The status and distribution of Lilljeborg's Whorl Snail *Vertigo lilljeborgi* within Glaslyn SSSI at Pont Croesor in 2022

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One of two sites at Pont Croesor supporting *Vertigo lilljeborgi* in 2022

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Crynodeb gweithredol

Cyflwynir canlyniadau arolwg monitro ym mis Awst 2022 yn SoDdGA Glaslyn ar gyfer Malwen Droellog Lilljeborg *Vertigo lilljeborgi*, sydd Dan Beth Bygythiad. Mae'r ardal a arolygwyd i'r gogledd o Bont Croesor ar Afon Glaslyn. Barnwyd fod yr ardal mewn cyflwr anffafriol wedi'r arolwg diwethaf ym mis Gorffennaf 2008 (Willing, 2009). Ailadroddwyd yr arolwg blaenorol gan yr arolwg newydd ac fe'i cynhaliwyd dros ddau ddiwrnod ym mis Awst. Mae cynefinoedd y gwlyptir yn parhau'n debyg iawn o ran golwg i'r rhai a ddisgrifir yn 2008 ac roedd amodau'r tywydd a lefel yr afon yn debyg.

Cafodd pob un o'r 8 safle eu harolygu eto a'u samplu drwy chwilio gweledol, curo llystyfiant a swmp-gasglu samplau o ddeunydd planhigion oedd yn pydru. Samplwyd nawfed safle ger Safle 7, y man lle cofnodwyd *V. lilljeborgi* ddiwethaf yn 2008. Defnyddiwyd samplwr sugno mewn 5 lleoliad ychwanegol rhwng safleoedd ar y lan ddwyreiniol. Cafwyd hyd i 12 malwen *V. lilljeborgi* llawn dwf yn Safle 7 a Safle 8, gan gadarnhau bod y rhywogaeth wedi goroesi ar ddwy ochr Afon Glaslyn, er ei bod yn dal i fod wedi ei chyfyngu i ardaloedd bach. Cafwyd hyd i ddwy falwen *Vertigo* ifanc hefyd yn Safle 6. Nid oedd modd adnabod y rhain yn gwbl hyderus fel *V. lilljeborgi*, oherwydd presenoldeb rhywogaeth arall, *Vertigo antivertigo*, gerllaw. Cafwyd hyd i bob sbesimen *Vertigo* mewn samplau swmp mawr oedd wedi'u sychu a'u rhidyllu. Ni welwyd unrhyw falwod *Vertigo* allan ar y safle, gan bwysleisio pwysigrwydd dulliau samplu lluosog.

Gan ddefnyddio'r Terfyn Isaf o 10 unigolyn a osodwyd gan Willing (2009) fel Amcan Cadwraeth, bernir bod *V. lilljeborgi* mewn cyflwr ffafriol yn SoDdGA Glaslyn ym mis Awst 2022. Er hynny, nid yw'r boblogaeth yn llawer uwch na'r Terfyn Isaf, ac mae'n parhau i fod yn fach ac o bosib dan fygythiad. Gallai mwy o waith samplu yn yr ardaloedd o amgylch Pont Croesor helpu i benderfynu a yw *V. lilljeborgi* yn bodoli'n ehangach ar orlifdir Afon Glaslyn.

Executive summary

Results of a monitoring survey in August 2022 for the Near Threatened Lilljeborg's Whorl Snail *Vertigo lilljeborgi* within Glaslyn SSSI are presented. The area surveyed is north of Pont Croesor on the Afon Glaslyn. Judged to be in Unfavourable condition after the last survey in July 2008 (Willing, 2009), the present survey over two days in August repeated the previous survey. The wetland habitats remain visually very similar to those described in 2008 and weather and river level conditions were similar.

All 8 sites were revisited and sampled by visual search, beating vegetation, and collecting bulk samples of decaying plant matter. A 9th site was sampled near Site 7, the point at which *V. lilljeborgi* was last recorded in 2008. A suction sampler was used in 5 additional locations between sites on the east bank. A total of 12 adults of *V. lilljeborgi* was found at Site 7 and Site 8, confirming that the species survives on both sides of the Afon Glaslyn, although it is still apparently restricted to small areas. Two juvenile *Vertigo* were also found at Site 6. These could not be unambiguously identified as *V. lilljeborgi*, owing to the presence of another species, *Vertigo antivertigo*, nearby. All *Vertigo* specimens were found in large bulk samples that had been dried and sieved. No *Vertigo* were observed in the field, emphasising the importance of multiple sampling methods.

Using the Conservation Objective Lower Limit of 10 individuals set by Willing (2009), *V. lilljeborgi* is judged to be in Favourable condition within Glaslyn SSSI in August 2022. Nonetheless, the population only just exceeds the Lower Limit, and remains small and potentially vulnerable. Further sampling in the areas around Pont Croesor could help determine whether *V. lilljeborgi* is more widespread on the Afon Glaslyn floodplain.

Introduction

Lilljeborg's Whorl Snail, *Vertigo lilljeborgi* (Westerlund, 1871), is a tiny, rare, Boreo-Arctic terrestrial snail. In Europe it occurs mainly in Scandinavia, with outlying populations in northern and western Britain, Ireland, and the high Pyrenees (Welter-Schultes, 2012). Using IUCN Red List criteria it is considered Near Threatened in Europe (Cuttelod *et al*., 2011). It is classed as Near Threatened in Great Britain, where it is known from under 20 sites, all in areas extremely vulnerable to grazing improvements and to changes in water levels (Seddon *et al*., 2014). Kerney (1999) considered that the main threats to it came from agricultural drainage and the raising or controlling of water levels in lakes or rivers, noting that several colonies had been destroyed in this way since the 1930s.

The species is a wetland habitat specialist, whose preferences were summarised by Kerney (1999) as follows: "Restricted to saturated decaying vegetation in *Carex* and *Juncus* swamps, sometimes shaded by alders. Most sites are at the margins of highland lakes and rivers, in places subject to deep natural flooding; occasionally it is found in small, isolated mires. *Vertigo lilljeborgi* tolerates acidic conditions. It is only rarely immediately associated with other species of *Vertigo*."

In Wales, *V. lilljeborgi* is known from six/seven localities (Table 1), five of which are on the Afon Teifi where it was first recorded in 1984 (Chater, 1985; Fowles, 1986). It had earlier been found at Pont Croesor on the Afon Glaslyn in 1970 (Dance, 1972) where the species is a qualifying feature of the Afon Glaslyn Floodplain SSSI (Willing, 2009). Here the population(s) straddle two vice counties - (Caernarvonshire [VC49] and Merionethshire [VC48]). There is also a record from Morfa Afon Rhyd-hir near Pwllheli in 1998. Records of molluscs including *Vertigo* species from many other Welsh wetlands confirms that *V. lilljeborgi* is genuinely restricted in its distribution. It is a qualifying feature on three Welsh SSSIs – Corsydd a Rwyth Cilyblaidd SSSI, Glaslyn SSSI and Rhosydd Bryn-maen SSSI (Howe, 2020).

Table 1. Welsh records of *Vertigo lilljeborgi*. From: Natural Resources Wales.

Site	Grid reference	Vice county	Date	Abundance
Cilyblaidd Marshes & Oxbow	SN542460	46	21/07/1985	0
Cilyblaidd Marshes & Oxbow	SN542459	46	23/02/1987	0
Gwaun Garthenor a Llanio-isaf	SN638558	46	27/06/1985	0
Gwaun Garthenor a Llanio-isaf	SN635556	46	05/07/1986	several shells
Highmead ox-bow	SN508430	46	25/06/1985	0
Highmead ox-bow	SN507430	46	12/09/1985	3 shells
Llangybi Kettle Hole	SN610529	46	05-06/07/1984	0
Llangybi Kettle Hole	SN610528	46	06/11/1987	0
Morfa Afon Rhyd-hir	SH367347	49	30/01/1998	2 shells
Pont Croesor	SH592415	49	16/05/1970	0
Pont Croesor	SH591415	49	24/06/1970	3 shells
Pont Croesor	SH592414	49	14/08/1970	9 shells
Pont Croesor	SH595415	48	24/07/1981	5 shells
Pont Croesor	SH591419	48	20/02/1998	32 shells
Pont Croesor	SH5917241551	49	30/07/2008	7 shells

The most recent record from Pont Croesor, and indeed from Wales, is from July 2008 during a Countryside Council for Wales-funded survey, which also developed a

Conservation Objective for the population (Willing, 2009). All seven shells found in 2008 were from a single sampling site (Site 7; see Figure 1) supporting flower-rich fen meadow lightly shaded by alders. Although high water levels hampered sampling, the population was considered to be in Unfavourable condition. Willing (2009) also provides a definition of suitable habitat at Pont Croesor as "**habitat that is exposed to periodic and sometimes extreme flooding. The habitat provides locations where vegetational flood debris (e.g. *Juncus, Carex, Phragmites, Typha, Schoenoplectus*) can accumulate at flood margins (edges of pools, river channels and lakes). Such strandline flood-litter habitats can be unshaded or partly shaded (as on the Afon Glaslyn floodplain) by alders *Alnus glutinosa* and willows *Salix spp.***" (see Table 2). Whilst Willing (2009) made recommendations for monitoring at Pont Croesor every two years, with a more extensive survey conducted every eight to ten years, the present survey is the first to be undertaken since 2008.

Over the intervening 14 years, the site appears to have changed relatively little, although the Welsh Highland Railway line crossing the bridge was reopened in 2009. The Osprey visitor centre (now run by Bywyd Gwyllt Glaslyn Wildlife) was redeveloped in 2014. Staff at the centre confirmed that flooding of the area surveyed remains a regular occurrence, and that the tidal influence on the Afon Glaslyn extends as far upstream as the bridge, as indicated on OS maps.

Methods

The methods of Willing (2009) were followed to ensure a common standard for monitoring. In 2008, fieldwork took place on 29th and 30th July whilst in 2022, fieldwork took place on 22nd and 23rd August. The weather experienced in 2022 was also similar to that described for 2008, with intermittent rain and drizzle and very high humidity throughout the survey. Willing (2009) described the river level as "very high" in 2008. Similar or higher values of the wetness index at each site was estimated during the current study (Appendix 1). The water table level is therefore likely to be closely comparable.

All 8 sites of Willing (2009) were revisited with the aid of the map and a GPS (smartphone) (Figure 1). In the earlier report, the sites were grouped into Area 1 (Sites 1-5: near an oxbow lake/old river channel) and Area 2 (Sites 6-8, narrow hollows running parallel to the current river channel). Both *V. lilljeborgi* and *V. antivertigo* were recorded from Area 1 by Adrian Fowles and Mike Howe (invertebrate ecologists with the Countryside Council for Wales) in 1998/1999. Willing (2009) recorded only *V. lilljeborgi*, and only from Area 2. As recommended by Willing (2009), at least 4 hours was spent surveying in each area in 2022 (Area 1: 6 hours, Area 2: 5 hours).

The habitats at each site strongly resembled the descriptions and photographs given in Willing (2009). Allowing for the growth of *Alnus* and *Salix* trees, there appears to have been little macroscopic change in vegetation at any of them, although the presence of what appeared to be *Crassula helmsii* (New Zealand Pigmyweed) mats was noted in Area 1. The amount of shading does not appear to have increased dramatically. Large areas can still be described as flower-rich. It therefore appears the same habitats were sampled as in 2008, and the 8 sites do not need to be redescribed here.

In 2022, a ninth site was added at SH59214145 (Figure 2). This is referred to as Site 9, and is to the south of Site 7, the only site at which *V. lilljeborgi* was recorded by Willing (2009). Site 9 had similar vegetation to Site 7, but is more heavily shaded by alder and willow. Like Site 7 it is close to both standing water in the fen and to the river's edge.

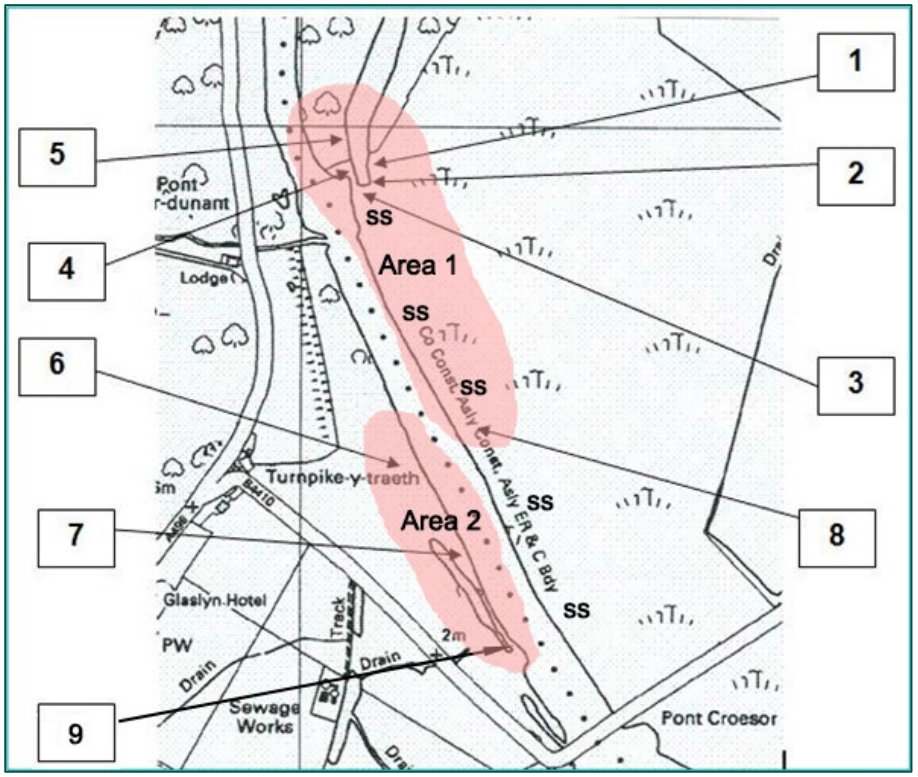

Figure 1. Map of the survey area showing the areas and sites sampled, including the new Site 9 and five suction samples on the east bank ("ss"). Modified from Willing (2009).


Figure 2. Vegetation at Site 9. The open water of the fen is visible in the midground. (22/8/2022)

In 2022, decaying vegetation under wetland plants consisted mainly of straw-like material that appeared to be mainly autochthonous. There was relatively little other flood debris other than occasional pieces of driftwood, with very rare items of rubbish. All 9 sites had been freshly grazed and trodden by cattle, which were on site at the time, and had at least some fresh cattle dung. In Area 1, evidence of fresh grazing occurred deep into the band of wetland vegetation.

At each site the following methods were used to search for *V. lilljeborgi* (and other terrestrial molluscs):

- Visual searching of vegetation, especially very close to the ground;
- Beating of vegetation 0.25 m or taller (e.g. *Typha, Persicaria, Equisetum, Lythrum, Carex, Juncus*) over a white plastic tray with a search grid;
- Collection of bulk samples of saturated, decaying stems, roots and leaves and flood debris from the base of the sward. As in Willing (2009), the wet weather and vegetation made effective sieving in the field impossible. One bulk sample was gathered per site, each comprising 3 litres when gently compressed. Each sample was taken away in a plastic bag, then air dried in a linen tote bag suspended in the wind and direct sunshine for 7-9 days. After drying, each sample was torn/agitated by hand and shaken through 2 mm and 0.5 mm sieves. All molluscs and empty shells were picked out with the aid of a magnifying loupe.

These are typical methods used to survey for the presence and abundance of *V. lilljeborgi* and other *Vertigo* species (e.g. Kevan & Waterston, 1933; Willing, 2009).

A petrol suction sampler (McCulloch MAC GBV 345) was also used at 5 additional points between the other sites on the east bank of the Afon Glaslyn. These follow the line of a long shallow hollow parallel to the river (Figure 3). Some were very wet and dominated by *Equisetum* and *Potentilla palustris*, others drier with *Juncus* and even occasional small *Rubus*. The tussocks in a small area were sucked for a total of 30 seconds at each location, and the contents of the sampler examined carefully in a tray. In recent years the author has found this method very effective at finding *Vertigo* and other molluscs in a wide range of grassy habitats throughout South Wales (Rowson & Cavadino, unpublished). It works in marshes and other wetlands, for instance to retrieve *V. antivertigo, Euconulus fulvus* and even slugs. It becomes ineffective only where standing water occupies more than approximately 25% of the ground surface. It still works in wet weather, such as that experienced during the survey, although the contents of the sample take longer to check.

Finally, a sieve on a pole was used to briefly check for molluscs on submerged grasses and other vegetation in the fen at Site 7 and 9 and at the edges of the river itself, as done by Dance (1972) and Willing (2009). Whilst Dance (1972) found living *V. lilljeborgi* using this method, only aquatic molluscs were recorded in 2022 (Appendix 1).

Molluscs were identified using Cameron (2008) and Rowson *et al*. (2014, 2021). *Vertigo* specimens were checked against the collections at the National Museum of Wales including the original *V. lilljeborgi* collected from Pont Croesor by Dance (1972). Voucher specimens from the survey have been retained.

Figure 3. Example of the vegetation investigated by suction sampling on the east bank. (23/8/2022)

Results

- A total of 12 adult *Vertigo lilljeborgi* were found, at Site 7 in VC49 (6 adults) and at Site 8 in VC48 (6 adults).
- *Vertigo antivertigo* was also found at Site 7 (2 adults).
- Small juvenile *Vertigo* were found at Site 6 (2 juveniles), Site 7 (1 juvenile) and Site 8 (1 juvenile).
- Photographs of the three sites at which *Vertigo* specimens were found are provided (Figs. 4-6).
- All the *Vertigo* specimens were from dried, sieved bulk samples, and were alive when collected. No *Vertigo* were seen during searching in the field, despite beating vegetation, visual search, and suction sampling.
- Of the 12 adult *V. lilljeborgi*, 10 were of the 4-toothed form and 2 of the 5-toothed form.
- Raw data from the 9 sites and suction samples are given in Appendix 1.

Figure 4. Site 6 of Willing (2009), at which juvenile *Vertigo* were found. (22/8/2022)

Figure 5. Site 7 of Willing (2009), at which *V. lilljeborgi* was found. (22/8/2022)

Figure 6. Site 8 of Willing (2009), at which *V. lilljeborgi* was found. (23/8/2022)

Discussion

The weather and water table conditions under which the 2008 and 2022 surveys were carried out were very similar. The addition of Site 9 and the suction samples in the current survey recorded additional species, but no further *Vertigo* individuals. In terms of *Vertigo*, the results can therefore be compared directly with those of Willing (2009).

The 2022 survey confirms that the *V. lilljeborgi* population is still extant at Site 7 in Area 2 in similar numbers to those found by Willing (2009) - 7 individuals in total in 2008, 6 adults in 2022. It is also extant at Site 8 in Area 1, at which it was not detected in 2008. The species is therefore living in both Area 1 and Area 2, on both sides of the Afon Glaslyn.

Vertigo lilljeborgi was found living alongside *V. antivertigo*, a species not recorded by Willing (2009). Dance (1972) had noted that living individuals of these two species were not found together, although living populations were found only 100m apart. Kevan & Waterston (1933) implied that *V. lilljeborgi* was rarely found with *V. antivertigo* (or *V. substriata*), while Kerney (1999) implied that it was rarely found with any other *Vertigo*. However, Adrian Fowles & Mike Howe found both *V. lilljeborgi* and *V. antivertigo* living in Area 1 in 1998/1999 in “good numbers” (Willing, 2009). It is to be hoped that the presence of *V. antivertigo* at Site 7 does not mean that *V. lilljeborgi* is under increased threat, either directly (due to interaction) or indirectly (reflecting a habitat change).

At least one of these species is also present at Site 6, where 2 juvenile *Vertigo* were found. Juveniles of *V. lilljeborgi* and *V. antivertigo* can usually be distinguished by their colour, but the *V. lilljeborgi* found in 2022 were unusually dark (see below). It is therefore not possible to say with certainty which species they were.

One difference from Willing (2009) was that no *Vertigo* were found in the field, only in bulk samples. This was the opposite situation to 2008, and re-emphasises the importance of using multiple methods.

No *V. lilljeborgi* were found in the northern part of Area 1, from which large samples were taken in both 2008 and 2022. The bulk samples were dominated by shells and living individuals of the aquatic snails *Menetus dilatatus* and *Physella acuta*. Three of the sites in Area 1, very close to one another, each produced over 100 *M. dilatatus*. Effort in this area could probably be reduced in future surveys by combining Sites 1-3, and Sites 4-5, into just two samples.

The abundance of living aquatic molluscs such as *M. dilatatus*, *P. acuta* and pisid bivalves suggests that the 9 study sites are far from being too dry for *V. lilljeborgi*, and may even be too wet, at least seasonally. Indeed, Willing (2009) suggested that prolonged flooding of the area could also account for the low numbers of other terrestrial molluscs. It is possible that the northern part of Area 1 is no longer suitable for *V. lilljeborgi*, and that a band of suitable vegetation (if any) has shifted north out of the survey area.

Menetus and *Physella* are both introduced species spreading in the UK (Rowson *et al*., 2021). While Willing (2009) also found many *M. dilatatus*, neither species was recorded by Dance (1972). It would almost certainly have been mentioned if he had found it in 1970, since he reported discovering it in Llyn Trawsfynydd in 1969 (Dance, 1970). The presence of large mats of the invasive wetland plant *Crassula helmsii* (New Zealand Pigmyweed) was also noticed in this area. This species was first recorded as naturalised in Britain in 1956, and is still spreading (Smith & Buckley, 2020).

The other terrestrial molluscs recorded by the 2022 survey are common hygrophilous species, typical of wetland habitats in which *V. lilljeborgi* has been found (Kevan & Waterston, 1933; Dance, 1972; Chater, 1985; Willing, 2009). As *V. lilljeborgi* was not found in the sites dominated by aquatic molluscs, perhaps slightly drier areas should be checked more widely (as was briefly attempted with the suction sampler in 2022). In particular the area on the west bank north of Site 6, towards Pont Aber-dunant, should be sampled. It includes shallow depressions heavily shaded by alders, which during the 2022 survey were rather dry (wetness index of 1-2 using the scale of Willing [2009]). Beating of the *Persicaria*-dominated vegetation on 22 August 2022 produced no molluscs. Unfortunately, suction sampling of this area was not possible on a return visit on 23 August 2022, due to the presence of horned cattle in the immediate vicinity.

More speculatively, the *Juncus* and grass tussocks of the pasture away from the east bank at Pont Croesor should be checked by suction sampling. The 1970 record by Dance (1972) was said to be from SH593415, while his text makes clear that all living *V. lilljeborgi* were found on the west bank, near the river, in the area shaded by alder and willow. (The “bushes” of Dance, 1972 are presumably today’s mature trees). In fact, grid reference SH593415 is some 50m from the east bank and near the middle of the cattle pasture (currently grazed by a dairy herd). This *Juncus* and grass meadow is subject to winter flooding (according to the Osprey centre staff) but is quite different in appearance to the depressions nearer the banks. This habitat may not support *V. lilljeborgi* but would be worth checking at least once since it is so widespread on the floodplain.

Beyond Pont Croesor, further sampling along the Afon Glaslyn towards Beddgelert might reveal additional *V. lilljeborgi* sites. Similar riverside depressions south of the steam railway look suitable, although downstream of Pont Croesor there is a tidal influence on the river that may not favour *V. lilljeborgi* or other molluscs. A brief use of the suction sampler

on the *Phragmites*-dominated sandbank in front of the Osprey hides (surveyed with permission), did not yield any *V. lilljeborgi*.

As is typical, most individual *V. lilljeborgi* found in 2022 had 4 teeth. The 4-toothed form (10 adults) dominated over the 5-toothed form (2 adults) by 10:2, or 5:1. Previous accounts have also found that the 4-toothed form dominated (Willing, 2009; Dance, 1972; Kevan & Waterston, 1933). More unusually, all the *V. lilljeborgi* found in 2022 had the same rich dark brown shell colour as the two *V. antivertigo* specimens (both of which had 7 teeth, slightly less tumid whorls, and a slightly less globular shape than the *V. lilljeborgi*). The shell of *V. lilljeborgi* is usually described as pale yellowish-brown, and that of *V. antivertigo* as dark brown (Cameron, 2008). All the *Vertigo* collected in 2022 were darker than Dance's 1970 specimens of *V. lilljeborgi* from Pont Croesor. They are also darker than the majority of *V. lilljeborgi*, from many other sites, in the Museum collection, and even darker than some of the *V. antivertigo*. Judging by the teeth and shape features, however, it appears that the 2022 *V. lilljeborgi* are simply darker than usual. Colour in this local, possibly transient, instance is therefore not useful in distinguishing *V. lilljeborgi* from *V. antivertigo*. Dance (1972) described differences in the colour of the live animals at Pont Croesor, and the shape of their tentacles. The two species are closely related, and following the phylogenetic study of Nekola *et al*. (2018) both are considered members of the subgenus *Alaea* Jeffreys, 1830.

Conservation Status of *Vertigo lilljeborgi* on the Afon Glaslyn Floodplain

Willing (2009) defined Conservation Objectives for this species for the Afon Glaslyn floodplain (Table 2). When the floodplain feature is in favourable condition, the Lower Limit for Favourable status for *V. lilljeborgi* is: "The combined total of *Vertigo lilljeborgi* present at the 2 monitoring sites is 10 individuals (counting 4 hours for each survey area)". In 2008, a combined total of 7 individuals of *V. lilljeborgi* were found, all in Area 2. Willing (2009) therefore concluded that the species was in Unfavourable condition.

Table 2. Conservation Objective for Lilljeborg's Whorl Snail on the Afon Glaslyn floodplain. From: Willing (2009).

Conservation objective (for when the feature is in favourable condition)	To maintain Lilljeborg's Whorl Snail *Vertigo lilljeborgi* on the Afon Glaslyn floodplain in favourable condition where:
Lower limit	The combined total of *Vertigo lilljeborgi* present at the 2 monitoring sites is 10 individuals (counting 4 hours for each survey area)
Habitat extent: **Lower limit**	**AND** that (a) at 'survey area 1' alder carr with occasional pools extends for at least 250m on the eastern bank of the Afon Glaslyn upstream of the Pont Croesor bridge and (b) that open fen is present connecting the lower end of abandoned river channel (lying immediately to the east and on the other side of the Afon Glaslyn, of Pont Aber-dunant) with the Afon Glaslyn.
Definition of suitable *Vertigo lilljeborgi* Habitat	*Vertigo lilljeborgi* are typically found in habitat that is exposed to periodic and sometimes extreme flooding. The habitat provides locations where vegetational flood debris (e.g. *Juncus, Carex, Phragmites, Typha, Schoenoplectus*) can accumulate at flood margins (edges of pools, river channels and lakes). Such strandline flood-litter habitats can be unshaded or partly shaded (as on the Afon Glaslyn floodplain) by alders *Alnus glutinosa* and willows *Salix spp.*

In 2022, a combined total of 12 adults of *V. lilljeborgi* were found, 6 in Area 2 and 6 in Area 1. It is probable that some of the 4 juvenile *Vertigo* found are also *V. lilljeborgi*. The methods and sites used, and survey conditions, are directly comparable to Willing (2009). The presence of the species on both sides of the river (in both VC48 and VC49) is likely to aid their survival. The vegetation at Pont Croesor appears to be very similar to that surveyed in 2008. It is therefore concluded that the species is now in Favourable condition.

Nonetheless, the number of *V. lilljeborgi* was small in both surveys, and the area of habitat occupied is tiny. The threshold of 10 individuals is low, arguably too low, and was exceeded only by 2 individuals (20%) making the differences marginal even though twice as many individuals were found in 2022 as in 2008. *Vertigo lilljeborgi* is thought to undergo wide fluctuations in population size, being easier to find in some years than others (Willing, 2009). This may mean small populations can build up rapidly when conditions are good, but small and localised populations remain vulnerable to threats. The apparent loss of the species from the northern part of Area 1 is concerning, and the small areas of occupied habitat should be monitored carefully.

References

Cameron, R. A. D. 2008. *Keys for the Identification of Land Snails in the British Isles.* Field Studies Council Publications, Shropshire. 83 pp.

Chater, A. O. 1985. *Vertigo lilljeborgi* living in Cardiganshire. *Journal of Conchology.* **32**: 147-148.

Cuttelod, A., Seddon, M. & Neubert, E. 2011. European Red List of Non-marine Molluscs. Luxembourg: Publications Office of the European Union.

Dance, S. P. 1970. Trumpet Ram's Horn Snail in North Wales. *Nature in Wales*. **12 (1)**: 10-14.

Dance, S.P. 1972. *Vertigo lilljeborgi* Westerlund in North Wales. *Journal of Conchology.* **27**: 387-389.

Fowles, A.P. 1986. Field meeting - Gwaun Garthenor a Llanio-isaf (22/635556) VC46, 5 July 1986. *Dyfed Invertebrate Group Newsletter.* **3**: 8-9.

Howe, M.A. 2020. *Vertigo lilljeborgi* account August 2020. NRW unpublished report. Natural Resources Wales, Bangor.

Kerney, M. 1999. *Atlas of the Land and Freshwater Molluscs of Britain and Ireland.* Conchological Society of Great Britain & Ireland/Harley Books, Colchester.

Kevan, D. K., & Waterston, A. R. 1933. *Vertigo lilljeborgi* (West.) in Great Britain (with additional Irish localities). *Journal of Conchology*. **19**: 296-313.

Nekola, J. C., Chiba, S., Coles, B. F., Drost, C. A., von Proschwitz, T., & Horsák, M. 2018. A phylogenetic overview of the genus *Vertigo* O. F. Müller, 1773 (Gastropoda: Pulmonata: Pupillidae: Vertiginae). *Malacologia.* **62 (1)**: 21-161.

Rowson, B., Turner, J. A., Anderson, R., & Symondson, W. O. C. 2014. *Slugs of Britain and Ireland: Identification, Understanding and Control.* Field Studies Council, Shropshire. 140 pp.

Rowson, B., Powell, H., Willing, M., Dobson, M., & Shaw, H. 2021. *Freshwater Snails of Britain and Ireland.* Field Studies Council, Shropshire. 192 pp.

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**. Natural Resources Wales, Bangor.

Smith, T., & Buckley, P. 2020. Biological Flora of the British Isles: *Crassula helmsii* (No. 290). *Journal of Ecology.* **108**: 797-813.
Welter-Schultes, F. W. 2012. *European Non-marine Molluscs, a Guide for Species Identification.* Planet Poster Editions, Göttingen, Germany. 674 pp.
Willing, M.J. 2009. *Monitoring invertebrate features on SSSIs:* Vertigo lilljeborgi *on the Afon Glaslyn Floodplain at Pont Croesor, Meirionnydd.* CCW Contract Science Report No. **866**. Countryside Council for Wales, Bangor.

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Appendix 1. Raw data

Site and Area numbers follow Willing (2009); see Figure 1 for map. Note that *Euglesa* specimens were not determined to species and were either *Euglesa personatum* or *E. obtusale*.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Vertigo lilljeborgi	0	0	0	0	0	0	6	6	0

Species	Group	2022 survey									Previous studies		
		Area 2 (west bank)			Area 1 (east bank)						Suction samples	2008 survey (Willing, 2009)	1998/1999 (M. Howe & A.	1970-1972 (Dance, 1972)
		Site 6	Site 7	Site 9	Site 1	Site 2	Site 3	Site 4	Site 5	Site 8				
Vertigo lilljeborgi	**Terrestrial**		**6 adults**							**6 adults**		**7 (4 adults, 3 juvs.)**	**Good numbers in**	**63 adults (total for 4 visits)**
Vertigo antivertigo	**Terrestrial**		**2 adults**											**+**
***Vertigo sp.* indet. (juveniles)**	**Terrestrial**	**2 juvs.**	**1 juv.**							**1 juv.**				
Oxyloma elegans (=pfeifferi)	Terrestrial	3	2	4	1		1	2	1	1	+	+		+
Succinea putris	Terrestrial							1						
Carychium minimum	Terrestrial									1		+		+
Cochlicopa lubrica	Terrestrial							2		1	+	+		+
Punctum pygmaeum	Terrestrial													+
Zonitoides nitidus	Terrestrial		2					1			+	+		
Nesovitrea hammonis (=radiatula)	Terrestrial													+
Euconulus fulvus	Terrestrial										+			
Cepaea sp. (juvenile)	Terrestrial			1							+			
Deroceras reticulatum	Terrestrial										+			
Deroceras laeve	Terrestrial													+
Arion circumscroptus silvaticus	Terrestrial													+
Arion flagellus (="lusitanicus")	Terrestrial													+
Potamopyrgus antipodarum	Aquatic							9						
Galba truncatula	Aquatic	1	5	3		1	1					+		
Ampullaceana balthica	Aquatic		1			1			1					
Menetus dilatatus	Aquatic			13	116	149	172	1	149	1		+		
Physella acuta	Aquatic			19		5	4		1					
Pisidiidae (*Euglesa personatum/E.*	Bivalve	12	2	2	8		28			2		+		
TOTALS	**22**	**3**	**5**	**6**	**3**	**4**	**5**	**6**	**4**	**5**	**6**	**8**	**1**	**10**
Grid reference		SH 59089 41732	SH 59172 41551	SH 5921 4145	SH 5906 4196	SH 5906 4195	SH 5905 4194	SH 5902 4195	SH 5903 4197	SH 59140 41755	(Various)	(Sites 1-8)	(North part of Area 1)	"SH 593 415"
Site wetness index in 2008 (Willing, 2009)		2-3	3-4	-	3-4	3-4	3-4	2-3	-	2-3	1-2			
Site wetness index (2022)		2	3	4	4	4	4	3	2	3	1-2			

Data Archive Appendix

The data archive contains:

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

[B] ~~A full set of maps produced in JPEG format~~.

[C] ~~A series of GIS layers on which the maps in the report are based with a series of word documents detailing the data processing and structure of the GIS layers~~.

[D] ~~A set of raster files in ESRI and ASCII grid formats~~.

[E] ~~*A database named [name] in Microsoft Access 2000 format with metadata described in a Microsoft Word document [name.doc]*~~.

[F] ~~A full set of images produced in [jpg/tiff] format~~.

[G] Species records held in Welsh Invertebrate Database (WID).

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no 125371.