Coetiroedd Cwm Elan/ Elan Valley Woodlands SAC: Lichen survey of Gro Woods & Nant Rhyd-coch/Dol y mynach

Andy Acton

Evidence Report No 623

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Table of contents

List of Figures

List of Tables

1. Crynodeb Gweithredol

Mae sawl ardal o ACA Coetiroedd Cwm Elan wedi cael eu harolygu am gennau, ond mae rhai unedau yn parhau yn anhysbys o ran cenneg. Roedd arolwg yng nghoetir ACA sy'n perthyn i Dŵr Cymru ar ochr dde-ddwyreiniol cronfa ddŵr Caban Coch (Unedau SoDdGA 584 Coedwig Gro a 585 Nant Rhyd-coch/Dol y mynach) yn cael ei ystyried yn flaenoriaeth arbennig gan y bydd yn helpu i gyfarwyddo gwaith rheoli yno, megis gwaith teneuo ac ailgyflwyno pori.

Roedd yr arolwg yn canolbwyntio ar goetir ar ochr dde-ddwyreiniol cronfa ddŵr Caban Coch (Unedau SoDdGA 584 Coedwig Gro a 585 Nant Rhyd-coch/Dol y mynach). Yn y ddau floc mae'r prif gen sydd o ddiddordeb yn gysylltiedig â choed derw hynod tir pori sy'n dyddio'n ôl i gyfnod cyn planhigfeydd coed derw'r bedwaredd ganrif ar bymtheg. Mae'r hyn sydd o ddiddordeb yn cynnwys rhywogaethau Cenedlaethol Anfynych, Cenedlaethol Brin a rhywogaethau mynegai 'dangosyddion hen goetiroedd' (Sanderson *et al.* 2018) coetiroedd Cefnforol Deheuol (**SOWI**) a Choedwigoedd Glaw Ucheldirol (**URI**) a nifer o rywogaethau sydd ar y rhestr goch naill ai yn y DU (Woods & Coppins 2102) a/neu Gymru (Woods, 2010).

Coedwig Gro (SoDdGA - Uned 584)

Mae Uned 584 wedi'i dominyddu gan goed derw sydd wedi sefydlu ers blynyddoedd maith ac a oedd yn rhan o blanhigfa yn wreiddiol, ond mae'n cynnwys nifer o goed derw hynod tir pori sy'n dyddio ymhellach yn ôl na'r coed derw llawn dwf a blannwyd. Roedd rhan helaeth o'r ardal gyffredinol hon mae'n debyg yn dir pori ucheldirol/coetir tir pori cyn plannu'r coed derw, ac roedd y tir ger yr uned yn dangos olion o goetir tir pori cyn plannu conwydd yn yr ugeinfed ganrif. Mewn rhai mannau mae adfywio yn fygythiad i'r diddordeb ar hen goed. Mae cylch-deneuo a monitro adfywio'n ofalus yn cael ei argymell. Hefyd mae rhywfaint o ailstrwythuro yn fanteisiol er mwyn annog datblygiad hen goed yn y dyfodol.

Nid oedd y gymuned o hen dyfiant *Lobarion pulmonariae* o risgl tra-fasig yn bresennol yng nghoedwig Gro. Roedd y gymuned o risgl asid cefnforol *Parmelietum laevigatae* yn bresennol ar hen goed bedw ond roedd y diddordeb mwyaf i'w gael ar goed derw hynod tir pori. Cofnodwyd diddordeb ychwanegol ar goed criafol. Ymhlith y rhywogaethau nodedig a gofnodwyd yng Ngoedwig Gro mae:

- 1 rhywogaeth sydd mae'n debyg mewn Perygl Difrifol (**?CR**) yng Nghymru (*Chrysothrix chrysophthalma* **NR)**
- 1 rhywogaeth ar y Rhestr Goch sydd Dan Fygythiad (**VU**) yng Nghymru (*Microcalicium ahlneri* **NS**)
- 4 rhywogaeth ar y Rhestr Goch sydd Dan Beth Bygythiad (**NT**) yng Nghymru (*Arthonia vinosa, Bunodophoron melanocarpum, Biatora chrysantha* **NS**, *Thelotrema lepadinum*)

Dol y mynach (SoDdGA - Uned 584)

Mae bloc 585 yn dir pori coetir hynafol gyda choed hynod niferus ond mae stoc wedi ei dynnu oddi yno. Mae'r blociau o gonwydd cyfagos wedi'u cwympo. Mae digonedd o adfywio wedi sefydlu o amgylch coed hynod yn y coetir porfa ac ar gonwydd cyfagos sydd wedi'u llwyrgwympo. Mae hyn yn achosi bygythiad o gysgodi i'r cennau o ddiddordeb ar y coed hynod. Gwnaed ymdrechion i fynd i'r afael â'r broblem y mae hyn yn ei achosi i gennau (e.e. cylch-deneuo) ond mae angen llawer iawn mwy o waith, ac yn ddelfrydol ynghyd â mwy o bori i reoli bonion rhag aildyfu ac atal rhagor o adfywio. Yn ddelfrydol dylai'r ardal gael ei phori gan wartheg.

Roedd cynrycholiad gwael o'r gymuned o hen dyfiant *Lobarion pulmonariae* o risgl tra-fasig yn Nol y Mynach a dim ond *Peltigera horizontalis* a gofnodwyd. Roedd y gymuned o risgl asid cefnforol *Parmelietum laevigatae yn bresennol ar hen goed bedw a choed derw hynod tir pori*. Roedd y diddordeb mwyaf ar goed derw hynod tir pori. Cofnodwyd diddordeb ychwanegol ar goed cyll. Ymhlith y rhywogaethau nodedig ar goed derw tir pori yn Nol y Mynach mae:

- 2 rywogaeth yn y categori Dan Beth Bygythiad (**NT**) yng Nghymru (*Arthonia vinosa* a *Thelotrema lepadinum*).

- Roedd rhai rhywogaethau hen goetiroedd nodedig eraill yn anfynych/prin neu'n lleol iawn e.e. *Lopadium disciforme*, *Lecidea sanguineoatra* **NS**, *Calicium lenticulare* **NS**.

CRYNODEB AR GYFER YR ACA

Mae nifer fawr o rywogaethau sydd ar y Rhestr Goch yng Nghymru yn adnabyddus oherwydd yr ACA, ac wedi eu cofnodi yn bennaf ar goed ond rhai ar greigiau (gweler manylion yn y prif adroddiad). Mae'r rhain wedi'u crynhoi isod:

- 1 rhywogaeth sydd wedi diflannu'n ddiweddar (**RE**) yng Nghymru

- 2 rywogaeth ar y Rhestr Goch Mewn Perygl Difrifol **CR** yng Nghymru

- 4 rhywogaeth sydd bron yn sicr Mewn Perygl Difrifol **?CR** yng Nghymru (heb eu gwerthuso'n ffurfiol gan Woods (2010) ond yn gymwys i ennill statws **CR** yng Nghymru): *Biatora ligni-mollis, Buellia violaceofusca, Chrysothrix chrysophthalma, Enterographa sorediata*.

- 2 rywogaeth sydd ar y Rhestr Goch Mewn Perygl (**EN**) yng Nghymru

- 19 rhywogaeth ar y Rhestr Goch Dan Fygythiad (**VU**) yng Nghymru

- 34 rhywogaeth ar y Rhestr Goch Dan Beth Bygythiad (**NT**) yng Nghymru (mae'n debygol bod rhywogaeth ychwanegol yn union y tu allan i'r ACA)

- 5 rhywogaeth lle ceir Diffyg Data (**DD**) ar eu cyfer yng Nghymru (mae'n debygol bod rhywogaeth ychwanegol yn union y tu allan i'r ACA)

- 2 rywogaeth heb eu gwerthuso (**NE**) yng Nghymru (*Antennulariella lichenisata* **NS E IR** a *Burgoa splendens*)

Mae hyn yn nifer enfawr o rywogaethau nodedig ac mae'r ACA yn amlwg o bwysigrwydd cadwraeth uchel. Fodd bynnag, mae llawer o'r rhywogaethau'n brin iawn neu'n gyfyngedig i'r lle a rhai ohonynt i'w cael yn unig mewn un neu ddau is-safle neu hyd yn oed ar ychydig o goed yn unig. Mae llawer o'r safleoedd cydrannol hefyd yn rhai anghyffiniol a chymharol ynysig. Argymhellir cynyddu'r cysylltiad rhwng is-safleoedd.

2. Executive Summary

Many areas of the Elan Valley Woodlands SAC have been surveyed for lichens, but some units remain unknown lichenologically. Survey in the Dwr Cymru-owned SAC woodland on the SE side of Caban Coch reservoir (SSSI units 584 Gro Woods and 585 Nant Rhyd-coch/Dol y mynach) was considered a particular priority because it will help inform management there, such as thinning and grazing reintroduction.

The survey focussed on woodland on the SE side of Caban Coch reservoir (SSSI units 584 Gro Woods and 585 Nant Rhyd-coch/Dol y mynach). In both blocks the main lichen interest is associated with veteran pasture oak trees that predate the 19th century oak plantations. The interest includes Nationally Scarce, Nationally Rare and 'old woodland indicator' index species (Sanderson *et al.* 2018) of Southern Oceanic woodlands (**SOWI**) and Upland Rainforests (**URI**) and a number of species that Red-listed either in the UK (Woods & Coppins 2102) and/or Wales (Woods, 2010).

Gro Woods (SSSI Unit 584)
Unit 584 is dominated by long established oakwoods of plantation origin but includes a number of veteran pasture oaks that predate the mature planted oaks. Much of this general area was probably upland pasture/pasture woodland before the oak planting, and the ground adjacent to the unit supported remnants of pasture woodland before 20th Century conifer planting. In some areas regeneration is posing a threat to the lichen interest on veterans. Halo thinning and careful monitoring of regeneration are recommended. Some restructuring to encourage the development of future veterans is also desirable.

The old growth *Lobarion pulmonariae* community of more base rich bark was not recorded at Gro. The oceanic acid bark *Parmelietum laevigatae* community was present on old birch but the greatest interest was on veteran pasture oaks. Additional interest was recorded on rowan. Notable species recorded at Gro include:

- 1 that is probably Critically Endangered **?CR** in Wales (*Chrysothrix chrysophthalma* **NR)**
- 1 Red-Listed Vulnerable **VU** in Wales (*Microcalicium ahlneri* **NS**)
- 4 Red-Listed Near Threatened **NT** in Wales (*Arthonia vinosa, Bunodophoron melanocarpum, Biatora chrysantha* **NS**, *Thelotrema lepadinum*)

Dol y mynach (SSSI Unit 584)
Block 585 is ancient woodland pasture with frequent veteran trees but stock has been removed. The adjacent conifer blocks have been felled. Abundant regeneration has established around veteran trees in the pasture woodland and on adjacent clearfell conifers. This poses a shade threat to the lichen interest on the veterans. Some attempts have been made to address the problem this poses for lichens (e.g. halo thinning) but much more work is needed, ideally with increased browsing to control regrowth from cut stumps and suppress further regeneration. Ideally the area would be grazed by cattle.

The old growth *Lobarion pulmonariae* community of more base rich bark was poorly represented at Dol y mynach with just *Peltigera horizontalis* recorded. The oceanic acid bark *Parmelietum laevigatae* community was present on old birch and veteran pasture oaks. The greatest interest was on veteran pasture oaks. Additional interest was recorded on hazel. Notable species on pasture oaks at Dol y mynach include:

- 2 species that are Near Threatened **NT** in Wales (*Arthonia vinosa* and *Thelotrema lepadinum*).

- Other *notable* old woodland species were scare/rare or very local e.g. *Lopadium disciforme*, *Lecidea sanguineoatra* **NS**, *Calicium lenticulare* **NS**.

SUMMARY FOR SAC

A large number of species that are Red-listed in Wales are known from the SAC, mostly recorded from trees but a few on rocks (see main report for details). These are summarised below:

- 1 species that has recently become extinct (**RE**) in Wales

- 2 Red-Listed Critically Endangered **CR** in Wales

- 4 that are almost most certainly Critically Endangered **?CR** in Wales (not formally evaluated by Woods (2010) but qualifying as **CR** in Wales): *Biatora ligni-mollis, Buellia violaceofusca, Chrysothrix chrysophthalma, Enterographa sorediata*.

- 2 Red-Listed Endangered **EN** in Wales

- 19 Red-Listed Vulnerable **VU** in Wales

- 34 Red-Listed Near Threatened **NT** in Wales (an additional species is probably just outwith the SAC)

- 5 Data Deficient **DD** in Wales(an additional species is probably just outwith the SAC)

- 2 Not Evaluated **NE** in Wales (*Antennulariella lichenisata* **NS E IR** and *Burgoa splendens*)

This is a huge number of notable species and the SAC is clearly of high conservation importance. However, many of the species are very rare or localised with some only occurring at one or two sub-sites or even on only on a few trees. Many of the component sites are also non-contiguous and relatively isolated. Increasing connectivity between sub-sites is recommended.

3. Introduction

Many areas of the Elan Valley Woodlands SAC have been surveyed in detail for lichens most recently by Acton (2020) and Sanderson (2014, 2019). The SAC is known to support an exceptional lichen flora of National importance and includes veteran trees that support lichen species that are threatened in Europe (Sanderson, 2014). Most previous lichen records are available on the National Biodiversity Network (NBN) https://species.nbnatlas.org/. However, analysis of data by NRW has shown that some units remain unknown lichenologically. Survey in the Dwr Cymru-owned SAC woodland on the SE side of Caban Coch reservoir (SSSI units 584 Gro Woods and 585 Nant Rhyd-coch/Dol y mynach) was considered a particular priority because it will help inform management there, such as thinning and grazing reintroduction.

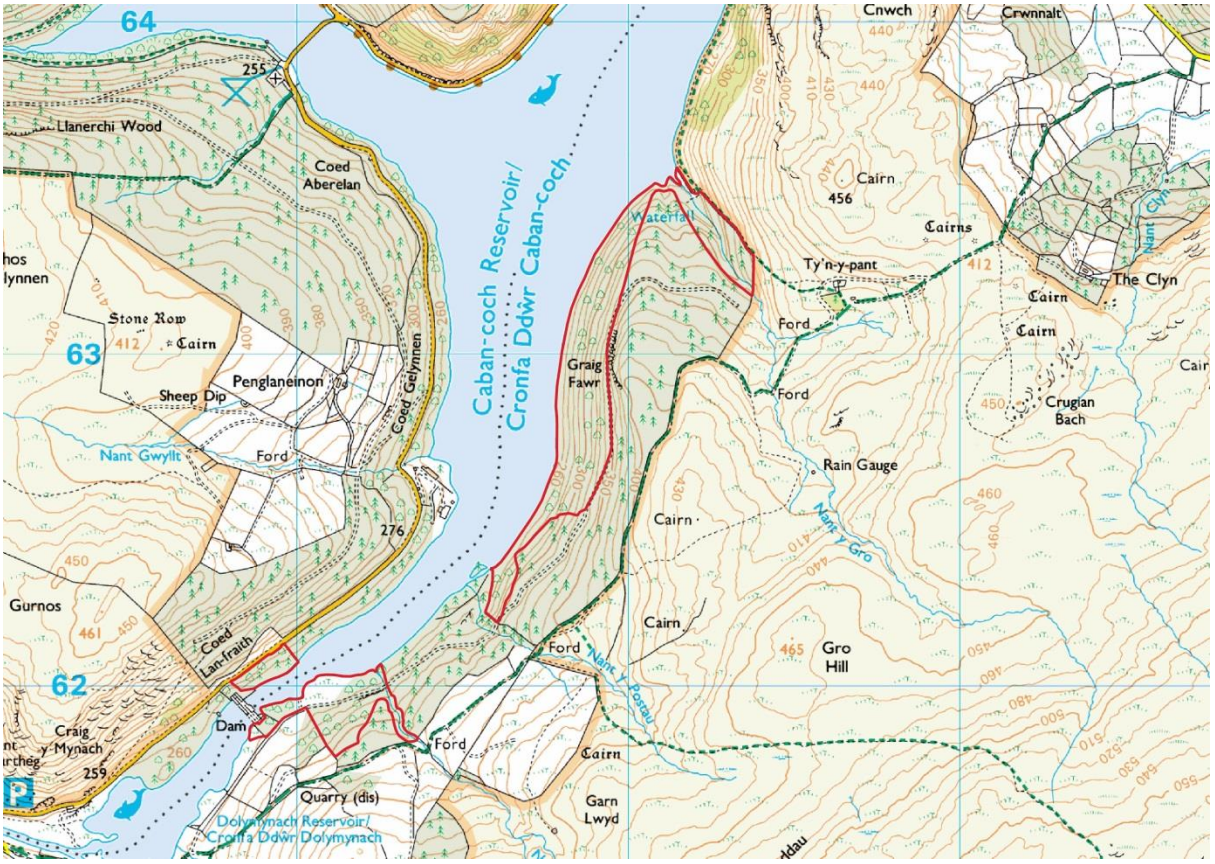

Figure 1: the location of Gro Woods (the northern polygon outlined in red) and Dol y mynach (the southern polygon outlined in red).

4. Aims and Objectives

In summary, the aims and objectives of the study were to:

- Record Nationally Scarce, Nationally Rare and ‘old woodland indicator’ index species (Sanderson *et al.* 2018) and species that are Red-listed either in the UK (Woods & Coppins 2102) and/or Wales (Woods, 2010).
- Discuss the notable species recorded.
- Generate maps of the best trees for lichens.
- Combine 2021 survey data with older records, to produce a site dossier that includes records of all notable lichens.
- Discuss findings.

5. Methods

5.1 Field survey

The fieldwork took the form of a walkover survey of the study site over 3 days (14th-16th November 2021) visiting woodland on the SE side of Caban Coch reservoir (SSSI units 584 Gro Woods and 585 Nant Rhyd-coch/Dol y mynach, Map 1). Both of these areas are within the extensive Elenydd SSSI, which also includes areas in Radnorshire and Ceredigion, as well as being within Elan Valley Woodlands SAC. Potential lichen habitats within the areas visited were searched for lichens, lichenicolous fungi and non-lichenized micro-fungi traditionally recorded by lichenologists. Survey effort concentrated on those microhabitats likely to support well-developed lichen communities and/or notable species.

Species lists were compiled and target notes recorded for features/species of particular interest such as Nationally Scarce/Rare, Red-Listed or otherwise notable species. Target notes were sometimes used to make a note on other features of interest. Locations were recorded using a handheld Garmin eTrex H Global Positioning System (GPS). Samples were collected of species not readily identifiable in the field using a x14 hand lens, for subsequent identification in the laboratory. As small a sample as possible was collected using hammer and chisel or knife, as appropriate.

Samples collected in the field were identified in the laboratory using the standard literature (Smith *et al*., 2009 *et seq.*; and various keys in the published and unpublished literature), compound/binocular microscopes, and chemical analysis. Field records and identifications from laboratory work were collated. All records will be submitted to the British Lichen Society (BLS) and be subsequently available through the National Biodiversity Network (http://data.nbn.org.uk/).

5.2 Desk Study

A list of all notable species recorded within the SAC was compiled based of the results of the fieldwork plus the data available on NBN. Some more recent lichen records are not yet on NBN, notably some of those recorded by Sanderson (2019) and Acton (2020), and notable species were extracted from these reports as part of the desk study. No other relevant lichen reports were provided/examined as part of this exercise and it was assumed all data in these would be on NBN. The data from these additional reports did appear to be on NBN but there could be omissions. For example an old record for *Chrysothrix chrysophthalma* was not on the NBN data but mentioned in Sanderson (2019) who searched for it at a known location without success. Detailed examination of the old survey reports might reveal other omissions from the NBN data.

6. Site Accounts

6.1 Main lichen habitats and lichen communities

In both survey blocks (SSSI units 584 Gro Woods and 585 Nant Rhyd-coch/Dol y mynach) the main lichen interest is associated with veteran pasture oak trees that predate the 19th century oak plantations (the main habitat type at Gro), but additional interest was recorded on older birch, hazel and rowan, as well as a developing interest on some of the older mature planted oaks.

The old growth *Lobarion pulmonariae* community of more base rich bark was not recorded at Gro and is very rare at Dol y mynach (just *Peltigera horizontalis* on a mossy fallen trunk). A 'proto-Lobarion' was recorded where bark conditions are not quite so acidic (e.g. with *Normandina pulchella*, *Lopadium disciforme*) perhaps indicating conditions might be becoming less acidic and more suitable for colonisation by *Lobarion* species (provided pollution levels are not limiting) but the site is isolated from known colonisation sources (e.g. at Carngafallt c.SN9354 and Coed yr Allt-goch c. SN9067)

The oceanic acid bark *Parmelietum laevigatae* community was present on old birch and some of the older planted oaks, but on most trees was not particularly diverse and generally limited to only those less specialist members of the community that appear to more readily colonise suitable habitat; these include *Megalaria pulverea* and *Trapelia corticola*, which were both frequent, and *Hypotrachyna laevigata*, which was occasional but rarely well developed. Although the community was often better developed on birch (e.g. *H. laevigata* was occasional on birch at Gro but rare on oak), the more notable *Parmelietum* species were recorded on veteran oaks, more rarely old/veteran birch.

The deadwood niches associated with veteran trees were exceptional, with dead standing trees/tall stumps and locally frequent stands of large, hollow veterans with expanses of bare lignum. Despite the abundance and apparent suitability of the deadwood habitat the lichen interest recorded at Dol y mynach was not as special as that recorded at Gro. However, this niche is often quite challenging to examine and sample effectively and greater interest could very easily have been overlooked. *Caliciales* including *Calicium glaucellum* and *Chaenothecopsis* aff. *nigra* **NS** were recorded associated with dead wood niches such as dead standing trees and inside hollowed-out ancient veteran oaks.

Although *Hypotrachyna laevigata* was occasional it generally occurred as small patches at Gro Woods. The best development at Gro was seen on this old birch at TN29 which had nice healthy patches of *H. laevigata.*

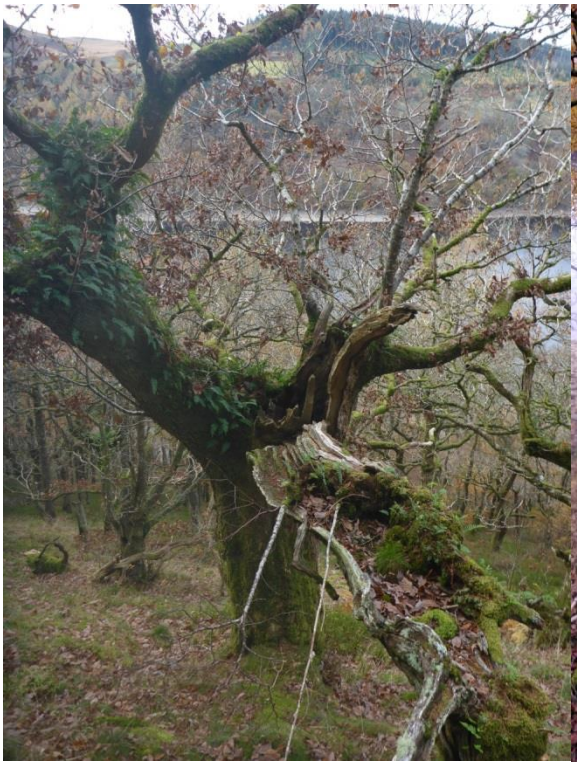

Figure 2 (left): veteran pasture oak at Gro Wood (target note TN7).

Figure 3 (right): old birch at Gro Woods (target note TN29) with well-developed patches of *Hypotrachyna laevigata* (the pale bluish grey patches clearly visible on the trunk).

Figure 4: veteran pasture oak at Gro Woods. (target note TN6).

Figure 5: veteran pasture oak at Dol y mynach (target note TN51).

6.2 Notable lichens at Gro Woods (SSSI Unit 584)

The more notable species at Gro Woods are listed below.

Notable **URI** *Parmelietum* species on oak at Gro include:

Biatora chrysantha	**URI**	**NS**	**NT** in Wales
Bryobilimbia sanguineoatra	**URI**	**NS**	
Bryoria fuscescens[1]			**VU** in Wales
Bunodophoron melanocarpum[2]	**URI**		**NT** in Wales
Lepra ophthalmiza	**URI**	**NS**	**DD** in Wales
Lopadium disciforme	**URI**		
Micarea doliiformis	**URI**	**NS**	
Opegrapha fumosa[1]			**VU** in Wales

Additional species on the bark of veteran pasture oaks include:

Arthonia vinosa	**SOWI**		**NT** in Wales
Bactrospora corticola[1]	**NS**		**NT** in Wales
Chaenotheca hispidula	**NS**		
Coenogonium confusum[1]	**SOWI**	**NS**	**NT** in Wales

Smooth patches of bark on oak and the smooth stems of some rowans support:

Thelotrema lepadinum	**SOWI**	**NT** in Wales

High lichen interest was associated with dead wood niches inside hollowed out ancient veteran oaks including:

Chrysothrix chrysophthalma	**NR**	**?CR** in Wales
Microcalicium ahlneri	**NS**	**VU** in Wales
Lecidea turgidula		Infrequent in Wales[3]

Other species at Gro included the bryicolous *Gyalideopsis muscicola* **NS**, and two under-recorded species, *Lecanora argentata* **NS** and the lichenicolous fungus *Paranectria oropensis* subsp. *oropensis* **NS**.

Arthonia vinosa was occasional and *Thelotrema lepadinum* was locally frequent at Gro Woods (the latter species was recorded on rowan as well as oak, but was uncommon on oak in the even-aged oak areas). The other *notable* species listed above recorded in 2021 were scare/rare or very local.

[1] Species recorded by Ray Woods 1998; not recorded in 2022 but possibly overlooked.
[2] Also recorded on one old birch.
[3] Sanderson 2019. First recorded for Radnorshire by Sanderson 2019.

6.3. Notable lichens at Dol y mynach (SSSI Unit 585)

The more notable species at Dol y mynach are listed below.

Notable **URI** *Parmelietum* species on veteran oak at Dol y mynach include:

Bryobilimbia sanguineoatra	**URI**	**NS**
Lopadium disciforme	**URI**	
Micarea doliiformis	**URI**	**NS**

Additional species on the bark of veteran pasture oaks include:

Arthonia vinosa	**SOWI**	**NT** in Wales
Calicium lenticulare	**URI**	**NS**

Smooth patches of bark on oak and the smooth stems of some hazels support:

Thelotrema lepadinum	**SOWI**	**NT** in Wales

Other notable species at Dol y mynach included *Peltigera horizontalis* **SOWI** and the bryicolous *Gyalideopsis muscicola* **NS**.

Arthonia vinosa was occasional and *Thelotrema lepadinum* was frequent at Dol y mynach (the latter species recorded on hazel as well as oak). The other notable species listed above were scare/rare or very local despite the presence of abundant veteran trees that appeared otherwise suitable.

7. Notes on the lichens

7.1 Summary list of notable lichens at Gro Woods/Dol y mynach

The main species of interest in the Gro Woods/Dol y mynach complex are summarised below. Each of these species is discussed briefly in section 7.2.

Arthonia vinosa	**SOWI**		**NT** in Wales	Both sites
Bactrospora corticola	**NS**		**NT** in Wales	Gro Woods (1998)
Biatora chrysantha	**URI**	**NS**	**NT** in Wales	Gro Woods
Bryobilimbia sanguineoatra	**URI**	**NS**		Both sites
Bryoria fuscescens			**VU** in Wales	Gro Woods (1998)
Bunodophoron melanocarpum	**URI**		**NT** in Wales	Gro Woods
Calicium lenticulare	**URI**	**NS**		Dol y mynach
Chaenotheca hispidula	**NS**			Gro Woods
Coenogonium confusum	**SOWI**	**NS**	**NT** in Wales	Gro Woods (1998)
Chrysothrix chrysophthalma	**NR**		?**CR** in Wales	Gro Woods
Lepra ophthalmiza	**URI**	**NS**	**DD** in Wales	Gro Woods
Lopadium disciforme	**URI**			Both sites
Micarea doliiformis	**URI**	**NS**		Both sites
Microcalicium ahlneri		**NS**	**VU** in Wales	Gro Woods
Opegrapha fumosa			**VU** in Wales	Gro Woods (1998)
Peltigera horizontalis	**SOWI**			Dol y mynach
Thelotrema lepadinum	**SOWI**		**NT** in Wales	Both sites

7.2 Notes on the lichens recorded

Each of the more notable species in the Gro Woods/Dol y mynach complex is discussed briefly below. Target Note locations (TNs) are shown on the maps 2 -4. Full details of all target notes with details on the GPS location, substrate and associated species are given in the Appendices.

Arthonia vinosa **SOWI** **NT** in Wales Both sites
On 10 oak (TN3, 5, 7, 8, 26, 32, 40, 43, 45, 46). Estimated to be occasional to locally frequent on old/veteran oaks.

Bactrospora corticola **NS** **NT** in Wales Gro Woods (1998)
Recorded by Ray Woods at Gro in 1998. Two samples collected from TN14 and TN18 remain to be examined.

Biatora chrysantha **URI** **NS** **NT** in Wales Gro Woods
Recorded on a veteran oak at Gro Woods (TN19). Small poorly developed thalli of this sterile green crust would be easily overlooked. Excessive tree regeneration poses a potential threat at some locations (refer to TNs).

Bryobilimbia sanguineoatra **URI** **NS** Both sites
Recorded on six oaks (TNs 6, 16, 19, 41, 43, 47). Excessive tree regeneration poses a potential threat at some locations (refer to TNs).

Bryoria fuscescens **VU** in Wales Gro Woods (1998), not recorded 2021
Recorded by Ray Woods at Gro in 1998; Ray did not record abundance as *B. fuscescens* was so common generally in 1998 (Ray Woods pers. comm.) Ray adds: 'I saw a small population of the latter [*B. fuscescens*] on acidic boulders south of Elan Village about 3 [years] ago-the only time I have found it of late'. It was not recorded in 2021 so if still present is probably rare or on the upper trunk/canopy.
Bryoria fuscescens is sensitive to ammonia and the observed decline in north and central wales is correlated with an increase in N pollution (Bosanquet, 2019).

Bunodophoron melanocarpum **URI** **NT** in Wales Gro Woods
On one veteran oak (TN15) and one old birch (TN22). *Bunodophoron melanocarpum* (**NT** in Wales) was recorded new to the SAC and new to VC42 Breconshire (Figure 5). The *B. melanocarpum* on the birch is threatened by Sitka regeneration which should be removed. This tree (and other old trees in the area) would probably benefit from halo thinning of nearby native and non-native regeneration (refer to TNs).

Calicium lenticulare **URI** **NS** Dol y mynach
On one veteran pasture oak (TN61).

Chaenotheca hispidula **NS** Gro Woods
On one oak (TN19). This was only the third record for VC42 Breconshire, but is known from one other location in SAC on opposite side of Caban Reservoir, (which is the only record from Radnorshire).

Coenogonium confusum **SOWI** **NS** **NT** in Wales Gro Woods (1998)
Ray recorded it on an old oak (Ray Woods, pers. comm.). Not recorded 2022.

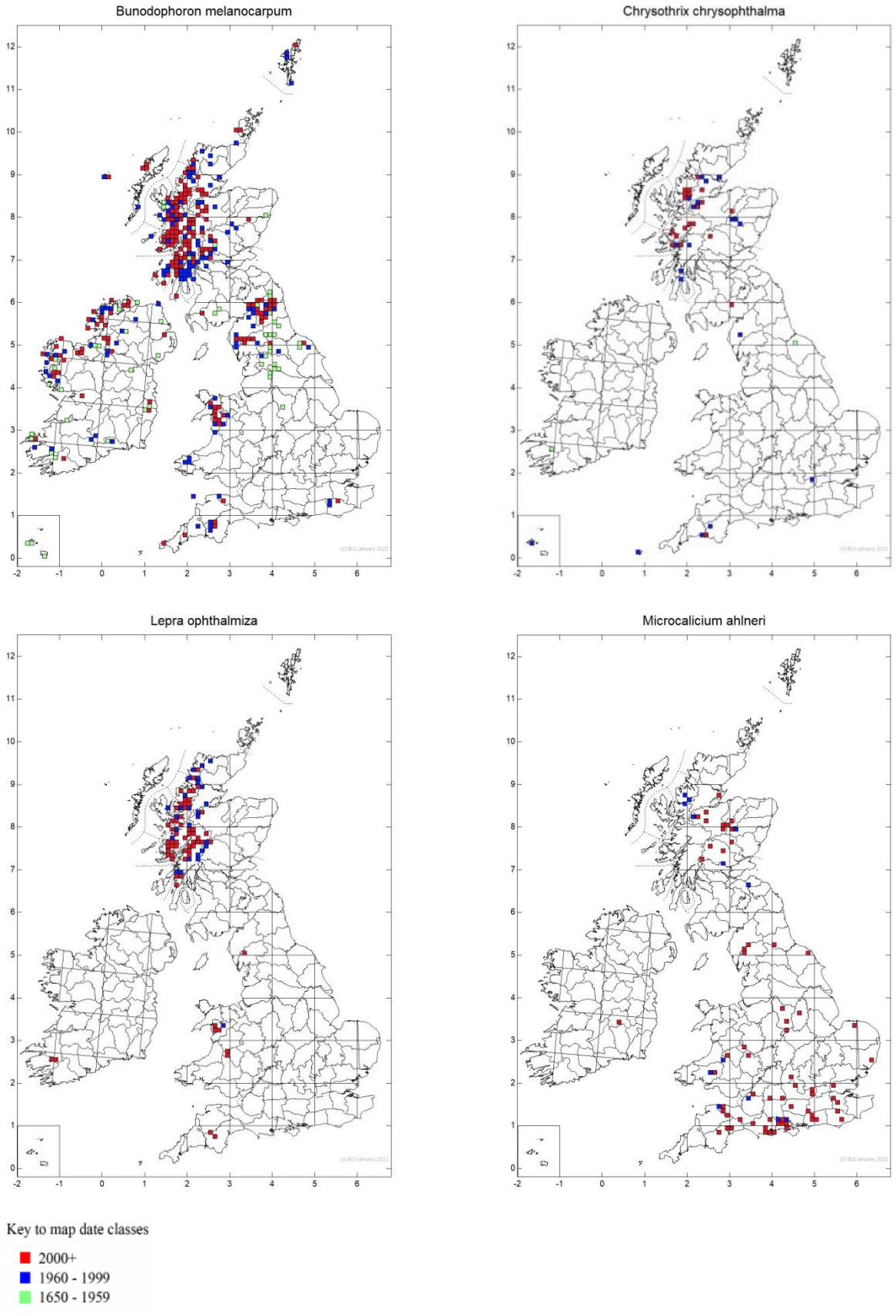

Figure 6: Distribution maps of some of the most notable species recorded in 2022.

Chrysothrix chrysophthalma **NR** ?**CR** in Wales Gro Woods
On three veteran oaks (TNs 1, 3, 8). This is the second site for Wales and it is likely to be Critically Endangered in Wales. Note, the BLS distribution map (Figure 6) does not show a 2011 record by Alan Orange on a dead standing oak in Allt Dhu at Carngafallt; this was searched for but not refound by Sanderson (2014). Most thalli at Gro in 2022 were abundantly fertile, a couple of thalli at Gro Woods with more well developed thallus and few fruits were recorded tentatively as fertile *Chrysothrix flavovirens*. Acton surveying woods on the north side of Caban Reservoir recorded similar thalli as fertile *C. flavovirens* (Acton, 2020). Additional survey for *C. chrysophthalma* is desirable.

Figure 7: Ancient hollow veteran pasture tree at Gro Woods (TN8) supporting *Chrysothrix chrysophthalma* **NR** **?CR** in Wales and *Microcalicium ahlneri* **NS** **VU** in Wales.

Figure 8: Close up photo of the tiny yellow fruits of *Chrysothrix chrysophthalma*.

Lepra ophthalmiza **URI** **NS** **DD** in Wales Gro Woods
On three oaks (TNs10, 12, 13). An important URI species new to the SSSI and the second location for VC42 Breconshire. It was first recorded for Breconshire by Sanderson (2014) within the SAC at Bedw Caemelyn. Neil only recorded it on one tree, and Alan Orange couldn't find *L. ophthalmiza* at its only known Radnor site recently (Ray Woods pers. comm.) so the population at Gro is significant. Under-browsing is posing a serious threat at TN10 and TN12 (refer to TNs). See Figure 9.

Figure 9: Close up of *Lepra ophthalmiza at target note TN12.*

Lopadium disciforme **URI** Both sites
On 4 oaks (TNs 4, 33, 44, 58). Excessive tree regeneration poses a potential threat at some locations (refer to TNs).

Micarea doliiformis **URI NS** Both sites
On 8 trees (TNs 10, 20, 31, 32, 35, 41, 43, 45). Appears to be occasional on suitable habitat. A particularly good population on oak at TN32. Excessive tree regeneration poses a threat at some locations (refer to TNs).

Figure 10: The greenish crust of *Micarea doliiformis* with tiny blackish barrel shaped pycnidia (a specialist reproductive structure in lichens that asexually produces fungal propagules).

Microcalicium ahlneri **NS** **VU** in Wales Gro Woods
On the lignum inside a hollow oak (TN8, Figure 6). This is an important new addition to the other records in the SAC (at Carngafallt, Sanderson, 2014).

Opegrapha fumosa **VU** in Wales Gro Woods (1998)
Not recorded 2021. A sterile crust that can easily be overlooked except when well developed.

Peltigera horizontalis **SOWI** Dol y mynach
On a fallen mossy tree trunk (TN60). The only *Lobarion* species recorded on site and this might be lost as the trunk decays unless it colonises adjacent suitable habitat (willows, hazels).

Thelotrema lepadinum **SOWI** **NT** in Wales Both sites
Occasional to locally frequent on oak. Also on rowan at Gro and hazel at Dol y mynach. Some locations recorded (see TNs) but not systematically recorded so most sightings of this species are not shown on the map.

Figure 11 (left): The Barnacle lichen *Thelotrema lepadinum*. The yellowish-fawn crust with purplish brown fruits is *Pyrrhospora quernea.*

Figure 12 (right): *Peltigera horizontalis* at TN60.

7.3 Target Note locations

The locations of the target notes including notable species discussed in section 7.2 are shown on the Maps in Figures 13-15. Full details are given in the Appendices. Some areas in the SSSI units were examined only briefly due to time constraints and some areas remain unexplored. In addition to new locations for recorded species, further survey work could find additional species new to the sites. Several species familiar to the author have been recorded in the past by Ray Woods at Gro but were not seen in 2021; this is a good indication that there is more lichen interest to be found.

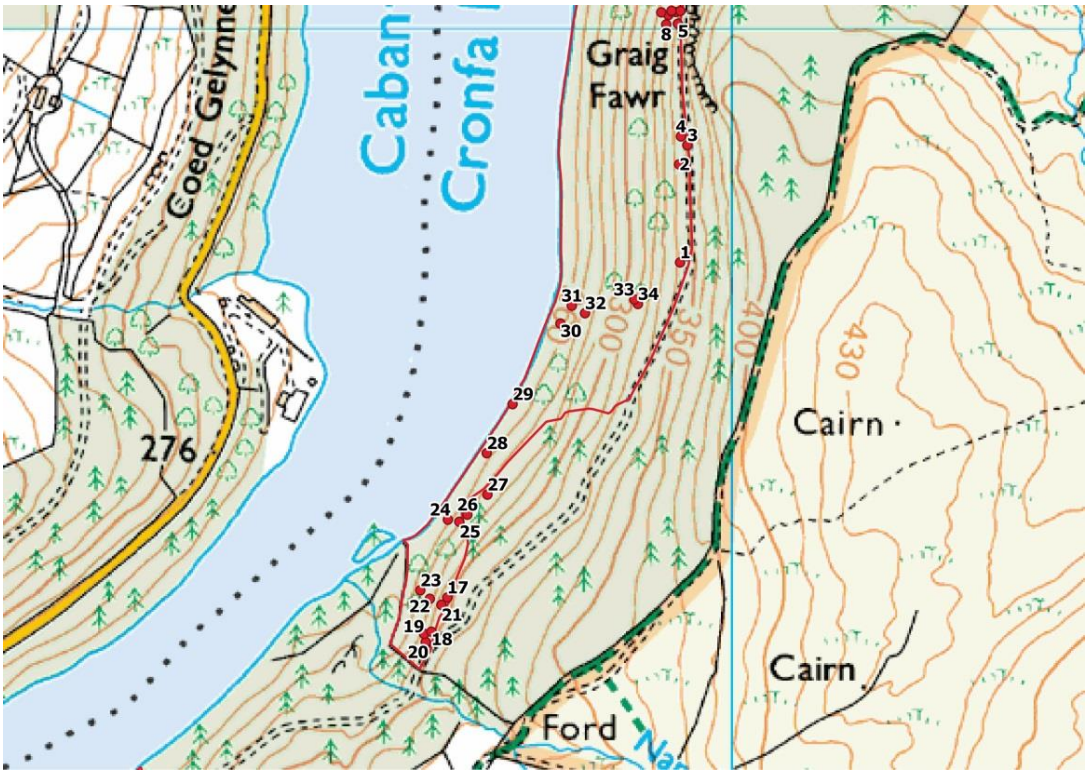

Figure 13: The location of target notes in the southern section of Gro Woods. The section further north is shown in greater detail in Figure 13.

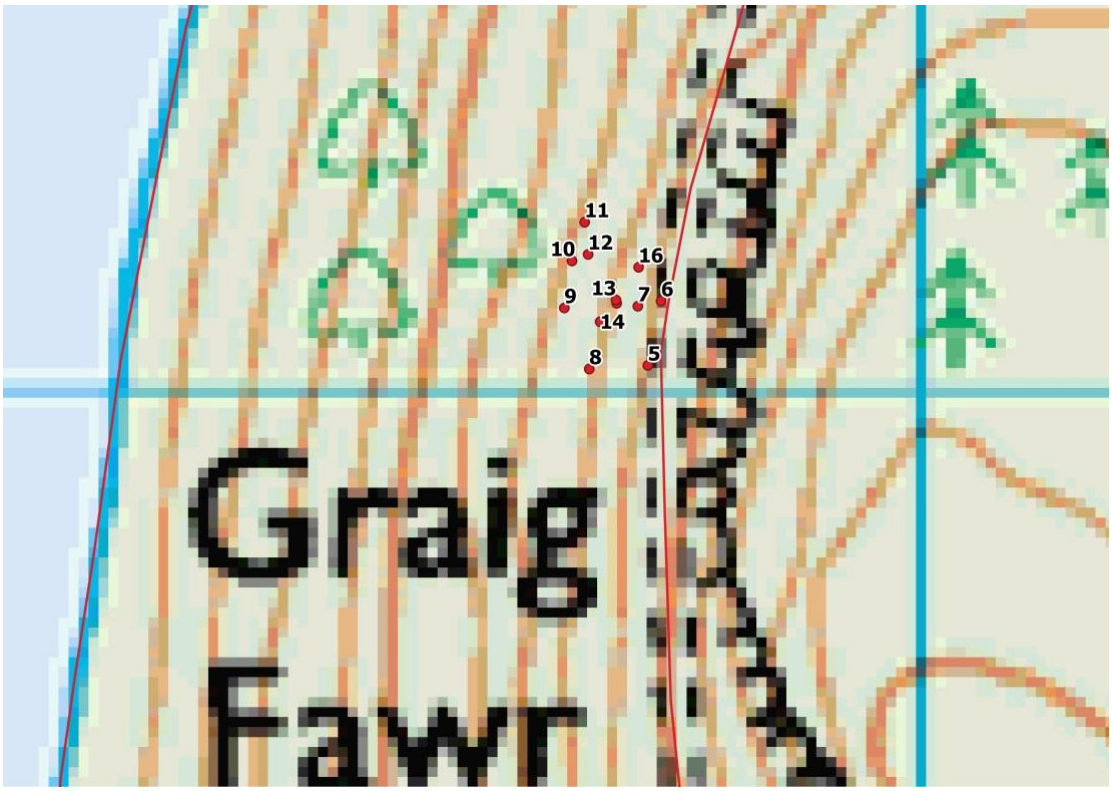

Figure 14: The target notes below Graig Fawr. Note TN15 is very close to TN13 and not visible/labelled on the map. The species recorded by Ray Woods in 1998 were recorded at SN919630 below Graig Fawr in the vicinity of the areas examined in 2021.

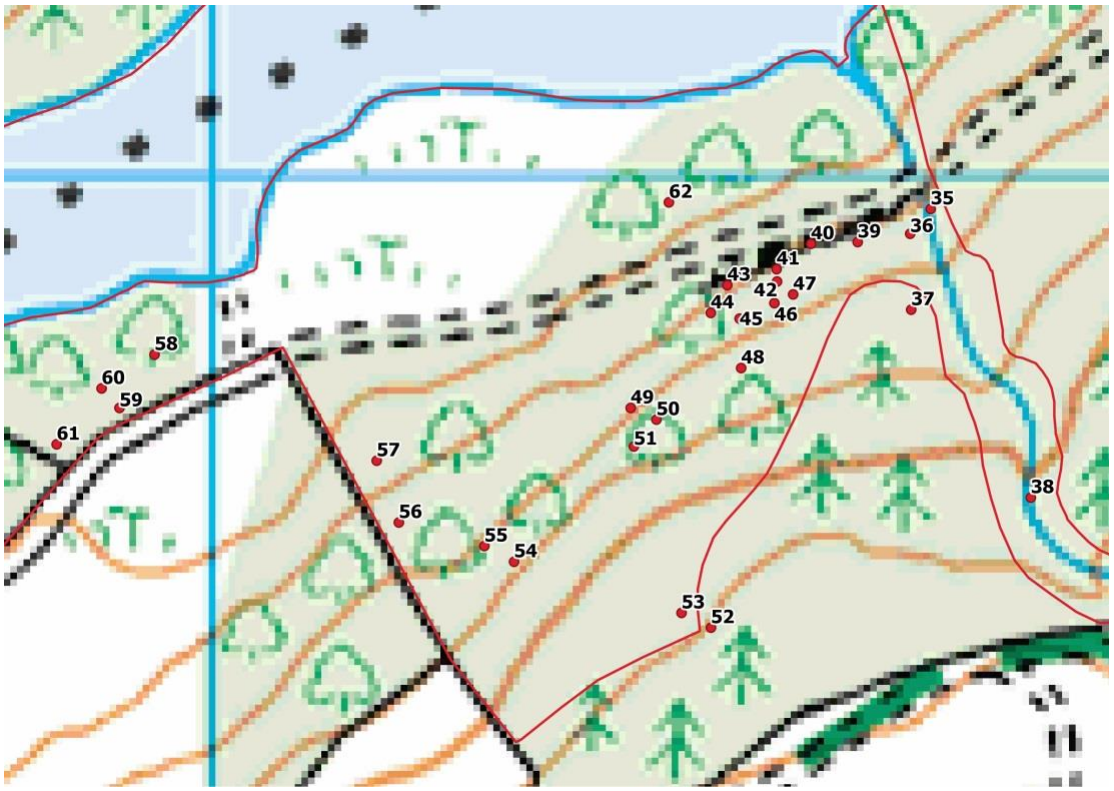

Figure 15: The location of target notes at Dol y mynach.

8. Evaluation

Woodland habitats for lichens can be assessed on the basis of notable assemblages of species as well as the presence of particularly notable species (e.g. Red-Listed species). Various indices have been developed to assess woodlands (e.g. Coppins & Coppins 2002 who developed the indices of Francis Rose). The woodland habitats for lichen at Gro have been assessed using the Upland Rainforest Index (**URI**) and Southern Oceanic Woodland Index (**SOWI**) of Sanderson *et al.* (2018). Index scores are generally applied over large areas of woodland, so the two SSSI units have been treated as a single woodland complex for the purposes of this assessment.

8.1 Upland Rainforest Index (URI) scores for Gro Woods/Dol y mynach

Sixteen URI species were recorded (Table 1). An additional notable species recorded in this community at Gro Woods is *Biatora chrysantha* (regarded as 'Bonus' species for oceanic woods by Coppins & Coppins, 2002). The threshold for SSSI quality is 10 in this area of Britain (Sanderson *et al.* 2018).

Table 1: Upland Rainforest Index (URI) species recorded in the woods on the SE side of Caban Reservoir in 2021 (at Gro Woods/Dol y mynach).

Species
Bunodophoron melanocarpum
Bryobilimbia sanguineoatra
Calicium lenticulare
Hypotrachyna laevigata
Lepra ophthalmiza
Lepraria membranacea
Lopadium disciforme
Megalaria pulverea
Micarea alabastrites
Micarea doliiformis
Mycoblastus caesius
Mycoblastus sanguinarius f. *sanguinarius*
Ochrolechia tartarea
Sphaerophorus globosus
Trapelia corticola
Usnea dasopoga

8.2 Southern Oceanic Woodland Index (SOWI) scores for Gro Woods/Dol y mynach

Fourteen SOWI species were recorded (Table 2). The threshold for SSSI quality is 20 in this area of Britain (Sanderson *et al.* 2018). Additional notable species recorded at Gro that indicate high quality habitats and were regarded as 'Bonus' species for

oceanic woods by Coppins & Coppins (2002) include *Biatora chrysantha*, *Opegrapha fumosa* and *Coenogonium confusum* (syn. *Porina rosei*).

Table 2: Southern Oceanic Woodland Index (SOWI) lichens recorded in the woods on the SE side of Caban Reservoir in 2021 (at Gro Woods/Dol y mynach).

Species
Anisomeridium ranunculosporum
Arthonia vinosa
Chaenotheca brunneola
Chaenotheca chrysocephala
Chaenotheca hispidula
Chaenotheca trichialis
Chaenothecopsis aff. nigra
Cladonia parasitica
Micarea alabastrites
Peltigera horizontalis
Pertusaria multipuncta
Thelopsis corticola
Thelotrema lepadinum
Usnea florida

8.3 Pinhead Index for Gro Woods/Dol y mynach

The Pinhead community (*Calicetum hyperelli* and *C. abietinum*) is a specialist community of bark and lignum niches sheltered from direct rainfall with the fruiting bodies (the 'pinhead') raised on a tiny stalks (the 'pins'). Typical niches are areas of lignum in the rain shadow of upper limbs, on the underside of decorticate limbs, on the rain-sheltered side of a leaning dead standing tree trunk, sheltered crevices in very rough gnarly bark, and hollows in veteran trees. The Pinhead Index is used to assess the quality of these specialist lichen niches at a site. The threshold for SSSI quality is 10 pinhead species (Sanderson *et al.* 2018).

Eleven 'pinhead' species were recorded (Table 3). An additional notable species recorded in the deadwood pinhead community at Gro Woods was *Chrysothrix chrysophthalma* (**NR**, **?CR** in Wales).

Table 3: Pinhead lichens recorded in the woods on the SE side of Caban Reservoir in 2021 (at Gro Woods/Dol y mynach).

Species
Calicium glaucellum
Calicium salicinum
Calicium lenticulare
Chaenotheca brunneola
Chaenotheca chrysocephala
Chaenotheca ferruginea
Chaenotheca hispidula
Chaenotheca trichialis
Chaenothecopsis sp. (spores too wide for *C. nigra*)
Chaenothecopsis aff. *nigra*
Microcalicium ahlneri

8.4 Overall evaluation

The **URI** and **Pinhead Index** scores for theses SSSI units clearly indicate the Dol y mynach/Gro Woods complex is of SSSI quality. They are within the extensive Elenydd SSSI, whereas most units of the Elan Valley Woodlands SAC are in standalone SSSI such as Caban Lakeside Woodlands SSSI or Carngafallt SSSI. The occurrence of some of the less widespread/scarcer/rarer *Parmelietum* community **URI** species such as *Bunodophoron melanocarpum* **NT** in Wales, and *Pertusaria ophthalmiza* **NS DD** in Wales, also supports this assessment, as does the presence of rare species recorded on high quality deadwood habitat: the pinhead *Microcalicium ahlneri* **NS VU** in Wales, and the very rare *Chrysothrix chrysophthalma* **NR**, **?CR** in Wales. Old/veteran trees also support provides specialist dry bark niches (e.g. for *Bactrospotra corticola* **NS**, **NT** in Wales, and *Chaenotheca hispidula* **NS**) and also niches also for other notable species (e.g. *Coenogonium confusum* **NS**, **NT** in Wales, *Opegrapha fumosa* **NS**, **VU** in Wales).

9. Lichen flora of the SAC

The SAC supports internationally important lichen-rich pasture woodlands (e.g. Sanderson, 2014, 2019). The 2022 desk study found that the SAC supports a huge number of Red-listed species (summarised below and listed in Table 4).

Many of the species are very rare or localised with some only occurring at one or two sub-sites or even on only a few trees. Many of the component sites are also non-contiguous and relatively isolated. Increasing connectivity between sub-sites is recommended (section 10) to improve the long term resilience of the woodland lichen floras in the face of 'extinction debts' due to 19th and 20th Century intensive management and past SO_2 pollution, as well as current threats such as ammonia pollution and climate change. However any woodland expansion/restoration should be done with the niche requirements of lichens in mind. Inappropriate restoration practices could be disastrous for the remnant flora (see discussion, section 10).

Species Red-listed in Wales.

- 1 species that has recently become extinct (**RE**) in Wales
- 2 Red-Listed Critically Endangered **CR** in Wales
- 4 that are almost most certainly Critically Endangered **?CR** in Wales (not formally evaluated by Woods (2010) but qualifying as **CR** in Wales): *Biatora ligni-mollis, Buellia violaceofusca, Chrysothrix Chrysophthalma, Enterographa sorediata*.
- 2 Red-Listed Endangered **EN** in Wales
- 19 Red-Listed Vulnerable **VU** in Wales
- 34 Red-Listed Near Threatened **NT** in Wales (an additional species is probably just outwith the SAC)
- 5 Data Deficient **DD** in Wales(an additional species is probably just outwith the SAC)
- 2 Not Evaluated **NE** in Wales (*Antennulariella lichenisata* **NS E IR** and *Burgoa splendens*)

A table of Red-listed lichens recorded in the SAC is presented as Table 4 in the Appendices.

10. Discussion

10.1 History and historical threats

The 1888 Six-inch map (survey date 1887) shows most of Gro as mixed broadleaved/planted conifer wood but the far south section of Gro as broadleaved. Dol y mynach is shown as broadleaved pasture woodland in 1887; this was presumably managed as sheltered winter grazing. The 20th Century conifer areas include mosaics of open ground with scattered stands of broadleaves and scattered stands of planted conifers. These higher altitude areas in transition to moorland were presumably managed by summer grazing.

The open grown veteran pasture trees through the site and wider SAC are remnants of the pasture woodland that predates the 19th Century enclosures (Sanderson 2014, 2019). Most of the oaks at Gro are tall straight stemmed oaks that appear to be even aged and of plantation origin, but some stands are not as closely spaced as, or as overwhelmingly dominated by oak as, some other stands of plantation oaks in Wales. At Gro, the presence of some gladed areas, post mature oak and birch trees point to a more mixed management history probably with periods of woodland management (e.g. thinning of oaks and/or removal of conifers of plantation origin shown on the 1887 maps) and periods of grazing.

In the 20th Century industrial conifer forestry was established over large areas e.g. north of Dol y mynach and upslope of Gro Woods. More veteran pasture trees were lost during this phase of forestry too.

10.2 Recent and current threats

Today the greatest concentration of veteran pasture trees is at Dol y mynach but locally Gro supports significant stands. These are the relict trees that have survived past management for wood products (e.g. timber/faggots) and have not been lost to industrial coniferisation. In addition to historical decline/loss of prime habitat (loss of open grown pasture trees) a major threat to lichens has been decline in condition of remaining trees. The decline in condition relates to atmospheric pollution (acid rain effects/SO_2 and more recently reactive N, section 10.3) and the shading of lower trunks that relates to reduction/removal of browsing (section 10.4). There is some evidence of fire damage at Dol y mynach but how intense/widespread and when this occurred is unknown (see TN36).

10.3 Pollution

The *Lobarion* community is very sensitive to SO_2 pollution and, although some forms of woodland management such as tree felling will have removed the *Lobarion* lichen habitat directly and led to declines, its apparent absence from the study site on veteran oaks (often a key habitat for the *Lobarion* where conditions are suitable) probably largely relates to past acid rain effects. Currently the main pollution effect is from reactive N (ammonia, NO_x and long-range wet N-deposition). There were no obvious signs of widespread high levels of N pollution in 2021 (e.g. large, noticeable

patches of nitrophyes such as *Xanthoria parietina* and *Physcia* spp.), but locally there were some signs of enrichment on some oak twigs at Dol y mynach (some *Physcia tenella* and *Caloplaca flavocitrina*).

The *Parmelietum laevigatae* is a community of acidic bark and is very vulnerable to ammonia pollution. The *Parmelietum* was occasional to locally frequent including some notable species. *H. laevigata* was only well developed locally and this could potentially be a result of pollution, but there were recently colonised thalli of this species so perhaps not. A clearer indication of the threat is an apparent decline in *Bryoria fuscescens* since 1998 (section 7.2). *Bryoria fuscescens* is an N-sensitive species considered to be declining in mid and north wales due to ammonia pollution (Bosanquet, 2019). More detailed pollution-specific monitoring would be needed to get a handle on the effects of N-pollution in the study site, but the apparent decline of a species that appears to be particularly sensitive to ammonia pollution does not bode well for the old woodland lichen flora.

10.4 Grazing, regeneration, infill and woodland structure

The main lichen interest at both sites is strongly associated with woodland features that arise under browsing - and maintenance of high lichen interest in woodlands is dependent on grazing. With heavy browsing a rich lichen flora can persist for long periods and in the absence of other factors (such as intensive woodland management and pollution) decline in the lichen flora is gradual, occurring over relatively long timescales (being largely driven by cumulative loss of veterans over time due to natural death). In contrast, without sufficient browsing the lichen flora can decline very quickly (within 5-20 years if browsing is very low/excluded); this is largely due to increased shade on lower trunks (e.g. due to tree regeneration, ivy).

At some point in the recent past (late 20th century?) grazing has been removed from former the pastures in the SAC and this is very clear at Dol y mynach (Figures 16-18). This led to a regeneration phase with young mature established trees at Dol y mynach having now established. There have also been more recent flushes of regeneration (pole and sapling stages), especially at Dol y mynach and on the conifer clearfells adjacent to both sites.

Currently the shade from infill poses a serious threat to the lichen interest. The infill of the pasture woodland at Dol y mynach will irrecoverably change the character of the woodland without intervention. The lichen flora will decline and the stands will develop into high forest with considerably higher shade levels and much lower lichen interest. Some of the southern section of Gro Woods is similarly infilling (with saplings/pole) and the northern section of Gro has locally abundant seedlings/saplings.

At Dol y mynach there has been some recent management to address the problem frequent widespread tree regeneration poses for lichens (e.g. halo thinning) but much more work is needed urgently, especially halo thinning saplings/poles around veteran trees. Many examples are given in the Target Notes. Although some denser groves of trees are fine and add to variety of a site, restructuring of some the young maturing

stands would be useful to try to establish a more open woodland akin to wood pasture.

To avoid continual rounds of intervention to control regrowth of cut stumps/further regeneration, appropriate levels of browsing are required. Increasing browsing is urgently required at Dol y mynach (ideally the introduction of cattle).

At Gro the problem with regeneration is much more localised but still needs some intervention such as halo thinning to secure the existing lichen interests (examples are given in the Target Notes). Gro is oak dominated and it is good for stands to diversify in composition (which is happening[1]) but maintenance of some areas with gladed conditions is important for the existing lichen flora. Retention of some long term glades with only sparsely successful or failed regeneration is desirable. Regeneration near older birch and oak (especially old open grown trees) will threaten the *Parmelietum* interest (on birch and older oaks) and the specialist deadwood interest on the veteran oak.

Increased browsing is desirable in some areas at Gro (see TNs) and should minimise the need for manual interventions if done soon enough. Monitoring the situation with regards to abundance of regeneration at Gro is essential.

[1] Rowan is the most common tree sapling in the understorey (holly is more local) but where there are more gladed conditions birch and oaks seem to establish ok. Hazel saplings were only seen in the clearfell conifer areas, not within the oakwood.

Figure 16: pole stage regeneration around veteran pasture trees at Dol y mynach (target note TN41).

Figure 17: pole stage regeneration around veteran trees at Dol y mynach (target note TN45).

Figure 18: sapling and pole stage regeneration around veteran pasture trees at Dol y mynach (target note TN54).

10.5 Future veterans

Halo thinning around existing veterans and using appropriate browsing to control regeneration should be the priority, but the development of potential future lichen habitat is also important. Encouraging the development of future veteran habitat with a diverse range of microhabitat conditions/lichen niches is the key.

Restructuring some areas will increase diversity by creating glades/gladed conditions, appropriate browsing levels will allow some low level regeneration but maintain diversity by prevent infill of all glades with dense regeneration, and preventing long term succession to even-structured, dense canopy high forest.

In addition to halo thinning around the veterans, halo thinning saplings/poles around selected mature trees could be undertaken to promote the development of future veterans with a diverse range of lichen niches (e.g. see TN25).

Trees selected for management as 'future veterans' should not be limited to oak. Although the more notable species were recorded on veteran oak, birch is important for the *Parmelietum* community and some important notable species were recorded in this community on birch (e.g. *Bunodophoron melanocarpum* **NT** in Wales). Veteran birch is an important, largely missing component of the oak dominated woods and development of future veteran birch (as well as veterans of other species such as rowan, hazel and holly) should be promoted.

The trees should be selected on the basis of current form. For example specimens with more interesting form such as low split trunks, multi-stemmed trunks, leaning trunks, large low limbs, will provide more niches than trees with tall straight trunks with no lower limbs. Appropriate browsing levels would be essential to maintain niches in suitable condition for lichen colonisation as the trees age.

Opening up some glades within the denser, even-aged oak areas at Gro would allow for diversification of structure over a shorter timescale than waiting for natural thinning of the oak stands. There is a good argument for opening up glades and thinning within even-aged oak stands with a view to allowing existing mature trees to establish as suitable replacement veterans sooner rather than awaiting tree deaths to open things up. Ideally sparse regeneration associated with glades would allow a new generation of open grown trees to establish in or at the edges of glades. This would require sufficiently sized glades and appropriate browsing levels/manual interventions, in order to secure veterans of the future with open grown form, and relatively well-lit trunks.

10.6 Conifer forestry

The clearfells adjacent to Dol y mynach and Gro are dominated by dense thicket regeneration that will establish into dense high forest (which would be unsuitable for colonisation by old growth lichens). Ideally significant networks of these areas would be heavily thinned to encourage development of a more patchy structure; areas with a more open woodland structure would over time would become more suitable for colonisation by old growth lichens. The priority for thinning/restructuring operations

should be areas adjacent to the existing wood pasture and areas that would increase connectivity between the SSSI units/component woods of the SAC.

10.7 Habitat networks and woodland restoration at the landscape scale

Many of the component woodlands of the SAC are relatively isolated. Given the poor establishment /colonisation capabilities of 'old growth' lichens (the main species of interest recorded during the survey) steps should be taken to increase connectivity but great care should be taken to ensure this is done with particular consideration of the specific niche requirements of lichens. As discussed above, dense thicket regeneration over large expanses will produce unsuitable habitat for lichen colonisation, and regeneration close to existing veteran trees can be disastrous for the lichen flora on those trees. Management to maintain /improve current conditions for old growth lichens (as the only colonisation sources we have) is the priority, with suitably sensitive restoration over suitable timescales to increase connectivity at the landscape scale over the longer term (Acton, in prep.). Restoration that compromises the existing interest or establishes unsuitable habitat for colonisation is incompatible with the maintenance/recovery of high quality lichen interest. With suitable restoration the lichen flora could improve over time and be more resilient to future pressures such as climate change.

11. References

Acton, A. In prep. *Lichens, Woodland Management & Woodland Restoration*. British Lichen Society.

Acton, A. 2000. *LIFE Celtic Rainforests Project: Lichen Monitoring - southern section*. Unpublished report to Snowdonia National Park Authority.

Coppins, A. M. & Coppins, B. J. 2002. *Indices of Ecological Continuity for Woodland Epiphytic Lichen Habitats in the British Isles*. British Lichen Society, London.

Sanderson, N.A. 2014. *Lichens & Woodland Management. Carngafallt RSPB Reserve Breckonshire.* Unpublished report to Plantlife International and RSPB.

Sanderson, N.A. 2019. *Epiphytic Lichen Survey of Caban Lakeside Woodlands SSSI and Coedydd Glannau a Cwm Coel SSSI Elan Valley Radnor*. NRW Evidence Report no. 378.

Sanderson, N.A., Wilkins, T.C., Bosanquet, S.D.S and Genney, D.R. 2018. *Guidelines for the Selection of Biological SSSIs Part 2: Detailed Guidelines for Habitats and Species Groups. Chapter 13 Lichens and associated microfungi.* Joint Nature Conservation Committee, Peterborough.

Smith, C. W., Aptroot, A., Coppins, B. J., Fletcher, A., Gilbert, O. L., James P.W. & Wolseley. P. A. 2009. *The Lichens of Great Britain and Ireland*. London: British Lichen Society.

Woods, R.G. 2010. *A Lichen Red Data List for Wales*. Plantlife, Salisbury.

Woods, R.G. & Coppins, B.J. 2012. A *Conservation Evaluation of British Lichens and Lichenicolous Fungi*. *Species Status 13*. Joint Nature Conservation Committee, Peterborough. http://jncc.defra.gov.uk/pdf/Lichens_Web.pdf

12. Appendices

The Appendices of data tables and location photographs have been removed from this version of the report because it is not possible to make them comply with Accessibility legislation. Full PDFs of the report are stored by the Natural Resources Wales Library and the National Library of Wales.

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