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The Importance of Watercourses for Lichens in Eryri SSSI

Alan Orange

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Author(s): **Alan Orange**
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1. Crynodeb Gweithredol

Cafodd 20 safle ar 15 o nentydd o fewn SoDdGA (Safle o Ddiddordeb Gwyddonol Arbennig) Eryri a SoDdGA Coedydd Aber eu harchwilio ar gyfer cennau. Roedd data cymharol ar gael o bedwar safle arall a oedd wedi cael eu harolygu yn ddiweddar o fewn SoDdGA Eryri. Cafodd safleoedd eu cymharu gan ddefnyddio cyfanswm nifer y rhywogaethau, nifer y rhywogaethau sy'n 'dibynnu ar ddŵr croyw' a sgoriau a gafwyd o'r Llyfr Data Coch, Rhywogaethau Cenedlaethol Anghyffredin a Chenedlaethol Brin. Cafodd cyfanswm o 202 o rywogaethau o gennau eu cofnodi, gan gynnwys chwe sydd yn y Llyfr Data Coch (dan fygythiad: *Lecanora achariana*, yn fregus: *Ionaspis odora*, *Koerberiella wimmeriana*, *Pertusaria chiodectonoides*, *Pterygiopsis lacustris*, *Stereocaulon delisei*) a 13 rhywogaeth sy'n agos at fod dan fygythiad. Roedd wyth rhywogaeth yn Genedlaethol Anghyffredin a 13 yn Genedlaethol Brin. Ystyriwyd bod 45 o rywogaethau yn 'ddibynnu ar ddŵr croyw'.

Roedd sgoriau safleoedd yn seiliedig ar y Llyfr Data Coch, Rhywogaethau Cenedlaethol Anghyffredin a Rhywogaethau Cenedlaethol Brin yn amrywio'n sylweddol. Fodd bynnag, cafodd rhywogaethau dan fygythiad neu fregus eu cofnodi ar 11 o'r 24 safle, ac roedd dros hanner y safleoedd yn cynnal cennau a oedd yn agos at fod dan fygythiad Roedd yr holl safleoedd bron yn cynnal rhywogaethau o ddiddordeb, ac roedd hyd yn oed y rhai a chanddynt y sgoriau isaf yn cynnal rhywogaethau nodedig nas cafwyd ar safleoedd eraill.

Gwnaeth dadansoddiad cydgasglol hierarchaidd o ddata awgrymu mai cyfoethogrwydd sylfaenol y creigiau islaw oedd y ffactor sengl pwysicaf wrth bennu'r amrediad o rywogaethau a gafwyd ar safle, er nad oedd yn bosibl adnabod y creigiau a oedd yn bresennol ar safle, a phrin oedd gallu mapiau daearegol i nodi'r is-haenau a oedd ar gael ar safle penodol. Tra bo llawer o'r safleoedd â'r sgoriau uchaf yn perthyn i'r 'grŵp â sylfaen gyfoethog', roedd eraill nad oeddent yn perthyn i'r grŵp hwn, felly, ni all y math o graig ragweld gwerth safle. Cafwyd bod rhai bryoffytau dŵr croyw'n ddangosyddion da o gyflyrau sylfaen gyfoethog. Ystyriwyd hefyd fod maint y nant (gollyngfa) yn cyfateb i sgôr uchel, yn bennaf o ganlyniad i'r arwynebedd mwy o graig sydd ar gael a rhagor o amrywiaeth o ficrogynefinoedd sy'n gysylltiedig â nentydd mwy. Fodd bynnag, nid oedd yn bosibl asesu hyn ond mewn modd goddrychol yn y math hwn o arolwg. Nid oedd yn bosibl asesu effaith gorchudd coed yn yr arolwg cyfredol gan nad oedd coedwigoedd ar yr un o'r safleoedd, ond gwyddys bod gorchudd coed yn atal tyfiant cennau ar afonydd, trwy effaith uniongyrchol y cysgod mae'n ei greu a rhagor o gystadleuaeth gan fryoffytau. Ni chafwyd hyd i unrhyw ffactorau syml a allai ragweld naill ai safleoedd â sgôr uchel neu sgôr isel, ac argymhellir bod angen cynnal arolwg o unrhyw nant lle mae maint sylweddol o graig i bennu ei hansawdd.

Mae'r safleoedd gorau a gofnodwyd yn ystod yr arolwg yn cymharu'n dda â'r safleoedd dŵr croyw gorau mewn mannau eraill yng Nghymru (er enghraifft rhannau o Afon Gwy ac Afon Wysg). Mae nentydd yn SoDdGA Eryri yn cynnal rhywogaethau nodedig sy'n brin neu'n absennol mewn mannau eraill yng Nghymru (er enghraifft *Collema glebulentum*, *Cryptothele rhodosticta*, *Lecanora achariana*, *Porina interjungens* a dwy rywogaeth o *Verrucaria* nad ydynt wedi cael eu disgrifio). Ni

chafwyd o hyd i rai rhywogaethau nodedig ond unwaith neu ychydig iawn o weithiau yn ystod yr arolwg, sy'n awgrymu bod angen llawer o nentydd i gynnal amrywiaeth dŵr croyw'r SoDdGA. I'r gwrthwyneb, mae nifer o rywogaethau ar goll ynddynt sydd i'w gweld mewn mannau eraill yng Nghymru (er enghraifft, *Collema dichotomum*, *Endocarpon adscendens*, *Leptogium magnussonii*, *Verrucaria madida*). Felly, mae cadwraeth cennau sy'n dibynnu ar ddŵr croyw yng Nghymru yn dibynnu ar amddiffyn safleoedd mewn llawer o ardaloedd gwahanol.

2. Executive Summary

Twenty sites on 15 streams within Eryri SSSI or Coedydd Aber SSSI were surveyed for lichens. Comparable data were available from an additional four recently-surveyed sites within Eryri SSSI. Sites were compared using total species-number, number of 'freshwater-dependent' species, and scores derived from the number of Red Data Book, Nationally Rare and Nationally Scarce species. A total of 202 lichen species were recorded, including six Red Data Book species (Endangered: *Lecanora achariana*, Vulnerable: *Ionaspis odora*, *Koerberiella wimmeriana*, *Pertusaria chiodectonoides*, *Pterygiopsis lacustris*, *Stereocaulon delisei*) and 13 Near Threatened species. Eight species were Nationally Rare and 13 Nationally Scarce. Forty-five species were considered to be 'freshwater-dependent'.

Sites varied considerably in scores based on Red Data Book, Nationally Rare and Nationally Scarce species. However, Endangered or Vulnerable species were recorded from 11 out of the 24 sites, and over half of the sites supported a Near Threatened lichen. Nearly all the sites supported species of interest, and even the lowest-scoring sometimes supported a notable species not found at other sites.

Hierarchical agglomerative clustering of data suggested that base-richness of underlying rocks was the most important single factor in determining the range of species found at a site, although identification of rocks present at a site was not possible, and available geological maps were limited in their ability to identify available substrata at a particular site. While many of the highest-scoring sites belonged to the 'base-rich group', others did not, so that rock type cannot predict the value of a site. Some common freshwater bryophytes were found to be good indicators of base-rich conditions. Stream size (discharge) was also considered to be correlated with high score, mainly due to the greater area of available rock and greater microhabitat diversity associated with larger streams. However, this could only be assessed in a subjective manner in this type of survey. The effect of tree cover could not be assessed in the present survey as the sites were all unwooded, but it is known that tree cover suppresses lichen interest on rivers, both by the direct effect of shading and the increased competition from bryophytes. No simple factors were found that could predict either high-scoring sites or low-scoring sites, and it is recommended that any stream with a significant amount of rock needs to be surveyed to determine its quality.

The best sites recorded during the survey compare well with the best freshwater sites in other parts of Wales (for instance parts of the River Wye and River Usk). Streams in Eryri SSSI support notable species that are rare or absent elsewhere in Wales (for instance *Collema glebulentum*, *Cryptothele rhodosticta*, *Lecanora achariana*, *Porina interjungens* and two undescribed *Verrucaria* species). Some notable species were found only once or a very few times during the survey, suggesting that many streams are needed to support the freshwater diversity of the SSSI. Conversely, they lack a number of species found elsewhere in Wales (for instance *Collema dichotomum*, *Endocarpon adscendens*, *Leptogium magnussonii*, *Verrucaria madida*). Thus the conservation of freshwater-dependent lichens in Wales depends on protection of sites in many different areas.

3. Introduction

Great Britain has a rich and relatively well-known lichen flora. Many lichen species show a marked restriction to certain geographical areas, related to factors including temperature, rainfall and reactive nitrogen deposition, and many are specific to a particular microhabitat, defined by characteristics of the substrate (such as rock type, or tree species), the supply of moisture, and degree of shade or disturbance. Historical factors, such as continuous availability of suitable habitat in one locality over a long period of time (such as continuous presence of mature trees) can be crucial in determining which species occur in a particular area, as some lichens have a limited ability to colonise new sites.

Rocks at the margins of rivers, streams and lakes support a suite of species which are mostly confined to these habitats, which are characterised by frequent to occasional submergence in water, combined with factors such as current or wave action, and scouring. Since this suite of species is almost confined to rocky substrata, they are best-developed at sites with moderate to high gradient, such as upland streams, and rejuvenating stretches of lowland rivers. The lichens of watercourses are still rather poorly surveyed in comparison with some other habitats; this is due in part to small but significant practical difficulties, such as the need for low water levels to carry out a complete survey, and the difficulties of collecting adequate voucher specimens from the often hard and smooth rocks. In addition, some river lichens belong to groups in which identification is difficult and the taxonomy poorly known until recently, for instance cyanolichens, and the family *Verrucariaceae*. The survey of Gilbert & Giavarini (1997) is the most extensive single study of the lichens of British rivers, surveying 45 sites in upland England. They divided the vertical range of species into four named zones: the submerged zone with 15 species, the fluvial mesic with c. 25 species, both zones with mainly 'aquatic' species; the fluvial xeric with 50 species of weakly aquatic or terrestrial species, and a fluvial terrestrial zones comprising mainly terrestrial species on rocks kept open by scouring. They also divided stream courses into headwaters (springs and rills), torrent zones (with a low lichen and bryophyte cover due to scouring and instability), colluvial zones (with gentler flow rates, large stable boulders, and often a rich lichen flora), and alluvial zones (suitable substratum rare due to soft beds and silting). The type of rock substratum was shown to be a more importance determinant of the lichen community present than water chemistry, although it was suggested that cyanolichens needed waters which were pH 6 and above throughout the year. Eutrophication was shown to be very damaging to lichens, which were replaced by silt and algal mats. Lichens of limestone and chalk streams were surveyed by Gilbert (1996). Apart from these two studies, floristic information on British streams is found mainly in numerous unpublished reports, often commissioned in response to an application for hydropower development.

The need to reduce greenhouse gas emissions has led to Government support for renewable energy schemes, for instance by means of feed-in tariffs, and financial and technical support for 'community' schemes. This support has helped make it financially viable for landowners and developers to install run-of-river hydropower schemes on upland streams. The characteristics of high discharge and/or high gradient which make streams attractive for hydropower development are also likely to make them suitable for lichens. Very many hydro schemes of this kind have already

been developed in upland Britain, and the number of applications for new schemes is high.

Small-scale hydro schemes in Great Britain allow, by conditions of the licence, a residual flow in the watercourse, below which abstraction ceases. Natural Resources Wales' approach also includes a percentage flow-split, based in part on ecological sensitivity, causing less water to be abstracted on ecologically sensitive streams/rivers than on less sensitive watercourses. Peak flows following heavy rainfall are also little affected. Abstraction occurs at medium flows, so that water levels fall more rapidly following rainfall events than would happen with no abstraction. A particular point on the stream bank is thus likely to experience a shorter total duration of immersion, and in some cases a lower frequency of immersion, following installation of a hydro scheme. Very few lichens occur permanently below base-flow levels of streams; most grow in the intermittently inundated zone. Thus changes to natural stream levels potentially affect those lichens that favour watercourses. Demars & Britton (2011) discussed areas of concern regarding hydro schemes and bryophytes and lichens, although they emphasised ravines and wooded areas, where humidity is a prime concern. They noted that the area of rock affected by changes to flow levels is dependent upon the channel profile; thus the gently shelving surfaces favoured by the Red Data Book lichen *Collema dichotomum* would be relatively strongly affected. They suggested that the probable slow rate of change in communities in run-of-river schemes, and the typically low cover of rare species at a site, are barriers to achieving successful monitoring of the effects of hydro development.

Eryri SSSI is located in North Wales in the Snowdonia National Park, and covers the high ground of the Snowdon and Carneddau ranges. Thus, in addition to its importance for nature conservation, it includes land of great beauty and cultural significance. Hydro schemes have recently been developed on a number of rivers within the SSSI, and more applications are pending. Lichens are a feature of the SSSI designation, so that applications for hydropower development must take account of any possible significance for lichens. Nevertheless, the knowledge of stream lichens within the SSSI is poor, based on a small number of surveys and some informal records. The aim of the present study is to assess the importance of watercourses in the SSSI for lichens, and to determine whether all watercourses are equally valuable, or whether some are outstanding and others of only moderate interest. In addition, it was hoped that it might be possible to find simple features of sites (such as degree of tree cover, geology, or gradient) that would allow a non-specialist to decide whether the site was likely to be poor or outstanding for lichens, so that a decision could be made whether or not to commission a specialist survey to support a hydropower application.

4. Methods

4.1. Site selection

Sites were selected from a suggested list of 40 sites supplied by Natural Resources Wales (NRW); a few of these, however, were outside Eryri SSSI, and thus

were not surveyed, and a small number are proposed for hydropower schemes, so that inclusion in this survey would have involved a conflict of interest. Sometimes two, rarely three, sites were situated on the same river. The limits of each site were usually defined by a 1 km square of the National Grid. Permission was obtained from the landowner before surveys were carried out. All the sites were on open, unwooded ground, usually on unfenced hill pasture. Sites surveyed are listed in Table 1 and mapped in Figure 4.

4.2. Fieldwork methods

Whenever possible, sites were visited in dry weather, when river levels were near base flow. Survey usually began at the downstream end of the site, at a 1 km square gridline. In practice, most time was spent near the start of each site, with the remainder of the site surveyed more quickly. Only rarely was there time to complete the whole length of the river within each 1 km square, and in these cases most of the site was simply walked over rapidly to look for interesting or differing areas. Survey was usually stopped either when time became short, or when very few extra species were being encountered. Waders were worn whenever possible, as this greatly increased efficiency of recording, even on the smaller streams. A number of specimens were collected to confirm identification.

Rock surfaces were examined, as far as possible, from below water level up to the top of the 'riparian zone'. The riparian zone was defined as all the riverside rock communities that differed from the adjacent non-riverine communities. In other words it comprised all the rock surfaces whose vegetation was influenced by the presence of the watercourse. In practice this typically meant rock surfaces up to approximately 1.5 m above base flow level. Often the influence of the river was more obvious in the bryophyte cover: tolerant riparian species such as *Racomitrium aciculare* often occurred well above water, and the moss *Grimmia ramondii*, often found on the tops of boulders in streams, nevertheless occurred at heights where it would be only rarely wetted by high flows. For purposes of indicating the microhabitat of each species the riparian zone was roughly divided into lower, middle and upper levels based on the lichen vegetation, with lower levels comprising very frequently inundated species and upper levels grading into terrestrial vegetation.

Lichen nomenclature follows Smith *et al.* (2009) unless stated in Appendix 1, which is an annotated list of species recorded during the survey. Common riparian bryophytes were noted when seen, to allow a broad comparison with the lichen data, but they were not searched for, and these records certainly do not constitute a bryophyte survey of the sites.

Water pH and conductivity was measured at 13 sites, usually near the bottom of the site, and at or near base-flow conditions.

4.3. Data sources

Available stream data for Eryri SSSI and neighbouring areas fall into the following categories:

1. Eryri SSSI or Coedydd Aber SSSI, surveyed by the writer in 2017 for this project (20 sites on 15 streams).
2. Eryri SSSI or Coedydd Aber SSSI, surveyed by the writer in other years (3 sites on 3 streams).
3. Eryri SSSI or Coedydd Aber SSSI, surveyed by Steve Chambers in other years (Nant yr Ogof only).
4. Eryri SSSI or Coedydd Aber SSSI, surveyed by the writer or Steve Chambers, but data incomplete (not a comprehensive survey, or water levels too high): Afon Las middle and Rhaeadr Ogwen only.
5. Not in SSSI, surveyed by the writer in 2017 for this project (Ceunant Mawr only).
6. Not in SSSI, surveyed by the writer in other years, some with incomplete data.

Categories 1 to 3 are listed in Table 1. Only sites in these categories have data complete enough for direct comparison of sites. All sites are within the National Park.

Three of the sites suggested for survey had already been surveyed by the writer in 2011 to 2013. It was considered to be a poor use of time to resurvey these, and the data from these earlier surveys are used here. The available data for these sites, however, span more than one 1 km square, and have been edited where necessary, for instance to exclude species recorded in tree-lined areas.

One survey carried out within the SSSI for the National Trust by Steve Chambers has been used. The species list in the report did not clearly distinguish between riparian and non-riparian species in the lists, as the penstock route and site of the turbine house were surveyed as well as the watercourse. Only species noted as riparian in the text have been included.

Data on geology of sites is taken from the British Geological Survey Geology of Britain viewer (<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>). Bedrock indicated as present at each site is listed in Table 1. This does not imply that the rocks named were those actually present and supporting lichens in the field. Superficial deposits are not mentioned except where till deposits appeared to be contributing many boulders.

4.4. Site grading and comparison

Lichen species were regarded as 'notable' if they belonged to one or more of the following categories:

- Wales Red List species (Critically Endangered, Endangered, Vulnerable, Near Threatened and Data Deficient) (Woods 2010).
- Nationally Rare (NR) species (Woods & Coppins 2012).
- Nationally Scarce (NS) species (Woods & Coppins 2012) .

Sites were compared using:

1. Total number of species.

2. Number of freshwater-dependent species. This is based on a list of lichen species largely confined in Britain to the margins of streams or lakes (Table 2). This list was compiled by the writer from personal experience, published data, and contact with some other lichen specialists. The list could have been extended, and the length of such a list is to some extent a matter of opinion. The scope of the list is quite conservative; it does not include the significant numbers of species which find suitable habitat beside streams, but which are also regularly found elsewhere.

3. NR/NS score. A score was calculated for each site based on the Nationally Rare (NR) and Nationally Scarce (NS) species, where NR species score 100 and NS score 30. This follows the guidelines for SSSI selection at <http://jncc.defra.gov.uk/page-2303>. These are admitted to be outdated and have recently been superseded, but are used here for the convenience of providing a score to compare sites.

4. Overall Score 1. This score was calculated by assigning NR species a score of 100 (as above), and adding a further 200 for each Red Data Book (RDB) species (Endangered and Vulnerable) which was present. The score of 200 for RDB species was an arbitrary figure to assist ranking of sites. NS species were not scored.

5. Overall Score 2. This score was calculated by adding a score of 200 for every RDB species to the NR/NS score.

6. Number of species of the family *Verrucariaceae* present (i.e. species of *Agonimia*, *Dermatocarpon*, *Hydropunctaria*, *Placopyrenium*, *Sporodictyon*, *Staurothele*, *Thelidium* and *Verrucaria*). This is intended mainly to give ecological information, as these taxa are often confined to freshwater and often avoid the more acidic rocks.

The category Near Threatened has not been scored separately, but all these are either NR or NS and this has been used in the scoring system.

Data Deficient is not a threat category and has not been scored, but it indicates species which may be considered threatened when more data are available. A good example is *Cryptothele rhodosticta*; this is data-deficient due to former confusion with other species, but even though the confusion has been cleared up for many years, there are still very few records of this species, and it is almost certainly rare in Wales, and probably in Great Britain.

There are a number of species which may be rare, but which are poorly known, some representing undescribed species. These have been excluded from the RDB, NR and NS scoring system so that the system is based only on published conservation gradings. They have been mentioned separately at the end of individual site accounts. The species are:

Acarospora Llugwy A
Acarospora Merch A
Aspicilia Cwm Glas Mawr A
Dermatocarpon arnoldianum auct.

4.5. Classification of sites and species

Sites and species were classified based on species occurrence and abundance at each site. Hierarchical agglomerative clustering was carried out in Primer 7. Sites were clustered using the Bray-Curtis similarity matrix (on square-root transformed data), species were clustered using Whittaker's index of association on untransformed data.

The three following data sets were analysed:

- A. Freshwater-dependent lichens (i.e. species listed in Table 3).
- B. Freshwater-dependent lichens and bryophytes (lichens listed in Table 3 and bryophytes also considered by the writer to be freshwater-dependent).
- C. All lichens.

The abundance of each species at each site was entered as 3, 2 or 1, where 3 is the most abundant. These abundances were based partly on notes made in the field (3, 2 and 1 roughly equivalent to abundant/frequent, occasional, and rare), or were estimated later.

5. Results

5.1. Species statistics and conservation grading

A total of 202 species were recorded beside rivers in the 24 sites in Eryri SSSI (Appendix 1). Of these, 45 are considered to be largely dependent on freshwater habitats, according to the list in Table 3. The total number of species recorded from each site varied from 31 to 67 (average 48) and the number of freshwater-dependent species (Table 3) varied from 4 to 25 (average 11).

One species (*Lecanora achariana*, in two sites) was a Red Data Book species of the category Endangered (in Wales, Woods 2010), it is also listed on Section 7 of the Environment (Wales) Act 2016. Five species (*Ionaspis odora*, *Koerberiella wimmeriana*, *Pertusaria chiodectonoides*, *Pterygiopsis lacustris* and *Stereocaulon delisei*) were Vulnerable. There were 13 Near Threatened Species. In addition to these, there were a further 8 Nationally Rare and a further 18 Nationally Scarce). Of these notable species, 32 occurred in a total of three or fewer sites, including all the Endangered and Vulnerable species (Table 4). Nearly half (21 out of 45) of the notable species are considered to be freshwater-dependent.

Red Data Book species (Endangered or Vulnerable) were found in 11 out of 24 sites. More than half the sites (15 out of 24) contained a Near Threatened Species (Table 3).

Sites varied greatly in the overall score calculated on the basis of RDB, NR and NS species. The best site (as ranked by Overall Score 2) had three Red Data Book species, 2 Nationally Rare and 11 Nationally Scarce, whereas the lowest ranked site had no RDB species, and a single Nationally Scarce species (Table 3).

Overall Score 1 (based on RDB and NR) ranked the sites in a broadly similar way to Overall Score 2 (based on RDB, NR and NS), and the top five sites were the same in each (but not in the same order).

Overall Score 2 correlates with total species number, number of freshwater-dependent species, number of *Verrucariaceae* species, number of RDB species, and number of NT species, suggesting that it is a useful way of ranking sites as part of an initial assessment of conservation value. It should be stressed, however, that this cannot be relied upon alone to make decisions on conservation value (see Discussion).

Every site supported at least one Nationally Scarce species, and thus all contribute to the SSSI Assemblage of Nationally Rare and Scarce Lichens, and all but three supported a Nationally Rare species.

No two streams were completely alike in character, and nearly all had some interest. Even four of the five lowest-ranking sites had notable species not found at any other sites:

Afon Merch: *Lecanora subaurea* on a metal-rich shingle-bank.

Nant Bochlywd: *Amygdalaria consentiens*.

Afon Llugwy lower: excellent colonies of *Umbilicaria deusta*, and a colony of the rare *Protoparmelia atriseda*.

Afon Cwm Llan upper: *Clauroxia chalybeoides*.

5.2. Site and species classification

Analysis of Dataset A (Freshwater-dependent lichens) classified the sites into six significant groups (Fig. 1). The first group (8 sites) was evidently defined by a greater frequency (higher proportion of sites) and greater abundance within sites of species including:

Aspicilia aquatica
Catillaria chalybeia
Dermatocarpon arnoldianum
Dermatocarpon leptophyllodes
Dermatocarpon luridum
Dermatocarpon meiophyllizum
Placopyrenium formosum

Staurothele fissa
Verrucaria Caseg A
Verrucaria cernaensis

Some of these species were found outside this group of sites, but not more than three at one site, and not at the highest level of abundance. Less frequent species confined to this group of sites included:

Pterygiopsis lacustris
Hydropunctaria scabra
Verrucaria hydrophila
Verrucaria devensis
Verrucaria Small spores
Verrucaria margacea

This group is interpreted as comprising streams with geologically intermediate or basic rocks, or perhaps slightly calcareous rocks. The group was further subdivided, but it is likely that the subgroups are not ecologically meaningful, but reflect differing survey effort; some of the preferential species are difficult to identify in the field and grow on frequently inundated rocks.

The second major group (16 sites) appears to be defined largely by the absence or infrequency of many of the preferential species of the first group. Species preferential for this second group, and confined to it, include:

Porpidia hydrophila (13 sites)
Rhizocarpon amphibium (9 sites)
Ionaspis odora (3 sites)
Porina guentheri (2 sites)
Cryptothele rhodosticta (2 sites)

This group was not further subdivided at any level of significance. It is interpreted as comprising streams with base-poor rock.

Analysis of Dataset B (Freshwater-dependent lichens and bryophytes) gave broadly similar results. There was the same main division into 'base-rich' and 'base-poor' sites, with the same sites as before in each division. The 'base-rich' group was subdivided in a different way, and with five instead of three significant divisions. These should probably not be taken too seriously, as bryophyte data were sparse, and there were none for Afon Anafon central (AAC).

In the 'base-rich' group of 8 sites, in addition to the lichens listed above, the following bryophytes were preferential:

Schistidium rivulare (7 sites)
Fontinalis antipyretica
Fontinalis squamosa

Species confined to this group included:

Cinclidotus fontinaloides (5 sites)
Chiloscyphus polyanthos (3 sites)
Amblystegium fluviatile (2 sites)
Hygrohypnum duriusculum (2 sites)
Platyhypnidium riparioides (2 sites)
Schistidium agassizii (1 site)

In the 'base-poor' group of 16 sites the following species of bryophyte were preferential:

Blindia acuta (9 sites)
Hyocomium armoricum (5 sites)

Nardia compressa (4 sites) would belong here but was inadvertently omitted from the analysis.

Analysis of Dataset C (all lichens) gave a broadly similar but somewhat less clear picture. The first division was again into 'base-rich' and 'base-poor' sites, but Afon Llafar upper was placed amongst the 'base-poor' sites. It is difficult to see why this was so, but terrestrial species including *Tremolecia atrata* were present, which are preferential for the 'base-poor' group. The site is apparently borderline between the two main groups, with mainly 'base-poor' species, but with a number of 'base-rich' species in small quantity.

Non-freshwater dependent species preferential for the seven 'base-rich' sites include:

Caloplaca crenularia (4 sites)
Collema flaccidum (4 sites)
Lecanora muralis (6 sites, versus 3 in the other group)
Lecanora rupicola (4 sites)
Lecidea fuscoatra (4 sites, versus 1 in the other group)
Ochrolechia parella (6 sites, versus 1 in the other group)
Physcia caesia (5 sites)
Rhizocarpon viridiatrum (5 sites)

Non-freshwater dependent species preferential for the 17 'base-poor' sites include:

Acarospora smaragdula
Amygdalaria pelobotryon (15 sites, versus 1 in the other group)
Immersaria athrocarpa (13 sites, versus 2 in the other group)
Porpidia rugosa
Stereocaulon pileatum
Tremolecia atrata (15 sites, versus 1 in the other group)

A number of sites were classified as the only members of significant groups, partly because of the presence of a few species which were rare in the dataset as a whole. Thus Afon Cwm Glas Mawr had *Acarospora sinopica*, *Ainoa mooreana*, *Aspicilia* Cwm Glas Mawr, *Ionaspis odora* and *Rhizocarpon oederi*, and Afon Melynlllyn

had *Bacidia inundata*, *Diploschistes scruposus*, *Schaereria cinereorufa*, *Trapeliopsis pseudogranulosa* and *Verrucaria sublobulata*.

5.3. Conservation grading in relation to site classification

Of the five top sites ordered by Overall Score 2 (Table 3), four occurred in the 'base-rich' group in the two freshwater-dependent analyses, but the fifth (Afon Lloer) was in the 'base-poor' group, partly due to the high-score given by the presence of the Endangered *Lecanora achariana* and the Vulnerable *Koerberiella wimmeriana* and *Stereocaulon delisei*. The first two of these species do, however, prefer slightly basic rocks in general. It is interesting to note that all five of the top sites are in the Carneddau massif, which suggests that the geology, geomorphology and hydrology of this block of mountains are especially suited to the development of diverse assemblages of notable lichens. The five lowest-scoring sites by Overall Score 2 were all in the 'base-poor' group. In the analysis of all lichens the picture was the same except that one top-five site (ALU) was placed in the 'base-poor' group.

The 'notable' species are found in both of the major divisions in each analysis ('base-rich' and 'base-poor'); in Table 4 an indication is given of the group in which they predominantly occur. Some species which were rare in the survey are nevertheless assigned to one or other group, based on previous experience. This division of sites and species into 'base-rich' and 'base-poor' is of course a crude approximation. However, it shows that notable species can be found in both the major types of stream.

5.4. Correlation of lichen conservation value with stream features

In this study it was only possible to make informal observations on the likely conditions which might predict a stream with high conservation value for lichens. The following features were considered:

1. Geology.

Data on geology were taken from the British Geological Survey Geology of Britain viewer (<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>). This can only be taken as an approximate guide to the rocks present at the site. The stated scale of the map is a maximum of 1: 50 000, so that small local variations may not be shown. Boulders may be derived from strata not present as bedrock at the site; for instance at some sites bedrock was not visible, and the abundant boulders were evidently derived from superficial till deposits. Even where there are no superficial deposits, several rock types may be present at a site, and these are difficult to identify without geological experience or even petrological analysis. In addition, there may be variation in petrology and chemical composition within named formations, so that base-rich and base-poor areas cannot be accurately predicted from the map. In this survey it was not possible to identify samples of rock collected in the field.

Despite these caveats, it is likely that rock chemistry is a factor of prime importance in determining the lichens growing at a site. The six sites which had ten or more species of *Verrucariaceae* probably had some boulders or bedrock derived from geologically basic or intermediate rocks. The Afon Goch is reported to have some trachyandesite (an intermediate rock), but there are also till deposits which probably supplied some of the boulders. The Afon Caseg and Afon Llafar are reported to be on siltstone bedrock, but many boulders appear to be of an igneous rock and to be derived from till. Basalt, gabbro, and andesite rocks occur in the area and could be the source of some of the boulders. Rhyolitic rocks might be expected to be very base-poor, and Afon Cwm Glas Mawr and Afon Cwm Glas Bach lower, where these rocks predominate, had none and 1 species of *Verrucariaceae* respectively. Overall Score correlates with number of species of *Verrucariaceae*, but not precisely. The highest-ranking site (Afon Lloer) has only 5 *Verrucariaceae*, and these were rare. This site achieves its high ranking partly due to the presence of the RDB species *Lecanora achariana* and *Koerberiella wimmeriana*, both of which are known to favour base-rich rock.

That local variations are important was illustrated by areas near the Afon Goch. The Afon Goch itself has a good lichen flora, but the Afon Rhaeadr Bach nearby appeared to be poor, despite a similar geology according to the map (the site was visited very briefly, but not surveyed). A short distance away on siltstone, a rheocene spring just outside the SSSI was base-rich, with two *Verrucaria* species not recorded during the survey.

Overall, **any sites known to have intermediate or basic rock (in geological terminology) are worthy of survey if there are applications for development.** However, it is difficult to predict sites which will be poor in lichens.

2. Discharge.

The overall 'size' of a stream is likely to have a strong influence on the lichen flora. In larger streams (higher discharge), other things being equal, the riparian zone will be higher and thus provide a greater area for riparian lichens. Larger streams generally have a greater area of exposed bedrock and boulders, due to scouring. The smaller streams (such as the upper Afon Melynlyn) may have boulders which are set in turf, and are mossy, with reduced areas available for lichens.

3. Diversity of microhabitat.

This is strongly linked to stream size. The larger streams tend to have more exposed rock, and boulders are often isolated, with all sides available for colonisation, sometimes including overhanging faces. Although microhabitat diversity in relation to lichens is impossible to quantify in a broad survey of this kind, it was noted in several places that gently shelving boulder surfaces or bedrock, especially where they dip below base-flow level, often tended to support notable species. Large boulders clearly will have more area available for colonisation. Small boulders may be too low to develop an upper riparian community, and they may be covered by mosses, especially where scouring is reduced. Nevertheless, notable low-riparian species can be supported by small boulders, so **the absence of large boulders is not an indication of low interest of a site.**

4. Gradient.

This could scarcely be assessed in isolation. Most sites had a sufficiently high gradient for the bed to have exposed bedrock or boulders. Parts of sites with a gentle gradient often tended to have smaller boulders, and these were often more mossy, due to reduced scouring. Abundant bryophyte growth here may reduce the area available for lichens. However, mosses with a tassel-like growth form may be less important competitors than mat-forming species; at one site *Dermatocarpon meiophyllizum* was found growing well amongst the long shoots of the moss *Schistidium rivulare*.

4. Water chemistry.

At the 13 sites where simple water chemistry parameters were measured, pH varied from 5.9 to 6.8 (average 6.3), and conductivity varied from 17 to 49 $\mu\text{S}/\text{cm}$ (average 29). These are fairly typical values for streams in Wales which drain base-poor rock, are not subject to marked acidification, and are not significantly nutrient-enriched. Lowland streams in Wales often show much higher conductivity values where there is nutrient-enrichment from agriculture or human settlement. However, conductivity values do not in themselves indicate the source of the dissolved material, which may be derived from the catchment rock, pollution, or sea spray.

Conductivity is weakly correlated with Overall Score; the six top-scoring sites had a conductivity of 25–49 $\mu\text{S}/\text{cm}$ (4 sites measured) and the six lowest-scoring had a conductivity of 17–36 $\mu\text{S}/\text{cm}$ (3 sites measured). However, Nant Gwryd was ranked ninth by Overall Score, with a conductivity of only 19 $\mu\text{S}/\text{cm}$, and Afon Melynlyn was third from bottom by Overall Score but had a relatively high conductivity of 36 $\mu\text{S}/\text{cm}$. It is likely that higher conductivity can indicate the possibility of a catchment which has a more 'basic' rock, but on its own it is a poor indicator of likely lichen interest. Additional chemical parameters, such as the levels of certain cations, might give better information but data are more technically difficult and expensive to record than conductivity.

5. Bryophytes

Informal observations on this survey and previous ones suggest that some common riparian mosses are good indicators of more 'base-rich' sites. It is suggested that within Eryri SSSI, **any stream known to support *Schistidium rivulare*, or especially *Cinclidotus fontinaloides*, may support a relatively rich lichen flora.** In particular these streams are likely to support lichens of the family *Verrucariaceae*. However, not all the notable lichens are from 'base-rich' streams, so it is not possible to predict a low-quality stream from the bryophyte flora.

6. Tree cover.

The sites in this survey were selected from areas with no woodland. However, at some sites there were a few trees and shrubs. The main effect of shade from trees

is to increase bryophyte cover, and this can be a significant factor reducing the area available for lichens. It is apparent from other surveys that species such as the moss *Isothecium holtii*, which may be rare or absent in unshaded reaches of streams, can expand to cover large areas of rock as soon as the stream enters woodland. In addition to the effects of bryophyte competition, many riparian lichens are intolerant of shade, although this cannot be demonstrated from the present survey. **Good riparian lichen sites are very likely to be damaged if the banks are allowed to become wooded.**

5.5. Comparison with other watercourses in Wales

Few sites have data which are directly comparable to the Eryri data. A selection of the few surveyed river sites in Wales are compared to sites in the present survey in Table 6. The sites on the River Wye and River Usk are important freshwater lichen sites, and the best Eryri sites are comparable with these in terms of the number of freshwater-dependent species present, and the Overall Score.

The few surveys available outside Eryri SSSI are for lengths of river mostly 0.5 to 2 km in length. Since rivers are linear features, and conditions downstream are dependent upon conditions upstream, it may be useful to compare longer reaches of river. Table 6 compares more extensive reaches of the River Wye and River Usk with the higher-scoring Eryri rivers. For this comparison, data for the Afon Caseg and Afon Llafar are combined, as for conservation purposes it might be useful to regard them as part of the same site. The two contiguous sites of the Afon Anafon are also combined. Again, the best Eryri sites compare well with high-quality sites elsewhere in Wales. This comparison is of scores only; differences in the composition of the river flora between different Welsh rivers are treated below.

5.6. Distribution of notable freshwater-dependent species in Wales

Some records of notable freshwater-dependent species in Wales are tabulated by watercourse in Table 7. Although the data are mainly those held by the writer, the overall distribution gives a reasonable picture of the distribution of these species in Wales.

Some freshwater-dependent species recorded in Eryri SSSI in the present survey are fairly widespread in Wales in streams which are rocky, slightly basic, and not eutrophicated, for instance *Dermatocarpon leptophyllodes* and *D. meiophyllizum*. Some are either almost confined to Eryri SSSI, or present in the SSSI and only rare elsewhere:

Aspicilia zonata (possibly under-recorded, only known from Afon Anafon in Britain)

Collema glebulentum (rare in North Wales).

Cryptothele rhodosticta (two base-poor streams; very rare in Wales, two other records not verified by the writer)

Ionaspis odora (two base-poor streams; known also from a base-poor stream above Llyn Bochlwyd, 23/6595)
Lecanora achariana (three slightly basic streams; also known from the lake Ffynnon Lloer within the SSSI)
Porina interjungens (rare in Wales, very few records)
Verrucaria Caseg A (unknown elsewhere, though may be overlooked)
Verrucaria Small Spores (an undescribed species, so far known only in Wales)

Conversely, a number of notable freshwater-dependent species are absent from rivers within Eryri SSSI:

Collema dichotomum
Endocarpon adscendens
Leptogium magnussonii
Leptogium subtorulosum
Verrucaria madida

At least some of these require more base-rich conditions than are found in the SSSI.

6. Discussion

The survey confirms that some of the rivers in Eryri SSSI are comparable in importance to any freshwater lichen site in Wales, such as high-quality sites on the River Wye and River Usk, when assessed in terms of number of Red Data Book species, Nationally Rare and Nationally Scarce species. In addition, some of the species dependent on rivers in Eryri SSSI are rare or absent elsewhere in Wales, so that the rivers in the SSSI are their main/sole refuge. Conversely, there are river-dependent species elsewhere in Wales that are not or scarcely represented in Eryri SSSI, so the rivers in the SSSI must be regarded as just one of the important parts of the freshwater lichen resource in Wales. Some notable species were found only once or a very few times during the survey, suggesting that **many streams are needed to support the freshwater diversity of the SSSI.**

In terms of the scores based on RDB and rare and scarce species, watercourses in the SSSI vary greatly in their value for lichens. The single most important factor appears to be the nature of the rock in the stream, with the richest sites tending to be associated with rocks which are basic or intermediate in the geological sense. This is, however, hard to define, due to the difficulty of identifying rock types without specialist equipment, and the possibility of sites having mixtures of rock types. In practice, sites with this sort of rock are recognisable by the presence of a suite of lichen species which have been observed to favour substrata with a slight calcareous or other 'basic' influence. This can readily be seen when sites and species are classified in a cluster analysis. In two of the best sites (Afon Llafar and Afon Caseg) there is no bedrock exposed in the stream, but instead the available rocks comprise boulders derived from glacial till. Thus, even accurate bedrock maps could not predict the rock type here. Another high-scoring site, however (Afon Lloer), did not appear to have intermediate or basic rocks, although some of the lichens indicated some 'basic'

influence. Although sites which appear to be on very base-poor rocks such as rhyolite tend to score poorly, base-poor sites can also have notable species. In addition, even the lowest scoring sites usually had notable species which were rare or absent at other sites. **The number of good-sized streams in the SSSI is not very large, and it is likely there is not much redundancy, each stream having its own character and suite of species.**

Stream size (discharge) also seems to have an influence on the grading of the sites, although this could not be quantified in a survey of this kind. Larger streams tended to have a greater area of rock available, and a greater variety of microhabitats, than small streams. The smaller streams do not have the scouring power to expose large areas of rock, and the lack of scouring also tends to increase bryophyte cover.

Bryophytes are good indicators of the base-richness of river sites, and the indicator species are often frequent at a site and easily seen. **If a bryophyte survey has revealed the presence of the mosses *Cinclidotus fontinaloides* and/or *Schistidium rivulare* on a rocky stream, then it is recommended that a lichen survey should be carried out as part of an environmental impact assessment.** On the other hand, the absence of these species does not necessarily indicate a stream with low lichen value. In view of the diversity of rivers revealed by the survey, it is recommended that a lichen survey should be carried out whenever there is an application for development affecting the river. The only exception would be streams of very low gradient and an absence of rocky substratum. It is also possible that very small streams would support few notable species, but this was not demonstrated by the survey, as most streams were of a good size. However, the RDB species *Ionaspis odora* is known from a very small stream above Llyn Bochlywd, much smaller than the streams visited during the survey.

The scoring system used in this report is employed to give a crude ranking of sites to aid assessment and description. It is based on the presence of RDB and rare/scarcely species, and does not take into account the abundance of each notable species, nor the number of freshwater-dependent species which are supported at the site (although these are tabulated). Many freshwater-dependent species are graded as Least Concern, so it is difficult to use them in a conservation grading. A full assessment of the value of a site needs to take into account the number of notable species, their distribution in Eryri and elsewhere, and the viability of the population of each. In addition the site should be assessed as to whether it is a good and sufficiently extensive example of the habitat. To some extent watercourses need to be assessed in their entirety, as one part is dependent on another. Rivers are unstable habitats, and migration and recolonisation of notable species may take place over a long length of the watercourse. Boulders which are currently suitable for a notable species may become unsuitable due to movement of the boulder, a change in local scouring giving increased moss growth, or even a change in the frequency of bird-perching. On a river outside the SSSI, the RDB species *Lecanora achariana* has persisted on two adjacent boulders for almost twenty years, but this is a short timescale in conservation.

Good freshwater lichen habitat is uncommon in Wales. Exposed rock is necessary, without excessive silting, so that suitable sites are mostly confined to upland areas and in rejuvenating lowland stretches of larger rivers such as the Wye and Usk. Although some freshwater species are shade-tolerant, dense woodland also

has a negative effect on lichen diversity. It has been suggested that increased tree cover would help to mitigate the effects of climate change on rivers (Lenane 2012), but this would have a negative effect on most lichens. As in Eryri, it is likely that some degree of basic influence in the rock is also necessary for many river-dependent lichens; the slightly calcareous mudstone and sandstone of the Wye and Usk respectively are suitable. Although few formal surveys have been carried out (usually of single sites and often in response to a hydropower application), it seems that good freshwater lichen sites are rare, and the best occupy a minute percentage of the land area of Wales. It is unfortunate, then, that especially the larger rocky streams, with a good gradient, are in demand for hydropower development.

The effects of run-of-river hydro schemes on lichens are difficult to predict. Any changes in the abundance and distribution of species are likely to be slow, and difficult to distinguish from natural variation. The pattern of rainfall varies from year to year, so that most species are probably capable of withstanding unsuitable conditions for a certain period. Low, gently sloping boulders were observed to be often valuable for notable species, and such surfaces will experience a greater change in wetted surface area following abstraction than will steep surfaces.

The surveys carried out during this project cannot be regarded as definitive. They cover only specific reaches of the rivers, and one or two are slightly incomplete because of poor weather or slightly raised water levels. At many sites, notable species occurred in small quantity, and are easily overlooked. If applications are made for development affecting any of these streams it is recommended that an additional survey is carried out, covering the precise areas affected, and any ancillary disturbance, such as weir construction and penstock routes.

I would like to thank all the landowners in the SSSI who allowed surveys to take place. Many thanks also to Dr Ingrid Juettner (Amgueddfa Cymru – National Museum Wales) for running cluster analyses.

7. Recommendations

The following recommendations stem from the results and discussion sections above. Suggestions for targeting lichen survey are:

- Any sites known to have intermediate or basic rock (in geological terminology) are worthy of survey (5.4.1);
- the absence of large boulders is not an indication of low interest of a site (5.4.3);
- conductivity is weakly correlated with Overall Score (5.4.5);
- any stream known to support [the moss] *Schistidium rivulare*, or especially [the moss] *Cinclidotus fontinaloides*, may support a relatively rich lichen flora (5.4.6);
- good riparian lichen sites are very likely to be damaged if the banks are allowed to become wooded (5.4.7).

Conclusions pertinent to conserving the SSSI lichen feature are:

- Some notable species were found only once or a very few times during the survey, suggesting that many streams are needed to support the freshwater diversity of the SSSI;
- the number of good-sized streams in the SSSI is not very large, and it is likely there is not much redundancy, each stream having its own character and suite of species.

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Table 1. Streams in Eryri SSSI for which comparable data are available

Site name	Site code	1 km square	grid ref. at bottom	grid ref. at top	alt. bottom	alt. top	dates surveyed	Bedrock geology
Afon Anafon central	AAC	67.71, 68.71	678.710	6890.7102	270	310	2013 May 01, 2013 Jun 05	1. Nant Ffrancon Subgroup - Siltstone. 2. Unnamed Igneous Intrusion, Ordovician - Microgranodiorite. (Superficial: till and others).
Afon Anafon upper	AAU	69.70	6916.7097	6919.7096	340	340	2017 Jul 19	1. Nant Ffrancon Subgroup - Siltstone. (2. Unnamed Igneous Intrusion, Ordovician - Porphyry). (Superficial: till and others).
Afon Berthen	ABE	64.63, 64.64	64116.64282	64732.63718	420	520	2017 Jul 18	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Caseg central	ACC	65.66	65017.66404	65841.66554	355	410	2017 Sep 19	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Caseg lower	ACL	64.66	64729.66434	649.664	330	355	2017 Sep 19	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Cwm Eigiau	ACE	70.63	70960.63308	70453.63466	390	470	2017 Sep 25	1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone.
Afon Cwm Glas Bach lower	GBL	61.57	61339.57464	61327.57087	140	250	2017 Sep 23	1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Lower Rhyolitic Tuff Formation - Tuff, Felsic.
Afon Cwm Glas Bach upper	GBU	61.56	61288.56995	61073.56817	260	350	2017 Sep 23	Lower Rhyolitic Tuff Formation - Tuff, Felsic.
Afon Cwm Glas Mawr	AGM	61.56	61997.56546	61769.56345	310	390	2017 Aug 03	Unnamed Igneous Intrusion, Ordovician - Rhyolite.

Afon Cwm Llan lower	CLL	62.51	6292.5138	6213.5202	30	250	2011 Mar 15	1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Bedded Pyroclastic Formation - Pyroclastic-rock. 3. Lower Rhyolitic Tuff Formation - Tuff, Felsic.
Afon Cwm Llan upper	CLU	61.52	61985.52127	61549.52218	260	300	2017 Sep 20	1. Lower Rhyolitic Tuff Formation - Tuff, Felsic. 2. Cwm Eigiau Formation - Mudstone And Siltstone.
Afon Goch	AGO	67.69	67003.69656	67187.69441	370	420	2017 Aug 08	1. Unnamed Igneous Intrusion, Ordovician - Microgranodiorite. 2. Unnamed Igneous Intrusion, Ordovician - Trachyandesite.
Afon Llafar central	ALC	65.65	65002.65402	65442.65044	390	420	2017 Sep 26	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Llafar lower	ALL	64.65	64771.65488	64873.65408	370	380	2017 Aug 11, Sep 26	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Llafar upper	ALU	66.64	68717.61411	66423.64096	430	470	2017 Sep 20	Nant Ffrancon Subgroup - Siltstone. (Superficial: till).
Afon Lloer	ALO	66.61	66697.61004	66674.61871	350	600	2017 Jun 27	1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Unnamed Igneous Intrusion, Ordovician - Microgabbro. 3. Capel Curig Volcanic Formation - Tuff, Felsic.
Afon Llugwy lower	LUL	70.59	70999.59333	70574.59598	240	250	2017 Aug 09	Cwm Eigiau Formation - Mudstone And Siltstone.
Afon Llugwy upper	LUU	68.61	68717.61411	68909.61658	430	460	2017 Jul 20	1. Llewelyn Volcanic Group - Sandstone. 2. Capel Curig Volcanic Formation - Tuff, Felsic.
Afon Melynlyn middle	MEL	70.66	70999.66641	70759.66016	480	560	2017 Aug 10	1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone And Siltstone.

Afon Merch	MER	63.52	63297.52060	63319.52340	220	320	2017 Sep 18	1. Lower Rhyolitic Tuff Formation - Tuff, Felsic. 2. Bedded Pyroclastic Formation - Pyroclastic-rock. 3. Unnamed Igneous Intrusion, Ordovician - Rhyolite.
Nant Bochlwyd	NBO	65.59, (65.60)	653.601	654.594	350	550	2017 Jun 28	1. Cwm Eigiau Formation - Mudstone And Siltstone. 2. Cwm Eigiau Formation - sandstone. 3. Pitts Head Tuff Formation - Tuff, Felsic.
Nant Gwryd	NGW	65.56, 66.56	6634.5596	6556.5653	270	370	2013 Aug 21, 22	1. Cwm Eigiau Formation - Mudstone And Siltstone. 2. Cwm Eigiau Formation - Sandstone. 3. Unnamed Igneous Intrusion, Ordovician - Microgabbro. 4. Lower Rhyolitic Tuff Formation - Tuff, Felsic.
Nant Idwal	NID	64.60	64979.60245	64837.60124	330	350	2017 Jul 20	1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone And Siltstone.
Nant yr Ogof	NYO	68.59	68644.60028	68135.59174	310	510	2016 May 31	1. Llewelyn Volcanic Group - Sandstone. 2. Llewelyn Volcanic Group - Siltstone.

Bedrock geology taken from British Geological Survey Geology of Britain viewer (<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>).

All streams surveyed by the writer, except Nant yr Ogof surveyed by Steve Chambers.

Grid references all have the prefix 23 (SH).

The site code was assigned for use in analyses.

Table 2. Lichens whose major habitat in Britain is beside streams, rivers or lakes

species	conservation evaluation		Notes
	Woods 2010 (Wales)	Woods & Coppins 2012 (GB)	
			NR/ NS
<i>Aspicilia aquatica</i>	DD		NR Previously often overlooked as other species. Reported from Afon Llafar, Afon Anafon, River Conwy, River Wye.
<i>Aspicilia laevata</i>			NS Afon Anafon, Afon Las.
<i>Aspicilia melanapsis</i>		EN	NR Very rare, Scotland. Not known in Wales.
<i>Aspicilia zonata</i>	ne	ne	NR? Only recently detected in Britain; may not be confined to rivers. Afon Anafon (the only British record so far).
<i>Bacidia carneoglauca</i>			NS Shady overhangs. Widespread in Wales.
<i>Bacidia inundata</i>			Widespread in Wales.
<i>Catillaria chalybeia</i>			NS Widespread in rocky rivers, shade-tolerant.
<i>Collema dichotomum</i>	EN	VU	NS Rare, mostly on larger watercourses. Recent records from River Wye, Irfon.
<i>Collema glebulentum</i>	NT		NS Mostly upland. Rare in North Wales.
<i>Collemopsidium angermannicum</i>	NT	NT	NS Scattered in rocky streams.
<i>Cryptothele rhodosticta</i>	DD		Very rare; Afon Llan, Nant Gwryd.
<i>Dermatocarpon arnoldianum auct.</i>	ne	ne	ne A segregate of <i>D. miniatum</i> , possibly an undescribed species. Scattered in North Wales.
<i>Dermatocarpon deminuens</i>		DD	NR Only British record from a tarn in Lake District. Not known in Wales.
<i>Dermatocarpon intestiniforme</i>			Rare by streams and on wet cliffs.
<i>Dermatocarpon leptophyllodes</i>	NT		NS Scattered in rocky streams.
<i>Dermatocarpon luridum</i>			Widespread in rocky streams.
<i>Dermatocarpon meiophyllizum</i>	NT		NS Scattered in rocky streams.
<i>Dermatocarpon rivulorum</i>		DD	NR Very rare. One old record from Meirionnydd.
<i>Endocarpon adscendens</i>	CR	EN	NR Very rare in Wales on calcareous rocks. River Usk, and a small persistent population beside artificial falls in St Fagans, Glamorgan.
<i>Ephebe hispidula</i>	DD	NT	NR Rare, poorly known. Few records for Wales.
<i>Ephebe lanata</i>			Widespread on rocky rivers.
<i>Gyalidea diaphana</i>		DD	NR Very rare, Scotland. Not known in Wales.

<i>Hydropunctaria rheitrophila</i>				Widespread in Wales; shade-tolerant
<i>Hydropunctaria scabra</i>			NR	Uncommon in Wales, streams and dripping rock faces in shade.
<i>Ionaspis lacustris</i>				Abundant.
<i>Ionaspis odora</i>	VU		NS	Mainly Scottish Highlands. Rare, a few records from Eryri.
<i>Ionaspis suaveolens</i>	VU	DD	NR	Rare upland species by streams and on moist rocks. Reported from Eryri, no details known.
<i>Lecanora achariana</i>	EN	CR	NR	Very rare; recent records from Afon Llafar, Afon Caseg, Ffynnon Lloer.
<i>Lecidea ahlesii</i>			NS	Occasional by shady streams.
<i>Leptogium magnussonii</i>	ne	ne	NR	Rare, only recently detected in Britain; rare on River Usk, River Wye, Afon Teifi.
<i>Leptogium subtorulosum</i>	EN	NT	NR	Rare in Britain. In Wales reported from Afon Pyrddin, River Wye.
<i>Massalongia carnosia</i>				Most commonly beside streams. Occasional in Mid and North Wales.
<i>Metamelaena umbonata</i>		DD	NR	Rare on limestone in streams in Scotland. Not known in Wales.
<i>Placopyrenium cinereoatratum</i>	DD	ne	NR	Scattered records, including River Usk, Nant y Llyn, River Wye, Irfon. Shade tolerant.
<i>Placopyrenium formosum</i>	?	DD	NR	Reported from Afon Llafar, Afon Anafon, Afon Caseg, River Wye.
<i>Placynthium flabellusum</i>	VU		NS	A single Welsh record, from Afon Ysgethin.
<i>Placynthium pannariellum</i>		NT	NS	Rare, mainly Scotland. One old record from Meirionnydd.
<i>Placynthium tantaleum</i>				One very old record from Meirionnydd.
<i>Polyblastia quartzina</i>	VU	DD	NR	Rare. One record from Brecon Beacons, taxonomy needs review.
<i>Polyblastia sp.</i>			NR	Unidentified species. Only known from Afon Las, growing on <i>Verrucaria anziana</i> .
<i>Polychidium muscicola</i>	NT		NS	Often by rivers but also terrestrial. Scattered in Mid and North Wales.
<i>Porina grandis</i>	VU		NR	Rare, mainly Scotland. In Wales known from a small woodland stream near Nantgwynant only.
<i>Porina guentheri</i> var. <i>lucens</i>		DD	NS	In Wales not uncommon by rivers in the north.
<i>Porina interjungens</i>	NT	NT	NS	Few records for Wales.
<i>Porina rivalis</i>	ne	ne	ne	Fairly widespread.
<i>Porocyphus kenmorensis</i>	NT	NT	NS	Rare, scattered in North and West Britain. River Wye, Afon Ysgethin, Afon Prysor, Afon Gamallt.
<i>Porocyphus leptogiella</i>	NT	NT	NR	Rare, scattered in North and West Britain. Scattered records in Wales.

<i>Porpidia hydrophila</i>				Frequent on base-poor rivers.
<i>Pterygiopsis concordatula</i>	VU	NT	NR	Rare. Poorly known in Wales, one old record may be from a river.
<i>Pterygiopsis lacustris</i>	VU	NT	NR	Rare, scattered in North and West Britain. Sites in Wales include Mawddach, Eden, Cwm-Ilefrith, Llafar.
<i>Pyrenopsis grumulifera</i>	DD	DD	NR	Rare, mainly Scotland. In Wales known from Afon Las only.
<i>Pyrenopsis subareolata</i>			NS	Rare, scattered in North and West Britain. Unshaded upland streams in Wales.
<i>Rhizocarpon amphibium</i>	DD	DD	NR	Rare. Occasional by rocky base-poor streams in North Wales.
<i>Rhizocarpon lavatum</i>				Abundant.
<i>Rinodina oxydata</i>			NS	Scattered, mainly terrestrial. In Wales mostly beside streams.
<i>Sporodictyon cruentum</i>				Widespread in upland Britain. By rocky upland streams in Wales.
<i>Staurothele fissa</i>				Widespread by rocky streams.
<i>Thelidium methorium</i>			NR	Very rare, Scotland. Not known in Wales.
<i>Thelidium pluvium</i>			NS	Scattered records beside streams.
<i>Verrucaria aethiobola</i>				Widespread in upland Britain.
<i>Verrucaria alpicola</i>			NR	Only recently recognised as British. In Wales known only from two streamlets in Mid Wales.
<i>Verrucaria anziana</i>	ne	ne	ne	Seems to be genuinely uncommon and somewhat upland in Wales.
<i>Verrucaria aquatilis</i>				Widespread by clean streams.
<i>Verrucaria cernaensis</i>				Widespread by rocky streams.
<i>Verrucaria consociata</i>	ne	ne	ne	There may be more than one taxon here; also on terrestrial stones. In Wales uncommon, in shade.
<i>Verrucaria devensis</i>	ne	ne	ne	Only recently distinguished from <i>V. praetermissa</i> . Fairly widespread in Wales.
<i>Verrucaria elaeomelaena s.l.</i>				Widespread in rocky streams, often in shade.
<i>Verrucaria funckii</i>				Widespread in the north and west of Britain. In Wales scattered in streams and streamlets, often in shade.
<i>Verrucaria humida</i>				Recently described species, in streamlets in Germany; one record in a flush in Meirionnydd. However, some terrestrial specimens may belong here.
<i>Verrucaria hydrophila</i>				Frequent in streams, often in shade.
<i>Verrucaria madida</i>	DD	VU	NR	In Wales one record from unshaded streamlet in Brecon Beacons.
<i>Verrucaria margacea</i>				Scattered records from rocky streams, shade-tolerant.
<i>Verrucaria nodosa</i>	ne	ne	NR	Recently described species. A few records from North Wales.

<i>Verrucaria pachyderma</i>	DD	DD	NR	Scattered records in Wales, shade tolerant.
<i>Verrucaria placida</i>	ne	ne	NR	Recently described species. In Wales so far only known from woodland streams in Coed yr Allt-goch, Elan Valley.
<i>Verrucaria praetermissa</i>				Widespread, tolerant of shade.
<i>Verrucaria rosula</i>				Widespread in north and west Britain.
<i>Verrucaria sublobulata</i>				Scattered records.
<i>Verrucaria</i> sp. (Caseg A)	ne	ne	ne	Unidentified species; rare in North Wales, poorly known.
<i>Verrucaria</i> sp. (small spores)	ne	ne	ne	Undescribed species. Rare, known from Brecon Beacons, Cwm Llefrith, Afon Las, Afon Anafon, Afon Goch.

NR = Nationally rare, NS = Nationally Scarce.

CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near-Threatened.

DD = Data Deficient, ne = not evaluated.

Table 3. Summary of sites scores based on conservation grading and other criteria

Sites ordered by Overall score 2. The 5 highest scoring sites in selected columns are highlighted (or highest 6 if 5 and 6 are equal).

Site:	Site code:	Number of lichen species	Number of freshwater species	Number of Verruca riaceae	EN	VU	NT	DD	NR	NS	NR/NS score	Overall score 1	Overall score 2
Afon Lloer	ALO	56	13	5	1	2	0	1	2	11	730	800	1330
Afon Anafon central	AAC	55	21	14	0	2	4	3	5	8	740	900	1140
Afon Goch	AGO	67	25	17	0	1	4	2	4	10	700	600	900
Afon Llafar upper	ALU	51	15	10	0	1	2	2	4	3	490	600	690
Afon Caseg central	ACC	55	10	6	1	0	1	1	3	4	420	500	620
Afon Anafon upper	AAU	40	17	12	0	0	5	2	4	6	580	400	580
Afon Caseg lower	ACL	58	18	12	0	1	2	1	2	5	350	400	550
Afon Llafar lower	ALL	59	14	8	0	0	2	2	3	6	480	300	480
Nant Gwryd	NGW	47	7	0	0	1	0	1	2	2	260	400	460
Afon Cwm Glas Bach lower	GBL	47	7	1	0	1	0	0	1	4	220	300	420
Afon Cwm Glas Mawr	AGM	34	5	0	0	1	2	1	1	8	190	300	390
Afon Cwm Glas Bach upper	GBU	36	6	2	0	1	0	1	1	2	160	300	360
Afon Llafar central	ALC	50	15	10	0	0	2	1	2	4	320	200	320
Afon Cwm Eigiau	ACE	58	13	6	0	0	2	1	1	7	310	100	310
Afon Llugwy upper	LUU	55	8	2	0	0	2	0	1	7	310	100	310
Nant Idwal	NID	48	12	6	0	0	3	1	1	7	310	100	310
Afon Berthen	ABE	47	7	2	0	0	1	1	2	3	290	200	290
Nant yr Ogof	NYO	31	4	0	0	1	0	0	0	2	60	200	260
Afon Cwm Llan lower	CLL	34	5	0	0	0	0	1	1	4	220	100	220
Afon Merch	MER	39	4	0	0	0	1	1	1	3	190	100	190
Nant Bochlwyd	NBO	47	7	2	0	0	1	1	1	2	160	100	160
Afon Melynlyn	MEL	53	8	3	0	0	0	0	0	5	150	0	150
Afon Llugwy lower	LUL	39	8	3	0	0	0	0	1	1	130	100	130
Afon Cwm Llan upper	CLU	42	4	1	0	0	0	0	0	3	90	0	90

Number of freshwater species: defined as in Table 3.

Overall score 1 = (NR x 100) + (EN x 200) + (VU x 200). [Thus ignoring Nationally Scarce scores].

Overall score 2 = (NR x 100) + (NS x 30) + (EN x 200) + (VU x 200).

EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, NR = Nationally Rare, NS = Nationally Scarce.

Table 4. Notable lichen taxa recorded

	Threat category/rarity						Number of sites	Freshwater - dependent
	EN	VU	NT	DD	NR	NS		
<i>Lecanora achariana</i>	EN				NR		2	F
<i>Ionaspis odora</i>		VU				NS	3	F
<i>Koerberiella wimmeriana</i>		VU				NS	1	
<i>Pertusaria chiodectonoides</i>		VU				NS	3	
<i>Pterygiopsis lacustris</i>		VU			NR		2	F
<i>Stereocaulon delisei</i>		VU				NS	3	
<i>Ainoa mooreana</i>			NT			NS	1	
<i>Amygdalaria consentiens</i>			NT			NS	1	
<i>Collema glebulentum</i>			NT			NS	2	F
<i>Collemopsidium angermannicum</i>			NT			NS	2	F
<i>Dermatocarpon leptophyllodes</i>			NT			NS	10	F
<i>Dermatocarpon meiophyllizum</i>			NT			NS	9	F
<i>Fuscidea intercincta</i>			NT			NS	1	
<i>Lecanora subaurea</i>			NT			NS	1	
<i>Porocyphus kenmorensis</i>			NT			NS	1	F
<i>Porpidia superba f. sorediata</i>			NT?		NR		3	
<i>Protoparmelia atriseda</i>			NT		NR		1	
<i>Stereocaulon leucophaeopsis</i>			NT			NS	3	
<i>Thelidium pluvium</i>			NT			NS	1	F
<i>Aspicilia aquatica</i>				DD	NR		9	F
<i>Aspicilia recedens</i>				DD	NR		3	
<i>Cryptothele rhodosticta</i>				DD	NR		2	F
<i>Hydropunctaria scabra</i>					NR		1	F
<i>Placopyrenium cinereoatratum</i>				DD	NR		1	F
<i>Placopyrenium formosum</i>					NR		8	F
<i>Rhizocarpon amphibium</i>				DD	NR		9	F
<i>Verrucaria pachyderma</i>				DD	NR		2	F
<i>Bacidia carneoglauca</i>						NS	1	F
<i>Bacidia inundata</i>						NS	3	F
<i>Calvitimela aglaea</i>						NS	1	
<i>Cladonia cyathomorpha</i>						NS	8	
<i>Claurouxia chalybeoides</i>						NS	1	
<i>Immersaria athrocarpa</i>						NS	15	
<i>Miriquidica pycnocarpa f. pycnocarpa</i>						NS	1	
<i>Miriquidica pycnocarpa f. sorediata</i>						NS	2	
<i>Pilophorus strumaticus</i>						NS	8	
<i>Porina guentheri var. lucens</i>						NS	2	F
<i>Porpidia contraponenda</i>						NS	3	
<i>Porpidia melinodes</i>						NS	6	
<i>Pyrenopsis subareolata</i>						NS	6	F
<i>Rhizocarpon viridiatrum</i>						NS	6	
<i>Rimularia badioatra</i>						NS	9	

<i>Rimularia intercedens</i>						NS	2	
<i>Umbilicaria deusta</i>						NS	1	
<i>Verrucaria anziana</i>						NS	4	F
Number in category:	1	5	13	6	12	33		21

Abbreviations (see Methods section for full explanation):

EN = Endangered, NT = Near Threatened, VU = Vulnerable (Woods 2010).

NR = Nationally Rare (Great Britain), NS = Nationally Scarce (Woods & Coppins 2012).

Freshwater-dependent: see list in Table 3.

Blue: species mainly in the 'base-rich' sites in the classification (Figs. 1-3.)

Red: species mainly in the 'base-poor' sites in the classification (Figs. 1-3.)

Table 5. Comparison of Eryri sites with selected river sites in Wales

Sites ordered by Overall score 2. The 5 highest scoring Eryri sites in selected columns are highlighted (or highest 6 if 5 and 6 are equal).

Site:	Site code:	Number of lichen species	Number of freshwater species	Number of Verrucar iaceae	CR	EN	VU	NT	DD	NR	NS	NR/NS score	Overall score 1	Overall score 2
Afon Lloer	ALO	56	13	5	0	1	2	0	1	2	11	730	800	1330
Afon Anafon central	AAC	55	21	14	0	0	2	4	3	5	8	740	900	1140
River Usk (Llangynidr Gorge)	-	54	14	14	1	0	1	2	1	4	3	550	600	950
Afon Goch	AGO	67	25	17	0	0	1	4	2	4	10	700	600	900
River Wye (Site B)	-	(29)	15	13	0	0	1	2	0	5	4	620	700	820
Afon Llafar upper	ALU	51	15	10	0	0	1	2	2	4	3	490	600	690
Afon Caseg central	ACC	55	10	6	0	1	0	1	1	3	4	420	500	620
Afon Anafon upper	AAU	40	17	12	0	0	0	5	2	4	6	580	400	580
Afon Ysgethin	-	56	17	9	0	0	1	3	2	2	6	380	100	580
Afon Caseg lower	ACL	58	18	12	0	0	1	2	1	2	5	350	400	550
Gelli Iago	-	42	10	5	0	0	1	0	2	2	4	320	100	520
Afon Llafar lower	ALL	59	14	8	0	0	0	2	2	3	6	480	300	480
Llyn Llagi stream	-	42	14	7	0	0	1	0	1	1	6	280	100	480
Nant Gwryd	NGW	47	7	0	0	0	1	0	1	2	2	260	400	460
Afon Cwm Glas Bach lower	GBL	47	7	1	0	0	1	0	0	1	4	220	300	420
Afon Cwm Glas Mawr	AGM	34	5	0	0	0	1	2	1	1	8	190	300	390
Afon Cwm Glas Bach upper	GBU	36	6	2	0	0	1	0	1	1	2	160	300	360
Afon Llafar central	ALC	50	15	10	0	0	0	2	1	2	4	320	200	320
Afon Cwm Eigiau	ACE	58	13	6	0	0	0	2	1	1	7	310	100	310
Afon Llugwy upper	LUU	55	8	2	0	0	0	2	0	1	7	310	100	310
Nant Idwal	NID	48	12	6	0	0	0	3	1	1	7	310	100	310
Afon Berthen	ABE	47	7	2	0	0	0	1	1	2	3	290	200	290
Nant yr Ogof	NYO	31	4	0	0	0	1	0	0	0	2	60	200	260
Afon Cwm Llan lower	CLL	34	5	0	0	0	0	0	1	1	4	220	100	220
Afon Merch	MER	39	4	0	0	0	0	1	1	1	3	190	100	190
Nant Bochlywd	NBO	47	7	2	0	0	0	1	1	1	2	160	100	160
Afon Melynllyn	MEL	53	8	3	0	0	0	0	0	0	5	150	0	150
Afon Llugwy lower	LUL	39	8	3	0	0	0	0	0	1	1	130	100	130
Afon Gamallt	-	41	10	5	0	0	0	3	0	0	4	120	0	120

Ceunant Mawr	-	46	14	8	0	0	0	1	0	0	3	90	0	90
Afon Cwm Llan upper	CLU	42	4	1	0	0	0	0	0	0	3	90	0	90
Afon Croesor	-	33	7	1	0	0	0	0	0	0	2	60	0	60

Data as in Table 4, but a column for CR added, and selected sites outside Eryri SSSI added, highlighted in pale orange.

Number of freshwater species: defined as in Table 3.

Overall score 1 = (NR x 100) + (EN x 200) + (VU x 200). [Thus ignoring Nationally Scarce scores].

Overall score 2 = (NR x 100) + (NS x 30) + (EN x 200) + (VU x 200).

EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, NR = Nationally Rare, NS = Nationally Scarce.

River Usk (Llangynidr Gorge): data from Orange (2012). River Wye 'Site B', data from Orange (2010); total number of species unknown.

Ceunant Mawr, VC 49, SH5655 (2017).

Afon Croesor, VC 48, SH6143, 6243, 6244 (1994).

Afon Gamallt, VC 48, SH7143, 7243 (1994.)

Afon Ysgethin, VC 48, SH5921 to 6122 (1996) .

Gelli Iago, VC 48, SH6347, 6348 (2011).

stream below Llyn Llagi, VC 48, SH6348, 6448 (2011).

Table 6. Comparison of four broadly-defined sites

Site:	Number of lichen species	Number of freshwater species	CR	EN	VU	NT	DD	NR	NS	NR/NS score	Overall score 1	Overall score 2
River Wye	97	28	0	2	1	4	2	5	10	800	1100	1400
River Usk	99	21	1	0	1	3	3	5	8	740	900	1140
Afon Caseg and Afon Llafar	91	24	0	1	1	2	2	5	8	740	900	1140
Afon Anafon	71	23	0	0	2	5	1	3	13	690	500	1090

Number of freshwater species: defined as in Table 3.

Overall score 1 = (NR x 100) + (EN x 200) + (VU x 200). [Thus ignoring Nationally Scarce scores].

Overall score 2 = (NR x 100) + (NS x 30) + (EN x 200) + (VU x 200).

EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient,

NR = Nationally Rare, NS = Nationally Scarce.

River Usk: combined records from grid ref. 22/9629 to 32/15.20 (Orange 2012).

River Wye: combined records from grid ref. 32/0744 to 1141 (Orange 2010), with additional records.

Afon Caseg and Afon Llafar: five sites (this survey) combined.

Afon Anafon: two sites (this survey) combined.

Table 7 (continued).

	Eryri SSSI various	Afon Conwy	Afon Iwrch	River Dee	Afon Cwm Llefrith	Afon Las	Afon Ogwen	stream near Moel	Afon Cwmnantcol	Afon Eden	Afon Gamallt	Afon Lliw	Afon Mawddach	Afon Prysor	Afon Tryweryn	Afon Ysgethin	Ceunant Liennyrch	Gelli Iago	Afon Banwy	Afon Rheidol	Afon Teifi	Afon Marteg	Irfon	River Wye	Afon Pyrddin	Nant Pennig	Nant y Llyn	River Usk
vice-county:	49	50	50	50	49	49	49	49	48	48	48	48	48	48	48	48	48	48	47	46	46	43	42	42/ 43	42	42	42	42
<i>Lecanora achariana</i>	r																											
<i>Leptogium magnussonii</i>																					p			p				r o
<i>Leptogium subtorulosum</i>																									p			
<i>Placopyrenium cinereoatratum</i>	r																						p	p			p	f
<i>Placopyrenium formosum</i>	o																							p				r
<i>Placynthium flabellousum</i>																p												
<i>Polychidium muscicola</i>	o					r			p			p			o	p												
<i>Porina interjungens</i>	r																											
<i>Porocyphus kenmorensis</i>	r									p	p	p				p	p								p			
<i>Pterygiopsis lacustris</i>	r				p					p		p	p												p			
<i>Pyrenopsis grumulifera</i>						p																						
<i>Rhizocarpon amphibium</i>	o					p		p										o										
<i>Verrucaria madida</i>																										r		
<i>Verrucaria pachyderma</i>	r						p			p		p	p			p	p			p			p	p	p			
<i>Verrucaria</i> sp. (Caseg A)	r																											
<i>Verrucaria</i> sp. (small spores)	r				p																					p		
Number of species:	2 1	4	4	4	6	7	3	3	5	6	5	8	6	4	5	8	4	3	3	3	5	4	5	13	4	5	3	9

Sources: mainly records by the writer, a few based on specimens in NMW: Afon Banwy R.G. Woods 1998.

Data for some rivers pooled from several sites. All records date from 1994 or later. p = present, o = occasional, r = rare, vr = very rare.

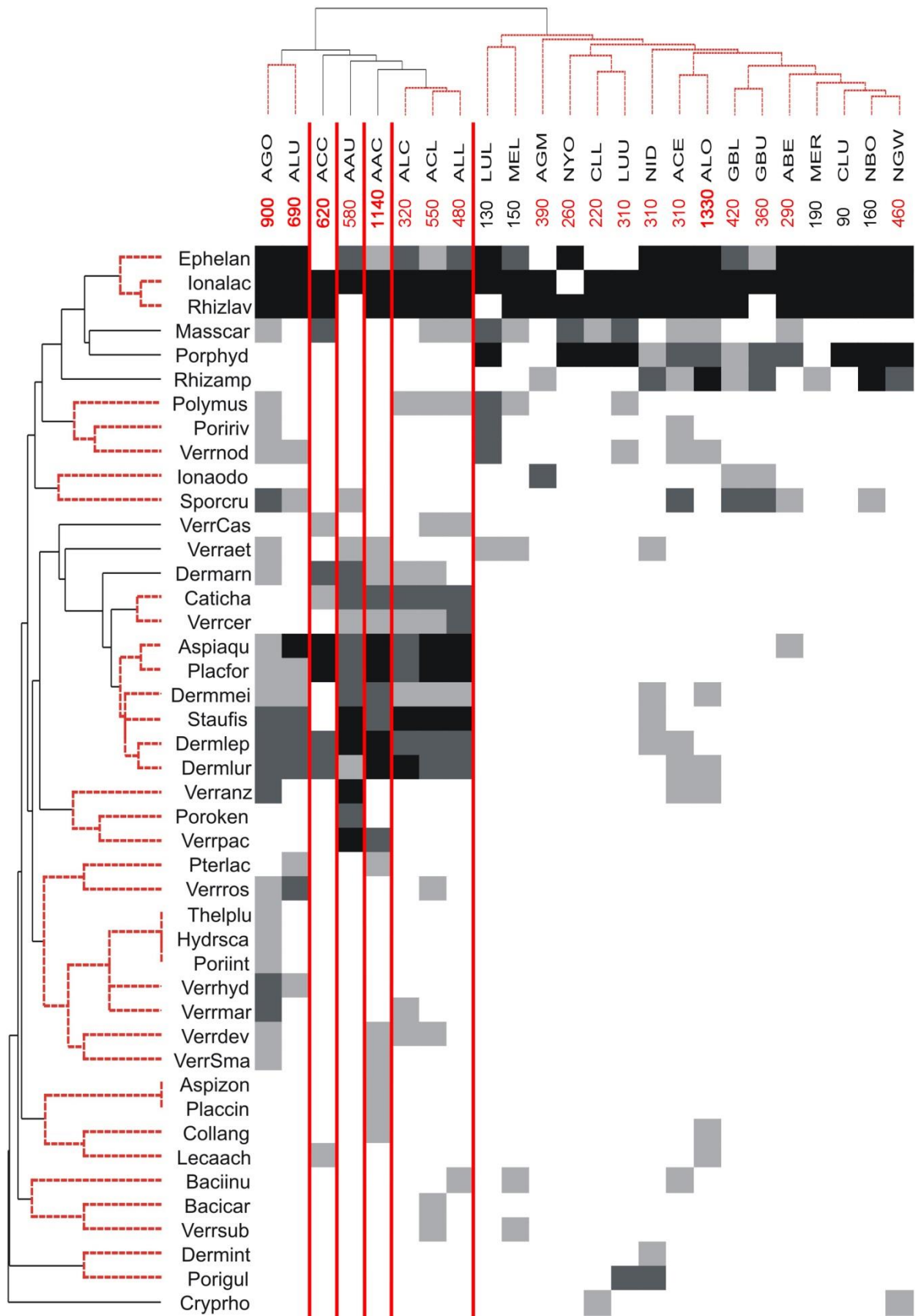


Figure 1. Classification of sites and species, based on freshwater-dependent lichens

In the dendrograms top and left the red lines indicate groups that are not statistically significant. Significant groups of sites divided by vertical red lines. The figure below the site abbreviation is Overall Score 2; red and bold = five top-scoring sites, black = five bottom-scoring sites.

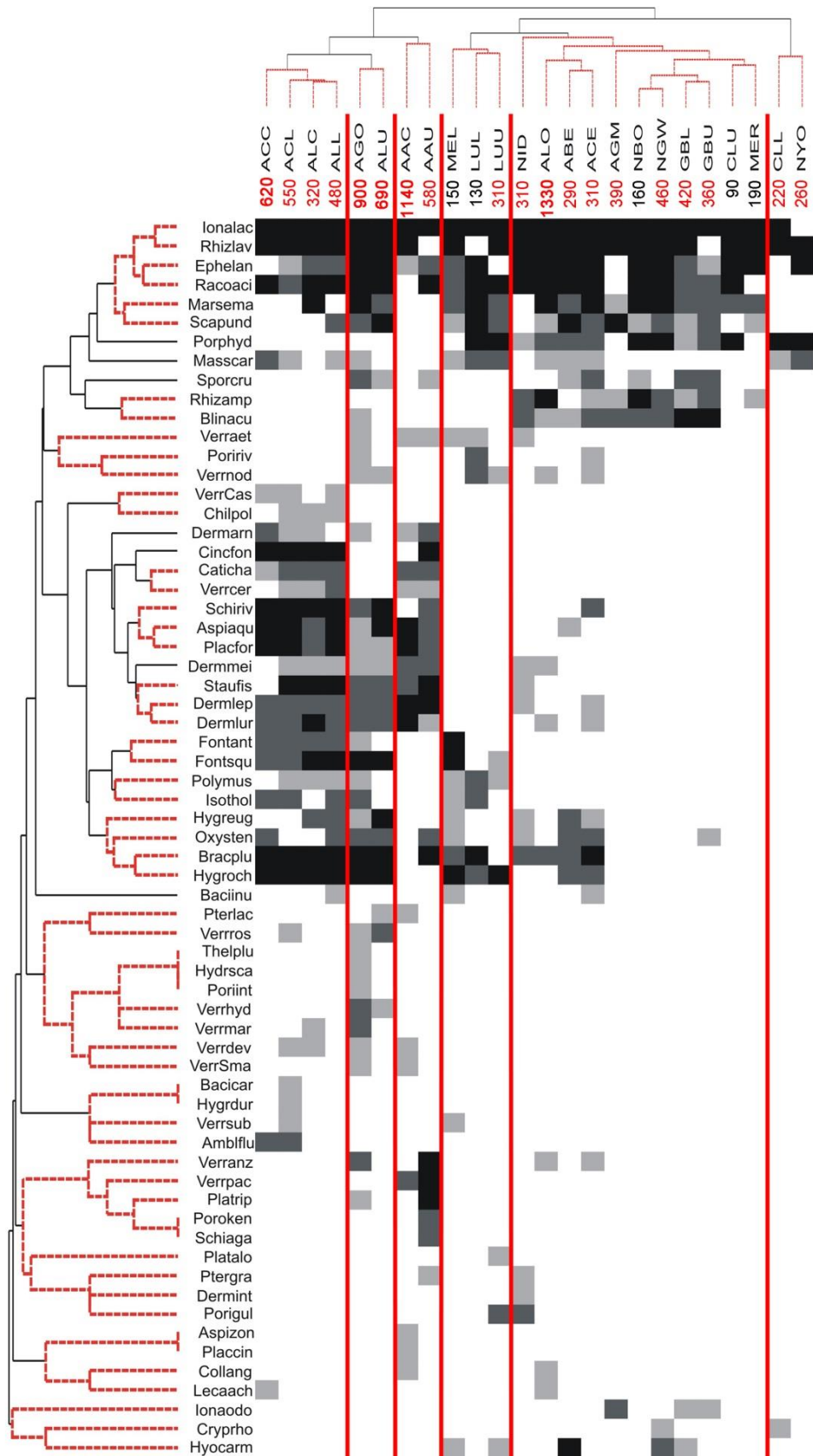


Figure 2. Classification of sites and species, based on freshwater-dependent lichens and bryophytes

In the dendrograms top and left the red lines indicate groups that are not statistically significant. Significant groups of sites divided by vertical red lines. The figure below the site abbreviation is Overall Score 2; red and bold = five top-scoring sites, black = five bottom-scoring sites.

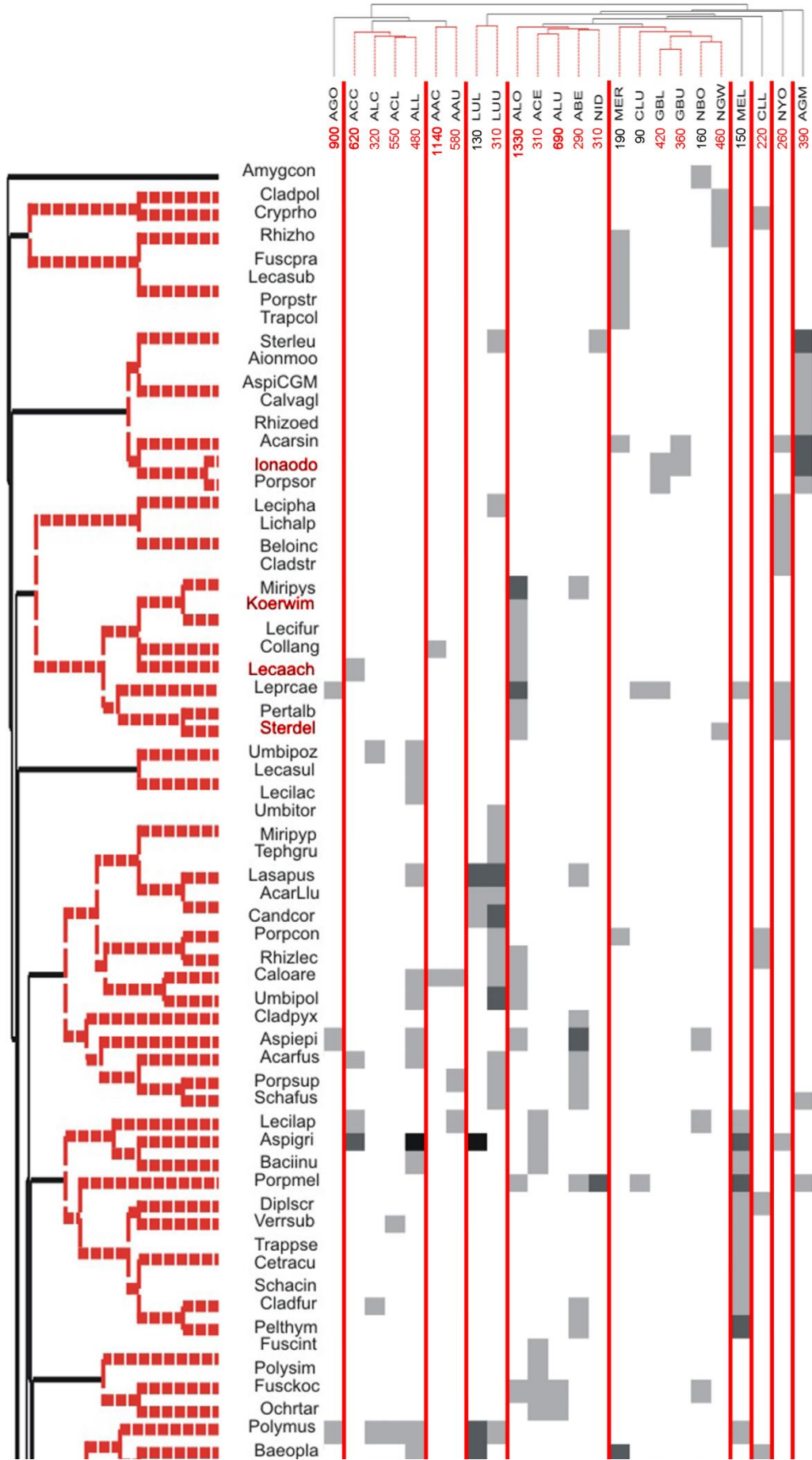


Figure 3. Classification of sites and species, based on all lichens

(Previous three pages). Classification of sites and species, based on all lichens. In the dendrograms top and left the red lines indicate groups that are not statistically significant (lower levels of species dendrogram omitted). Abundance of species at each site indicated by shade: black = abundant/frequent, mid grey = occasional, light grey = rare. Significant groups of sites divided by vertical red lines. The figure below the site abbreviation is Overall Score 2; red and bold = five top-scoring sites, black = five bottom-scoring sites. The names of Endangered and Vulnerable species are shown in red.

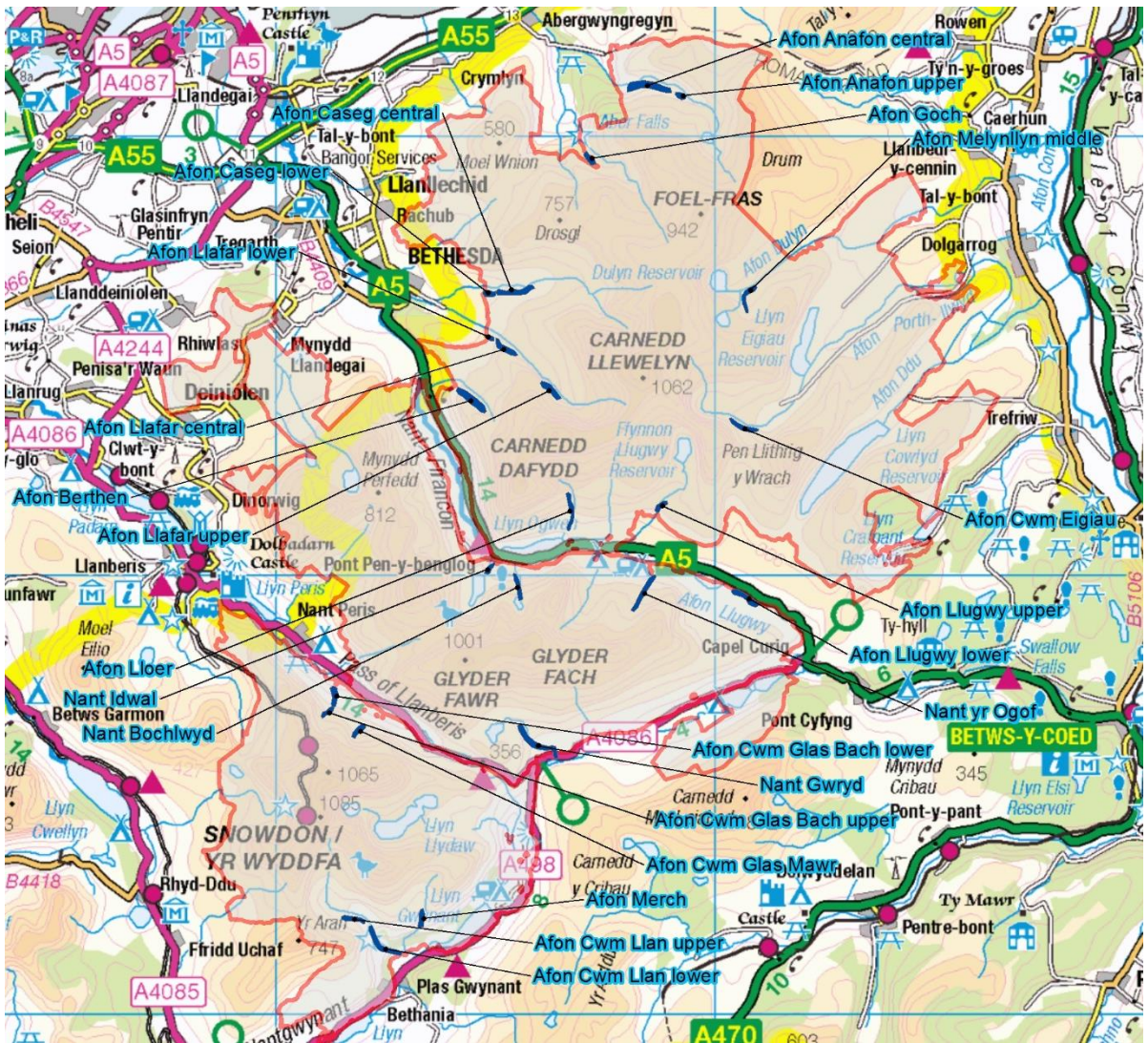


Figure 4. Distribution of sites (blue areas) within Eryri SSSI (red boundary).

Appendix 1. Lichen taxa recorded in sites compared for the analysis (Table 1)

species	notes	number of occurrences
<i>Acarospora fuscata</i>	A frequent terrestrial species of slightly nutrient-enriched rocks.	4
<i>Acarospora</i> Llugwy A	An unidentified species, possibly related to <i>Trimmatothelopsis versipellis</i> . 'Type' is 23782.	2
<i>Acarospora</i> Merch A	An unidentified pale brown species with rugose apothecial discs.	2
<i>Acarospora sinopica</i>	A species of iron-enriched rocks, seemingly tolerant of immersion.	4
<i>Acarospora smaragdula</i>	A frequent terrestrial species of slightly nutrient-enriched rocks.	8
<i>Agonimia tristicula</i>	Widespread on siliceous boulders by upland rivers, but also widespread on mossy limestone and mortar. Preliminary data suggest that two taxa may be involved, but more work is necessary.	18
<i>Ainoa mooreana</i>	An uncommon species of seeping rocks, only incidentally by streams.	1
<i>Amygdalaria consentiens</i>	An uncommon upland species of moist rocks.	1
<i>Amygdalaria pelobotryon</i>	Moist upland rocks.	16
<i>Arthorhaphis citinella</i>	On dry vertical surfaces which are typically irrigated occasionally.	4
<i>Aspicilia</i> Anafon A	A possibly undescribed species. 'Type' is 21553. Identification requires DNA sequencing for now.	1
<i>Aspicilia aquatica</i>	A poorly known, possibly overlooked species of streams.	9
<i>Aspicilia caesiocinerea</i>	A widespread species of slightly nutrient enriched rocks, not confined to rivers.	15
<i>Aspicilia</i> Cwm Glas Mawr A	Light grey areoles with isidiate soralia at margins, K + red; 'type' is 23812. Does not fit any recorded species, but is related to <i>A. epiglypta</i> . Identification requires DNA sequencing for now.	1
<i>Aspicilia epiglypta</i>	A probably under-recorded species of siliceous rocks.	5
<i>Aspicilia granulosa</i>	A widespread species of siliceous rocks, only recently recognised in Britain. Would traditionally be part of <i>A. grisea</i> s.l.	4

<i>Aspicilia grisea</i> agg.	There are 3 or 4 taxa which could be named as <i>A. grisea</i> , so records mean little and must be checked (ideally sequenced) whenever possible. These records are those that could not be identified to species.	6
<i>Aspicilia recedens</i>	A poorly known species reported mainly from coastal habitats; it typically occurred in small quantities amongst <i>A. caesiocinerea</i> .	3
<i>Aspicilia simoensis</i>	A poorly known species, but apparently widespread, distinguished by fragile clusters of darker soredia; part of <i>A. grisea</i> agg.	10
<i>Aspicilia zonata</i>	Known only from one British record (Afon Anafon); possibly overlooked, but not detected at other sites during the 2017 survey.	1
<i>Bacidia carneoglauca</i>	Typically on rain-sheltered surfaces in shaded humid sites by streams, for instance under boulders, or on stones in cavities in river banks, often in woodland.	1
<i>Bacidia inundata</i>	Almost confined to streams.	3
<i>Bacidia trachona</i>	Rain-sheltered siliceous rocks, widespread in upland Britain, terrestrial.	2
<i>Baeomyces placophyllus</i>	An occasional species of thin acid soil in moist places.	4
<i>Baeomyces rufus</i>	A frequent species of moist rock and soil.	11
<i>Belonia incarnata</i>	A rare species of soil.	1
<i>Buellia aethalea</i>	Frequent on siliceous rocks; probably more than one taxon is present under this name.	11
<i>Buellia ocellata</i>	Siliceous rocks, terrestrial.	3
<i>Caloplaca arenaria</i>	A local species of mildly basic rocks, terrestrial.	5
<i>Caloplaca crenularia</i>	A species of slightly basic siliceous rocks, terrestrial.	4
<i>Caloplaca holocarpa</i>	Slightly basic siliceous rocks, terrestrial.	1
<i>Caloplaca vitellinula</i>	Slightly basic siliceous rocks, terrestrial.	2
<i>Calvitimela aglaea</i>	An occasional species of upland siliceous rocks.	1
<i>Candelariella coralliza</i>	Typically on bird-perching rocks.	2
<i>Candelariella vitellina</i>	Nutrient-enriched rocks, often on bird perches in streams, with <i>Aspicilia caesiocinerea</i> .	9
<i>Catillaria atomarioides</i>	A local terrestrial species.	1
<i>Catillaria chalybeia</i>	On frequently inundated rocks, often with blue pigment in the apothecia (then distinguished as var. <i>chloropoliza</i>), but sometimes without such a pigment; also found in terrestrial habitats. It is likely that riparian and terrestrial forms are different taxa, but more study is needed.	6
<i>Cetraria aculeata</i>	Terrestrial macrolichen.	1
<i>Cladonia cervicornis</i>	A terrestrial macrolichen, but often found on seasonally moist upland rocks.	4
<i>Cladonia coccifera</i>	Terrestrial macrolichen.	6
<i>Cladonia cyathomorpha</i>	Typically on seasonally moist mossy rocks, not confined to rivers, but rather frequently found in small quantities in the upper riparian.	8

<i>Cladonia furcata</i>	Terrestrial macrolichen.	3
<i>Cladonia polydactyla</i>	Terrestrial macrolichen.	1
<i>Cladonia pyxidata</i>	Terrestrial macrolichen.	1
<i>Cladonia strepsilis</i>	Terrestrial macrolichen.	1
<i>Cladonia subcervicornis</i>	Terrestrial macrolichen, common on upland rocks	13
<i>Claurouxia chalybeoides</i>	An uncommon species of moist rocks.	1
<i>Collema flaccidum</i>	On seeping or occasionally inundated rocks which are slightly base-enriched.	4
<i>Collema glebulentum</i>	Beside rivers and lakes in slightly base-enriched upland habitats.	2
<i>Collemopsidium angermannicum</i>	A riparian species of siliceous rocks.	2
<i>Cryptothele rhodosticta</i>	A rare species of acidic siliceous rocks, apparently needing surfaces which experience a delicate balance between wet and dry.	2
<i>Dermatocarpon arnoldianum auct.</i>	A rare species of frequently inundated rocks in streams and lochans; usually included in <i>D. miniatum</i> , which is typically on terrestrial limestone, but probably representing a distinct species, under investigation by the writer. The name <i>D. arnoldianum</i> has been incorrectly applied to this taxon but is used here for convenience.	6
<i>Dermatocarpon intestiniforme</i>	A species of regularly inundated or seeping rocks in northern and western Britain. The name is probably incorrect and this may be an undescribed species.	1
<i>Dermatocarpon leptophyllodes</i>	A local species of streams, sometimes in low riparian zone but more often on drier, well-drained crests than the other species of the genus.	10
<i>Dermatocarpon luridum</i>	A frequent species of streams in upland Britain, but avoiding acidic sites.	10
<i>Dermatocarpon meiophyllizum</i>	A local riparian species of frequently inundated rocks, avoiding acidic substrata.	9
<i>Dibaeis baeomyces</i>	Terrestrial species of disturbed soil and tracks.	2
<i>Diploschistes scruposus</i>	Terrestrial species of well-drained, vertical rocks.	2
<i>Ephebe lanata</i>	Common on upland rivers and on seasonally irrigated rocks in upland Britain, most abundant on base poor rocks in high rainfall areas.	20
<i>Fuscidea cyathoides</i>	Frequent species of siliceous rocks.	13
<i>Fuscidea intercincta</i>	Uncommon terrestrial species of steep rock faces in the uplands.	1
<i>Fuscidea kochiana</i>	Frequent species of siliceous rocks.	4
<i>Fuscidea lygaea</i>	Frequent species of upland siliceous rocks, but often noticeably vigorous in the riparian zone, even occurring shallowly submerged..	19
<i>Fuscidea praeruptorum</i>	Local species of steep rock faces in the uplands.	1
<i>Hydropunctaria scabra</i>	A rather local aquatic species of streams and lochans, avoiding the more acidic rocks, often confined to woodland in southern Britain, perhaps to avoid high temperatures.	1

<i>Hypotrachyna afrorevoluta</i>	Common terrestrial species, mostly on trees.	2
<i>Immersaria athroocarpa</i>	A rather frequent upland species of poorly-drained surfaces, often found in the upper riparian.	15
<i>Ionaspis lacustris</i>	Abundant by streams and lakes, also irrigated surfaces and moist stones. Variable in colour, with differently-coloured thalli growing together, but preliminary studies suggest these have no taxonomic significance.	23
<i>Ionaspis odora</i>	Very much northern and upland in Britain, in streams but also on moist rocks and scree in high-altitude high-rainfall areas; probably rare in Wales, there is a record from above Llyn Bochlywd at 590 m.	3
<i>Koerberiella wimmeriana</i>	A rare, upland, northern and western species in Britain, on moist rocks which are not too acidic.	1
<i>Lasallia pustulata</i>	A conspicuous macrolichen of somewhat nutrient-enriched upland rocks.	4
<i>Lecanora achariana</i>	A northern species which is very rare in Britain, probably associated with bird-perching and usually beside streams and lakes. Very few extant Welsh sites. Afon Caseg (this survey) is a new locality.	2
<i>Lecanora dispersa</i>	A terrestrial species common on calcareous rocks.	1
<i>Lecanora intricata</i>	Frequent terrestrial species,	16
<i>Lecanora muralis</i>	Frequent terrestrial species, including in urban situations; beside streams often associated with bird-perching and mildly base-rich rock. Despite being abundant in towns, this species is an favorable indicator of slightly base-rich conditions in streams.	9
<i>Lecanora polytropa</i>	Frequent terrestrial species,	5
<i>Lecanora rupicola</i>	Terrestrial species of slightly basic rocks.	4
<i>Lecanora soralifera</i>	Frequent terrestrial species.	9
<i>Lecanora subaurea</i>	Uncommon greenish yellow crust confined to strongly metal-enriched rocks; terrestrial, but tolerant of moisture on a shingle bank by Afon Merch.	1
<i>Lecanora sulphurea</i>	Terrestrial species of slightly basic rocks.	1
<i>Lecidea furvella</i>	Terrestrial species.	1
<i>Lecidea fuscoatra</i>	Terrestrial species of slightly basic rocks.	5
<i>Lecidea lactea</i>	Terrestrial species, many records now referred to <i>L. swartzioidea</i> .	1
<i>Lecidea lapicida</i>	Terrestrial species.	5
<i>Lecidea lithophila</i>	Frequent terrestrial species, especially on recently exposed surfaces.	16
<i>Lecidea phaeops</i>	Typically on moist and seeping, steep surfaces, but only incidentally beside rivers.	2
<i>Lecidea swartzioidea</i>	Widespread terrestrial species in the <i>Lecidea lactea</i> group, status poorly known and needs more study.	11
<i>Lecidella scabra</i>	Terrestrial species of slightly basic rocks.	2
<i>Lecidella stigmataea</i>	Terrestrial species of slightly basic rocks.	1
<i>Lepraria caesioalba</i>	Terrestrial upland species.	6

<i>Leptogium gelatinosum</i>	Terrestrial species of calcareous rocks; morphologically variable; riparian material is well-developed and fertile, and might merit investigation.	2
<i>Lichenomphalia alpina</i>	A local upland species of banks and soily crevices.	1
<i>Massalongia carnosa</i>	Typically growing amongst mosses on occasionally inundated rocks, upper riparian.	12
<i>Melanelixia fuliginosa</i>	Frequent terrestrial species.	4
<i>Micarea leprosula</i>	Frequent terrestrial species of mosses on upland rocks, but often in seasonally irrigated places.	5
<i>Micarea lignaria</i> var. <i>lignaria</i>	Frequent terrestrial species of siliceous rock and moss.	5
<i>Miriquidica leucophaea</i>	Frequent terrestrial species.	11
<i>Miriquidica pycnocarpa</i> f. <i>pycnocarpa</i>	Moist upland rocks.	1
<i>Miriquidica pycnocarpa</i> f. <i>sorediata</i>	Upland rocks.	2
<i>Ochrolechia parella</i>	Terrestrial species of slightly basic rocks.	7
<i>Ochrolechia tartarea</i>	Mainly upland species of mossy rock and acidic bark.	2
<i>Opegrapha gyrocarpa</i>	Terrestrial species of rain-sheltered, shaded rocks.	4
<i>Ophioparma ventosum</i>	Terrestrial upland species.	3
<i>Parmelia omphalodes</i>	Terrestrial species.	14
<i>Parmelia saxatilis</i>	Terrestrial species.	15
<i>Peltigera hymenina</i>	Frequent terrestrial species of turf and mossy rocks.	2
<i>Peltigera membranacea</i>	Frequent terrestrial species of turf and mossy rocks.	4
<i>Peltigera rufescens</i>	Frequent terrestrial species of turf and mossy rocks.	2
<i>Pertusaria albescens</i>	Terrestrial species.	2
<i>Pertusaria amara</i>	Terrestrial species.	4
<i>Pertusaria aspergilla</i>	Terrestrial species.	10
<i>Pertusaria chiodectonoides</i>	Terrestrial species, often coastal; rare in Wales, avoiding acidic rocks; also found beside River Usk.	3
<i>Pertusaria corallina</i>	Terrestrial species.	16
<i>Pertusaria excludens</i>	Terrestrial species.	5
<i>Pertusaria lactea</i>	Terrestrial species.	6
<i>Pertusaria pseudocorallina</i>	Terrestrial species.	18
<i>Physcia caesia</i>	Terrestrial species, but can be abundant on bird-perching rocks in streams.	6
<i>Physcia dubia</i>	Terrestrial species of nutrient-enriched places.	2
<i>Physcia tenella</i>	Terrestrial species of nutrient-enriched places.	2
<i>Pilophorus strumaticus</i>	On moist or seeping rock, only incidentally beside streams.	8
<i>Placidium rufescens</i>	Mainly terrestrial and preferring calcareous rock crevices.	1
<i>Placopsis lambii</i>	Frequent species of siliceous rock, especially where enriched with iron.	18

<i>Placopyrenium cinereoatratum</i>	Uncommon species which is often initially parasitic on <i>Staurothele fissa</i> . Reported new for Britain, with description, by Orange (2009).	1
<i>Placopyrenium formosum</i>	Uncommon species which is initially parasitic on <i>Aspicilia aquatica</i> , but which can be abundant with only small quantities of the host. Described by Orange (2009).	8
<i>Polychidium muscicola</i>	Typically on mossy rocks by streams, but not confined to streams.	7
<i>Polysporina simplex</i>	Terrestrial species.	1
<i>Porina guentheri</i> var. <i>lucens</i>	Riparian species, typically on steep and well-drained faces, local. The var. <i>guentheri</i> seems not to be riparian, and it is possible that they represent different species.	2
<i>Porina interjungens</i>	A rare species of rocks beside rivers and on damp cliffs.	1
<i>Porina lectissima</i>	A widespread species of seeping rocks and rain channels, but apparently intolerant of immersion and only incidentally beside rivers.	9
<i>Porina rivalis</i>	A recently described species (Orange 2015), apparently widespread on frequently submerged rocks in streams, rarely on very wet rocks.	3
<i>Porocyphus kenmorensis</i>	A rare species of streams and lochans, on frequently submerged rocks.	1
<i>Porpidia cinereoatra</i>	Terrestrial species.	12
<i>Porpidia contraponenda</i>	A mainly northern terrestrial species, favouring moist rocks.	3
<i>Porpidia crustulata</i>	Terrestrial species, usually on recently exposed surfaces and stones; often on cobbles in Eryri streams.	8
<i>Porpidia hydrophila</i>	A frequent species of acidic rocks in streams and irrigated faces, often a conspicuous species in base-poor streams.	13
<i>Porpidia irrigua</i>	On seasonally irrigated rocks, but only incidentally beside rivers. Formerly confused with the more northern <i>P. contraponenda</i> , and newly described by Orange (2014).	13
<i>Porpidia macrocarpa</i>	Terrestrial species, mainly on moist, recently exposed or disturbed rocks and stones. Probably an aggregate species.	16
<i>Porpidia melinodes</i>	Terrestrial species.	6
<i>Porpidia rugosa</i>	A species of moist or irrigated rock faces, not confined to streams.	10
<i>Porpidia soledizodes</i>	Terrestrial species.	2
<i>Porpidia speirea</i>	Terrestrial species of slightly basic rocks.	1
<i>Porpidia striata</i>	Terrestrial species, often on recently exposed stones.	1
<i>Porpidia superba</i> f. <i>sorediata</i>	An uncommon taxon; f. <i>superba</i> tends to be on markedly calcareous substrata and could be a distinct taxon.	3
<i>Porpidia tuberculosa</i>	Frequent terrestrial species.	15

<i>Protoparmelia atriseda</i>	A rare terrestrial species associated with <i>Rhizocarpon geographicum</i> .	1
<i>Protoparmelia badia</i>	Terrestrial species.	7
<i>Pterygiopsis lacustris</i>	A rare species of streams and lakes.	2
<i>Pyrenopsis subareolata</i>	A local species of flushed acidic siliceous rocks, apparently needing surfaces which experience a delicate balance between wet and dry.	6
<i>Rhizocarpon amphibium</i>	An uncommon riparian species of frequently inundated acidic rocks, apparently more frequent on acidic rocks.	9
<i>Rhizocarpon distinctum</i>	Terrestrial species of slightly calcareous rocks.	1
<i>Rhizocarpon geographicum</i>	Frequent terrestrial species; intolerant of immersion, but sometimes found on well-drained crests even rather shortly above water.	17
<i>Rhizocarpon hochstetteri</i>	Terrestrial upland species.	2
<i>Rhizocarpon lavatum</i>	Abundant species of streams, also on moist rocks in other situations.	21
<i>Rhizocarpon lecanorinum</i>	Uncommon terrestrial species.	3
<i>Rhizocarpon oederi</i>	Terrestrial species, especially on metal-rich rocks.	1
<i>Rhizocarpon reductum</i>	Frequent terrestrial species of recently exposed surfaces and pebbles.	7
<i>Rhizocarpon viridiatrum</i>	Uncommon species initially parasitic on <i>Aspicilia caesiocinerea</i> .	6
<i>Rimularia badioatra</i>	Mainly upland species, terrestrial, but often associated with riverside rocks.	9
<i>Rimularia intercedens</i>	Uncommon terrestrial species.	2
<i>Schaereria cinereorufa</i>	Upland terrestrial species.	1
<i>Schaereria fuscocinerea</i>	Upland terrestrial species.	3
<i>Scoliciosporum umbrinum</i>	Frequent terrestrial species.	16
<i>Sphaerophorus globosus</i>	Mainly upland terrestrial macrolichen.	3
<i>Sporodictyon cruentum</i>	Riparian species, often in relatively base-poor places, and often on stones.	8
<i>Staurothele fissa</i>	Riparian species, frequent, avoiding acidic sites.	8
<i>Stereocaulon dactylophyllum</i>	Terrestrial macrolichen.	1
<i>Stereocaulon delisei</i>	Terrestrial macrolichen, but seems often to be beside rivers.	3
<i>Stereocaulon evolutum</i>	Terrestrial macrolichen.	9
<i>Stereocaulon leucophaeopsis</i>	Terrestrial crustose lichen.	3
<i>Stereocaulon pileatum</i>	Terrestrial macrolichen.	9

<i>Stereocaulon vesuvianum</i>	Terrestrial macrolichen. The varieties were not distinguished. ITS sequences of a sorediate morph and an adjacent fertile morph from Melynlyn were identical, suggesting that fertility and morphological variation may not be of much taxonomic importance in this species.	16
<i>Tephromela atra</i>	Frequent terrestrial species.	18
<i>Tephromela grumosa</i>	Terrestrial species.	1
<i>Thelidium pluvium</i>	Riparian species, avoiding acidic sites.	1
<i>Trapelia collaris</i>	Terrestrial species, apparently rare beside rivers. A new segregate of <i>T. coarctata</i> s.l., described by Orange (2017).	1
<i>Trapelia elacista</i>	Widespread species of moist, recently exposed rocks and stones, well-adapted to riparian situations but also elsewhere. Nomenclature follows Orange (2017).	14
<i>Trapelia glebulosa</i>	Terrestrial species of recently exposed rocks and stones. Nomenclature follows Orange (2017).	5
<i>Trapelia involuta</i>	Terrestrial species of recently exposed rocks and stones. Nomenclature follows Orange (2017).	16
<i>Trapelia obtegens</i>	Terrestrial species of recently exposed rocks and stones. Nomenclature follows Orange (2017).	8
<i>Trapelia placodioides</i>	Terrestrial species of moist rocks.	20
<i>Trapeliopsis pseudogranulosa</i>	Terrestrial species of acidic soil, mosses and wood.	1
<i>Tremolecia atrata</i>	Frequent terrestrial species.	16
<i>Umbilicaria deusta</i>	An uncommon, mainly upland, macrolichen; not riparian but often found near water.	1
<i>Umbilicaria polyphylla</i>	Upland terrestrial macrolichen.	3
<i>Umbilicaria polyrhiza</i>	Upland terrestrial macrolichen.	2
<i>Umbilicaria torrefacta</i>	Upland terrestrial macrolichen.	1
<i>Verrucaria aethiobola</i>	Riparian species, avoiding acidic sites.	6
<i>Verrucaria anziana</i>	Riparian species, avoiding acidic sites, distinctly northern in distribution, misunderstood until rather recently.	4
<i>Verrucaria Caseg A</i>	An unidentified, possibly undescribed species, detected only during this survey. Difficult to distinguish from <i>Verrucaria margacea</i> in the field. The 'type' is 23850.	3
<i>Verrucaria cernaensis</i>	Riparian species, avoiding acidic sites.	5
<i>Verrucaria devensis</i>	Riparian species, avoiding acidic sites. Confused with <i>V. praetermissa</i> until recently (Orange 2014).	4
<i>Verrucaria fusconigrescens</i>	Terrestrial species, mainly coastal.	1
<i>Verrucaria hydrophila</i>	Riparian species of streams and streamlets, often in shade; possibly a complex of very similar taxa, some growing on shaded stones in terrestrial habitats. Nomenclature follows Orange (2013).	2

<i>Verrucaria margacea</i>	Riparian species, avoiding acidic sites; often in shade. British material is not conspecific with the type material, but the group needs more study.	2
<i>Verrucaria nodosa</i>	Recently described (Orange 2013) and poorly known. Seems to be occasional in small quantities in upland streams, more tolerant of base-poor conditions than most species of <i>Verrucaria</i> .	6
<i>Verrucaria pachyderma</i>	Uncommon riparian species, avoiding acidic sites.	2
<i>Verrucaria rosula</i>	Recently described (Orange 2013), rather frequent by streams and on moist rocks, often in shade; exposed forms often form a brown, sterile crust.	3
<i>Verrucaria</i> small spores	An undescribed species known only from a few streams in North Wales and one in the Brecon Beacons.	2
<i>Verrucaria sublobulata</i>	A riparian species, overlooked until rather recently.	2
<i>Xanthoparmelia conspersa</i>	Terrestrial species, often on poorly drained surfaces or in rain tracks.	13
<i>Xanthoparmelia loxodes</i>	Terrestrial macrolichen, often coastal	2
<i>Xanthoria parietina</i>	Terrestrial macrolichen associated with nitrogen-rich and often calcareous substrata.	1

Appendix 2. Accounts of individual sites

Sites surveyed in 2017, and the few other sites available for Eryri SSSI, are listed below. For each site there is an annotated species list, a list of species of conservation concern, and brief notes on the site or the survey. All sites except Nant yr Ogof were surveyed by the writer. A few photographs are presented to show the aspect of each site.

For each site the following are listed:

Site name

Site code (assigned to assist cluster analyses)

1 km square(s)

Area of survey (grid ref. of top and bottom of surveyed area).

Altitude of surveyed area.

Date of survey.

Geology. Data is taken from the British Geological Survey Geology of Britain viewer (<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>). Usually only bedrock geology is mentioned below. However, in some cases the stream boulders were clearly derived from till, and in most sites there is the possibility that boulders do not all belong to the local bedrock.

Species lists often cite numbers assigned to localities in the field; the grid references of these localities are listed in a table after the species data.

Sites are in alphabetical order.

Afon Anafon central

Site code: AAC. 1 km squares: 67.71, 68.71. Area surveyed: 678.710 to 6890.7102. Alt.: , 270-310 m. Date of survey: 1 May 2013, 5 June 2013.

Geology: 1. Nant Ffrancon Subgroup - Siltstone. 2. Unnamed Igneous Intrusion, Ordovician - Microgranodiorite. (Superficial deposits of till may provide much of the rock).

Data are taken from Orange (2013; A Lichen Survey of a Proposed Hydropower Scheme on the Afon Anafon, report to National Trust). Only records from the unshaded, unfenced upper part of the site are included below.

An excellent example of a lichen-rich upland stream. It has a good range of freshwater species including the Nationally Scarce *Verrucaria pachyderma*. There are two species regarded as Vulnerable in Wales, and five regarded as Near Threatened. The populations of *Aspicilia aquatica*, *Dermatocarpon leptophyllodes*, and *Placopyrenium formosum* are a good size and clearly viable. The survey provided the first British record of *Aspicilia zonata*, which is still the only British record.

A number of species indicate base-rich conditions, including *Caloplaca holocarpa*, *Lecanora rupicola* and *Ochrolechia parella*. No lichens were recorded on permanently submerged rocks. The lower riparian zone (frequently submerged rocks) had *Collembopodium angermannicum*, *Staurothele fissa* (frequent), *Dermatocarpon luridum* (occasional to frequent), *D. meiophyllizum* (occasional to frequent), *Verrucaria cernaensis* (occasional). *Placopyrenium cinereoatratum* was seen twice amongst *Staurothele fissa* (on which this species is sometimes found as a parasite), but was probably more frequent (it needs to be searched for with a hand lens).

In general, *Verrucaria* species were not abundant. Semi-stable stones (small cobbles) somewhat sheltered amongst rocks at the side of the channel appeared to have a greater frequency and abundance of *Verrucaria* spp. than larger rocks, and the only colony of *Verrucaria pachyderma* that was seen was from this substratum.

Aspicilia aquatica was abundant, often colonised by the parasitic lichen *Placopyrenium formosum*. *Dermatocarpon leptophyllodes* was frequent on unshaded rocks, and occasional in light shade. The upper riparian had *Aspicilia caesiocinerea*, *Candelariella vitellina*, *Lecanora muralis*, *Lecanora rupicola* (occasional), *Physcia caesia*. The latter and others are favoured by nutrient enrichment; however, there was no sign of bird-perching or other very localised enrichment at the site. *Fuscidea lygaea* was frequent as a genuinely riparian species: in upland Wales this species is locally abundant away from water, but at the present site it was often conspicuous in the riparian zone.

Site:	Afon Anafon central
<i>Agonimia tristicula</i>	Unshaded rocks, mid to upper riparian, 67.71.

<i>Aspicilia Anafon A</i>	On small boulder, 10-20 cm above water, frequently submerged, 6783.7102. Unidentified species. (Voucher: 21553).
<i>Aspicilia aquatica</i>	Unshaded rocks, frequent, 67.71, 68.71.
<i>Aspicilia zonata</i>	On small boulder, upper riparian, grid ref. 6870.7110. (Voucher: 21563).
<i>Buellia aethalea</i>	Rocks, 68.71. K - .
<i>Buellia ocellata</i>	Upper riparian, 67.71.
<i>Caloplaca arenaria</i>	Upper riparian, rare, 68.71.
<i>Caloplaca crenularia</i>	Upper riparian, ?rare, 68.71.
<i>Caloplaca holocarpa</i>	Upper riparian, rare, 67.71.
<i>Candelariella vitellina</i>	Upper riparian, 67.71.
<i>Catillaria atomarioides</i>	Upper riparian, 67.71.
<i>Catillaria chalybeia</i>	Low riparian, 67.71. (var. chloropoliza).
<i>Collema glebulentum</i>	Unshaded rocks, lower riparian, occasional, 68.71.
<i>Collemopsidium angermannicum</i>	Low riparian, rare but easily overlooked, 67.71.
<i>Dermatocarpon arnoldianum auct.</i>	Rare, 67.71.
<i>Dermatocarpon leptophyllodes</i>	Mid riparian, frequent, 67.71, 68.71.
<i>Dermatocarpon luridum</i>	Low/mid riparian, occasional or locally frequent; 67.71.
<i>Dermatocarpon meiophyllizum</i>	Lower riparian, 67.71, 68.71.
<i>Ephebe lanata</i>	Poorly drained hollow in unshaded rock, rare, 67.71.
<i>Fuscidea lygaea</i>	Occasional on unshaded rocks, mid riparian, 67.71. Typically a terrestrial species, but riparian at this site, sometimes forming a distinct band near water level.
<i>Immersaria athroocarpa</i>	Upper riparian, 67.71, 68.71.
<i>Ionaspis lacustris</i>	Low to mid riparian.
<i>Lecanora muralis</i>	Frequent. 67.71, 68.71.
<i>Lecanora rupicola</i>	Upper riparian.
<i>Lecidella stigmataea</i>	Upper riparian, 67.71.
<i>Melanelixia fuliginosa</i>	Upper riparian, 67.71.
<i>Miriquidica leucophaea</i>	Upper riparian.
<i>Ochrolechia parella</i>	Upper riparian, 67.71, 68.71.
<i>Parmelia omphalodes</i>	Upper riparian.
<i>Parmelia saxatilis</i>	Upper riparian.
<i>Pertusaria chiodectonoides</i>	Upper riparian, 67.71.
<i>Pertusaria pseudocorallina</i>	Upper riparian, 67.71.
<i>Physcia caesia</i>	Upper riparian, 67.71.
<i>Placopsis lambii</i>	Upper riparian, 67.71
<i>Placopyrenium cinereoatratum</i>	Low riparian, associated with <i>Staurothele fissa</i> , 6787.7106, 6856.7119.
<i>Placopyrenium formosum</i>	On <i>Aspicilia aquatica</i> , frequent, 67.71, 68.71.
<i>Porina lectissima</i>	67.71.
<i>Porpidia tuberculosa</i>	Rocks.
<i>Pterygiopsis lacustris</i>	Low riparian, with <i>Staurothele fissa</i> , 67875.71065. (Voucher sub 21569, det. 2017).
<i>Rhizocarpon geographicum</i>	Upper riparian.
<i>Rhizocarpon lavatum</i>	Low to mid riparian, frequent, 67.71, 68.71.
<i>Rhizocarpon viridiatrum</i>	On <i>Aspicilia caesiocinerea</i> , rare, 68.71.
<i>Rimularia badioatra</i>	Rare, 67.71, 68.71.
<i>Scoliciosporum umbrinum</i>	Upper riparian.

<i>Staurothele fissa</i>	Low riparian, occasional, 67.71, 68.71.
<i>Stereocaulon dactylophyllum</i>	Upper riparian, 68.71.
<i>Stereocaulon vesuvianum</i>	Upper riparian, rare; 68.71.
<i>Tephromela atra</i>	Upper riparian.
<i>Verrucaria aethiobola</i>	On stone at margin. (Conf. 2017, voucher 21568).
<i>Verrucaria cernaensis</i>	Mid riparian, 67.71.
<i>Verrucaria devensis</i>	Low riparian, on cobble at side of channel. (Voucher: sub 21561).
<i>Verrucaria fusconigrescens</i>	Upper riparian, very rare, 67.71.
<i>Verrucaria pachyderma</i>	Low riparian, 67.71.
<i>Verrucaria</i> small spores	Low riparian, on cobble at side of channel, 6844.7117. (Voucher: 21561).
<i>Xanthoparmelia conspersa</i>	Upper riparian.
Number of lichen species:	55
Number of riparian species:	21
EN	0
VU	2
NT	4
DD	3
NR	5
NS	8

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Pterygiopsis lacustris</i>	VU	NT	NR	
<i>Pertusaria chiodectonoides</i>	VU		NS	
<i>Collembosidium angermannicum</i>	NT	NT	NS	
<i>Collema glebulentum</i>	NT		NS	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Placopyrenium cinereoatratum</i>	DD		NR	
<i>Verrucaria pachyderma</i>	DD	DD	NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Immersaria athrocarpa</i>			NS	
<i>Rhizocarpon viridiatrum</i>			NS	
<i>Rimularia badioatra</i>			NS	

Poorly known species of possible concern:

Aspicilia Anafon A

Dermatocarpon arnoldianum auct.

Verrucaria small spores



Looking downstream from proposed hydropower intake in 2013.



Looking downstream from constructed intake in 2017.



The penstock crossing the stream, 2017.



Lower part of site, 2013.

Afon Anafon upper

Site code: AAU. 1 km square: 69.70. Area of survey: 6916.7097 to 6919.7096. Alt.: 340 m. Date of survey: 19 July 2017.

Geology: 1. Nant Ffrancon Subgroup - Siltstone. (2. Unnamed Igneous Intrusion, Ordovician - Porphyry). (Superficial deposits of till may provide much of the rock).

Survey was cut short by heavy rain, so only about two hours were spent at the site, surveying the lower 100 m. Although the character of the site was established, a second visit would surely reveal more species.

Drains unenclosed upland pasture, with areas of bracken, *Erica tetralix* and probably many others. Bryophytes are frequent, and a conspicuous component of the stream, but they do not become a threat to lichens except in the shade of a *Salix cinerea* shrub. *Verrucariaceae* are frequent, including four *Dermatocarpon* species (including *D. arnoldianum auct.*), and several *Verrucaria* including *V. anziana* and *V. pachyderma*. The *V. anziana* is distinctive by the pale pinkish-grey cracked thallus; it has at least two parasites at the site. *Ephebe* is inconspicuous. The stream evidently has a fairly high discharge, and there is a good variety of microhabitat on boulders of various sizes. There is little or no bedrock.

The bryophytes were rich, though scarcely investigated, and included *Schistidium rivulare* and *S. agassizii*.

The base-rich rock is clearly the over-riding feature of this site. The relatively high discharge provides microhabitat diversity and a rather tall riparian zone.

Site:	Afon Anafon upper (69.70)
<i>Agonimia tristicula</i>	Amongst short Brachythecium plumosum, rare, c.fr.
<i>Aspicilia aquatica</i>	Mid riparian, occasional.
<i>Aspicilia caesiocinerea</i>	Upper riparian, occasional.
<i>Bacidia trachona</i>	On rock sheltered by large boulder.
<i>Caloplaca arenaria</i>	Upper riparian, rare.
<i>Caloplaca crenularia</i>	Upper riparian, occasional.
<i>Candelariella vitellina</i>	Upper riparian, occasional.
<i>Catillaria chalybeia</i>	Lower riparian, occasional [not possible to collect any].
<i>Collema glebulentum</i>	Low to mid riparian, occasional.
<i>Dermatocarpon arnoldianum auct.</i>	Low riparian, perhaps not as confined to low levels as <i>D. meiophyllizum</i> , brown but more papery than other; occasional. (Voucher: 23755).
<i>Dermatocarpon leptophyllodes</i>	Mid-riparian, frequent.
<i>Dermatocarpon luridum</i>	Lower riparian, one colony seen.
<i>Dermatocarpon meiophyllizum</i>	Lower riparian, occasional.

<i>Ephebe lanata</i>	Low to mid riparian, occasional but in small quantities and inconspicuous.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora muralis</i>	Upper riparian, occasional. A typical upper riparian species.
<i>Lecanora rupicola</i>	Upper riparian, occasional.
<i>Lecidea fuscoatra</i>	Upper riparian, rare.
<i>Lecidea lapicida</i>	Upper riparian, 40 (69160.70976).
<i>Ochrolechia parella</i>	Upper riparian, occasional.
<i>Parmelia saxatilis</i>	Upper riparian, occasional.
<i>Pertusaria excludens</i>	Upper riparian, occasional.
<i>Physcia caesia</i>	Abundant on gently sloping top of a boulder, upper riparian.
<i>Placidium rufescens</i>	Mid riparian, 40 (69160.70976).
<i>Placopyrenium formosum</i>	On <i>Aspicilia aquatica</i> , but becoming independent, occasional.
<i>Porocyphus kenmorensis</i>	Low riparian, occasional. (Voucher: 23754).
<i>Porpidia cinereoatra</i>	Upper riparian, occasional,
<i>Porpidia macrocarpa</i>	Upper riparian, 40 (69160.70976).
<i>Porpidia speirea</i>	Upper riparian, 40 (69160.70976).
<i>Porpidia superba</i> f. <i>sorediata</i>	Mid riparian, 40 (69160.70976).
<i>Rhizocarpon distinctum</i>	Upper riparian, 40 (69160.70976).
<i>Rimularia badioatra</i>	Mid riparian, rare.
<i>Sporodictyon cruentum</i>	Low riparian, very rare.
<i>Staurothele fissa</i>	Low riparian, frequent.
<i>Tephromela atra</i>	Upper riparian, occasional.
<i>Trapelia elacista</i>	Mid riparian.
<i>Verrucaria aethiobola</i>	Low riparian.
<i>Verrucaria anziana</i>	Lower riparian, frequent.
<i>Verrucaria cernaensis</i>	Lower riparian, frequent. Field record.
<i>Verrucaria pachyderma</i>	Low riparian, some submerged, frequent.
Number of lichen species:	40
Number of riparian species:	17
CR	
EN	0
VU	0
NT	5
DD	2
NR	4
NS	6
NR/NS score	580
Bryophytes (freshwater species, recorded casually)	
These were recorded to assist classification of streams, but this does not constitute a survey	
<i>Amphidium mougeotii</i>	occasional
<i>Brachythecium plumosum</i>	frequent
<i>Cinclidotus fontinaloides</i>	frequent
<i>Oxystegus tenuirostris</i>	occasional
<i>Platyhypnidium riparioides</i>	frequent
<i>Pterogonium gracile</i>	rare

<i>Racomitrium aciculare</i>	frequent
<i>Schistidium agassizii</i>	occasional
<i>Schistidium rivulare</i>	occasional
<i>Thamnobryum alopecurum</i>	occasional
<i>Trichostomum brachydontium</i>	rare

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Collema glebulentum</i>	NT		NS	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Porocyphus kenmorensis</i>	NT		NS	
<i>Porpidia superba</i> f. <i>sorediata</i>	NT?		NR	
<i>Verrucaria pachyderma</i>	DD	DD	NR	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Verrucaria anziana</i>			NS	
<i>Rimularia badioatra</i>			NS	

Poorly known species of possible concern:

Dermatocarpon arnoldianum auct.



Bottom of site. The short stretch shown here has a good diversity of notable lichens (see Appendix 3 for a photograph of this site with raised water levels)..

Afon Berthen

Site code: ABE. 1 km squares: 64.63, 64.64. Survey area: 64116.64282 to 64732.63718. Alt. 420-520 m. Date of survey: 18 July 2017.

Geology: Nant Ffrancon Subgroup - Siltstone.

SE of Bethesda. Recorded from wall upwards, spanning two 1 km squares, as it was thought best to include the lower parts, as these are often better. Decided to go no further upwards as was becoming very similar.

Site with bed of boulders and cobbles, with no bedrock. Drains upland grassland and blanket mire. Much of the site has low banks and the stream is not large; these two factors probably result in a low diversity of microhabitats and a relatively low area of available rock. The lower part is split into two branches for a few hundred metres. Above this, whether as a result of the combined streams or some other factor such as geology, the stream becomes more mossy, with mosses competing with lichens, though this does not seem to be critical. The flora is species-poor, with *Ionaspis lacustris*, *Rhizocarpon lavatum* frequent; *Porpidia hydrophila* is local but does not become conspicuous or a major component. *Verrucariaceae* rare in upper part of site, comprises a few small colonies of *Sporodictyon cruentum*. The riparian grades rapidly into the terrestrial, so that a distinctive upper riparian is very poorly developed.

Site:	Afon Berthen
<i>Acarospora fuscata</i>	Upper riparian, rare; 30.
<i>Agonimia tristicula</i>	Mid/upper riparian amongst <i>Andreaea rothii</i> , rare; 30,
<i>Amygdalaria pelobotryon</i>	Upper riparian, rare; 30.
<i>Aspicilia aquatica</i>	Mid riparian; 30.
<i>Aspicilia caesiocinerea</i>	Peak of small boulder, 32.
<i>Aspicilia epiglypta</i>	Mid to upper riparian, occasional; 30,31, 32, 35, 39. (Vouchers 23742, 23743).
<i>Aspicilia simoensis</i>	Mid-riparian, with <i>Ephebe lanata</i> , <i>Racomitrium aciculare</i> ; 35, 39. (Vouchers 23747, 23749).
<i>Baeomyces rufus</i>	Mid-riparian, rare; 31.
<i>Buellia aethalea</i>	Upper riparian, rare; 37.
<i>Cladonia cyathomorpha</i>	Upper riparian, rare; 37.
<i>Cladonia furcata</i>	Upper riparian, rare; 32.
<i>Cladonia pyxidata</i>	Upper riparian, rare; 32.
<i>Ephebe lanata</i>	Mid riparian, abundant.
<i>Fuscidea lygaea</i>	Upper riparian, occasional; not growing near the water as at some other sites.
<i>Ionaspis lacustris</i>	Low to mid (to upper) riparian, abundant.
<i>Lasallia pustulata</i>	Upper riparian, rare; 30.
<i>Lecanora intricata</i>	Upper riparian, occasional.
<i>Lecanora soralifera</i>	Upper riparian, occasional.
<i>Lecidea fuscoatra</i>	Upper riparian, rare; 33.
<i>Lecidea lithophila</i>	Upper riparian, occasional; 32.
<i>Lecidea swartzioidea</i>	Upper riparian, occasional.

<i>Massalongia carnosa</i>	Upper riparian on moss, rare and in small quantity; 30.
<i>Miriquidica leucophaea</i>	Upper riparian, occasional.
<i>Miriquidica pycnocarpa</i> f. <i>sorediata</i>	Upper riparian, rare; 33.
<i>Parmelia saxatilis</i>	Upper riparian, rare; 30.
<i>Peltigera hymenina</i>	Upper riparian, rare; 32.
<i>Pertusaria aspergilla</i>	Upper riparian, rare.
<i>Pertusaria corallina</i>	Upper riparian, occasional.
<i>Pertusaria pseudocorallina</i>	Upper riparian, occasional.
<i>Pilophorus strumaticus</i>	Upper riparian on sloping boulder, rare; 30.
<i>Placopsis lambii</i>	Mid riparian, rare; 37.
<i>Porina lectissima</i>	Mid riparian, very rare; 37.
<i>Porpidia hydrophila</i>	Low riparian, occasional; 30.
<i>Porpidia irrigua</i>	Upper riparian, rare; 35.
<i>Porpidia macrocarpa</i>	Upper riparian, occasional.
<i>Porpidia melinodes</i>	Upper riparian, rare; 30.
<i>Porpidia superba</i> f. <i>sorediata</i>	Upper riparian, 37. Fertile, with sparse soralia. (Voucher 23748).
<i>Rhizocarpon geographicum</i>	Upper riparian, abundant.
<i>Rhizocarpon lavatum</i>	Mid riparian, abundant.
<i>Schaereria fuscocinerea</i>	Upper riparian, rare; 31.
<i>Sporodictyon cruentum</i>	On a few cobbles and boulders in upper part of site, low riparian; 39.
<i>Tephromela atra</i>	Upper riparian, occasional.
<i>Trapelia elacista</i>	Mid-riparian, occasional; 34, 37.
<i>Trapelia involuta</i>	Upper riparian, on rock or <i>Andreaea rothii</i> , rare.
<i>Trapelia placodioides</i>	Mid-riparian, frequent; a thallus with apothecia and no soredia near bottom end of site.
<i>Tremolecia atrata</i>	Upper riparian, rare.
<i>Xanthoparmelia conspersa</i>	Upper riparian, rare; 35.
Number of lichen species:	47
Number of riparian species:	7
EN	0
VU	0
NT	1
DD	1
NR	2
NS	3
NR/NS score	290
Bryophytes (freshwater species, recorded casually)	
These were recorded to assist classification of streams, but this does not constitute a survey	
<i>Andreaea rothii</i>	f
<i>Blindia acuta</i>	r
<i>Brachythecium plumosum</i>	Occasional.
<i>Bryum alpinum</i>	r-o
<i>Bryum pseudotriquetrum</i>	r
<i>Hygrohypnum eugyrium</i>	o in upper part of site
<i>Hygrohypnum ochraceum</i>	o in upper part of site

<i>Hyocomium armoricum</i>	o-lf
<i>Jungermannia exsertifolia</i>	vr in upper part of site
<i>Marsupella emarginata</i>	o
<i>Oxystegus tenuirostris</i>	o
<i>Pellia epiphylla</i>	o
<i>Racomitrium aciculare</i>	Abundant.
<i>Racomitrium fasciculare</i>	Occasional.
<i>Scapania undulata</i>	o-f

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Porpidia superba</i> f. <i>sorediata</i>	NT?		NR	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Miriquidica pycnocarpa</i> f. <i>sorediata</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Porpidia melinodes</i>			NS	

Locality	Map reference
30	23/64116.64282
31	23/64155.64260
32	23/64210.64211
33	23/64235.64200
34	23/64316.64160
35	23/64406.64079
36	23/64476.64038
37	23/64530.63989
38	23/64629.63902
39	23/64732.63718



At bottom of surveyed area.



At top of surveyed area.

Afon Caseg central

Site code: ACC. 1 km square: 65.66. Area surveyed: 65017.66404 to 65841.66554. Alt.: 355-410 m. Date of survey: 19 September 2017.

Geology: Nant Ffrancon Subgroup - Siltstone. (All boulders in the stream are derived from superficial deposits of till).

The stream cuts through banks of till, and all the boulders are derived from this; there is no bedrock visible at any point. The flora is rich, and the rocks are clearly relatively base-rich.

Similar to Afon Caseg lower, though probably has fewer larger boulders.

Relatively low and small boulders (locality 132) are capable of supporting notable species like *Dermatocarpon arnoldianum* and *Aspicilia aquatica*, though they will not allow the development of an upper riparian zone. *Lecanora achariana* occurred on two small boulders; this is a new site for this rare and Endangered species.

Site:	Afon Caseg central
<i>Acarospora fuscata</i>	Upper riparian, rare.
<i>Agonimia tristicula</i>	Occasional, small quantities.
<i>Aspicilia aquatica</i>	Frequent.
<i>Aspicilia caesiocinerea</i>	Present.
<i>Aspicilia simoensis</i>	Upper riparian, rare; 130 (field record), 133.
<i>Buellia aethalea</i>	Occasional. K + red, I + blue.
<i>Buellia ocellata</i>	Present, 132.
<i>Caloplaca crenularia</i>	Upper riparian, rare; 133.
<i>Candelariella vitellina</i>	Present.
<i>Catillaria chalybeia</i>	Present; 132.
<i>Cladonia cervicornis</i>	Upper riparian, rare.
<i>Cladonia coccifera</i>	Rare.
<i>Cladonia cyathomorpha</i>	On mossy boulders, upper riparian, rare; 130, 133.
<i>Cladonia subcervicornis</i>	Present.
<i>Collema flaccidum</i>	Present.
<i>Dermatocarpon arnoldianum</i> auct.	Occasional?, 130 (small boulder), 132 (low boulder c. 1.5 m long),
<i>Dermatocarpon leptophyllodes</i>	Occasional; 130,
<i>Dermatocarpon luridum</i>	Occasional.
<i>Fuscidea cyathoides</i>	Present.
<i>Fuscidea lygaea</i>	On a vertical face, 130.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora achariana</i>	On three small boulders, mid to more or less upper riparian, with species including <i>Aspi aqu</i> , <i>Brach plu</i> , <i>Iona lac</i> , <i>Leca rup</i> , <i>Plac for</i> , <i>Raco aci</i> , <i>Rhiz geo</i> , <i>Rimu bad</i> ; 135. (Grid ref. 65644.66410).
<i>Lecanora intricata</i>	Present.
<i>Lecanora muralis</i>	Occasional?
<i>Lecanora rupicola</i>	Upper riparian, occasional.
<i>Lecidea fuscoatra</i>	Upper riparian, occasional.
<i>Lecidea lapicida</i>	Rare.
<i>Lecidea lithophila</i>	Present.
<i>Lecidea swartzioidea</i>	Occasional.

<i>Leptogium gelatinosum</i>	On <i>Schistidium rivulare</i> , mid riparian, rare; 132, 133. A fertile morph with more or less smooth lobe margins.
<i>Massalongia carnosa</i>	Present; 130, 133 (with <i>Grimmia trichophylla</i> and <i>Andreaea rothii</i>), .
<i>Melanelixia fuliginosa</i>	Present.
<i>Miriquidica leucophaea</i>	Rare.
<i>Ochrolechia parella</i>	Present.
<i>Parmelia omphalodes</i>	Present.
<i>Parmelia saxatilis</i>	Present.
<i>Peltigera membranacea</i>	Occasional on mossy rocks or grassy banks, upper riparian.
<i>Peltigera rufescens</i>	Upper riparian, rare.
<i>Pertusaria corallina</i>	Present.
<i>Pertusaria pseudocorallina</i>	Present.
<i>Physcia tenella</i>	Upper riparian, rare; 130.
<i>Placopyrenium formosum</i>	Frequent.
<i>Porina lectissima</i>	Upper riparian, rare; 133.
<i>Porpidia tuberculosa</i>	Present.
<i>Rhizocarpon geographicum</i>	Present.
<i>Rhizocarpon lavatum</i>	Present.
<i>Rhizocarpon viridiatrum</i>	On <i>Aspicilia caesiocinerea</i> , rare; 133.
<i>Rimularia badioatra</i>	Upper riparian, rare; 135.
<i>Stereocaulon evolutum</i>	Present.
<i>Stereocaulon vesuvianum</i>	Present.
<i>Tephromela atra</i>	Present.
<i>Trapelia placodioides</i>	Upper riparian, rare; 135.
<i>Verrucaria Caseg A</i>	Low riparian, on rock c. 40 cm long (133). (Voucher: 23850).
<i>Xanthoparmelia conspersa</i>	Present.
<i>Xanthoparmelia loxodes</i>	Upper riparian, with <i>Parmelia omphalodes</i> (occasionally submerged, as shown by pieces of dead vegetation); 132; locally abundant upper riparian, but at same level as a patch of <i>Isothecium holtii</i> ; 133..

Number of lichen species:	55
Number of riparian species:	10
EN	1
VU	0
NT	1
DD	1
NR	3
NS	4
NR/NS score	420

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Amblystegium fluviatile</i>	Present.
<i>Andreaea rothii</i>	Rare.
<i>Brachythecium plumosum</i>	Frequent.
<i>Bryum pseudotriquetrum</i>	Occasional.
<i>Cinclidotus fontinaloides</i>	Frequent.
<i>Fontinalis antipyretica</i>	Present.
<i>Fontinalis squamosa</i>	Present.
<i>Grimmia trichophylla</i>	Frequent.
<i>Hedwigia stellata</i>	Rare.
<i>Hygrohypnum ochraceum</i>	Frequent.
<i>Hypnum andoi</i>	Rare.
<i>Isothecium holtii</i>	Occasional.
<i>Oxystegus tenuirostris</i>	Present.
<i>Plagiochila porelloides</i>	Rare.

<i>Pogonatum urnigerum</i>	Rare.
<i>Racomitrium aciculare</i>	Frequent.
<i>Racomitrium sudeticum</i>	Rare.
<i>Schistidium rivulare</i>	Frequent.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Lecanora achariana</i>	EN	CR	NR	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Rhizocarpon viridiatrum</i>			NS	
<i>Rimularia badioatra</i>			NS	

Poorly known species of possible concern:

Dermatocarpon arnoldianum auct.

Verrucaria Caseg A

Locality	Map reference
130	23/65017.66404
131	23/65056.66456
132	23/65108.66431
133	23/65182.66451
134	23/65644.66410
135	23/65841.66554



Bottom of site.



Stream with small, often mossy boulders. Boulders with *Lecanora achariana* indicated by red dot. Grid ref. 65644.66410.



Same place; boulders with *Lecanora achariana* in centre foreground, and left of centre.



Lecanora achariana at Afon Caseg central.

Afon Caseg lower

Site code: ACL. 1 km square: 64.66. Survey area: 64729.66434 to 649.664. Alt.: 330-355 m. Date of survey: 19 September 2017.

Geology: Nant Ffrancon Subgroup - Siltstone. (All boulders derived from superficial deposits of till).

The stream looked good at first glance; it looks similar to the Afon Llafar, there are many boulders, and it is relatively large. Just below the site is a recent weir which presumably denotes a hydro scheme.

The stream cuts through banks of till, and all the boulders are derived from this; there is no bedrock visible at any point. The flora is rich, and the rocks are clearly relatively base-rich, with *Lecanora rupicola*, *Lecidea fuscoatra*, rarely *Ochrolechia parella*, and others. The moss *Cinclidotus fontinaloides* is frequent. *Verrucaria* does not seem diverse, though some was not collectable to check the identity. At locality 124 the gradient was already lower than below, with smaller boulders, but there were still many species of interest, and one cannot assume that less bouldery stretches are poor.

Site:	Afon Caseg lower
<i>Agonimia tristicula</i>	Rare to occasional.
<i>Aspicilia aquatica</i>	Mid riparian, frequent; including 120, 121, 124, 126.
<i>Aspicilia caesiocinerea</i>	Present.
<i>Aspicilia simoensis</i>	Upper riparian, 120 (field record), 121.
<i>Bacidia carneoglaucia</i>	On rock below overhanging boulder, very rare; 120b.
<i>Buellia ocellata</i>	Upper riparian, rare.
<i>Caloplaca vitellinula</i>	On rock below overhanging boulder, very rare; 120b. Field record, but agreed perfectly with other material.
<i>Candelariella vitellina</i>	Occasional.
<i>Catillaria chalybeia</i>	Low to mid riparian, occasional. No blue pigment (one specimen).
<i>Cladonia subcervicornis</i>	Present.
<i>Collema flaccidum</i>	Rocks near water, occasional; low riparian.
<i>Dermatocarpon arnoldianum</i> auct.	Low riparian near water level; 120. (Voucher: 23840).
<i>Dermatocarpon leptophyllodes</i>	Mid riparian, occasional, in rather small quantities; 120, 121, 123, 124, .
<i>Dermatocarpon luridum</i>	Occasional.
<i>Dermatocarpon meiophyllizum</i>	Just above water level, 120.
<i>Ephebe lanata</i>	Rare.
<i>Ionaspis lacustris</i>	Frequent. Less rusty in colour than at sites with more acid rocks, a pale warm brown.
<i>Lecanora dispersa</i>	On bird-perching rock, rare; 120.
<i>Lecanora intricata</i>	Present.
<i>Lecanora muralis</i>	Upper riparian, frequent.
<i>Lecanora rupicola</i>	Occasional to frequent, upper riparian; 121.
<i>Lecidea fuscoatra</i>	Occasional, upper riparian.
<i>Lecidea lithophila</i>	Present.
<i>Lecidella scabra</i>	On rock below overhanging boulder, very rare; 120b.
<i>Leptogium gelatinosum</i>	On <i>Schistidium rivulare</i> , mid riparian, rare; 121. A fertile morph with more or less smooth lobe margins.
<i>Massalongia carnosa</i>	Upper riparian on <i>Grimmia trichophylla</i> , 123.
<i>Melanelixia fuliginosa</i>	Upper riparian, rare.

<i>Ochrolechia parella</i>	Upper riparian, seen on two boulders; 121.
<i>Parmelia omphalodes</i>	Occasional.
<i>Parmelia saxatilis</i>	Present.
<i>Pertusaria aspergilla</i>	Occasional, upper riparian.
<i>Pertusaria chiodectonoides</i>	Upper riparian; 120.
<i>Pertusaria corallina</i>	Present.
<i>Pertusaria lactea</i>	Present.
<i>Pertusaria pseudocorallina</i>	Present.
<i>Phycia caesia</i>	Occasional, upper riparian on enriched rocks; 120.
<i>Placopyrenium formosum</i>	Mid riparian, on <i>Aspicilia aquatica</i> but sometimes independent later, frequent; 120, 121, 124, 126.
<i>Polychidium muscicola</i>	Amongst <i>Grimmia trichophylla</i> and <i>Racomitrium aciculare</i> on level top of boulder receiving slight splash, upper riparian, rare; 121.
<i>Porina lectissima</i>	Moist side of boulder, upper riparian, rare; 123.
<i>Porpidia cinereoatra</i>	Present.
<i>Porpidia macrocarpa</i>	Present.
<i>Porpidia tuberculosa</i>	Present.
<i>Protoparmelia badia</i>	Upper riparian, rare; 120.
<i>Rhizocarpon lavatum</i>	Present but not abundant.
<i>Rhizocarpon viridiatrum</i>	On <i>Aspicilia caeiocinerea</i> , rare; 121.
<i>Scoliosporum umbrinum</i>	Present.
<i>Staurothele fissa</i>	Low riparian, frequent.
<i>Stereocaulon evolutum</i>	Upper riparian, rare.
<i>Tephromela atra</i>	Present.
<i>Verrucaria Caseg A</i>	Cobble near water level (120b), 125. (Voucher: 23842).
<i>Verrucaria cernaensis</i>	Low riparian, rare; 120a, 121.
<i>Verrucaria devensis</i>	Low riparian, with <i>V. cernaensis</i> , very rare; 121. Field record.
<i>Verrucaria rosula</i>	Low riparian, rare; 120.
<i>Verrucaria sublobulata</i>	Low riparian, rare or overlooked; 120b.
<i>Xanthoparmelia conspersa</i>	Frequent, upper riparian.
Number of lichen species:	58
Number of riparian species:	18
EN	0
VU	1
NT	2
DD	1
NR	2
NS	5
NR/NS score	350

Bryophytes (freshwater species, recorded casually)

These were recorded to assist classification of streams, but this does not constitute a survey

<i>Amblystegium fluviatile</i>	occasional
<i>Brachythecium plumosum</i>	frequent
<i>Chiloscyphus polyanthos</i>	rare
<i>Cinclidotus fontinaloides</i>	frequent
<i>Fontinalis antipyretica</i>	present
<i>Fontinalis squamosa</i>	present
<i>Grimmia trichophylla</i>	present
<i>Hygrohypnum duriusculum</i>	120.
<i>Hygrohypnum ochraceum</i>	frequent
<i>Isothecium holtii</i>	Present.
<i>Racomitrium aciculare</i>	present
<i>Schistidium rivulare</i>	frequent
<i>Thamnobryum alopecurum</i>	rare

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Pertusaria chiodectonoides</i>	VU		NS	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Bacidia carneoglauca</i>			NS	
<i>Rhizocarpon viridiatrum</i>			NS	

Poorly known species of possible concern:

Dermatocarpon arnoldianum auct.

Verrucaria Caseg A

Locality	Map reference
120a	23/64729.66434
120b	nearby, sl lower
121	23/64751.66436
123	not recorded
124	23/64804.66384
125	23/64837.66377
126	not recorded



Bottom of site, with good-sized boulders.



Stream at locality 125 (grid ref. 64837.66377); even with only small boulders, this stretch still has much interest.

Afon Cwm Eigiau

Site code: ACE. 1 km square: 70.63. Area surveyed: 70960.63308 to 70453.63466. Alt. 390-470m. Date of survey: 25 September 2017.

Geology: 1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone.

At the bottom of the site there are mostly small boulders and a little bedrock; lichen crusts were well-developed in the upper riparian, unlike some 'bare'-looking streams. The low and mid riparian are species poor, with *Ionaspis lacustris*, *Rhizocarpon lavatum*, local *Ephebe lanata*, and only rare *Sporodictyon cruentum*, *Porina rivalis* and very rare *Verrucaria nodosa* and *V. anziana*. A single low, sloping boulder had very sparse *Dermatocarpon* spp., and some *Rhizocarpon amphibium*. Bryophytes were conspicuous, though not dominating, especially *Racomitrium aciculare* and *Brachythecium plumosum*. *Schistidium rivulare* was present in the lower part, which was a sign of very slight base-enrichment. The base-loving lichen species are far too rare for this to be a good site.

There is a gorge section; this was not examined but was wet and mossy. The upper part of the site was walked over but not examined closely.

Site:	Afon Cwm Eigiau
<i>Acarospora smaragdula</i>	Mid to upper riparian, occasional; 170, 174.
<i>Agonimia tristicula</i>	On <i>Racomitrium aciculare</i> , rare; 173, 175.
<i>Amygdalaria pelobotryon</i>	Mid riparian, rare; 170.
<i>Aspicilia caesiocinerea</i>	Upper riparian, rare.
<i>Aspicilia granulosa</i>	Mid riparian, local, occasional; 170.
<i>Aspicilia simoensis</i>	Upper riparian on boulder; 170, 177. (Vouchers: 23863, 23873).
<i>Bacidia inundata</i>	Low riparian, rare; 177.
<i>Baeomyces rufus</i>	Mid riparian, rare.
<i>Buellia aethalea</i>	Upper riparian. K + red, I + blue.
<i>Cladonia cyathomorpha</i>	On mossy rocks in upper riparian, occasional; 173, 176.
<i>Dermatocarpon leptophyllodes</i>	Two small thalli on sloping boulder, very rare; 173.
<i>Dermatocarpon luridum</i>	One small thallus on sloping boulder, very rare; 173.
<i>Ephebe lanata</i>	Locally frequent, low to mid riparian.
<i>Fuscidea cyathoides</i>	Occasional.
<i>Fuscidea intercincta</i>	Dry underside of sloping boulder, upper riparian; 173.
<i>Fuscidea kochiana</i>	Upper riparian, rare.
<i>Fuscidea lygaea</i>	Mid to upper riparian, frequent.
<i>Immersaria athroocarpa</i>	Upper riparian, occasional.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora intricata</i>	Occasional.
<i>Lecanora polytropa</i>	Rare.
<i>Lecidea lapicida</i>	Rare.
<i>Lecidea lithophila</i>	Upper riparian, frequent.
<i>Lecidea swartzioidea</i>	Upper riparian, frequent.
<i>Massalongia carnosa</i>	Upper riparian, on <i>Andreaea rothii</i> , rare; 172.

<i>Micarea lignaria</i> var. <i>lignaria</i>	Upper riparian on dead moss, rare.
<i>Miriquidica leucophaea</i>	Upper riparian, occasional.
<i>Ochrolechia tartarea</i>	Upper riparian, rare; 177.
<i>Parmelia omphalodes</i>	Upper riparian, occasional.
<i>Parmelia saxatilis</i>	Upper riparian, occasional.
<i>Pertusaria aspergilla</i>	Occasional.
<i>Pertusaria corallina</i>	Occasional.
<i>Pertusaria pseudocorallina</i>	Rare.
<i>Placopsis lambii</i>	Upper riparian, rare; 177.
<i>Polysporina simplex</i>	Upper riparian, on two boulders, rare; 170, 172.
<i>Porina rivalis</i>	On shaded underside of slanting stone locked amongst cobbles and small boulders, just below to shortly above (3 cm) water level, rare; 174.
<i>Porpidia crustulata</i>	On semi-stable cobble, low riparian, occasional; 173, 175.
<i>Porpidia hydrophila</i>	Low to mid riparian, and on seeping bedrock at side, occasional.
<i>Porpidia irrigua</i>	Upper riparian, rare; 177.
<i>Porpidia macrocarpa</i>	Mid to upper riparian, occasional.
<i>Porpidia rugosa</i>	Splashed rocks near falls, rare; 174.
<i>Porpidia tuberculosa</i>	Mid to upper riparian, occasional.
<i>Protoparmelia badia</i>	Upper riparian, rare; 170.
<i>Rhizocarpon amphibium</i>	On steep side of boulder with <i>Racomitrium aciculare</i> , <i>Fuscidea lygaea</i> , mid riparian, rare; 173.
<i>Rhizocarpon geographicum</i>	Frequent.
<i>Rhizocarpon lavatum</i>	Mostly mid riparian, frequent.
<i>Rimularia badioatra</i>	Mid riparian, occasional; 170, 173.
<i>Scoliciosporum umbrinum</i>	Occasional.
<i>Sporodictyon cruentum</i>	Low to mid riparian, rare to occasional; 170, 174.
<i>Stereocaulon vesuvianum</i>	Occasional.
<i>Trapelia elacista</i>	Low to mid riparian, on small boulders and semi-stable cobbles, frequent.
<i>Trapelia glebulosa</i>	On small boulder, mid riparian, rare; 171.
<i>Trapelia involuta</i>	Upper riparian, occasional.
<i>Trapelia obtegens</i>	Upper riparian, rare; 176. Esorediate fertile morph.
<i>Trapelia placodioides</i>	Mid riparian, occasional.
<i>Tremolecia atrata</i>	Upper riparian, occasional.
<i>Verrucaria anziana</i>	Small boulder, low riparian, very rare, rather poorly developed; 174. Field record.
<i>Verrucaria nodosa</i>	Small boulder, low riparian, very rare; 174. Field record.
Number of lichen species:	58
Number of riparian species:	13
EN	0
VU	0
NT	2
DD	1
NR	1
NS	6
NR/NS score	280

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Anomobryum julaceum</i>	Rare.
<i>Blindia acuta</i>	Occasional, seen in lower part of site.
<i>Brachythecium plumosum</i>	Frequent.
<i>Bryum alpinum</i>	Rare to occasional.
<i>Bryum capillare</i>	Rare.
<i>Campylopus atrovirens</i>	Rare.
<i>Dichodontium pellucidum</i>	Rare.
<i>Fissidens dubius</i>	Rare.
<i>Grimmia donniana</i>	Occasional.
<i>Hygrohypnum eugyrium</i>	Rare, 170.
<i>Hygrohypnum ochraceum</i>	Occasional.
<i>Marsupella emarginata</i>	Frequent.
<i>Oxystegus tenuirostris</i>	Occasional.
<i>Plagiochila porelloides</i>	Very rare.
<i>Pogonatum urnigerum</i>	Occasional.
<i>Racomitrium aciculare</i>	Frequent.
<i>Racomitrium affine/heterostichum</i>	Occasional.
<i>Racomitrium fasciculare</i>	Occasional.
<i>Racomitrium sudeticum</i>	Occasional.
<i>Scapania compacta</i>	Rare.
<i>Scapania undulata</i>	Occasional.
<i>Schistidium rivulare</i>	Occasional at lower end of site.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Fuscidea intercincta</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Rimularia badioatra</i>			NS	
<i>Verrucaria anziana</i>			NS	

Locality	Map reference
170	23/70960.63308
171	23/70912.63335
172	23/70867.63310
173	23/70849.63305
174	23/70813.63293
175	23/70787.63308
176	23/70762.63320
176 (b)	23/70580.63383
177	23/70453.63466



Bottom of site (locality 170).



Sloping boulder to left of centre was the best at the site, with a little *Dermatocarpon leptophyllodes* and *Rhizocarpon amphibium* (locality 173).



Upper part of site (locality 177).

Afon Cwm Glas Bach lower

Site code: GBL. 1 km square: 61.57. Area surveyed: 61339.57464 to 61327.57087. Alt. 140-250 m. Date of survey: 23 September 2017.

Geology: 1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Lower Rhyolitic Tuff Formation - Tuff, Felsic.

Survey hampered somewhat at first by fine drizzle, later dry.

The stream is small to medium-sized, with boulders and bedrock. The rocks often look rather bare and dull, with rather poorly-developed crusts, with occasional white splashes of *Pertusaria*. *Fuscidea lygaea* is abundant, especially in the mid riparian (though it does not have the enhanced vigour of some riparian colonies of this species beside streams). Bryophytes are inconspicuous, and even *Racomitrium aciculare* is in small quantities. The sparseness of bryophytes is due in part to scouring, but *Racomitrium aciculare* and *Marsupella emarginata* became more abundant in slight shade of a small ash tree, as did the lichen *Ephebe lanata*, so it is likely that drought and exposure in summer are also important. The altitude is low here, this is only 'upland' in terms of land use.

There are some falls with extensive bedrock, but this is mostly covered by algae and cyanobacteria; these faces are probably moist for long periods then dry for long periods, making them unsuitable for most lichens; areas adjacent to turf have some lichens presumably because they are moist for longer periods. The base of the falls has some *Rhizocarpon amphibium*, otherwise these impressive faces are of little significance. *Ionaspis odora* occurred, despite the low altitude.

Site:	Afon Cwm Glas Bach lower
<i>Acarospora smaragdula</i>	Occasional, including on an iron-rich stone.
<i>Amygdalaria pelobotryon</i>	Mid to upper riparian, rare to occasional; 150, 152.
<i>Arthorhaphis citinella</i>	On slightly overhanging side of boulder, upper riparian; 150.
<i>Bacidia trachona</i>	On rock in shade and shelter of a boulder, rare; 150.
<i>Baeomyces rufus</i>	Upper riparian, occasional.
<i>Cladonia cyathomorpha</i>	Thin soil, upper riparian (150), thin soil on shaded boulder (153), rare.
<i>Cladonia subcervicornis</i>	Upper riparian, occasional.
<i>Dibaeis baeomyces</i>	Crevice, upper riparian, rare.
<i>Ephebe lanata</i>	In small quantities, not at all conspicuous, occasional; becoming a little more abundant in slight shade from an ash tree.
<i>Fuscidea lygaea</i>	Low to upper riparian, abundant; especially frequent in mid riparian, but some also at water level or slightly below.
<i>Immersaria athroocarpa</i>	Upper riparian, occasional.
<i>Ionaspis lacustris</i>	Mostly low riparian, extending to upper, frequent.
<i>Ionaspis odora</i>	On boulder, mid riparian (151),
<i>Lecanora soralifera</i>	Upper riparian, rare.
<i>Lecidea lithophila</i>	Upper riparian, occasional.
<i>Lepraria caesioalba</i>	On slightly overhanging side of boulder, upper riparian, rare; 150.
<i>Micarea leprosula</i>	Upper riparian, rare.

<i>Micarea lignaria</i> var. <i>lignaria</i>	Upper riparian, on thin soil or ddead bryophytes, occasional.
<i>Opegrapha gyrocarpa</i>	On rock in shade and shelter of a boulder, rare; 150.
<i>Pertusaria amara</i>	Upper riparian, rare to occasional [sample must be checked!!]
<i>Pertusaria aspergilla</i>	Upper riparian, rare.
<i>Pertusaria corallina</i>	Upper riparian, occasional.
<i>Pertusaria excludens</i>	Upper riparian, rare.
<i>Pertusaria lactea</i>	Upper riparian, rare.
<i>Pilophorus strumaticus</i>	On slightly overhanging side of boulder, upper riparian, small quantity (150); on moist bedrock near falls (153); rare.
<i>Placopsis lambii</i>	Upper riparian, occasional.
<i>Porina lectissima</i>	Mid riparian, on boulder in slight shade from ash tree, rare; 151.
<i>Porpidia cinereoatra</i>	Upper riparian, occasional.
<i>Porpidia crustulata</i>	Semi-stable stone; 153.
<i>Porpidia hydrophila</i>	On bedrock below falls, close to turf, rare; 153.
<i>Porpidia macrocarpa</i>	Mid riparian, occasional.
<i>Porpidia rugosa</i>	Mid to upper riparian, once shallowly submerged, occasional.
<i>Porpidia soledizodes</i>	Wet stones sheltered by boulder; 150.
<i>Porpidia tuberculosa</i>	Occasional, mid to upper riparian.
<i>Rhizocarpon amphibium</i>	On boulder, immediately below water level, in slight shade from ash tree; several thalli on bedrock at foot of falls, surrounded by Stigonema; rare; 153.
<i>Rhizocarpon geographicum</i>	Upper riparian, occasional.
<i>Rhizocarpon lavatum</i>	Low to upper riparian, frequent.
<i>Rhizocarpon reductum</i>	Upper riparian, rare.
<i>Scoliciosporum umbrinum</i>	Upper riparian, rare.
<i>Sporodictyon cruentum</i>	On semi-stable stones shortly above or below water level, occasional; 150, 152.
<i>Stereocaulon pileatum</i>	Mid riparian, rare.
<i>Stereocaulon vesuvianum</i>	Upper riparian, occasional.
<i>Trapelia elacista</i>	Low to mid riparian on semi-stable stones, frequent; 150.
<i>Trapelia glebulosa</i>	Stone on semi-stable shingle, rare; 151.
<i>Trapelia obtegens</i>	Upper riparian, occasional; esorediate fertile morph; 150.
<i>Trapelia placodioides</i>	Upper riparian, frequent..
<i>Tremolecia atrata</i>	Upper riparian, occasional.
Number of lichen species:	47
Number of riparian species:	7
EN	0
VU	1
NT	0
DD	0
NR	1
NS	4
NR/NS score	220
Bryophytes (freshwater species, recorded casually)	
These are recorded to assist classification of streams, but this does not constitute a survey	
<i>Blindia acuta</i>	Frequent near water level.
<i>Bryum alpinum</i>	Rare.

<i>Campylopus atrovirens</i>	Occasional.
<i>Diphyscium foliosum</i>	Rare, c.fr.
<i>Fissidens dubius</i>	Rare,
<i>Grimmia donniana</i>	Rare.
<i>Gymnomitrium crenulatum</i>	Occasional.
<i>Hyocomium armoricum</i>	On rocks sheltered and shaded by a boulder, rare.
<i>Marsupella emarginata</i>	Occasional.
<i>Nardia compressa</i>	Rare?
<i>Pellia epiphylla</i>	On rocks sheltered and shaded by a boulder, rare.
<i>Racomitrium aciculare</i>	Ocaisional, but in small quantities, inconspicuous; more abundant in slight shade of an ash tree.
<i>Racomitrium ellipticum</i>	Upper riparian, locally frequent.
<i>Racomitrium sudeticum</i>	Upper riparian, occasional to frequent.
<i>Scapania undulata</i>	Present (rare?).

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Ionaspis odora</i>	VU		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Pilophorus strumaticus</i>			NS	

Locality	Map reference
150	23/61339.57464
151	23/61310.57392
152	23/61343.57227
153	23/61340.57174
154	23/61327.57087



Near bottom of site (locality 150).



The presence of one tree increases bryophyte cover on the rocks below it.



The irrigated expanses of bedrock are mostly poor for lichens.

Afon Cwm Glas Bach upper

Site code: GBU. 1 km square: 61.56. Area surveyed: 61288.56995 to 61073.56817. Alt. 260-350 m. Date of survey: 23 September 2017.

Geology: Lower Rhyolitic Tuff Formation - Tuff, Felsic.

Similar to Afon Cwm Glas Bach lower, but of course becoming smaller. Lichens are not rich; bryophytes are inconspicuous. *Ionaspis odora* occurred. Some parts have a rather unstable bed with small boulders and cobbles which are moved occasionally and are thus semi-stable; this is suitable habitat for *Trapelia elacista*. Ground up to 2 m from stream has been disturbed in the past by floods in one place. The small size of the upper stream probably limits the diversity, possibly the water can become low in summer. The lichen flora is probably limited by base-poor rock, relatively small size, and relatively scarcity of sizeable boulders.

Site:	Afon Cwm Glas Bach upper
<i>Acarospora sinopica</i>	Plentiful on one rock splashed by water chute, overall rare; 162.
<i>Acarospora smaragdula</i>	Mid riparian, occasional.
<i>Agonimia tristicula</i>	On <i>Andreaea rothii</i> , very rare; 164.
<i>Amygdalaria pelobotryon</i>	Upper riparian, occasional.
<i>Cladonia subcervicornis</i>	Rare.
<i>Ephebe lanata</i>	Upper riparian, rare; 160.
<i>Fuscidea lygaea</i>	Frequent.
<i>Immersaria athroocarpa</i>	Occasional.
<i>Ionaspis lacustris</i>	Mainly lower riparian, frequent.
<i>Ionaspis odora</i>	Low riparian, rare; 160.
<i>Lecanora intricata</i>	Rare.
<i>Lecidea lithophila</i>	Frequent. mid to upper riparian.
<i>Pertusaria aspergilla</i>	Rare.
<i>Pertusaria corallina</i>	Occasional.
<i>Pertusaria excludens</i>	Good colonies on one sloping rock, overall rare; 161.
<i>Pertusaria pseudocorallina</i>	Occasional.
<i>Placopsis lambii</i>	Occasional.
<i>Porpidia cinereoatra</i>	Upper riparian, occasional.
<i>Porpidia crustulata</i>	On semi-stable stone, mid riparian; 160.
<i>Porpidia hydrophila</i>	Low riparian, occasional.
<i>Porpidia irrigua</i>	Upper riparian, rare.
<i>Porpidia macrocarpa</i>	Mid riparian, occasional.
<i>Porpidia rugosa</i>	Rare.
<i>Porpidia tuberculosa</i>	Occasional.
<i>Rhizocarpon amphibium</i>	Low riparian, occasional, once on block c. 50 cm long, mostly on even more stable surfaces; 160, 162, 165.
<i>Rhizocarpon geographicum</i>	Rare to occasional.
<i>Rhizocarpon reductum</i>	Mid to upper riparian, occasional.
<i>Scoliciosporum umbrinum</i>	Rare.
<i>Sporodictyon cruentum</i>	On semi-stable stones, occasional; 160, 162.
<i>Stereocaulon pileatum</i>	Mid riparian, occasional.
<i>Stereocaulon vesuvianum</i>	Rare to occasional.
<i>Trapelia elacista</i>	On semi-stable stones and rocks, low to mid riparian, frequent.
<i>Trapelia glebulosa</i>	On a stone, upper riparian; 162.
<i>Trapelia obtogens</i>	Upper riparian, rare. Esorediate fertile morph.
<i>Trapelia placodioides</i>	Occasional.

<i>Tremolecia atrata</i>	Occasional.
Number of lichen species:	36
Number of riparian species:	6
CR	
EN	0
VU	1
NT	0
DD	1
NR	1
NS	2
NR/NS score	160

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	Frequent.
<i>Andreaea rupestris</i>	Rare.
<i>Blindia acuta</i>	Frequent near water level.
<i>Campylopus atrovirens</i>	Occasional.
<i>Grimmia donniana</i>	Occasional.
<i>Marsupella emarginata</i>	Occasional.
<i>Oxystegus tenuirostris</i>	Rare.
<i>Racomitrium aciculare</i>	Occasional.
<i>Racomitrium ellipticum</i>	Occasional.
<i>Racomitrium fasciculare</i>	Occasional.
<i>Racomitrium sudeticum</i>	Occasional.
<i>Scapania undulata</i>	Present.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Ionaspis odora</i>	VU		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Immersaria athrocarpa</i>			NS	

Locality	Map reference
160	23/61288.56995
161	23/61269.56946
162	23/61269.56921
163	23/61214.56873
164	23/61094.56833
165	23/61073.56817



Bottom of site (locality 160).



Looking down the stream along a rather unstable bed of cobbles and small boulders (locality 163).

Afon Cwm Glas Mawr

Site code: AGM. 1 km square: 61.56. Survey area: 61997.56546 to 61769.56345. Alt. 310- 390 m. Date of survey: 3 August 2017.

Geology: Unnamed Igneous Intrusion, Ordovician - Rhyolite.

Stream on NE-facing hillside. The rocks are acidic, and bryophyte cover is very low. There are numerous iron-rich rocks. *Rhizocarpon lavatum* is abundant in a rather robust morph. Surprisingly, *Ephebe lanata* is completely absent, although there are dark patches of a slender free-living *Stigonema*. The common and tolerant freshwater moss *Racomitrium aciculare* is also completely absent. These two absences must be significant, indicating that the character of this stream is different to many others, perhaps by hard, base-poor rock. *Ionaspis odora* is occasional, at least in the upper part surveyed.

Site:	Afon Cwm Glas Mawr
<i>Acarospora sinopica</i>	Upper riparian, occasional on iron-rich rocks; 100, 102.
<i>Acarospora smaragdula</i>	Moist stone below boulder, 100 (voucher 23810); upper riparian, rare; and 102 on iron-rich boulder.
<i>Ainoa mooreana</i>	in small quantities, occasional, 100; on stones at side of channel, moistened by seeping bank, mid riparian; 104.
<i>Aspicilia</i> Cwm Glas Mawr A	Iron-rich rock, upper riparian; 100. (Voucher 23812).
<i>Aspicilia granulosa</i>	On rock near stream, and on rock by water chute, probably often irrigated; 101. (Vouchers 23817, 23820).
<i>Baeomyces rufus</i>	Occasional in small quantity.
<i>Calvitimela aglaea</i>	On moss on rock, upper riparian, rare; 101.
<i>Fuscidea lygaea</i>	Upper riparian, frequent.
<i>Immersaria athroocarpa</i>	Upper riparian, occasional; 100.
<i>Ionaspis lacustris</i>	Frequent.
<i>Ionaspis odora</i>	On cobbles and small boulders, mostly near water level or shallowly submerged, occasional; 104, 105.
<i>Opegrapha gyrocarpa</i>	On cobble underneath a boulder, very rare; 103.
<i>Porpidia irrigua</i>	Upper riparian, rare; 103.
<i>Porpidia macrocarpa</i>	Upper riparian, occasional.
<i>Porpidia melinodes</i>	Upper riparian.
<i>Porpidia rugosa</i>	On steep moist face, rare.
<i>Porpidia soledizodes</i>	On stone below boulder; 101.
<i>Porpidia tuberculosa</i>	Mid riparian.
<i>Pyrenopsis subareolata</i>	On rock c. 30°, mid riparian, rather bare-looking and probably kept open by high flows, rare; 101.
<i>Rhizocarpon amphibium</i>	Mid riparian; 104.
<i>Rhizocarpon geographicum</i>	Upper riparian, occasional, rather infrequent compared to other sites.
<i>Rhizocarpon lavatum</i>	Frequent, often as a robust morph.
<i>Rhizocarpon oederi</i>	Upper riparian, occasional on iron-rich rocks.
<i>Rhizocarpon reductum</i>	Upper riparian.
<i>Rhizocarpon viridiatrum</i>	On <i>Aspicilia</i> sp.; 100.
<i>Schaereria fuscocinerea</i>	Upper riparian, rare; 101.
<i>Scoliciosporum umbrinum</i>	100.
<i>Stereocaulon leucophaeopsis</i>	Upper riparian, occasional, especially on iron-rich rocks.
<i>Stereocaulon pileatum</i>	Especially on iron-rich rocks, from water level to upper riparian, frequent.

<i>Stereocaulon vesuvianum</i>	Occasional.
<i>Trapelia elacista</i>	Moist stone; 104.
<i>Trapelia involuta</i>	Upper riparian.
<i>Trapelia placodioides</i>	Upper riparian.
<i>Tremolecia atrata</i>	Frequent.

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	frequent.
<i>Anthelia julacea</i>	occasional
<i>Blindia acuta</i>	occasional
<i>Campylopus atrovirens</i>	occasional
<i>Marsupella emarginata</i>	rare?
<i>Nardia compressa</i>	frequent.
<i>Oligotrichum hercynicum</i>	rare?
<i>Pellia epiphylla</i>	occasional
<i>Racomitrium ellipticum</i>	occasional to frequent, mid to upper
<i>Scapania undulata</i>	frequent.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Ionaspis odora</i>	VU		NS	
<i>Ainoa mooreana</i>	NT		NS	
<i>Stereocaulon leucophaeopsis</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Calvitimela aglaea</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Porpidia melinodes</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	
<i>Rhizocarpon viridiatrum</i>			NS	

Poorly known species of possible concern:

Aspicilia Cwm Glas Mawr A

Locality	Map reference
100	23/61997.56546
101	23/61939.56516
102	23/61904.56507
103	23/61871.56471
104	23/61793.56387
105	23/61769.56345



Bottom of site (locality 100).



Top of surveyed area (locality 105); *Ionaspis odora* occurs on cobbles.

Afon Cwm Llan lower

Site code: CLL. 1 km square: 62.51. Area surveyed: 6292.5138 to 6213.5202. Alt: 30-250 m. Date surveyed: 15 March 2011.

Geology: 1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Bedded Pyroclastic Formation - Pyroclastic-rock. 3. Lower Rhyolitic Tuff Formation - Tuff, Felsic.

Data are taken from Orange (2011; *A Lichen Survey of Three Streams with Proposed HEP Schemes in Snowdonia National Park*, Amgueddfa Cymru – National Museum Wales, report to National Trust).

The lower part of the site has a bed of numerous boulders and some bedrock, in part shaded by mature trees; in the middle of the site is an impressive cascade of falls; the upper part of the site comprises mainly bedrock with a series of falls and pools. The flora suggests base-poor rock, and lichen and bryophyte diversity is relatively low. The rocks typically have a dark aspect, created in part by dark bryophytes such as *Nardia compressa*, and lichens including the cyanobacterial *Ephebe lanata*, but also by an abundance of free-living cyanobacteria, with rocks often covered with dark brown to blackish mats of *Stigonema*, and also *Scytonema* in wetter areas, and dull red patches of *Gloeocapsa*; during the two visits, sleek dark brown mats of a non-heterocystous filamentous cyanobacterium with false branching were abundant below water level.

Thirty-four species were recorded in the riparian zone, which is typically dominated by *Ephebe lanata*, *Ionaspis lacustris*, *Porpidia hydrophila*, *Rhizocarpon lavatum*, and cyanobacteria, and the bryophytes *Racomitrium aciculare* and (especially in the permanently or very frequently submerged zone) *Nardia compressa*. An upper riparian zone contains in addition species including *Cladonia subcervicornis*, *Massalongia carnosa* (rare) and *Placopsis lambii* (rare).

Cryptothele rhodosticta was the species of greatest conservation interest that was recorded. This was first recorded at the site by the writer in May 1998, at the foot of the main falls. During the present survey it was refound in the same position, and three additional colonies were detected on or near the falls. It occurred on gently sloping, unshaded, smooth expanses of bedrock. It is useful to know that this species can persist in the same place over more than a decade, and is not ephemeral.

Site:	Afon Cwm Llan lower
<i>Amygdalaria pelobotryon</i>	Occasionally flushed rocks on falls, rare.
<i>Arthorhaphis citinella</i>	Present.
<i>Aspicilia caesiocinerea</i>	Present.
<i>Baeomyces placophyllus</i>	Present.
<i>Baeomyces rufus</i>	Present.
<i>Buellia aethalea</i>	Upper riparian; rare.
<i>Cladonia coccifera</i>	Present.
<i>Cladonia subcervicornis</i>	Present.
<i>Cryptothele rhodosticta</i>	Gently sloping unshaded bedrock on or below main falls.
<i>Diploschistes scruposus</i>	Vertical face of boulder, rare.
<i>Fuscidea lygaea</i>	Present.

<i>Immersaria athroocarpa</i>	Present.
<i>Ionaspis lacustris</i>	Present.
<i>Lecidea lithophila</i>	Present.
<i>Massalongia carnosa</i>	Top of boulder, under trees, 6280.5136; rare.
<i>Opegrapha gyrocarpa</i>	Present.
<i>Pertusaria pseudocorallina</i>	Present.
<i>Pilophorus strumaticus</i>	On boulders and bedrock; rare.
<i>Placopsis lambii</i>	Present.
<i>Porina lectissima</i>	Present.
<i>Porpidia cinereoatra</i>	Present.
<i>Porpidia contraponenda</i>	Present.
<i>Porpidia hydrophila</i>	Frequent.
<i>Porpidia irrigua</i>	Occasionally flushed rocks on falls.
<i>Porpidia rugosa</i>	Present.
<i>Rhizocarpon geographicum</i>	Present.
<i>Rhizocarpon lavatum</i>	Frequent.
<i>Rhizocarpon lecanorinum</i>	Occasionally flushed rocks on falls.
<i>Rimularia badioatra</i>	Top of shaded boulder.
<i>Stereocaulon pileatum</i>	Present.
<i>Stereocaulon vesuvianum</i>	Present.
<i>Trapelia involuta</i>	Present.
<i>Trapelia obtegens</i>	Present. Esorediate fertile morph [as <i>T. coarctata</i> ; specimen checked]
<i>Trapelia placodioides</i>	Present.
Number of lichen species:	34
Number of riparian species:	5
EN	0
VU	0
NT	0
DD	1
NR	1
NS	4
NR/NS score	220

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Cryptothele rhodosticta</i>	DD	DD	NR	IR
<i>Immersaria athroocarpa</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Porpidia contraponenda</i>			NS	
<i>Rimularia badioatra</i>			NS	



The main falls; *Cryptothele rhodosticta* occurs on the flat rocks immediately below the falls.



Upper part of the site.

Afon Cwm Llan upper

Site code: CLU. 1 km square: 61.52. Area surveyed: 61985.52127 to 61549.52218. Alt.: 260-300 m. Date of survey: 20 September 2017.

Geology: 1. Lower Rhyolitic Tuff Formation - Tuff, Felsic. 2. Cwm Eigiau Formation - Mudstone And Siltstone.

The rocks are evidently base-poor. Low and mid riparian zones are species-poor, with *Ionaspis lacustris* abundant, *Rhizocarpon lavatum* frequent but apparently of low cover, *Porpidia hydrophila* occasional, and *Fuscidea lygaea* frequent in the mid zone. Upper riparian with a fairly poor range of typical acid rock species, but about three boulders with the notable species *Claurouxia chalybeoides*. *Ephebe lanata* frequent but also low cover, but the free-living cyanobacterium *Stigonema* is often abundant. Submerged stones have a lot of algae and/or cyanobacteria, especially a filamentous cyanobacterium forming sleek dark brown mats; this was noted at the lower site a few years ago.

The acid-loving hepatic *Nardia compressa* is abundant, submerged or shallowly emergent; the moss *Racomitrium aciculare* is frequent but of low cover.

The uppermost few hundred metres of the area surveyed were just walked over, but seemed similar to lower parts.

Site:	Afon Cwm Llan upper
<i>Acarospora</i> Merch A	Upper riparian, rare; 143.
<i>Agonimia tristicula</i>	Rare on moist rocks on bank; 142.
<i>Amygdalaria pelobotryon</i>	Upper riparian, rare; 140.
<i>Arthorhaphis citinella</i>	Vertical rocks, rare; 140.
<i>Aspicilia granulosa</i>	Upper riparian, occasional.
<i>Aspicilia simoensis</i>	Top of boulder, upper riparian; 144. (Voucher: 23854).
<i>Baeomyces rufus</i>	Upper riparian, occasional.
<i>Cladonia cervicornis</i>	Upper riparian, rare.
<i>Claurouxia chalybeoides</i>	Upper riparian, on c. 3 boulders; 140.
<i>Ephebe lanata</i>	Frequent, but not of high cover.
<i>Fuscidea cyathoides</i>	Upper riparian, occasional.
<i>Fuscidea lygaea</i>	Abundant in mid riparian, almost frequent in upper.
<i>Immersaria athroocarpa</i>	Frequent mid to upper, low cover.
<i>Ionaspis lacustris</i>	Abundant low riparian, also in mid.
<i>Lecanora intricata</i>	Upper riparian, occasional.
<i>Lecanora polytropa</i>	Rare.
<i>Lecanora soralifera</i>	Upper riparian, occasional.
<i>Lecidea lithophila</i>	Upper riparian, occasional.
<i>Lecidea swartzioidea</i>	Upper riparian; 142.
<i>Lepraria caesioalba</i>	Upper riparian, on <i>Andreaea rothii</i> , rare; 140, 142.
<i>Micarea leprosula</i>	Vertical rocks, rare; 140.
<i>Micarea lignaria</i> var. <i>lignaria</i>	Vertical rocks, rare; 140.
<i>Miriquidica leucophaea</i>	Upper riparian, occasional.
<i>Opegrapha gyrocarpa</i>	Vertical rocks in small gorge, rare, 142.
<i>Parmelia saxatilis</i>	Upper riparian, occasional.
<i>Pertusaria aspergilla</i>	Upper riparian, rare.
<i>Placopsis lambii</i>	Upper; occasional; 140

<i>Porpidia hydrophila</i>	Low to mid, occasional to frequent.
<i>Porpidia irrigua</i>	Upper riparian, occasional.
<i>Porpidia melinodes</i>	Upper riparian, rare.
<i>Porpidia tuberculosa</i>	Mid riparian, rare.
<i>Rhizocarpon geographicum</i>	Upper riparian, occasional.
<i>Rhizocarpon lavatum</i>	Frequent, mid to upper riparian, but not in great quantity (most rusty lichen seems to be <i>Ionaspis</i>).
<i>Rhizocarpon reductum</i>	Low to usually upper riparian, occasional.
<i>Scoliciosporum umbrinum</i>	Upper riparian, rare.
<i>Stereocaulon pileatum</i>	Rare, one thallus mid riparian; 141.
<i>Stereocaulon vesuvianum</i>	Occasional, small quantities.
<i>Tephromela atra</i>	Upper riparian, occasional.
<i>Trapelia involuta</i>	Upper riparian, rare.
<i>Trapelia obtegens</i>	Upper riparian, rare; non-soresidate, fertile morph; 143, 144.
<i>Trapelia placodioides</i>	Upper riparian, rare.
<i>Tremolecia atrata</i>	Mid to upper, frequent.
Number of lichen species:	42
Number of riparian species:	4
EN	0
VU	0
NT	0
DD	0
NR	0
NS	3
NR/NS score	90

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	Occasional.
<i>Campylopus atrovirens</i>	Rare to occasional on seeping banks.
<i>Grimmia donniana</i>	Frequent.
<i>Marsupella emarginata</i>	Occasional, mostly on seeping rocks rather than in the stream.
<i>Nardia compressa</i>	Abundant throughout site, submerged or shortly above water in rapids.
<i>Racomitrium aciculare</i>	Frequent, but at low cover.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Clauroxia chalybeoides</i>			NS	
<i>Immersaria athrocarpa</i>			NS	
<i>Porpidia melinodes</i>			NS	

Poorly known species of possible concern:

Acarospora Merch A

Locality	Map reference
140	23/61985.52127
141	23/61914.52158
142	23/61771.52162
143	23/61722.52160
144	23/61711.52175
145	23/61549.52218



Bottom of site.



Locality 141 (grid ref. 61914.52158).



The falls here are narrow and confined, not forming extensive bedrock as at some sites; any exposed rock has only bryophytes and cyanobacteria.

Afon Goch

Site code: AGO. 1 km square: 67.69. Survey area: 67003.69656 to 67187.69441. Alt.: 370- 420 m. Date of survey: 8 August 2017, 19 October 2017.

Geology: 1. Unnamed Igneous Intrusion, Ordovician - Microgranodiorite. 2. Unnamed Igneous Intrusion, Ordovician - Trachyandesite.

The lower part of the site is the best, with steeper gradient and more varied and extensive rock. The water level was slightly raised on 8 August; *Verrucaria anziana* and *Staurothele fissa* could be identified but they were just under water. A visit near base flow on 19 October confirmed these and added a small number of additional species, including *Porina interjungens* and *Thelidium pluvium*, not detected at other sites during the survey. Despite one record of *Hydropunctaria scabra*, the *Verrucariaceae* at the site are not very abundant. *Verrucaria* species other than *V. anziana* were often confined to semi-stable cobbles, which were usually too hard to sample, and too large for comfortable collection. The stream seems relatively base-rich, with *Schistidium rivulare*. There were four *Dermatocarpon* species, but rather local, with *D. arnoldianum* restricted to one area of low bedrock. Here it was confined to a surface where scouring reduced bryophyte cover.

Site:	Afon Goch
<i>Agonimia tristicula</i>	Occasional; 60, 62. (220), 225.
<i>Amygdalaria pelobotryon</i>	Mid riparian, 62.
<i>Aspicilia aquatica</i>	Rocks near wate, rare; 63, (223).
<i>Aspicilia caesiocinerea</i>	Frequent.
<i>Aspicilia epiglypta</i>	Mid riparian, with <i>Racomitrium aciculare</i> ; 64.
<i>Aspicilia recedens</i>	Upper riparian, rare; 63, 224.
<i>Aspicilia simoensis</i>	Occasional, upper riparian (<i>A. grisea</i> agg.); one confirmed as <i>A. simoensis</i> , 220..
<i>Baeomyces rufus</i>	Occasional.
<i>Caloplaca crenularia</i>	Upper riparian, very rare, 62.
<i>Candelariella vitellina</i>	Occasional, with <i>Aspicilia caesiocinerea</i> .
<i>Cladonia cervicornis</i>	occasional, upper riparian.
<i>Cladonia coccifera</i>	occasional, upper riparian.
<i>Cladonia cyathomorpha</i>	upper riparian, 60; mid riparian, 220.
<i>Cladonia subcervicornis</i>	occasional, upper riparian.
<i>Dermatocarpon arnoldianum</i> auct.	Very shallowly submerged on first visit, shallowly exposed second visit, with <i>D. leptophyllodes</i> , <i>Racomitrium aciculare</i> , <i>Brachythecium plumosum</i> , on low bedrock, rare. 61. This species was not seen elsewhere.
<i>Dermatocarpon leptophyllodes</i>	Low to mid riparian, occasional, shallowly submerged to emergent and moist during slightly elevated flow today; 60, 61, 62.
<i>Dermatocarpon luridum</i>	Occasional, low to mid riparian; varying from submerged to emergent in today's slightly raised levels; 60, 61, 63
<i>Dermatocarpon meiophyllizum</i>	Low riparian, rare; shallowly submerged at slightly elevated flow; 60, 61.
<i>Ephebe lanata</i>	Frequent, in good quantity.
<i>Fuscidea cyathoides</i>	Rare.
<i>Fuscidea lygaea</i>	Frequent, mid to upper riparian, once submerged; the 'freshwater' morph.

<i>Hydropunctaria scabra</i>	on rock near water level with Derm lur, Verr dev, Verr small spores (sub 23773).
<i>Ionaspis lacustris</i>	Abundant, low riparian mainly.
<i>Lecanora intricata</i>	Occasional.
<i>Lepraria caesioalba</i>	Rare.
<i>Massalongia carnosa</i>	Mid riparian, rare: 62: with <i>Andreaea rothii</i> , <i>Racomitrium aciculare</i> , <i>Agonimia tristicula</i> ; 63: with <i>Andreaea rothii</i> , <i>Cladonia subcervicornis</i> , <i>Rhizocarpon geographicum</i> ; on boulder, 225.
<i>Ophioparma ventosum</i>	On steep faces, upper riparian; 60.
<i>Parmelia omphalodes</i>	Occasional.
<i>Peltigera membranacea</i>	Low mossy boulder, 220.
<i>Pertusaria amara</i>	Upper riparian, 60.
<i>Pertusaria aspergilla</i>	Upper riparian, rare.
<i>Pertusaria chiodectonoides</i>	Rare?; 60.
<i>Physcia dubia</i>	Upper riparian on bird-perching rock, rare; 64.
<i>Physcia tenella</i>	On bird-perching boulder, rare; 224.
<i>Placopsis lambii</i>	Occasional.
<i>Placopyrenium formosum</i>	On <i>Aspicilia aquatica</i> , very rare, 223.
<i>Polychidium muscicola</i>	Mid riparian, with <i>Hyocomium</i> , <i>Racomitrium aciculare</i> , <i>Agonimia tristicula</i> ; rare, 60; on boulder, c.fr., 225.
<i>Porina interjungens</i>	On splashed rock in mid riparian, with <i>Ionaspis lacustris</i> , <i>Fuscidea lygaea</i> , <i>Racomitrium aciculare</i> , rare; 220.
<i>Porina rivalis</i>	On stones; 62, 222.
<i>Porpidia cinereoatra</i>	Upper riparian, 62.
<i>Porpidia crustulata</i>	On a cobble, 221.
<i>Porpidia irrigua</i>	rare, 62.
<i>Porpidia tuberculosa</i>	occasional, mid to upper riparian.
<i>Rhizocarpon geographicum</i>	Frequent.
<i>Rhizocarpon lavatum</i>	Frequent.
<i>Rhizocarpon viridiatrum</i>	On <i>Asoicilia caesiocinerea</i> , 221.
<i>Rimularia badioatra</i>	Mid riparian, 220.
<i>Rimularia intercedens</i>	Upper riparian, extending into mid riparian on steep face; rare; 61.
<i>Sphaerophorus globosus</i>	Upper riparian, rare.
<i>Sporodictyon cruentum</i>	Occasional on rocks, sometimes on semi-stable stones at edge of channel; low riparian; 60, 62 (220).
<i>Staurothele fissa</i>	Occasional, low riparian, shallowly submerged today at slightly raised levels. 60, 62, 63.
<i>Stereocaulon evolutum</i>	Occasional.
<i>Stereocaulon vesuvianum</i>	Occasional.
<i>Tephromela atra</i>	Frequent.
<i>Thelidium pluvium</i>	On cobble; 222.
<i>Trapelia elacista</i>	On stones, low to medium riparian, at least once submerged.
<i>Trapelia glebulosa</i>	Upper riparian, rare, 62.
<i>Trapelia involuta</i>	Upper riparian, rare, 62.
<i>Trapelia placodioides</i>	Rare.
<i>Verrucaria aethiobola</i>	On a steep low face, very rare; 61.
<i>Verrucaria anziana</i>	Occasional, low riparian, all shallowly submerged 8 August at slightly elevated flow. 60, 61, 63. (220, 222).
<i>Verrucaria devensis</i>	on rock near water level with Derm lur, Hydr sca, Verr small spores (sub 23773).
<i>Verrucaria hydrophila</i>	On cobbles; 220, 222.
<i>Verrucaria margacea</i>	semi-stable stones and cobbles; 62, 222.
<i>Verrucaria nodosa</i>	On a semi-stable stone at edge of stream, very rare; 62. Field identification but confident.
<i>Verrucaria rosula</i>	semi-stable stone at margin in small quantity; 62. [confirmed in lab].

<i>Verrucaria</i> small spores	on rock near water level with Derm lur, Hydr sca, Verr dev (23773).
Lichenicolous fungi	
<i>Thelidium</i> (so-called) parasite on <i>Verr mar</i>	on <i>Verrucaria</i> margacea; 62. (Voucher 23777).
<i>Verrucaria conturmatula</i>	on <i>Ionaspis lacustris</i> ; 220.
Number of lichen species:	67
Number of riparian species:	25
EN	0
VU	1
NT	4
DD	2
NR	4
NS	10
NR/NS score	700
Overall score	800

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	frequent
<i>Anomobryum julaceum</i>	rare
<i>Blindia acuta</i>	rare
<i>Brachythecium plumosum</i>	frequent
<i>Bryum alpinum</i>	occasional
<i>Campylopus atrovirens</i>	occasional
<i>Fontinalis antipyretica</i>	rare?
<i>Fontinalis squamosa</i>	abundant
<i>Hygrohypnum eugyrium</i>	rare
<i>Hygrohypnum ochraceum</i>	frequent
<i>Isothecium holtii</i>	rare to occasional
<i>Marsupella emarginata</i>	frequent
<i>Oxystegus tenuirostris</i>	occasional
<i>Platyhypnidium riparioides</i>	rare (slender form like R. alop).
<i>Pogonatum urnigerum</i>	occasional
<i>Racomitrium aciculare</i>	abundant
<i>Racomitrium affine/heterostichum</i>	occasional
<i>Scapania undulata</i>	occasional
<i>Schistidium rivulare</i>	occasional

Site:	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Pertusaria chiodectonoides</i>	VU		NS	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Porina interjungens</i>	NT		NS	
<i>Thelidium pluvium</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Aspicilia recedens</i>	DD		NR	
<i>Hydropunctaria scabra</i>			NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Rimularia intercedens</i>			NS	
<i>Verrucaria anziana</i>			NS	

Poorly known species of possible concern:

Dermatocarpon arnoldianum auct.

Verrucaria small spores

Locality	Map reference
60	23/67003.69656
61	23/67070.69584
62	23/67117.69538
63	23/67187.69520
64	23/67187.69441
220	23/67009.69647
221	23/67054.69593
222	23/67070.69585
223	23/67178.69462
224	23/67267.69335
225	23/67420.69255



Bottom of site.



Location of *Dermatocarpon arnoldianum* (red dot); locality 61, see next photograph.



Low bedrock (below and right of centre) with four species of *Dermatocarpon*; these are mainly on the upstream side, where the current reduces bryophyte growth and the rock is frequently submerged (locality 61).



Upper end of surveyed area.

Afon Llafar lower

Site code: ALL. 1 km square: 64.65. Area surveyed: 64771.65488 to 64873.65408. Alt.: 370- 380 m. Date of survey: 11 August 2017, 26 September 2017.

Geology: Nant Ffrancon Subgroup - Siltstone. (Boulders are probably all derived from superficial deposits of till).

On 11 August in drizzle; difficult to see crusts on rocks. On 26 September levels near base-flow, weather dry and warm.

The bottom of the site has many boulders of good size, and the stream is a good size. Lichens indicative of mild base-enrichment are plentiful. Bryophytes are conspicuous but not dominant. All the rock visible is derived from extensive till deposits; no bedrock is apparent.

Site:	Afon Llafar lower
<i>Acarospora fuscata</i>	Upper riparian, rare; 90/180.
<i>Agonimia tristicula</i>	Rare; 180.
<i>Aspicilia aquatica</i>	Low to mid riparian, occasional to frequent; 90, 91, 183, .
<i>Aspicilia caesiocinerea</i>	Upper riparian, frequent.
<i>Aspicilia epiglypta</i>	Present.
<i>Aspicilia grisea agg.</i>	Upper riparian, frequent.
<i>Aspicilia recedens</i>	90.
<i>Bacidia inundata</i>	Low to mid riparian, rare.
<i>Baeomyces placophyllus</i>	On mossy rocks in lee of boulder, rare; 183.
<i>Caloplaca arenaria</i>	Upper riparian.
<i>Candelariella vitellina</i>	Upper riparian.
<i>Catillaria chalybeia</i>	Low riparian, occasional; 91, 182.
<i>Cladonia cyathomorpha</i>	Upper riparian, rare; ?, 183.
<i>Collema flaccidum</i>	On moss, low riparian, rare; 90.
<i>Dermatocarpon leptophyllodes</i>	Occasional; 90/180, 91/181, 183.
<i>Dermatocarpon luridum</i>	Low to mid riparian, sometimes submerged, occasional; 90, 91/181.
<i>Dermatocarpon meiophyllizum</i>	Low riparian, near water level with <i>Cinclidotus fontinaloides</i> , <i>Schistidium rivulare</i> , <i>Fontinalis squamosa</i> ; 91/181, 180.
<i>Ephebe lanata</i>	Occasional, inconspicuous, in small quantities.
<i>Fuscidea cyathoides</i>	Upper riparian, rare to occasional.
<i>Immersaria athroocarpa</i>	Upper riparian, rare.
<i>Ionaspis lacustris</i>	Low riparian, frequent.
<i>Lasallia pustulata</i>	Upper riparian, rare; 90/180, .
<i>Lecanora intricata</i>	Present.
<i>Lecanora muralis</i>	Upper riparian, occasional.
<i>Lecanora sulphurea</i>	One thallus in upper riparian, very rare; 183.
<i>Lecidea fuscoatra</i>	Upper riparian, occasional.
<i>Lecidea lactea</i>	Rare.
<i>Lecidea lithophila</i>	Present.
<i>Lecidea swartzioidea</i>	Upper riparian, frequent. [to be checked].
<i>Lecidella scabra</i>	Present.
<i>Massalonia carnosa</i>	On <i>Racomitrium aciculare</i> ; 90.
<i>Ochrolechia parella</i>	Mid to upper riparian, rare; 90, 181.
<i>Parmelia omphalodes</i>	Present.
<i>Parmelia saxatilis</i>	Present.

<i>Pertusaria corallina</i>	Upper riparian, rare.
<i>Pertusaria pseudocorallina</i>	Upper riparian, occasional.
<i>Physcia caesia</i>	Seen twice, on bird-perches, with <i>Aspicilia caesiocinerea</i> , <i>Candelariella vitellina</i> , <i>Brachythecium plumosum</i> , <i>Racomitrium aciculare</i> ; 90, 91.
<i>Placopsis lambii</i>	Upper riparian, rare to occasional.
<i>Placopyrenium formosum</i>	On <i>Aspicilia aquatica</i> , frequent; 90/180, 91, 183.
<i>Polychidium muscicola</i>	Rare; 90, 183.
<i>Porpidia cinereoatra</i>	Present.
<i>Porpidia crustulata</i>	Low riparian; 92.
<i>Porpidia macrocarpa</i>	Upper riparian, occasional.
<i>Porpidia tuberculosa</i>	Upper riparian, occasional.
<i>Rhizocarpon lavatum</i>	Present.
<i>Rhizocarpon viridiatrum</i>	On <i>Aspicilia caesiocinerea</i> , rare; 181.
<i>Scoliciosporum umbrinum</i>	Upper riparian, occasional.
<i>Sphaerophorus globosus</i>	A few small thalli on boulder, upper riparian, rare; 183.
<i>Staurothele fissa</i>	Lower riparian, frequent.
<i>Tephromela atra</i>	Upper riparian, occasional.
<i>Trapelia elacista</i>	Low riparian, rare.
<i>Trapelia involuta</i>	Upper riparian, occasional.
<i>Trapelia placodioides</i>	Present.
<i>Umbilicaria polyphylla</i>	Upper riparian on one boulder, rare; 183.
<i>Umbilicaria polyrhiza</i>	Upper riparian on one boulder, rare; 183.
<i>Verrucaria Caseg A</i>	90.
<i>Verrucaria cernaensis</i>	Lower riparian, rare to occasional; 180, 182.
<i>Xanthoparmelia conspersa</i>	Upper riparian, frequent.
<i>Xanthoparmelia loxodes</i>	Upper riparian in good quantity on one boulder (rare); 183.

Number of lichen species:	59
Number of riparian species:	14

EN	0
VU	0
NT	2
DD	2
NR	3
NS	6
NR/NS score	480

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	Occasional.
<i>Andreaea rupestris</i>	Rare.
<i>Brachythecium plumosum</i>	Frequent.
<i>Chiloscyphus polyanthos</i>	Occasional at water level.
<i>Cinclidotus fontinaloides</i>	Frequent.
<i>Fontinalis antipyretica</i>	Occasional.
<i>Fontinalis squamosa</i>	Abundant.
<i>Grimmia ramondii</i>	Occasional.
<i>Hygrohypnum eugyrium</i>	Occasional.
<i>Hygrohypnum ochraceum</i>	Frequent.
<i>Hypnum cupressiforme</i>	Top of boulder, rare; 181.
<i>Isothecium holtii</i>	Occasional.
<i>Oxystegus tenuirostris</i>	Occasional.
<i>Philonotis fontana</i>	Occasional.
<i>Plagiochila porelloides</i>	Occasional on mossy sides of boulders.
<i>Racomitrium aciculare</i>	Frequent.

<i>Scapania undulata</i>	Occasional.
<i>Schistidium rivulare</i>	Frequent.
<i>Thamnobryum alopecurum</i>	Local, rare to occasional.

Site:	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Aspicilia recedens</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Bacidia inundata</i>			NS	
<i>Cladonia cyathomorpha</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Rhizocarpon viridiatrum</i>			NS	

Poorly known species of possible concern:

Verrucaria Caseg A

Locality	Map reference
90	23/64771.65488
91	23/64812.65442
92	23/64873.65408
180	23/64785.65461
181	23/64816.65441
182	23/64856.65415
183	23/64951.65411



Bottom of site.



Low boulder in foreground has *Dermatocarpon meiophyllizum* around water level (locality 181).

Afon Llafar central

Site code: ALC. 1 km square: 65.65. Area surveyed: 65002.65402 to 65442.65044. Alt. 390-420 m. Date of survey: 26 September 2017.

Geology: Nant Ffrancon Subgroup - Siltstone. (Boulders are probably all derived from superficial deposits of till).

Boulders are smaller than in Afon Llafar lower; bryophytes are conspicuous and of high cover, presumably due to the lesser effects of current and abrasion in this slightly smaller stream with perhaps slightly less gradient. In at least the lower parts of the site, it is clear (as in the lower site) that cobbles and small boulders are sometimes turned by floods.

Verrucaria species are sparse, and often seen on semi-stable cobbles. Sometimes these may have been moved by the water, so that although the species are visible to the surveyor, they may be in poor condition. The stream was probably at base flow or near, but some lichens are submerged, some *Ionaspis lacustris* and some *Dermatocarpon luridum*. Possibly some *Verrucaria* is missed underwater.

The upper part of the site has mostly small boulders which are mossy enough for mosses to be competition for lichens. Some of the larger boulders here are too steep sided to be very suitable for some of the notable species. One low, level boulder was considered to be suitable in position but too mossy, but on inspection it had *Dermatocarpon leptophyllodes*, and *D. meiophyllizum*, some of which was hidden amongst long tufts of *Schistidium rivulare*; one thallus of *D. meiophyllizum* was 32 mm diameter (moist). However, no further suitable boulders were seen above this until the top of the site, and it is clear that the variety of boulder size and shape necessary for a varied flora was reduced here. This quality of microhabitat diversity is hard to define. Some larger boulders of course had an upper riparian flora which was missing on the smaller ones.

There are two old weirs.

Site:	Afon Llafar central
<i>Agonimia tristicula</i>	Rare; 193.
<i>Aspicilia aquatica</i>	Occasional; 190, 193, 194, 195.
<i>Aspicilia caesiocinerea</i>	Upper riparian, frequent.
<i>Buellia aethalea</i>	Upper riparian, occasional. K + red, I + blue.
<i>Candelariella vitellina</i>	Occasional on bird-perching boulders, once growing over <i>Aspicilia caesiocinerea</i> .
<i>Catillaria chalybeia</i>	Occasional.
<i>Cladonia cyathomorpha</i>	Upper riparian, rare; 191.
<i>Cladonia furcata</i>	Upper riparian, rare.
<i>Collema flaccidum</i>	Low riparian, on one rock (thus rare); 190.
<i>Dermatocarpon arnoldianum</i> auct.	On top of low boulder, with <i>Aspicilia aquatica</i> , <i>Placopyrenium formosum</i> , <i>Lecanora muralis</i> , <i>Dermatocarpon leptophyllodes</i> , <i>Racomitrium aciculare</i> ; 190. (Voucher: 23881).
<i>Dermatocarpon leptophyllodes</i>	Occasional; 190, 191, 193, 195, 197.

<i>Dermatocarpon luridum</i>	Frequent; 190, 193, 194, 197.
<i>Dermatocarpon meiophyllizum</i>	Low to mid riparian, mixed with <i>D. leptophyllodes</i> (190), on low boulder (191), low boulder amongst dense <i>Schistidium rivulare</i> (195).
<i>Ephebe lanata</i>	Occasional.
<i>Fuscidea cyathoides</i>	Rare.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora intricata</i>	Occasional.
<i>Lecanora muralis</i>	Occasional.
<i>Lecanora polytropa</i>	Rare.
<i>Lecanora soralifera</i>	Upper riparian, rare.
<i>Lecidea lithophila</i>	Upper riparian.
<i>Lecidea swartzioidea</i>	Upper riparian.
<i>Melanelixia fuliginosa</i>	Very rare.
<i>Ochrolechia parella</i>	Rare; 193.
<i>Parmelia omphalodes</i>	Occasional.
<i>Parmelia saxatilis</i>	Occasional.
<i>Pertusaria lactea</i>	Rare.
<i>Pertusaria pseudocorallina</i>	Rare.
<i>Physcia caesia</i>	Occasional, once abundant on bird perch with <i>Lecanora muralis</i> , <i>Candelariella vitellina</i> , <i>Aspicilia caesiocinerea</i> .
<i>Placopyrenium formosum</i>	Occasional; 190, 193.
<i>Polychidium muscicola</i>	Mid riparian, rare; 193.
<i>Porpidia crustulata</i>	Large cobble, 191.
<i>Protoparmelia badia</i>	Upper riparian, rare.
<i>Rhizocarpon geographicum</i>	Upper riparian, frequent.
<i>Rhizocarpon lavatum</i>	Frequent, but not very conspicuous.
<i>Rhizocarpon reductum</i>	Upper riparian, rare.
<i>Rimularia badioatra</i>	Upper riparian, rare.
<i>Scoliciosporum umbrinum</i>	Occasional.
<i>Staurothele fissa</i>	Frequent.
<i>Stereocaulon evolutum</i>	Rare.
<i>Trapelia elacista</i>	Low riparian, rare; 193.
<i>Trapelia involuta</i>	Upper riparian, 191.
<i>Trapelia placodioides</i>	Occasional.
<i>Tremolecia atrata</i>	Upper riparian, rare.
<i>Umbilicaria polyrhiza</i>	Upper riparian, but on small boulder in channel, rare; 191.
<i>Verrucaria cernaensis</i>	Low riparian, rare; 193.
<i>Verrucaria devensis</i>	Low riparian, seen once (rare); 194.
<i>Verrucaria margacea</i>	Low riparian, sometimes on cobble, rare or overlooked; 191, 193.
<i>Xanthoparmelia conspersa</i>	Upper riparian, occasional.
Number of lichen species:	49
Number of riparian species:	15
EN	0
VU	0
NT	2

DD	1
NR	2
NS	4
NR/NS score	320

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Brachythecium plumosum</i>	Frequent.
<i>Bryum capillare</i>	Present.
<i>Bryum pseudotriquetrum</i>	Occasional.
<i>Chiloscyphus polyanthos</i>	Present.
<i>Cinclidotus fontinaloides</i>	Present.
<i>Fontinalis antipyretica</i>	Present.
<i>Fontinalis squamosa</i>	Abundant.
<i>Grimmia ramondii</i>	In good quantities on several boulders.
<i>Grimmia trichophylla</i>	Occasional.
<i>Hedwigia stellata</i>	Present.
<i>Hygrohypnum eugyrium</i>	Occasional.
<i>Hygrohypnum ochraceum</i>	Frequent.
<i>Hypnum cupressiforme</i>	Rare.
<i>Marchantia polymorpha</i>	Wet rocks, rare.
<i>Marsupella emarginata</i>	Frequent or occasional.
<i>Pogonatum urnigerum</i>	Present.
<i>Racomitrium aciculare</i>	Frequent.
<i>Racomitrium affine/heterostichum</i>	Occasional.
<i>Schistidium rivulare</i>	Frequent.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Cladonia cyathomorpha</i>			NS	
<i>Rimularia badioatra</i>			NS	

Poorly known species of possible concern:

Dermatocarpon arnoldianum auct.

Locality	Map reference
190	23/65002.65402
191	23/65051.65348
192	23/65112.65290
193	23/65147.65225
194	23/65265.65154
195	23/65328.65106
196	23/65430.65066
197	23/65442.65044



Bottom of site.



Low, mossy boulder (the larger in foreground) with *Dermatocarpon meiophyllizum* (locality 195).



Two large boulders (opposite bank). The right hand one (with green cushions of the moss *Grimmia ramondii*) was considered all riparian, the left hand one may be 'terrestrial' at the apex.

Afon Llafar upper

Site code: ALU. 1 km square: 66.64. Area surveyed: 66010.64462 to 66423.64096. Alt. 430-470 m. Date of survey: 20 September 2017.

Geology: Nant Ffrancon Subgroup - Siltstone. (Many boulders are probably derived from superficial deposits of till).

Weather very blustery, a little drizzle later.

The stream has mostly small boulders in the channel, which are conspicuously mossy, and where mosses are a competitor for lichens. *Dermatocarpon* occurs sparsely where mosses are absent on low boulders. There are still signs of slight base enrichment, with *Schistidium rivulare* probably frequent, but at least in part of the site the rocks seem to be base-poor compared to sites lower on this river. Lichens are limited by moss growth (not enough current to keep rocks free), and perhaps low diversity of types of rock.

Finding two boulders with *Dermatocarpon meiophyllizum* at the top of the site emphasises the importance of low, flat boulders for some of the notable species.

Site:	Afon Llafar upper
<i>Acarospora smaragdula</i>	Mid riparian, rare, two colonies seen.
<i>Agonimia tristicula</i>	Rare, 200, 205.
<i>Aspicilia aquatica</i>	Frequent; 200, 204, 205.
<i>Aspicilia recedens</i>	Low boulder with <i>Rhizocarpon geographicum</i> , 202.
<i>Aspicilia simoensis</i>	Upper riparian, probably occasional; 200.
<i>Candelariella vitellina</i>	Occasional.
<i>Cladonia subcervicornis</i>	Occasional.
<i>Dermatocarpon leptophyllodes</i>	Occasional, mid riparian; 200, 201, 208.
<i>Dermatocarpon luridum</i>	Mid riparian, rare to occasional. 206.
<i>Dermatocarpon meiophyllizum</i>	Low boulder, mid riparian (207); low boulder at water level (208).
<i>Ephebe lanata</i>	Frequent, though not in large quantities.
<i>Fuscidea cyathoides</i>	Occasional.
<i>Fuscidea kochiana</i>	Rare.
<i>Fuscidea lygaea</i>	Occasional.
<i>Immersaria athroocarpa</i>	Rare; 206.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora intricata</i>	Present.
<i>Lecanora muralis</i>	Rare to occasional; 202.
<i>Lecidea lithophila</i>	Occasional.
<i>Lecidea swartzioidea</i>	Present.
<i>Miriquidica leucophaea</i>	Rare.
<i>Ochrolechia tartarea</i>	Upper, riparian, rare; 200.
<i>Ophioparma ventosum</i>	Rare.
<i>Parmelia omphalodes</i>	Occasional.
<i>Peltigera rufescens</i>	Upper riparian, rare.

<i>Pertusaria corallina</i>	Occasional.
<i>Pertusaria pseudocorallina</i>	Occasional.
<i>Placopsis lambii</i>	Mid riparian, occasional.
<i>Placopyrenium formosum</i>	Rare; 204.
<i>Porina lectissima</i>	On steep flushed bedrock, rare; 206.
<i>Porpidia crustulata</i>	On semi-stable cobbles, occasional.
<i>Porpidia irrigua</i>	Rare; 204.
<i>Porpidia macrocarpa</i>	Upper riparian, occasional.
<i>Porpidia rugosa</i>	Steep face of bedrock; 206.
<i>Porpidia tuberculosa</i>	Rare.
<i>Pterygiopsis lacustris</i>	Mid riparian on small boulder; 201.
<i>Rhizocarpon geographicum</i>	Frequent.
<i>Rhizocarpon lavatum</i>	Frequent.
<i>Sphaerophorus globosus</i>	Rare.
<i>Sporodictyon cruentum</i>	On cobble; 203.
<i>Staurothele fissa</i>	Occasional.
<i>Stereocaulon evolutum</i>	Upper riparian, rare.
<i>Tephromela atra</i>	Occasional.
<i>Trapelia elacista</i>	Low to mid riparian, occasional.
<i>Trapelia involuta</i>	Rare.
<i>Trapelia obtegens</i>	Upper riparian, rare; 200. Esorediate fertile morph.
<i>Trapelia placodioides</i>	Rare.
<i>Tremolecia atrata</i>	Occasional.
<i>Verrucaria hydrophila</i>	On cobble, low riparian; 183. (Voucher: 23880).
<i>Verrucaria nodosa</i>	On crest of small boulder; 201.
<i>Verrucaria rosula</i>	Occasional, mid riparian, as a sterile dark brown crust.
Number of lichen species:	51
Number of riparian species:	15
EN	0
VU	1
NT	2
DD	2
NR	4
NS	3
NR/NS score	490

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea alpina</i>	Steep flushed bedrock, rare, 206.
<i>Anomobryum julaceum</i>	Rare.
<i>Brachythecium plumosum</i>	Frequent.
<i>Bryum alpinum</i>	Rare.
<i>Bryum pseudotriquetrum</i>	Present.
<i>Fontinalis squamosa</i>	Abundant.
<i>Frullania tamarisci</i>	Rare,
<i>Grimmia ramondii</i>	Occasional; 200, 204.
<i>Grimmia trichophylla</i>	Present.

<i>Hygrohypnum eugyrium</i>	Frequent.
<i>Hygrohypnum ochraceum</i>	Frequent.
<i>Hypnum andoi</i>	Rare.
<i>Marsupella emarginata</i>	Present.
<i>Oxystegus tenuirostris</i>	Occasional.
<i>Pellia epiphylla</i>	Present.
<i>Philonotis fontana</i>	Present.
<i>Plagiochila porelloides</i>	Rare.
<i>Racomitrium aciculare</i>	Frequent.
<i>Racomitrium affine/heterostichum</i>	Occasional.
<i>Scapania undulata</i>	Occasional to frequent.
<i>Schistidium rivulare</i>	Frequent.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Pterygiopsis lacustris</i>	VU	NT	NR	
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Aspicilia aquatica</i>	DD		NR	
<i>Aspicilia recedens</i>	DD		NR	
<i>Placopyrenium formosum</i>		DD	NR	
<i>Immersaria athroocarpa</i>			NS	

Locality	Map reference
200	23/66010.64462
201	23/66070.64445
202	23/66100.64363
203	23/66170.64328
204	23/66202.64328
205	23/66327.64219
206	23/66349.64197
207	23/66376.64125
208	23/66386.64125
209	23/66423.64096



Bottom of site.



Small boulder (red dot) with *Pterygiopsis lacustris* (locality 201).



Low boulder in foreground with *Dermatocarpon meiophyllizum* (locality 208).

Afon Lloer

Site code: ALO. 1 km square: 66.61. Area surveyed: 66697.61004 to 66674.61871. Alt.: 350- 600 m. Date of survey: 27 June 2017.

Geology: 1. Unnamed Igneous Intrusion, Ordovician - Rhyolite. 2. Unnamed Igneous Intrusion, Ordovician - Microgabbro. 3. Capel Curig Volcanic Formation - Tuff, Felsic.

This is a good-sized stream, which would surely be viable for hydropower. Drains unimproved upland grassland, blanket mire, and bracken. Bed with boulders and much bedrock. The stream bed has a dark aspect, due (at least in lower sections) due to abundant blackish *Ephebe*, dark brown *Stigonema*, and dull reddish coccoid cyanobacteria. *Ephebe* largely occupies the low riparian zone; a mid riparian zone is represented by species including *Rhizocarpon amphibium*, *R. lavatum* and *Ionaspis lacustris*. The upper riparian contains many terrestrial species, but was recorded as upper riparian due to occasional apparently riparian species, including *Agonimia tristicula* and *Amygdalaria pelobotryon*. Some of the crests of boulders are clearly washed over by high flows, even when the lichens there are terrestrial. *Verrucariaceae* are absent in the lower sections (apart from one colony of *Verrucaria nodosa*). Bryophytes are strangely species-poor, and are of low cover. *Rhizocarpon amphibium* is probably a notable species of this sort of base-poor stream.

In the upper part of the site there is a slight change; *Verrucariaceae* are present though rare (*Verrucaria* sp., *Dermatocarpon luridum*), and the moss *Brachythecium plumosum* is occasional. Possibly some boulders are of a different rock type.

The relatively large discharge, and bedrock bed, means that there are a good range of microhabitats, and the bed is sometimes quite wide, as at water-slides over smooth expanses of bedrock. Some marginal rocks are flushed by water draining from the bank, but they are kept open by high river flows, making them part of the riparian system.

Two small colonies of *Lecanora achariana* were seen in the upper part of the site. This species is known to occur at Ffynnon Lloer, at the top of the Afon Lloer. Whether the river colonies are 'stragglers' from there, or whether they are independently viable, is unknown.

Site:	Afon Lloer
<i>Agonimia tristicula</i>	growing amongst <i>Andreaea rothii</i> , <i>Racomitrium aciculare</i> and <i>Ephebe</i> , occasional. 10, 13, 18.
<i>Amygdalaria pelobotryon</i>	upper riparian, occasional; 11, 15,
<i>Aspicilia caesiocinerea</i>	upper riparian, occasional; 10, 16,
<i>Aspicilia epiglypta</i>	On boulders, mid to upper riparian; (Voucher 23719, 23721).
<i>Buellia aethalea</i>	upper riparian, occasional in upper part of site; 15.
<i>Caloplaca arenaria</i>	upper riparian, on a crest of bedrock surrounded by <i>Ephebe</i> and <i>Racomitrium aciculare</i> ; rare, 13.
<i>Candelariella vitellina</i>	upper riparian, rare; 10.
<i>Collempsidium angermannicum</i>	in thin films of water on sloping rocks, where there is less competition from algae and cyanobacteria, rare; 11, 15.
<i>Dermatocarpon luridum</i>	shallowly submerged in pool at side of channel, rare; 17.
<i>Dermatocarpon meiophyllizum</i>	in small quantity in upper part of site, rare; 15, 18.
<i>Ephebe lanata</i>	mainly lower riparian, abundant.

<i>Fuscidea cyathoides</i>	upper riparian, occasional.
<i>Fuscidea kochiana</i>	upper riparian, rare.
<i>Fuscidea lygaea</i>	mid-riparian, frequent, 10. This normally terrestrial species looks quite 'at home' in the riparian zone, sometimes with larger apothecia than normal.
<i>Immersaria athroocarpa</i>	upper riparian, occasional; 10,
<i>Ionaspis lacustris</i>	riparian, abundant.
<i>Koerberiella wimmeriana</i>	moist vertical face with <i>Ephebe lanata</i> , riparian, but also gently flushed by adjacent ground; the river keeps the habitat open; 17.
<i>Lecanora achariana</i>	mid riparian, rare. 18: one thallus with <i>Brachythecium plumosum</i> , <i>Rhizocarpon geographicum</i> , <i>Rhizocarpon lavatum</i> , <i>Ionaspis lacustris</i> , <i>Racomitrium aciculare</i> , E side of stream; 19: sloping boulder on W side of main flow, with <i>Brachythecium plumosum</i> , <i>Racomitrium aciculare</i> , <i>Rimularia badioatra</i> , <i>Ionaspis lacustris</i> .
<i>Lecanora sorallifera</i>	upper riparian, rare.
<i>Lecidea furvella</i>	upper riparian, rare; 10.
<i>Lecidea lithophila</i>	upper riparian, rare; 15.
<i>Lecidea swartzioidea</i>	mid and upper riparian, 10, 13, 15, 17.
<i>Lepraria caesioalba</i>	upper riparian, rare to occasional; 10,
<i>Massalongia carnosa</i>	riparian, on <i>Andreaea rothii</i> on bedrock to side of channel, rare; 17.
<i>Miriquidica leucophaea</i>	upper riparian, occasional.
<i>Miriquidica pycnocarpa</i> f. <i>sorediata</i>	upper riparian, occasional. 10, 13.
<i>Ochrolechia parella</i>	upper riparian, rare; 12.
<i>Parmelia omphalodes</i>	rare.
<i>Pertusaria albescens</i>	mid/upper riparian, above zone of <i>Pyrenopsis subareolata</i> and <i>Ephebe lanata</i> .
<i>Pertusaria aspergilla</i>	upper riparian, rare.
<i>Pertusaria corallina</i>	upper riparian, occasional.
<i>Pertusaria pseudocorallina</i>	upper riparian, occasional.
<i>Pilophorus strumaticus</i>	mid riparian, but also moist from seepage in turf, rare; 12.
<i>Placopsis lambii</i>	mid riparian, occasional; 10, 13, 15,
<i>Porpidia hydrophila</i>	low or mid riparian, occasional; 10.
<i>Porpidia macrocarpa</i>	upper riparian, rare; 10.
<i>Porpidia melinodes</i>	upper riparian, rare; 11.
<i>Porpidia rugosa</i>	upper riparian, occasional.
<i>Porpidia tuberculosa</i>	upper riparian, occasional.
<i>Protoparmelia badia</i>	upper riparian, rare, 10.
<i>Pyrenopsis subareolata</i>	mid riparian, on sloping, sometimes flushed faces, with <i>Stigonema</i> and coccoid cyanobacteria, but which are too dry for too prolonged a period for more than sparse <i>Ephebe</i> , occasional; 10, 12,
<i>Rhizocarpon amphibium</i>	mid riparian, often above main zone of <i>Ephebe</i> , occasional to frequent; 10, 14, 16,
<i>Rhizocarpon geographicum</i>	upper riparian, frequent.
<i>Rhizocarpon lavatum</i>	riparian, frequent.
<i>Rhizocarpon lecanorinum</i>	upper riparian, rare; 10.
<i>Rimularia badioatra</i>	mid riparian, occasional; 10, 18.
<i>Scoliciosporum umbrinum</i>	upper riparian, occasional; 10.
<i>Stereocaulon delisei</i>	upper riparian, rare; 11, 17.
<i>Tephromela atra</i>	upper riparian, occasional; 10.
<i>Trapelia placodioides</i>	upper riparian, rare to occasional.
<i>Tremolecia atrata</i>	upper riparian, rare; 15.
<i>Umbilicaria polyphylla</i>	upper riparian, rare; 12.
<i>Verrucaria anziana</i>	mid riparian, upper part of site only, rare; 15.

<i>Verrucaria nodosa</i>	riparian, rare; 10. Field record.
<i>Xanthoparmelia conspersa</i>	upper riparian, rare; 13, 15,
Number of lichen species:	55
Number of riparian species:	13
EN	1
VU	2
NT	0
DD	1
NR	2
NS	11
NR/NS score	730

Bryophytes (freshwater species, recorded casually)

<i>Andreaea rothii</i>	frequent.
<i>Blindia acuta</i>	rare.
<i>Brachythecium plumosum</i>	occasional in upper parts of site (17, 18), but apparently absent below.
<i>Bryum alpinum</i>	rare.
<i>Campylopus atrovirens</i>	rare.
<i>Dicranella palustris</i>	rare, 15.
<i>Fissidens dubius</i>	rare.
<i>Grimmia ramondii</i>	rare; 10.
<i>Marsupella emarginata</i>	frequent
<i>Racomitrium aciculare</i>	abundant.
<i>Scapania undulata</i>	rare?

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
	<i>Lecanora achariana</i>	EN	CR	NR
<i>Koerberiella wimmeriana</i>	VU		NS	
<i>Stereocaulon delisei</i>	VU	NT	NS	IR
<i>Collemopsidium angermannicum</i>	NT	NT	NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Verrucaria anziana</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Miriquidica pycnocarpa</i> f. <i>sorediata</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Porpidia melinodes</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	
<i>Rimularia badioatra</i>			NS	

Locality	Map reference
10	23/66697.61004
11	23/66690.61032
12	23/66680.61053
13	23/66677.61093
14	23/66778.61396
15	23/66694.61689
16	23/66705.61713
17	-
18	23/66701.61745
19	23/66691.61797

(No photographs were taken of this site).

Afon Llugwy lower

Site code: LUL. 1 km square: 70.59. Survey area: 70999.59333 to 70574.59598. Alt. 240-250 m. Date of survey: 9 August 2017.

Geology: Cwm Eigiau Formation - Mudstone And Siltstone.

This stream looked interesting, with many projecting, partly mossy, small to occasionally large boulders. It was rather disappointing, the lower levels dominated by *Ionaspis lacustris*, *Racomitrium lavatum*, *Ephebe lanata*. Occasional *Porina rivalis*, which seemed quite at home on small boulders at low level, and occasional *Verrucaria nodosa*, not in great quantity but still also at home. This species seems to occur where other *Verrucaria* do not grow.

Bryophytes were rather conspicuous, which I attribute to the low gradient and thus less violent scouring. Abundant bryophytes encourage *Polychidium*, which was somewhat frequent, and also *Agonimia* and *Massalongia*.

The upper riparian was interesting for a number of boulders with good colonies of *Umbilicaria deusta*; one lower boulder is clearly rather often submerged at high water, and this species is clearly associated with the river. Nutrient-enrichment presumably from bird perching encouraged *Aspicilia caesiocinerea*, *Candelariella coraliza*, and *Lasallia pustulata*. The Near Threatened *Protoparmelia atriseda* occurred on one large boulder at the very top of the riparian zone.

There are many willows along the bank; they mostly do not affect it, but some boulders were excessively shaded, swallowed by willow shrubs. The stream is fenced off from the land on the west, and the lush bank with bracken, herbs and *Molinia* is an unpleasant contrast (in terms of ease of access) to grazed upland pasture. The stream is bound to become wooded eventually if grazing continues to be excluded, at least on the west side.

Notable absences: all *Dermatocarpon*, nearly all *Verrucaria*. No *Fontinalis* was noticed.

Site:	Afon Llugwy (lower, 9 Aug 2017)
<i>Acarospora</i> Llugwy A	On crest of small boulder with <i>Racomitrium aciculare</i> , <i>Porpidia hydrophila</i> ; 70. (Voucher: 23782).
<i>Agonimia tristicula</i>	Occasional to frequent, on mosses .
<i>Amygdalaria pelobotryon</i>	Upper/mid riparian with <i>Brachythecium plumosum</i> , rare; 71.
<i>Aspicilia caesiocinerea</i>	Occasional.
<i>Aspicilia simoensis</i>	Upper riparian/terrestrial; 73. (Voucher 23793).
<i>Baeomyces placophyllus</i>	Upper riparian, on moss; occasional; 71, 75,
<i>Buellia aethalea</i>	Occasional, upper riparian.
<i>Candelariella coraliza</i>	Upper riparian, one or two boulders.
<i>Cladonia subcervicornis</i>	Occasional.
<i>Ephebe lanata</i>	Frequent.
<i>Fuscidea lygaea</i>	Upper riparian, occasional; not behaving like the 'freshwater' morph.
<i>Hypotrachyna afrorevoluta</i>	Occasional (2-3 colonies), upper riparian.
<i>Ionaspis lacustris</i>	Abundant.
<i>Lasallia pustulata</i>	On tops of two boulders; 74.

<i>Massalongia carnosa</i>	Occasional on mossy rocks, mid to upper riparian; 70, 71, 75,
<i>Parmelia omphalodes</i>	Rare.
<i>Parmelia saxatilis</i>	Occasional.
<i>Peltigera membranacea</i>	Upper riparian, rare.
<i>Pertusaria lactea</i>	70, 71, 72.
<i>Pertusaria pseudocorallina</i>	Occasional to frequent, upper riparian.
<i>Placopsis lambii</i>	Occasional to rather frequent, upper riparian.
<i>Polychidium muscicola</i>	Occasional on mossy rocks, often on steep faces, or on ledges; mid to upper riparian; 70, 71, 74.
<i>Porina lectissima</i>	On side of large boulder in light shade, upper riparian, rare; 75.
<i>Porina rivalis</i>	On small boulders, low riparian, evidently at home here; occasional; 71, 74,
<i>Porpidia cinereoatra</i>	71.
<i>Porpidia crustulata</i>	On stable cobble at margin, rare; 70.
<i>Porpidia hydrophila</i>	Locally frequent, but not ubiquitous.
<i>Protoparmelia atriseda</i>	Upper riparian on large boulder, rare; 73.
<i>Scoliciosporum umbrinum</i>	mid riparian on small boulder, 72.
<i>Tephromela atra</i>	Rare.
<i>Trapelia elacista</i>	Low riparian, once at water level, often on cobbles; seems happy as a freshwater species; 70, 72.
<i>Trapelia involuta</i>	Occasional, mostly in previously denuded areas, upper riparian.
<i>Trapelia obtegens</i>	Upper riparian, rare; 71. Non-soediate.
<i>Tremolecia atrata</i>	Mid riparian on steep face, rare.
<i>Umbilicaria deusta</i>	Several good colonies on boulders, upper riparian, but certainly influenced by the river; 75.
<i>Verrucaria aethiobola</i>	Uncertain record, one thallus (uncollectable); 71.
<i>Verrucaria nodosa</i>	Occasional, mid riparian, with <i>Ephebe</i> , <i>Racomitrium aciculare</i> , <i>Rhizocarpon lavatum</i> ; 70, 74, 77.
<i>Xanthoparmelia conspersa</i>	Occasional, upper riparian.
Number of lichen species:	38
Number of riparian species:	8
EN	0
VU	0
NT	0
DD	0
NR	1
NS	1
NR/NS score	130
Bryophytes (freshwater species, recorded casually)	
These are recorded to assist classification of streams, but this does not constitute a survey	
<i>Brachythecium plumosum</i>	Abundant.
<i>Bryum pseudotriquetrum</i>	Occasional.
<i>Fissidens pusillus</i>	Submerged, seen once.
<i>Hygrohypnum ochraceum</i>	Occasional.
<i>Hypnum andoi</i>	rare
<i>Isothecium holtii</i>	Occasional.
<i>Marsupella emarginata</i>	frequent
<i>Plagiochila porelloides</i>	rare
<i>Racomitrium aciculare</i>	Abundant.
<i>Scapania undulata</i>	frequent?

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Umbilicaria deusta</i>			NS	

Poorly known species of possible concern:

Acarospora Llugwy A

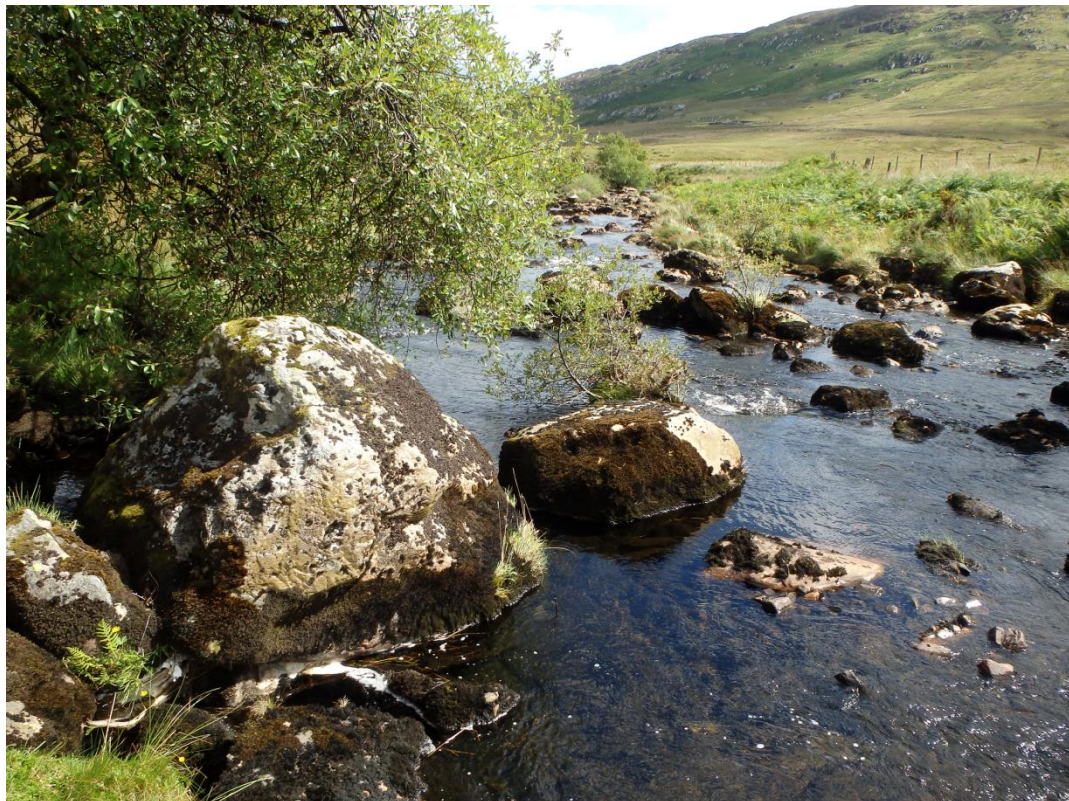
Locality	Map reference
70	23/70999.59333
71	23/70963.59357
73	23/70937.59357
74	23/70912.59359
75	23/70683.59563
76	23/70664.59576
77	23/70574.59598



Bottom of site, with willows.



A mossy boulder supporting *Polychidium* on the steep sides.



Large boulder with excellent colony of *Umbilicaria deusta* (sloping right hand side) (locality 75).



Large boulder with *Umbilicaria deusta* (locality 76).

Afon Llugwy upper

Site code: LUU. 1 km square: 68.61. Survey area: 68717.61411 to 68909.61658. Alt. 430- 460 m. Date of survey: 20 July 2017.

1. Llewelyn Volcanic Group - Sandstone. 2. Capel Curig Volcanic Formation - Tuff, Felsic.

A stream with boulders, of good size (discharge greater than Afon Berthen, but smaller than Nant Idwal). Superficially the rock did not look unusual for the area, but it seemed rather soft, like a fine sandstone, on one boulder with some small pebble-like inclusions.

Flora suggests base-poor conditions. *Ionaspis lacustris*, *Ephebe lanata*, *Rhizocarpon lavatum*, *Porpidia hydrophila* were frequent, and there were few other genuinely freshwater species. *Massalongia carnosa* in several places. *Polychidium muscicola* on one boulder only. At the top the gradient is less, and the boulders are small. It is not impossible that any of the species below could occur here, but there is less chance, as the range of microhabitats is less; for instance the low gradient and small boulders means less chance of irrigated boulder faces. It also became more mossy here, with some low rocks covered by bryophytes, whereas below they might have the *Ionaspis* community. This could be an effect of reduced scouring.

Site:	Afon Llugwy upper
<i>Acarospora fuscata</i> <i>Acarospora</i> Llugwy A	Upper riparian, rare. On level top of small boulder in stream, with <i>Racomitrium aciculare</i> , <i>Ionaspis lacustris</i> , <i>Rhizocarpon lavatum</i> , <i>Trapelia elacista</i> ; 50. (Voucher: 23764).
<i>Acarospora smaragdula</i>	Upper riparian, rare.
<i>Agonimia tristicula</i>	Upper riparian, on <i>Andreaea rothii</i> , occasional; 50, 51.
<i>Amygdalaria pelobotryon</i>	Upper riparian, occasional; 50, 51.
<i>Aspicilia caesiocinerea</i>	Upper riparian, occasional.
<i>Aspicilia simoensis</i>	Upper riparian, 50.
<i>Buellia aethalea</i>	Upper riparian, occasional.
<i>Caloplaca arenaria</i>	Upper riparian, rare; 50.
<i>Candelariella coralliza</i>	Upper riparian, 50, 54.
<i>Cladonia coccifera</i>	Upper riparian, rare.
<i>Cladonia subcervicornis</i>	Upper riparian, occasional.
<i>Fuscidea cyathoides</i>	Upper riparian, occasional.
<i>Fuscidea lygaea</i>	Upper riparian. Not behaving like a freshwater species.
<i>Immersaria athroocarpa</i>	Upper riparian, rare; 50, 51.
<i>Ionaspis lacustris</i>	Low to mid riparian, abundant.
<i>Lasallia pustulata</i>	Upper riparian, occasional.
<i>Lecanora intricata</i>	Upper riparian, occasional.
<i>Lecanora muralis</i>	Upper riparian, rare; 53.
<i>Lecanora polytropa</i>	Upper riparian, occasional.
<i>Lecidea phaeops</i>	Steep face, very rare; 50.
<i>Lecidea swartzioidea</i>	Upper riparian, occasional.
<i>Massalongia carnosa</i>	On mosses in mid-riparian, occasional; 51, 53.

<i>Miriquidica pycnocarpa</i> f. <i>pycnocarpa</i>	Upper riparian, rare; 51.
<i>Parmelia omphalodes</i>	Upper riparian, occasional.
<i>Parmelia saxatilis</i>	Upper riparian, occasional.
<i>Pertusaria corallina</i>	Upper riparian, occasional.
<i>Pertusaria pseudocorallina</i>	Upper riparian, occasional.
<i>Pilophorus strumaticus</i>	Sloping side of boulder, upper riparian, rare; 50.
<i>Placopsis lambii</i>	Upper riparian, rare to occasional.
<i>Polychidium muscicola</i>	In shallow groove on gently sloping upper surface of boulder, upper riparian; 51. C. fr.
<i>Porina guentheri</i> var. <i>lucens</i>	On steep face of small boulders, rare to occasional; 52, 53.
<i>Porpidia contraconopsea</i>	Upper riparian, 50.
<i>Porpidia hydrophila</i>	Low riparian, frequent.
<i>Porpidia irrigua</i>	Upper riparian, 50.
<i>Porpidia superba</i> f. <i>sorediata</i>	Upper riparian, 50.
<i>Protoparmelia badia</i>	Upper riparian, rare,
<i>Pyrenopsis subareolata</i>	51: at edge of bare-looking area, probably extensively washed-over then dry for extended periods. 52.
<i>Rhizocarpon lavatum</i>	Low to mid riparian, abundant.
<i>Rhizocarpon lecanorinum</i>	Upper riparian, rare; 50.
<i>Schaereria fuscocinerea</i>	Rare.
<i>Scoliciosporum umbrinum</i>	Upper riparian, occasional.
<i>Stereocaulon evolutum</i>	Upper riparian, rare, small quantity; 51.
<i>Stereocaulon leucophaeopsis</i>	Upper riparian, rare; 50.
<i>Stereocaulon pileatum</i>	Upper riparian, rare.
<i>Tephromela atra</i>	Upper riparian, occasional.
<i>Tephromela grumosa</i>	Upper riparian, rare.
<i>Trapelia elacista</i>	Mid-riparian; 50.
<i>Trapelia involuta</i>	Upper riparian, occasional; once on rock where some <i>Brachythecium plumosum</i> lost.
<i>Trapelia obtegens</i>	Mid/upper riparian, rare; 51. Non-sorediate morph.
<i>Trapelia placodioides</i>	Upper riparian, occasional.
<i>Umbilicaria polyphylla</i>	Upper riparian, occasional.
<i>Umbilicaria torrefacta</i>	Upper riparian, rare; 50.
<i>Verrucaria nodosa</i>	In small groove in small boulder, very rare, 50. Confirmed by ITS sequence.
<i>Xanthoparmelia conspersa</i>	Upper riparian, occasional.
Number of lichen species:	55
Number of riparian species:	8
EN	0
VU	0
NT	2
DD	0
NR	1
NS	7
NR/NS score	310
Bryophytes (freshwater species, recorded casually)	
These are recorded to assist classification of streams, but this does not constitute a survey	
<i>Amphidium mougeotii</i>	occasional
<i>Fontinalis squamosa</i>	local? 54.
<i>Grimmia hartmannii</i>	Upper riparian, 51.
<i>Heterocladium heteropterum</i>	rare
<i>Hygrobiella laxifolia</i>	Low riparian, wet; 52.
<i>Hygrohypnum ochraceum</i>	Upper part of site, locally frequent.
<i>Hyocomium armoricum</i>	rare

<i>Marsupella emarginata</i>	occasional?
<i>Platyhypnidium alopecuroides</i>	rare?, 54
<i>Racomitrium aciculare</i>	frequent
<i>Racomitrium aquaticum</i>	occasional
<i>Scapania undulata</i>	present

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Porpidia superba</i> f. <i>sorediata</i>	NT?		NR	
<i>Stereocaulon leucophaeopsis</i>	NT		NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Miriquidica pycnocarpa</i> f. <i>pycnocarpa</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Porina guentheri</i> var. <i>lucens</i>			NS	
<i>Porpidia contraponenda</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	

Poorly known species of possible concern:

Acarospora Llugwy A

Locality	Map reference
50	23/68717.61411
51	23/68721.61467
52	23/68724.61537
53	23/68740.61563
54	23/68899.61627



Near bottom of site.



Top of surveyed area, locality 54.

Afon Melynlyn middle

Site code: MEL. 1 km square: 70.66. Survey area: 70999.66641 to 70759.66016. Alt. 480- 560 m. Date of survey: 10 August 2017.

1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone And Siltstone.

The lower end of the site is on the main stream; at the bottom there are boulders; the flora is poor. Near water level the rocks look bare and a little silty, even *Ionaspis* was not as ubiquitous as on most streams. There was one colony of *Polychidium*. One thallus of *Verrucaria aethiobola*. Further upstream was a long stretch with low gradient and little rock.

The stream leading down from Melynlyn reservoir is very small at the bottom, and a great deal appears to be dry; by the reservoir the gully is perfectly dry. Due to abstraction from the reservoir this is no longer a proper stream and was not worth recording, so the remaining larger tributary to the east was followed to complete the site. This has a higher gradient than the main stream; the boulders are often set in turf, as the stream is not large enough to keep them exposed, and many rocks are mossy, especially low ones near water. The result is that there is a low diversity of habitat for lichens, and low-zone lichens are squeezed out by bryophytes. The mossy nature is good only for a few terrestrial macrolichens, like *Peltigera hymenina* and *P. membranacea*. There was some *Massalongia*, otherwise a poor stream. *Bacidia inundata* was seen on disturbed cobbles; a scrap of this was also seen at the bottom of the site. There were a few rough brown crusts that could have been *Verrucaria nodosa*, but these could not be collected, and the species cannot be recorded.

Site:	Afon Melynlyn
<i>Agonimia tristicula</i>	80, 82
<i>Amygdalaria pelobotryon</i>	82 r upper
<i>Aspicilia caesiocinerea</i>	80 o
<i>Aspicilia grisea</i> agg.	80, 82
<i>Bacidia inundata</i>	On semi-stable cobble at margin; 84.
<i>Baeomyces rufus</i>	82 r
<i>Cetraria aculeata</i>	82: on mossy face, upper riparian.
<i>Cladonia cervicornis</i>	82
<i>Cladonia coccifera</i>	80 o, 82
<i>Cladonia cyathomorpha</i>	80 o, 82 r
<i>Cladonia furcata</i>	82 r
<i>Diploschistes scruposus</i>	80 r,
<i>Ephebe lanata</i>	80 f, 82 o
<i>Fuscidea cyathoides</i>	82 r
<i>Hypotrachyna afrorevoluta</i>	83
<i>Immersaria athroocarpa</i>	82
<i>Ionaspis lacustris</i>	80 f, 82 o

<i>Lecanora intricata</i>	o; 80, 82
<i>Lecidea lapicida</i>	Upper riparian; 80.
<i>Lecidea lithophila</i>	80, 82
<i>Lecidea swartzioidea</i>	Upper riparian; 80.
<i>Lepraria caesioalba</i>	82 r
<i>Massalongia carnosa</i>	82: on <i>Andreaea rothii</i>
<i>Micarea leprosula</i>	Upper, f; 80, 82
<i>Miriquidica leucophaea</i>	80,
<i>Ophioparma ventosum</i>	82 r
<i>Parmelia omphalodes</i>	82
<i>Parmelia saxatilis</i>	o; 80, 82
<i>Peltigera hymenina</i>	82 o
<i>Peltigera membranacea</i>	82 o
<i>Pertusaria corallina</i>	80, 83
<i>Pertusaria pseudocorallina</i>	80,
<i>Physcia caesia</i>	80: on small boulder with <i>Aspicilia caesiocinerea</i> (at level of <i>Brachythecium plumosum</i>).
<i>Polychidium muscicola</i>	Upper riparian amongst <i>Racomitrium aciculare</i> , rare; 80.
<i>Porpidia cinereoatra</i>	80
<i>Porpidia irrigua</i>	82 r
<i>Porpidia macrocarpa</i>	82 r
<i>Porpidia melinodes</i>	o; 80, 82
<i>Protoparmelia badia</i>	r, 80,
<i>Rhizocarpon geographicum</i>	Upper, f; 80, 82
<i>Rhizocarpon lavatum</i>	80 f, 82
<i>Rimularia badioatra</i>	Upper, 80 r,
<i>Schaereria cinereorufa</i>	80 r,
<i>Scoliciosporum umbrinum</i>	80 r,
<i>Stereocaulon vesuvianum</i>	82 o, 83
<i>Tephromela atra</i>	82
<i>Trapelia involuta</i>	82
<i>Trapelia placodioides</i>	80, 82
<i>Trapeliopsis pseudogranulosa</i>	82 r
<i>Tremolecia atrata</i>	80, 82
<i>Verrucaria aethiobola</i>	Low riparian, very rare; 80.
<i>Verrucaria sublobulata</i>	On semi-stable cobble at margin, rare; 84.
<i>Xanthoparmelia conspersa</i>	80.

Number of lichen species:	53
Number of riparian species:	8
EN	0
VU	0
NT	0
DD	0
NR	0
NS	5
NR/NS score	150
Bryophytes (freshwater species, recorded casually)	

These were recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	80, 82
<i>Andreaea rupestris</i>	80 r
<i>Barbilophozia floerkei</i>	80
<i>Brachythecium plumosum</i>	80 82
<i>Fontinalis antipyretica</i>	80 f, 82
<i>Fontinalis squamosa</i>	80, 82 abundant
<i>Frullania tamarisci</i>	80
<i>Grimmia ramondii</i>	Several good colonies on top of boulders, 80.
<i>Grimmia trichophylla</i>	80
<i>Hygrohypnum eugyrium</i>	80
<i>Hygrohypnum ochraceum</i>	80 f, 82 f
<i>Hyocomium armoricum</i>	82
<i>Hypnum andoi</i>	80
<i>Isothecium holtii</i>	80
<i>Marsupella emarginata</i>	80 82
<i>Oxystegus tenuirostris</i>	80
<i>Philonotis fontana</i>	82
<i>Plagiochila porelloides</i>	80
<i>Pogonatum urnigerum</i>	80
<i>Racomitrium aciculare</i>	80, 82
<i>Racomitrium affine/heterostichum</i>	80
<i>Racomitrium fasciculare</i>	80
<i>Scapania compacta</i>	80
<i>Scapania undulata</i>	80

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Bacidia inundata</i>			NS	
<i>Cladonia cyathomorpha</i>			NS	
<i>Immersaria athroocarpa</i>			NS	
<i>Porpidia melinodes</i>			NS	
<i>Rimularia badioatra</i>			NS	

Locality	Map reference
80	23/70999.66641
81	23/70855.66467
82	23/70670.66228
83	23/70708.66185
84	23/70759.66016



Bottom of site.



Upper part of site, small rocks set in turf, and mossy near the water.

Afon Merch

Site code: MER. 1 km square: 63.52. Survey area: 63297.52060 to 63319.52340. Alt.: 220- 320 m. Date of survey: 18 September 2017.

1. Lower Rhyolitic Tuff Formation - Tuff, Felsic. 2. Bedded Pyroclastic Formation - Pyroclastic-rock. 3. Unnamed Igneous Intrusion, Ordovician - Rhyolite.

Only the lower part of the 1 km square was surveyed, due to lack of time, although the stream became smaller and maybe different above this, and few new species were being found. Seen from a distance, the stream seems to run through old mine spoil heaps above the site.

The flora was disappointing. The rock is base-poor and often iron-rich, as suggested by frequent *Stereocaulon pileatum*. The flora is poor, with a low to mid zone of *Rhizocarpon lavatum*; *Fuscidea lygaea* was often abundant in the mid zone. *Aspicilia granulosa* was sometimes abundant on level or gently sloping rocks in the mid zone. Despite some nice falls with extensive bedrock, little of interest was found. There was no sign of crustose cyanolichens.

Bryophytes were also poor; the common and tolerant freshwater moss *Racomitrium aciculare* was not seen at all, and generally mosses were only present on moist banks and crevices, including *Nardia compressa*, *Campylopus atrovirens* and *Marsupella emarginata*. There was some *Scapania undulata* submerged at the top of the site, possibly overlooked below.

At the top of the surveyed area is a shingle bank with the uncommon metallophyte *Lecanora subaurea* occasional, including on some stones wet from seepage. Some other stones in the shingle were clearly iron-rich. It is interesting to see this species in an apparently natural situation, although the stones might ultimately be derived from mining activities. Other metallophytes seen were *Acarospora sinopica*, *Placopsis lambii* and *Stereocaulon pileatum*, but a longer survey might show more.

Site:	Afon Merch
<i>Acarospora</i> Merch A	Extensive bedrock by falls (113). (Voucher: 23836).
<i>Acarospora sinopica</i>	In small quantities on bedrock by falls, rare, 112, 113.
<i>Amygdalaria pelobotryon</i>	Mid riparian, occasional, and on slightly irrigated rock at side, 110.
<i>Aspicilia granulosa</i>	Mid riparian on gently sloping boulder (112), low rock, with <i>Rhizocarpon lavatum</i> (113), extensive bedrock by falls, occasionally submerged (113). Vouchers: 2388, 23837, 23838.
<i>Aspicilia simoensis</i>	Upper riparian; 110.
<i>Baeomyces placophyllus</i>	Moist grooves in rocks, upper riparian, occasional, 110, 112.
<i>Baeomyces rufus</i>	Rare.
<i>Ephebe lanata</i>	Frequent, though not in great quantity.
<i>Fuscidea lygaea</i>	Abundant in mid riparian, clearly at home there.
<i>Fuscidea praeruptorum</i>	Upper riparian, rare; 110.
<i>Immersaria athroocarpa</i>	Mid riparian, occasional.
<i>Ionaspis lacustris</i>	Low to mid, frequent.
<i>Lecanora subaurea</i>	Very small quantity on boulder (110), occasional on stones of shingle bank, some wet from seepage (115).
<i>Micarea leprosula</i>	Upper riparian, rare.

<i>Micarea lignaria</i> var. <i>lignaria</i>	Upper riparian, rare.
<i>Pertusaria corallina</i>	Occasional, 110.
<i>Pertusaria excludens</i>	Rare; 110.
<i>Pertusaria lactea</i>	Occasional.
<i>Pertusaria pseudocorallina</i>	Rare, 110.
<i>Placopsis lambii</i>	Mid riparian, frequent.
<i>Porpidia cinereoatra</i>	Rare.
<i>Porpidia contraponenda</i>	Upper riparian, rare; 111.
<i>Porpidia irrigua</i>	Slightly irrigated rock, 110.
<i>Porpidia macrocarpa</i>	Low to mid on rocks and semi-stable stones, occasional.
<i>Porpidia rugosa</i>	Bedrock, upper riparian, 110.
<i>Porpidia striata</i>	Upper riparian; 111.
<i>Rhizocarpon amphibium</i>	Rare, 110.
<i>Rhizocarpon hochstetteri</i>	Rocks beside falls, mid riparian, rare; 112.
<i>Rhizocarpon lavatum</i>	Abundant in low to mid riparian, forming an orange zone.
<i>Rhizocarpon reductum</i>	Occasional.
<i>Stereocaulon evolutum</i>	On rocks below falls, 110.
<i>Stereocaulon pileatum</i>	On rocks and semi-stable stones, frequent.
<i>Stereocaulon vesuvianum</i>	Upper riparian, occasional.
<i>Tephromela atra</i>	Rare.
<i>Trapelia collaris</i>	Semi-stable cobble, mid riparian, rare; 113.
<i>Trapelia glebulosa</i>	Stone in small seepage at margin; 111.
<i>Trapelia involuta</i>	Upper riparian, occasional.
<i>Trapelia placodioides</i>	Upper riparian, occasional.
<i>Tremolecia atrata</i>	Upper riparian, occasional.
Number of lichen species:	39
Number of riparian species:	4
EN	0
VU	0
NT	1
DD	1
NR	1
NS	3
NR/NS score	190

Bryophytes (freshwater species, recorded casually)

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	occasional
<i>Anthelia julacea</i>	rare
<i>Campylopus atrovirens</i>	occasional
<i>Grimmia donniana</i>	rare
<i>Jungermannia gracillima</i>	rare
<i>Marsupella emarginata</i>	occasional
<i>Nardia compressa</i>	occasional
<i>Oligotrichum hercynicum</i>	occasional
<i>Scapania undulata</i>	submerged at top of site.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Lecanora subaurea</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Immersaria athrocarpa</i>			NS	
<i>Porpidia contraponenda</i>			NS	

Poorly known species of possible concern:

Acarospora Merch A

Locality	Map reference
110	23/63297.52060
111	23/63313.52112
112	23/63324.52179
113	23/63344.52214
114	23/63316.52319
115	23/63319.52340



The rusty coloured zone near the water is mainly *Rhizocarpon lavatum*, above this the grey is often *Fuscidea lygaea* (locality 111)



Falls with extensive bedrock, which is, however, species-poor (locality 113).



Shingle bank with iron-rich stones and the uncommon metallophyte *Lecanora subaurea* (locality 115). Old spoil heaps visible in background near top left.

Nant Bochlwyd

Site code: NBO. 1 km squares: 65.59, (65.60). Survey area: 653.601 to 654.594. Alt.: 350-550. Date of survey: 28 June 2017.

1. Cwm Eigiau Formation - Mudstone And Siltstone. 2. Cwm Eigiau Formation - sandstone. 3. Pitts Head Tuff Formation - Tuff, Felsic.

Overcast, with mostly drizzle. Surveyed from just above road, to near lake at top. Localities 20-23, and 24-27, correspond to the two 1 x 1 km squares.

The stream has bedrock and boulders and some small falls, and drains unimproved hill land with blanket mire. Many of the boulders (maybe all) are of a massive, pale rock. The east side of the steep section below the lake has a softer, more shaly rock exposed.

The stream was a little disappointing, and was species-poor. *Porpidia hydrophila* was abundant and conspicuous. Other low to riparian species included *Ionaspis lacustris*, *Rhizocarpon amphibium* (frequent), *R. lavatum*. *Pyrenopsis subareolata* was seen only once. The upper riparian seemed species-poor. Many wet rocks appeared dark, but *Ephebe* was not particularly abundant, and dark areas were often *Stigonema*.

Site:	Nant Bochlwyd
<i>Acarospora smaragdula</i>	upper riparian, rare; 23.
<i>Agonimia tristicula</i>	on dead or weakly growing <i>Andreaea rothii</i> , upper riparian, rare; 23.
<i>Amygdalaria consentiens</i>	upper riparian, rare; 20.
<i>Amygdalaria pelobotryon</i>	upper riparian, occasional; 20.
<i>Aspicilia epiglypta</i>	Rare; 22.
<i>Baeomyces rufus</i>	upper riparian, rare; 25.
<i>Cladonia subcervicornis</i>	upper riparian, rare; 24.
<i>Ephebe lanata</i>	low to mid riparian, frequent, though usually not in great quantity; 20, 24, 27.
<i>Fuscidea cyathoides</i>	upper riparian, occasional; 20, 24.
<i>Fuscidea kochiana</i>	upper riparian, rare; 20.
<i>Fuscidea lygaea</i>	mid to upper riparian; in one place well-grown and forming a zone above water level; 24.
<i>Immersaria athroocarpa</i>	upper riparian, occasional; 20, 21.
<i>Ionaspis lacustris</i>	frequent; 20, 24.
<i>Lecanora intricata</i>	upper riparian, rare; 20.
<i>Lecanora polytropa</i>	upper riparian, occasional; 20.
<i>Lecanora soralifera</i>	upper riparian, rare; 23.
<i>Lecidea lapicida</i>	upper riparian; 22.
<i>Lecidea lithophila</i>	upper riparian, occasional; 21.
<i>Micarea lignaria</i> var. <i>lignaria</i>	upper riparian, rare; 21.
<i>Miriquidica leucophaea</i>	upper riparian, rare; 23.
<i>Parmelia saxatilis</i>	upper riparian, rare; 24.

<i>Pertusaria amara</i>	upper riparian, 20.
<i>Pertusaria aspergilla</i>	upper riparian, occasional; 20.
<i>Pertusaria corallina</i>	upper riparian, occasional; 20.
<i>Pertusaria lactea</i>	upper riparian, rare; 23.
<i>Pertusaria pseudocorallina</i>	upper riparian, occasional; 20, 23.
<i>Pilophorus strumaticus</i>	upper riparian, on rocks flushed from bank, rare; 23.
<i>Placopsis lambii</i>	mid riparian, occasional; 20, 23, 24.
<i>Porpidia hydrophila</i>	low to mid riparian, abundant, conspicuous; 20, 21, 22, 23, 24.
 <i>Porpidia macrocarpa</i>	 on probably fairly recently exposed rocks, moist or splashed, rare; 26.
 <i>Porpidia rugosa</i>	 mid riparian, rare; 23.
<i>Porpidia tuberculosa</i>	mid to upper riparian, frequent; 20, . Seems to often occur as a thin, blue-grey morph on moist rocks.
 <i>Protoparmelia badia</i>	 upper riparian, rare; 20.
<i>Pyrenopsis subareolata</i>	mid riparian on rocks with cyanobacteria, rare; 21.
<i>Rhizocarpon amphibium</i>	mid riparian, frequent; 20, 24, 27.
<i>Rhizocarpon geographicum</i>	upper riparian, frequent; 20.
<i>Rhizocarpon lavatum</i>	low to mid riparian or above, frequent; 20, 21, 24, 25, 27.
<i>Scoliciosporum umbrinum</i>	upper riparian, occasional; 20.
<i>Sporodictyon cruentum</i>	on splashed rock near falls, very rare; 26.
<i>Stereocaulon evolutum</i>	upper riparian, rare; 23.
<i>Stereocaulon pileatum</i>	mid riparian, rare; 20.
<i>Stereocaulon vesuvianum</i>	upper riparian, occasional; 20.
<i>Tephromela atra</i>	upper riparian, occasional; 20, 24, 26.
<i>Trapelia elacista</i>	moist rocks, probably fairly recently exposed, occasional; 24, 25, 26.
 <i>Trapelia involuta</i>	 probably fairly recently exposed rocks to side of falls, 25.
<i>Trapelia placodioides</i>	mid to upper riparian, frequent; 20, 25, 26, 27.
<i>Tremolecia atrata</i>	upper riparian, rare; 20.
Number of lichen species:	47
Number of riparian species:	7
EN	0
VU	0
NT	1
DD	1
NR	1
NS	2
NR/NS score	160
Bryophytes (freshwater species, recorded casually)	
These are recorded to assist classification of streams, but this does not constitute a survey	
<i>Andreaea rothii</i>	frequent.
<i>Blindia acuta</i>	occasional.
<i>Gymnomitrium crenulatum</i>	rare.
<i>Marsupella emarginata</i>	abundant.
<i>Pellia epiphylla</i>	occasional.

<i>Racomitrium aciculare</i>	frequent.
<i>Racomitrium ellipticum</i>	rare.
<i>Scapania undulata</i>	present.

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Amygdalaria consentiens</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Immersaria athroocarpa</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	

Locality	Map reference
20	23/65298.60269
21	23/65329.60232
22	23/65391.66206
23	23/65424.60159
24	-
25	23/65510.59862
26	23/65534.59684
27	23/65559.59471



Near bottom of site (locality 20).



Falls like this greatly expand the size of the riparian zone, producing a variety of faces of various aspect, slope and dampness (locality 23).



View of upper part of site.

Nant Gwryd

Site code: NGW. 1 km squares: 65.56, 66.56. Area of survey: 6634.5596 to 6556.5653. Alt.: 270-370 m. Date of survey: 21 and 22 August 2013.

1. Cwm Eigiau Formation - Mudstone And Siltstone. 2. Cwm Eigiau Formation - Sandstone. 3. Unnamed Igneous Intrusion, Ordovician - Microgabbro. 4. Lower Rhyolitic Tuff Formation - Tuff, Felsic.

Data from Orange, A. (2013; *A Lichen and Bryophyte Survey of a Proposed Hydropower Scheme on the Nant Gwryd*. Amgueddfa Cymru - National Museum Wales: unpublished report to North Wales Hydropower).

At low and mid riparian levels, abundant lichens included *Ephebe lanata*, *Fuscidea lygaea*, *Ionaspis lacustris*, *Porpidia hydrophila*, *Rhizocarpon lavatum* and *Tremolecia atrata*; at these levels bryophytes were generally sparse and inconspicuous, but frequent species included *Marsupella emarginata*, *Pellia epiphylla*, *Racomitrium aciculare* and *Scapania undulata*. Crests of rocks and boulders, representing the upper riparian zone, had a more diverse flora, with species including the lichens *Aspicilia caesiocinerea*, *Candelariella vitellina*, *Fuscidea cyathoides*, *Pertusaria aspergilla*, *P. corallina*, *P. pseudocorallina*, *Porpidia cinereoatra*, *P. rugosa* and *Tephromela atra*, and the bryophytes *Grimmia ramondii*, *Hedwigia stellata*, *Racomitrium affine* and *R. sudeticum*. *Grimmia ramondii* grew on the crests of two boulders up to approximately 1 m above present water level; although rarely submerged, this moss is clearly influenced by the river, as this is a characteristic habitat of the species. Rocks which were moist from frequent immersion or from splash were often dark from a covering of the cyanobacterium *Stigonema* (and sometimes the lichenised form *Ephebe lanata*), a characteristic sight in many upland nutrient-poor streams.

Site:	Nant Gwryd
<i>Amygdalaria pelobotryon</i>	Mid/upper riparian, rare. Grid refs. 65.56, 66.56.
<i>Aspicilia caesiocinerea</i>	Crest of boulder, rare, 66.56.
<i>Baeomyces rufus</i>	Occasional.
<i>Buellia aethalea</i>	Crest of boulder, rare, 66.56. K - .
<i>Caloplaca vitellinula</i>	Upper riparian on rock crests, occasional.
<i>Cladonia coccifera</i>	Rare.
<i>Cladonia polydactyla</i>	Side of large boulder, rare.
<i>Cladonia subcervicornis</i>	Occasional.
<i>Cryptothele rhodosticta</i>	Several small, sterile colonies near to water on a broad expanse of bedrock; this species was recorded here fertile on 15 April 2011. 65.56.
<i>Dibaeis baeomyces</i>	Soil by thin turf over rocks, rare.
<i>Ephebe lanata</i>	Low to mid riparian, frequent.
<i>Fuscidea cyathoides</i>	Upper riparian, occasional.
<i>Fuscidea lygaea</i>	Mid to upper riparian, frequent.
<i>Immersaria athroocarpa</i>	Mid to upper riparian, frequent in small quantities.
<i>Ionaspis lacustris</i>	Low to mid riparian, frequent.

<i>Lecanora intricata</i>	Occasional.
<i>Lecanora soralifera</i>	Rare.
<i>Lecidea lithophila</i>	Occasional.
<i>Micarea leprosula</i>	Rare.
<i>Miriquidica leucophaea</i>	Upper riparian, occasional.
<i>Parmelia omphalodes</i>	Rare.
<i>Parmelia saxatilis</i>	Occasional.
<i>Pertusaria aspergilla</i>	Occasional.
<i>Pertusaria corallina</i>	Occasional.
<i>Pertusaria pseudocorallina</i>	Occasional.
<i>Pilophorus strumaticus</i>	Mid/upper riparian, rare, 66.56.
<i>Placopsis lambii</i>	Mid to upper riparian, occasional.
<i>Porpidia cinereoatra</i>	Upper riparian, occasional.
<i>Porpidia hydrophila</i>	Low to mid riparian, frequent and conspicuous.
<i>Porpidia irrigua</i>	Mid to upper riparian, rare to occasional. 65.56, 66.56.
<i>Porpidia macrocarpa</i>	Mid to upper riparian, occasional.
<i>Porpidia rugosa</i>	Mid to upper riparian, frequent.
<i>Porpidia tuberculosa</i>	Upper riparian, occasional.
<i>Pyrenopsis subareolata</i>	Scattered on gently sloping rocks on a broad expanse of bedrock, 6579.5621.
<i>Rhizocarpon amphibium</i>	Low to mid riparian, rare to occasional. 65.56, 66.56.
<i>Rhizocarpon hochstetteri</i>	Gently sloping bedrock, mid riparian, rare; 65.56.
<i>Rhizocarpon lavatum</i>	Low to mid riparian, frequent.
<i>Rhizocarpon reductum</i>	Upper riparian, rare.
<i>Scoliciosporum umbrinum</i>	Occasional.
<i>Stereocaulon delisei</i>	Mid/upper riparian, rare, 66.56.
<i>Stereocaulon pileatum</i>	Mid to upper riparian, occasional.
<i>Stereocaulon vesuvianum</i>	Upper riparian, occasional.
<i>Tephromela atra</i>	Occasional.
<i>Trapelia involuta</i>	Rare.
<i>Trapelia placodioides</i>	Mid to upper riparian, occasional.
<i>Tremolecia atrata</i>	Mid riparian, frequent.
<i>Xanthoparmelia conspersa</i>	Upper riparian, rare.
Number of lichen species:	47
Number of riparian species:	7
EN	0
VU	1
NT	0
DD	1
NR	2
NS	2
Bryophytes	
This list was intended to be comprehensive	
<i>Andreaea rothii</i>	Frequent.
<i>Andreaea rupestris</i>	Rare.
<i>Anthelia julacea</i>	Occasional.

<i>Blindia acuta</i>	Occasional.
<i>Bryum alpinum</i>	Rare.
<i>Campylopus atrovirens</i>	Occasional.
<i>Diphyscium foliosum</i>	Rare.
<i>Diplophyllum albicans</i>	Occasional.
<i>Fossombronia foveolata</i>	Mid riparian, rare.
<i>Grimmia donniana</i>	Rare.
<i>Grimmia ramondii</i>	On crests of boulders up to c. 1 m, rare.
<i>Gymnocolea inflata</i>	Present.
<i>Gymnomitrium crenulatum</i>	Present, seen twice.
<i>Hedwigia stellata</i>	Rare.
<i>Heterocladium heteropterum</i>	Rare.
<i>Hygrobiella laxifolia</i>	Mid riparian, ?rare.
<i>Hyocomium armoricum</i>	Occasional.
<i>Hypnum jutlandicum</i>	Rare.
<i>Jungermannia obovata</i>	Shallowly submerged, rare.
<i>Marsupella emarginata</i>	Frequent in small quantities.
<i>Pellia epiphylla</i>	Frequent.
<i>Polytrichum alpinum</i>	Rare.
<i>Racomitrium aciculare</i>	Frequent in small quantities.
<i>Racomitrium affine/heterostichum</i>	Occasional (R. affine).
<i>Racomitrium fasciculare</i>	Occasional.
<i>Racomitrium sudeticum</i>	Occasional.
<i>Scapania undulata</i>	Occasional.

Site:	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Stereocaulon delisei</i>	VU	NT	NS	IR
<i>Cryptothele rhodosticta</i>	DD	DD	NR	IR
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Immersaria athroocarpa</i>			NS	
<i>Pilophorus strumaticus</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	



Lower part of the site.



Extensive bedrock in centre of site, with small amounts of *Cryptothele rhodosticta*.

Nant Idwal

Site code: NID. 1 km square: 64.60. Survey area: 64979.60245 to 64837.60124. Alt. 330-350 m. Date of survey: 19 July 2017, 20 July 2017.

1. Cwm Eigiau Formation - Sandstone. 2. Cwm Eigiau Formation - Mudstone And Siltstone.

Probably no more than an hour was spent at the site on 19 July, when survey was cut short by light rain. On 20 July the survey was completed, but water levels were raised so that the lower riparian was almost invisible. A further visit might well add species of *Verrucaria* and others.

There is evidence of base-richness in the presence of *Dermatocarpon meiophyllizum* and *Verrucaria aethiobola*. This was one of only two streams in the SSSI where *Porina guentheri* was recorded. *Dermatocarpon intestiniforme* was found only at this site. *Rhizocarpon amphibium* was present, spotted under water about three times on 20 July. The lower part of the site is probably richer as the gradient is slightly greater, giving more diversity of microhabitat. There are some boulders which appear to be of a differing rock type which has a greenish colour and is more base-rich, but these are in a minority; they can look more mossy than other boulders.

Site:	Nant Idwal
<i>Acarospora smaragdula</i>	Upper riparian; 43.
<i>Agonimia tristicula</i>	Mid-riparian amongst mosses or Ephebe; 43, 44, 45.
<i>Amygdalaria pelobotryon</i>	Upper riparian, 43.
<i>Buellia aethalea</i>	Mid-riparian; 43.
<i>Cladonia subcervicornis</i>	Upper riparian, 43.
<i>Dermatocarpon intestiniforme</i>	44: on boulder shortly below to 10 cm above somewhat raised water level, with <i>Ephebe lanata</i> , <i>Fuscidea lygaea</i> ; mid riparian.
<i>Dermatocarpon leptophyllodes</i>	On two low boulders of probably base-rich rock, rare; 46.
<i>Dermatocarpon meiophyllizum</i>	Low riparian; 43, 46.
<i>Ephebe lanata</i>	Frequent.
<i>Fuscidea cyathoides</i>	Upper riparian, 43.
<i>Fuscidea lygaea</i>	Frequent, behaving like a freshwater species, often more frequent than on terrestrial rocks.
<i>Ionaspis lacustris</i>	Frequent.
<i>Lecanora intricata</i>	Upper riparian; 43.
<i>Lecanora muralis</i>	Upper riparian, 45, 46.
<i>Lecanora soralifera</i>	Upper riparian, rare.
<i>Lecidea lithophila</i>	Upper riparian, occasional; 43.
<i>Lecidea swartzioidea</i>	Upper riparian [check].
<i>Parmelia omphalodes</i>	Upper riparian, 43.
<i>Parmelia saxatilis</i>	Upper riparian, occasional.
<i>Pertusaria corallina</i>	Upper riparian; 43.

<i>Pertusaria excludens</i>	Upper riparian, 43, 44.
<i>Pertusaria pseudocorallina</i>	Upper riparian, occasional.
<i>Physcia dubia</i>	On top of boulder, upper riparian, rare; 47.
<i>Placopsis lambii</i>	Upper riparian; 45.
<i>Porina guentheri</i> var. <i>lucens</i>	Mid-riparian, often but not always on steep faces, and sometimes near moss which probably provides extended moisture. 43, 44, 45.
<i>Porina lectissima</i>	Upper riparian, rare; 47.
<i>Porpidia cinereoatra</i>	Mid-riparian; 43.
<i>Porpidia hydrophila</i>	Low to mid-riparian, 43.
<i>Porpidia irrigua</i>	Mid-riparian; 43, 45.
<i>Porpidia macrocarpa</i>	Upper riparian.
<i>Porpidia melinodes</i>	Upper riparian, occasional; 43.
<i>Porpidia tuberculosa</i>	Upper riparian; 45.
<i>Pyrenopsis subareolata</i>	On gently sloping rather bare surface, mid-riparian, rare; 45.
<i>Rhizocarpon amphibium</i>	Low to mid-riparian, occasional, 43, 45, . Mostly submerged on 20 July in slightly higher flow.
<i>Rhizocarpon geographicum</i>	Upper riparian, 43.
<i>Rhizocarpon lavatum</i>	Mid-riparian, frequent.
<i>Rimularia intercedens</i>	Upper riparian, rare; 44.
<i>Scoliciosporum umbrinum</i>	Upper riparian; 43.
<i>Staurothele fissa</i>	Low riparian; 43. Would be submerged on 20 July and unseen.
<i>Stereocaulon leucophaeopsis</i>	Upper riparian, rare; 47.
<i>Stereocaulon vesuvianum</i>	Upper riparian; 43.
<i>Tephromela atra</i>	Upper riparian; 43.
<i>Trapelia elacista</i>	Mid riparian, occasional; 43.
<i>Trapelia involuta</i>	Mid/upper riparian, rare; 47.
<i>Trapelia placodioides</i>	Mid-riparian; 43.
<i>Tremolecia atrata</i>	Upper riparian; 43.
<i>Verrucaria aethiobola</i>	Low riparian; 43. Would be submerged on 20 July and unseen.
<i>Xanthoparmelia conspersa</i>	Mid-riparian; 43, 44.
Lichenicolous fungi	
<i>Sclerococcum sphaerale</i>	On <i>Pertusaria corallina</i> .
<i>Verrucaria conturmatula</i>	On <i>Ionaspis lacustris</i> ; 43.
Number of lichen species:	48
Number of riparian species:	12
EN	0
VU	0
NT	3
DD	1
NR	1
NS	7
NR/NS score	310
Bryophytes (freshwater species, recorded casually)	

These are recorded to assist classification of streams, but this does not constitute a survey

<i>Andreaea rothii</i>	occasional>
<i>Anomobryum julaceum</i>	45
<i>Blindia acuta</i>	present
<i>Brachythecium plumosum</i>	occasional>
<i>Campylopus atrovirens</i>	rare
<i>Ctenidium molluscum</i>	rare
<i>Fissidens osmundoides</i>	45
<i>Frullania tamarisci</i>	rare
<i>Grimmia ramondii</i>	Upper riparian, 43, 47.
<i>Hedwigia stellata</i>	Upper riparian, 43.
<i>Hygrohypnum eugyrium</i>	45
<i>Isothecium myosuroides</i>	rare
<i>Lejeunea lamacerina</i>	45
<i>Oxystegus tenuirostris</i>	present
<i>Plagiochila porelloides</i>	rare?
<i>Pterogonium gracile</i>	rare
<i>Racomitrium aciculare</i>	frequent
<i>Thamnobryum alopecurum</i>	rare
<i>Trichostomum crispulum</i>	45

Species of conservation concern	Woods (2010)	Woods & Coppins (2012)	NR/NS	IR
<i>Dermatocarpon leptophyllodes</i>	NT		NS	
<i>Dermatocarpon meiophyllizum</i>	NT		NS	
<i>Stereocaulon leucophaeopsis</i>	NT		NS	
<i>Rhizocarpon amphibium</i>	DD	DD	NR	
<i>Porina guentheri</i> var. <i>lucens</i>			NS	
<i>Porpidia melinodes</i>			NS	
<i>Pyrenopsis subareolata</i>			NS	
<i>Rimularia intercedens</i>			NS	

Locality	Map reference
43	23/64979.60245
44	23/64936.60227
45	23/64896.60177
46	23/64878.60155
47	23/64837.60124



Bottom of site on 19 July.



Bottom of site on 20 July, the lower levels submerged and under-represented in the survey.



The gradient lessens here (locality 44).



The small boulder (centre) is apparently of basic rock, and is more mossy than more acidic boulders; it supported *Dermatocarpon leptophyllodes* (locality 46).

Nant yr Ogof

Site code: NYO. 1 km square: 68.59. Area surveyed: 68644.60028 to 68135.59174. Alt. 310-510 m. Date of survey: 31 May 2016. Surveyor: Steve Chambers.

1. Llewelyn Volcanic Group - Sandstone. 2. Llewelyn Volcanic Group - Siltstone.

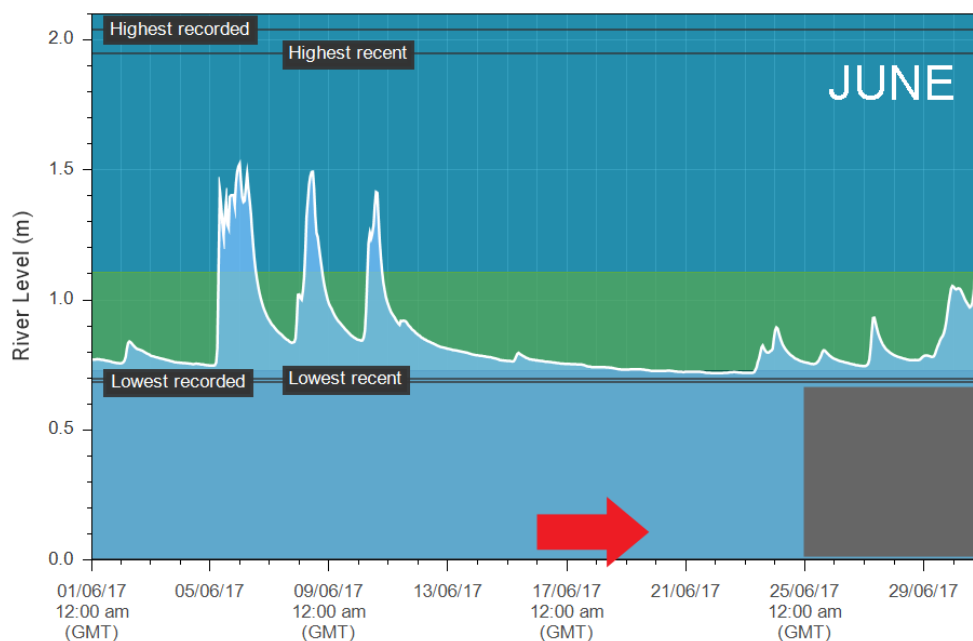
Data are taken from a report for the National Trust by Steve Chambers. Species recorded outside the riparian zone have been excluded from the list below, as far as possible.

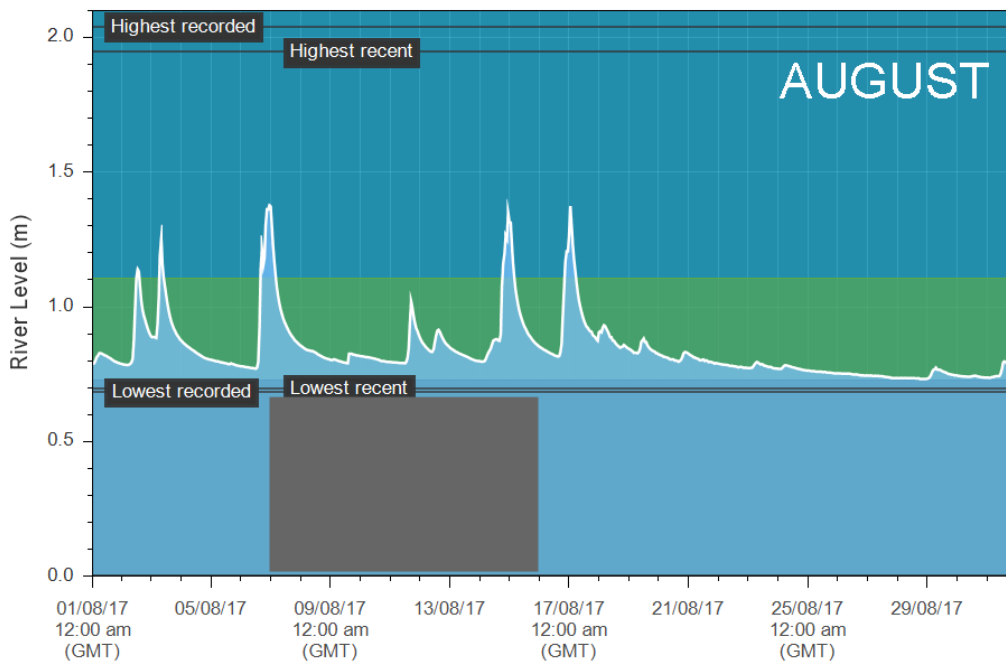
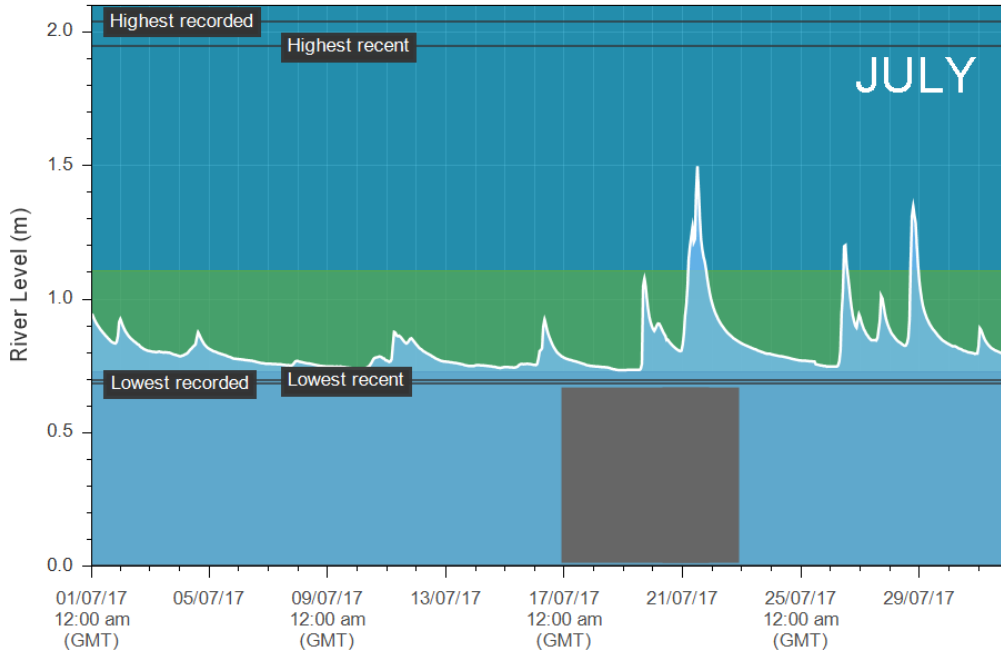
Site:	Nant yr Ogof
<i>Acarospora sinopica</i>	Upper flat surface of mid-channel boulder at 68627.59999.
<i>Amygdalaria pelobotryon</i>	Tiny amounts near outfall.
<i>Arthorhaphis citinella</i>	Near outfall.
<i>Aspicilia caesiocinerea</i>	Boulder tops.
<i>Aspicilia grisea</i> agg.	Near outfall.
<i>Belonia incarnata</i>	A soily lip of a boulder on the W bank at 68140.59188, alt 525m
<i>Cladonia strepsilis</i>	Small amount on Andreaea at 68135.59174.
<i>Cladonia subcervicornis</i>	Near outfall.
<i>Ephebe lanata</i>	Locally frequent.
<i>Fuscidea lygaea</i>	Near outfall.
<i>Lecanora intricata</i>	Near outfall.
<i>Lecanora soralifera</i>	Near outfall.
<i>Lecidea phaeops</i>	Near outfall.
<i>Lepraria caesioalba</i>	Near outfall.
<i>Lichenomphalia alpina</i>	Rare; moist peaty crevice on boulder.
<i>Massalongia carnosa</i>	More frequent in upper reaches.
<i>Miriquidica leucophaea</i>	Near outfall.
<i>Pertusaria albescens</i>	'Aff. albescens'.
<i>Pertusaria corallina</i>	Fertile.
<i>Pilophorus strumaticus</i>	Rare. At 68620.59981, probably not dependent on immersion here. Shady damp N-side of a large streambank boulder at 68285.59411
<i>Placopsis lambii</i>	Present.
<i>Porpidia hydrophila</i>	Abundant.
<i>Porpidia macrocarpa</i>	Present. (Some might be <i>P. irrigua</i>).
<i>Rhizocarpon geographicum</i>	Near outfall.
<i>Rhizocarpon lavatum</i>	Present.
<i>Stereocaulon delisei</i>	Terrestrial? '23(SH)/68294.59449, alt 470m, the E-facing sloping side of a large boulder sitting on the W bank c. 2m away from the stream edge held a good colony'.
<i>Stereocaulon evolutum</i>	Near outfall.
<i>Stereocaulon vesuvianum</i>	Near outfall.
<i>Tephromela atra</i>	Near outfall.
<i>Trapelia placodioides</i>	Damp vertical boulder sides.
<i>Tremolecia atrata</i>	Near outfall.
Lichenicolous fungi	
<i>Abrothallus caerulescens</i>	On <i>Xanthoparmelia conspersa</i> near outfall.

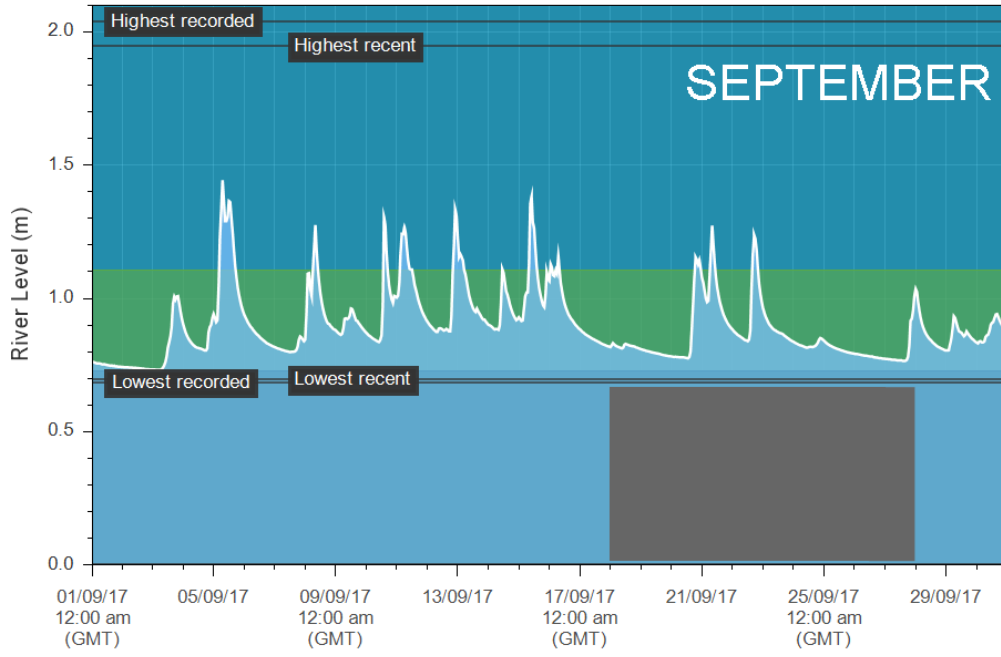
<i>Endococcus rugulosus</i>	On Rhizocarpon lavatum.
<i>Endococcus verrucosporus</i>	On Ionaspis lacustris.
Number of lichen species:	31
Number of riparian species:	4
EN	0
VU	1
NT	0
DD	0
NR	0
NS	2
NR/NS score	60

Appendix 3. River levels and fieldwork

Dry, settled weather is necessary for efficient surveying of rivers. During the rather wet summer of 2017 ensuring successful fieldwork was difficult. Fieldwork (and accommodation) was arranged with as little notice as possible, so as to coincide with forecasts of dry weather. The graphs of levels of the Nant Peris below (from Natural Resources Wales website) show the uncertainty of this. Periods of planned fieldwork, when the writer was staying in North Wales, are shown as grey boxes. Efficient survey is only possible when levels on the graph begin to approach the 'lowest recent' level. Unfortunately, the longest period of settled weather, in late August, coincided with a prior commitment and fieldwork was not possible. The project was unofficially approved on approximately 16 June (red arrow in figure), so that planning of fieldwork could begin.









Afon Anafon upper on 19 July 2017, levels near base-flow.



Afon Anafon upper at 13.45 on 21 July 2017, with most of the riparian zone submerged.