Scottish Natural Heritage
Research Report No. 1161

Site Condition Monitoring of *Vertigo geyeri* and *Vertigo genesii* 2017

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RESEARCH REPORT

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SCM Reports

This report was commissioned by SNH as part of the Site Condition Monitoring (SCM) programme to assess the condition of special features (habitats, species populations or earth science interests) on protected areas in Scotland (Sites of Special Scientific Interest, Special Areas of Conservation, Special Protection Areas and Ramsar). Site Condition Monitoring is SNH's rolling programme to monitor the condition of special features on protected areas, their management and wider environmental factors which contribute to their condition.

The views expressed in the report are those of the contractor concerned and have been used by SNH staff to inform the condition assessment for the individual special features. Where the report recommends a particular condition for an individual feature, this is taken into account in the assessment process, but may not be the final condition assessment of the feature. Wider factors, which would not necessarily be known to the contractor at the time of the monitoring, are taken into consideration by SNH staff in making final condition assessments.

RESEARCH REPORT

Summary

Site Condition Monitoring of *Vertigo geyeri* and *Vertigo genesii* 2017

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Contractor: Killeen, I., Willing, M. & Moorkens, E.
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Keywords

SCM; Geyer's whorl snail*; Vertigo geyeri*; round-mouthed whorl snail; *Vertigo genesii*.

Background

This report describes a Condition Assessment of Geyer's whorl snail *Vertigo geyeri,* and the round-mouthed whorl snail *Vertigo genesii* in the Tulach Hill & Glen Fender Meadows SAC, and at other sites in Perthshire, on the Black Isle and on the island of Islay.

Both *Vertigo geyeri* and *V. genesii* are listed on Annex II of the EU Habitats and Species Directive Both species are known from sites in Perthshire and on the Black Isle, and, in addition, *V. geyeri* is known from sites on Islay. There are no Scottish sites which are unique to *Vertigo genesii*, it has always been found with *V. geyeri*, and, therefore, the assessments for both species were concurrent.

Both *Vertigo geyeri* and *V. genesii* live in small colonies in wet, open, calcareous, sometimes stony, spring flushes and fen meadow; frequently where there is tufa deposition. The sites can vary in size from a few tens of square metres to greater than one hectare. The nature of the flushes is dendritic and therefore the area of suitable *V. geyeri* & *V. genesii* habitat (permanently wet, base-rich) can often be very small.

In 2012, to provide information for the third (2013) round of Article 17 reporting, Condition Assessments of *Vertigo geyeri* and *V. genesii* were carried out in 2012 at a selection of Perthshire, Black Isle and Islay sites using methods designed to allow assessments of Population, Habitat and Future Prospects. The results of these studies were published as commissioned reports. Having obtained baseline data in 2012 on the attributes required to assess condition, those baseline surveys were used to establish thresholds for the extent of optimal habitat and species distribution upon which subsequent Population Assessment and Habitat for the Species Assessment could be made. Future Prospects were assessed by examining how the impacts were affecting the other attributes and their impact if they continue unchecked. The Overall Assessment was then determined by how well the site meets these key targets for the attributes associated with each of the two species.

The present 2017 study has been carried out to provide information for the next round of Article 17 reporting, due in 2019. For the mainland sites the 2017 Condition Assessment

has been based on the targets set, and recommendations made in the 2012 study. On Islay, site condition monitoring has been based upon the results of the 2012 surveys and additionally formalised to produce a clear set of targets to be used in 2017 (and future years) and which are comparable and compatible with the mainland sites.

The Condition Assessment was carried out using methods designed to allow assessments of Population, Habitat and Future Prospects.

The attributes used to assess Condition were:

- Area of occupancy of *Vertigo geyeri* and *V. genesii* habitat in the Tulach Hill & Glen Fender Meadows SAC, and at other selected sites in Perthshire, on the Black Isle and on the island of Islay
- Area of occupancy of *Vertigo geyeri* and *V. genesii* in selected transects or plot areas
- Number of overall positive recordings per number of field samples
- Hydrological field assessment

On the Scottish mainland, eight main areas were surveyed: The Tulach Hill and Glen Fender Meadows SAC, Perthshire, Loch Tummel, Schiehallion and Glen Tilt, also in Perthshire, two sites on the Black Isle, and 2 sites at Deeside, all of which were surveyed in 2012. Two further areas in Perthshire at Loch Loch (in Beinn a`Ghlo SAC) and Ben Vrackie were added in 2017.

On Islay six main areas were surveyed; single flush sites at Loch Smigedail, Margadale River and Loch Ard Achadh with flush 'complexes' in three further areas, on hillsides west of Loch Finlaggan, on slopes at Balachlaven and on the shores of Loch Lossit. Although all of these sites were surveyed in 2012, additional flush areas were sampled in 2017 at Loch Finlaggan, Balachlaven and Loch Lossit the former two adding additional *Vertigo geyeri* sites.

Main findings

- In terms of habitat area there has been very little change since 2012 with small differences more likely to arise from inaccuracies in GPS measurements rather than expansions or contractions of actual area. Additional habitat for both species was identified at the southern end of Loch Moraig and confirmed on Ben Vrackie although the suitable habitat components are very small (0.15 ha and 0.02 ha respectively). However, a more widespread survey at Braelangwell Wood on the Black Isle revealed that the area of suitable *Vertigo* habitat was more extensive than previously recorded with a further 0.2 ha of suitable habitat identified. The survey at Loch Loch, which was not assessed in 2012, showed that there was at least 0.05 ha of suitable *V. genesii* habitat, but was fragmented and spread over a wide area.

- *Vertigo geyeri* was found at all of the sites at which it had previously been recorded in 2012 with the exception of Loch Tummel. As was the case in 2012, the species could not be found at the two Deeside sites at Morrone Birkwood and Glen Lui from where it had been previously recorded. At the sites where *V. geyeri* was the only species found, densities as high as 400 individuals per m^2 were recorded. *Vertigo genesii* was found again at Glen Fender Meadows and at Braelangwell Wood on the Black Isle, and was confirmed to be still surviving at Loch Loch and on Ben Vrackie. As juveniles of the two species cannot be separated, it was not possible to determine densities for *V. genesii* alone. As in 2012, *Vertigo genesii* could not be found at the two Tulach Hill sites, or the Glen Tilt site from where it was previously recorded.

- The two Black Isle sites continue to support populations of the very rare pupillid snail *Pupilla pratensis*, which has only been recorded from one other site in Britain.

- The six Islay flushes and flush 'complexes' support the only known *Vertigo geyeri* populations in western Scotland. All but one of the sites are situated across the north-east of the island with a solitary further site situated in the far south of the island. *V. geyeri* was found at all the sites where it was recorded in 2012 with additional range extensions with the discovery of further flushes at Loch Finlaggan and Balachlaven. None of the Islay flushes are particularly extensive with several small 'islands' surrounded by large blocks of unsuitable habitat (mostly acidic heather moorland). The total area of flush habitat in the survey areas amounts to only about 1 hectare (1.018 ha) about a third of which (0.342 ha) consists of optimal *V. geyeri* habitat. All sites were assessed as **Favourable Maintained**.

- There is an extensive area of habitat for *Vertigo geyeri* in Scotland which is in good condition, and the snail was present most sites and generally in relatively high abundance. However, *V. geyeri* could not be found at Loch Tummel in spite of the apparently excellent habitat, and as in 2012, it could not be found at the Deeside sites, but these absences were not considered enough to outweigh all of the positives and to change the population assessment to Favourable Declining. Therefore, the overall assessment is **Favourable Maintained**.

- There is an extensive area of habitat for *Vertigo genesii* which is in good condition. However, in spite of the confirmation of the species' presence at Loch Loch and on Ben Vrackie, the continued absence of *V. genesii* at sites on Tulach Hill and in Glen Tilt means that Population has been assessed as **Unfavourable Unchanged**, and, therefore, the overall assessment is Unfavourable Unchanged.

- Based upon these assessments, recommendations have been made for future Condition Assessments. General recommendations for management at each site have also been made.

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1. BACKGROUND

Scotland supports several sites for two species of whorl snail listed on Annex II of the EU Habitats and Species Directive: Geyer's whorl snail *Vertigo geyeri,* and the round-mouthed whorl snail *Vertigo genesii.* These sites also support several Annex I habitats including 7220 Petrifying Springs with tufa formation, and 7230 Alkaline fens. Both species are known from sites in Perthshire and on the Black Isle, and, in addition, *V. geyeri* is known from sites on Islay.

Most of the sites in Perthshire for *V. geyeri* and *V. genesii* lie within the boundaries (and are a qualifying feature) of the Tullach Hill and Glen Fender Meadows SAC. Several other sites (e.g. Ben Vrackie, Loch Moraig) are in close proximity to the SAC and in the same 10 km squares, whereas others (e.g. Loch Tummel, Lochan an Daim) are in close proximity to the SAC but in different 10 km squares. The Glen Tilt and Loch Loch sites are within the Beinn a`Ghlo SAC but *Vertigo* species are not qualifying features. This is also the case with Morrone Birkwood SAC where *Vertigo geyeri* is not a qualifying feature. Of the Black Isle sites, Belmaduthy Dam has SAC designation but *Vertigo* species are not qualifying features, whereas Braelangwell Woods only have SSSI designation.

None of the six Islay sites / site complexes lie within an SAC and neither are they afforded SSSI protection. The 2012 survey report (Willing 2013) highlighted this situation and recommended that SNH reviewed this situation in order to provide recognition and protection for these important sites.

All known sites for *Vertigo geyeri* and *V. genesii* on a 1 km and 10 km square basis are shown in Appendix 1, Tables 1-3. However, for Tullach Hill & Glen Fender in particular there are several individual flushes with one or both *Vertigo* species within each 1 km square.

In the Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006 (JNCC 2007), the overall UK assessment for *Vertigo geyeri* and *Vertigo genesii* was Favourable.

To provide information for the third (2013) round of Article 17 reporting, Condition Assessments of *Vertigo geyeri* and *V. genesii* were carried out in 2012 at a selection of Perthshire, Black Isle and Islay sites using methods designed to allow assessments of Population, Habitat and Future Prospects. The results of these studies were published as commissioned reports:

Killeen, I.J. 2013. Whorl snails (*Vertigo* spp.) surveillance in Scotland: a condition assessment of Geyer's whorl snail *Vertigo geyeri,* and the round-mouthed whorl snail *Vertigo genesii* in Perthshire and the Black Isle*. Scottish Natural Heritage Commissioned Report No. 616.*

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

Results from these surveys contributed to the Article 17 reports (JNCC 2013a, b) which gave the UK status for the 2 species as follows:

	Vertigo geyeri	***Vertigo genesii***
Range	Favourable	Unfavourable Bad
Population	Favourable	Favourable
Habitat	Favourable	Favourable
Future Prospects	Favourable	Unfavourable Bad
Overall	Favourable	Unfavourable Bad

2. OBJECTIVES AND SCOPE OF WORK

The principal requirements of Article 17 reporting are assessments of Range, Population, Habitat, Future Prospects and Overall. To fulfil these criteria, a programme of work which covered an adequate sub-sample of sites and using methodology specifically designed for *Vertigo* species Condition Assessments was carried out. There are no Scottish sites which are unique to *Vertigo genesii*, it has always been found with *V. geyeri*, and, therefore the assessments for both species are concurrent.

For the mainland sites the 2018 Condition Assessment will be based on the targets set in the 2012 study. It was proposed that the 2012 survey should be repeated more or less in its entirety along with sampling at sites not covered by the present survey (e.g. elsewhere on Tulach Hill, Loch Loch, Ben Vrackie).

- Fully repeat the transects T4 and T9 at Tulach Hill
- Sample flushes 24 and 28 at Tulach Hill (previous *V. genesii* sites) and re-determine flush boundaries and extent of suitable habitat
- Fully repeat the transects M3 and M8 at Glen Fender
- Sample one of either GF1 or GF2 flush areas at Glen Fender and re-determine boundaries and extent of suitable habitat [both surveyed in 2017]
- Make assessment of Loch Moraig site including the south end (not surveyed in 2012)
- Take at least one sample from each of the three units at Braelangwell Wood and re-determine flush boundaries and extent of suitable habitat
- Fully repeat Belmaduthy Dam transect, and sample at least 2 other flush areas
- Sample the two flush areas at Lochan an Daim and re-determine boundaries and extent of suitable habitat
- Sample flushes 1, 4 and 9 at Glen Tilt (additionally Flush 2 sampled in 2017)
- Take at least one sample from the Loch Tummel site and re-determine flush boundaries and extent of suitable habitat
- Sample the two flushes at Morrone Birkwood and the one at Glen Lui
- Sample flushes at Loch Loch and Ben Vrackie (neither surveyed in 2012)

On Islay, site condition monitoring was based upon the results of the 2012 surveys but was additionally ‘formalised’ to produce a clear set of targets to be used in 2017 (and future years) and which are comparable and compatible with the mainland sites.

- 1 flush near the Magadale River
- 1 flush on shores of Loch Smigeadail
- 3 flushes on shore of Loch Lossitt
- 4 flush complexes near Loch Finlaggan
- 1 flush at head of Loch Achadh (The Oa)
- 2 flushes plus a wider flush search at Ballachlaven (a negative site in 2012 but positive in 1998)

3. METHODOLOGY

The methodology used for *Vertigo geyeri* and *V. genesii* Condition Assessment has evolved over the last 10 years. The methods suggested by Killeen (2001) for the Sunbiggin Tarn and Moors SAC in England was further developed and refined for use in the Anglesey by Killeen & Moorkens (2004, 2007). The methodology was developed further for application to Article 17 reporting in Republic of Ireland sites (Moorkens & Killeen 2011), Killeen 2010 for Widdybank Fell and Sunbiggin Tarn, and for the 3rd round of reporting in Scotland in 2012 (Killen 2013, Willing 2013).

The attributes used to assess Condition are:

- Area of occupancy of *Vertigo geyeri/genesii* habitat in individual flush areas
- Area of occupancy of *Vertigo geyeri/genesii* in selected transects or plots
- Number of overall positive recordings per number of field samples
- Hydrological field assessment

3.1 Area of habitat by site

Within each of the sites, areas of habitat were delineated for the purposes of monitoring *Vertigo geyeri/genesii*. Specific habitat suitable for the snail(s) was identified, using best expert knowledge. Areas that could not possibly support the species were excluded from the study areas. In individual flush systems which were visited, the area of potential *Vertigo* habitat can be delineated with a GPS. After such ground-truthing it is possible to identify all other potential flushes (e.g. on Tullach Hill) and the polygons containing all potentially suitable habitat can be marked on aerial photographs to enable their transfer to a GIS system.

3.2 Assessment of individual flushes

It was not considered practical to set up transects in all of the sites surveyed, due to the high number of individual flushes, but also the more discreet nature of the flushes, which do not lend themselves to linear transects. Therefore most sites, including all of those on Islay were assessed by describing, photographing and sampling individual flush areas.

3.3 Assessment using linear transects

Transects are useful for assessing the condition of the SAC in particular, but also in other large sites, and provide a repeatable means of future monitoring. Transects were laid out using 30 m tape measures. A recognisable feature was chosen as start and end points (e.g. boulders, mounds, bushes) and the ends located with a GPS.

Starting at the 0 metre end, the habitat (at the plant community level) along the tape was described and the linear distance of that habitat type measured using the 30 m tapes. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transects. Whilst there was not always a clear boundary, best expert judgement is used to delineate e.g., *Schoenus* fen from *Molinia* grassland, from mossy/sedge lawn and so on. The habitat in each zone is then categorized into 3 classes according to its suitability for *Vertigo geyeri/genesii*, an example of which is shown below:

- Optimal - Flushed fen grassland with sedge/moss lawns 10-25 cm tall, containing species such as *Carex viridula, C. hostiana, C. dioica, Pinguicula vulgaris, Briza media, Equisetum palustre, Eleocharis quinquefolia, Eriophorum* spp., *Juncus articulatus, Selaginella selaginoides, Tofieldia pusilla,* and the mosses *Drepanocladus* spp.*, Campylium stellatum*, *Palustriella* spp. with tussocks of *Schoenus nigricans* no

greater than 80 cm tall or *Schoenus ferrugineus* no greater than 40 cm tall. Water table between 0- 5 cm of the soil surface, but not above ground level.

- Sub-optimal - Vegetation composition as above but either vegetation height is less than 5 cm or greater than 15 cm, or the water table is below 5cm or ground is flooded at the time of sampling.
- Unsuitable - Any other habitat

3.4 Snail sampling

In selected delineated habitat zones on transects, and in individual flushes, a bag of moss/sedge plants and litter (c. two litres volume) was also taken. This is approximately equivalent to an area measuring 0.4 m x 0.4 m (0.16 m^2). These samples were collected by cutting vegetation (sward and small tussocks comprising mainly sedge, rushes, grasses and moss) at ground level using a sharp knife with a serrated blade, or by plucking handfuls of moss and sedge. To avoid local destruction of the sward, material was collected by amalgamating small sub-samples from a relatively wide area (c. 2 m x 2 m) within each zone or flush.

The vegetative material was teased apart and spread on sheets of newspaper to dry. This was then shaken over a 5 mm sieve to remove the bulk of the plant material but to allow all molluscs to pass through. The residue was passed over a graded stack of sieves and examined microscopically. A slightly different sorting and separation technique was applied to all the Islay sourced bulk samples. Here bulk samples were placed into fine muslin bags and air dried to constant mass. Dried material was then passed through a series of sieves (5, 2 and 0.5 mm meshes), with most *Vertigo* specimens being retained in the 0.5 mm fraction. Sieved fractions were sorted on white trays and examined with a low-power head-mounted magnifier and then microscopically.

Specimens of *V. geyeri* and *V. genesii* with a developed lip and/or apertural teeth were recorded as adults and all others as juveniles. However, owing to the difficulty in reliably separating immature specimens of the two species, these were counted as *V. geyeri/genesii* juveniles. All other mollusc species were also picked out and either counted or recorded as presence/absence.

3.5 Condition assessment

Having obtained baseline data on the attributes required to assess condition, the baseline surveys are used establish thresholds to reflect the extent of optimal habitat and distribution for Population Assessment and Habitat for the Species Assessment. Future Prospects are assessed by examining how the impacts are affecting the other attributes (i.e. population and habitat for the species) and their impact if they continue unchecked. Future prospects should balance positives and negatives to determine whether the species will survive at a particular site for the foreseeable future. The Overall Assessment at a particular site is then determined by how well the site meets these key targets for the attributes associated with this species.

4. RESULTS

Fieldwork for this study was carried out at times of year considered to be most suitable for assessing extent and condition of potential whorl snail habitat (late spring/early summer) and late summer/early autumn. The site coverage, timing and team personnel were:

Islay: Martin Willing (22nd to 29th June 2017)
Perthshire: Ian Killeen and Evelyn Moorkens (10th – 19th June 2017)
Black Isle and Deeside: Ian Killeen and Evelyn Moorkens (12th – 16th September 2017)

The results from all sites are shown in appendices which contain maps, aerial photographs with outlines of habitat extent, sample location details, transect results, results of molluscan analysis and photographs.

A separate Appendix is given for each main survey site:

Appendix 2: Tulach Hill and Glen Fender Meadows
Appendix 3: Schiehallion (Lochan an Daim)
Appendix 4: Glen Tilt
Appendix 5: Loch Tummel
Appendix 6: Loch Loch
Appendix 7: Ben Vrackie
Appendix 8: Black Isle Braelangwell Wood
Appendix 9: Black Isle Belmaduthy Dam
Appendix 10: Deeside
Appendix 11: Islay

Table 1 shows area of suitable habitat at each site or sub-site. The total areas are based principally upon determination of boundaries using a GPS, supplemented with interpretation from aerial photographs. The amount of suitable area is based upon best expert judgement of the amount of habitat considered to be optimal and sub-optimal. Table 2 gives a summary of the results from the quantitative sampling. Tables 3 and 4 give the Condition Assessments for *Vertigo geyeri* and *V. genesii* respectively.

Table 1: Area of Suitable Habitat

		2012			2017			
Site	Sub-site	Total area (ha)	% Suitable	Area suitable (ha)	Total area (ha)	% Suitable	Area suitable (ha)	Comments
Tulach Hill	Flushes 1-3	0.80	75	0.6	0.80	75	0.6	Not fully surveyed in 2017, but no evidence of change
	Flush 4	1.05	75	0.79	1.05	75	0.79	
	Flush 5/6	0.7	10	0.07	-	-	-	Not surveyed in 2017
	Flush 7	1.2	10	0.12	-	-	-	Not surveyed in 2017
	Flush 8/9	1.57	20	0.31	1.57	20	0.31	
	Flush 13	2.8	25	0.7	2.8	25	0.7	Not surveyed in 2017
	Flush 24	1.5	20	0.3	1.5	20	0.3	
	Flush 28	0.94	25	0.23	0.94	25	0.23	
	Invervack	<1	10	0.1	-	-	-	Not surveyed in 2017
Glen Fender	GF1	1.16	25	0.29	1.16	25	0.29	
	GF2	1.14	25	0.28	1.14	25	0.28	
	GF3	0.25	20	0.05	-	-	-	Not surveyed in 2017, but no evidence of change
	GF4	0.14	20	0.03	-	-	-	Not surveyed in 2017, but no evidence of change
	GF5	0.65	10	0.06	-	-	-	Not surveyed in 2017, but no evidence of change
	M3	2.0	20	0.4	2.0	20	0.4	
	M8	2.73	25	0.68	2.73	25	0.68	
	Loch Moraig (N)	1.2	25	0.3	1.2	25	0.3	
	Loch Moraig (S)	-	-	-	1.1	15	0.15	Not surveyed in 2012
Lochan an Daim	South of road	0.05	50	0.025	0.05	50	0.025	
	North of road	0.15	40	0.06	0.15	40	0.06	
Glen Tilt	All	<1	20	0.2	<1	20	0.2	
Loch Tummel	All	0.45	40	0.18	0.45	40	0.18	
Loch Loch	All	-	-	-	?	-	0.05	Total area indeterminate due to fragmented habitat
Ben Vrackie	All	-	-	-	?	-	0.02 ?	Total area indeterminate due to fragmented habitat

Table 1 (continued): Area of Suitable Habitat

		2012			2017			
Site	Sub-site	Total area (ha)	% Suitable	Area suitable (ha)	Total area (ha)	% Suitable	Area suitable (ha)	Comments
Black Isle Braelangwell Wood	Western Unit	0.8	20	0.16	0.8	20	0.16	
	Central Unit	0.31	50	0.16	0.31	50	0.16	
	Eastern Unit	1.22	25	0.31	1.22	25	0.31	
	East/central 2017	-	-	-	1.0	20	0.2	Additional recognized habitat
Black Isle Belmaduthy Dam	All	4.0	20	0.8	4.0	20	0.8	
Deeside	Glen Lui	0.5	10	0.05	0.5	10	0.05	
	Morrone 2	0.5	10	0.05	0.5	10	0.05	
	Morrone 3	0.4	10	0.04	0.4	10	0.04	

Table 1 (continued): Area of Suitable Habitat

		2012			2017			
Site	Sub-site	Total area (ha)	% Suitable	Area suitable (ha)	Total area (ha)	% Suitable	Area suitable (ha)	Comments
Islay	Margadale River	*	*	*	0.009	40	0.0036	* area considered similar in 2012 (no noticeable change detected)
	Loch Smigeadail	*	*	*	0.058	40	0.023	* area considered similar in 2012 (no noticeable change detected)
	Finlaggan: S1	*	*	*	0.027	10	0.003	* area considered similar in 2012 (no noticeable change detected)
	Finlaggan: S1A	-	-	-	0.015	20	0.003	New site in 2017
	Finlaggan: S1B	-	-	-	0.104	40	0.042	New site in 2017
	Finlaggan: S2	*	*	*	0.063	10	0.006	* area considered similar in 2012 (no noticeable change detected)
	Finlaggan: S3	*	*	*	0.218	20	0.044	* area considered similar in 2012 (no noticeable change detected)
	Finlaggan: S4	*	*	*	0.156	60	0.094	* area considered similar in 2012 (no noticeable change detected)
	Balachlaven NE	-	-	-	0.089	10	0.009	New site in 2017
	Balachlaven SW	*	*	*	0.108	10	0.011	* area considered similar in 2012 (no noticeable change detected)
	Loch Lossit 1	*	*	*	0.018	60	0.011	* area considered similar in 2012 (no noticeable change detected)
	Loch Lossit 2	*	*	*	0.006	70	0.004	* area considered similar in 2012 (no noticeable change detected)
	Loch Lossit 3	*	*	*	0.067	60	0.04	* area considered similar in 2012 (no noticeable change detected)
	Loch Ard Achadh	*	*	*	0.08	60	0.048	* area considered similar in 2012 (no noticeable change detected)

Table 2: Summary of the results from the quantitative sampling

		2017										2012
	Site	No. of samples	No. of +ve samples	No. with adult *geyeri*	No. with adult *genesii*	No. with juvs	Total *geyeri*	Total *genesii*	Total juvs	No. *Vertigo* m^{-2}		No. *Vertigo* m^{-2}
Tulach Hill	Flush 4	3	3	3	0	3	17	0	10	56		83
	Flush 9	2	2	2	0	2	10	0	4	44		59
	Flush 24	2	2	2	0	2	10	0	15	78		62
	Flush 28	1	1	1	0	1	3	0	2	31		131
Glen Fender	GF1	1	1	1	1	1	15	3	8	163		367
	GF2	1	1	1	1	1	12	1	12	156		169
	M3	2	2	2	1	2	7	2	18	84		88
	M8 transect	4	4	4	2	4	26	13	61	156		155
	Loch Moraig (north)	2	2	1	1	2	3	7	18	88		175
	Loch Moraig (south)	1	1	1	0	1	4	0	6	63		NS
Lochan an Daim	South of road	1	1	1	0	1	2	0	1	19		87
	North of road	2	2	2	0	2	53	0	42	297		409
Glen Tilt	South of river	3	1	1	0	1	19	0	13	67		14
	North of river	1	1	1	0	1	3	0	3	38		62
Loch Tummel	All	2	0	0	0	0	0	0	0	0		25
Loch Loch	All	11	5	0	4	5	0	14	11	14		NS
Ben Vrackie	All	3	2	1	1	2	3	4	4	23		NS

Table 2 continued: Summary of the results from the quantitative sampling

		2017										2012
	Site	No. of samples	No. of +ve samples	No. with adult *geyeri*	No. with adult *genesii*	No. with juvs	Total *geyeri*	Total *genesii*	Total juvs	No. *Vertigo* m^{-2}		No. *Vertigo* m^{-2}
Black Isle Braelangwell Wood	Western Unit	4	3	2	1	3	5	1	15	33		25
	Central Unit	2	2	2	2	2	13	26	29	200		384
	Eastern Unit	5	5	5	0	5	30	1	114	180		15
Black Isle Belmaduthy Dam	General	2	2	2	0	2	69	0	21	281		52
	Transect	2	2	2	0	2	55	0	63	369		21
Deeside	Glen Lui	2	0	0	0	0	0	0	0	0		0
	Morrone Birkwood	3	0	0	0	0	0	0	0	0		0
Islay	Margadale River	2	2	2	-	2	21	-	-	66		38
	Loch Smigeadail	2	2	2	-	2	21	-	-	66		44
	Finlaggan: S1	1	1	0	-	1	1	-	-	7		3
	Finlaggan: S1A	1	1	1	-	0	2	-	-	13		New site in
	Finlaggan: S1B	1	1	0	-	2	2	-	-	13		New site in
	Finlaggan: S2	1	1	1	-	1	4	-	-	26		38
	Finlaggan: S3	2	2	2	-	1	10	-	-	31		7
	Finlaggan: S4	2	2	2	-	1	29	-	-	91		19
	Balachlaven NW	2	1	1	-	0	4	-	-	13		New site in
	Balachlaven SW	2	2	2	-	1	4	-	-	13		0
	Loch Lossit 1	1	1	1	-	1	10	-	-	63		6
	Loch Lossit 2	1	1	1	-	1	8	-	-	50		3
	Loch Lossit 3	2	2	2	-	1	5	-	-	16		13
	Loch Ard Achadh	4	4	4	-	3	45	-	-	70		28

5. CONDITION ASSESSMENT FOR *VERTIGO GEYERI*

Having obtained extensive baseline data in 2012 (based upon knowledge acquired in 1998) on the attributes required to assess condition, the 2012 surveys established thresholds to reflect the extent of optimal habitat and distribution of the snail. These targets have been used to assess present Condition.

5.1 Population assessment

Table 3: Targets for population assessment

		2012		2017	
Indicator	**Target**	**Result**	**Pass/Fail**	**Result**	**Pass/Fail**
Presence/ absence	• Adult snails are present in the 4 **Tulach Hill** monitoring flush areas (flushes 3, 24, 28 and Invervack)	Present in all 4 flushes	Pass	Only flush areas 24 and 28 sampled, present in both	Favourable maintained
Presence/ absence	• Adult snails are present in the 4 **Glen Fender** monitoring flush areas (GF1, GF2, M8 and Loch Moraig North)	Present in all 4 flushes	Pass	Present in all 4 flushes	Favourable maintained
Presence/ absence	• Adult snails are confirmed to be present in 2 zones with Optimal habitat in **Tulach Hill** Transect T4 AND in at least 1 zone in **Tulach Hill** Transect T9, with no evidence of decline*	Present in the 5 (of 6) optimal zones sampled	Pass	Present in all 5 optimal zones sampled	Favourable maintained
Presence/ absence	• Adult snails are confirmed to be present in 2 zones with Optimal habitat in each of **Glen Fender** Transect M3 AND Transect M8, with no evidence of decline*	Present in the 6 (of 8) optimal zones sampled	Pass	Present in all 6 optimal zones sampled	Favourable maintained
Presence/ absence	• Adult or sub-adult snails are present at **Lochan an Daim** (minimum 2 samples)	Present	Pass	Present	Favourable maintained
Presence/ absence	• Adult or sub-adult snails are present at **Loch Tummel** (minimum 2 samples)	Present	Pass	Absent	Unfavourable declining
Presence/ absence	• Adult snails are present in **Glen Tilt** Flush area 4, and 2 flushes on the north side of the river (minimum 2 samples from each)	Present in flush 4 and 2 flushes on the north side	Pass	Present in flush 4 and the 1 flush sampled on the north side	Pass/Favourable maintained

Presence/ absence	• Adult or sub-adult snails are present at least 1 flush on **Ben Vrackie** (minimum 2 samples)	Sampled in 1999, not sampled in 2012		Present in 1 flush	Favourable maintained
Presence/ absence	• Adult snails are present in each of the 3 units at **Braelangwell Wood** (minimum 2 samples in each)	Present in each unit	Pass	Present in each unit	Favourable maintained
Presence/ absence	• Adult or sub-adult snails are present in 2 flush areas (sample minimum of 2) with a geographical spread at **Belmaduthy Dam** and in at least 1 zone with Optimal habitat on the transect, with no evidence of decline*	Present in all flushes sampled, and 2 transect zones	Pass	Present in both flushes sampled, and 2 transect zones	Favourable maintained
Presence/ absence	• Adult or sub-adult snails are present in the **Glen Lui** flush area, and in 1 of the **Morrone Birkwood** flushes	Absent at both sites	Fail	Absent at both sites	Unfavourable Unchanged
Presence/ absence	• Islay: **Margadale River**: adult snails present in the single monitoring flush (minimum 2 standard samples taken)	present	Pass	Present	Favourable maintained
Presence/ absence	• Islay: **Loch Smigeadail**: adult snails present in the single monitoring flush (minimum 2 standard samples taken)	present	Pass	Present	Favourable maintained
Presence/ absence	• Islay: **Loch Finlaggan**: Adult snails are present in each of four monitoring flush areas (1 complex, 2, 3, 4) (minimum 1 sample from each of the site 1 complex units and S2 with minimum of 2 standard samples taken from sites 3 & 4)	present	Pass	Present	Favourable maintained
Presence/ absence	• Islay: **Balachlaven**: Adult or sub-adult snails present in at least one of the two flushes (minimum of 2 standard samples taken from each)	Absent in the single flush sampled in 2012	Fail	Present (in original flush and newly located 2017 flush)	Favourable maintained
Presence/ absence	• Islay: **Loch Lossit:** Adult snails are present in each of the three flush sites (2 standard samples taken from each)	present	Pass	Present	Favourable maintained
Presence/ absence	• Islay: **Loch Ard Achadh**: Adult snails are present in the flush site (minimum 2 standard samples taken)	present	Pass	Present	Favourable maintained

5.2 Habitat for the species assessment

Table 4: Targets for habitat assessment

		2012		2017	
Indicator	**Target**	**Result**	**Pass/Fail**	**Result**	**Pass/Fail**
Habitat extent (site level)	• The **Tulach Hill** flush areas (flushes 1-4, 9, 24, 28 and Invervack) should have a combined area of at least 5.2 ha, of which at least 2.0 ha should be Optimal & sub-optimal	5.29 ha in area, of which 2.02 ha is Optimal and sub-optimal	Pass	Excl. Invervack (1ha). 4.29 ha area, 1.92 ha is Opt/sub-opt	Favourable maintained
Habitat extent (site level)	• The **Glen Fender** monitoring flush areas (GF1, GF2, M8 and Loch Moraig North) should have a combined area of at least 6.2 ha, of which at least 1.5 ha should be Optimal & sub-optimal	6.23 ha in area, of which 1.55 ha is Optimal and sub-optimal	Pass	At least 6.2 ha, of which at least 1.5 ha is Optimal & sub-optimal	Favourable maintained
Habitat extent (transect)	• At least 55 m of the habitat on **Tulach Hill** Transect T4 is classed as Optimal & sub-optimal AND at least 55 m is Optimal wetness	60m is Optimal habitat and wetness	Pass	60m is Optimal habitat and wetness	Favourable maintained
Habitat extent (transect)	• At least 34 m of the habitat on **Tulach Hill** Transect T9 is classed as Optimal & sub-optimal AND at least 34 m is Optimal wetness	34.3 m is Optimal habitat and wetness	Pass	34.5 m with Opt/sub-opt	Favourable maintained
Habitat extent (transect)	• At least 30 m of the habitat on **Glen Fender** Transect M3 is classed as Optimal and a further 30 m is Optimal and sub-optimal AND at least 55 m is Optimal wetness	34 m is Optimal habitat and 26 m is sub-optimal, 60 m is optimal wetness	Pass	34 m is Optimal habitat and 26 m is sub-optimal, 60 m is optimal wetness	Favourable maintained
Habitat extent (transect)	• At least 90 m of the habitat on **Glen Fender** Transect M8 is classed as Optimal and a further 30 m is Optimal and sub-optimal AND at least 120 m is Optimal wetness	90 m is Optimal habitat and 32 m is sub-optimal, 122 m is optimal wetness	Pass	114.5 m is Optimal habitat and 7.5 m is sub-optimal, 122 m is optimal wetness	Favourable maintained
Habitat extent (site level)	• The flushes sampled at **Lochan an daim** should support at least 0.08 ha of habitat classed as Optimal and sub-optimal	0.085 ha of habitat classed as Optimal and sub-optimal	Pass	0.085 ha of habitat classed as Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• The flushes sampled at **Glen Tilt** should support at least 0.2 ha of habitat classed as Optimal and sub-optimal	0.2 ha of habitat classed as Optimal and sub-optimal	Pass	0.2 ha of habitat classed as Optimal and sub-optimal	Favourable maintained

Habitat extent (site level)	• The flushes sampled at **Loch Tummel** should support at least 0.15 ha of habitat classed as Optimal and sub-optimal	0.18 ha of habitat classed as Optimal and sub-optimal	Pass	0.18 ha of habitat classed as Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• The flushes sampled at **Ben Vrackie** should support at least 0.01 ha of habitat classed as Optimal and sub-optimal	Not sampled in 2012		At least 0.01 ha is Optimal and sub-optimal	Favourable
Habitat extent (site level)	• The **Braelangwell Wood** flush areas in the three units should have a combined area of at least 2.5 ha, of which at least 0.6 ha should be Optimal & sub-optimal	2.53 ha in area, of which 0.63 ha is Optimal and sub-optimal	Pass	2.53 ha in area, of which 0.63 ha is Opt/sub-opt plus another 1 ha in East/central of which 0.2 is opt/sub-opt	Favourable maintained
Habitat extent (site level)	• The **Belmaduthy Dam** flush area should be at least 4 ha, of which at least 0.8 ha should be Optimal & sub-optimal	4.0 ha in area, of which 0.8 ha is Optimal and sub-optimal	Pass	4.0 ha in area, of which 0.8 ha is Optimal and sub-optimal	Favourable maintained
Habitat extent (transect)	• At least 20 m of the habitat on the **Belmaduthy Dam** transect is classed as Optimal and sub-optimal AND at least 20m is Optimal wetness	20.1 m is Optimal and sub-optimal, 16.6 m is optimal wetness	Fail	17.1 m is Optimal and sub-optimal, 11.2 m is optimal wetness	Favourable declining
Habitat extent (site level)	• The flushes sampled at **Glen Lui** should support at least 0.05 ha of habitat classed as Optimal and sub-optimal	0.05 ha of habitat classed as Optimal and sub-optimal	Pass	Less than 0.05 ha classed as Optimal and sub-optimal	Favourable declining
Habitat extent (site level)	• The flushes sampled at **Morrone Birkwood** should support at least 0.09 ha of habitat classed as Optimal and sub-optimal	0.09 ha of habitat classed as Optimal and sub-optimal	Pass	0.09 ha is classed as Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• Islay: **Margadale River**: The flush area of optimal habitat should occupy an area of about 0.0036 ha (within a total flush area of about 0.009 ha).	The total areas were not calculated in 2012 but are now judged to be almost identical to the 2017	Pass	Site conforms to target	Pass

		estimations			
	• Islay: **Loch Smigeadail**: The flush area of optimal habitat should occupy an area of about 0.023 ha (within a total flush area of about 0.06 ha).	The total areas were not calculated in 2012 but are now judged to be similar to the 2017 estimations	Pass	Site conforms to target	Pass
	• Islay: **Loch Finlaggan**: The total combined flush area of optimal habitat (from 3 sites and also a 'complex of 3 sites) should occupy an area of about 0.2 ha (within a total flush area of about 0.6 ha).	The total areas were not calculated in 2012 but are now judged to be similar to the 2017 estimations (Note two additional flushes added in 2017)	Pass	Site conforms to target	Pass
	• Islay: **Balachlaven**: The total combined flush area of optimal habitat (from 2 flush sites) should occupy an area of about 0.02 ha (within a total flush area of about 0.2 ha).	The one flush that was assessed in 2012 appears to have remained unchanged in area when visited in 2017	Pass (for one flush only)	Site conforms to target	Pass
	• Islay: **Loch Lossit**: The total combined flush area of optimal habitat (from 3 flush sites) should occupy an area of about 0.06 ha (within a total flush area of about 0.1 ha).	The total areas were not calculated in 2012 but are now judged to be almost identical to the 2017 estimations	Pass	Site conforms to target	Pass

	• Islay: **Loch Ard Achadh**: The flush area of optimal habitat should occupy an area of about 0.05 ha (within a total flush area of about 0.08 ha).	The total areas were not calculated in 2012 but are now judged to be almost identical to the 2017 estimations	Pass	Site conforms to target	Pass

5.3 Future prospects assessment *Vertigo geyeri*

The future prospects for *Vertigo geyeri* are assessed by listing the activities that are influencing or are likely to influence the site that could result in the status of the species changing at that site. A standard list of impacts, with their standard codes has been used (see http://cdr.eionet.europa.eu/help/habitats_art17).

The locations of the pressure, its influence (positive, negative or neutral), and the intensity of the pressure (low, medium or high) are noted. The combination of the influences, both positive and negative is balanced to assess the site's future prospects as Favourable or Unfavourable.

Future Prospects have been assessed by examining how impacts are affecting the other attributes (i.e. population and habitat for the species) and their impact if they continue unchecked.

Several impacts are having an effect on *Vertigo geyeri* at the sites assessed although most are assessed as neutral (Table 5). However, if it can be demonstrated that there are negative hydrological impacts at Loch Tummel and at Deeside site, then in the next reporting round Future Prospects for these sites are likely to be assessed as Poor.

Future prospects should balance positives and negatives to determine whether the species will survive at this site for the foreseeable future. On the basis of the results of the 2017 surveys and the status quo being maintained, Future prospects for *Vertigo geyeri* in Scotland have been assessed as Favourable.

Table 5: Vertigo geyeri *Future Prospects Assessment - Impacts and Pressures (site basis)*

Site	Activity code	Activity	Influence	Intensity	Comments
All sites	M	Climate change			Climate change (M) has been included and although not assessed, its influence is likely only to be negative
	M01	Changes in abiotic conditions			
	M01.01	temperature changes (e.g. rise of temperature & extremes)			
	M01.02	droughts and less precipitations			
Tulach Hill	A04.02.01	non intensive cattle grazing	Negative	Low	Very few cattle appear to be on site but had been an issue in Flush area 9
	A04.02.02	non intensive sheep grazing	Negative	Low	Not an issue in the 2017 survey sites, but has impacted unprotected flushes elsewhere on Tulach Hill
	A04.02.05	non intensive mixed animal grazing (deer)	Negative	Low	Low impact
	A04.03	abandonment of pastoral systems, lack of grazing	Negative	Medium	Problematic at Invervack in 2012, potential issue at Tulach Hill Flush 9 since fencing off
	C01	Mining and quarrying	Negative	Low	Very large quarry on north slope of Tulach Hill, expansion could impact on flushes, particularly their hydrological function
Glen Fender	A04.02.01	non intensive cattle grazing	Negative	Low	Although stocking levels are relatively low, the weight of the animals has a high impact on the fragile flushes (evident at Loch Moraig south and Glen Fender Flush 3 in particular)
	A04.02.02	non intensive sheep grazing	Neutral	Low	Low impact at present
	G05	Other human intrusions and disturbances	Negative	Low	Quad bike damage to the fragile flushes
Lochan an Daim	A04.02.02	non intensive sheep grazing	Neutral	Low	Low impact at present
	A05.02	stock feeding	Negative	Low	Supplementary feeders present at flush margins
	G02.07	camping and caravans	Negative	Low	Overnight parking by camper vans at flush margins
	H05.01	garbage and solid waste	Negative	Low	Plastic and other waste on site, presumably from campers

Glen Tilt	A04.02.02	non intensive sheep grazing	Negative	Low	Stocking levels higher than at some other sites, grassland sward closely cropped in some areas
	A05.02	stock feeding	Negative	Low	Considerable local damage where feeders are installed, with resultant rank vegetation
Loch Tummel	J02.05	Modification of hydrographic functioning, general	Negative	Unknown	The apparent loss of *V. geyeri* from the site may arise from hydrological changes. Dipwells required.
Ben Vrackie	A04.02.02	non intensive sheep grazing	Neutral	Low	Low stocking levels within a large area
Black Isle Braelangwell Wood	A04.02.01	non intensive cattle grazing	Negative	Low	Cattle only appear to be present in the western unit, but their weight is damaging to the flushes
	D02.01	electricity and phone lines	? Negative	Low	There does not appear to have been any maintenance since 2012, there the impact is neutral but future work on the ground around the poles could severely impact the flushes
	A04.02.03	non intensive horse grazing	Positive	Low	Horses only appear to be present in the eastern/central units and there is no impact
Black Isle Belmaduthy Dam	A04.02.01	non intensive cattle grazing	Negative	Low	Stocking levels unclear but have potential to damage the fragile flushes
	B02	Forest and Plantation management & use	? Negative	Unknown	Drying of the site possibly from impacts of drainage during felling, or increased water demand following replanting and growth. Dipwells required.
	G05	Other human intrusions and disturbances	Negative	Low	Quad bike damage to the flushes near the main gate
Deeside	A04.02.05	non intensive mixed animal grazing (deer)	Neutral	Low	
	J02.05	Modification of hydrographic functioning, general	? Negative	Unknown	Localized abstractions at Morrone maybe affecting the hydrological stability of the flushes
	J02.06	Water abstractions from surface waters			
	J02.07	Water abstractions from groundwater			

Islay: Margadale River	B01.02	Artificial planting on open ground non-native trees	Potential negative	low	Softwood (Sitka spruce) plantations very close to site although fenced off
	F03.01.01	Damage caused by game (excess population density)	negative	medium	Flush vegetation is very close-cropped by red deer
	I01	Invasive non-native species	negative	low	advance of *Rhododendron ponticum* up the hill side – a noticeable advance since 2012
Islay: Loch Smigeadail	F03.01.01	Damage caused by game (excess population density)	negative	medium	Flush vegetation is very close-cropped by red deer
Islay: Finlaggan	A04.02.01	Non-intensive cattle grazing	negative	High*	*Chiefly affecting flush sites 1, 1A, 1B, 2. Much lower impact at sites 3, 4.
	J02.05	Modification of hydrographic functioning, general	Negative	Unknown	All Finlaggan sites (due to recently cleared land drains)
Islay: Loch Ard Achadh	A04.02.01	Non-intensive cattle grazing	negative	low	Site was moderately poached in 2012 but situation now improved

5.4 Overall assessment

The baseline condition assessment for *Vertigo geyeri* in Scotland can be determined by how well the sites meets the key targets for the attributes associated with this species. There is an extensive area of habitat for the species which is in good condition for *Vertigo geyeri*, and the snail was present at the majority of sites and was generally present in relatively high abundance. The absence at Loch Tummel and the continued absence from the Deeside sites except at Deeside is, at present, not considered enough to outweigh all of the positives and to change the population assessment to Favourable Declining. Therefore, the overall assessment is Favourable Maintained.

Attribute	**Assessment**
Population	Favourable Maintained
Habitat for the species	Favourable Maintained
Future Prospects	Favourable Maintained
Overall	Favourable Maintained

6. CONDITION ASSESSMENT FOR *VERTIGO GENESII*

Having obtained some baseline data in 1998 on the attributes required to assess condition, the 2012 baseline survey established thresholds to reflect the extent of optimal habitat and distribution of the snail.

6.1 Population assessment

Table 6: Targets for population assessment

		2012		2017	
Indicator	**Target**	**Result**	**Pass/Fail**	**Result**	**Pass/Fail**
Presence/ absence	• Adult snails are present in the 2 **Tulach Hill** monitoring flush areas (flushes 24, 28)	Absent	Fail	Absent	Unfavourable Unchanged
Presence/ absence	• Adult snails are present in the 4 **Glen Fender** monitoring flush areas (GF1, GF2, M8 and Loch Moraig North)	Present in all 4 flushes	Pass	Present in all 4 flushes	Favourable maintained
Presence/ absence	• Adult snails are present in 2 zones with Optimal habitat in each of **Glen Fender** Transect M3 AND Transect M8 (minimum 2 zones on each sampled), with no evidence of decline*	Present in 5 (of 8) optimal zones sampled	Pass	Present in 3 (of 6) optimal zones sampled	Favourable maintained
Presence/ absence	• Adult snails are present in each of the 3 units at **Braelangwell Wood** (minimum 2 samples in each)	Present in each unit	Pass	Present in central & western unit	Favourable maintained
Presence/ absence	• Adult snails are present in at least one **Glen Tilt** Flush (from area 4, and 2 flushes on the north side of the river in minimum 2 samples from each) , with no evidence of decline*	Absent	Fail	Absent	Unfavourable Unchanged
Presence/ absence	• Adult snails are present in 2 flush areas at **Loch Loch**	Not surveyed in 2012		Present in each unit	Favourable maintained
Presence/ absence	• Adult snails are present in at least 1 flush on **Ben Vrackie**	Not surveyed in 2012		Present in 1 flush	Favourable maintained

6.2 Habitat for the species assessment

Table 7: Targets for habitats assessment

		2012		2017	
Indicator	**Target**	**Result**	**Pass/Fail**	**Result**	**Pass/Fail**
Habitat extent (site level)	• The **Tulach Hill** flush areas (flushes 24, 28) should have a combined area of at least 2.4 ha, of which at least 0.5 ha should be Optimal & sub-optimal	2.44 ha in area, of which 0.53 ha is Optimal and sub-optimal	Pass	2.44 ha in area, of which 0.53 ha is Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• The **Glen Fender** monitoring flush areas (GF1, GF2, M8 and Loch Moraig North) should have a combined area of at least 6.2 ha, of which at least 1.5 ha should be Optimal & sub-optimal	6.23 ha in area, of which 1.55 ha is Optimal and sub-optimal	Pass	6.23 ha in area, of which 1.55 ha is Optimal and sub-optimal	Favourable maintained
Habitat extent (transect)	• At least 30 m of the habitat on **Glen Fender** Transect M3 is classed as Optimal and a further 30 m is Optimal and sub-optimal AND at least 55 m is Optimal wetness	34 m is Optimal habitat and 26 m is sub-optimal, 60 m is optimal wetness	Pass	34 m is Optimal habitat and 26 m is sub-optimal, 60 m is optimal wetness	Favourable maintained
Habitat extent (transect)	• At least 90 m of the habitat on **Glen Fender** Transect M8 is classed as Optimal and a further 30 m is Optimal and sub-optimal AND at least 120 m is Optimal wetness	90 m is Optimal habitat and 32 m is sub-optimal, 122 m is optimal wetness	Pass	114.5 m is Optimal habitat and 7.5 m is sub-optimal, 122 m is optimal wetness	Favourable maintained
Habitat extent (site level)	• The **Braelangwell Wood** flush areas in the three units should have a combined area of at least 2.5 ha, of which at least 0.6 ha should be Optimal & sub-optimal	2.53 ha in area, of which 0.63 ha is Optimal and sub-optimal	Pass	2.53 ha in area, of which 0.63 ha is Opt/sub-opt plus another 1 ha in East/central of which 0.2 is opt/sub-opt	Favourable maintained
Habitat extent (site level)	• The flushes sampled at **Glen Tilt** should support at least 0.2 ha of habitat classed as Optimal and sub-optimal	0.2 ha of habitat classed as Optimal and sub-optimal	Pass	0.2 ha of habitat classed as Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• The flushes sampled at **Loch Loch** should support at least 0.05 ha of habitat classed as Optimal and sub-optimal	Not surveyed in 2012		At least 0.05 ha is Optimal and sub-optimal	Favourable maintained
Habitat extent (site level)	• The flushes sampled **Ben Vrackie** should support at least 0.01 ha of habitat classed as Optimal and sub-optimal	Not surveyed in 2012		At least 0.01 ha is Optimal and sub-optimal	Favourable maintained

6.3 Future prospects assessment *Vertigo genesii*

The future prospects for *Vertigo genesii* are assessed by listing the activities that are influencing or are likely to influence the site that could result in the status of the species changing at that site. A standard list of impacts, with their standard codes has been used (see http://cdr.eionet.europa.eu/help/habitats_art17).

The locations of the pressure, its influence (positive, negative or neutral), and the intensity of the pressure (low, medium or high) are noted. The combination of the influences, both positive and negative is balanced to assess the site's future prospects as Favourable or Unfavourable.

Future Prospects have been assessed by examining how impacts are affecting the other attributes (i.e. population and habitat for the species) and their impact if they continue unchecked. Several impacts are having an effect on *Vertigo genesii* at the sites assessed although most are assessed as neutral (Table 8). However, over-frequent maintenance to the power lines at Braelangwell is likely to be detrimental. There does not appear to have been any maintenance since 2012, and thus the impact is neutral but future work on the ground around the poles could severely impact the flushes.

Future prospects should balance positives and negatives to determine whether the species will survive at this site for the foreseeable future. On the basis of the status quo being maintained, Future prospects have been assessed as Favourable Maintained.

Table 8: Impacts and Pressures (site basis)

			Influence	Intensity	Comments
All sites	M	Climate change			Climate change (M) has been included and although not assessed, its influence is likely only to be negative
	M01	Changes in abiotic conditions			
	M01.01	temperature changes (e.g. rise of temperature & extremes)			
	M01.02	droughts and less precipitations			
Tulach Hill	A04.02.01	non intensive cattle grazing	Negative	Low	Very few cattle appear to be on site but had been an issue in Flush area 9
	A04.02.02	non intensive sheep grazing	Negative	Low	Not an issue in the 2017 survey sites, but has impacted unprotected flushes elsewhere on Tulach Hill
	A04.02.05	non intensive mixed animal grazing (deer)	Negative	Low	Low impact
	C01	Mining and quarrying	Negative	Low	Very large quarry on north slope of Tulach Hill, expansion could impact on flushes, particularly their hydrological function
Glen Fender	A04.02.01	non intensive cattle grazing	Negative	Low	Although stocking levels are relatively low, the weight of the animals has a high impact on the fragile flushes (evident at Loch Moraig south and Glen Fender Flush 3 in particular)
	A04.02.02	non intensive sheep grazing	Neutral	Low	
	G05	Other human intrusions and disturbances	Negative	Low	Quad bike damage to the fragile flushes
Loch Loch	A04.02.02	non intensive sheep grazing	Neutral	Low	Low stocking levels within a large area
Ben Vrackie	A04.02.02	non intensive sheep grazing	Neutral	Low	Low stocking levels within a large area
Black Isle Braelangwell Wood	A04.02.01	non intensive cattle grazing	Negative	Low	Cattle only appear to be present in the western unit, but their weight is damaging to the flushes
	D02.01	electricity and phone lines	? Negative	Low	There does not appear to have been any maintenance since 2012, thus the impact is neutral but future work on the ground around the poles could severely impact the flushes
	A04.02.03	non intensive horse grazing	Positive	Low	Horses only appear to be present in the eastern/central units and there is no impact

7. DISCUSSION

The results and observations from the 2017 surveys give a high degree of confidence that the approach and methodology devised along with the targets and thresholds set are appropriate for the Assessment of Condition of *Vertigo geyeri* and *Vertigo genesii* in Scotland. We recommend that this regime is implemented for future monitoring.

Tables 9 and 10 give summaries of the 2017 Condition Assessments for entire sites and/or sub-sites based on these targets. The assessments for the majority of sites are unchanged from 2012 with Habitat and Population assessed as Favourable Maintained and Future Prospects as Good.

Table 9: Summary of Vertigo geyeri *Condition Assessment*

Site	**Habitat**	**Population**	**Future Prospects**	**Comments**
Tulach Hill monitoring flush areas (flushes 3, 9, 24, 28	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Tullach Hill Transects 4 and 9	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Fender monitoring flush areas (GF1, GF2, M8 and Loch Moraig N)	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Fender Transect M3 and Transect M8	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Lochan an Daim	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Tilt	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Loch Tummel	Favourable maintained	Unfavourable declining	Poor	Decline from 2012, snail absent
Ben Vrackie	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Braelangwell Wood	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Belmaduthy Dam main site	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Belmaduthy Dam transect	Favourable declining	Favourable maintained	Good	Decline from 2012 based on habitat extent but may be temporary
Glen Lui	Favourable declining	Unfavourable Unchanged	Poor	Decline from 2012 based on habitat quality, site appears to be drying out, snail still absent
Morrone Birkwood	Favourable maintained	Unfavourable Unchanged	Poor	Snail still absent
Islay: Margadale River	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Islay: Loch Smigeadail	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Islay: Loch Finlaggan	Favourable maintained	Favourable maintained	Possibly poor	Recent drainage may impact the site
Islay: Balachlaven	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Islay: Loch Lossit	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Loch Ard Achadh	Favourable maintained	Favourable maintained	Good	Unchanged from 2012

Table 9: Summary of Vertigo genesii *Condition Assessment*

Site	Habitat	Population	Future Prospects	Comments
Tulach Hill flush areas (flushes 24, 28)	Favourable maintained	Unfavourable Unchanged	Poor	Snail still absent, therefore prospects poor
Glen Fender monitoring flush areas (GF1, GF2, M8 & Loch Moraig N)	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Fender Transect M3	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Fender Transect M8	Favourable maintained	Favourable maintained	Good	Unchanged from 2012
Glen Tilt	Favourable maintained	Unfavourable Unchanged	Poor	Snail still absent, therefore prospects poor
Loch Loch	Favourable maintained	Favourable maintained	Good	Greater local range than previously found
Ben Vrackie	Favourable maintained	Favourable maintained	Good	Only found in 1 flush in 2017
Braelangwell Wood	Favourable maintained	Favourable maintained	Good	Unchanged from 2012, but greater area of occupancy found in 2017

In the Habitat Assessment, two sites show a change: the extent and quality of the habitat on the Belmaduthy Dam transect and at Glen Lui had reduced below the target thresholds and therefore were assessed as Favourable Declining. At some sites (Braelangwell Wood and Loch Moraig) the area of *Vertigo* habitat increased but this arises from additional survey rather than a spread in the habitat. There appears to be very little difference in the extent of habitat within the flushes examined (Table 6). At some sites, e.g. Glen Fender, the boundaries of the flushes at were re-determined (see Appendix 2) and show very little difference from 2012, and are within error that might be expected from a hand-held GPS.

In the Population Assessment, Loch Tummel was assessed as Unfavourable Declining due to the absence of *V. geyeri* (see below). *Vertigo geyeri* was still absent from Glen Lui and Morrone Birkwood and thus are assessed as Unfavourable Unchanged. Similarly, for *V. genesii* the continued absence of the snail at Tullach Hill and Glen Tilt results in the Population Assessment being Unfavourable Unchanged. Whilst counts of *Vertigo* species within samples were made and densities estimated, the differences between sites or between surveys are not necessarily significant as there is likely to be an artefact of seasonal, altitudinal and aspect differences. *Vertigo* species are at their most abundant in late summer/early autumn following their main breeding events), although weather patterns can have a significant influence. A component of the Article 17 reporting is to provide information on population size i.e. numbers of individuals. Taking Tullach Hill Flush 28 as an example, where there is 0.23 ha of potential habitat – in 2012 the density of *V. geyeri* based upon the samples was 131 m^{-2}. If this was multiplied up, the population of *V. geyeri* in the flush would be 301,300 individuals. However, in 2017 the density was only 31 m^{-2} and thus the number of individuals would be 71,300 individuals. This does not represent a four-fold decline in the population and neither is likely to be a real estimate of the population. For an animal that is subject to such fluctuations, population estimates are unreliable and meaningless.

The absence of the species under assessment from a site has to result in Future Prospects being assessed as Poor, although if the habitat is still Favourable Maintained, then a re-introduction may be possible.

For *Vertigo geyeri*, the decline in habitat at Belmaduthy Dam and the absence of the species at Loch Tummel is, at present, insufficient to downgrade the Condition Assessment, especially given the number of sites and extent of habitat in Scotland. Therefore the Overall Assessment for *V. geyeri* in Scotland is Favourable Maintained.

In the 2013 round of Article 17 reporting, *Vertigo genesii* was assessed as Unfavourable Bad due to the loss of the species at Glen Tilt. In 2017 the snail could still not be found at Tullach Hill (Unfavourable Unchanged) but its presence at Ben Vrackie and Loch Loch (not included in the 2012 survey) was confirmed, and for the latter site, the extent of habitat was greater than previously known (including a new 1 km square). There is no real decline since 2012 and neither is there an improvement, therefore, the Overall Assessment is Unfavourable Unchanged.

Detailed accounts of all the sites surveyed, along with management issues are described in all of the separate appendices. However, there are some sites, especially Loch Tummel, which are of particular concern:

At Loch Tummel in 2012, condition of the habitat was apparently excellent, but *Vertigo geyeri* was very uncommon (as were other snail species). Only 16 individuals were found in four samples giving a mean density of 25 individuals per m^2. No *V. geyeri* were found in 2017, indeed, a total of only 10 snails were found in the 2 samples taken from the most favourable habitat.

Reasons for the apparent loss of *V. geyeri* and snails in general at Loch Tummel are not clear but are most likely to be associated with negative hydrological effects. Water levels on Loch Tummel are dictated by the operations of the hydro-electricity plant at the western end. If the lake levels are subject to periods of significant fluctuations or extended periods of low level then there is likely to be a negative impact on the phreatic pressure of the springs on the low surrounding slopes. If this has led a cessation in flow from the springs, and an overall drying out of the flush habitat, particularly at key times of year in the snails' reproductive period, then this could account for the loss of *V. geyeri* from a habitat that still appears to be suitable. Moisture levels in the litter where the snail occurs become too dry to support the species where normal spring seepages fail to reach the soil surface, even for a short period of time (Kuczynska & Moorkens, 2010). A very similar phenomenon has been observed at a lake site with spring flushes in western Ireland. This was formerly (until mid-2000s) a good site for *V. geyeri* and a rich associated molluscan fauna (Moorkens personal observations). Yet by the late-2000s the species and most of the associated fauna disappeared (and not recovered). Detailed analysis of abstraction data has shown that there was one summer with a prolonged period of high abstraction and this is believed to have caused the loss of the *V. geyeri* population.

The installation and monitoring of dipwells and local phreatic tubes with level recorders within the Loch Tummel site would be extremely useful in monitoring levels and fluctuations in shallow groundwater water levels at the site. Groundwater dipwells would establish the direction of groundwater movement and its level of reliance on the Loch levels at different conditions. More frequent monitoring (at least every 2 years) of *V. geyeri* is also required. If negative results continue to be obtained from samples taken in the most optimal habitat then it must be presumed that the loss is permanent and that a re-introduction programme would be required. However, this is only practical if it can be demonstrated that there will be no further negative hydrological impacts. If springs can be demonstrated to operating sustainably, then a re- introduction should be considered.

Hydrological instability is the major cause of declines and losses of *Vertigo geyeri* and *V. genesii* populations. The apparent dryness of the Belmaduthy Dam on the Black Isle site in September (especially given the wet summer) is of possible concern (Appendix 9). There

has been considerable forestry management over the last 10 years and although possible impacts of drainage during felling, or increased water demand following replanting and growth cannot be retrospectively demonstrated, the installation and monitoring of dipwells (and phreatic tubes at the important habitat) within the site would be extremely useful in determining any future change.

At Loch Finlaggan on Islay a recently deeply dug field has the potential to severely impact the *Vertigo geyeri* population (Appendix 11.3). Given the very small areas of flush habitat and the low numbers of *V. geyeri* at this site, it could be particularly vulnerable to such changes in the hydrology.

Reasons for the deterioration of the Deeside sites are not clear but are most likely to be associated with hydrology. Glen Lui appears to be prone to flooding and drying, and periods of summer drying may have led to the site becoming no longer suitable. At Morrone Birkwood the flushes are wetter but there is a small reservoir nearby and water is piped to a local house. Abstraction of the springs, combined with periods of drought at key times of year may account for the loss of *V. geyeri* from a habitat that still appears to be suitable.

We strongly recommend that hydrological investigations are implemented at Loch Tummel, Belmaduthy Dam and Loch Finlaggan. Molluscan monitoring frequency at these sites should also be increased.

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APPENDIX 1: KNOWN SITES FOR *VERTIGO GEYERI* AND *VERTIGO GENESII*

Table A1.1: Known Scottish mainland sites (on a 1km square basis) for Vertigo geyeri

District	Location	1 km square Grid Ref	10 km square	Last record	Reference	Comments
Black Isle	Belmaduthy Dam	NH64-57-	NH65	2017	This survey	
Black Isle	Braelangwell Wood	NH68-63-	NH66	2017	This survey	
Perthshire	Lochan an Daim	NN71-57-	NN75	2017	This survey	
Perthshire	Loch Tummel	NN82-59-	NN85	2012	Killeen 2013	Not found in 2017
Perthshire	Glen Banvie	NN82-69-	NN86	1995	No details	No subsequent survey
Perthshire	Invervack	NN83-64-		2012	Killeen 2013	Not surveyed in 2017
Perthshire	Invervack	NN84-64-		1995	Colville 1997	Site not found in 2012
Perthshire	Tulach Hill	NN86-63-		1998	Killeen & Colville 1999	No subsequent survey
Perthshire	Tulach Hill	NN86-64-		1995	Killeen & Colville 1999	No subsequent survey
Perthshire	Tulach Hill	NN87-63-		2017	This survey	
Perthshire	Tulach Hill	NN87-64-		2017	This survey	
Perthshire	Tulach Hill	NN88-62-		1998	Killeen & Colville 1999	No subsequent survey
Perthshire	Tulach Hill	NN88-63-		1998	Killeen & Colville 1999	No subsequent survey
Perthshire	Glen Fender	NN88-66-		2017	This survey	
Perthshire	Tulach Hill	NN89-62-		2017	This survey	
Perthshire	Tulach Hill	NN89-63-		2012	Killeen 2013	Not surveyed in 2017
Perthshire	Glen Fender	NN89-66-		2017	This survey	
Perthshire	Glen Fender	NN89-67-		2017	This survey	
Perthshire	Tulach Hill	NN90-62-	NN96	2017	This survey	
Perthshire	Loch Moraig	NN90-66-		2017	This survey	
Perthshire	Glen Fender	NN90-67-		2017	This survey	
Perthshire	Ben Vrackie	NN94-61-		2017	This survey	
Perthshire	Glen Tilt	NN90-71-	NN97	2017	This survey	
Perthshire	Glen Tilt	NN91-71-		1998	Killeen & Colville 1999	Not found in 2012
Perthshire	Glen Tilt	NN91-72-		1998	Killeen & Colville 1999	No subsequent survey
Deeside	Glen Lui	NO05-92-	NO09	1998	Killeen & Col. 1999b	Not found in 2012 or 2017
Deeside	Morrone Birkwood	NO13-90-	NO19	1998	Killeen & Col. 1999b	Not found in 2012 or 2017

Table A1.2: Known sites on Islay (on a 1km square basis) for Vertigo geyeri

District	Locations	1 km square Grid Ref	10 km square	Last record	Reference	Comments
Islay	Loch Ard Acadh	NR31-43-	NR34	2017	This report	Previous surveys in 1998, 2004, 2012
Islay	Finlaggan S4	NR37-66-	NR36	2017	This report	Previous surveys in 1996, 2012
Islay	Finlaggan S1, S2, S3, Balachlaven part S2(SW)	NR37-67-		2017	This report	Previous surveys in 1996, 2012
Islay	Balachlaven part - S2(SW), Balachlaven S1(NE)	NR37-68-		2017	This report	Balachlaven S2(SE): Previous surveys in 1996, 2012 Balachlaven S1 (NW) – new in 2017
Islay	Finlaggan S1A, 1B	NR38-67-		2017	This report	Both new sites in 2017
Islay	Loch Smigeadail	NR38-75-	NR37	2017	This report	Previous surveys in 1998, 2012
Islay	Loch Lossit S3	NR40-65-	NR46	2017	This report	Previous surveys in 1996, 2012
Islay	Loch Lossit S2	NR41-65		2017	This report	Previous surveys in 1996, 2012
Islay	Loch Lossit S1	NR41-67-		2017	This report	Previous surveys in 1996, 2012
Islay	Margadale River	NR40-74-	NR47	2017	This report	Previous surveys in 1998, 2012

Table A1.3: Known Scottish sites (on a 1km square basis) for Vertigo genesii

District	Location	1 km square Grid Ref	10 km square	Last record	Reference	
Perthshire	Tulach Hill	NN87-64-		IJK Aug 1998	Killeen & Colville 1999	Not found in 2012 or 2017
Perthshire	Tulach Hill	NN87-63-		IJK Aug 1998	Killeen & Colville 1999	Not found in 2012 or 2017
Perthshire	Glen Fender	NN88-66-	NN86	2017	This survey	
Perthshire	nr. Blair Atholl	NN89-62-		1998	B Colville	Tulach Hill east – not found subsequently
Perthshire	nr. Blair Atholl	NN89-63-		1998	B Colville	Tulach Hill east – not found subsequently
Perthshire	Glen Fender	NN89-66-		2017	This survey	
Perthshire	Loch Moraig	NN90-66-	NN96	2017	This survey	
Perthshire	Glen Fender	NN90-67-		2017	This survey	
Perthshire	Ben Vrackie	NN94-61-		2017	This survey	
Perthshire	Glen Tilt	NN91-71-	NN97	IJK Aug 1998	Killeen & Colville 1999	Not found in 2012
Perthshire	Loch Loch	NN98-73-		2017	This survey	New 1 km square record
Perthshire	Loch Loch	NN99-72-		2017	This survey	
Black Isle	Braelangwell Wood	NH68-63-	NH66	2017	This survey	

APPENDIX 2: TULACH HILL & GLEN FENDER MEADOWS SAC

The SAC supports by far the largest area of flush habitat with *Vertigo geyeri* and *V. genesii* in Britain. In the Tulach Hill component at least 30 separate flush units have been identified and at Glen Fender and Moraig, there are at least another 12 flush areas. The results from the original 1999 survey in which a high proportion of the flushes were examined showed that at least *V. geyeri* was present in most, whereas *V. genesii* was restricted mostly to the Glen Fender component (Killeen & Colville 1999).

In 2012, a representative selection of flushes in both components were surveyed (Killeen 2013) yet even within the selected flush areas there was over 18 ha of habitat, of which 5.2 ha was considered to be suitable (optimal and sub-optimal). Only adult *Vertigo geyeri* and indeterminate *V. geyeri/genesii* were found on Tulach Hill whereas adults of both *V. geyeri* and *V. genesii* were found at Glen Fender and Loch Moraig. Densities of the 2 species were relatively high throughout. Population, Habitat and Future Prospects were all assessed as Favourable.

In 2017, all monitoring transects were repeated and several of the individual flush areas surveyed in 2012 were re-examined, with the addition of the southern end of Loch Moraig (Figures A2.1 to A2.5).

There appears to be very little difference in the extent of habitat within the flushes examined. The boundaries of 2 flushes at Glen Fender were re-determined (Figures A2.6, A2.7) and show very little difference from 2012, and are within error that might be expected from a hand-held GPS. The results from the 4 transects showed some small variations in the proportions classed as Optimal and Sub-optimal (Figures A2.8 to A2.11). Tulach Hill Transect 4 and Glen Fender Transect M3 were unchanged, whereas Tullach Transect 9 and Glen Fender M8 showed a small increase in the proportion of habitat classed as Optimal. Throughout the SAC, most of the habitat was in good condition.

In 1999 *V. genesii* was recorded at two sites on Tulach Hill (flushes 24 and 28), but the species was not recorded in 2012 and again, it was not found in 2017. It would be premature to infer that the species has disappeared from Tulach Hill. *V. genesii* has a preference for flushes with a more stony element, whereas most of the Tulach Hill flushes are dominated by rich flush sward habitat, and, therefore, if *V. genesii* is extremely localized, despite best attempts to sample a representation of each flush, the correct habitat may be being missed. A survey focusing solely on stony flushes should confirm where *V. genesii* is living. However, *V. geyeri* was found in all flushes and transect samples taken on Tulach Hill with similar densities to 2012 - densities of adults and juveniles combined ranged from 31 to 93/m^2 (mean 72/m^2) (Table A2.3).

Both *Vertigo geyeri* and *V. genesii* were in all flushes sampled at Glen Fender and Loch Moraig North, whereas only *V. geyeri* was found at Loch Moraig south (Table A2.4). Densities of the two species combined were high ranging from 60 to 220 individuals per m^2 (mean 208/m^2), slightly lower but not significantly different from 2012.

Overall, both components of the SAC were in good condition and in general, as in 2012, there are only a few management issues. Some flushes on Tulach Hill are grazed by cattle, others are grazed by sheep. Mostly, this does not appear to be having any significant impact on the flushes except at Flush 13 where the hillside is overgrazed by sheep. At Glen Fender, particularly at the western part, grazing by cattle is causing some damage to the flushes. There are also places for supplementary feeding which causes serious damage to the flushes.

Population, Habitat and Future Prospects are all assessed as Favourable.

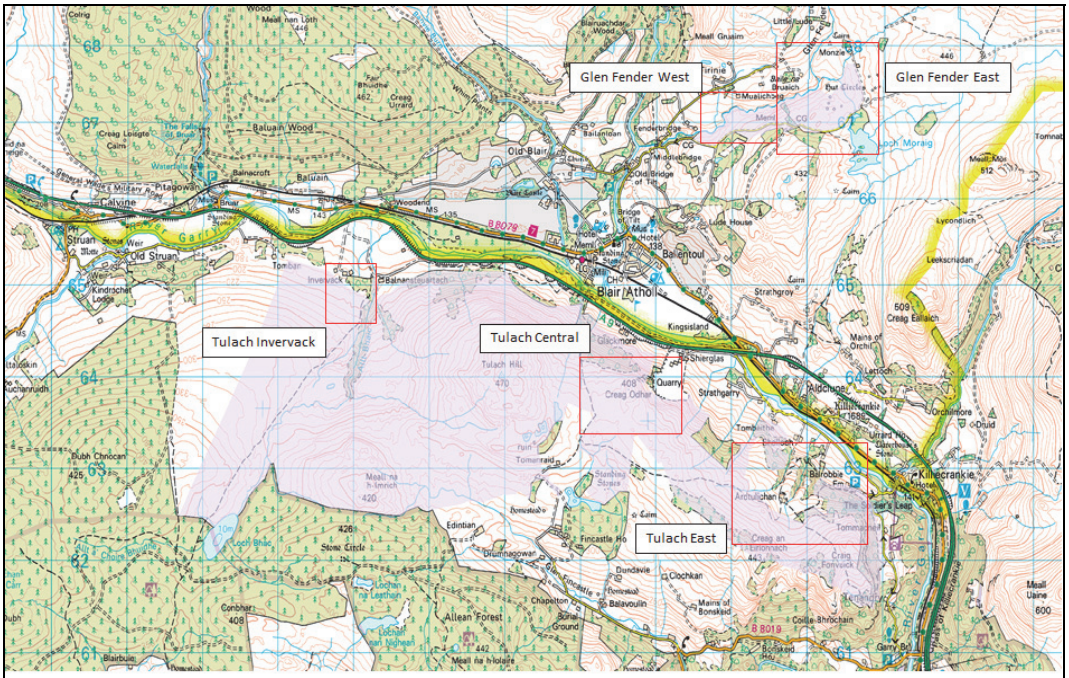


Figure A2.1: Map of Tulach Hill & Glen Fender Meadows SAC with the main sample areas (Invervack not sampled in 2017)

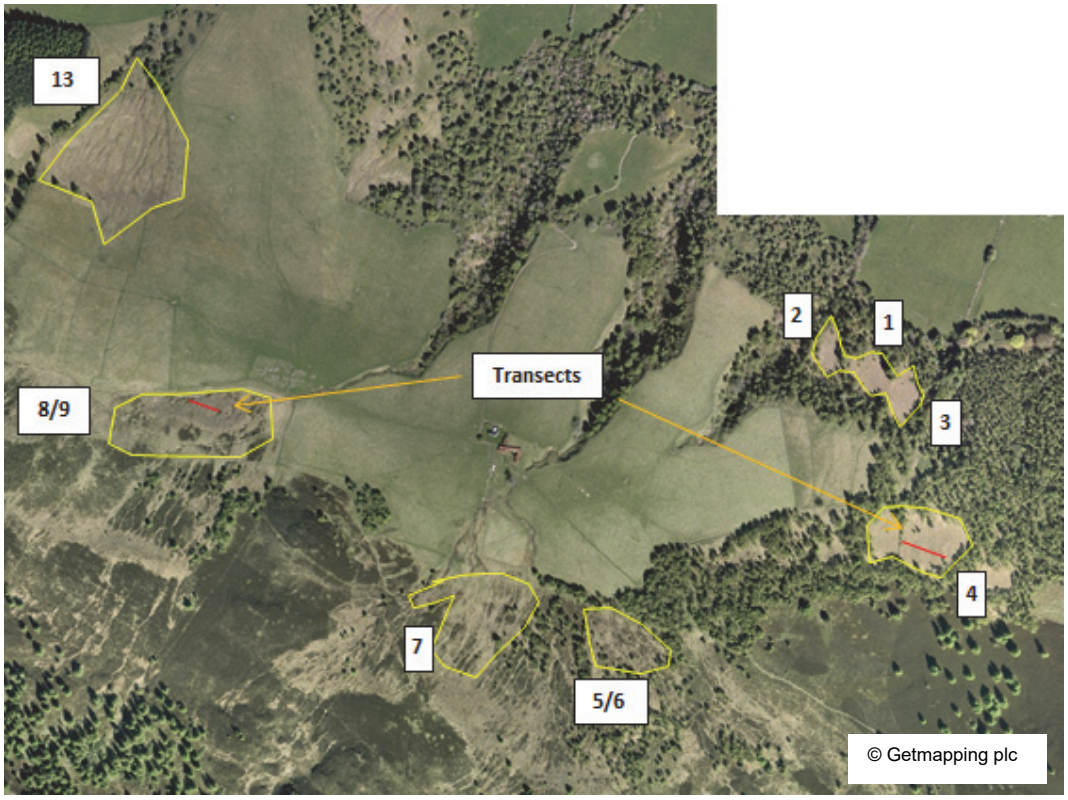


Figure A2.2: Tulach Hill East flushes and sample sites (not all sampled in 2017)

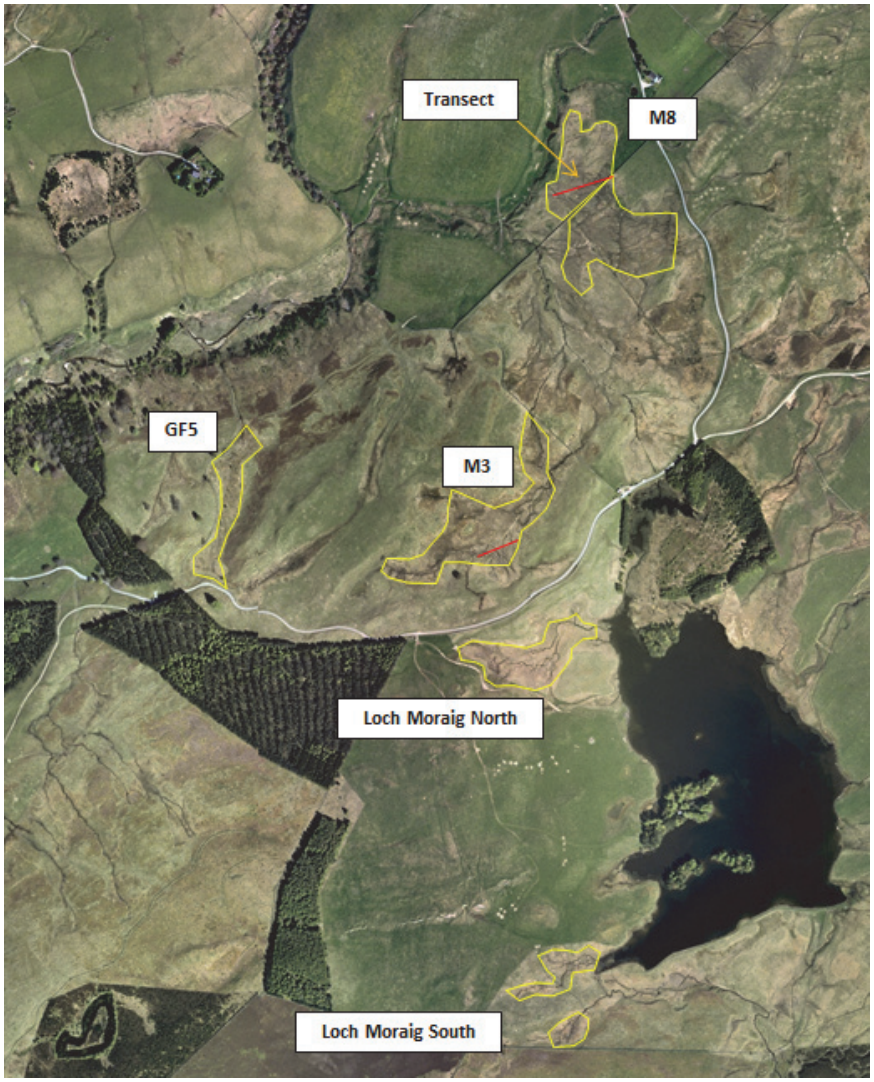


Figure A2.5: Glen Fender East and Loch Moraig flushes and sample sites

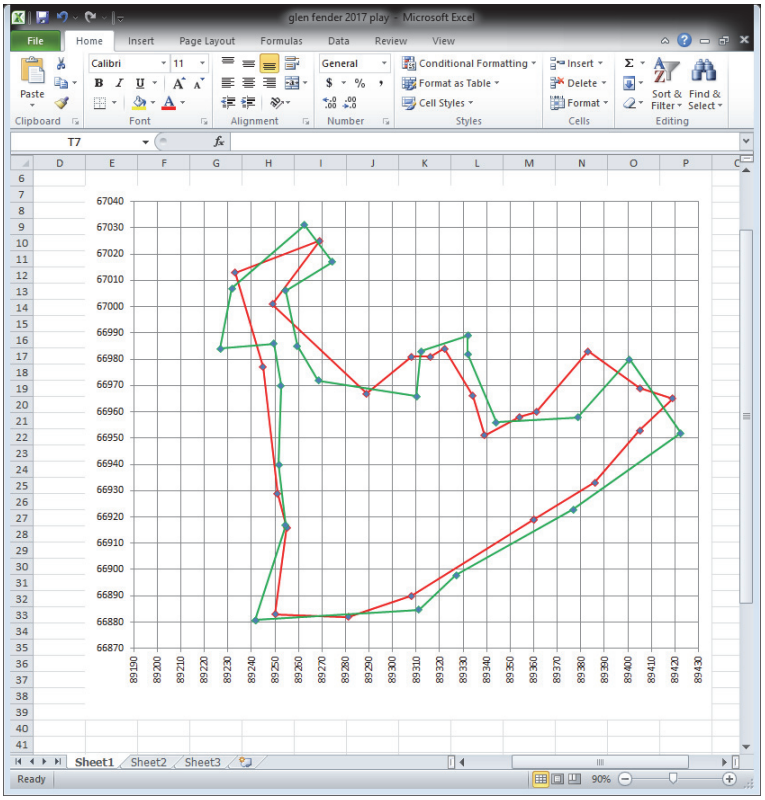


Figure A2.6: Glen Fender Flush GF1 comparison of outline polygons between 2012 (green) and 2017 (red)

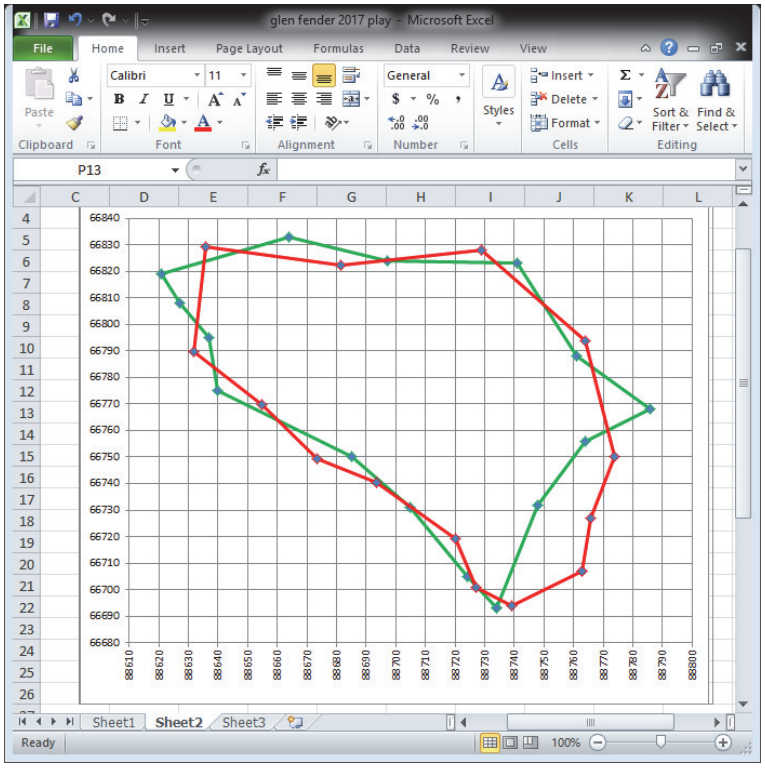


Figure A2.7: Glen Fender Flush GF2 comparison of outline polygons between 2012 (green) and 2017 (red)

Table A2.1: Tulach Hill sample sites

Flush No	Grid Ref	Habitat description
4	NN90260 62524 to 90306 62495	60m transect, see Figures A2 and A7. Extensive hillside flush, stony in places, but mainly homogenous habitat with luxuriant mosses (*Palustriella* and *Campylium*) and *Carex viridula*
9	NN89391 62748 to 89337 62701	60m transect, see Figures A2 and A8
24A	NN87704 63576	Dendritic network of runnels with *Drepanocladus, Campylium, Saxifraga,* occasional *Palustriella*
24B	NN87788 63532	Sward and mounds with mosaic of moss and sedge habitat, also *Pinguicula*
28	NN87072 64056	Extensive seepage slope with *Eriophorum, Carex viridula, Campylium, Drepanocladus*, juniper, some tufa deposition

Table A2.2: Glen Fender Meadows sample sites

Flush No	Grid Ref	Habitat description
Loch Moraig (North)	NN90379 66834	Near springhead, mounds and runnels with mosses and sedges, diverse flora (see GF1 below)
Loch Moraig (South)	NN90491 66357	Gentle-sloping flush slope and sward, very mossy (*Campylium*) but with less diverse flora than the other sites. Cattle grazed and with poaching damage.
GF1	NN89265 66945	Extensive area of fen meadow, seepage slopes, runnels with high diversity fen flora: typically with mosses (*Drepanocladus* and *Campylium),* sedges *(Carex viridula, C. dioica, C. pulicaria), Tofieldia, Eleocharis, Eriophorum, Equisetum, Saxifraga, Selaginella,* orchids
GF2	NN88621 66819	Extensive area of fen meadow, seepage slopes, runnels with high diversity fen flora (see GF1 above)
M3	NN90347 67003 to 90408 67019	60m transect, across a spring line, see Figure A6 and A9 – similar flora to GF1
M8	NN90563 67608 to 90430 67548	145m transect, down a stony flush slope, see Figure A6 and A10 – similar flora to GF1 but also with *Schoenus ferrugineus*

Table A2.3: Results: Molluscan analysis of Tulach Hill samples

Species	**4 Transect**			**9 Transect**		**24A**	**24B**	**28**
	15m	**31m**	**50m**	**21m**	**50m**			
Vertigo geyeri Adult	9	5	3	4	6	7	3	3
Vertigo genesii Adult	-	-	-	-	-	-	-	-
V. geyeri/genesii Juvenile	5	3	2	2	2	8	7	2
Aegopinella pura				2				
Carychium minimum	7	4		4	5	4	4	3
Carychium tridentatum				9				
Cochlicopa lubrica	1	3	3	2	3		2	1
Columella aspera							1	
Euconulus alderi			1	4	3	3	2	
Nesovitrea hammonis	3	11	9	2	2		2	2
Oxyloma elegans				1	2			
Punctum pygmaeum	1	3	3		2		1	1
Trochulus hispidus		2			2	2	1	1
Vertigo substriata		3				6	4	
Vitrea contracta	2	2	6	10	3	2	3	3
Galba truncatula	4		2	1		1		1
Pisidium personatum				1	1	1		1
Total No. of species	7	8	7	11	10	8	10	9
Total No. of snails	32	36	29	42	31	34	30	18

Table A2.4: Results: Molluscan analysis of Glen Fender samples

Species Site	**Loch Moraig North A**	**Loch Moraig North B**	**Loch Moraig South**	**GF1**	**GF2**	**M3 Transect**		**M8 transect**			
						9m	**31m**	**15m**	**48m**	**77m**	**116 m**
Vertigo geyeri Adult	3	0	4	15	12	3	4	4	2	14	6
Vertigo genesii Adult	0	7	0	3	1	2	0	0	10	3	0
V. geyeri/genesii Juvenile	9	9	6	8	12	11	7	11	15	18	17
Carychium minimum	3	6	23	11	8	16	13	8	9	11	4
Carychium tridentatum			1					2	1		
Cochlicopa lubrica	1	3	5			3	2	3		1	
Columella aspera						2	2		1	1	1
Euconulus alderi	7	3	8			8	1	9	5	11	
Nesovitrea hammonis	3	9	7	7	5	1		8	3	5	1
Oxyloma elegans	1	1						2	1	1	
Punctum pygmaeum			3	6	7	11	7	8		1	2
Trochulus hispidus				3				3			
Vertigo antivertigo			4		3	8	3			1	
Vertigo substriata	6		4		4	2	2		2	2	3
Vitrea contracta			2			10	3				
Galba truncatula	3	2	2	7	4			3	3	2	2
Radix balthica			1					2	5		
Pisidium personatum		1		2		3	2	3	5	2	
Total No. of species	8	9	12	8	8	12	10	12	12	14	7
Total No. of snails	36	41	70	62	56	80	46	66	62	74	36

Start Point:	Start point is a juniper bush by wall at NN90260 62524
End point:	End point is dead conifer at NN90306 62495
Transect Length:	60 m
Description:	Extensive hillside flush surrounded by trees, stony in places, but mainly homogenous habitat with luxuriant mosses (*Palustriella* and *Campylium*) and *Carex viridula.* In Flush area 4 of the 1998 survey (Killeen & Colville 1999)
Direction:	North-west to south-east
Sampling frequency:	Starting at the 0 m end, the habitat (at the plant community level) along the tape was described and the linear distance of that habitat type measured. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transect. Three samples were taken at various intervals along the transect from zones with optimal and sub-optimal habitat and analysed in the laboratory for their snail composition

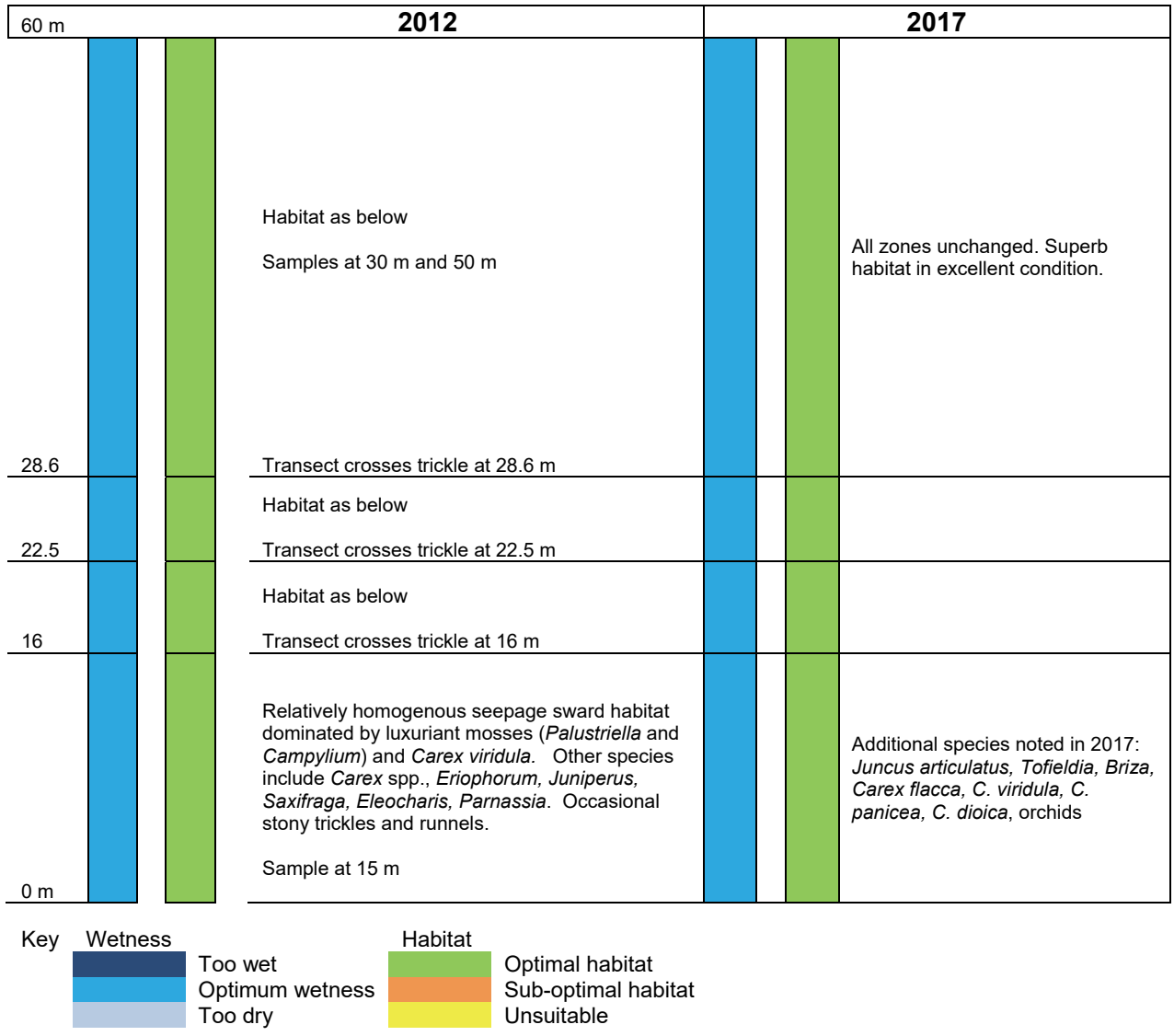


Figure A2.8: Tulach Hill Flush 4 transect

Start Point:	Start point is by 3 stones on the stream edge at NN89301 62748
End point:	At NN89337 62701
Transect Length:	60 m
Description:	Hillside flush comprising a series of flushing runnels and seepage sward amongst heather and *Molinia* mounds. In Flush area 9 of the 1998 survey (Killeen & Colville 1999)
Direction:	North-west to south-east towards large hawthorn tree at NN89351 62686
Sampling frequency:	As for Tulach Transect 4. Two samples were taken at various intervals along the transect principally from zones with optimal and sub-optimal habitat and analysed in the laboratory for their snail composition

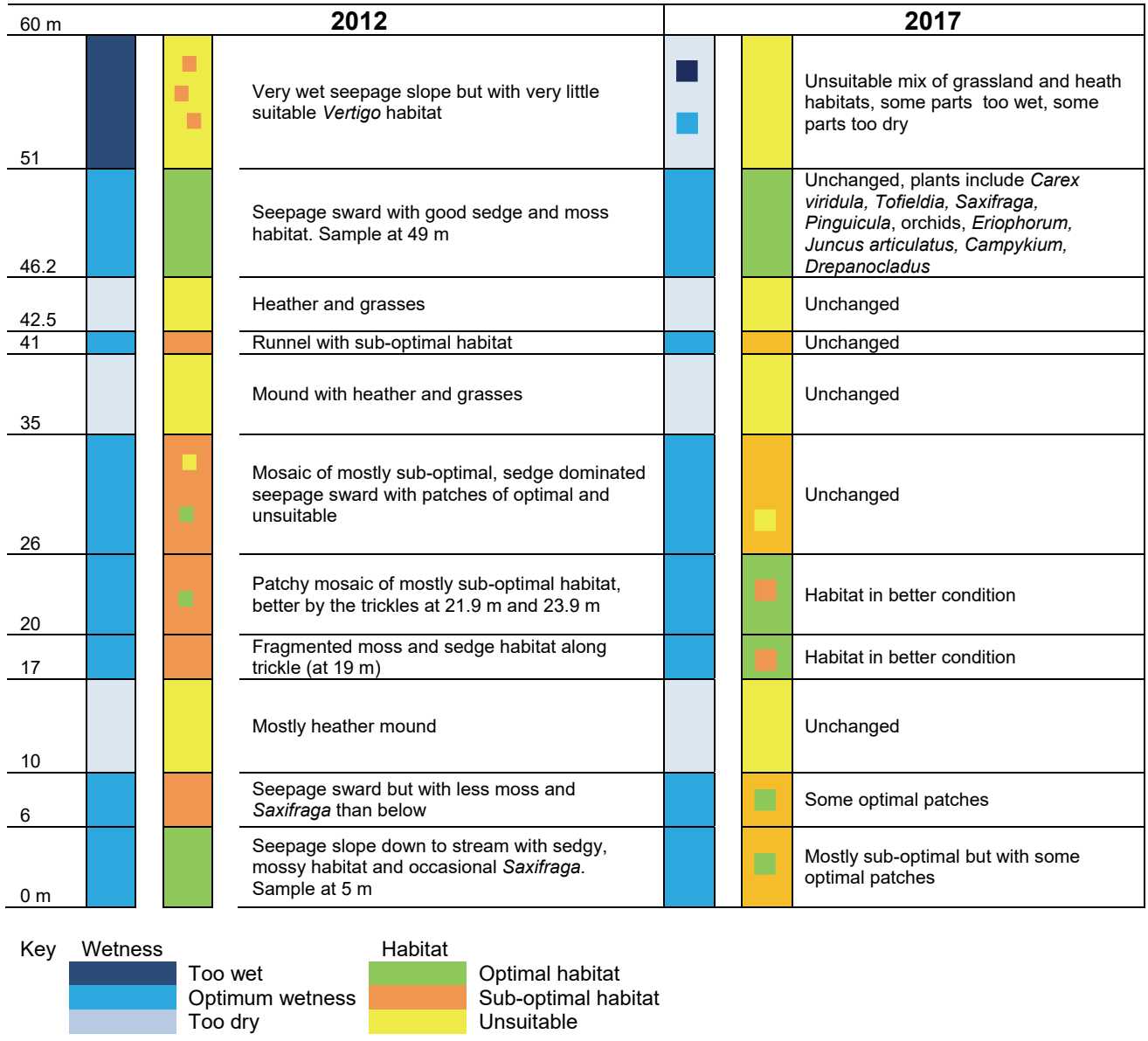


Figure A2.9: Tulach Hill Flush 9 transect

Start Point:	Start point is by a grassy mound by the spring at NN90347 67003
End point:	Mound near the end of the flush habitat at NN90408 67019
Transect Length:	60 m
Description:	Transect runs along the north side of a spring line for the first 30 m then across a seepage slope.
Direction:	West to east
Sampling frequency:	As for Tulach Transect 4. Two samples were taken at various intervals along the transect principally from zones with optimal and sub-optimal habitat and analysed in the laboratory for their snail composition

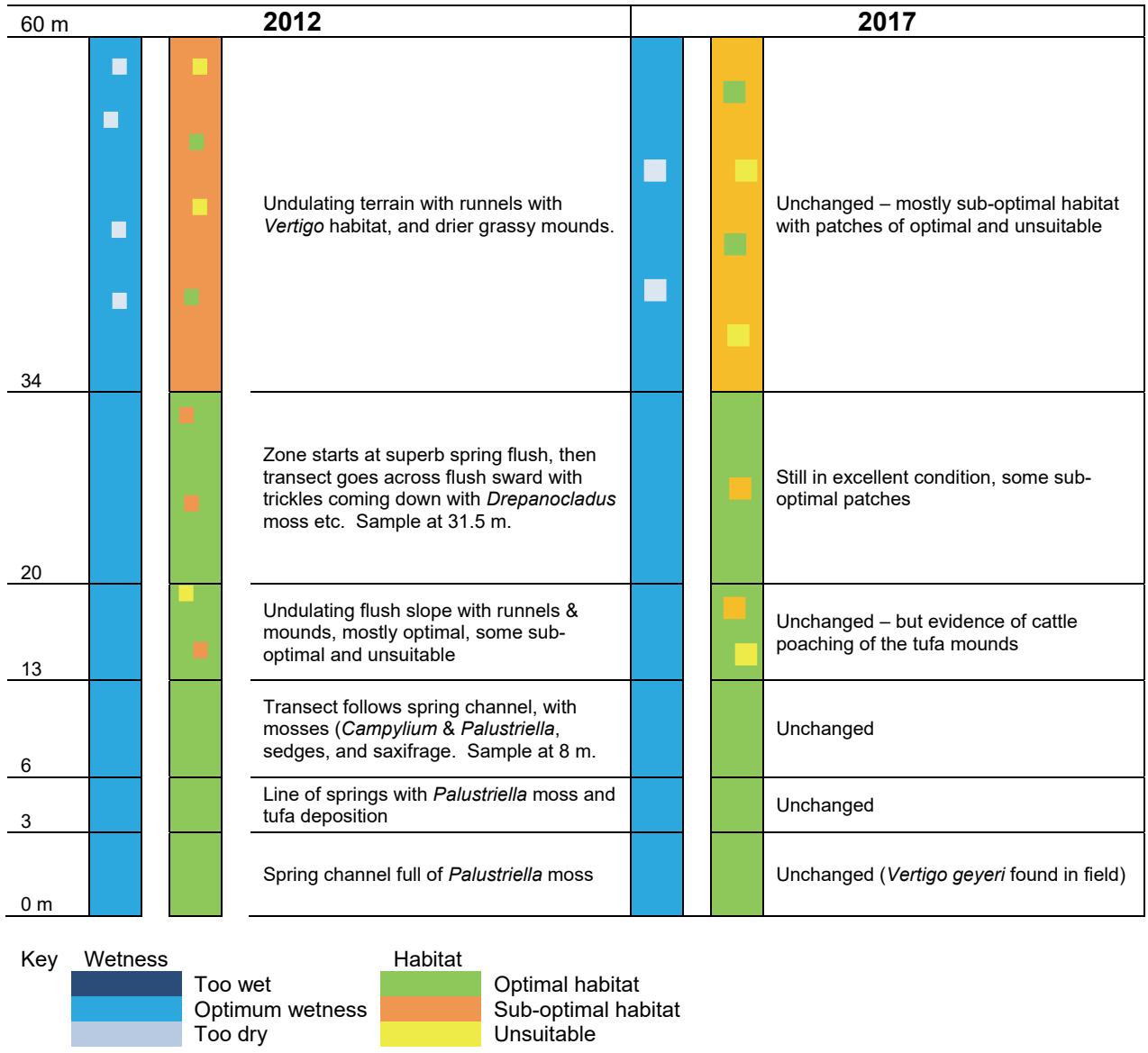


Figure A2.10: Glen Fender M3 transect

Start Point:	Start point is by larger fence post on the wall at NN90563 67608
End point:	NN90430 67548
Transect Length:	145 m
Description:	Transect runs down the flush slope through the best of the *Schoenus ferrugineus* habitat. Closely follows Transect M8 of the 1998 survey (Killeen & Colville 1999)
Direction:	West to east
Sampling frequency:	Four samples were taken at various intervals along the transect

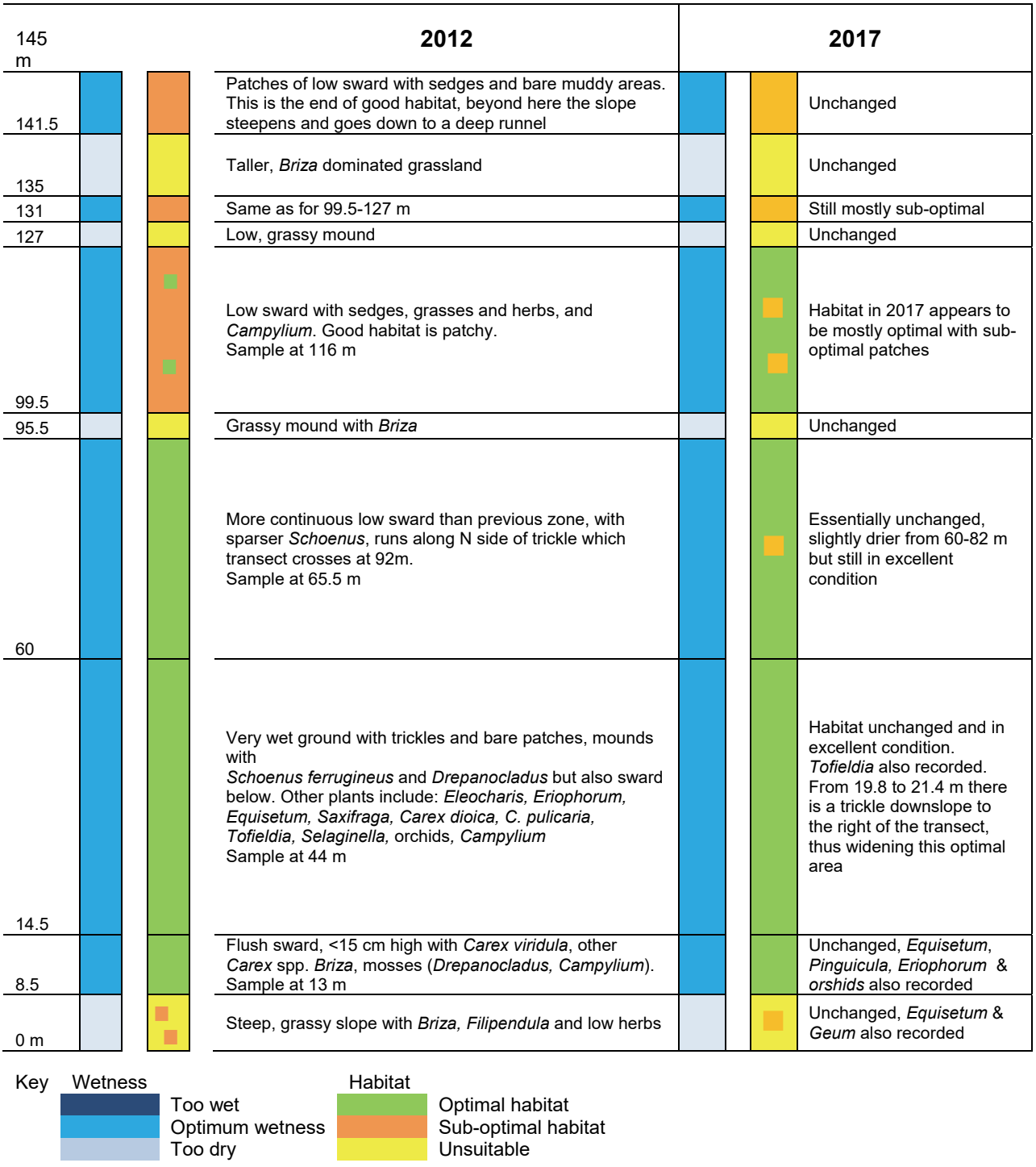
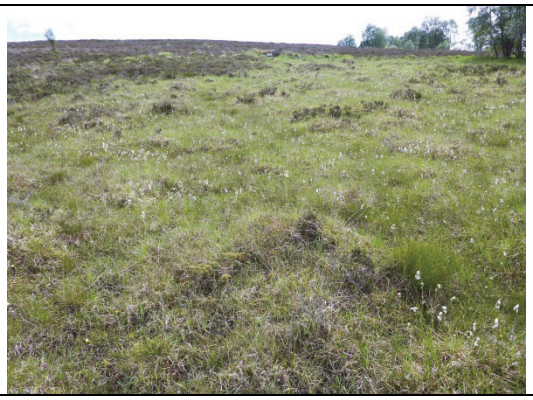
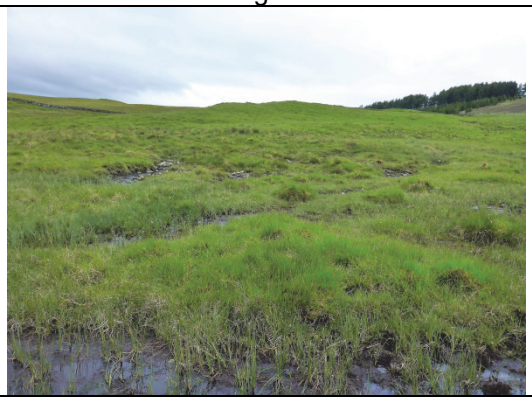


Figure A2.11: Glen Fender M8 transect

Figure A2.12: Photographs - Tulach Hill and Glen fender

	
Tullach Hill Site 4 Transect, view towards start	Tullach Hill Site 4 Transect, view towards end
	
Tullach Hill Site 4 Transect habitat at 15m sample	Tullach Hill Site 4 Transect habitat at 31m sample
	
Tullach Hill Site 9 Transect, view towards start	Tullach Hill Site 9 Transect, view towards end

	
Tullach Hill Site 9 Transect habitat at 9m sample	Tullach Hill Site 9 Transect habitat at 50m sample
	
Tulach Hill Site 24	Tulach Hill Site 24 site A
	
Tulach Hill Site 24 habitat with *Tofieldia*	Tulach Hill Site 24 site B
	
Tulach Hill Site 28	Tulach Hill Site 28

	
Tulach Hill Site 28	
	
Loch Moraig north site A	Loch Moraig north spring head site B
	
Loch Moraig south	Loch Moraig south
	
Glen Fender GF1	Glen Fender GF1

	
Glen Fender GF2	Glen Fender GF2
	
Glen Fender M3 Transect view west from 30m	Glen Fender M3 Transect view east from 30m
	
M3 Transect sample site at 9m	M3 Transect tufa spring at 13m

M3 Transect sample site at 31m

M3 Transect habitat at sample site at 31m

M8 transect flush slope

M8 transect stony flush

M8 transect view up slope from 80m

M8 transect view down slope from 60m

M8 transect habitat in stony flush at 13m

M8 transect seepage sward habitat at 117m

APPENDIX 3: SCHIEHALLION (LOCHAN AN DAIM)

This is a small site comprising two flush units: a very small spring on the south side of the road and a larger flush slope on the north side of the road (Figure A3.1). In 2012 it was estimated that there was 0.08 ha optimal and sub-optimal habitat. *Vertigo geyeri* was very common with recorded densities of 87/m^2 on the south side of the road and 409/m^2 on the north side.

The 2017 results show there is very little difference in the extent of habitat within the flushes examined. The boundaries were re-determined (Figure A3.2) and show very little difference from 2012, and are within error that might be expected from a hand-held GPS. Therefore, the very small spring on the south side of the road remains at 0.05 ha, and the larger flush slope on the north side of the road remains at 0.15 ha. It was again estimated that 0.08 ha was optimal and sub-optimal habitat. As in 2012, *Vertigo geyeri* was very common with recorded densities of almost 500/m^2 on the on the north side of the road.

The main impact at the site is sheep grazing but overnight parking by camper vans on the roadside verges is having an adverse effect on the margins of the flush areas. There was a supplementary feeder at the site margins under the trees and plastic rubbish was scattered through the site (presumably from campers).

Figure A3.1: Lochan an Daim principal flush area

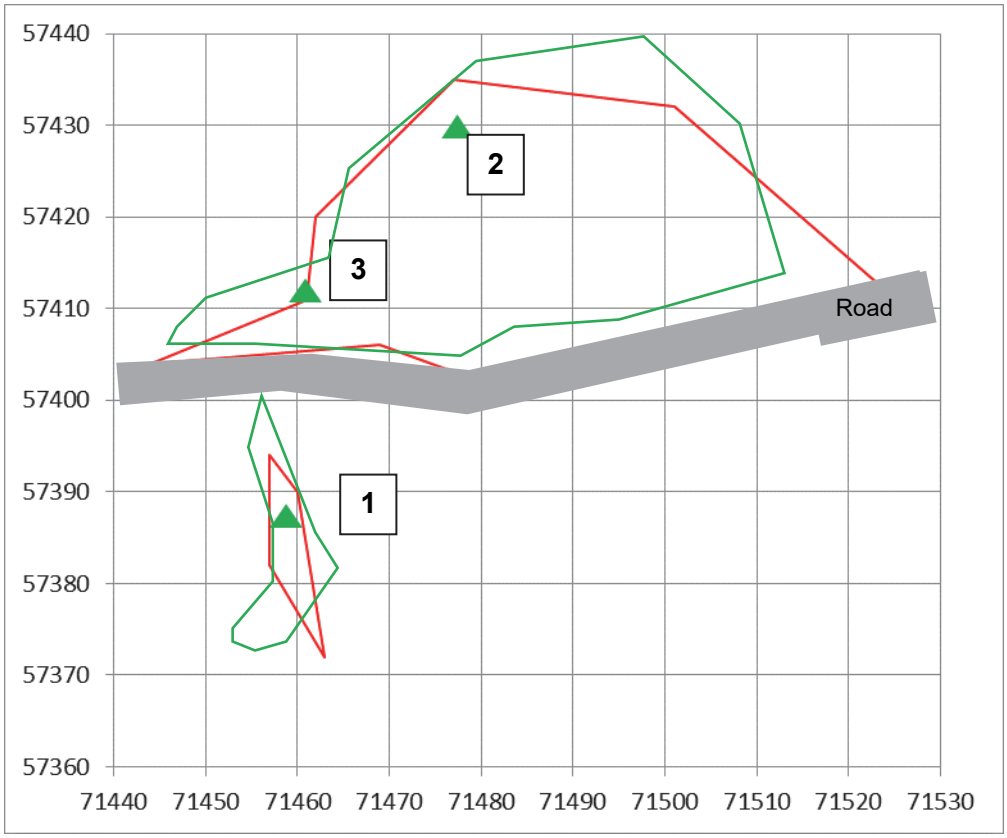


Figure A3.2: Lochan an Daim principal flush area outline polygon and sample sites (red = 2012, green = 2017)

Table A3.1: Lochan an Daim sample sites

No	Grid Ref	Habitat description
1	NN71458 57388	Narrow, stony flush on south side of road near spring with some tufa deposition. Plants include *Saxifraga azoides, Carex viridula, Pinguicula, Eriophorum,Tofieldia, Eleocharis, Drepanocladus, Campylium,* occasional *Selaginella*. Some willow and myrtle scrub
2	NN71480 57427	Slope with flush sward with all of above species plus additional *Carex* spp. (*hostiana, dioica* etc). Sample from main, central part of the flushing sward habitat
3	NN71460 57413	As above, but sample from low down the slope

Table A3.2: Results: Molluscan analysis of Lochan an Daim samples

Species Site	**1**	**2**	**3**
Vertigo geyeri Adult	2	42	11
V. geyeri Juvenile	1	37	5
Carychium minimum	6	19	11
Cochlicopa lubrica	2	7	2
Columella aspera			
Euconulus alderi	2	15	5
Nesovitrea hammonis	4	7	6
Punctum pygmaeum		6	3
Vertigo substriata	2	13	3
Vitrea contracta			1
Galba truncatula	1	7	2
Pisidium personatum	1	5	
Total No. of species	8	9	9
Total No. of snails	21	158	49

Figure A3.3: Lochan an Daim photographs

Flush on south side of road

Sample site 1

Flush on north side of road looking east

Flush on north side of road looking west

Sample site 2

Sample site 3

APPENDIX 4: GLEN TILT

The hillside slopes on the south side of the River Tilt are very steep and comprise mainly grassland which is heavily grazed by sheep. Flushes, many with tufa deposition, arise along a spring line at an altitude of approximately 300 m, and flush habitat is restricted in area and lies adjacent to streams and runnels. A smaller, more extensive flush arises on flatter terrain nearer the river, and there are other flushes on the slopes just to north of the road. Figure A4.1 shows the flushes with the 2012 numbering notation.

Both *Vertigo genesii* and *V. geyeri* have been recorded from Glen Tilt, but *V. genesii* was recorded only in 1995, whereas records from all subsequent surveys have been for *V. geyeri* (Killeen 2013).

In 2017, flush sites 1, 2, 4 and 9 were resurveyed and sampled (Table A4.1). As in 2012, *V. geyeri* was recorded in flush sites 4 and 9, but not in sites 1 and 2 (Table A4.2). Good numbers of *V. geyeri*, equivalent to a density of 200 individuals/m^2 were recorded from flush site 4.

Good *Vertigo* habitat at Glen Tilt is sparse and fragmented, and it is estimated that the area of suitable habitat (optimal and sub-optimal) throughout the survey area is barely more than 0.2 ha – unchanged from 2012. Many of the flushes have apparently suitable habitat (e.g. flush sites 1 and 2) but do not support the snail – possibly the slopes are too steep and do not provide a sufficiently even hydrological regime.

The entire area is grazed by sheep which do have the potential to negatively affect the relatively small areas of flush, particularly if stocking levels increase above those at present.

Vertigo genesii has not been positively recorded at this site since 1995, and, in the 2013 round of Article 17 reporting this was considered a loss and as a result *V. genesii* was assessed as Unfavourable Bad (JNCC 2013b). However, Glen Tilt lies within Beinn a`Ghlo SAC as does Loch Loch (see Appendix 6), which supports several flushes in the same 10 km square as the old Glen Tilt record (NN97). Although the there is a local loss of range, the actual area of occupancy is probably little affected by the loss of the Glen Tilt site.

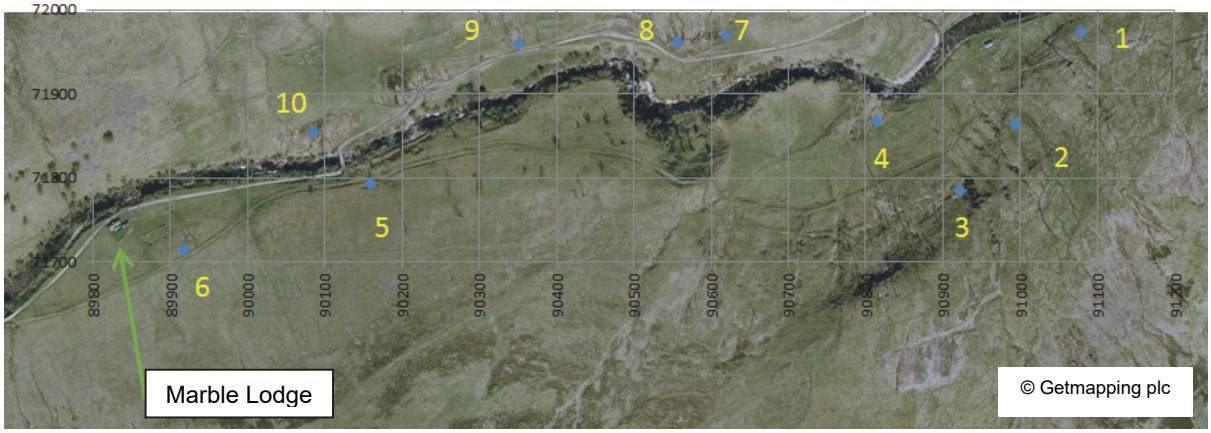


Figure A4.1: Glen Tilt aerial showing flush numbering notation (sites 1, 2, 4 and 9 sampled in 2017)

Table A4.1: Glen Tilt sample sites

No	Grid Ref	Habitat description
1	NN91080 71975	Hillside spring beyond Balanaesie. Tufa depositing with *Eleocharis, Eriophorum, Drepanocladus, Palustriella, Carex viridula,* sparse *Saxifraga, Selaginella, Campylium,* other *Carex* spp.
2	NN90994 71865	Steep spring slope with tufa, mostly *Palustriella, Saxifraga* and *Carex viridula*. Habitat 2-3m wide
4	NN90815 71868	Flush area at base of slope with seepage sward, stony in places, with *Carex viridula, Palustriella, Saxifraga, Pinguicula*, orchids, *Eriophorum*
9	NN90358 71941	Slope with series of stony flush runnels, mostly *Saxifraga, Carex viridula,* and *Drepanocladus*

Table A4.2: Results: Molluscan analysis of Glen Tilt samples

Species **Site**	**1**	**2**	**4**	**9**
Vertigo geyeri Adult	-	-	19	3
Vertigo genesii Adult	-	-	-	-
V. geyeri/genesii Juvenile	-	-	13	3
Arianta arbustorum		3		
Carychium minimum	6	1		6
Carychium tridentatum		4		
Cochlicopa lubrica		1	2	2
Columella aspera		1		
Euconulus alderi	2	2	7	
Nesovitrea hammonis	3	8		
Punctum pygmaeum	8	8	3	
Trochulus hispidus			3	
Vallonia excentrica		1		
Vertigo antivertigo		1		
Vertigo pygmaea	1			2
Vertigo substriata	5	9	2	2
Vitrea contracta				
Galba truncatula	4	3	2	4
Pisidium personatum			1	
Total No. of species	7	12	8	6
Total No. of snails	29	42	52	22

Figure A4.2: Glen Tilt photographs

Glen Tilt Flush 1

Glen Tilt Flush 2

View west from Glen Tilt Flush 2

Glen Tilt Flush 4

Glen Tilt Flush 4 spring head

Glen Tilt Flush 4 view down slope

	
Glen Tilt Flush 9 view up slope	Glen Tilt Flush 9 view down slope
	
Glen Tilt Flush 9 spring head	Glen Tilt Flush 9 optimal habitat

APPENDIX 5: LOCH TUMMEL

The habitat at the Loch Tummel site comprises an open south-facing slope with a series of highly calcareous, tufa depositing springs giving rise to runnels with mounds of *Schoenus ferrugineus* and mosses, and areas of flush sward with sedges and mosses, and a high botanical diversity. In 2012, approximately 40% (0.18 ha) of the total area (0.45 ha) was considered to be optimal and sub-optimal habitat. There does not appear to be any change in 2017 – visibly the site has superb habitat structure and composition and appears to be in excellent condition.

In 2012, condition of the habitat was apparently excellent, but *Vertigo geyeri* was rather uncommon. Only 16 individuals were found in four samples giving a mean density of 25 individuals per m^2. **No** *V. geyeri* were found in 2017, indeed, a total of only 10 snails were found in the 2 samples taken from the most favourable habitat.

Reasons for the apparent loss of *V. geyeri* and snails in general at this are not clear but are most likely to be associated with hydrological instability. Water levels on Loch Tummel are dictated by the operations of the hydro-electricity plant at the western end. If the lake levels are subject to periods of significant fluctuations or extended periods of low level then there is likely to be a negative impact on the phreatic pressure of the springs on the low surrounding slopes. If this has led a cessation in flow from the springs, and an overall drying out of the flush habitat, particularly at key times of year in the snails' reproductive period, then this could account for the loss of *V. geyeri* from a habitat that still appears to be suitable. A very similar phenomenon has been observed at a lake site with spring flushes in western Ireland. This was formerly (until mid-2000s) a good site for *V. geyeri* and a rich associated molluscan fauna (Moorkens personal observations). Yet by the late-2000s the species and most of the associated fauna disappeared (and not recovered). Detailed analysis of abstraction data has shown that there was one summer with a prolonged period of high abstraction and this is believed to have caused the loss of the *V. geyeri* population.

The installation and monitoring of dipwells (phreatic tubes) within the Loch Tummel site would be extremely useful in monitoring levels and fluctuations in shallow groundwater water levels at the site. More frequent monitoring (at least every 2 years) of *V. geyeri* is also required. If negative results continue to be obtained from samples taken in the most optimal habitat then it must be presumed that the loss is permanent and that a re-introduction programme would be required. However, this is only practical if it can be demonstrated that there will be no further negative hydrological impacts.

Figure A5.1: Loch Tummel House (tile NN8259) aerial showing flush area polygon

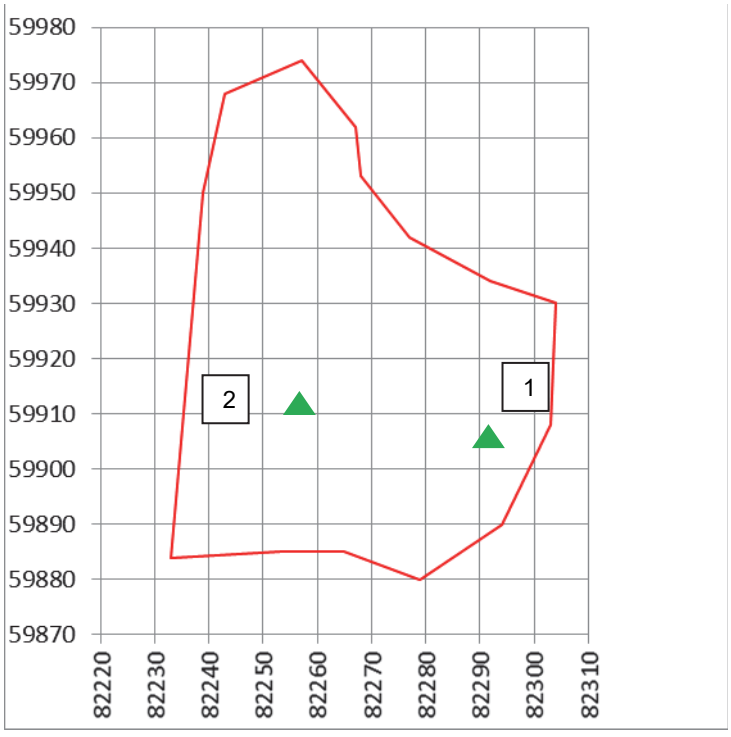


Figure A5.2: Loch Tummel House showing flush area polygon and sample sites

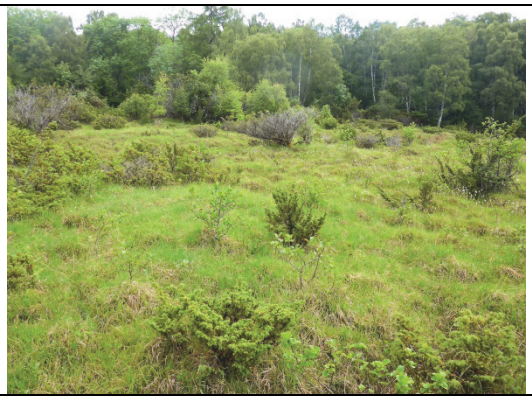
Table A5.1: Loch Tummel sample sites

No	Grid Ref	Habitat description
1	NN82291 59905	Stony flush with *Schoenus ferrugineus, Saxifraga* and mosses
2	NN82258 59909	Oozing fen mire (not stony) with abundant *Drepanocladus* & *Campylium* (no *Schoenus*)

Table A5.2: Results: Molluscan analysis of Loch Tummel samples

Species **Site**	**1**	**2**
Vertigo geyeri Adult	0	0
Vertigo genesii Adult		
V. geyeri/genesii Juvenile	0	0
Euconulus alderi	1	
Nesovitrea hammonis	2	
Oxyloma elegans	2	2
Vitrea contracta	1	
Galba truncatula	2	
Total No. of species	5	1
Total No. of snails	8	2

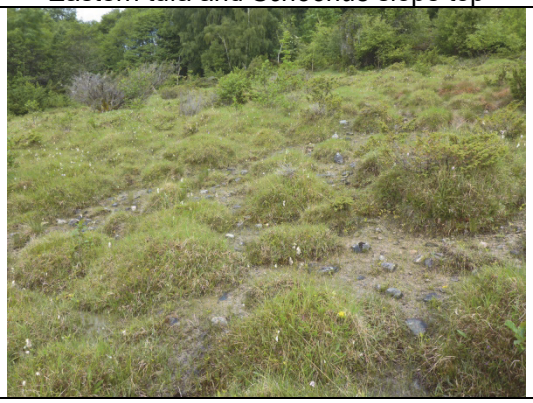
Figure A5.3: Loch Tummel House photographs



Site from SW corner

Eastern tufa and *Schoenus* slope top

Eastern tufa and *Schoenus* slope bottom



Central part of site

View on upper slope looking east

View on upper slope looking west

APPENDIX 6: LOCH LOCH

Loch Loch lies within Beinn a`Ghlo SAC (as does Glen Tilt) but was not included in the 2012 survey. Colville had recorded *Vertigo genesii* in 1998 from Square NN9972 but there do not appear to be any details on the extent of this survey. The purpose of the present survey was to locate potential *Vertigo* habitat in Glen Loch, to sample as appropriate, and to use the results as a baseline to establish targets for future monitoring.

Alkaline flushes were present over a 1 km section of Glen Loch, south of Loch Loch (Figure A6.1). The sites close to the valley floor (sites 1-6) were characteristically stony with small, often fragmented patches of habitat comprising mounds with mosses (especially *Drepanocladus*) and *Saxifraga azoides*. The flushes on higher ground (7-9) provided more extensive areas of habitat of both open stony flushes amongst a dendritic network of flushing sward. However, the small areas and fragmented nature of the habitat means that there is probably less than 5000m^2 (0.05 ha) which supports optimal and sub-optimal habitat.

Only *Vertigo genesii* (adult) was found but was present in 4 of the flushes (Table A6.2). Numbers of individuals were relatively low; the sample from site 6 had the highest number (12), equivalent to a density of 75 m^{-2}.

Two further flushes with potential habitat were also sampled in Glen Fernate, but *Vertigo genesii/geyeri* was not found.

The Loch Loch flushes are in a remote location with very poor vehicular access, and, therefore, there are few threats. Sheep are present but stocking levels appear to be low enough such that their impact is minimal.

Population, Habitat for the species, and Future Prospects are all assessed as favourable.

Table A6.1: Loch Loch sample sites

No	Grid Ref	Habitat description
1	98907 73729	Sedge ward with *Eriophorum* and *Pinguicula* and some Sphagnum, insufficiently calcareous, and prone to flooding
2	98923 73708	Stony flush emerging from high heather banks, sparse *Saxifraga* and *Armeria*. Mostly stones with flowing water and very small patches of *Drepanocladus*
3	98919 73657	More extensive than 2, stony flush area below high heather banks with *Saxifraga, Armeria, Pinguicula* and small mossy mounds (some *Campylium*, mostly *Drepanocladus*). Sample taken
4	98955 73638	Small patches of flushing habitat where streams emerge from peat
5	98985 73493	Rather dry stony flush with interspersed pockets of moss and sedge, springhead with *Palustriella* (Sample taken here)
6	98989 73075	Cushions of moss and sedgy seepage sward around large sandy/gravelly area. Sample taken
7A top	99170 72891	Hillside flush slope with more extensive patches of good *Vertigo* habitat: *Carex viridula, C. dioica, C. panicea, Selaginella, Eleocharis, Saxifraga, Pinguicula, Eriphorum, Briza, Drepanocladus* (2 samples)
7B bottom	99145 72896	
8	99204 72808	Steeper flush but with good habitat development at the shallower slope curves. Sample taken
9	99239 72699	Small flush patch with mosses and sedges, surrounded by *Sphagnum*
10	04493 67382	Glen Fernate – near bridge over river. Flush emerges from hills in a very gentle slope. Diverse flora with most of the usual indicator species (*Equisetum*, several *Carex* species, and *Campylium stellatum*)
11	04908 66776	Glen Fernate – Steep flushes (poached by sheep, and with tyre tracks) with *Carex viridula, Saxifraga, Tofieldia, Eleocharis, Eriophorum, Pinguicula*, orchids very little moss. Habitat patchy and marginal.

Figure A6.1: Loch Loch aerial image with flush and sample locations

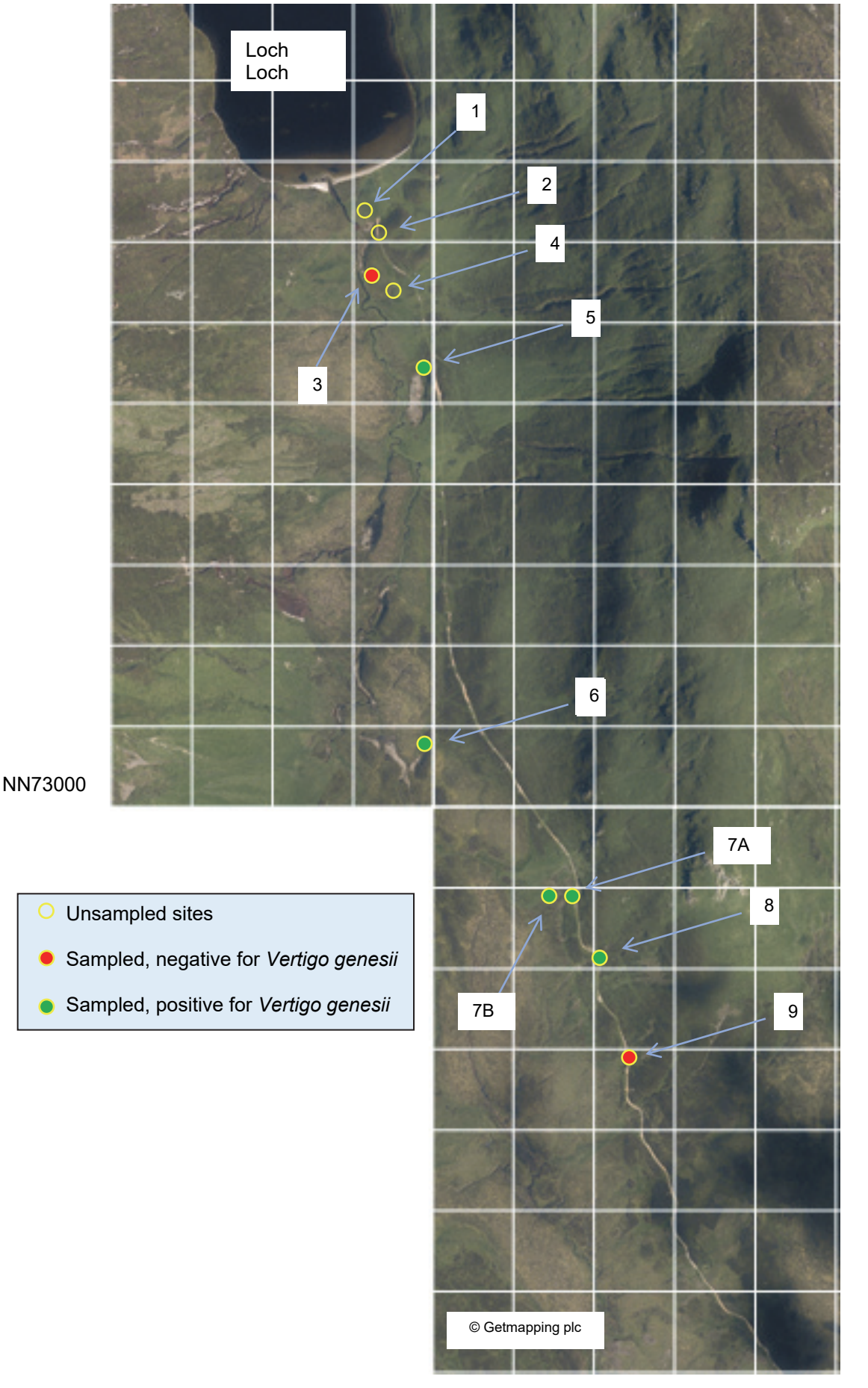


Table A6.2: Results: Molluscan analysis of Loch Loch samples

Species Flush No.	**3**	**5**	**6**	**7A top**	**7B bot**	**8**	**10**	**11**
Vertigo geyeri Adult	-	-	-	-	-	-	-	-
Vertigo genesii Adult	-	-	6	3	4	1	-	-
V. genesii Juvenile	-	1	6	1	2	1	-	-
Carychium minimum						4		
Carychium tridentatum					4			
Cochlicopa lubrica		1		2				
Columella aspera			1			1		
Nesovitrea hammonis	1			1	1		1	
Punctum pygmaeum	1				1			3
Vertigo substriata				2	3		1	1
Vitrea contracta					1	1		
Galba truncatula	3	1	3		1	1	1	
Pisidium personatum							1	
Total No. of species	3	3	3	4	7	5	4	2
Total No. of snails	5	3	16	9	17	9	4	4

Figure A6.3: Loch Loch site photographs

Loch Loch southern end

Loch Loch Flush 2

Loch Loch Flush 3

Loch Loch Flush 4

Loch Loch Flush 5

Loch Loch Flush 6

Loch Loch Flush 6

Loch Loch Flush 7

	
Loch Loch Flush 7	Loch Loch Flush 7
	
Loch Loch Flush 8	Loch Loch Flush 9
	
Flush 10 (Glen Fernate)	Flush 11 (Glen Fernate)

APPENDIX 7: BEN VRACKIE

Flushes supporting both *Vertigo geyeri* and *V. genesii* were last surveyed in 1998 (Killeen & Colville 1999). The purpose of the present survey was to relocate the previously identified *Vertigo* habitat, to sample as appropriate, and to use the results as a baseline to establish targets for future monitoring.

Several flushes were present adjacent to the main footpath to Ben Vrackie. However, most had very little suitable *Vertigo* habitat as they were insufficiently calcareous. Only three flush areas supported suitable habitat and were sampled (Figure A7.1, Table A7.1). All of these are very small in area, amounting to a few 10s of square metres. *Vertigo geyeri* was found in flush sample 2 and *V. genesii* was found in flush sample 3, but only in low numbers (Table A7.2). The flush at site 3 supports the brown bog rush *Schoenus ferrugineus* which was transplanted from a site near the shore of Loch Tummel in the 1950's before the population there was destroyed when the loch level was raised for the hydro scheme (SNH 2010). Given that the present extant Loch Tummel flush has only supported *V. geyeri*, it seems likely that the Ben Vrackie receptor site already supported *V. genesii.*

There are few threats to the flushes, low intensity sheep grazing is the only issue, but is not having any perceptible impact. However, given the small and fragmented nature of the flushes, they are inevitably vulnerable.

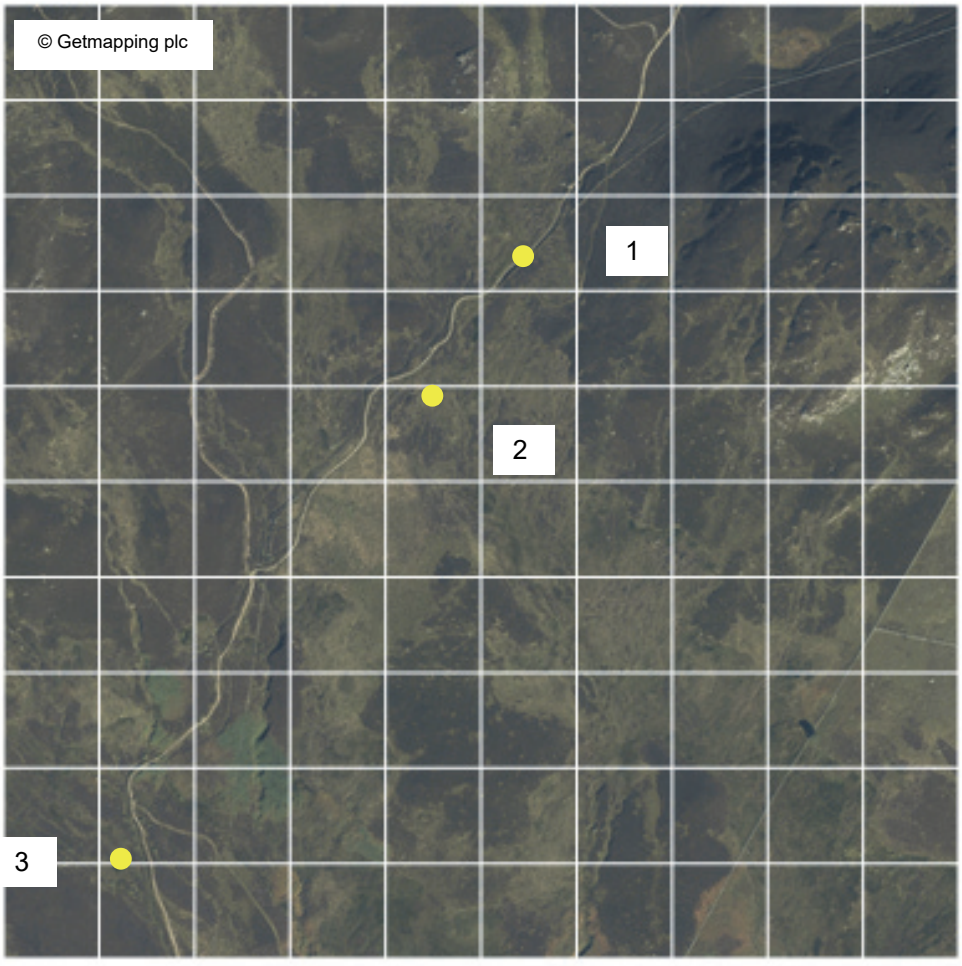


Figure A7.1: Ben Vrackie aerial image of square NN9461 with flush and sample locations

Table A7.1: Ben Vrackie sample sites

No	Grid Ref	Habitat description
1	NN94539 61740	Boggy flush with *Carex viridula* and *Campylium stellatum*, but few other indicators
2	NN94460 61606	Flushy sward with sparse sedges and mosses, occasional *Tofieldia*, *Briza* and *Eleocharis*, but indicator species generally sparse and patchy (very little optimal habitat)
3	NN94138 61176	On E side of path, gently sloping stony flush with mosses (*Drepanocladus, Palustriella, Campylium*), *Pinguicula, Tofieldia, Schoenus ferrugineous, Eriphorum, Eleocharis, Saxifraga*, sparse sedges

Table A7.2: Results: Molluscan analysis of Ben Vrackie samples

Species Site No.	**1**	**2**	**3**
Vertigo geyeri Adult	-	3	-
Vertigo genesii Adult	-	-	4
V. genesii Juvenile	-	1	3
Carychium minimum	3	3	15
Carychium tridentatum			3
Euconulus alderi			2
Nesovitrea hammonis			6
Punctum pygmaeum		1	4
Vertigo substriata	6		7
Vitrea contracta	1		1
Galba truncatula	1	4	
Pisidium personatum		4	1
Total No. of species	4	5	9
Total No. of snails	11	16	46

Figure A7.2: Ben Vrackie photographs

	
Ben Vrackie Sample site 1	Ben Vrackie Sample site 1
	
Ben Vrackie Sample site 2	Ben Vrackie Sample site 3
	
Ben Vrackie Sample site 3	Ben Vrackie Sample site 3

APPENDIX 8: BLACK ISLE – BRAELANGWELL WOOD

The habitat at Braelangwell Wood comprises a series of small and large flush areas within open woodland slopes. In 2012, three main units were recognised with a total area of c. 2.5 ha, of which over 0.6 ha was considered to be optimal or sub-optimal. In 2017 further areas of potential *Vertigo* habitat were identified just to the north of the wall boundary of the eastern compartment and an extensive area between the eastern and central units (se Figure A8.2). This gives an additional area of approximately 1 ha, and although the potential habitat is more fragmented, at least 20% (0.2 ha), possibly more was considered to be optimal or sub-optimal.

Vertigo geyeri and *V. genesii* were found in all three of the main units, and *V. geyeri* was found in the newly recognised area between the eastern and central units (sample 5). The number of the 2 whorl snails varied considerably from site to site, from zero in site 9 to 50 in site 3 (Table A8.2), giving a maximum density of 312/m^2. As was found in 2012, the tufaceous flushes in the central unit supported higher numbers of *Vertigo genesii*. The very rare pupillid snail *Pupilla pratensis* was again recorded in the central flush unit.

The habitat is generally in excellent condition, unchanged from 2012. The western unit is grazed by cattle, and the eastern unit is grazed by horses, socking levels are very low but grazing by cattle has the potential to damage the fragile habitat. In 2012, it was noted that the clearance of a corridor to access electricity lines had caused some localized damage to the central unit. However, there does not appear to have been any subsequent work and the whorl snail habitat has recovered and is amongst the best on the site. It is very important that appropriate mitigation is taken when further works or maintenance is planned.

Population, Habitat are assessed as Favourable maintained and Future Prospects assessed as Good.

Figure A8.1: Braelangwell Wood aerial image with 2012 flush polygons outlined

Figure A8.2: Braelangwell Wood flush areas outline polygon and sample sites (red = 2012, blue = additional in 2017)

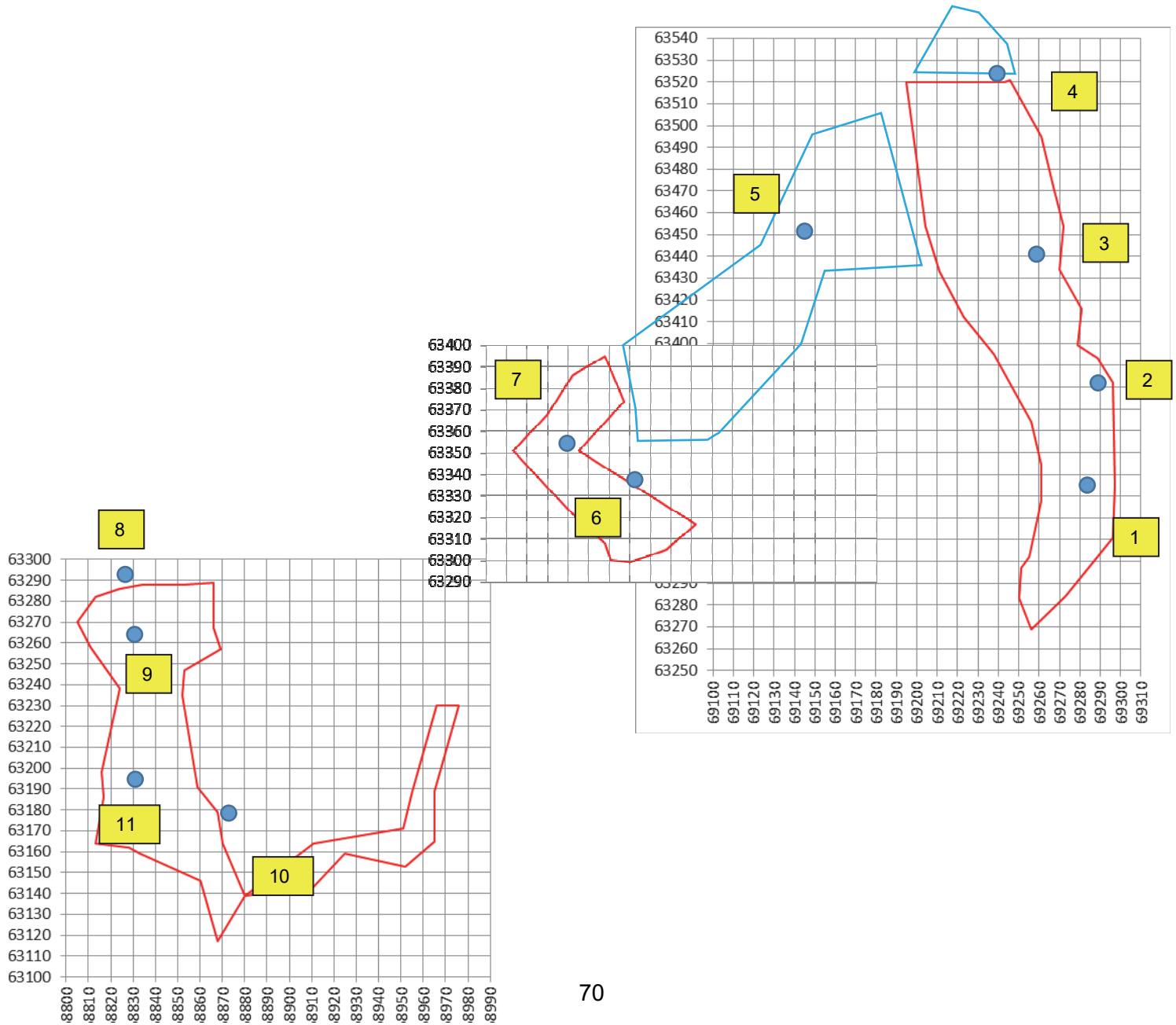


Table A8.1: Braelangwell sample sites

No	Grid Ref	Habitat description
	Eastern unit	
1	NH69285 63321	Dendritic flush sward with mosses, sedges, *Parnassia, Schoenus nigricans*, pockets of standing water
2	NH69290 63370	Steep flush slope with *Schoenus nigricans*, other plants as above but also the moss *Campylium stellatum* [close to 2012 site 2]
3	NH69260 63434	Saturated, moss-dominated flush with *Palustriella, Drepanocladus and Calliergonella,* and *Pinguicula, Eriophorum, Equisetum, Carex viridula*, *Parnassia,* orchids [2012 site 1]
4	NH69246 63521	Spring runnel, plants much the same as site 3 [2012 site 5]
5	NH69147 63443	New site between eastern and central units. Spring runnel, plants much the same as site 3
	Central unit	
6	NH69063 63323	Tufa depositing flush with *Schoenus, Carex viridula, Pinguicula, Parnassia, Palustriella, Drepanocladus, Campylium* [2012 site 11]
7	NH69028 63341	Tufaceous seepage sward with all of above plus *Carex dioica, Eleocharis quinquefolia, Parnassia, Selaginella* (No *Schoenus*) [2012 site 12]
	Western unit	
8	NH68824 63274	Flushy fen meadow and seepage sward with *Carex viridula, Equisetum, Parnassia, Campylium*
9	NH68830 63243	As above, also with some *Schoenus* [near 2012 site 8]
10	NH68874 63178	Calcareous runnel with tufa, flora with abundant *Eriophorum, Parnassia* and *Equisetum,* and most other indicator species as above [2012 site 9]
11	NH68831 63171	Flushy runnel, very mossy with sedges, *Schoenus* [2012 site 7]

Table A8.2: Results: Molluscan analysis of Braelangwell Wood samples

Species Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Vertigo geyeri Adult	11	2	7	6	4	2	11	-	-	1	4
Vertigo genesii Adult	-	-	1	-	-	9	17	-	-	1	-
V. geyeri/genesii Juvenile	37	8	42	14	13	11	13	6	-	3	6
Acanthinula aculeata		1									
Aegopinella pura											1
Carychium minimum	5	12	7	9	57	24	11	9	12	6	7
Carychium tridentatum										1	
Cepaea nemoralis	2	2			2		1	2		1	
Cochlicopa lubrica	2	4	1	2	2	1		4			1
Columella aspera	1	2				1		1			3
Discus rotundatus						1					
Euconulus alderi	5	8	17	22	19	25	17	20	5	9	9
Leiostyla anglica						1					
Nesovitrea hammonis	1	12	2	3	9	14	3	3	3	14	6
Oxyloma elegans	3	2	3		22	13	11				4
Punctum pygmaeum	7	10	8	14	3	9	8	7	4	8	11
Pupilla pratensis						5	8				
Spermodea lamellata		1									
Vertigo antivertigo					1						
Vertigo substriata	2	10		11	4	3		5	11		3
Vitrea contracta		2	1				5			1	
Galba truncatula	3	3	2	2	2	5	18				
Radix peregra			2								
Pisidium personatum						5	6				
Pisidium casertanum						1	3				
Total No. of species	11	14	10	8	11	16	13	9	5	9	10
Total No. of snails	79	79	92	83	138	130	152	37	35	45	55

Figure A8.3: Braelangwell Wood photographs

Southern end of eastern unit

Site 1 habitat

Site 2 habitat

Site 3 habitat

Northern end of eastern unit

Site 4 habitat

Site 5 habitat

Site 5 habitat

Site 5 *Vertigo geyeri*

Between sites 5 and 11

Central open area under powerlines

Site 11 habitat

Site 11 tufa deposition

Site 12 habitat

Site 21 habitat

Site 22 habitat

	
Site 23 habitat	Site 24 habitat
	
Site 24 *Drepanocladus* moss habitat	

APPENDIX 9: BLACK ISLE – BELMADUTHY DAM

All the potential *Vertigo* habitat at the site lies within one area at the northern part of the site on a slope below a spring line. The 2012 survey showed that the flushes were contained within a relatively large area of 4 ha, but they were fragmented and more restricted to runnels and small areas of flush sward amongst heathy habitat. A maximum of 20% (0.8 ha) was considered optimal and sub-optimal. *Vertigo geyeri* was widespread at the site and was locally frequent, with densities ranging from 6 to 131 individuals per m^2. Both Population and Habitat were assessed as Favourable.

Results from the 2017 survey showed that the extent of habitat, distribution and extent of optimal and sub-optimal habitat is little changed. There was some evidence from the results from the Transect (see Figure A9.4) that the site was slightly drier than in 2012, and there were some variations in condition of the habitat, e.g. some zones had changed from optimal in 2012 to sub-optimal with optimal patches in 2017. However, at present, there is insufficient evidence of a decline in habitat quality and, therefore, the overall assessment for Habitat Condition is Favourable Maintained.

Vertigo geyeri was present in each of the 4 samples taken with densities ranging from 75 to >700 individuals per m^2. This density is much higher than in 2012 but is probably an artefact of sampling time – *Vertigo* tend to be commoner in late summer/early autumn after their main breeding event (in 2012 Belmaduthy was sampled in late spring). The very rare pupillid snail *Pupilla pratensis* was again recorded. The assessment for Population is Favourable Maintained.

The apparent dryness of the site in September (especially given the wet summer) is of possible concern. The only obvious change at the site since 2012 is forestry growth. Figure A9.1 shows an aerial image provided by SNH in 2012, and Figure A9.2 shows the 2017 image from Google Maps. The North area was felled in 2003 and replanted in 2008. The Western area was felled in 2007/8 and replanted 2013 and the East area was felled in 2008 and replanted 2013. Areas of open space/broadleaves have been left adjacent to the site (Colin Leslie Pers. comm.). Possible impacts of drainage during felling, or increased water demand following replanting and growth cannot be retrospectively demonstrated, but the installation and monitoring of dipwells (phreatic tubes) within the site would be extremely useful in determining any future change.

The site is grazed by low numbers of cattle, and although cattle can be damaging to fragile spring habitats, the present regime does not appear to be adversely impacting the site.

Future Prospects are assessed as Good.

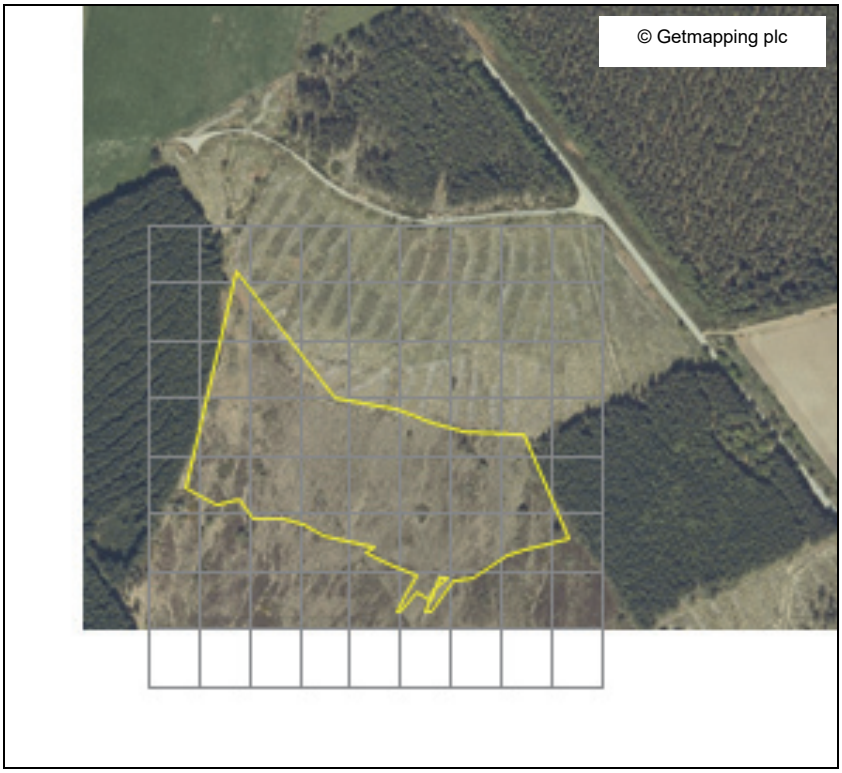


Figure A9.1: Belmaduthy Dam principal flush area (2012 aerial imagery)

Figure A9.2: Belmaduthy Dam principal flush area (2017 aerial imagery)

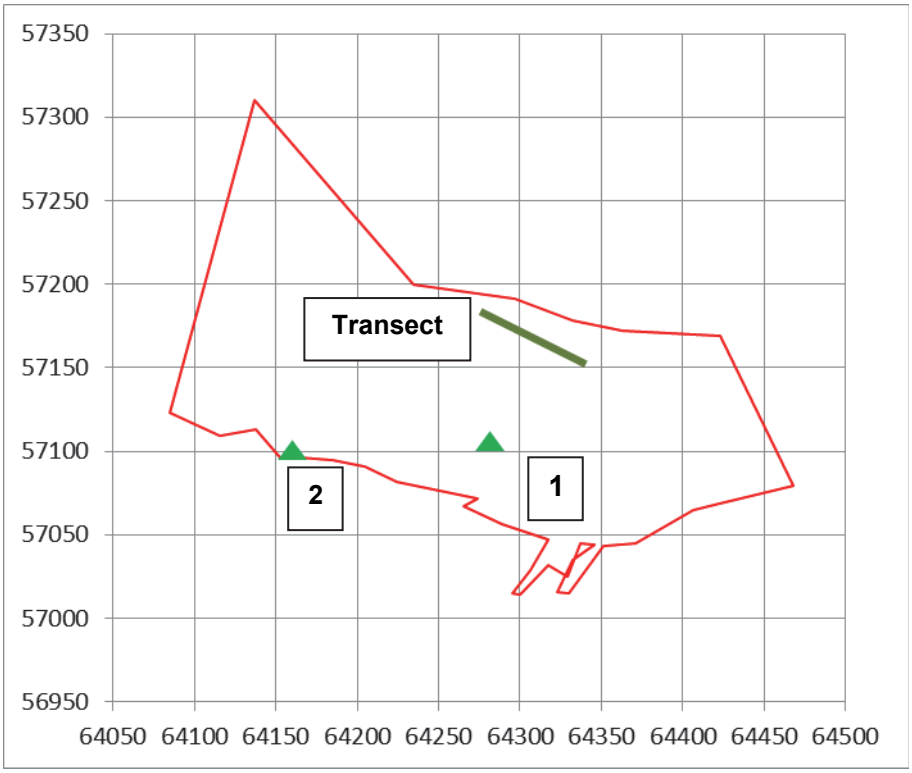


Figure A9.3: Belmaduthy Dam principal flush area outline polygon and sample sites

Table A9.1: Black Isle, Belmaduthy Dam sample sites

No	Grid Ref	Habitat description
1	NH64284 57118	Seepage sward with *Schoenus nigricans*, flushy depressions with sedges and mosses, mostly *Campylium* and some *Drepanocladus (*close to 2012 sample site 4)
2	NH64166 57100	In SW margins of potential habitat, optimal flush with *Schoenus, Drepanocladus, Campylium, Carex viridula, Pinguicula, Parnassia, Equisetum* (close to 2012 sample site 6)

Table A9.2: Results: Molluscan analysis of Belmaduthy Dam samples

	Transect		**Other sites**	
	15m	55m	1	2
Vertigo geyeri Adult	6	63	48	7
V. geyeri Juvenile	6	15	56	7
Carychium minimum	3	7	10	15
Carychium tridentatum	3		4	
Cochlicopa lubrica	2	3	8	2
Columella aspera	3	2		
Euconulus alderi		3	3	2
Leiostyla anglica	28			
Nesovitrea hammonis	2	2	7	2
Oxyloma elegans				1
Punctum pygmaeum	8	7		3
Pupilla pratensis	2		10	
Vertigo antivertigo	3	2	2	
Vertigo substriata	13	5	3	2
Vitrea contracta	6	1	5	
Galba truncatula		2	2	2
Pisidium personatum			5	1
Total No. of species	12	11	12	10
Total No. of snails	85	112	163	44

Start Point:	Post near 2 birch trees at NH64312 57173
End point:	Post at NH64365 57138
Transect Length:	62.8m
Description:	The transect runs between 2 posts across an undulating slope with flush runnels and drier mounds
Direction:	North-west to south-east
Sampling frequency:	Starting at the 0 metre end, the habitat (at the plant community level) along the tape was described and the linear distance of that habitat type measured. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transect. Two samples were taken from zones with optimal and sub-optimal habitat and analysed in the laboratory for their snail composition

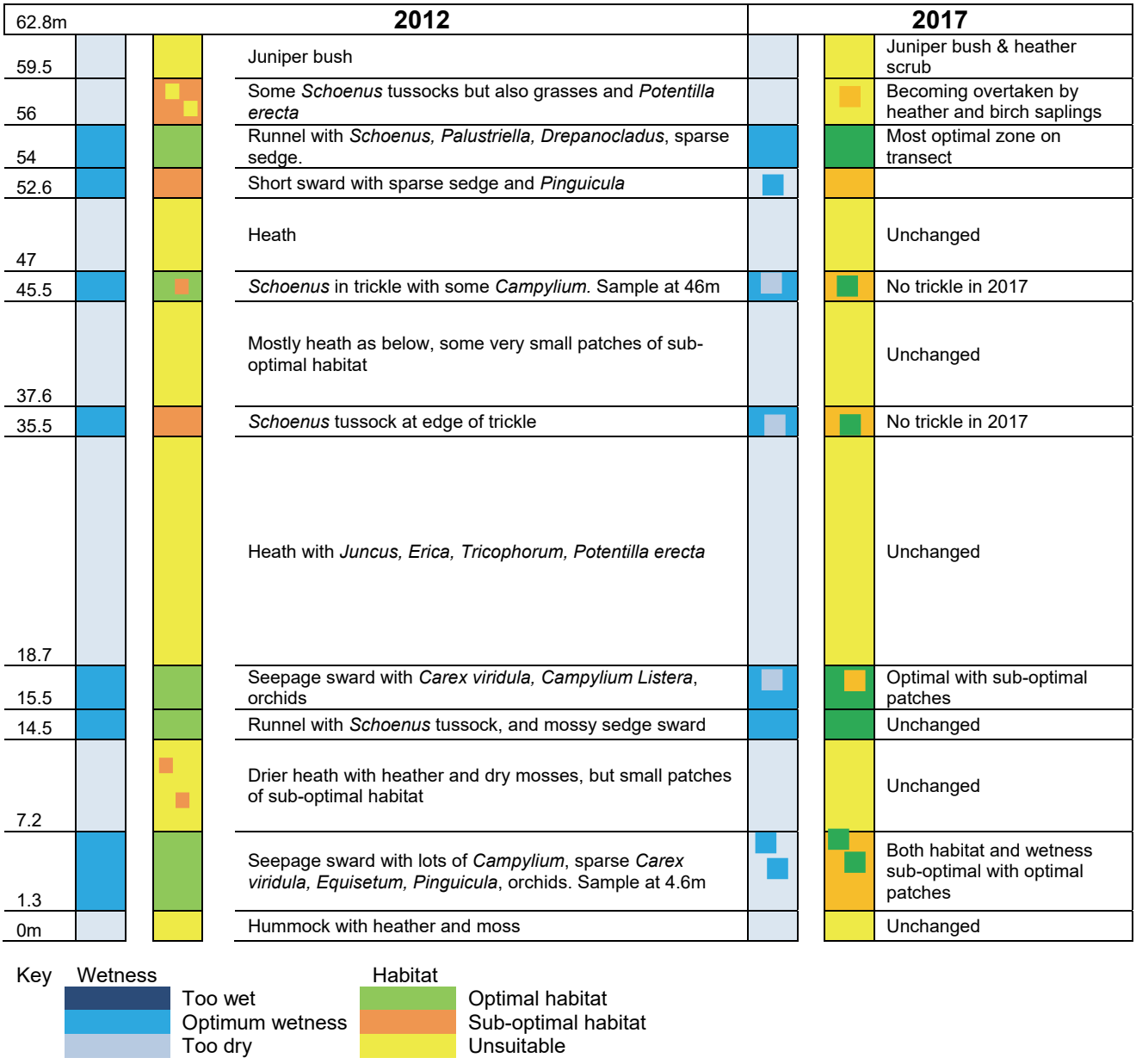
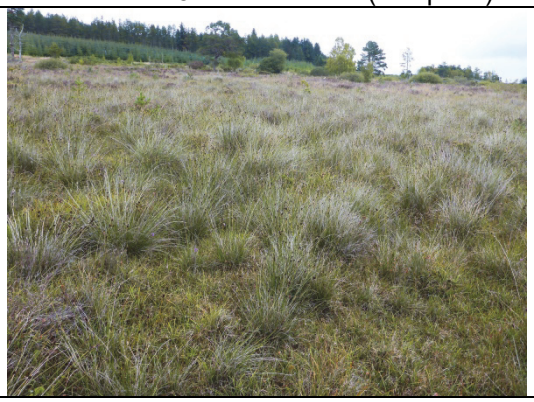
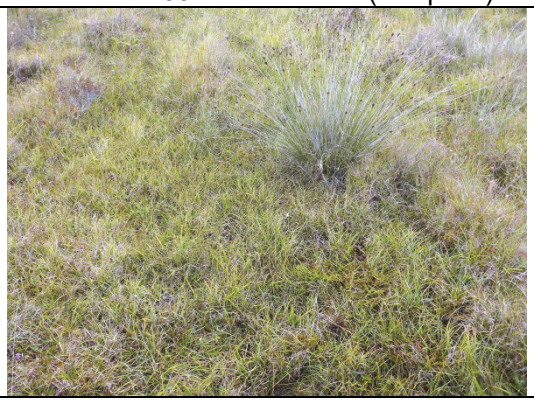
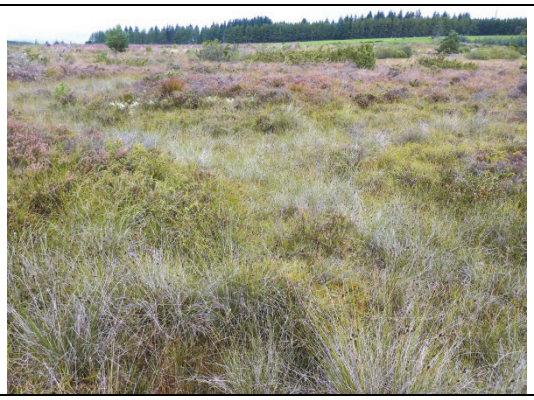


Figure A9.4: Belmaduthy Dam transect

Figure A9.5: Photographs Belmaduthy Dam

	
Belmaduthy site from the north-east	Transect from end point to start
	
Habitat at 15 m on transect (sample 1)	Habitat at 55 m on transect (sample 2)
	
Site 4 habitat	Site 4 habitat
	
Site 6 habitat	Site 6 habitat

APPENDIX 10: DEESIDE

All three of the sites (two at Morrone Birkwood and one at Glen Lui) in which *Vertigo geyeri* was recorded in 1999 were resurveyed in 2012, but the species was not found at all in the five samples all taken from the most optimal habitat in 2012. Although the habitat was in good condition, especially at Morrone, both sites were assessed as Unfavourable on the basis of the species' absence.

Vertigo geyeri was not found at either site in 2017, and, therefore, the assessment for Population is Unfavourable Unchanged. Given that the snail has not been recorded at either site for almost 20 years, the survival at these sites is doubtful. If it is not found again in the next monitoring round (?2023) then Population should be assessed as Destroyed.

At Morrone Birkwood there is still sufficient habitat in good condition to apparently support the species, and the sampling should have yielded the snail, especially as other typically associated species were found in moderate numbers. At Glen Lui there was some optimal/sub-optimal habitat in good condition in the southern part of the site (sample 4) but much of the upper slope (sample 5) was very dry and supported only fragments of sub-optimal habitat. Therefore habitat for the species was assessed as Favourable Maintained at Morrone and Unfavourable Declining at Glen Lui.

Reasons for the deterioration of these sites are not clear but are most likely to be associated with hydrology. Glen Lui appears to be prone to flooding and drying, and *as V. geyeri* requires hydrological stability, periods of summer drying may have led to the site becoming no longer suitable. At Morrone the flushes are wetter but there is a small reservoir nearby and water is piped to a local house. Abstraction of the springs, combined with periods of drought at key times of year may account for the loss of *V. geyeri* from a habitat that still appears to be suitable.

Future Prospects are assessed as Poor on the basis of absence of the snail, and unlikely to return without translocation, impacts of unstable hydrology, and poor resilience to climate change.

Figure A10.11: Glen Lui (tile NO0492) aerial showing flush area polygons & sample sites

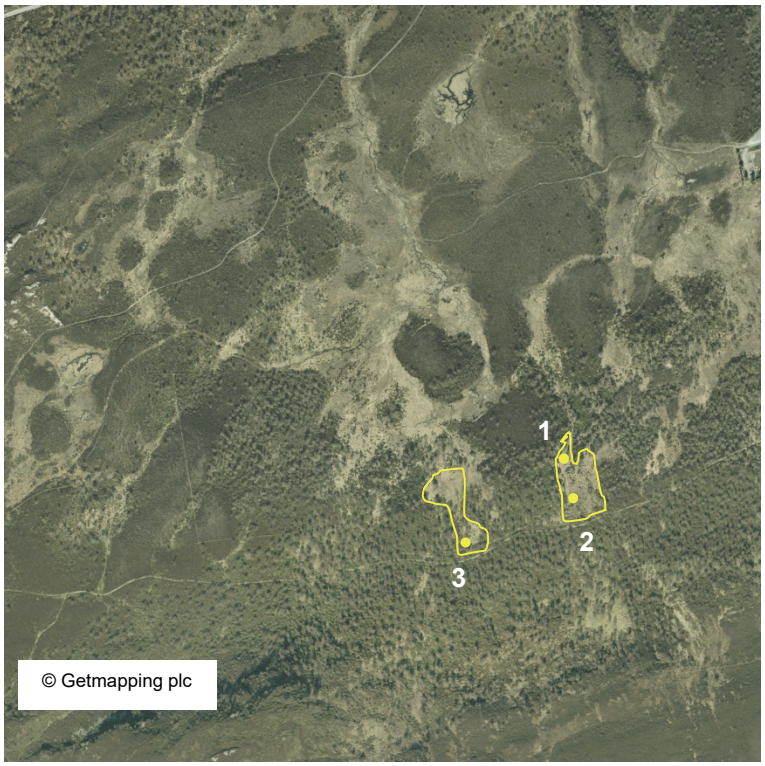


Figure A10.2: Morrone Birkwood (tile NO1390) aerial showing flush area polygons & sample sites

Table A10.1: Deeside sample sites

No	Grid Ref	Habitat description
1	NO13739 90388	Morrone Birkwood 1999 Flush 2. Bottom of main flush slope, sward with mostly *Juncus articulatus, Carex viridula* and *Drepanocladus*
2	NO13750 90348	Morrone Birkwood 1999 Flush 2. Near top of flush slope, sward with species as for site 3, plus *Palustriella* moss and *Saxifraga azoides*
3	NO13616 30295	Morrone Birkwood 1999 Flush 3. Runnels with mostly *Palustriella, Saxifraga and Drepanocladus*, much less *Carex* and *Juncus* than sites 3 and 4
4	NO04949 92654	Glen Lui 1999 site 3. Wetter, stony flush with more frequent and denser mounds of moss and *Saxifraga*, plus *Pinguicula*
5	NO04930 72705	Glen Lui 1999 site 2. Rather dry, stony flush with mounds of *Drepanocladus* and *Saxifraga* in the wettest places

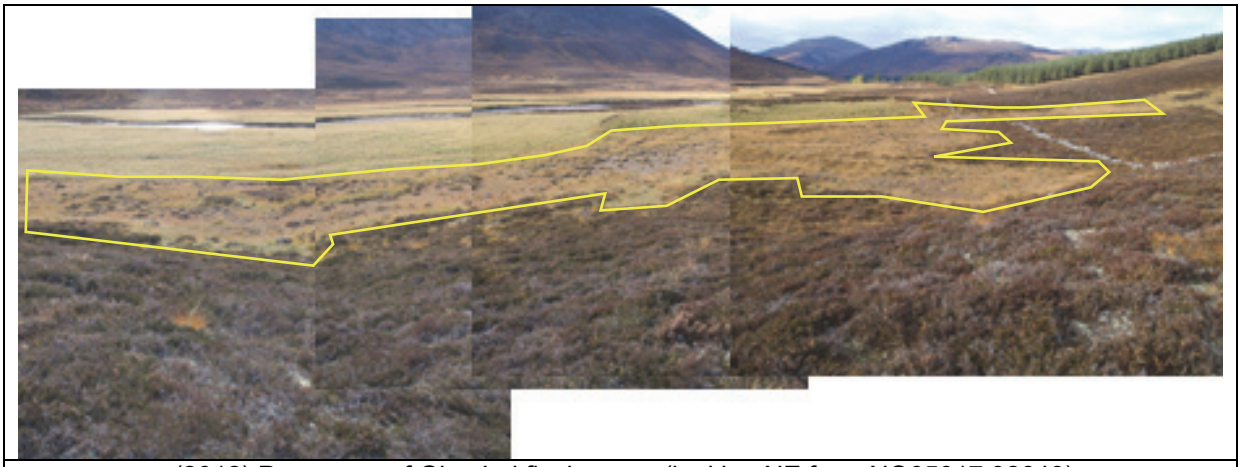
Table A10.2: Results: Molluscan analysis of Deeside samples

Site	**1**	**2**	**3**	**4**	**5**
Species	Morrone 1	Morrone 2	Morrone 3	Glen Lui 1	Glen Lui 2
Vertigo geyeri Adult	-	-	-	-	-
V. geyeri Juvenile	-	-	-	-	-
Carychium minimum	5	15	11	8	2
Carychium tridentatum		1			
Cochlicopa lubrica	3	5	2	2	4
Columella aspera				2	
Euconulus alderi	3	3	3	21	5
Nesovitrea hammonis	6	3	2	2	1
Punctum pygmaeum	5	6	3	3	
Vertigo substriata	8	6	3	11	4
Vitrea contracta	1	1	1	3	2
Vitrian pellucida				2	
Galba truncatula	12	6	5	6	1
Pisidium personatum	1	1	2	4	
Total No. of species	9	10	9	11	7
Total No. of snails	44	37	32	64	19

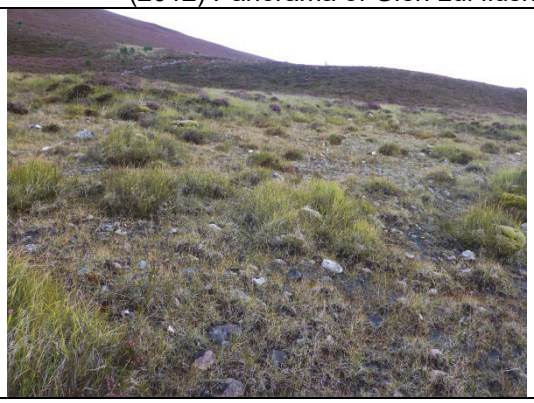
Figure A10.3: Morrone Birkwood photographs

	
Morrone Birkwood Flush 2	Flush 2 view from springhead
	
Flush 2 top of slope habitat	Flush 2 bottom of slope
	
Morrone Birkwood Flush 3	Morrone Birkwood Flush 3

Figure A10.4: Glen Lui photographs



(2012) Panorama of Glen Lui flush areas (looking NE from NO05017 92648)



Glen Lui site 4

Glen Lui site 4 habitat

Glen Lui site 5

Glen Lui site 5 habitat

APPENDIX 11: ISLAY SITES

A11.1 Margadale River

All *Vertigo geyeri* habitat lies within one compact compartment (upper width about 12m and extending in a narrowing wedge down slope for about 18 m). The flush is sharply distinguished from surrounding *Erica tetralix* / *Calluna vulgaris* heathland by appearance of scattered *Schoenus* tussocks. The flush is bisected by a series of small stony channels, in places containing tufa-encrusted pebbles / cobbles. The total flush area is approximately 0.009 ha of which 0.0036 ha (40%) is judged to be optimal habitat. *Vertigo geyeri* is moderately frequent at the site with an estimated mean frequency of 66 m^{-2}. As also noted during the 2012 survey, the site is closely cropped by red deer.

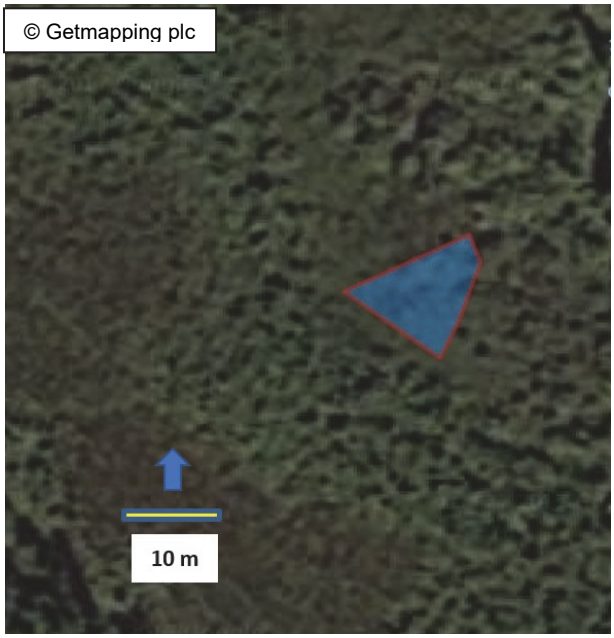


Fig A11.1.1: Flush area at Margadale River

Table A11.1.1: Margadale River sample sites

Grid Ref	Habitat description
Taken near site boundaries (Note: due to small size of site GPS margins of error of +/- about 7 – 8 m at each bearing) NR 40173 74096 NR 40181 74103 NR 40187 74098 NR 40183 74085	Altitude (m OD): 100 Aspect: east Ground moisture levels: most site 3 (2 on tops of tussocks and 4 in channels) Approximate mean vegetation height: 10 cm Vegetation: Occasional *Schoenus nigricans* with close-cropped *Carex* / moss lawn (including: *C. viridula* agg, *Carex* spp, *Briza media*, *Eliocharis spp*, other grasses, *Juncus* spp, *Hieracium* spp, *Pinguicula sp, Anagallis tenella)*

Table A11.1.2: Results: Molluscan analysis of Margadale River samples

	Samples	
	S1	**S2**
***Vertigo geyeri* Adult**	**5**	**9**
***V. geyeri* Juvenile**	**4**	**3**
***V. geyeri* (dead adult)**	**1**	**1**
Acicula fusca		✓
Carychium minimum	✓	✓
Carychium tridentatum		✓
Cochlicopa lubrica	✓	✓
Euconulus fulvus	(dead)	✓
Leiostyla anglica	✓	✓
Nesovitrea hammonis	✓	✓
Vertigo antivertigo	✓	✓
Vertigo substriata	✓	✓
Potamopyyrgus antipodarum		✓
Galba truncatula	✓	✓
Pisidium personatum	✓	✓
Total No. of live species	9	13

Figure A11.1.2: Photographs of Margadale River flush

Looking across Margadale flush towards east

Looking up Margadale flush from near base

Close-up of close-grazed flush vegetation at Margadale site

A11.2 Loch Smigeadail

All *Vertigo geyeri* habitat lies within one compact compartment extending from the top of a low bank immediately above the stony loch shore (upper width about 15 m and extending in an approximately rectangular area up a slope for about 20m). The flush which is marked by scattered *Schoenus* tussocks, grades in small tongues into surrounding *Erica tetralix* / *Calluna vulgaris* heathland by appearance of scattered *Schoenus* tussocks. The flush is bisected by series small stony channels, in places containing tufa-encrusted pebbles / cobbles. The total flush area is approximately 0.058ha of which 0.023ha (40%) is judged to be optimal habitat. *Vertigo geyeri* is moderately frequent at the site with an estimated mean frequency of 66 m^{-2}. As also noted during the 2012 survey, the site is lightly cropped by red deer. A second flush complex (site 1b) lies about 35 m to the west of the survey site lying between NR38520 7566 – NR38507 75649). This was also sampled although there was less *Carex*/moss lawn and wider stony channels. The general ground conditions were drier (ground moisture levels mostly 2) and the two bulk samples from this additional flush produced no *V. geyeri* and fewer molluscan species than the monitoring site.

Figure A11.2.1: Flush area at Loch Smigeadail

Table A11.2.1: Loch Smigeadail sample sites

Grid Ref	Habitat description (Site 1)
Taken near site boundaries (Note: due to small size of site GPS margins of error of +/- about 7 – 8 m at each bearing) NR 38568 75616 NR 38536 75622 NR 38550 75637 NR 38562 75632	Altitude (m OD): 185 Aspect: south Ground moisture levels: most site 3 (2 on tops of tussocks and 4 in channels) Approximate mean vegetation height: 15 cm but < 10 on *Carex*/moss 'lawn' Vegetation: Very similar to Margadale River (*Carex virudula, Carex* spp / moss lawn with occasional *Schoenus nigricans* tussocks

Table A11.2.2: Results: Molluscan analysis of Loch Smigeadail samples

	Site 1		Additional Site 1A	
	S1	**S2**	**S1**	**S2**
***Vertigo geyeri* Adult**	**10**	**2**		
***V. geyeri* Juvenile**	**5**	**4**		
***V. geyeri* (dead adult)**	**12**	**9**		
Acicula fusca	✓	✓		
Carychium minimum	✓	✓		
Carychium tridentatum	✓	✓		
Cochlicopa lubrica	✓	✓		
Columella aspera	✓		✓	✓
Leiostyla anglica	✓	✓	✓	✓
Punctum pygmaeum	✓			
Vertigo substriata	✓	✓	✓	✓
Galba truncatula	✓	✓	✓	
Pisidium personatum	✓	✓		
Total No. of species	11	9	4	3

Figure A11.2.2: Photographs of Loch Smigeadail flushes

View of Loch Smigeadail flush in central area of main flow

View of Loch Smigeadail flush margins

A11.3 Loch Finlaggan

The Loch Finlaggan *Vertigo geyeri* flushes (sites 1 – 4) extend for about 1.05 km lying along a spring line running in a south-westerly line from the site complex 1. All of the sites lie within cattle-grazed fields and are surrounded by relatively dry cattle pasture. Site 1 was surveyed in 2012, but two additional new flushes lying about 300m to the east were located in 2017 (sites 1A & 1b). All flushes are marked by the presence of *Schoenus* tussocks, but these do not always extend across the entire potentially suitable habitat. Sites 1 and 2 are affected by moderately heavy cattle grazing which has led to relatively severe poaching of flush habitat. A recently re-cleared field drain lies below sites 1, 1b, 2 and 3 which may lower ground water levels at these sites (see Figure A11.3.7).

Finlaggan Site 1 complex & Site 2:

Site 1: As in 2012 this area is significantly affected by cattle poaching, which is reducing the amount of suitable habitat (up to 50% bare ground in places). The total flush area is approximately 0.027 ha of which 0.003 ha (10%) is judged to be optimal habitat. *Vertigo geyeri* is (as in 2012) scarce at the site with an estimated mean frequency of $7m^{-2}$.

Site 1A: A newly discovered flush in 2017. As with Site 1 this area is significantly affected by cattle poaching which is reducing the amount of suitable habitat (up to 50% bare ground in places). The total flush area is approximately 0.015 ha of which 0.003 ha (20%) is judged to be optimal habitat. *Vertigo geyeri* is (as in 2012) scarce at the site with an estimated mean frequency of $13m^{-2}$.

Site 1B: A newly discovered flush in 2017. As with Site 1 & 1A this area is significantly affected by cattle poaching which is reducing the amount of suitable habitat (up to 40 - 50% bare ground in places). The total flush area is approximately 0.104 ha of which 0.042 ha (40%) is judged to be optimal habitat. *Vertigo geyeri* is scarce at the site with an estimated mean frequency of $13m^{-2}$.

Site 2: As in 2012 very similar to neighbouring Site 1. The total flush area is approximately 0.063 ha of which 0.006 ha (10%) is judged to be optimal habitat. *Vertigo geyeri* occasional at the site with an estimated mean frequency of 26 m^{-2}.

Figure A11.3.1: Flush area at Finlaggan Site 1

Figure A11.3.2: Flush area at Finlaggan Site 1B

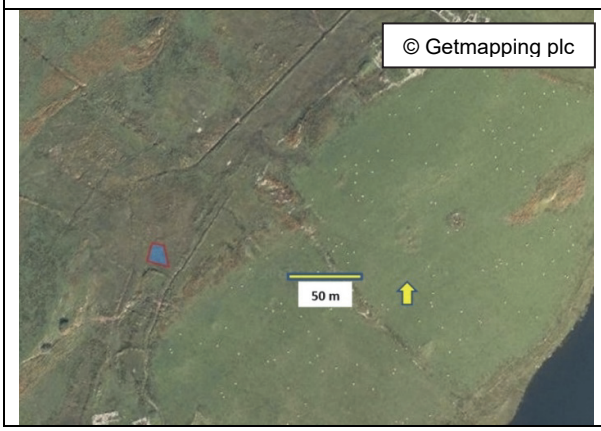
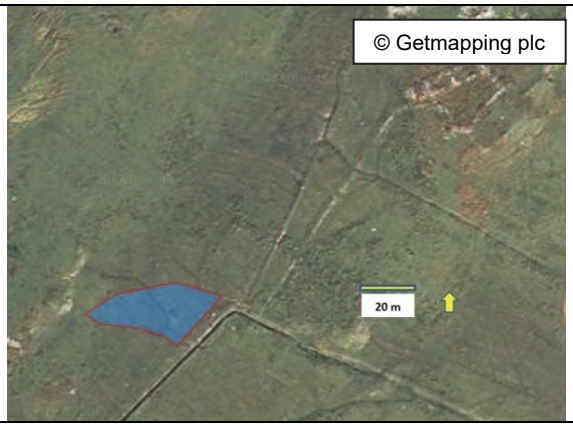
Figure A11.3.3: Flush area at Finlaggan Site 1A	*Figure A11.3.4: Flush area at Finlaggan Site 2*
	

Table A11.3.1: Loch Finlaggan sample sites 1 and 2

Grid Ref	**Habitat description Site 1**
Taken near site boundaries (Note: due to small size of site GPS margins of error of +/- about 7 – 8 m at each bearing) NR 37948 67467 NR 37957 67447 NR 37975 67446	Altitude (mOD): 85 Aspect: south-east Ground moisture levels: most site 2 with only occasional 3 near channels Approximate mean vegetation height: 10 cm Vegetation: Occasional *Schoenus nigricans* tussocks and small *Carex viridula* agg / moss lawn
Grid Ref	**Habitat description Site 1A**
Taken near site boundaries (Note: due to small size of site a single central GPS) NR 38046 67592	Altitude (mOD): 85 Aspect: south-east Ground moisture levels: most site 2 (2 on tops of tussocks and 4 in channels) Approximate mean vegetation height: 10 cm Vegetation: as site 1
Grid Ref	**Habitat description Site 1B**
Taken near site boundaries (Note: due to small size of site GPS margins of error of +/- about 7 – 8 m at each bearing) NR 38145 67712 NR 38195 67721 NR 38172 67707 NR 38125 67673	Altitude (mOD): approx. 85m Aspect: south-east Ground moisture levels: level 2 with occasional 3 in *Carex* / moss lawn areas. Approximate mean vegetation height: 10 - 20 cm Vegetation: patches of *Carex viridula* agg., *Carex* spp and diverse fen flora (*Pinguicula sp, Ranunculus flammula, Lychnis flos-cuculi, Dactylorhiza purpurella, Cirsium palustre, Anagallis tenella* (in many ways similar flora to Loch Ard Achdadh although additionally with occasional *Schoenus nigricans* tussocks).
Grid Ref	**Habitat description Site 2**
Taken near site boundaries NR 37872 67383 NR 37899 67391 NR 37919 67380 NR 37901 67365	Altitude (mOD): approx. 85m Aspect: south-east Ground moisture levels: level 2 with occasional 3 in *Carex* / moss lawn areas. Approximate mean vegetation height: 10 - 20 cm Vegetation: As site 1

Table A11.3.2: Results: Molluscan analysis of Loch Finlaggan sample for sites 1 and 2

	Site 1 complex (sites)			**Site 2**
	1	1A (new)	1B (new)	
***Vertigo geyeri* Adult**		**2**		**3**
***V. geyeri* Juvenile**	**1**		**2**	**1**
***V. geyeri* (dead adult)**		**1**		**1**
Carychium minimum		✓	✓	✓
Cochlicopa lubrica			✓	✓
Columella edentula				✓
Euconulus fulvus				✓
Leiostyla anglica			✓	
Nesovitrea hammonis			✓	✓
Oxyloma elegans	✓			✓
Punctum pygmaeum			✓	
Vertigo pygmaea			✓	
Vertigo antivertigo		✓	✓	✓
Vertigo substriata	✓	✓	✓	✓
Potamopyyrgus antipodarum				✓
Galba truncatula			✓	
Pisidium personatum	✓	✓	✓	✓
Total No. of species	4	5	11	11

Sites 3 and 4:

Site 3: The site seems to have changed little since 2012. Unlike sites 1 complex and 2 there is only very light cattle grazing. The flush is fed from springs on moderately sloping ground that drain south-eastwards in a saturated bog (ground moisture levels 4 – 5). The total flush area is approximately 0.218 ha of which 0.04 ha (20%) is judged to be optimal habitat. *Vertigo geyeri* occasional at the site with an estimated mean frequency of 31 m^{-2}. The area was lightly cattle grazed with no poach-damage evident. A newly re-channelled drainage ditch lies at the lower margins of this flush area and might cause lowering of ground water levels in lower sectors of the flush.

Site 4: A low ridge runs diagonally across the site in a south-easterly direction which slightly splits the site into two, immediately adjacent units. The northern sector has flush draining from steeper ground where the majority of the *Schoenus nigricans* tussocks are situated. The southern compartment has noticeably less *S. nigricans;* both areas had 'good' areas of *Carex viridula*, low *Carex* spp moss 'lawn'. *V. geyeri* were more numerous in the northern unit that in the southern, but at the time of survey the habitat seemed equally suitable in both areas and so any reason for the differences are unclear. The total flush area is approximately 0.156 ha of which 0.094 ha (60%) is judged to be optimal habitat. *Vertigo geyeri* ranged between occasional and frequent at the site with an estimated mean frequency of 91 m^{-2}. (163 m^{-2} in northern sector; 19 m^{-2} in southern sector). The area was lightly cattle grazed with no poach-damage evident.

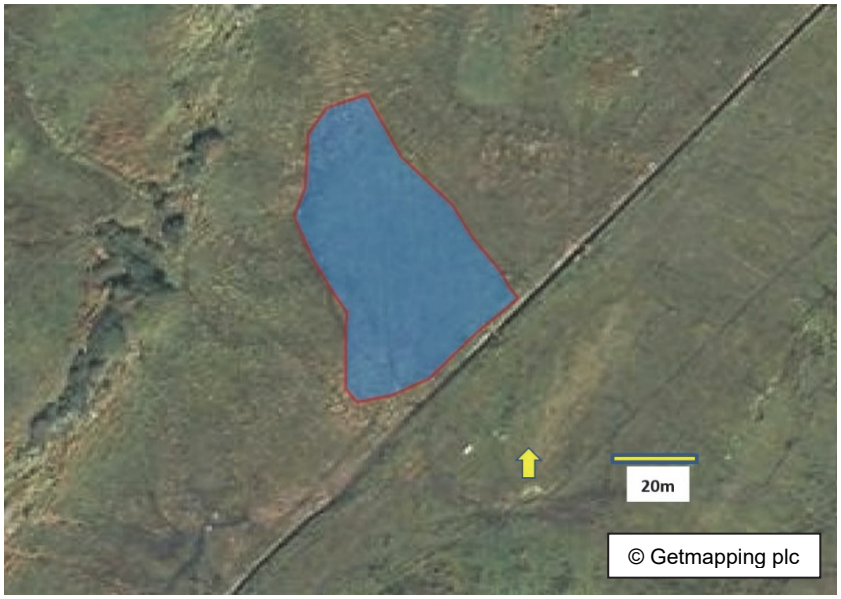


Figure A11.3.5: Flush area at Finlaggan Site 3

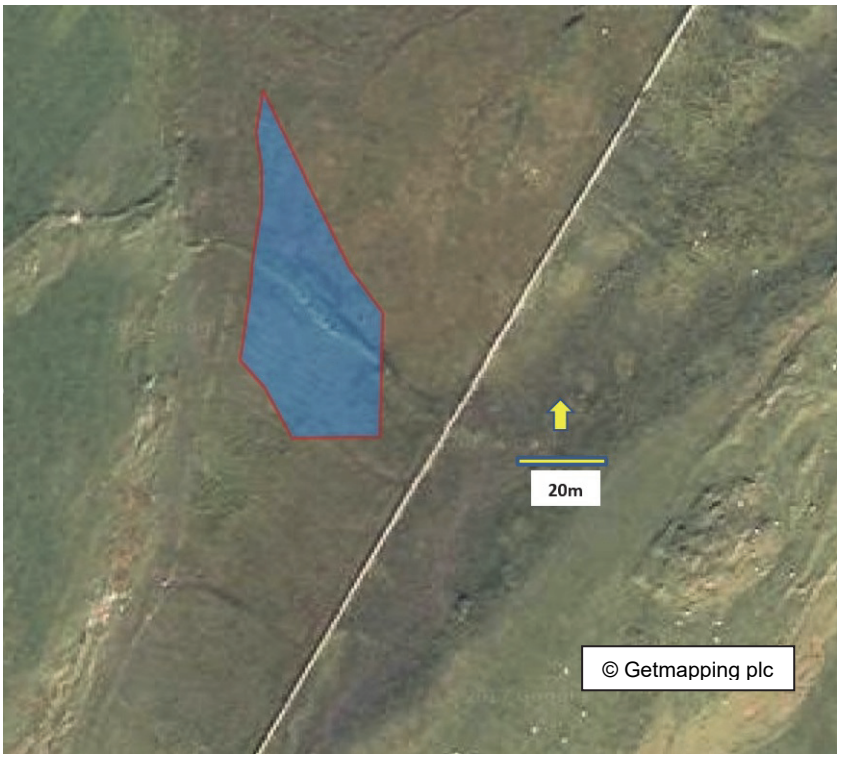


Figure A11.3.6: Flush area at Finlaggan Site 4

Table A11.3.3: Loch Finlaggan sites 3 and 4 sample sites

Grid Ref	**Habitat description Site 3**
Taken near site boundaries NR 37795 67343 NR 37806 67273 NR 37819 67280 NR 37799 67344	Altitude (mOD): 85 Aspect: south east Ground moisture levels: most site 3 (4 in channels) Approximate mean vegetation height: 20 - 30 cm Vegetation: Occasional clumps of *Schoenus nigricans* tussocks and *Carex viridula* agg small *Carex* /moss lawn. Also various grasses and *Juncus* spp.
Grid Ref	**Habitat description Site 4**
Taken near site boundaries NR 37504 66928 NR 37500 66989 NR 37514 66957 NR 37516 66932	Altitude (mOD): 85 Aspect: south east Ground moisture levels: most site 3 (2 on tops of tussocks) Approximate mean vegetation height: 10 cm Vegetation: Clumps of *Schoenus nigricans* mostly to east of central ridge *Carex viridula* agg small *Carex* / moss lawn. Also various grasses and *Juncus* spp.

Table A11.3.3: Results: Molluscan analysis of Loch Finlaggan sites 3 and 4 samples

	Site 3		**Site 4**	
	S1	S2	S1	S2
***Vertigo geyeri* Adult**	**7**	**1**	**20**	**3**
***V. geyeri* Juvenile**	**2**		**6**	
***V. geyeri* (dead adult)**			**1**	
Carychium minimum	✓	✓	✓	
Carychium tridentatum	✓			
Cochlicopa lubrica	✓	✓		
Euconulus fulvus	✓	✓	✓	✓
Nesovitrea hammonis	✓		✓	
Oxyloma elegans	✓		✓	✓
Punctum pygmaeum				✓
Vertigo pygmaea	✓		10	20
Vertigo antivertigo	✓	✓	25	23
Vertigo substriata	✓	✓	5	3
Potamopyyrgus antipodarum		✓	✓	
Galba truncatula		✓	✓	✓
Pisidium personatum		✓		
Total No. of species	10	9	10	8

Figure A11.3.7: Photographs of Loch Finlaggan flushes

	
Finlaggan 1 showing tightly grazed and poached flush habitat	Finlaggan 1 newly cleared field drain running across the site
	
Finlaggan 1B	Finlaggan 1B showing cattle poached flush habitat
	
Finlaggan 1A	Newly cleared field drain near Finlaggan sites 1A & 1B

	
Finlaggan 2	Finlaggan 2 showing cattle poached flush habitat
	
Finlaggan 3	Finlaggan 3
	
Newly cleared field drain near Finlaggan site 3	Finlaggan site 4

A11.4 Balachlaven

The two Balachlaven flushes drain down initially step slopes from a high spring-line both in a south-easterly direction. The north-eastern flush (NE flush) was newly surveyed in 2017 whereas the south-western (SW flush) one was surveyed in 2012. A ridge of land separates the two flushes. At both flushes a series of narrow (mostly <1m width) stony channels (lined with tufa-covered rocks) drain down slopes dominated by *Schoenus nigricans* tussocks. At the NE flush a there is a total flush area of approximately 0.089 ha of which 0.009 ha (10%) is judged to be optimal habitat; *Vertigo geyeri* were scarce at the site with an estimated mean frequency of 13 m^{-2}. At the SE flush a there is a total flush area of approximately 0.108 ha of which 0.011 ha (10%) is judged to be optimal habitat; *Vertigo geyeri* were also scarce at the site with an estimated mean frequency of 13 m^{-2}. The two flush areas had not been recently grazed, but it is believed that the sites experience occasional light cattle grazing; no poach-damage was evident. Considering the seeming suitability of these flushes (lightly grazed and with numerous base-rich seepages molluscs were surprisingly scarce. Whether this may be associated with the now abandoned mine working present on this side of the glen is not known. The far side of the valley was extensively searched for the tiny flush where *V. geyeri* was recorded in 1996 but again, as in 2012 this flush could not be re-located. This northerly facing side of the narrow glen was very heavily cattle-poached and this may be one reason for the loss of this site (Figure A11.4.3).

Figure A11.4.1: Flush area at Balachlaven 1 (NE flush)

Figure A11.4.2: Flush area at Balachlaven 1 (SW flush)

Table A11.4.1: Balachlaven sample sites

Grid Ref	**Habitat description Balachlaven NE flush**
Taken approximate flush borders: NR 37348 68187 NR 37351 68202 NR 37385 68198 NR 37385 68135	Altitude (mOD): 120 - 140 Aspect: south east Ground moisture levels: most site 3 (4 in channels) Approximate mean vegetation height: 15 - 20 cm Vegetation: Site dominated by rank *Schoenus nigricans* tussocks with areas of shorter *Carex viridula* agg / *Carex* spp / short moss 'lawn' between especially lying close to drainage channels
Grid Ref	**Habitat description Balachlaven SW flush**
Taken near upper and lower flush boundaries: NR 37286 68087 NR 37291 67983	*Overall very similar to NE flush.* Altitude (mOD): 120 - 140 Aspect: south east Ground moisture levels: most site 3 (4 in channels) Approximate mean vegetation height: 15 - 20 cm Vegetation: Site dominated by rank *Schoenus nigricans* tussocks with areas of shorter *Carex viridula* / *Carex* spp / short moss 'lawn' between especially lying close to drainage channels

Table A11.4.2: Results: Molluscan analysis of Balachlaven samples

	Flush 1 (NE)		**Flush 2 (SW)**	
	S1	S2	S1	S2
***Vertigo geyeri* Adult**		**4**	**1**	**1**
***V. geyeri* Juvenile**				**2**
***V. geyeri* (dead adult)**	**1**	**1**		
Carychium minimum	✓	✓	✓	✓
Cochlicopa lubrica			✓	✓
Columella aspera		✓	✓	
Euconulus fulvus			✓	
Leiostyla anglica		✓	✓	
Nesovitrea hammonis		✓	✓	
Oxychilus alliarius		✓	✓	
Oxyloma elegans	✓		✓	✓
Vertigo pygmaea	✓			
Vertigo antivertigo	✓	✓		✓
Vertigo substriata	✓	✓		✓
Potamopyyrgus antipodarum	✓		✓	
Galba truncatula		✓	✓	✓
Pisidium personatum	✓			✓
Total No. of live species	8	9	11	8

Figure A11.4.3: Photographs of Balachlaven flushes

Balachlaven S1 (NE) (view looking down flush from top)

Balachlaven S1 (NE) (view looking upwards)

Balachlaven: looking across towards S1 (NE) from far side of glen

Balachlaven: looking across towards S2 (SW) from far side of glen

Balachlaven S2 (SW) flush habitat

Balachlaven heavily cattle-poached ground on hillside opposite flush sites where a tiny *V. geyeri* flush was recorded in 1996

A11.5 Loch Lossit

The three Loch Lossit flush sites although relatively short distances apart on the margins of this small loch are all unconnected. Two sites (LL1 & LL2) lie close to the loch margins and are un-grazed and un managed; LL3 by contrast are rather indistinct flushes arising on sloping ground running down to the loch and are lightly cattle grazed. The presence of all three flushes are marked by the presence of some *Schoenus nigricans.* The three sites: at the LL1 flush a there is a total flush area of approximately 0.018 ha of which 0.011 ha (60%) is judged to be optimal habitat; *Vertigo geyeri* were occasional at the site with an estimated mean frequency of 63 m^{-2}; at LL 2 a there is a total flush area of approximately 0.006 ha of which 0.004 ha (70%) is judged to be optimal habitat; *Vertigo geyeri* were occasional at the site with an estimated mean frequency of 50 m^{-2} and at LL3 a there is a total flush area of approximately 0.067 ha of which 0.04 ha (60%) is judged to be optimal habitat; *V. geyeri* were scarce at the site with an estimated mean frequency of 16 m^{-2}. An additional area of small flushes (LL 1A in this report but not surveyed in 2012) and lying just south of LL 1 were additionally sampled but did not produce *V. geyeri* although habitat seemed suitable.

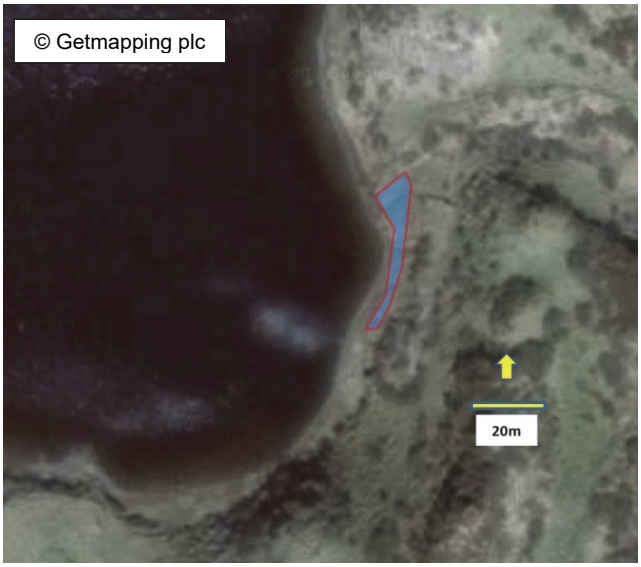


Figure A11.5.1: Flush area at Loch Lossit 1

Figure A11.5.2: Flush area at Loch Lossit 2

Figure A11.5.3: Flush area at Loch Lossit 3

Table A11.5.1: Loch Lossit sample sites

Grid Ref	**Habitat description Loch Lossit 1/1A**
Taken near site boundaries LL1: NR 41001 64946 NR 41002 64983 LL1A (new and negative site): NR 40970 64912 NR 40988 64929	Altitude (mOD): 95 Aspect: west Ground moisture levels: most site 3 (4 in channels) Approximate mean vegetation height: 20 cm Vegetation: occasional clumps of *Schoenus nigricans* set amongst *Myrica gale;* areas of shorter *Carex viridula* agg / low *Carex* spp / moss blanket with *Juncus* spp, *Anagallis tenella, Pinguicula sp Hydrocotyle vulgaris*
Grid Ref	**Habitat description Loch Lossit 2**
As such a small site a central grid reference is appropriate NR 41189 65246	Altitude (mOD): 95 Aspect: west Ground moisture levels: most site 3 (2 on tops of tussocks and on margins) Approximate mean vegetation height: 20cm Vegetation: a tiny ungrazed open fen with occasional of *Schoenus nigricans* set amongst diverse fen flora including *Carex virudula*, *Carex* spp, moss carpet, *Juncus* spp, *Eriophorum* spp, *Equisetum fluviatile*, *Polygala vulgaris, Filipendula ulmaria, Hydrocotyle vulgaris, Lychnis flos-cuculi, Dactylorhiza purpurella, Cirsium palustre, Mentha aquatica.* Occasional *Alnus glutinosa* saplings and *Myrica gale* on flush margins.
Grid Ref	**Habitat description Loch Lossit 3**
Taken near site boundaries NR 40965 65455 NR 40917 65447 NR 40939 65439	Altitude (mOD): 95 - 115 Aspect: south-west Ground moisture levels: most site 3 (2 on tops of tussocks) Approximate mean vegetation height: 15cm Vegetation: occasional *Schoenus nigricans* set amongst diverse fen flora including *Carex virudula*, *Carex* spp, moss carpet, *Juncus articulates,* *Juncus* spp, *Equisetum fluviatile*, *Polygala vulgaris, Filipendula ulmaria, Hydrocotyle vulgaris, Eriophorum* spp, *Lychnis flos-cuculi, Dactylorhiza purpurella, Cirsium palustre, Mentha aquatica, Myrica gale, Anagallis tenella*

Table A11.5.2: Results: Molluscan analysis of Loch Lossit samples

	LL1	**LL1A**		**LL2**	**LL3**	
		S1	S2		S1	S2
***Vertigo geyeri* Adult**	**6**			**7**	**4**	**1**
***V. geyeri* Juvenile**	**4**			**1**		
***V. geyeri* (dead adult)**				**2**		
Acicula fusca	✓	✓	✓	✓		
Aegopinella nitidula	✓	✓	✓			
Aegopinella pura			✓			
Ashfordia granulata	✓					
Carychium minimum	✓	✓	✓	✓	✓	
Carychium tridentatum			✓	✓		
Cochlicopa lubrica	✓		✓		✓	✓
Columella aspera	✓	✓	✓	✓	✓	
Euconulus fulvus				✓	✓	
Leiostyla anglica	✓	✓	✓	✓		
Nesovitrea hammonis	✓	✓	✓	✓	✓	✓
Oxyloma elegans	✓	✓	✓	✓		
Punctum pygmaeum					✓	
Vertigo pygmaea		✓				
Vertigo antivertigo	✓	✓			✓	
Vertigo substriata	✓	✓	✓	✓	✓	✓
Vitrea crystallina	✓	✓	✓	✓		
Potamopyyrgus antipodarum		✓				✓
Galba truncatula	✓	✓		✓	✓	
Pisidium personatum			✓		✓	✓
Total No. of species	14	13	13	12	11	6

Figure A11.5.4: Photographs of Loch Lossit flushes

Loch Lossit: general view across S1

Loch Lossit: close up of habitat S1 with *Schoenus nigricans* & *Myrica gale* tussocks

Loch Lossit: general view across S2

Loch Lossit: general view across S3

Loch Lossit: *Schoenus nigricans* tussocks on margins of S3

A11.6 Loch Ard Achadh

This site is situated in the extreme south of Islay on the Oa and therefore situated about 25 km from the most southerly of the northern *V. geyeri* sites on the island, those at Loch Lossit. The site differs from all of the other Islay sites in not being marked by the conspicuous presence of *Schoenus nigricans.* All of the other Islay sites are essentially upland calcareous flushes whereas this site is a base-rich fen. The site forms a triangular area of habitat that changes at the eastern end as the land grades quite suddenly into unimproved cattle pasture.

The total flush area is approximately 0.08 ha of which 0.048 ha (60%) is judged to be optimal habitat. *Vertigo geyeri* is moderately frequent at the site with an estimated mean frequency of 70 m^{-2}. As also noted during the 2012 survey, the site is closely cropped by red deer.

Loch nan Gillean, which lies about 450 m north-west of Loch Ard Achadh, was reported by SNH as having *V. geyeri* records. Although the source of these records could not be located, the shores of the loch were examined for the presence of any base-rich flushes, which might support the snail. A search revealed no potentially suitable base-rich habit and it is suggested that the records arose because of possible confusion with sites at nearby Loch Ard Achadh.

Figure A11.6.1: Flush area at Loch Ard Achadh

Table A11.6.1: Loch Ard Achadh sample sites

Grid Ref	**Habitat description**
Taken near site boundaries (Note: when overlain on map these refs [taken with two different Garmin GPS devices] seem to show a southern shift of about 6m from true locations) NR 31486 43016 NR 31505 43039 NR 31543 43025 NR 31501 43002	Altitude (mOD): 95 Aspect: south-west Ground moisture levels: most site 3 (2 on tops of tussocks and 4 in channels) Approximate mean vegetation height: 30 cm Vegetation: A loch-side base-rich fen. Numerous *Carex* spp., including *C. viridula* agg, *Juncus articulatus*, *Juncus* spp, *Equisetum fluviatile*, *Filipendula ulmaria, Hydrocotyle vulgaris, Lychnis flos-cuculi, Dactylorhiza purpurella, Cirsium palustre, Mentha aquatica, Caltha palustris, Hieracium spp, Anagallis tenella, Potentilla palustris, Geum rivale, Galium palustre, Senecio aquaticus, Epilobium palustre, Senecio aquaticus*

Table A11.6.2: Results: Molluscan analysis of Loch Ard Achadh samples

	LAA 1	LAA 2	LAA 3	LAA 4
***Vertigo geyeri* Adult**	**6**	**13**	**12**	**8**
***V. geyeri* Juvenile**	**1**	**4**	**1**	
***V. geyeri* (dead adult)**				
Carychium minimum	✓	✓	✓	
Cochlicopa lubrica		✓		
Columella aspera		✓		
Euconulus fulvus		✓	✓	
Leiostyla anglica	✓	✓	✓	
Nesovitrea hammonis	✓		✓	
Punctum pygmaeum	✓	✓		✓
Vertigo pygmaea	✓	✓	✓	✓
Vertigo antivertigo	✓	✓	✓	✓
Vertigo substriata	✓	✓		✓
Potamopyyrgus antipodarum			✓	✓
Galba truncatula	✓	✓	✓	✓
Pisidium personatum	✓	✓		✓
Pisidium casertanum			✓	
Total No. of species	10	12	10	8

Figure A11.6.2: Photographs of Loch Ard Achadh

	
Loch Ard Achadh: looking across loch at whole of the rectangular shaped *V. geyeri* fen (note marked break at upper edge of site)	Loch Ard Achadh: looking across loch at whole of the rectangular shaped *V. geyeri* fen (note marked break at upper edge of site)

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