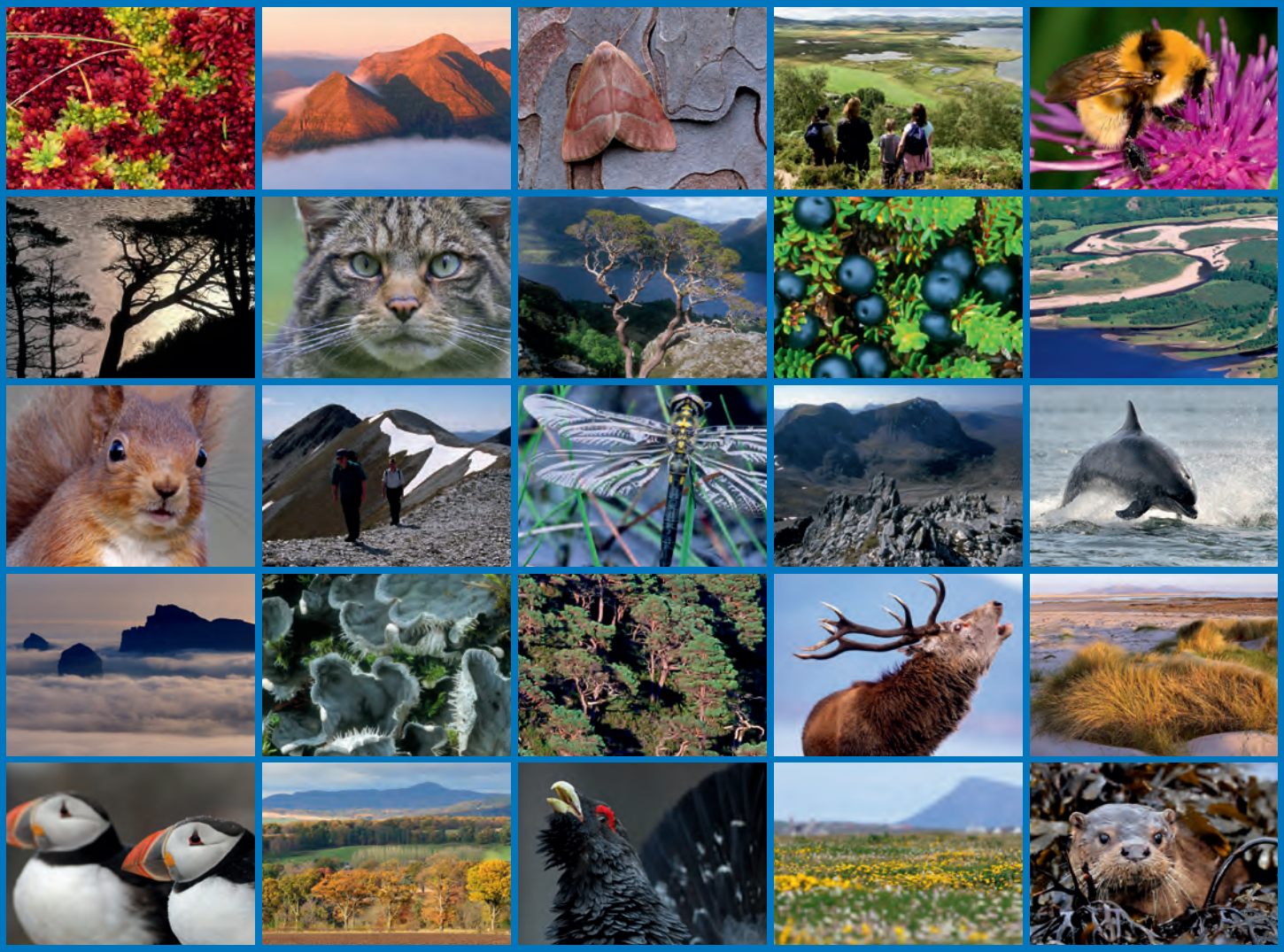
Scottish Natural Heritage
Commissioned Report No. 616

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
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

COMMISSIONED REPORT

Commissioned Report No. 616

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

For further information on this report please contact:

Dr Athayde Tonhasca
SNH
Battleby
Perth
PH1 3EW
Telephone: 01738 458671
E-mail: athayde.tonhasca@snh.gov.uk

This report should be quoted as:

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.*

COMMISSIONED REPORT

Summary

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

Commissioned Report No.: 616
Contractor: Malacological Services
Year of publication: 2013

Background

Both *Vertigo geyeri* and *V. genesii* are listed on Annex II of the EC Habitats 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.

To provide information for the next round of Article 17 reporting, due in 2013, a condition assessment of *Vertigo geyeri* and *V. genesii* has been carried out at a selection of sites in Perthshire, and sites in the Black Isle and Deeside, using methods designed to allow assessments of population, habitat and future prospects.

Main findings

- The Condition Assessment for *Vertigo geyeri* was 'favourable-maintained'. The species was generally widespread and common at all sites surveyed with the exception of the Deeside sites where it was not found.
- The Condition Assessment for *Vertigo genesii* was 'favourable-declining'. Although habitat and future prospects were assessed as 'favourable-maintained', population was assessed as 'favourable-declining' due to the absence of the species at two sites from where it had been formerly recorded.

For further information on this project contact:
Athayde Tonhasca, Scottish Natural Heritage, Battleby, Perth, PH1 3EW.
Tel: 01738 458671
For further information on the SNH Research & Technical Support Programme contact:
Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725000 or research@snh.gov.uk

Table of Contents **Page**

Acknowledgements

All aerial photographs used in this report are used under Licence from Scottish Natural Heritage. I am grateful to Gabor Barton (SNH) of provision of these aerial tiles.

I thank Athayde Tonhasca (SNH) for logistical support and SNH regional officers Sandra Penman, Rhona McInroy and Tim Dawson for securing access to all of the sites. I am grateful to all landowners for permission to survey on their land. Special thanks go to Polly Freeman (Atholl Estates) for access to Glen Tilt, to Mr S. Harrison, landowner of Braelangwell Wood for useful discussion, and to Mrs Priscilla Lorimer for information on the Loch Tummel site.

1 BACKGROUND AND OBJECTIVES

Scotland supports several sites for two species of whorl snail listed on Annex II of the EC Habitats 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.

In the second report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006, the overall national assessment for *Vertigo geyeri* and *Vertigo genesii* was favourable.

To provide information for the next round of Article 17 reporting, due in 2013, condition assessments of *V .geyeri* and *V. genesii* have been carried out at a selection of Perthshire and Black Isle sites using methods designed to allow assessments of population, habitat and future prospects (a condition assessment of the Islay sites was carried out under a separate project).

The fieldwork for this project was carried out in two phases between 19 and 25 June 2012, and from 20 to 25 October 2012.

2 KNOWN DISTRIBUTION IN SCOTLAND

A significant portion of the distributional and ecological information in the Perthshire sites in particular, is based upon work carried out on behalf of SNH in the late 1990s (Killeen & Colville, 1999a). Subsequently, two sites for the species were found on the Black Isle (personal observation). SNH personnel carried out monitoring of selected sites in Glen Fender & Tullach Hill in autumn 2001 (Killeen, 2002) but very little work has been done in the last 10 years.

The sites for *Vertigo geyeri* (excluding Islay) and *V. genesii* on a 1 km and 10 km square basis are shown in Tables 1 and 2 respectively. However, for Tullach Hill & Glen Fender in particular there are several individual flushes with one or both *Vertigo* species within each 1 km square.

Most of the sites 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.

Table 1: known sites (on a 1km square basis) for Vertigo geyeri *(excluding Islay)*

District	Location	Grid Ref	10 km square	Last record	Reference
Black Isle	Belmaduthy Dam	NH64-57-	NH65	1999	Colville pers record
Black Isle	Braelangwell Wood	NH68-63-	NH66	1998	Howe pers record
Perthshire	Lochan an Daim	NN71-57-	NN75	1995	Colville pers record
Perthshire	Loch Tummel	NN87-59-	NN85	1995	Colville pers record
Perthshire	Glen Banvie	NN82-69-		1995	No details
Perthshire	Invervack	NN83-64-		1995	Colville pers record
Perthshire	Invervack	NN84-64-		1995	Colville pers record
Perthshire	Tulach Hill	NN86-63-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN86-64-		1995	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN87-63-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN87-64-	NN86	IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN88-62-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN88-63-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN89-62-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN89-63-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Glen Fender	NN89-66-		1999	BAP Steering Group
Perthshire	Glen Fender	NN89-67-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN90-62-		1995	Killeen & Colville 1999a
Perthshire	Loch Moraig	NN90-66-	NN96	1995	Killeen & Colville 1999a
Perthshire	Glen Fender	NN90-67-		1995	Killeen & Colville 1999a
Perthshire	Ben Vrackie	NN94-61-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Glen Tilt	NN91-71-	NN97	IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Glen Tilt	NN91-72-		IJK Aug 1998	Killeen & Colville 1999a
Deeside	Glen Lui	NO05-92-	NO09	IJK Aug 1998	Killeen & Colville 1999b
Deeside	Morrone Birkwood	NO13-90-	NO19	IJK Aug 1998	Killeen & Colville 1999b

Table 2: known sites (on a 1km square basis) for Vertigo genesii

District	Location	Grid Ref	10 km square	Last record	Reference
Perthshire	nr. Blair Atholl	NN89-62-		1998	Colville pers record
Perthshire	nr. Blair Atholl	NN89-63-		1998	Colville pers record
Perthshire	Glen Fender	NN89-66-	NN86	IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN87-64-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Tulach Hill	NN87-63-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Loch Moraig	NN90-66-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Glen Fender	NN90-67-	NN96	IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Ben Vrackie	NN94-61-		IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Glen Tilt	NN91-71-	NN97	IJK Aug 1998	Killeen & Colville 1999a
Perthshire	Loch Loch	NN99-72-		1998	Colville pers record
Black Isle	Braelangwell Wood	NH68-63-	NH66	1998	Howe pers record

3 SCOPE OF WORK - RATIONALE

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.

To obtain adequate and up-to-date information on range as required, it was recommended that all 10 km squares were surveyed although the quantity and the detail of work should be designed to suit the nature of the sites. The Tullach Hill & Glen Fender Meadows SAC is split into two units separated by the River Garry.

The previous studies showed that on Tullach Hill, calcareous flushes were spread over several kilometres of hillside. *Vertigo geyeri* was present at most sites whereas *V. genesii* was found only in two flushes. It was proposed to sample flushes with a geographical spread but which included the two where *V. genesii* were recorded, and also Invervack which had not been sampled since 1995. This was to include bulk sampling, habitat quality and extent assessment and setting up two monitoring transects.

Calcareous flushes occur throughout the smaller Glen Fender unit of the SAC, plus at Loch Moraig. It was proposed to carry out bulk sampling, habitat quality and extent assessment at separate flush units, and to resurvey the Monzie transects set up in the 1998/1999 surveys (and which were also repeated in 2001).

Ben Vrackie is in close proximity to the SAC and in the same 10 km square as Glen Fender, and, therefore, it was not considered necessary to sample this site.

The sites at Loch Tummel and Lochan an Daim, whilst in close proximity to the SAC, are the only sites in 10 km squares NN85 and NN75 respectively and neither have been surveyed since 1995. Bulk sampling, habitat quality and extent assessment at each of the sites were considered to be adequate.

Beinn a`Ghlo SAC – the Glen Tilt and Loch Loch sites are both within 10 km square NN97. Bulk sampling, habitat quality and extent assessment at the Glen Tilt sites were considered to be adequate. Survey of Loch Loch was not considered to be feasible due to the extreme remoteness of the site, and the time required was not available.

Deeside – based upon the results of the 1999 surveys, both Morrone Birkwood and Glen Lui are considered to be very marginal sites for *Vertigo geyeri*, the species appeared to be highly localised and had been found only in very low numbers. Bulk sampling, habitat quality and extent assessment were considered to be adequate.

Black Isle – no systematic work had been carried out at the Black Isle sites, the records are based upon ad hoc sampling from ‘the best looking’ habitat. Therefore, there was a need for more detailed information on population and habitat at the site. At selected sites, bulk sampling, habitat quality and extent assessment were made and at one site, a monitoring transect was set up.

4 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 were further developed and refined for use in Anglesey by Killeen & Moorkens (2004, 2008), and developed further for application in Republic of Ireland sites (Moorkens & Killeen, 2011) and Killeen (2010) for Widdybank Fell and Sunbiggin Tarn.

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.

4.1 Area of habitat by site

Within each of the sites, areas of habitat will be delineated for the purposes of monitoring *Vertigo geyeri/genesii*. Specific habitat suitable for the snails 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. Afterwards it was possible to identify all other potential flushes (e.g. on Tullach Hill) and the polygons containing suitable habitat to be marked on aerial photographs and enable their transfer to a GIS system.

4.2 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 were be assessed by describing, photographing and sampling individual flush areas.

4.3 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.

The habitat (at the plant community level) was described and the linear distance of that habitat type measured using the 30 m tape. 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 three 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 up to 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 5 cm or ground is flooded at the time of sampling.
- Unsuitable - Any other habitat.

4.4 Snail sampling

In selected delineated habitat zones on transects, and in individual flushes, a bag of moss/sedge plants and litter (c. 2 L volume) was also taken. This is approximately equivalent to an area measuring 0.4 x 0.4 m. 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 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.

Specimens of *V. geyeri* and *V. genesii* with a developed lip and/or aperture 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 counted.

4.5 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

5 RESULTS

A separate annex is given for each main survey site:

Annex A: Tulach Hill and Glen Fender Meadows.
Annex B: Black Isle Braelangwell Wood.
Annex C: Black Isle Belmaduthy Dam.
Annex D: Schiehallion (Lochan an Daim).
Annex E: Glen Tilt.
Annex F: Loch Tummel.
Annex G: Deeside.

These appendices contain maps, aerial photographs with outlines of habitat extent, sample location details, transect results, mollusc analysis and photographs.

Table 3 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 4 gives a summary of the results from the quantitative sampling.

A summary of the results at each of the main sites is given in the following sections.

5.1 Tulach Hill and Glen Fender Meadows

The SAC supports by far the largest area of flush habitat with *Vertigo geyeri* and *V. genesii* in Britain. In the Tulach Hill component less than half of the flushes were surveyed, yet their total area amounted to over 9 ha, of which at least 3.2 ha was considered to be suitable (optimal and sub-optimal). Similarly in the Glen Fender Meadows component (and adjacent northern flush at Loch Moraig) the total flush area was over 9 ha, with at least 2 ha of suitable habitat. The suitable habitat in all of the other Perthshire and Black Isle sites combined amounts to less than 1 ha.

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 Glean Fender and Loch Moraig. Previously adult *V. genesii* had been recorded at two sites on Tulach Hill (flushes 24 and 28). Given the presence of adult *V. genesii* at Glen Fender (and on the Black Isle), the absence of adults at these Tulach Hill sites is insufficient reason to believe the species has disappeared. However, the flushes should be re-sampled soon (e.g. autumn 2013) to establish the species status.

At Glen Fender and Loch Moraig, based on adults alone, *Vertigo geyeri* was the more frequent species with 95 individuals retrieved from all samples, whereas 48 *V. genesii* were found. This generally follows the pattern found in 1998. Densities of the two species combined were very high, ranging from 88 to 367 individuals/m^2 (mean 208/m^2). On Tulach Hill the densities of adults and juveniles combined ranged from 44 to 131/m^2 (mean 72/m^2). Very little of the transect work carried out in 2012 is directly comparable to that carried out in 1998. Glen Fender transects M3 and M8 were previously surveyed although a more sophisticated method was used in 2012. The results are generally similar with respect to numbers and distribution of the two species.

Overall, both components of the SAC were in good condition and in general 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 the western end of Tulach Hill at Invervack, the cattle and/or sheep grazing has been removed with the result that some of the flushes are beginning to scrub-up. 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.

5.2 Black Isle Braelangwell Wood

The habitat at Braelangwell Wood comprises a series of small and large flush areas within open woodland slopes. Three main units were recognised. Previous surveys appear to have focused upon the westernmost unit, but this survey has shown good *Vertigo* habitat to be much more extensive, with over 0.6 ha considered to be optimal or sub-optimal (Table 3). The habitat is generally in excellent condition, although grazing by cattle has the potential to damage the habitat. The clearance of a corridor to access electricity lines has caused some localized damage to the central unit (see Annex B Figure B1) and needs to be taken into consideration in future management plans. *Vertigo geyeri* and *V. genesii* were found in all three of the main units, although in the western and eastern units, the snails were found in rather low numbers (15 to 25 individuals of the two species combined per m^2) (Table 4).

However in the flushes in the central unit at the base of the slope, an overall density of 384/m^2 was recorded. The central flush unit also supported a population of the very rare pupillid snail *Pupilla pratensis* which was recorded for the first time at the site. This is only the second known site in Britain for the species (the other being Belmaduthy Dam).

Table 3: Area of Suitable Habitat

Site	Sub-site	Total area (ha)	% Suitable	Area suitable (ha)
Tulach Hill	Flushes 1-3	0.80	75	0.6
	Flush 4	1.05	75	0.79
	Flush 5/6	0.7	10	0.07
	Flush 7	1.2	10	0.12
	Flush 8/9	1.57	20	0.31
	Flush 13	2.8	25	0.7
	Flush 24	1.5	20	0.3
	Flush 28	0.94	25	0.23
	Invervack	<1	10	0.1
Glen Fender	GF1	1.16	25	0.29
	GF2	1.14	25	0.28
	GF3	0.25	20	0.05
	GF4	0.14	20	0.03
	GF5	0.65	10	0.06
	M3	2.0	20	0.4
	M8	2.73	25	0.68
	Loch Moraig (north)	1.2	25	0.3
Black Isle Braelangwell Wood	Eastern Unit	1.22	25	0.31
	Western Unit	0.8	20	0.16
	Central Unit	0.31	50	0.16
Black Isle Belmaduthy Dam	All	4.0	20	0.8
Lochan an Daim	South of road	0.05	50	0.025
	North of road	0.15	40	0.06
Glen Tilt	All	<1	20	0.2
Loch Tummel	All	0.45	40	0.18
Deeside	Glen Lui	0.5	10	0.05
	Morrone 2	0.5	10	0.05
	Morrone 3	0.4	10	0.04

Table 4: Summary of the results from the quantitative sampling

	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}
Tulach Hill	Flushes 1-3	1	1	1	0	1	2		10	75
	Flush 4	3	3	3	0	3	19		21	83
	Flush 8/9	2	2	2	0	2	6		13	59
	Flush 13	1	1	1	0	1	4		3	44
	Flush 24	2	2	2	0	2	12		8	62
	Flush 28	1	1	1	0	1	13		8	131
	Invervack	1	1	1	0	1	5		3	50
Glen Fender	GF1	1	1	1	1	1	37	2	20	367
	GF2	1	1	1	1	1	9	4	14	169
	M3	2	2	2	2	2	2	7	19	88
	M8 south	1	1	1	1	1	12	14	21	294
	M8 (N) transect	4	4	4	2	4	23	16	60	155
	Loch Moraig (north)	1	1	1	1	1	12	5	11	175
Black Isle Braelangwell Wood	Eastern Unit	5	3	3	1	3	8	1	3	15
	Western Unit	5	3	2	2	3	8	4	16	25
	Central Unit	2	2	2	2	2	26	29	68	384
Black Isle Belmaduthy Dam	General	6	6	6	0	6	31	0	19	52
	Transect	3	2	2	0	2	5	0	5	21
Lochan an Daim	South of road	1	1	1	0	1	6	0	8	87
	North of road	2	2	2	0	2	69	0	62	409
Glen Tilt	South of river	6	1	1	0	1	8	0	6	14
	North of river	4	4	3	0	4	10	0	31	62
Loch Tummel	All	4	4	3	0	4	7	0	9	25
Deeside	Glen Lui	2	0	0	0	0	0	0	0	0
	Morrone Birkwood	3	0	0	0	0	0	0	0	0

5.3 Black Isle Belmaduthy Dam

All potential *Vertigo* habitat at the site lies within one area at the northern part on a slope below a spring line. Although the flushes are all contained within a relatively large area of 4 ha, they are fragmented and more restricted to runnels rather than larger areas of flush sward as at Braelangwell; therefore, a maximum of 20% (0.8 ha) is considered optimal and sub-optimal. *Vertigo geyeri* was widespread at the site and was locally frequent, with densities ranging from 6 to 131 individuals/m^2 (mean 52). The present grazing regime does not appear to be adversely impacting the site, but tracks from quad bikes are causing local damage to some of the flush areas.

5.4 Schiehallion (Lochan an Daim)

This is a small site comprising two flush units: a very small spring on the south side of the road (0.05 ha) and a larger flush slope on the north side of the road (0.15 ha). It was estimated that 0.08 ha was optimal and sub-optimal habitat. 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. *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.

5.5 Glen Tilt

In his 1995 survey in Glen Tilt, Colville (personal communication) only recorded *Vertigo genesii* (from a flush on the slopes, south of the River Tilt above Balaneasie). In the 1998 survey, only *V. geyeri* was recorded (Killeen & Colville, 1999a), adults at 2 sites and indeterminate *V. geyeri/genesii* juveniles at a further three places. In 2012, four of the 1998 sites were surveyed plus an additional four new sites. Only *Vertigo geyeri* (adult) plus indeterminate juveniles were found. Table 5 gives a summary comparison of 1998 and 2012 sites. On the south side of the river it was not found at either of the sites near Balaneasie (1 and 2), but was found at a new site (4 of 2012 survey). It was found at the two 1998 sites (6a, 6b) on the north side of the river and in a new site (10 of 2012 survey). If it is taken that all of the juveniles are *V. geyeri* then the densities range from 14/m^2 on the south side of the river to 62/m^2 on the north side.

Table 5: Summary of Glen Tilt results compared to the 1998 survey

1998	*V. geyeri* adult	Juveniles	2012	*V. geyeri* adult	Juveniles
1		+ve	1		
2	+ve		2		
3		+ve	NS		
4			3		
5			NS		
6a		+ve	7 & 8	+ve	+ve
6b	+ve		9	+ve	+ve
			4	+ve	+ve
			5		
			6		
			10	+ve	+ve

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. At the new site (4) the habitat was more extensive and on flatter terrain. The flora in these flushes is much less diverse than in the SAC with small *Carex* spp. and *Saxifraga aizoides* occurring most frequently. The flushes on the north side of the river are also on less steep ground and are botanically more diverse. However, it is

estimated that the area of suitable habitat (optimal and sub-optimal) throughout the survey area is barely more than 0.2 ha. 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 recorded at this site since 1995, and, therefore, its status in Glen Tilt requires review. If *V. genesii* is not found on a subsequent monitoring survey in 3 or 6 years, then it should be regarded as a *V. geyeri* only site.

5.6 Loch Tummel

The habitat at the Loch Tummel site comprises an open south-facing slope with a series of highly calcareous springs giving rise to runnels with mounds of *Schoenus ferrugineus* and mosses, and areas of flush sward with sedges and mosses. Approximately 40% (0.18 ha) of the total area (0.45 ha) was considered to be optimal and sub-optimal habitat. The site is confined by walls and fences and at the time of survey there was no evidence of any grazing – the sward height being maintained by wetness. In spite of the apparent excellent condition of the habitat, *Vertigo geyeri* was rather uncommon. Only 16 individuals were found in the four samples giving a mean density of 25 individuals/m^2.

5.7 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. In 1999, at these sites the species was living at very low density, just four individuals of *V. geyeri* were found in five samples at Morrone Birkwood and only one juvenile in the two samples from Glen Lui. However, the species was not found at all in the five samples all taken from the most optimal habitat in 2012. Although the flush areas at Morrone Birkwood are small in area (c. 0.9 ha), there was sufficient habitat in good condition to support the species, and the sampling should have yielded the snail, especially as other typically associated species were found in moderate numbers. Similarly at Glen Lui there was sufficient habitat in good condition and with a molluscan fauna typical of calcareous flushes, although at this site there were indications that the hydrology may not be stable enough, as it appeared to be prone to flooding and drying. Both sites are assessed as unfavourable on the basis of the species' absence.

6 CONDITION ASSESSMENT FOR *VERTIGO GEYERI*

Having obtained some baseline data in 1998 on the attributes required to assess condition, the present 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: *9-10 passes 'favourable-maintained' (green); 7-8 passes 'favourable-declining' (amber); 6 or less passes 'unfavourable-declining' (red)*

Indicator	Target	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
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
Presence/ absence	• Adult snails are confirmed to be present in 2 zones with optimal habitat in Tulach Transect T4 AND in at least 1 zone in Tulach Transect T9, with no evidence of decline*	Present in the 5 (of 6) optimal zones sampled	Pass
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
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
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
Presence/ absence	• Adult or sub-adult snails are present at Lochan an Daim (minimum 2 samples)	Present	Pass
Presence/ absence	• Adult or sub-adult snails are present at Loch Tummel (minimum 2 samples)	Present	Pass
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
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

*As the current study acted as a baseline, a higher number of samples were removed than is recommended for monitoring. A balance must be found between over sampling and ensuring that a

decline has not occurred. Where habitat conditions appear to be good, a minimal sampling for monitoring purposes is recommended, but if a decline is observed this should trigger further investigations

6.2 Habitat for the species assessment

Table 7: Targets for habitat assessment: 13-14 passes 'favourable-maintained' (green); 10-12 passes 'favourable-declining' (amber); 9 or less passes 'unfavourable-declining' (red).

Indicator	Target	Result	Pass/Fail
Habitat extent (site level)	• The Tulach Hill flush areas (flushes 1-4, 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
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
Habitat extent (transect)	• At least 55 m of the habitat on Tulach Transect T4 is classed as optimal and at least 55 m is optimal wetness	60 m is optimal habitat and wetness	Pass
Habitat extent (transect)	• At least 34 m of the habitat on Tulach Transect T9 is classed as optimal and at least 34 m is optimal wetness	34.3 m is optimal habitat and wetness	Pass
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
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
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
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
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

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
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
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
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
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

6.3 Future prospects assessment

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. 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 green, amber or red.

Table 8: Future prospects assessment

Activity	Main Locations Affected	Influence	Intensity
non intensive cattle grazing	Tulach Hill, Glen Fender, Braelangwell Wood	Neutral	Low
non intensive sheep grazing	Tulach Hill, Glen Tilt	Neutral	Low
non intensive mixed animal grazing	(deer) Tulach Hill	Neutral	Low
abandonment of pastoral systems, lack of grazing	Invervack	Negative	Medium
electricity and phone lines	Braelangwell Wood	Negative	Low
camping and caravans	Lochan an Daim	Neutral	Low
Other human intrusions and disturbances	Quad bikes – Glen Fender, Belmaduthy Dam	Neutral	Low

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. However, lack of grazing at Invervack could become a problem and over-frequent maintenance to the power lines at Braelangwell is likely to be detrimental.

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' (green).

6.4 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 all sites except at Deeside, and was generally present in relatively high abundance. The absence at Deeside was 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' (green).

Attribute	Assessment
Population	favourable-maintained
Habitat for the species	favourable-maintained
Future prospects	favourable-maintained
Overall	favourable-maintained

7 CONDITION ASSESSMENT FOR *VERTIGO GENESII*

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

7.1 Population assessment

Table 9: Targets for population assessment: 4-5 passes 'favourable-maintained' (green); 3 passes 'favourable-declining' (amber); 2 or less passes 'unfavourable-declining' (red).

Indicator	Target	Result	Pass/Fail
Presence/ absence	• Adult snails are present in the 2 Tulach Hill monitoring flush areas (flushes 24, 28)	Absent	Fail
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
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
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
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

*As the current study acted as a baseline, a higher number of samples were removed than is recommended for ongoing monitoring. A balance must be found between over sampling and ensuring that a decline has not occurred. Where habitat conditions appear to be good, a minimal sampling for monitoring purposes is recommended, but if a decline is observed this should trigger further investigations.

7.2 Habitat for the species assessment

Table 10: Targets for habitat assessment: 5-6 passes 'favourable-maintained' (green); 4 passes favourable-declining' (amber); 3 or less passes 'unfavourable-declining' (red)

Indicator	Target	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
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	6.23 ha in area, of which 1.55 ha is optimal and sub-optimal	Pass

	6.2 ha, of which at least 1.5 ha should be optimal & sub-optimal		
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
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
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
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

7.3 Future prospects assessment

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. 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 green, amber or red.

Table 11: Future prospects assessment

Activity	Main Locations Affected	Influence	Intensity
non intensive cattle grazing	Tulach Hill, Glen Fender, Braelangwell Wood	Neutral	Low
non intensive sheep grazing	Tulach Hill, Glen Tilt	Neutral	Low
non intensive mixed animal grazing	(deer) Tulach Hill, Deeside	Neutral	Low
electricity and phone lines	Braelangwell Wood	Negative	Low
Other human intrusions and disturbances	Quad bikes – Glen Fender	Neutral	Low

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. However, over-frequent maintenance to the power lines at Braelangwell is likely to be detrimental.

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' (green).

7.4 Overall assessment

The baseline condition assessment for *Vertigo genesii* in Scotland can be determined by how well the site 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 genesii*. The absence of *V. genesii* at sites on Tulach Hill and in Glen Tilt means that population is assessed as 'favourable-declining', and, therefore, the overall assessment is 'favourable-declining' (amber).

Attribute	Assessment
Population	favourable-declining
Habitat for the species	favourable-maintained
Future prospects	favourable-maintained
Overall	favourable-declining

8 RECOMMENDATIONS

8.1 Monitoring

The 1998 survey established the distribution of *Vertigo geyeri* and *V. genesii* in the Perthshire sites and in particular in the SAC. Whilst this has partially acted as a baseline, it is the present survey which has established sites and transects for future condition assessment, both in Perthshire and on the Black Isle. Ideally, monitoring would be carried out at 3-yearly intervals but given the large number of sites, and the amount of work required, it is more likely that monitoring will be carried out at 6-year intervals to coincide with Article 17 requirements. To base the next condition assessment on the targets set in the present study, 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). Any monitoring frequency should be re-assessed in light of any deterioration of condition or any changes to individual site management. As a minimum the following is recommended (with the targets adjusted accordingly):

- Repeat transects T4 and T9 at Tulach Hill.
- Sample flushes 24 and 28 at Tulach Hill (previous *V. genesii* sites) and determine new flush boundaries and extent of suitable habitat.
- Repeat transects M3 and M8 at Glen Fender.
- Sample one of either GF1 or GF2 flush areas at Glen Fender and determine new boundaries and extent of suitable habitat.
- Take at least one sample from each of the three units at Braelangwell Wood and determine new flush boundaries and extent of suitable habitat.
- Repeat Belmaduthy Dam transect, and sample at least two other flush areas.
- Sample the two flush areas at Lochan an Daim and determine new boundaries and extent of suitable habitat.
- Sample flushes 1, 4 and 9 at Glen Tilt.
- Take at least one sample from the Loch Tummel site and determine new 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.

It is strongly recommended that Tulach Hill flushes 24 and 28 are sampled again in autumn 2013 to confirm the presence of adult *Vertigo genesii*.

8.2 Management

The key management issues are listed in the following sections

8.2.1 Tulach Hill and Glen Fender Meadows

- Ensure current stocking levels are not exceeded.
- Reduce sheep stock levels in Tulach Hill Flush area 13.
- Re-introduce grazing to Invervack.
- Cease supplementary feeding of cattle in the Glen Fender flushes.
- Discourage use of quad bikes and tractors in the Glen Fender flushes.

8.2.2 Black Isle Braelangwell Wood

- Ensure current stocking levels are not exceeded, agree practice with the new owner.
- Develop an acceptable methodology with the power company for maintaining the electricity lines to ensure minimal damage to the flushes.

8.2.3 Black Isle BelmaduthyDam

- Ensure current stocking levels are not exceeded, agree practice with the owners.
- Discourage use of quad bikes in the flush areas.

8.2.4 Schiehallion (Lochan an Daim)

- Ensure current stocking levels are not exceeded, agree practice with the owners.
- Fence off parts of the roadside verges adjacent to the flushes to prevent overnight parking by camper vans.

8.2.5 Glen Tilt

- Ensure current stocking levels are not exceeded, agree practice with the owners.

8.2.6 Loch Tummel

- Agree a management plan with the owners to maintain the status quo.

8.2.7 Deeside

- Maintain the status quo.

9 REFERENCES

Killeen, I.J. & Colville, B. 1999a. Distribution and Monitoring of *Vertigo geyeri* and *Vertigo genesii* in Perthshire. *Scottish Natural Heritage Commissioned Report* F97AC309. SNH, Battleby.

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

Killeen, I.J. 2001. Survey of EU Habitats Directive *Vertigo* species in England. 1. *Vertigo geyer*i in Sunbiggin Tarn & Moors, Cumbria. *English Nature Research Report No. 418. English Nature, Peterborough.*

Killeen, I.J. 2002. Monitoring surveys of whorl snails (*Vertigo* spp.) in Scottish Natura sites. *Unpublished report. Scottish Natural Heritage.*

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

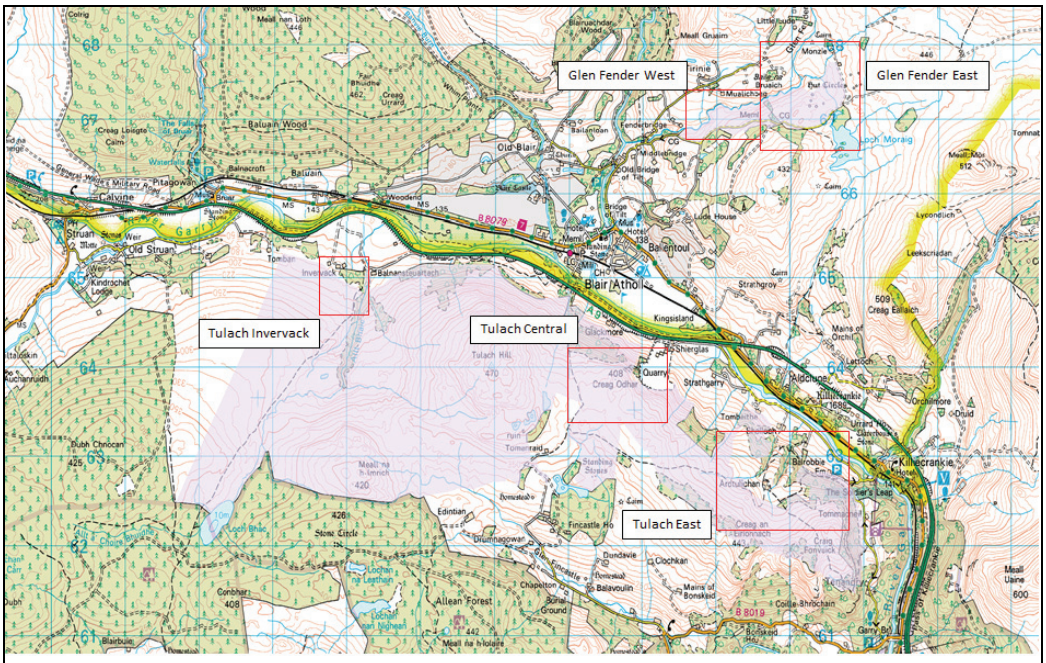
Killeen, I.J. & Moorkens, E.A., 2008. 2007 Condition monitoring of *Vertigo geyeri* on Cors Eirddreiniog & Waun Eurad SAC. *CCW Environmental Monitoring Report No.* 42. Countryside Council for Wales, Bangor.

Killeen, I.J. 2010. A Condition Assessment of *Vertigo geyeri* at Sunbiggin Tarn and Moors, Cumbria. *Unpublished report, Natural England*.

Moorkens, E.A. & Killeen, I.J. 2011. Monitoring and Condition Assessment of Populations of *Vertigo geyeri*, *Vertigo angustior* and *Vertigo moulinsiana* in Ireland. *Irish Wildlife Manuals, No. 55. National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht, Dublin, Ireland.*

ANNEX A: TULACH HILL & GLEN FENDER MEADOWS SAC

Figure A1: Map of Tulach Hill & Glen Fender Meadows SAC with the five main sample areas



EC Site Code: UK0012891 Tulach Hill and Glen Fender Meadows Special Area of Conservation (SAC)
Produced by: Geographic Information Group, SNH, 2012

Figure A2: Tulach Hill East flushes and sample sites

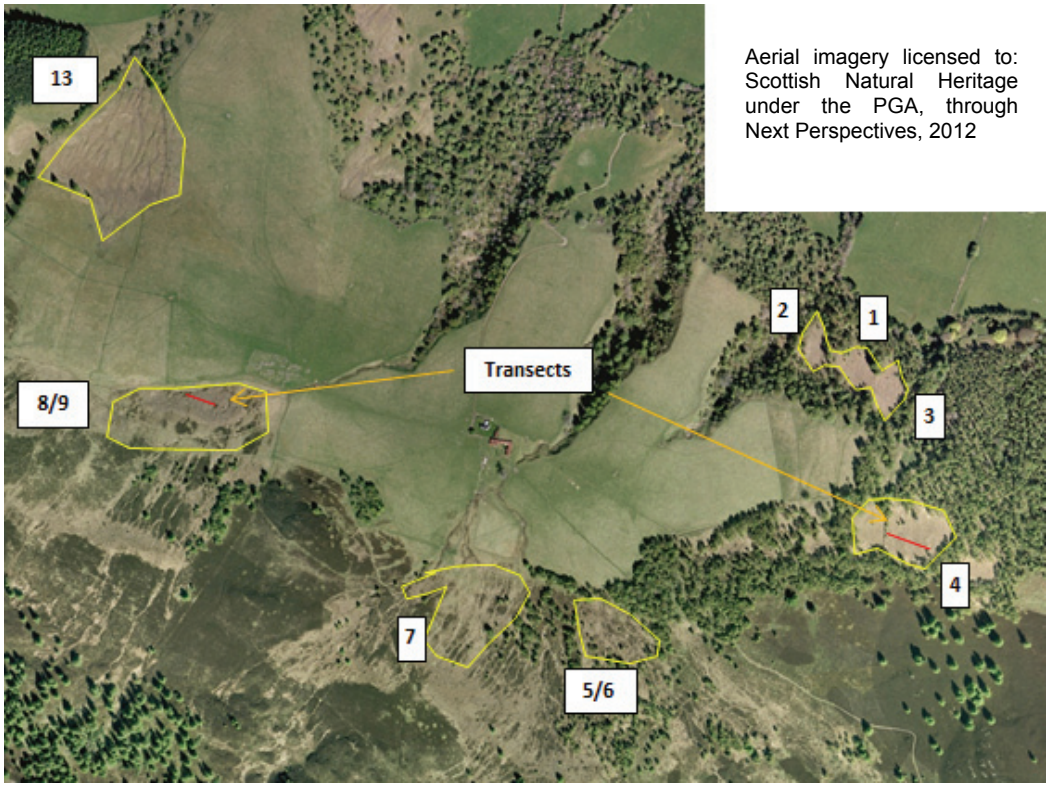
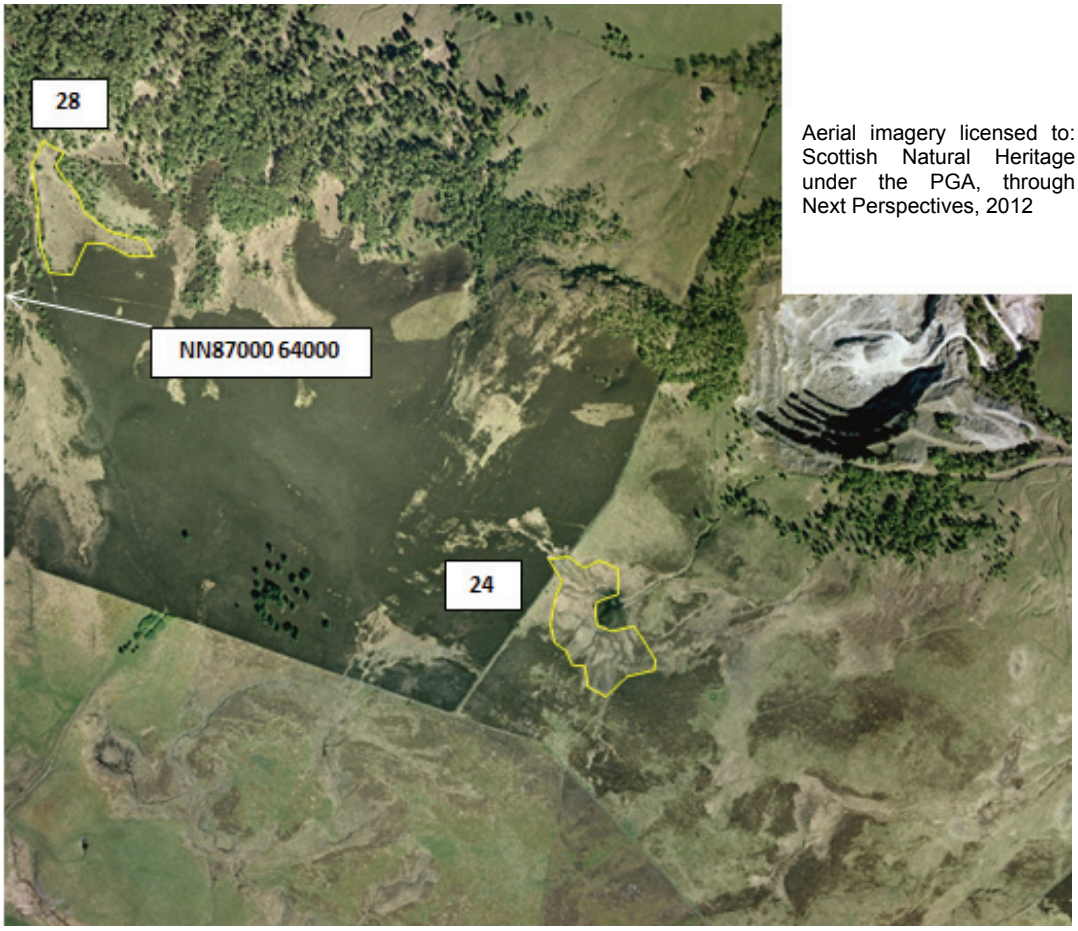


Figure A3: Tulach Hill Central flushes and sample sites



Aerial imagery licensed to: Scottish Natural Heritage under the PGA, through Next Perspectives, 2012

Figure A5: Glen Fender West flushes and sample sites

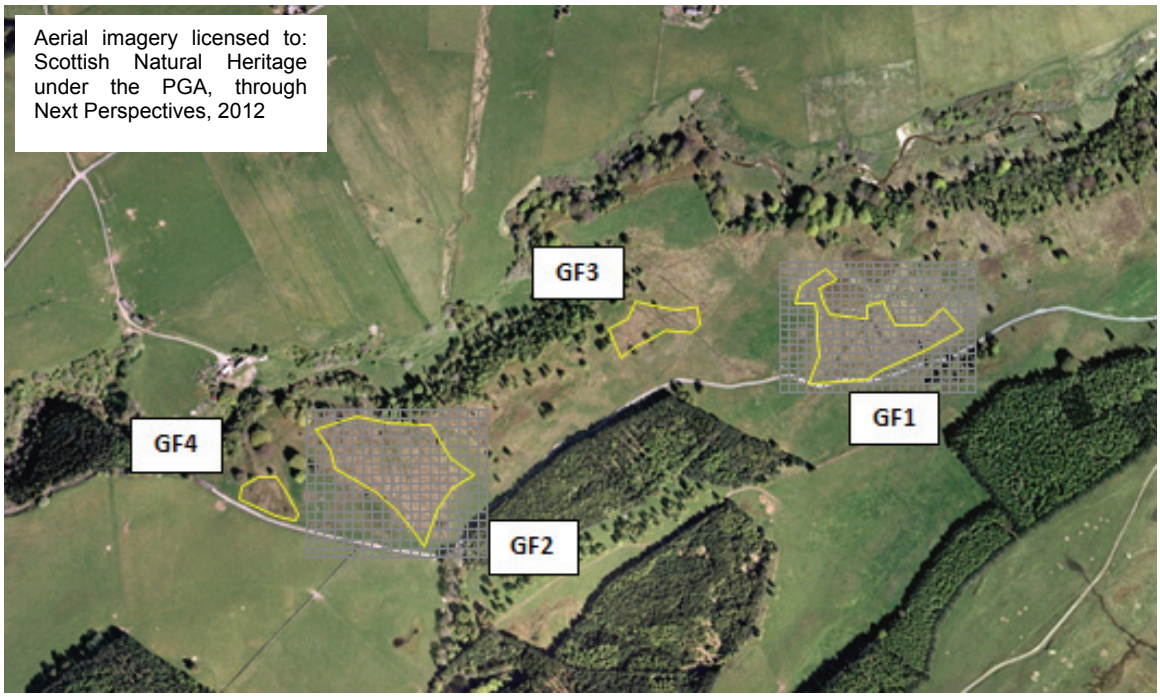


Figure A6: Glen Fender East flushes and sample sites

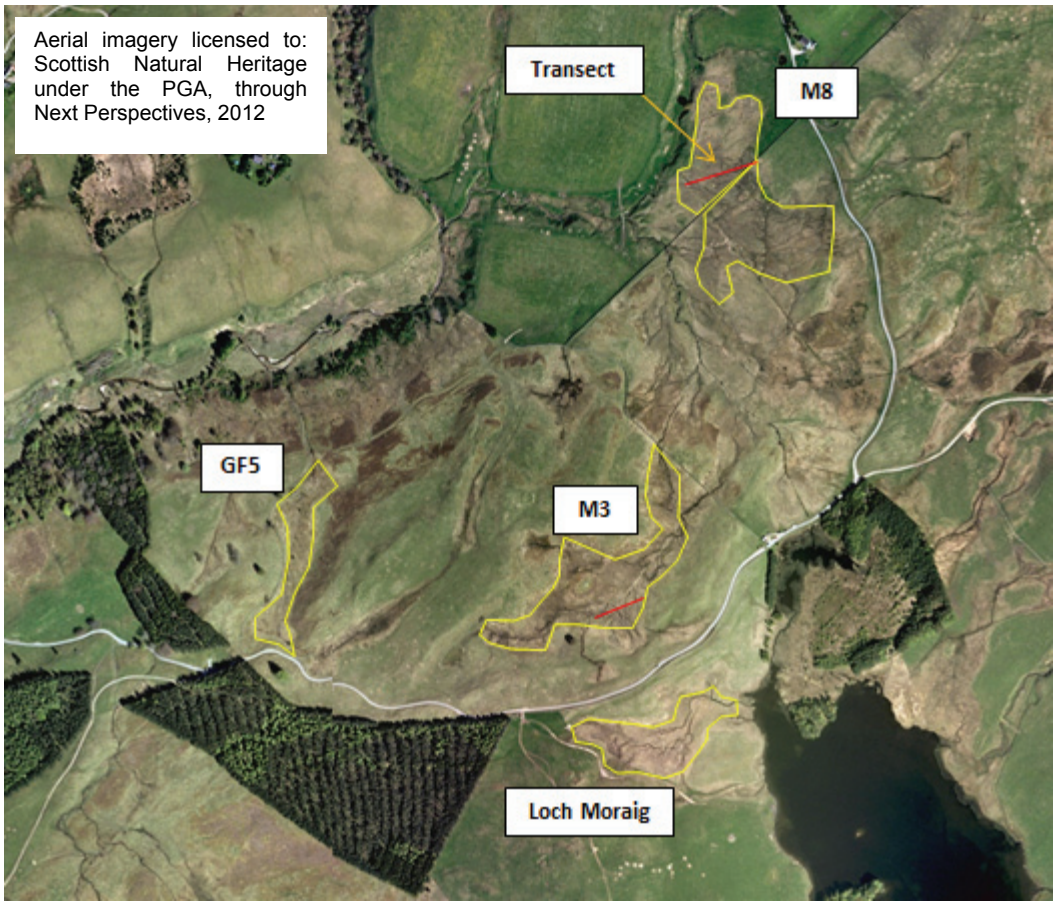


Table A1: Tulach Hill & Glen Fender Meadows sample sites

Flush No	Grid Ref	Habitat description
3	NN90271 62744	Extensive hillside flush, stony in places, but mainly homogenous habitat with luxuriant mosses (*Palustriella* and *Campylium*) and *Carex viridula*
4	NN90260 62524 to 90306 62495	60m transect, see Figures A2 and A7
9	NN89391 62748 to 89337 62701	60m transect, see Figures A2 and A8
13	NN89178 63001	Relatively step flush slope with stony areas and extensive tufa deposition. Habitat dominated by *Carex viridula*, with mosses (*Palustriella* mostly)
24A	NN87755 63631	Dendritic network of runnels with *Drepanocladus, Campylium, Saxifraga,* occasional *Palustriella*
24B	NN87797 63530	Sward and mounds with mosaic of moss and sedge habitat, also *Pinguicula*
28	NN87079 64049	Extensive seepage slope with *Eriophorum, Carex viridula, Campylium, Drepanocladus*, juniper, some tufa deposition

Table A1 continued: Tulach Hill & Glen Fender Meadows sample sites

Flush No	Grid Ref	Habitat description
Invervack	NN83895 64786	Runnel with calcareous flush habitat (*Drepanocladus, Carex viridula, Campylium, Eriophorum, Selaginella*) amongst heather moorland and mire
GF1	NN89265 66945	Extensive area of fen meadow, seepage slopes, runnels with high diversity fen flora (see M8 below)
GF2	NN88621 66819	Spring with runnels with mosses and sedge
M8 south	NN89553 67524	On south side of wall near base of *Schoenus ferrugineus* flush, with mounds with mosses and *Carex viridula, Drepanocladus* , *Eleocharis, Eriophorum, Equisetum, Saxifraga, Carex dioica, C. pulicaria, Tofieldia, Selaginella,* orchids*, Campylium*
Loch Moraig	NN90379 56834	Near springhead, mounds and runnels with mosses and sedges, diverse flora (see M8)
M3	NN90347 67003 to 90408 67019	60m transect, see Figure A6 and A9
M8	NN90563 67608 to 90430 67548	145m transect, see Figure A6 and A10

Table A2: Results: Molluscan analysis of Tulach Hill samples

Species	3	4			9		13	24A	24B	28	Ínverv
		15m	30m	50m	5m	49m					
Vertigo geyeri Adult	2	9	6	4	5	1	4	6	6	13	5
Vertigo genesii Adult											
V. geyeri/genesii Juvenile	10	13	4	4	9	4	3	4	4	8	3
Vertigo substriata	4	8	5	4	4	14	9	2	3	1	2
Columella aspera	4	2			2	4	4	2		1	
Carychium minimum	12	17	9	14	14	12	12	3	3	3	1
Carychium tridentatum	4			1		1		2		2	
Oxyloma elegans					1		3				
Cochlicopa lubrica		1	2	5	6	1	3		1	2	6
Punctum pygmaeum	14	3		8	6	4	11	16	2	13	
Nesovitrea hammonis	9	5	2	4	1	3	1	1	3		1
Vitrea contracta	7	1	2			4	11			2	
Euconulus alderi	5	8	2	6	7	10	9	4	2	1	2
Trochulus hispidus	4	2	3	4	3	4	10	2	4	2	
Galba truncatula		2		1	9	5	3	5	4	6	6
Pisidium personatum		1	3		1					1	1
Total No. of species	10	12	9	10	12	12	13	10	9	12	8
Total No. of snails	75	72	38	55	68	67	83	47	32	55	27

Table A3: Results: Molluscan analysis of Glen Fender samples

Species	Site	GF1	GF2	Loch Moraig	M3 Transect 8m	M3 Transect 31.5m	M8	M8 transect 13m	M8 transect 44m	M8 transect 65m	M8 transect 116m
Vertigo geyeri Adult		37	9	12	1	1	12	3	6	8	6
Vertigo genesii Adult		2	4	5	4	3	14	12	4		
V.geyeri/genesii Juvenile		20	14	11	7	12	21	12	9	18	21
Vertigo substriata		2	4	9	1	2	13	1	2	1	6
Columella aspera					1	3	2			1	
Carychium minimum		9	13	12	14	11	13	3	5	6	5
Carychium tridentatum		3			4		12	2			
Oxyloma elegans				1			2	4	2		
Cochlicopa lubrica				5	4	4	1				
Punctum pygmaeum		7	2	2	4	4	2	2		2	5
Nesovitrea hammonis		4	1	2		2	4	12	2	4	2
Vitrea contracta					4	4					
Euconulus alderi		10	3	4	7	5	19	7	8	6	3
Vertigo antivertigo			4	6	1	3		1			4
Galba truncatula		17	5	10	6		8	4	2	2	6
Pisidium personatum			2	8	3	6	2		6	1	
Total No. of species		9	10	12	13	12	13	11	9	9	8
Total No. of snails		111	61	87	61	60	125	63	46	49	58

Figure A7: Tulach Hill Flush 4 transect

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 1999a)
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

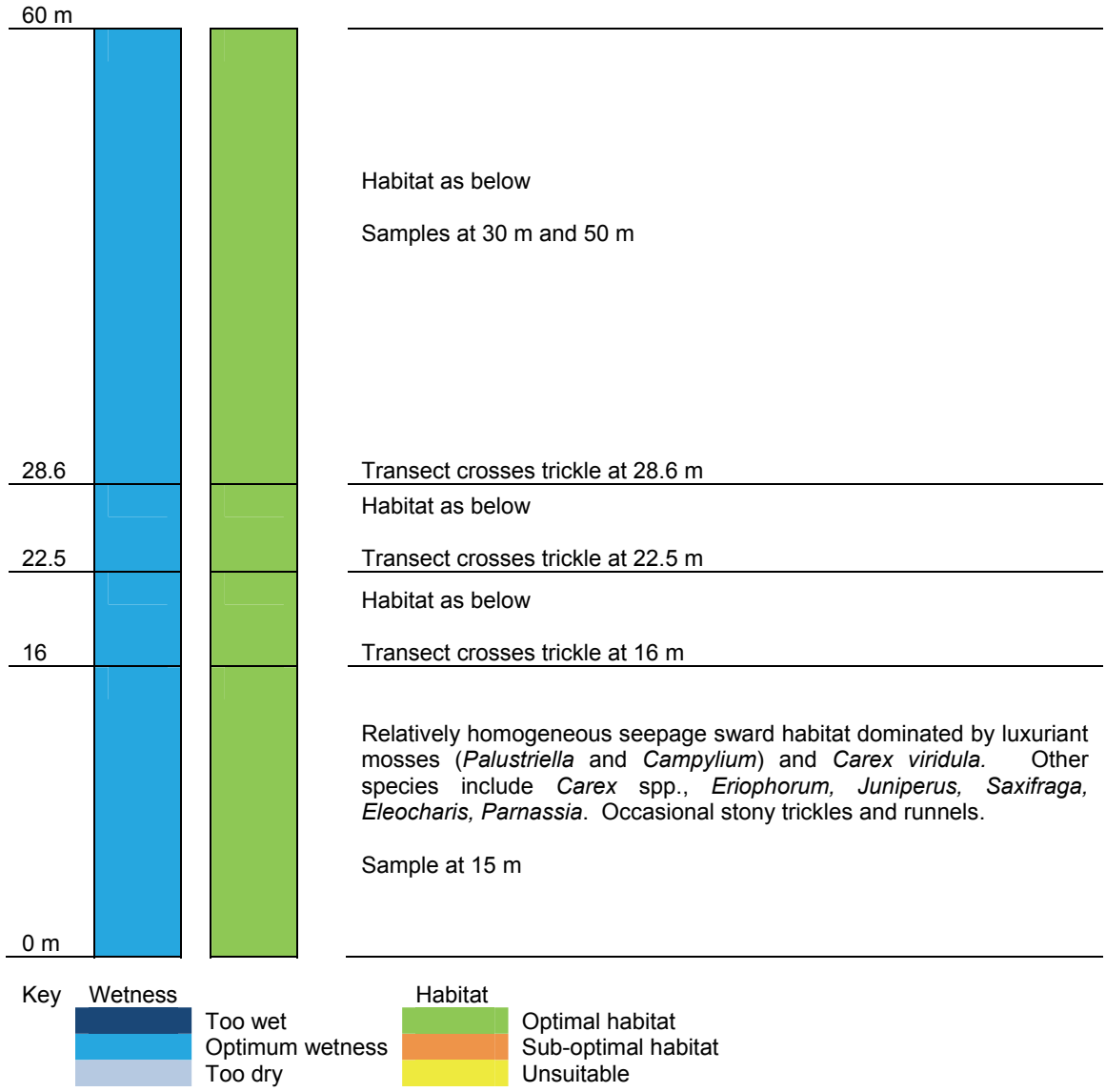


Figure A8: Tulach Hill Flush 9 transect

Start Point:	Start point is by three 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 1999a)
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

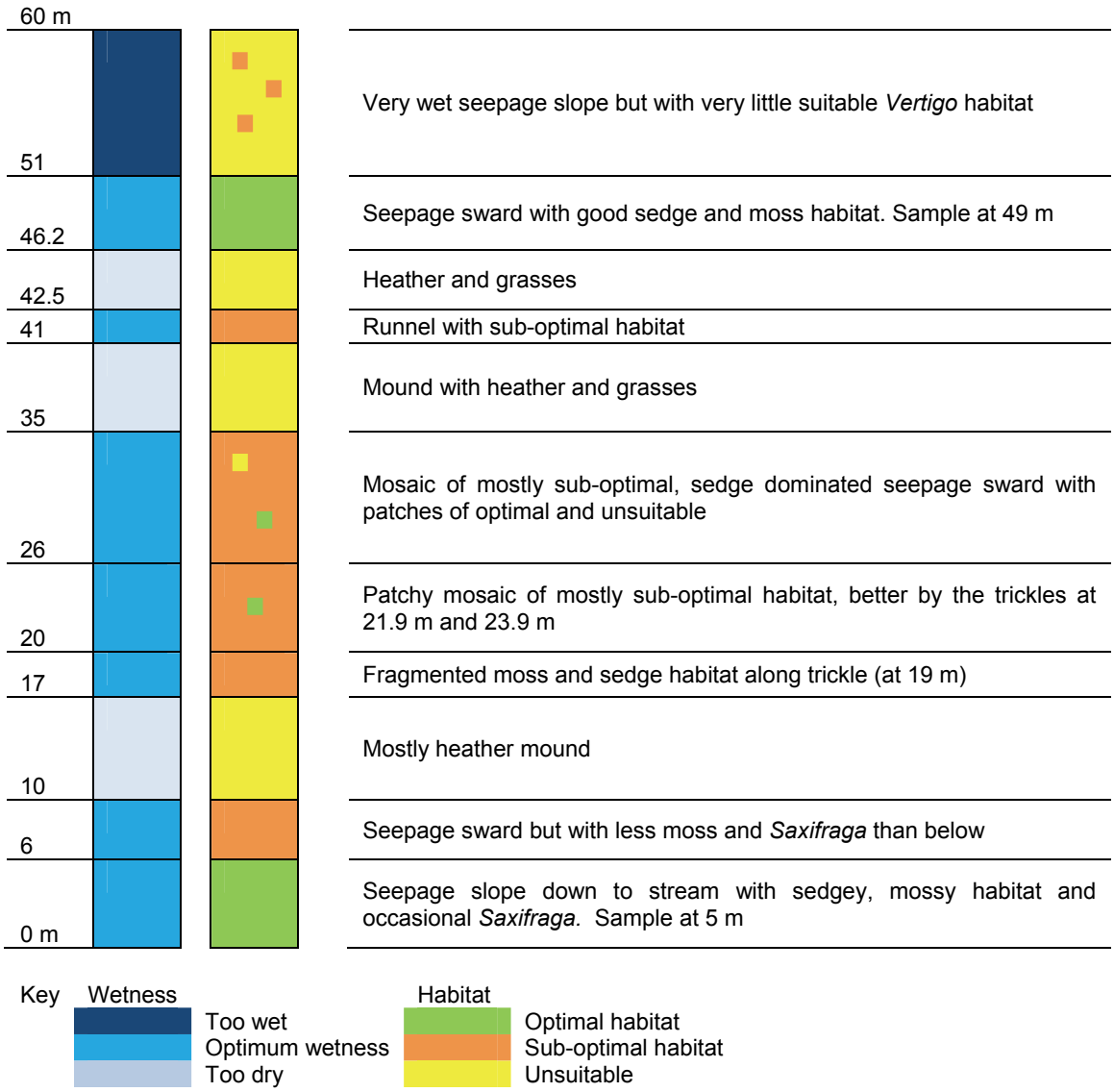


Figure A8: Glen Fender M3 transect

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. In Flush area 9 of the 1998 survey.
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

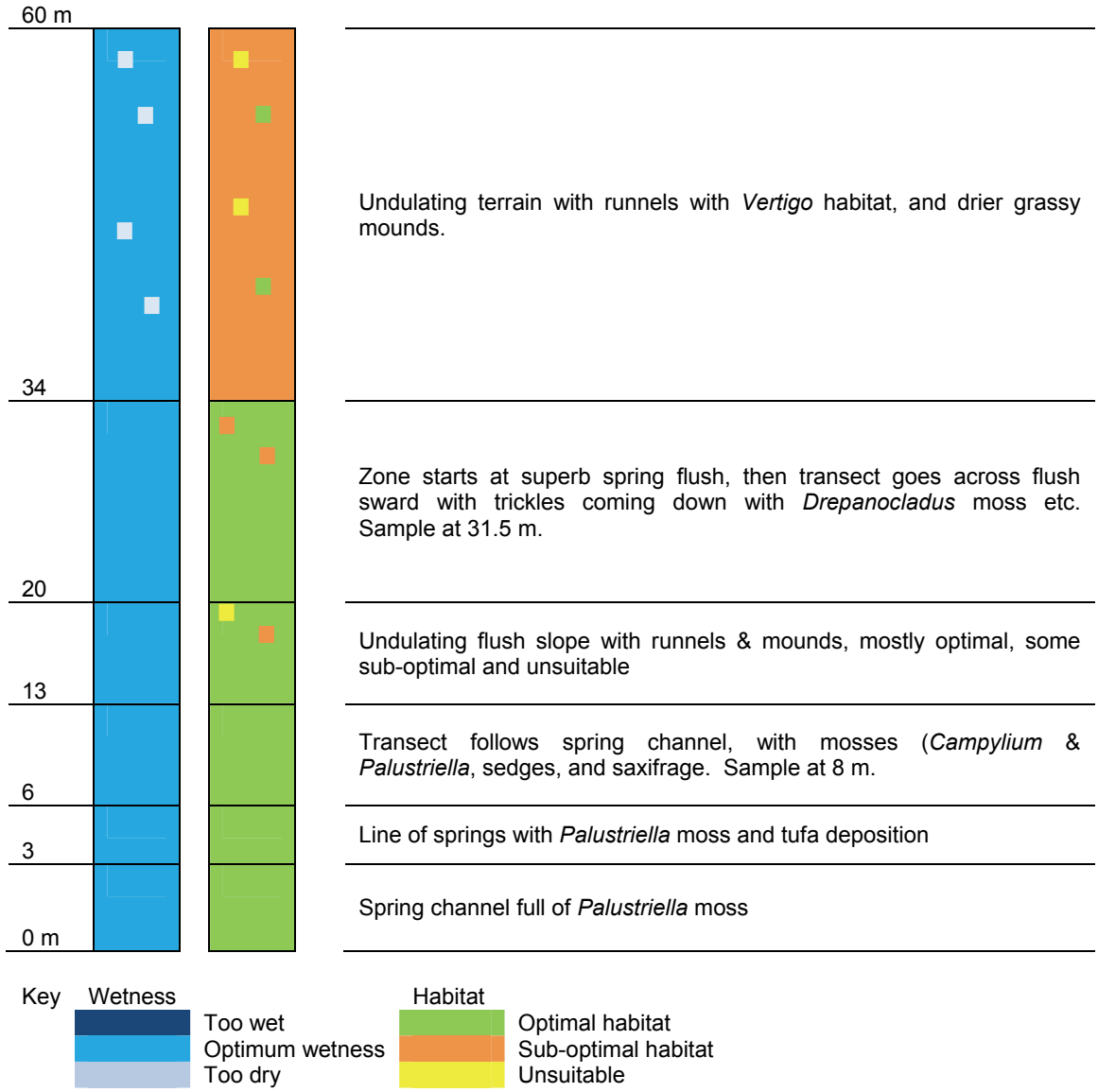
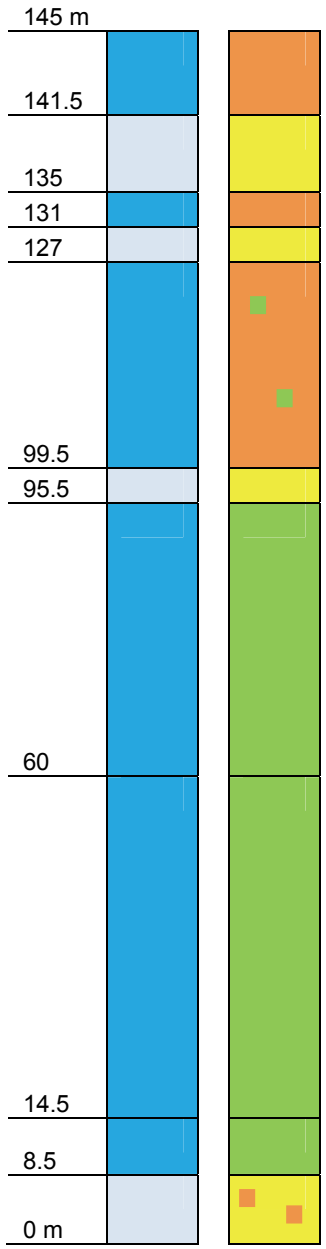


Figure A9: Glen Fender M8 transect

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, 1999a)
Direction:	West to east
Sampling frequency:	As for Tulach Transect 4. Four samples were taken at various intervals along the transect



141.5 – 145 m	Patches of low sward with sedges and bare muddy areas. This is the end of good habitat, beyond here the slope steepens and goes down to a deep runnel
135 – 141.5	Taller, *Briza* dominated grassland
131 – 135	Same as for 99.5-127 m
127 – 131	Low, grassy mound
99.5 – 127	Low sward with sedges, grasses and herbs, and *Campylium*. Good habitat is patchy. Sample at 116 m
95.5 – 99.5	Grassy mound with *Briza*
60 – 95.5	More continuous low sward than previous zone, with sparser *Schoenus*, runs along N side of trickle which transect crosses at 92m. Sample at 65.5 m
14.5 – 60	Very wet ground with trickles and bare patches, mounds with *Schoenus ferrugineus* and *Drepanocladus* but also sward below. Other plants include: *Eleocharis, Eriophorum, Equisetum, Saxifraga, Carex dioica, C. pulicaria, Tofieldia, Selaginella,* orchids*, Campylium* Sample at 44 m
8.5 – 14.5	Flush sward, <15 cm high with *Carex viridula*, other *Carex* spp. *Briza*, mosses (*Drepanocladus, Campylium*). Sample at 13 m
0 – 8.5 m	Steep, grassy slope with *Briza, Filipendula* and low herbs

Key

Wetness
- Too wet
- Optimum wetness
- Too dry

Habitat
- Optimal habitat
- Sub-optimal habitat
- Unsuitable

Photographs: Tulach Hill

1. Tulach Hill Flush 1 (foreground) and 3 (back)

2. Tulach Hill flush area 3 habitat

3. Tulach Hill flush area 4, east of wall

4. Tulach Hill flush area 4, west of wall

5. Tulach Hill flush area 7

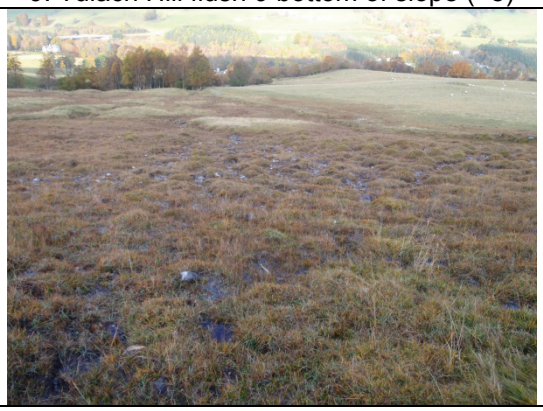
6. Tulach Hill flush area 7 habitat

7. Tulach Hill flush 9 view NE from NN8929 6299

8. Tulach Hill flush area 9 habitat

9. Tulach Hill flush 9 bottom of slope (=8)

10. Tulach Hill flush 13



11. Tulach Hill flush 13

12. Tulach Hill flush 13 habitat

13. Tulach Hill flush 13 habitat with tufa

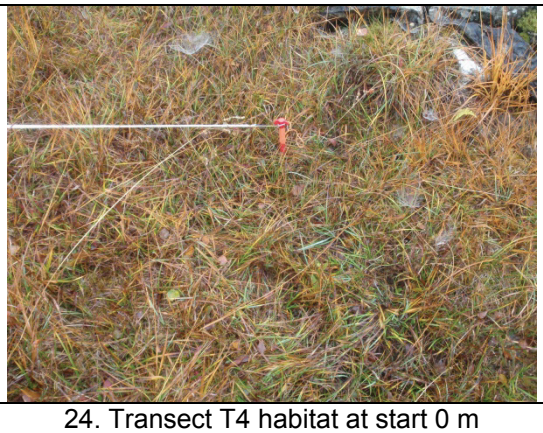
14. Tulach Hill flush 24

15. Tulach Hill flush 24, habitat at 24A

16. Tulach Hill flush 24, habitat at 24B

	
17. Tulach Hill flush 28	18. Tulach Hill flush 28 habitat
	
19. Tulach Hill Invervack	20. Tulach Hill Invervack habitat

Photographs: Tulach Hill Transect T4

	
21. Transect T4 view towards start from 30 m	22. Transect T4 view towards end tree from 30 m
	
23. Transect T4 view towards start from end 60 m	24. Transect T4 habitat at start 0 m

25. Transect T4 habitat at 16 m

26. Transect T4 habitat at start 23.5 m

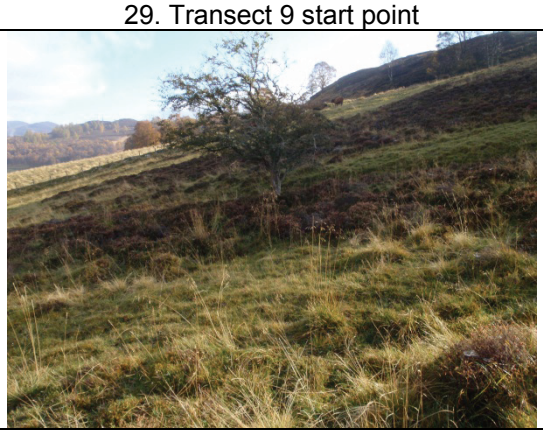
27. Transect T4 habitat at 40 m

28. Transect T4 habitat at 50 m

Photographs: Tulach Hill Transect 9

29. Transect 9 start point

30. Transect 9 view towards start from end



31. Transect 9 hawthorn just beyond end point

32. Transect 9 habitat at 6 m

	
33. Transect 9 habitat at 10-17 m (unsuitable)	34. Transect 9 habitat at 23.9 m
	
35. Transect 9 habitat at 34.5 m	36. Transect 9 habitat at 48 m
	
37. Transect 9 view downslope from 48 m	

Photographs: Glen Fender

38. Glen Fender flush area GF1, view from road

39. Glen Fender flush area GF1, habitat (cattle trampled)

40. Glen Fender flush area GF2 view from road

41. Glen Fender flush area GF2 view from road

42. Glen Fender flush area GF3 lower slopes

43. Glen Fender flush area GF5 view from road

44. Glen Fender flush area GF5 spring habitat (note quad bike tracks)

45. Supplementary feeding in area west of GF5

46. Glen Fender flush area M3, view west

47. Glen Fender flush area M3 springs

48. Glen Fender flush area M3 habitat

49. Glen Fender flush area M8, view NE from road with Monzie farm in background

50. Glen Fender flush area M8, view east along the separating wall

51. Glen Fender flush area M8, sample site on south side of wall

52. Glen Fender flush area M8, habitat on south side of wall with track damage

53. Glen Fender flush area M8, habitat on north side of wall

Photographs: Glen Fender Transect M3

54. Transect M3: view back from end point at 60 m

55. Transect M3: view towards end point from start

56. Transect M3: Habitat at 1.8 m

57. Transect M3 : Habitat at 3 m

58. Transect M3 : View back from 13 m towards start

59. Transect M3 : View from 13 m towards end

	
60. Transect M3 : Habitat at 20 m	61. Transect M3 : Habitat at 32.5 m
	
62. Transect M3: view towards end from 34 m	63. Transect M3: Habitat at 41.5 m

Photographs: Glen Fender Transect M8

64. Transect M8 start point fence post

65. Transect M8 view down from start

66. Transect M8 view back from boulder at 59 m

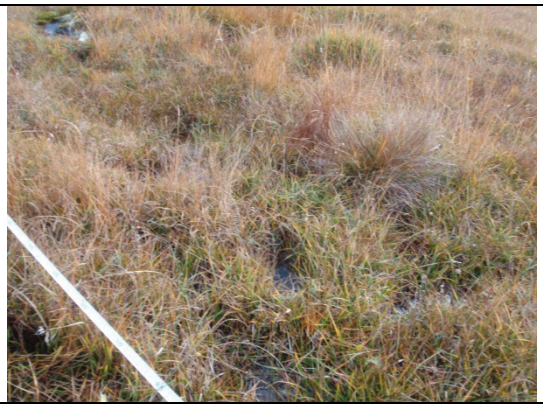
67. Transect M8 : Habitat in 0-8.5 m zone

68. Transect M8 : Habitat at 14 m

69. Transect M8 : Habitat in 14.5-60 m zone

70. Transect M8 : Habitat at 35 m

71. Transect M8 : Habitat at 55 m



72. Transect M8 : Habitat at 65.5 m

73. Transect M8 : Habitat at 97 m, grassy mound

74. Transect M8 : View back from 90 m

75. Transect M8 : View back from 120 m

76. Transect M8 : Habitat at 116 m

77. Transect M8 : Habitat at 129 m

78. Transect M8 : Habitat at 133 m

79. Transect M8 : Habitat at 144 m

Photographs: Loch Moraig

80. Loch Moraig flush: view downslope from spring

81. Loch Moraig flush: habitat near springhead

82. Loch Moraig flush: habitat near base of slope

83. Loch Moraig flush: habitat near base of slope

ANNEX B: BLACK ISLE - BRAELANGWELL WOOD

Table B1: Black Isle, Braelangwell Wood sample sites

No	Grid Ref	Habitat description
	Eastern unit	
1	NH69266 63431	Saturated, moss-dominated flush with *Palustriella, Drepanocladus and Calliergonella,* and *Pinguicula, Eriophorum, Equisetum, Carex viridula*, orchids
2	NH69294 63385	Steep flush slope with *Schoenus nigricans*, other plants as above but also the moss *Campylium stellatum*
3	NH69251 63297	Small spring flush area on upper slope with mostly *Schoenus, Carex viridula* and *Palustriella*
4	NH69238 63395	Flush with mounds of moss (*Drepanocladus & Campylium*), *Schoenus, Equisetum, Carex viridula*
5	NH69246 63521	Spring runnel, plants much the same as site 1
	Western unit	
6	NH68868 63117	SW corner of seepage sward with *Carex viridula, Equisetum, Pinguicula, Drepanocladus, Palustriella, Campylium*, orchids
7	NH68828 63862	Flushy runnel, very mossy with sedges, *Schoenus* and *Equisetum*
8	NH68842 63235	Taller, flushy sward with similar flora but less optimal
9	NH68869 63163	Calcareous runnel with all flora as for site 1
10	NH68925 63159	Flush slope with all flora as for site 1 plus other *Carex* spp., *Juncus articulatus, Eleocharis quinquefolia*
	Central unit	
11	NH69061 63323	Tufa depositing flush with *Schoenus, Carex viridula, Pinguicula, Palustriella, Drepanocladus, Campylium*
12	NH69028 63338	Tufaceous seepage sward with all of above plus *Carex dioica, Eleocharis quinquefolia, Selaginella* (No *Schoenus*)

Figure B1: Braelangwell Wood principal flush areas

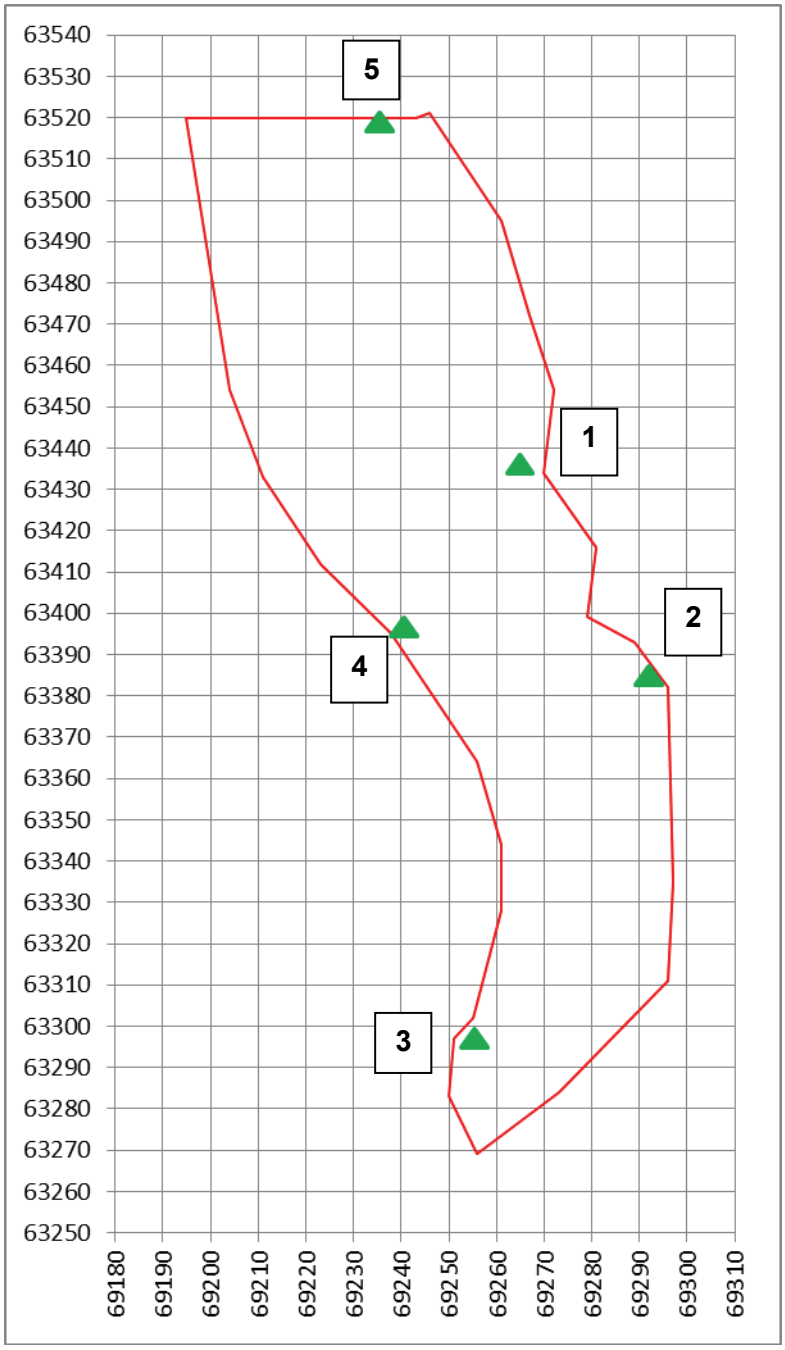


Figure B2: Braelangwell Wood Eastern flush area outline polygon and sample sites

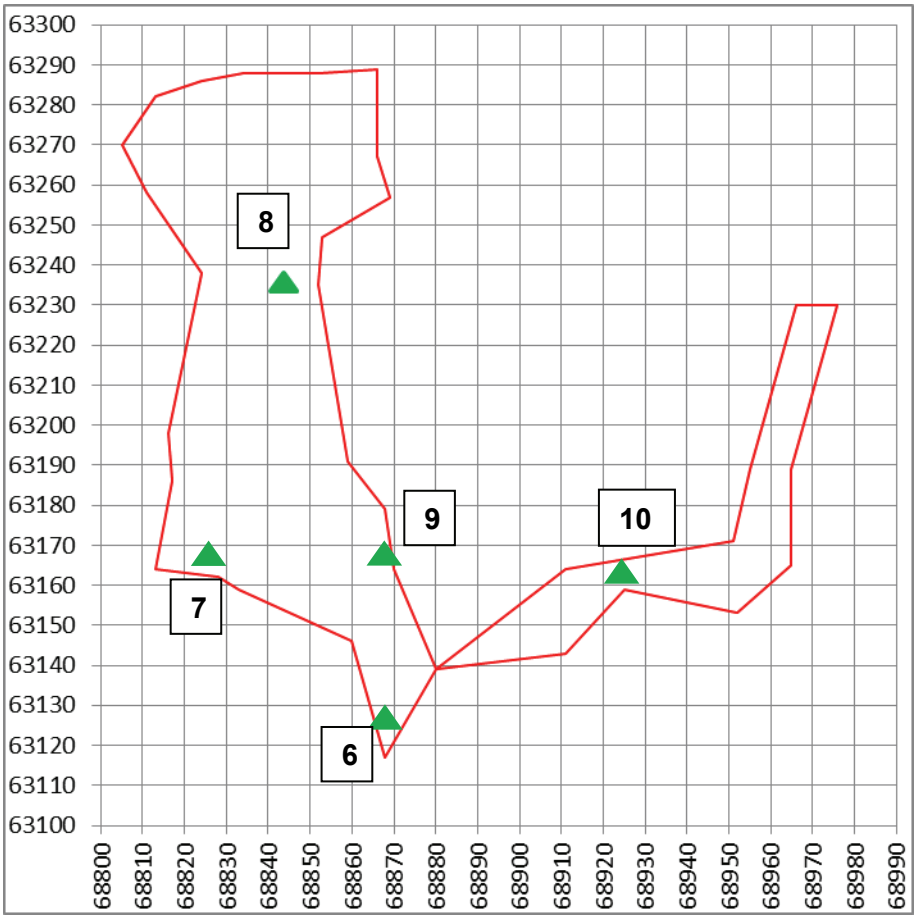


Figure B3: Braelangwell Wood Western flush area outline polygon and sample sites

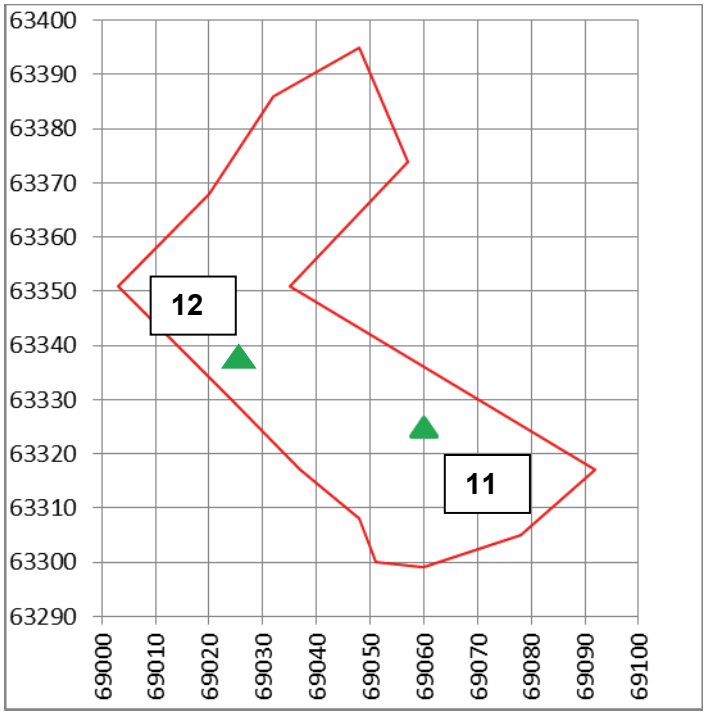


Figure B4: Braelangwell Wood Central flush area outline polygon and sample sites

Table B2: Results: Molluscan analysis of Braelangwell Wood samples

Species Site No.	1	2	3	4	5	6	7	8	9	10	11	12
Vertigo geyeri Adult	3	2			3		1		7		3	23
Vertigo genesii Adult		1					3		1		10	19
V. geyeri/genesii Juvenile	2				1		4		8	4	12	56
Acanthinula aculeata			1	1							1	1
Aegopinella pura		1		1		1		1			1	
Carychium minimum	8	7	2	3	3	11	4	4	13	11	3	16
Carychium tridentatum	3	2	10	12		5	8		8			
Cepaea nemoralis						3						
Cochlicopa lubrica	3			4	3	1	2	4	7	2		2
Columella aspera	1	4	1			4			2			2
Euconulus alderi	7		4	5	7	10	6	4	4	11	4	2
Leiostyla anglica	6	5	23	10	3				12	1		
Nesovitrea hammonis	3	2	1	16	2	8	1	1	5	9	3	4
Oxyloma elegans											8	
Punctum pygmaeum	1	2		7		3	4	5	1	2	2	10
Pupilla pratensis											9	11
Spermodea lamellata		2										
Vertigo antivertigo					1							
Vertigo substriata		7	1	7		3		6	6		3	9
Vitrea contracta	1	1		2			1	1	1			
Galba truncatula		6		1	18			1	4		9	1
Pisidium personatum										1	9	
Total No. of species	10	13	8	11	9	10	9	9	13	8	13	12
Total No. of snails	38	42	43	69	41	49	34	27	79	41	77	156

Figure C4: Photographs

84. Eastern unit typical habitat

85. Sample site 1

86. Sample site 2

87. Sample site 3

88. Sample site 4

89. Sample site 5

90. Western unit view down from NE corner

91. Sample site 6

92. Sample site 7

93. Sample site 8

	
94. Sample site 9	95. Sample site 10
	
96. Central unit view up from bottom of slope	97. Sample site 11
	
98. Sample site 12	99. Habitat to N of Sample site 12

ANNEX C: BLACK ISLE - BELMADUTHY DAM

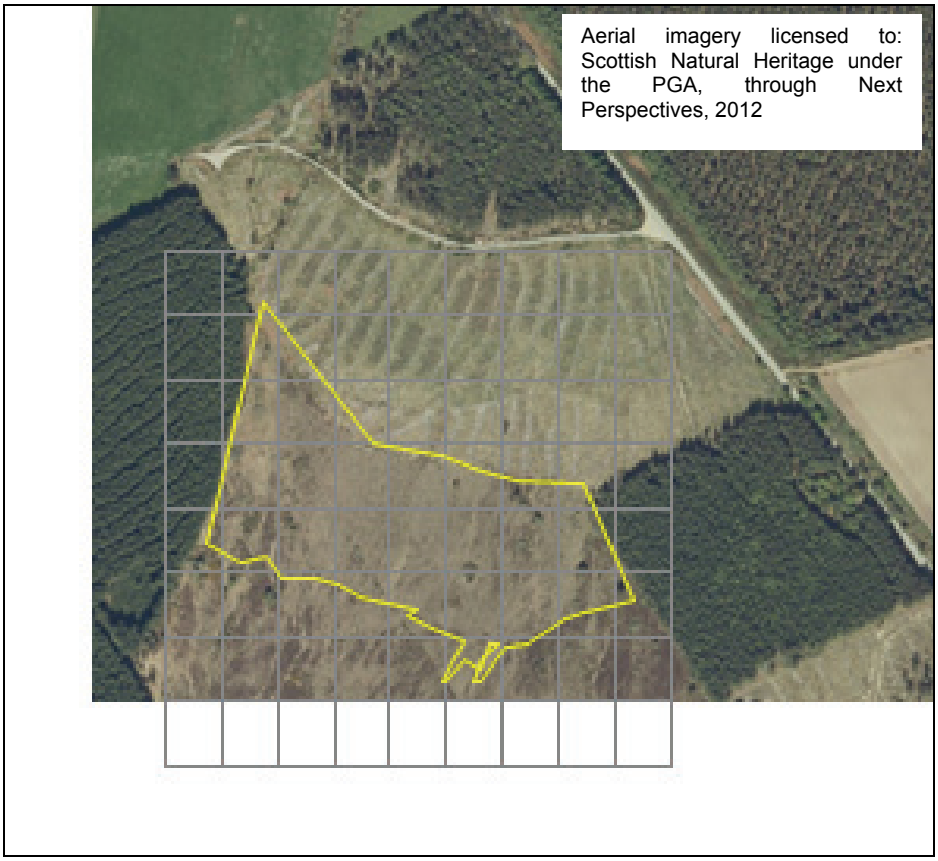


Figure C1: Belmaduthy Dam principal flush area

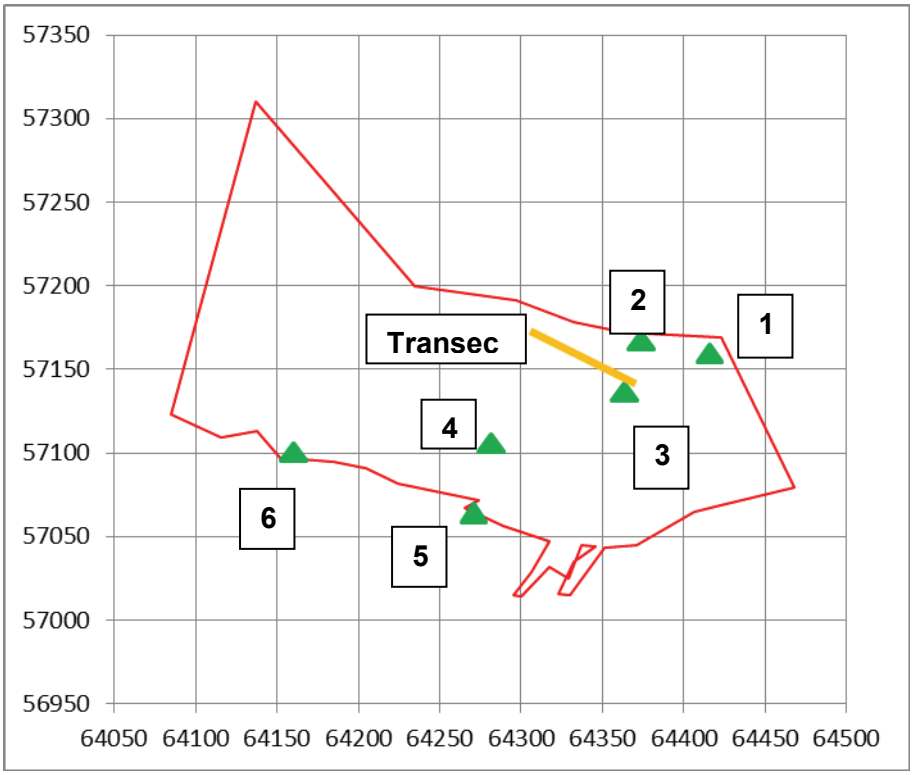


Figure C2: Belmaduthy Dam principal flush area outline polygon and sample sites

Table C1: Black Isle, Belmaduthy Dam sample sites

No	Grid Ref	Habitat description
1	NH64416 57157	Flush near gate
2	NH64377 57172	Spring with *Palustriella*
3	NH64360 57140	Flush area with *Schoenus, Carex viridula, Pinguicula, Drepanocladus*
4	NH64287 57117	Seepage with mostly *Campylium* and some *Drepanocladus*
5	NH64265 57068	Near ditch on south side of the main site, near large *Schoenus* tussock with *Carex viridula*, orchids, *Campylium, Drepanocladus*
6	NH64161 57100	In SW corner, optimal flush with *Schoenus, Drepanocladus, Campylium, Carex viridula, Pinguicula*

Table C2: Results: Molluscan analysis of Belmaduthy Dam samples

Species	Site No.	1	2	3	4	5	6	Transect		
								4.2m	46m	55m
Vertigo geyeri Adult		1	3	3	10	1	13	2		3
V. geyeri Juvenile			2		5	4	8	2		3
Carychium minimum			3		10	5	6	3	1	2
Carychium tridentatum		1	1	2				1	4	2
Clausilia bidentata						1				
Cochlicopa lubrica		1	2	1	4	3	1	1	1	2
Columella aspera		1				1				1
Euconulus alderi			3	3						1
Leiostyla anglica			14					47	21	17
Nesovitrea hammonis						1				1
Punctum pygmaeum				2			1	3	2	4
Pupilla pratensis					1			2		
Vertigo antivertigo		1	2	1			2			
Vertigo substriata			3		2	3	2	19	1	3
Vitrea contracta					1	1				
Galba truncatula		2			3		2			1
Pisidium personatum					3	1		3	6	3
Total No. of species		6	8	6	8	9	7	9	7	12
Total No. of snails		7	33	12	39	21	35	83	36	43

Figure C3: Belmaduthy Dam transect

Start Point:	Post near two birch trees at NH64312 57173
End point:	Post at NH64365 57138
Transect Length:	62.8m
Description:	The transect runs between two 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. Three 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

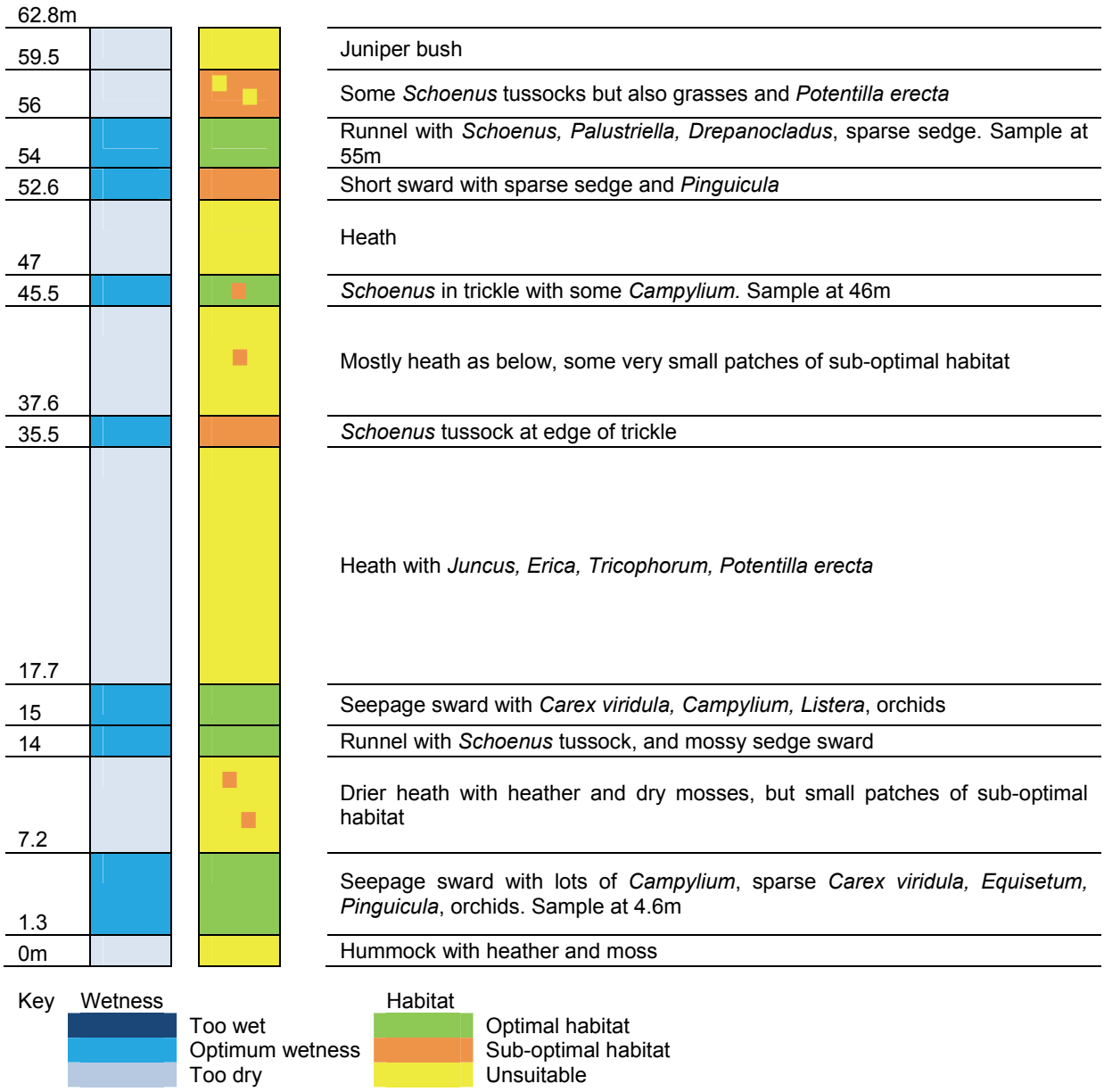


Figure C4: Photographs Belmaduthy Dam

100. View SW from gate with sample site 1

101. View W from NH6437 5104

102. Near SW corner at NH6415 5110

103. *Equisetum* swamp along western edge

104. Habitat at NH6433 5118

105. Habitat at NH6438 5117

106. Sample site 3

107. Sample site 4

	
108. Sample site 5	109. Sample site 6

ANNEX D: SCHIEHALLION (LOCHAN AN DAIM)

Figure D1: Lochan an Daim principal flush area

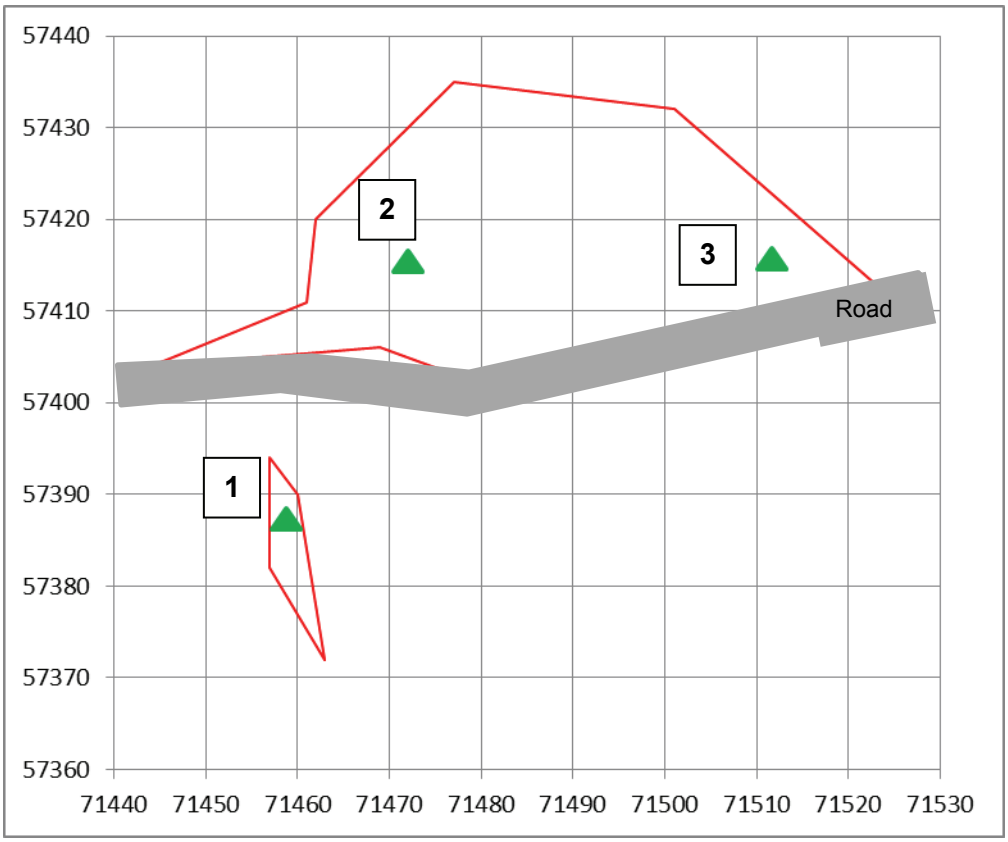


Figure D2: Lochan an Daim principal flush area outline polygon and sample sites

Table D1: Lochan an Daim sample sites

No	Grid Ref	Habitat description
1	NN71460 57383	Narrow, stony flush on south side of road near spring with some tufa deposition. Plants include *Saxifraga azoides, Carex viridula, Pinguicula, Eriophorum, Eleocharis, Drepanocladus*, occasional *Selaginella*
2	NN71472 57415	Slope with flush sward with all of above species plus additional *Carex* spp., *Tofieldia, Campylium.* Sample from low down the slope
3	NN71512 57415	As above, but sample from higher up the slope

Table D2: Results: Molluscan analysis of Lochan an Daim samples

Species	Site	1	2	3
Vertigo geyeri Adult		6	54	15
V. geyeri Juvenile		8	33	29
Vertigo substriata		7	3	4
Columella aspera				1
Carychium minimum		12	24	10
Cochlicopa lubrica		9		2
Punctum pygmaeum		8	1	
Nesovitrea hammonis		5	2	2
Vitrea contracta		3	2	2
Euconulus alderi		1	3	6
Galba truncatula		1	2	8
Pisidium personatum			1	1
Total No. of species		9	9	10
Total No. of snails		60	125	80

Figure 3: Photographs - Lochan an Daim

	
110. Flush on S side of road	111. Flush on N side of road looking upslope (E)
	
112. Sample site 1 habitat	113. Flush on N side near base of slope
	
114. Sample site 2 habitat	115. Sample site 3 habitat

ANNEX E: GLEN TILT

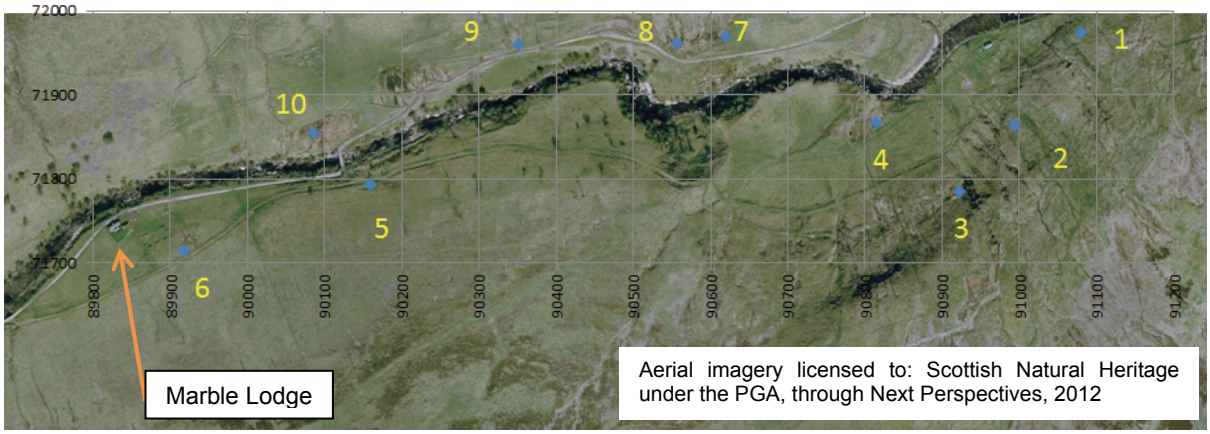


Figure E1: Glen Tilt aerial showing sample sites

Table E1: 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
3	NN90922 71785	Steep slope with runnel, mostly *Carex viridula, Eriophorum* and *Pinguicula*, mosses very sparse
4	NN90815 71868	Flush area at base of slope with seepage sward, stony in places, with *Carex viridula, Palustriella, Saxifraga, Pinguicula*, orchids, *Eriophorum*
5	NN90159 71793	Small flush just SE of bridge, habitat as for site 6
6	NN89919 71715	Near Marble Lodge, stony flush with *Carex viridula, Saxifraga, Palustriella, Drepanocladus, Pinguicula, Eriophorum, Selaginella*
7	NN90620 71970	Network of spring flush runnels with *Carex viridula, Juncus articulatus, Eriophorum, Campylium, Selaginella, Briza*
8	NN90557 71962	
9	NN90358 71941	Slope with series of stony flush runnels, mostly *Saxifraga, Carex viridula,* and *Drepanocladus*
10	NN90088 71846	Flush on N side of river, W of bridge

Table E2: Results: Molluscan analysis of Glen Tilt samples

Species	Site	1	2	3	4	5	6	7	8	9	10
Vertigo geyeri Adult					8			1		6	3
Vertigo genesii Adult											
V. geyeri/genesii Juvenile					6			5	2	15	9
Acanthinula aculeata		1									
Arianta arbustorum				1	1						
Carychium minimum		2	1	2	3	2	7	5	7	13	22
Carychium tridentatum		3	1		11	12	2				
Cochlicopa lubrica		2	7	4	4	1	3	1		5	1
Columella aspera			4							6	4
Columella edentula		1									
Euconulus alderi		1	3	2	8						
Nesovitrea hammonis		4	5		1	3	8				1
Oxyloma elegans										17	3
Punctum pygmaeum		1	4		8	2	1	9	3	5	3
Trochulus hispidus			1	2	1						
Vallonia excentrica			3	1			1				
Vertigo antivertigo								1		11	3
Vertigo pygmaea		1			2					7	1
Vertigo substriata			5		3	6	1	7	5	18	12
Vitrea contracta		1	7	1	2	1			3	2	1
Galba truncatula		11			1	2	15	2	2	19	4
Radix balthica							1				
Pisidium personatum					4			3			1
Pisidium casertanum								3	2		
Total No. of species		11	12	8	15	9	9	9	7	11	13
Total No. of snails		28	42	15	64	29	39	36	24	124	68

Figure E2 Photographs - Glen Tilt

116. Flushes on slope on S side of river

117. Sample site 1

118. Sample site 2

119. Sample site 3

120. Flush site 4

121. Flush site 4 with *Palustriella*

	
122. Flush site 5	123. Flush site 6 towards Marble Lodge
	
124. Flush on N side of track, sites 7 & 8 view E	125. Flush on N side of track, sites 7 & 8 view W
	
126. Flush site 9	127. Flush site 10 (see other flush in background)

ANNEX F: LOCH TUMMEL

Figure F1: Loch Tummel House (tile NN8259) aerial showing flush area polygon

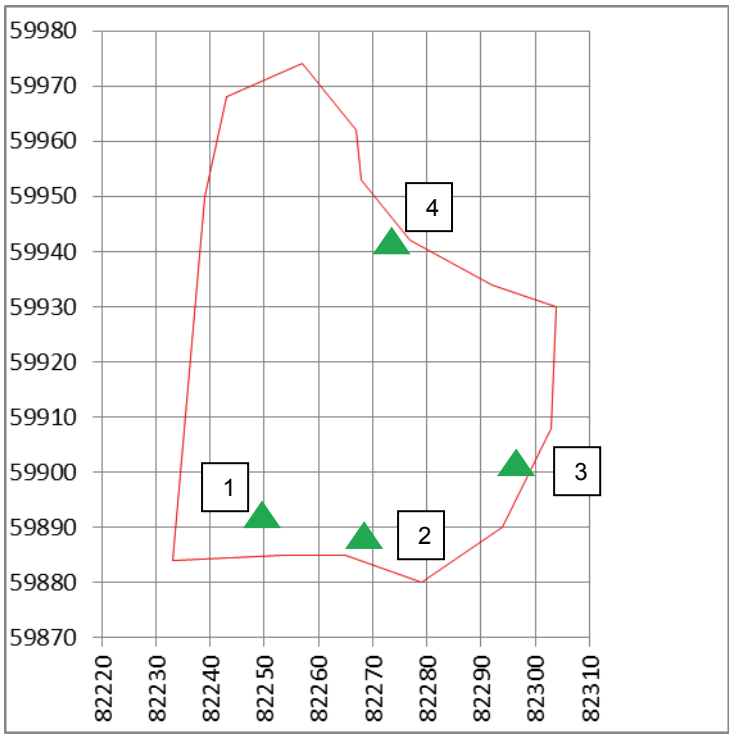


Figure F2: Loch Tummel House showing flush area polygon and sample sites

Table F1: Loch Tummel sample sites

No	Grid Ref	Habitat description
1	NN82250 59891	Diverse moss & sedge sward near bottom of slope in SW corner with *Drepanocladus, Camplyium, Carex viridula, Eriophorum*
2	NN82268 59887	South-east, high diversity sward with above species plus orchids, *Tofieldia, Eleocharis, Pinguicula*
3	NN82299 59899	Stony flush with *Schoenus ferrugineus, Saxifraga* and mosses
4	NN82277 59942	Diverse sward near top of slope

Table F2: Results: Molluscan analysis of Loch Tummel samples

Species	Site	1	2	3	4
Vertigo geyeri Adult			2	4	1
Vertigo genesii Adult					
V. geyeri/genesii Juvenile		2	1	5	1
Carychium minimum				1	5
Oxyloma elegans		5	1	5	2
Cochlicopa lubrica		1		2	2
Euconulus alderi				1	2
Trochulus hispidus			2	2	4
Galba truncatula					2
Pisidium personatum		1	1	1	3
Total No. of species		4	4	7	8
Total No. of snails		9	11	32	30

Figure F3: Photographs - Loch Tummel

128. View upslope from bottom of site

129. View down east side

130. *Schoenus ferrugineus* habitat

131. Moss and sedge sward habitat

132. Site 1 habitat

133. Site 2 habitat

134. Site 3 habitat

135. Site 4 habitat

ANNEX G: DEESIDE

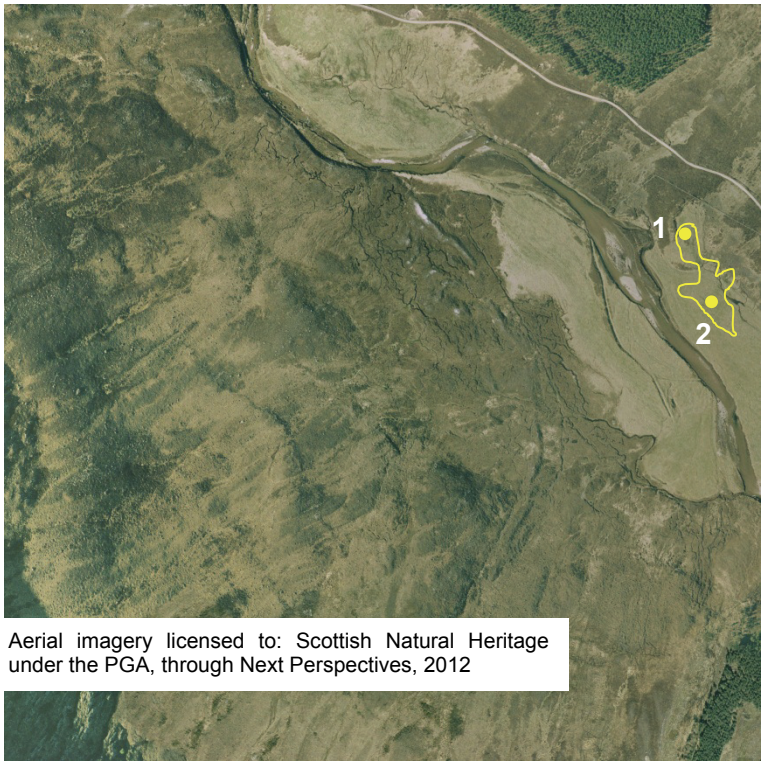


Figure G1: Glen Lui (tile NO0492) aerial showing flush area polygons & sample sites

Figure G2: Morrone Birkwood (tile NO1390) aerial showing flush area polygons & sample sites

Table G1: Deeside sample sites

No	Grid Ref	Habitat description
1	NO04932 92729	Glen Lui 1999 site 2. Rather dry, stony flush with mounds of *Drepanocladus* and *Saxifraga* in the wettest places
2	NO04961 92654	Glen Lui 1999 site 3. Wetter, stony flush with more frequent and denser mounds of moss and *Saxifraga*, plus *Pinguicula*
3	NO13739 90396	Morrone Birkwood 1999 Flush 2. Bottom of main flush slope, sward with mostly *Juncus articulatus, Carex viridula* and *Drepanocladus*
4	NO13749 90346	Morrone Birkwood 1999 Flush 2. Near top of flush slope, sward with species as for site 3, plus *Palustriella* moss and *Saxifraga azoides*
5	NO13609 90290	Morrone Birkwood 1999 Flush 3. Runnels with mostly *Palustriella, Saxifraga and Drepanocladus*, much less *Carex* and *Juncus* than sites 3 and 4

Table G2: Results: Molluscan analysis of Deeside samples

Site	1	2	3	4	5
Species	Glen Lui 2	Glen Lui 3	Morrone 2A	Morrone 2B	Morrone 3
Vertigo geyeri Adult	-	-	-	-	-
V. geyeri Juvenile	-	-	-	-	-
Vertigo substriata	4	4	7	4	1
Columella aspera	11	23			1
Carychium minimum	6	5	5	3	23
Cochlicopa lubrica	6	7		1	5
Punctum pygmaeum	16	2	2	2	8
Nesovitrea hammonis	2			5	4
Vitrea contracta	1	1			1
Euconulus alderi	23	18	1	2	1
Galba truncatula	15	12	8	7	6
Total No. of species	9	8	5	7	9
Total No. of snails	84	72	23	24	50

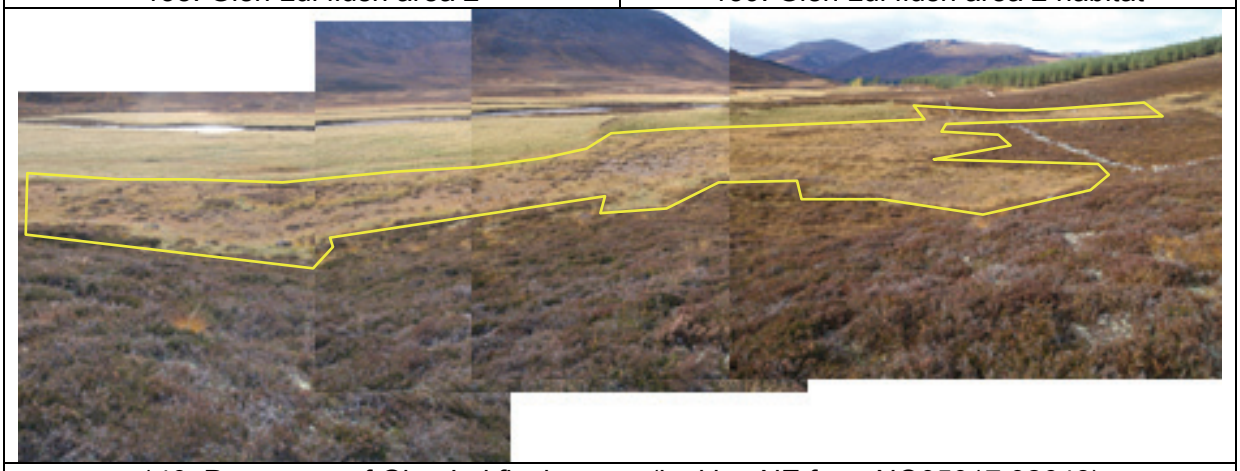
Figure G3: Photographs - Deeside

136. Glen Lui flush area 1

137. Glen Lui flush area 1 habitat

138. Glen Lui flush area 2

139. Glen Lui flush area 2 habitat



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

141. Morrone Flush 3 & 4 looking down slope

142. Morrone site 3 looking upslope

143. Morrone site 4 habitat

144. Site 5 flush

www.snh.gov.uk

ISBN: 978-1-78391-004-5

Policy and Advice Directorate, Great Glen House,
Leachkin Road, Inverness IV3 8NW
T: 01463 725000

You can download a copy of this publication from the SNH website.

recycle

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad