3rd and 4th October 2016 (Figure 3), with nine samples from five site compartments collected from Cors Erddreiniog on 6th October 2016 (Figures 4 & 5). None of the samples contained *V. geyeri*. Survey results for other Mollusca, including other *Vertigo* species, are given in Appendix 1 and 2, and site descriptions are given in Appendix 3 & 4. All sites were photographed and images appear in Appendix 5.

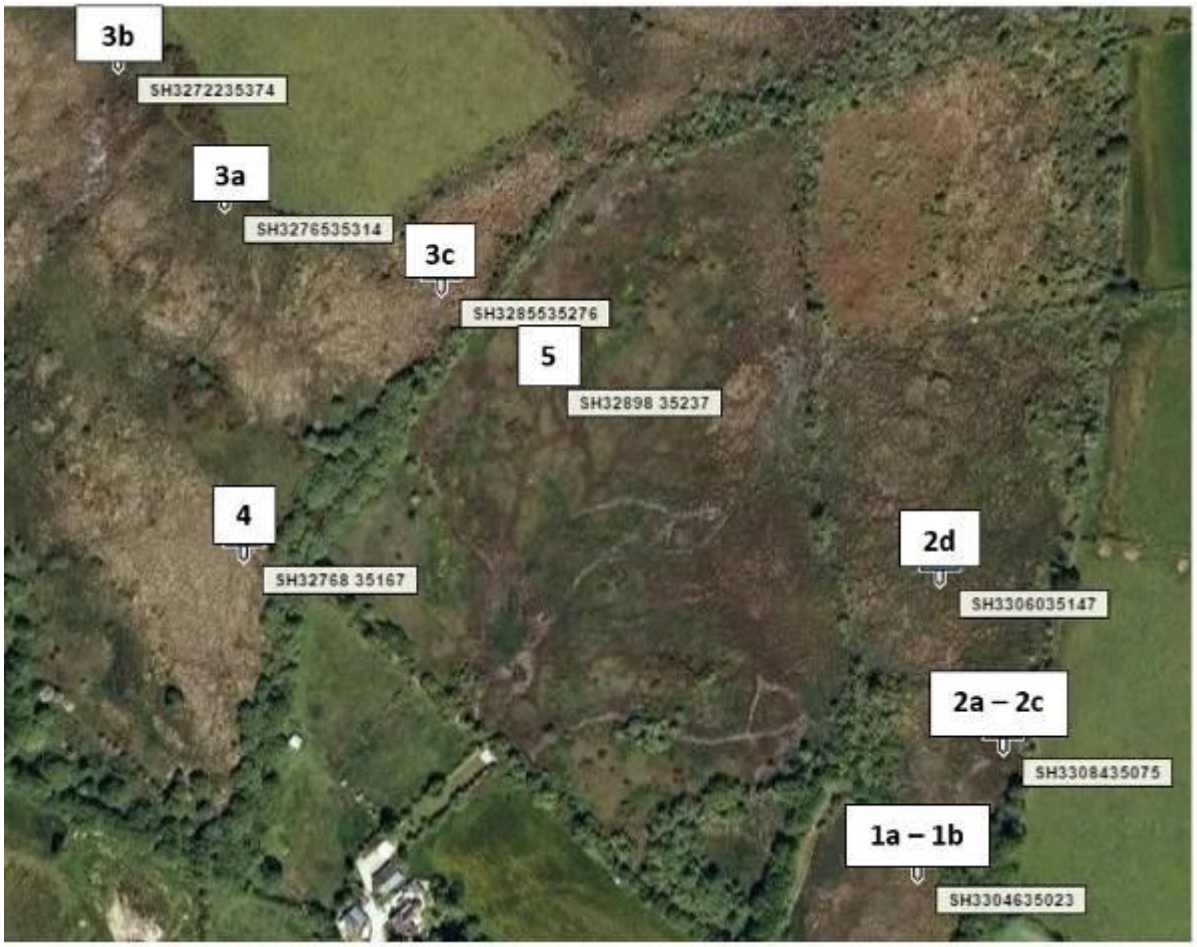

Figure 3: *Vertigo geyeri* sampling locations on Cors Geirch in 2016.

Figure 4: *Vertigo geyeri* sampling locations on Cors Erddreiniog in 2016. Note that two site labels overlap in Compartment 11a. Sampling station numbers relating to these points are given in Appendix 4.

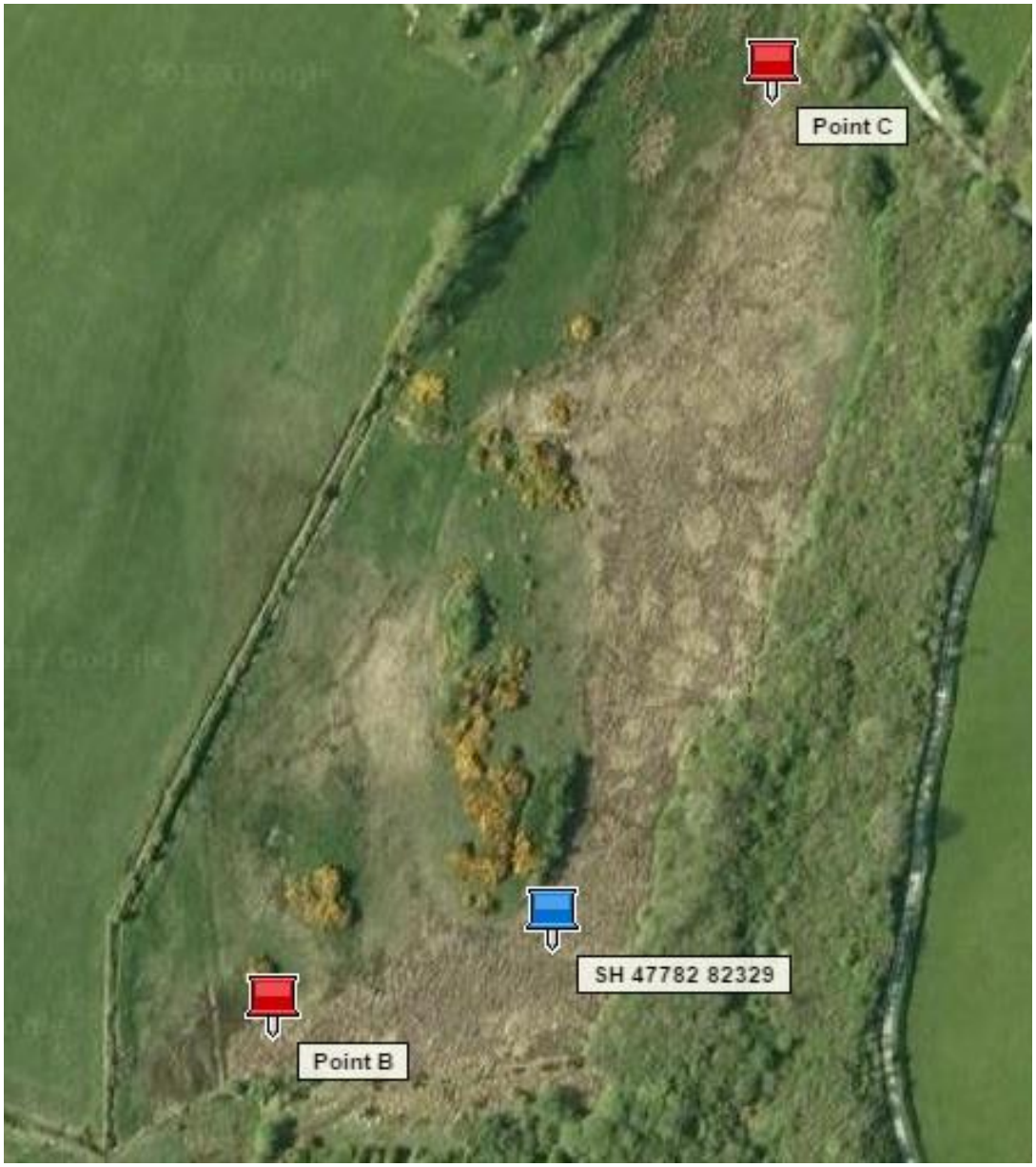

Figure 5: *Vertigo geyeri* sampling location in Compartment 13c and extent of visual search between Points B & C.

6. Discussion

6.1. Cors Geirch NNR/SSSI

In 2005, Dylan Lloyd sampled a total of 0.3015ha from four areas of suitable *Schoenus* seepages (based on an interpretation of suitable habitat given by Killeen & Moorkens [2004]), finding two shells of *V. geyeri* in Area A (see Figure 6). He assessed the location where Barry Colville had recorded a single shell in *Myrica – Molinia* habitat in 1998 as unsuitable. Similar sampling in 2008 recorded four shells in Area D north (Figure 7). All known locations are shown in Figure 2.

The 2016 survey revisited all areas bar the *Myrica – Molinia* location (Figure 3) where *V. geyeri* had been reported and removed bulk samples from these sites, selecting where possible 'short *Carex*-turf habitat'. *V. geyeri* was not found although other *Vertigo* species were recorded. Some possible reasons for *V. geyeri* absence are given in Table 2.

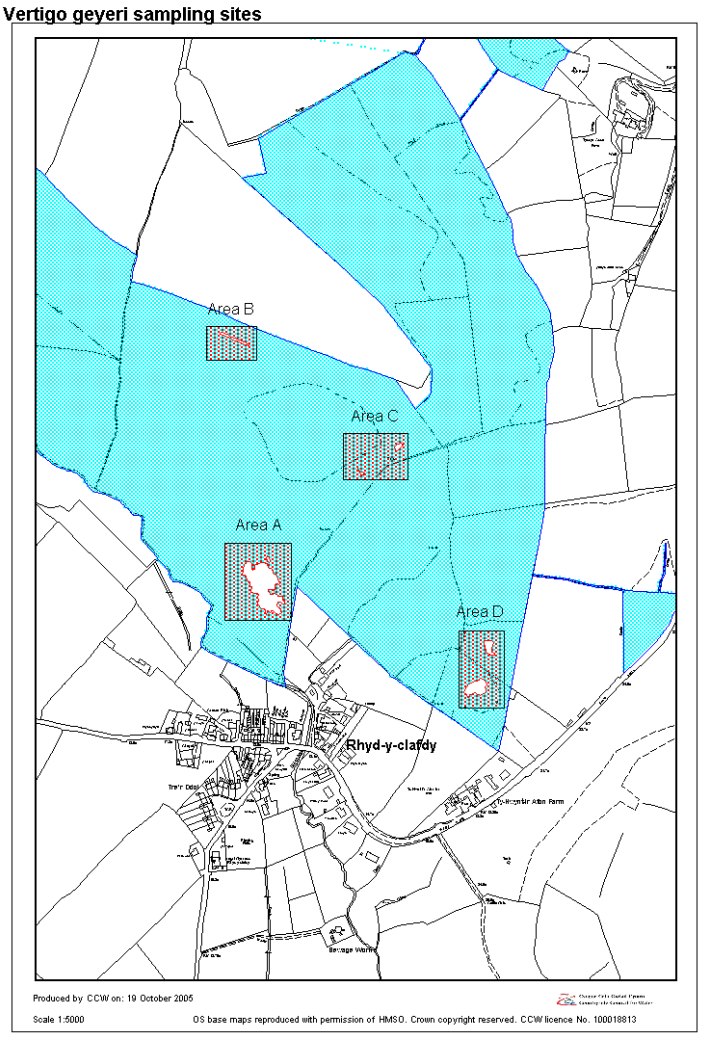

Figure 6: Sample sites surveyed by Dylan Lloyd on Cors Geirch in 2005 (from Lloyd, 2005).

Figure 7: Sample sites surveyed by Dylan Lloyd on Cors Geirch in 2008 (from Lloyd, 2008).

Table 2. Simplified analysis of Cors Geirch survey sites.

Survey Sites (this report)	Links to previous reported *V. geyeri* locations	Possible reasons for absence of *V. geyeri*
1	Lloyd 2008	Site very wet (except for top of tussocks); plants associations including *Sphagnum* mosses suggest areas of neutral to acidic conditions although overall the site is base-rich; no areas of 'damp *Carex* lawn' habitat.
2 a - c	Lloyd 2008 ? Lloyd 2005	Only small areas of *Carex* lawn' habitat on the slightly better draining sloping area between the *Schoenus* fen with its pools and the marginal alder / *Salix* to the immediate west. These areas were examined after a period of wet weather but may well dry in periods of low rainfall and / or higher summer temperature. Another possibility (discussed below) is that *V. geyeri* may never have been recorded in this survey area.
2d	No known survey of this flush	Only small areas of '*Carex* lawn' habitat lying between drier, more acid 'heath' and saturated flushed conditions.This area has

		previously been mapped as *Juncus subnodulosus* marshy grassland and may have become more rank since vegetation was mapped.
3a - b	Colville 1998	Rank, relatively dry hummocks with poached furrows and hollows between. Almost no '*Carex* lawn' habitat. Current state of site maybe due to low levels of grazing causing rank *Schoenus / Juncus* tussock growth.
3c	No known survey of this flush	A very wet flush with *Schoenus* tussocks falling sharply into saturated flush conditions so only tiny areas of short '*Carex* lawn' habitat. This area produced *V. geyeri* in 1996.
4	Lloyd 2005 Lloyd 2008	Hummocks with poached hollows; no '*Carex* lawn' habitat. Wholly unsuitable for *V. geyeri.* May have been more open in 2005 and 2008.
5	Lying just slightly north of Colville 1998	Well drained but humid (ground moisture 3); areas of closely horse-cropped '*Carex*-lawn' seemingly near suitable for *V. geyeri.* This area has been observed to experience periodic flooding in very wet winters which would render it unsuitable for *V.geyeri.*

It is clear that *V. geyeri* was present at four locations on Cors Geirch from 1996 to 2005 (vouchers from 1996 and 2005 have now been checked by the author of this report, and specimens were recorded in 1998 by a reliable expert [Barry Colville]). Specimens from a fifth location in 2008 have yet to be determined by an expert conchologist. Until these are confirmed, there remains a possibility that these four shells are of the superficially very similar *V. pygmaea*. Reasons for this suggestion include:

1. The two species can easily be confused, even for those recorders with a wide experience of them. It can often be necessary to compare specimens of the quite variable *V. pygmaea* with reference specimens of *V. geyeri*.
2. There are at least three recent examples of reported *V. geyeri* turning out, upon closer scrutiny, to be *V. pygmaea* (e.g. Willing 2013, 2017). Killeen and Moorkens (2004, p. 14) had difficulty in determining if a juvenile *Vertigo* specimen from one of their Cors Erddreiniog sites was either *V. geyeri* or *V. pygmaea*.
3. The area reported with four *V. geyeri* in 2008 (Area D north) was re-surveyed in this survey. Three large bulk samples were removed (Area 2, 2016); although no *V. geyeri* were found, *V. pygmaea* was recovered from two of the samples. Additionally, further *V. pygmaea* specimens were collected in the field during this survey and by NRW staff during an earlier *V. geyeri* search in the area in 2015 (Dylan Lloyd & Mike Howe, pers. comm.). It may be significant that Lloyd did not find *V. pygmaea* in the three bulk samples taken from this area; it might have

been expected to have been in his samples. Examination of the specimens would resolve this issue.

Lloyd sets out a protocol (condition assessment) for monitoring *V. geyeri* at Cors Geirch. If it is still considered necessary to monitor the snail (following its possible loss from the site), then Lloyd's described procedures may need to be simplified. The 2016 survey showed significant habitat changes since the 2005 and 2008 surveys. It is therefore not appropriate to restrict any new monitoring to his specified areas ('A', 'B', 'C' and 'D'). It may in future be better to sample any areas of potential habitat by 'opportunistic' bulk sampling (as undertaken with the 2016 survey) possibly combined with a trial use of vacuum sampling. Lloyd's protocol states that for the snail to be considered in 'favourable condition' on Cors Geirch, it must be recorded in two of four specified areas. Perhaps an assessment of 'favourable' should include the live presence of the snail in any two areas of the site.

6.2. Cors Erddreiniog NNR/SSSI

To put the 2016 Cors Erddreiniog survey into context, it is necessary to review previous work and this requires reference to a reserve compartment map (Figure 8). Figures 9 and 10 show the location of records made between 1994 and 1997. The results of the first wide-scale survey in 2003 (Killeen & Moorkens, 2004) are shown in Figure 11. Snail populations were associated with patches of suitable habitat along the NE boundary spring-line, with the highest numbers recorded on the south-west sloping flushes of Compartment 13c. Here, it was found in 9 out of 11 samples reflecting Colville's survey success in this area in 1994. No *V. geyeri* were found in the northwest Compartments 21, 22h and 22j where Sutton had recorded the snail in 1997. In an overall assessment, Killeen & Moorkens (2004) considered Cors Erddreiniog to be in an 'Unfavourable Condition' for *V. geyeri* because suitable habitat for the snail was in fragmented patches and the height of the vegetation over much of the site suggested under-grazing (allowing the development of rank, shading tussocks).

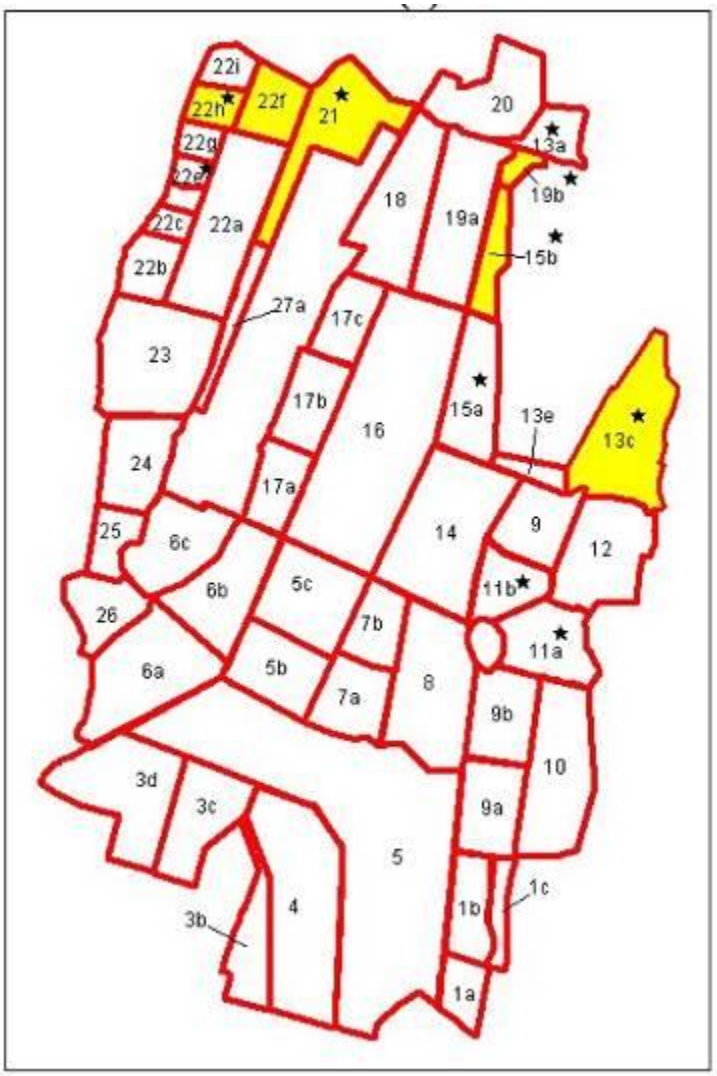

Figure 8: Cors Erddreiniog NNR/SSSI Compartments (map adapted from Killeen & Moorkens, 2008). Yellow shaded areas indicate where *V.geyeri* was recorded in 2007 and star points where suitable habitat was present at that time.

Figure 9: *V. geyeri* locations on Cors Erddreiniog reported in Colville (1994).

Figure 10: *V. geyeri* locations on Cors Erddreiniog recorded by Adrian Fowles and R. Marriott (four southern sites – two points fully overlap) and Matt Sutton (two northern sites) between 1994 and 1997.

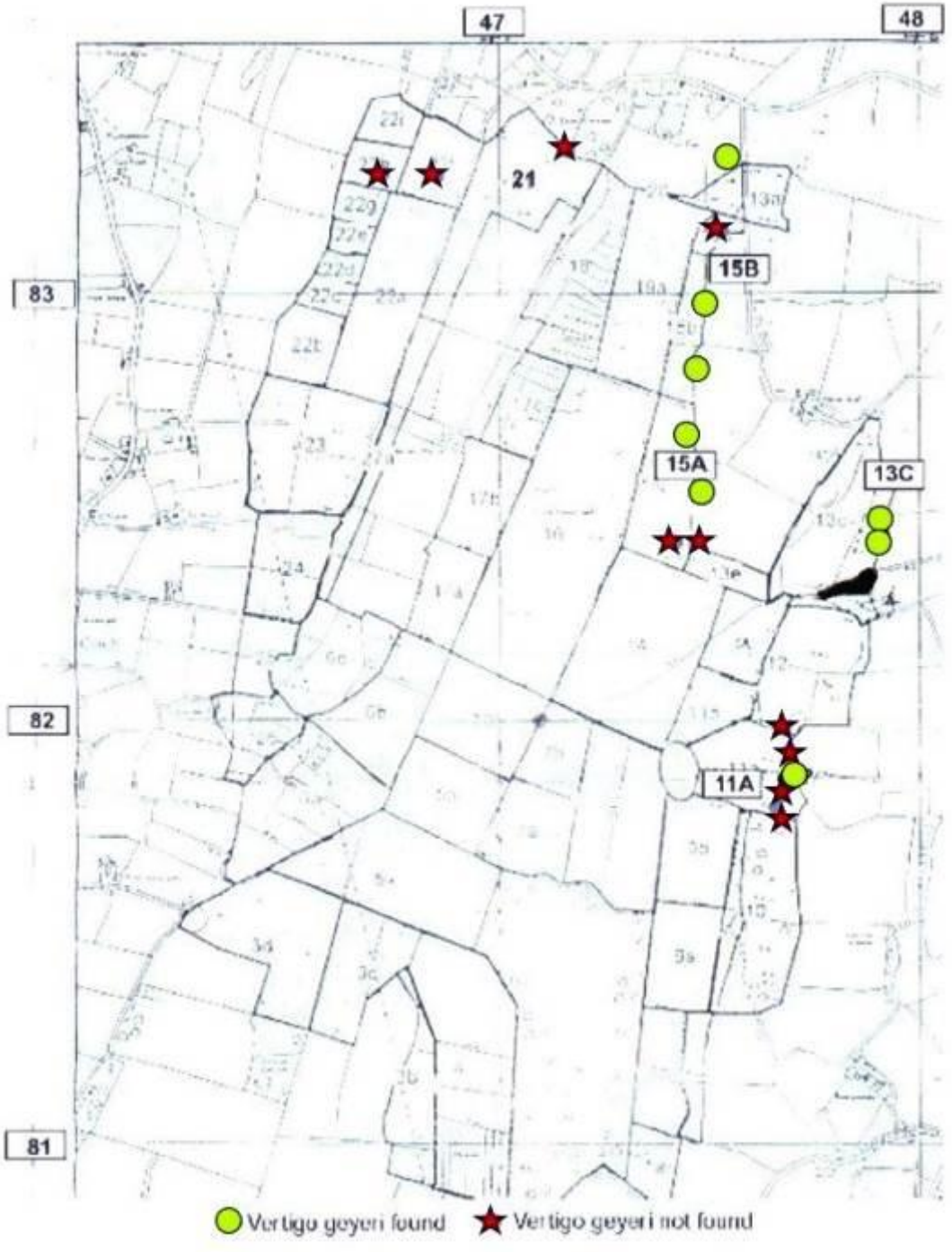

Figure 11: *V. geyeri* survey at Cors Erddreiniog 2003 displaying positive and negative survey locations (adapted from Killeen & Moorkens, 2004).

Killeen & Moorkens (2008) found a significant decline in the population in Compartment 13c in 2007, with only three specimens found in one of thirteen samples, in stark contrast to results in 1994 and 2003. They linked this decline to tussock formation within the flushes and across the entire compartment which was shading the '*Carex* lawn' habitat required by the snail. Active management was

proposed involving the integration of physical cutting and light grazing. Reduced numbers in Compartment 15 when compared to the 2003 survey results were also attributed to under-grazing which was resulting in a patchiness of suitable habitat. In contrast, over-grazing by cattle in Compartment 13a was cited as a possible cause of snail absence. Unlike the 2003 survey, three populations were recorded in the north-west area of the NNR, including 175 specimens in Compartment 21 and small numbers in Compartments 22f & 22h (Figure 12). The management in these areas by selective strimming and light pony grazing was considered to have produced areas of ideal '*Carex* lawn' habitat.

Figure 12: *V. geyeri* survey at Cors Erddreiniog 2007 displaying positive survey locations (data from Killeen & Moorkens, 2008).

The 2016 survey follows a 9-year hiatus of records. An examination of survey sites offers possible insights into *V. geyeri* losses.

1. Site 1 (Compartment 21): the close-grazed free-draining '*Carex* lawn' was sampled close to the 2007 location which had produced numerous *V. geyeri*. The area still appeared suitable for *V. geyeri* and so reasons for its absence are unclear. It is not known what events may have affected the site since 2007. Compartments 22f and 22h were not sampled in 2016.
2. Sites 2a – 2d (Compartments 19a & 19b): No *V. geyeri* were recorded from 19a/b in 2016 although the 2003 surveys found it at locations throughout these compartments. The

snail had, however declined here by 2007 when it was only recorded at a single location in 19a. In 2016, only scraps of '*Carex* lawn' were present at sites 2a – 2c; much of the area consisting of grazed tussocks with cattle-poached hollows between. Site 2d by contrast had a higher concentration of rank tussocks with shaded, damp hollows between and minimal low *Carex* habitat.

3. Site 3 (Compartment 13c): This former *V. geyeri* 'hot-spot' produced abundant snails during the 1994 and 2003 surveys. By 2007, under-grazing was cited as a reason for the sharp decline in snail presence (then only found in a single sample). In 2016, the whole site was blanketed in uncut and un-grazed *Schoenus nigricans / Juncus subnodulosus* tussocks. Over much of the compartment these had partially collapsed forming a mat on the ground, over-shading the flush channels and leaving an almost complete absence of '*Carex*-lawn' habitat (<1% potentially suitable *V. geyeri* habitat remaining). As no *V. geyeri* (or other *Vertigo* species) were recorded, it seems likely that *V. geyeri* has been lost from this compartment. Management advice suggesting an integrated programme of strimming and light grazing in this compartment (Killeen & Moorkens, 2008) has not been followed on a regular basis.
4. Site 4 (Compartment 11a): Two sites were sampled in very close proximity. Very little short '*Carex*-lawn' habitat was present, the sites being dominated by un-grazed *Schoenus nigricans / Juncus subnodulosus* tussocks. *V. geyeri* was not recorded (the last confirmed record here being in 1994).
5. Site 5 (Compartment 10): In this south-east area of the NNR, the spring-line flushes are very heavily pony-grazed and poached leaving almost no suitable habitat; *V. geyeri* was not recorded.

It is perhaps premature to assume the complete loss of *V. geyeri* from Cors Erddreiniog although it seems to have gone from the former stronghold in Compartment 13c and probably from Compartment 15a/b. A trend of habitat deterioration linked to *V. geyeri* decline, and described in the 2003 and 2007 survey reports, has continued for another nine years. The snail's absence from Compartment 21 sample is puzzling as habitat conditions there seemed potentially suitable; however, the area occupied in 2007 was very small. The relatively brief 2016 surveillance of Cors Erddreiniog did not include sampling in Compartments 19b, 22f and 22h, which all had snail presence in 2007. Additionally, Compartment 21 (a large unit) was only sampled at one location. A re-survey of these compartments is required.

The maintenance of suitable hydrological conditions is probably the most important factor influencing site occupancy by *V. geyeri*. One of the most important requirements is high ground water levels throughout the year. A detailed study of on micro-habitat requirements of *V. geyeri* in Ireland found the snail to require particular

hydrological conditions, with soil moisture usually around 80% and with a water table no more than 0.1m below ground level (Kuczyńska & Moorkens, 2010). Cameron *et al.* (2003: p.161) describe the hydrological requirements of the snail thus: "*It is found just at the interface between the water table and the base of the herb layer, at open spots where the surface substrates are continually at, or near field capacity, but not subject to seasonal flooding".* Any changes, both on site or elsewhere in the catchment, to the flow of base-rich waters could compromise the ability of sites to support the snail.

The other key factor influencing *V. geyeri* management at its Welsh localities is grazing. As hydrological conditions do not seem to have deteriorated at Cors Erddreiniog, then the grazing regime is probably of greater importance in causing the decline or possible total loss of *V. geyeri*. Sharland (2000, p.4) writes, "*The environment in which V. geyeri exists is a fragile equilibrium which can easily be damaged by removal of grazing which allows undergrowth (sic) to grow rapidly and crowd out the existing vegetation community. Conversely, if the area is managed unsympathetically by too much grazing or by harsh mechanical clearance processes then this also has a detrimental effect on the habitat*". Killeen & Moorkens (2008, p.15) expanding on the same theme for Cors Erddreiniog write, "*Overgrazing can lead to erosion of vegetation by poaching along the springline, where optimal habitat should occur, and undergrazing can lead to tussock growth, which can lead to lack of function of sub-habitat over time. Lack of function has two causes. If tussocks grow to a level where there is too steep a slope between the tussock clump and the lower moss and Carex viridula lawn below, during the wettest periods there will be no saturated shelf between the dry tussock above and the inundated pool below, and during brief periods on inundation the snails of that micro-habitat will perish. The second effect that leads to loss of function is shading. Vertigo geyeri is a snail of open habitats becoming most active on warm summer and autumn days where the humid open sedge lawn facilitates feeding and reproductive success*".

To inform conservation management choices (and autecological understanding) for *V. geyeri,* then more frequent site surveillance is required. Prior to the 2016 surveys, Cors Erddreiniog and Cors Geirch had not been assessed for 9 and 8 years respectively. With such a long hiatus, it is difficult to identify and understand the specific causes of population declines or losses. During these periods, sites will have experienced potentially significant natural events such as flooding, periods of drought, high summer and low winter temperatures, and the effects of these will have inter-related with any changing site management routines, most importantly levels of grazing and the stock species used.

Killeen & Moorkens (2008) and Lloyd (2008) provide detailed and prescriptive monitoring protocols for *V. geyeri* for Cors Erddreiniog and Cors Geirch respectively.

These may be quite difficult and time-consuming to undertake, especially for those new to, or relatively inexperienced in, *V. geyeri* survey work. With unlimited time, financial resources and highly experienced personnel, such approaches may be ideal but, given today's budgetary restrictions and difficulties in obtaining suitably-experienced surveyors, then much simpler surveillance needs to be devised to allow quicker and more frequent assessments of *V. geyeri* populations and their habitat.

7. Conclusions & Recommendations

V. geyeri was not found at either Cors Erddreiniog or Cors Geirch in October 2016. Whilst small populations are easily overlooked, suitable habitat on both sites is currently both small and very fragmented and, as such, snail populations will be faring badly at best. Most areas which supported the snail in the recent past are either under-grazed or over-grazed. The key area for *V. geyeri* on Cors Erddreiniog in both 1994 and 2003, Nant Isaf spring field (Compartment 13c), has not been grazed for over 20 months and is currently very rank and supports little suitable habitat and it is very likely that the snail has been lost from this part of the site. Nevertheless, grazing should be re-instated here as a matter of great urgency. The area where *V. geyeri* was found in 1985 (Compartment 9) is over-grazed and the seepage lines are heavily poached by ponies. On Cors Geirch, the area where *V. geyeri* was first found in 1996 and again in 1998 and 2005 is rather rank and grazing levels need to be increased to open up the seepages and the general sward.

As all previously-recorded locations for *V. geyeri* were not sampled in 2016, further survey work is required to look at Compartments 19b, 22f and 22h on Cors Erddreiniog, and the *Myrica* – *Molinia* station on Cors Geirch NNR where Barry Colville found a single shell in 1998. If this further work locates populations of *V. geyeri* at either site, then the development of simplified surveillance guidelines might allow for more regular and affordable assessments of the snail on these two SACs.

8. Acknowledgements

Natural Resources Wales is thanked for funding this project, which was planned and managed by Dr. Mike Howe. Mike is also thanked for his help during all phases of the field work and for making valued comments that have improved the final report. Additionally, I thank Emyr Humphreys, NRW Senior Reserves Manager of both reserves, who assisted in the field during parts of the survey.

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10. Appendix 1. Molluscs recorded from the eleven sampling locations on Cors Geirch NNR/SSSI in 2016.

Species	1a	1b	2a	2b	2c	2d	3a	3b	3c	4	5
Terrestrial											
Carychium minimum	1		1		5						4
Carychium tridentatum	1										
Oxyloma elegans/Succinidae		1		3		4			3		3
Cochlicopa lubrica			1			1					1
Vertigo antivertigo			32	33	3	3					8
Vertigo substriata					3	2					1
Vertigo pygmaea			2	1							2
Nesovitrea hammonis	5	2						1	2		1
Zonitoides nitidus			1								
Cepaea nemoralis	1						1		1		
Aquatic											
Potamopyrgus antipodarum	1						1				
Galba truncatula			6	10	5	1	1	5		2	10
Pisidium personatum			3	2			1				
Pisidium casertanum			2	7	9						11
Pisidium sp	2		1	5	2		1				

11. Appendix 2. Molluscs recorded from Cors Erddreiniog NNR/SSSI in 2016. Grid references for the nine sampling stations are given in Appendix 4.

Species	1	2a	2b	2c	2d	3	4a	4b	5
Terrestrial									
Carychium minimum		10	30	33			5	20	2
Oxyloma elegans/Succinidae	4	4		2	4	3	5		8
Cochlicopa lubrica		6	20	10			3		
Vertigo antivertigo	13	16	25	31					30
Vertigo substriata		1	5	1				1	
Vertigo pygmaea	4	10	2						6
Vertigo spp	5	1	1	2					
Punctum pygmaeum		1							
Nesovitrea hammonis		2	5	8	1	2	6	19	1
Zonitoides nitidus		6	1	1				1	1
Euconulus fulvus (agg)		6		1		4	3	8	
Aegopinella nitidula								1	
Cepaea nemoralis							1		
Aquatic									
Potamopyrgus antipodarum			7		1				
Galba truncatula	1	5	18	9	10	2	9	14	7
Pisidium personatum	2		11	1	3				2

Pisidium casertanum		1							
Pisidium sp		1					1		

12. Appendix 3. Site locations and habitat descriptions on Cors Geirch NNR/ SSSI.

Site:	Grid Ref (All Ord Survey prefix 'SH')	Site wetness (1 – 5)	Shading	General vegetation/ dominant specie / site management	Figs. (in Appendix 8.4 following main report)
1	33046 35023 (samples 1a & 1b about 15m apart; grid ref at central point)	4 – 5; apart from top of tussocks the whole site was very saturated	Trees on margins of site; some encroaching alder & sallow	*Menyanthes trifoliata,* sparse *Schoenus nigricans,* Very little *'Carex* lawn' except on tops of few scattered tussocks. Occasional *Erica tetralix* & much ground cover moss dominated including *Sphagnum* spp	Fig. 13
2	Three grid refs taken across area: **2a**: 33084 35075 **2b**: 33082 35084 **2c**: taken across lower (toward west) levels of sites 2a & 2b **2d**: 33060 35147	4 – 5; apart from top of tussocks the whole site was very saturated	Slight lateral from bank of trees to east	Sites **2a & 2b** 'tongues' of flush draining westwards over area of approximately 50m x 15m, *Juncus subnodulosus, Myrica gale* on tussock tops; Site **2d** flush area of approximately 50m x 15m; light horse grazed and with frequent presence of *Schoenus nigricans,* some short *Carex* on tops of tussocks. For sub-sites **2a – 2d** estimated at < 20% potentially suitable *Vertigo geyeri* habitat.	Fig. 14 (2a/b) Fig. 15 (2d)
3	Three sites: **3a**: 32765 35314 **3b**: 32722 35374 **3c**: 32855 35276	**3a**: 2 – 3; 4 in hollows between tussocks **3b**: 2 – 3 similar to 3a but drier **3c**: 4 - 5	nil @ all sites	**3a**: light cattle-grazed, rank tussocks with occasional damp ground in hollows between. *Juncus subnodulosus,* occasional *Schoenus nigricans* very few *Carex* sp; estimated < 1% suitable 'damp *Carex* lawn' *Vertigo geyeri* habitat; **3b**: much as 3a but drier; **3c**: rather too wet for access by grazing animals & so appeared un-grazed; similar to site 2c tussocks with *Schoenus nigricans, Juncus subnodulosus, occasional Myrica gale, Erica tetralix.* Site grades into areas with *Cladium mariscus.* No 'damp	Fig.16 (3a) Fig.17 (3c)

				Carex lawn'. Possibly 0% potentially suitable *Vertigo geyeri* habitat.	
4	32768 35167	Mostly 2 – 3 on tussock tops with 4 – 5 in shaded hollows between tussocks	nil	Light cattle-grazed, rank tussocks with occasional damp ground in hollows; some *Schoenus nigricans, Phragmites australis, Myrica gale, Erica tetralix, Calluna vulgaris, Narthecium ossifragum.* Estimated < 1% potentially suitable *Vertigo geyeri* habitat present.	Fig. 18
5	32898 35237	3 - 4	nil	A mostly close-cropped, horse-grazed sward; *Juncus subnodulosus, Hydrocotyle vulgaris, Succisa pratensis,* areas of damp (not flooded) '*Carex* lawn' with *Carex* spp, *Carex flacca*.	Fig. 19

13. Appendix 4. Site locations and habitat descriptions at Cors Erddreiniog.

Site:	Grid Ref (All Ord Survey prefix 'SH')	Site wetness (1 – 5)	Shading	General vegetation/ dominant species / site management	Figs.
1	47145 83300	3	Alder/ sallow hedge to immediate east so some lateral morning shade	Moderately pony grazed (may previously have also been cattle). Areas of short '*Carex*-dominated lawn' with some small areas of bare-poached ground; species noted include *Carex* spp, *C. demissa*, *Molinia*, *Erica tetralix*, *Succisa pratensis, Parnassia palustris, Juncus spp, Briza, Nathecium ossifragum,* scarce *Schoenus nigricans*	Fig. 20
2a	Surveyed between points: 47476 83007 & 47457 82886 (sample point approx.. 47453 82936	2 - 3	nil	Cattle-grazed. *Juncus* with short *Carex* spp in herbaceous sward, some *Mentha aquatic*, *Hydrocotyle vulgaris*, *Succisa pratensis, Molinia; Schoenus nigricans* following seepage line rank tussocks but poached hollows and channels between. Some signs of enrichment from improved & fertilised field on slopes above.	Fig. 21
2b	Surveyed between points: 47457 82886 & 47432 82858* (* sample	3 - 4	nil	Cattle-grazed. Varied sward structure with noticeable base-rich seepages observed (calcareous deposition seen), short grazed areas with mosses, *Carex* spp, *Juncus* spp, *Molinia*, *Mentha aquatica*, *Myrica gale*, *Succisa*	Fig. 22

	point)			*pratensis, Eriophorum spp, Hydrocotyle vulgaris*, *Epilobium* sp and occasional *Schoenus nigricans.*	
2c	Surveyed between points: 47432 82858 & 47411 82782* (* sample point)	2 tussock tops; 3 – 4 hollows and small gulleys between	nil	Cattle-grazed. Varied sward structure (height 20 – 30 cm) with tussocks including *Schoenus nigricans, Juncus sp.* (incl. *subnodulosus, articulatus, acutiflorus), Molinia, Succisa pratensis, Eriophorum spp, Mentha aquatica, Pedicularia* spp, *Myrica gale, Festuca sp, Carex* spp (incl, *lepidocarpus)*	Fig. 23
2d	Sampled between points: 47431 82558 & 47438 82492 (sample point approx.. 47422 82530	1 - 2 tussock tops; 3 - 4 hollows and small gulleys	Ground surface over most of this area heavily over-shaded by rank (ungrazed & uncut) *Schoenus nigricans*	Minimal cattle-grazing. Area of tall tussocks with much *Schoenus nigricans* with no bare ground but further down slope with some open tufaceous seepages with *Eriophorum*, mosses and *Galium* sp . Also *Juncus sp.* (incl. *subnodulosus, articulatus, acutiflorus), Succisa pratensis, Prunellus, Molinia, Festuca sp, Pedicularis* sp, General statement for 'Area 2' (Samples 2a – 2d; Cors Nant Isaf) as whole: moderately cattle grazed with drier areas closely grazed but wetter areas ranker as relatively lighter grazed.	Fig. 24
3	Sample location: 47782 82329. Surveyed between approx. 47694 82305 (lower slope) to 47859 82591 (upper slope)		1 – 4 (only 4 in hollows and channels mostly covered by *Scheonus nigricans*.	No grazing. Almost all sloping ground is covered by rank *Schoenus nigricans* in varying proportions with *Juncus subnodulosus*. In many areas this has collapsed to form a dense matt . A very few areas remain open to reveal areas of tufa seepage where additionally *Molinia* also present. Estimated <0.1 % of area with habitat suitable to support *Vertigo geyeri.*	Fig. 25 Fig. 26
4a	47617 81912	Nil	3 - 4	Lightly grazed. Small area of short *Carex* lawn surrounded by ranker vegetation in a flush with some *Juncus* spp, *Schoenus nigricans* tussocks, *Pedicularis* sp, *Triglochin palustris,* occasional *Phragmites, Molinia, Succisa pratensis and mosses*	
4b	47620 81919	Nil	3	Possibly very lightly grazed. Small area of short *Carex* lawn lacking *Schoenus nigricans* with mosses, *Juncus* spp, *Molinia*, *Pedicularis* spp	Fig. 27

5	47543 81477	3 - 4	Nil	Pony over-grazed *Schoenus nigricans* seepages with high % of bare mud; the *S. nigricans* tussocks grazed to form rounded hummocks; sample point also with matt of *Carex* spp, *Juncus* sp, *Succisa pratensis, Parnassia palustris,*browm mosses. The samples were taken from the least over-grazed '*Carex* lawn' areas.	Fig. 28 Fig. 29

14. Appendix 5. Survey site images (October 2016).

Figure 13: Cors Geirch Site 1.

Figure 14: Cors Geirch Site 2a/b.

Figure 15: Cors Geirch Site 2d.

Figure 16: Cors Geirch Site 3a.

Figure 17: Cors Geirch Site 3c.

Figure 18: Cors Geirch Site 4.

Figure 19: Cors Geirch Site 5.

Figure 20: Cors Erddreiniog Site 1.

Figure 21: Cors Erddreiniog Site 2a.

Figure 22: Cors Erddreiniog Site 2b.

Figure 23: Cors Erddreiniog Site 2c.

Figure 24: Cors Erddreiniog Site 2d.

Figure 25: Cors Erddreiniog Site 3 (view 1).

Figure 26: Cors Erddreiniog Site 3 (view 2).

Figure 27: Cors Erddreiniog Site 4.

Figure 28: Cors Erddreiniog Site 5.

Figure 29: Cors Erddreiniog Site 5 (showing pony-poached ground).

15. 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. 118724.

Published by:
Natural Resources Wales
Maes-y-ffynnon
Penrhosgarnedd
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