YSTRADFFIN HEP

BRYOPHYTE MONITORING (YEAR 2)

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GRITTEN ECOLOGY

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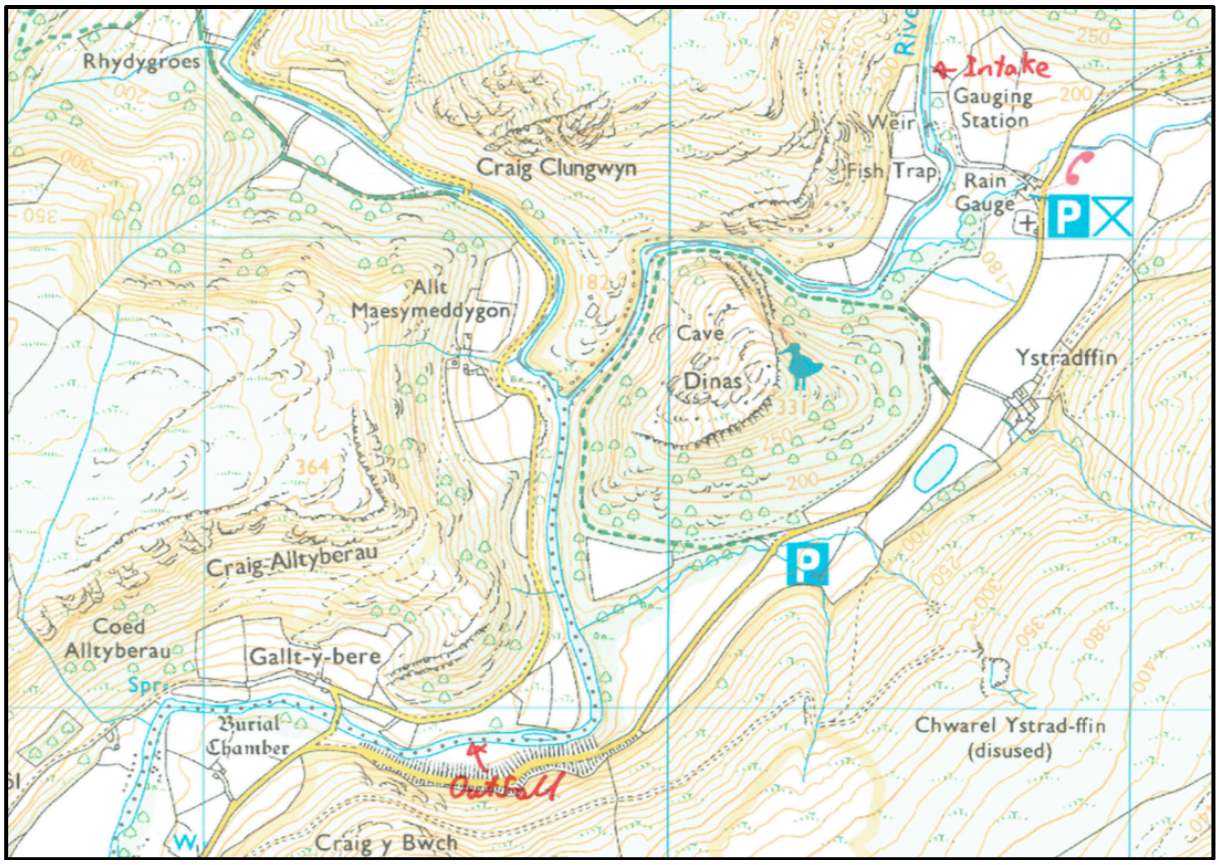
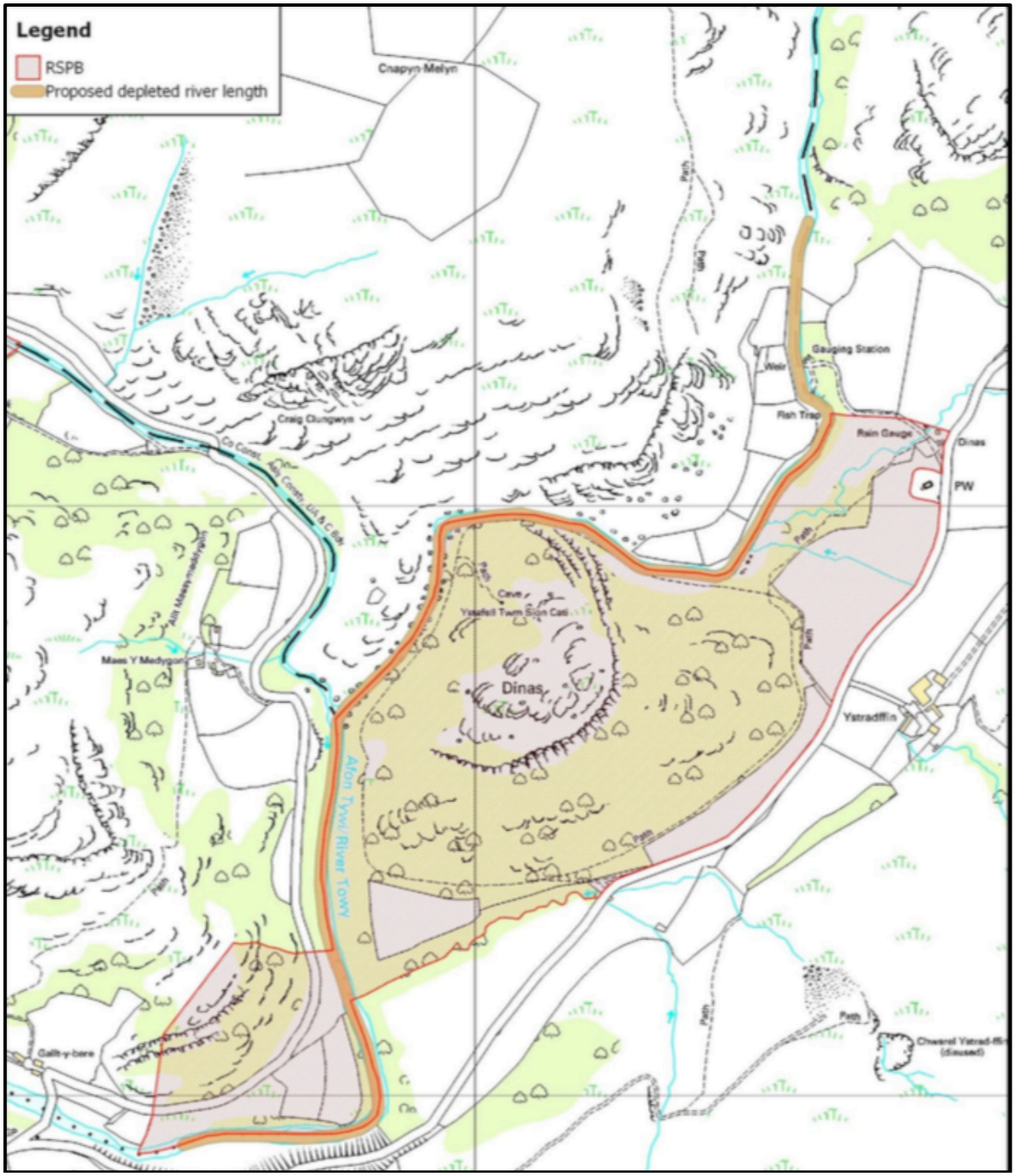
1.0 INTRODUCTION

A run-of-river Hydro-electric (HEP) scheme on the Afon Tywi at Ystradffin, Rhandirmwyn, Camarthenshire (**Map 1**), has been granted planning permission and the scheme is now generating electricity. Whilst the Planning Application was being considered by the Local Planning Authority, concern was expressed by the RSPB that the distribution of a rare moss *Racomitrium macounii ssp. alpinum* that was found in two previous surveys beside the river might be affected by water abstraction. The depleted reach of the Afon Tywi runs along the western boundary of the Gwenffrwd Dinas RSPB reserve. This reserve lies within the Cwm Doethie-Mynydd Mallaen Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC), and the Elenydd-Mallaen Special Protection Area (SPA). The boundaries of the RSPB reserve are shown in **Map 2**).

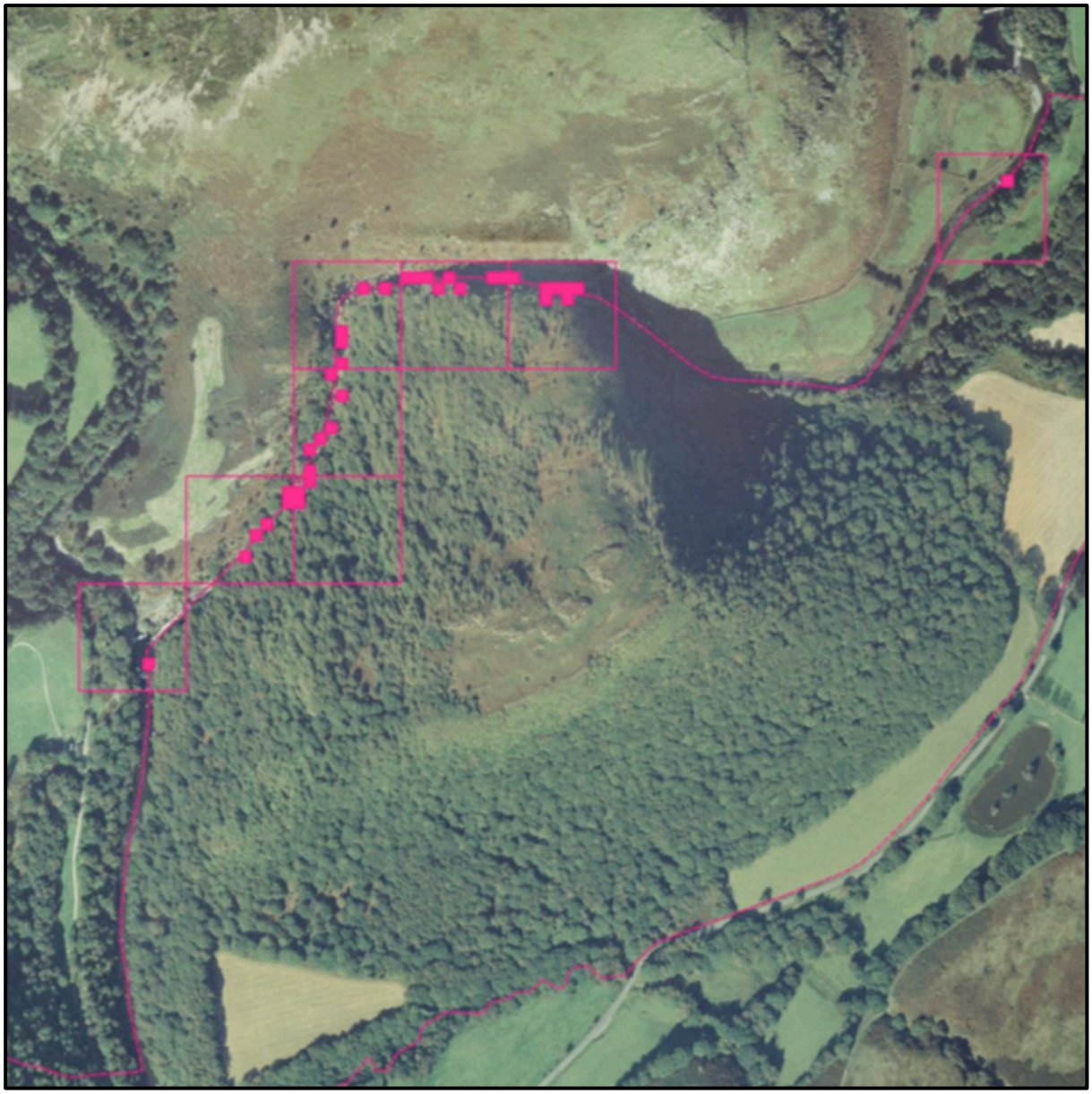


Map 1: Gwenffrwd Dinas RSPB reserve with the Intake and Outfall for the HEP scheme marked.

R. macounii ssp. alpinum is Red listed in Wales (Bosanquet & Dines, 2011) and present in only one other site in South Wales. Its distribution in the Gwenffrwd Dinas reserve was studied during surveys by Lansdown (2011) and Callaghan (2017). A map of the distribution of *R. macounii* was made by Callaghan (2017) and is shown here as **Map 3**.



Map 2: The boundary of the Gwenffrwd RSPB reserve and the depleted reach of the Afon Tywi (from Callaghan (2017)).



Map 3: The distribution of *R. macounii ssp. alpinum* along the Afon Tywi in the Gwenffrwd Dinas RSPB reserve (taken from Callaghan (2017).

According to Newton (2011), the distribution of the Nationally Scarce (Pescott, 2016) *R. macounii ssp. alpinum* in Wales is probably more widespread than is presently understood. She describes the species as "… a colonist of rock exposures and large boulders in fast-flowing acidic rivers, in situations that are subject to periodic inundation. It occurs low down in the bed of the river where it is frequently exposed but is also common on the tops of massive rock exposures that are under water only in times of full spate conditions".

She continues "…within the surveyed length of the Afon Tywi, *R. macounii ssp. alpinum* was reported to be "frequent on bedrock and boulders in the channel and margins (Lansdown survey). It is further described as growing "in a fairly narrow zone between the water level at the time of the survey (which was probably around the normal summer water level) and a level approximately 1m above this (Lansdown survey)." That *R. macounii ssp. alpinum* in the Afon Tywi tends to favour the level tops

of boulders, as is normally the case and often at much greater heights above summer water levels, is evidence that the species is not totally dependent on constant or even frequent inundation".

Following Callaghan's (2017) survey, he described *R. macounii ssp. alpinum* as being "… clearly the most important bryophyte found during the survey…" and that "… a highly significant population is present within the area surveyed … where it is very closely linked with the river".

Accordingly, a baseline monitoring protocol of *R. macounii ssp. alpinum* was established on 28th September 2020 *before the installation of the HEP scheme was completed* (Gritten, 2020). The five permanently marked quadrats were relocated and their bryophyte assemblages recorded during fine weather on 25.8.22 by **Gritten Ecology**.

It should be noted that the Afon Tywi along the depleted reach is subjected to a very highly regulated flow from the Llyn Brianne reservoir approximately 300 metres above the Intake Weir. Generally, it is understood that winter water levels are kept artificially high to allow for the free movement of migratory Salmonids.

2.0 METHODOLOGY

The following methodology was used, based on similar protocols already established by **Gritten Ecology** in other rivers subject to HEP scheme proposals elsewhere. This has already been described in Gritten (2020) for the Ystradffin HEP scheme but is worth repeating here.

1. Two suitable sites with similar bryology were located within the depleted reach on the east bank within the area of *R. macounii ssp. alpinum* distribution shown in **Map 3**. By and large, sites were selected at approximately the same height above the river and within the same distance from the river's edge. Several photographs were taken from progressively closer distances to aid relocation of each quadrat. A written description was also made to assist in quadrat site relocation (see Gritten, 2020).
2. Where possible, each quadrat site or suite of quadrat sites was selected with a future (re-monitoring) reproducible statistical analysis in mind and the proximity of prominent features. This latter is very important since future quadrat site relocation is crucial.
3. Whilst each site (and its landmark approaches) was described in detail, the reasons for the selection of each quadrat site was also described.
4. Aspect (using a compass), level to the horizontal (using Apple's iLevel Handy) and10-figure GPS NGRs (using a Garmin eTrex) were noted for each quadrat.
5. Each of the five quadrats was 25 x 25 cm permanently marked with yellow rawl plugs, generally at the top two corners drilled into the rock with a portable SDS drill. In all cases, and especially where the bryophyte sward was deep, two corners were marked with stainless steel screws screwed into the rawl plugs

(after the bryophytes had been monitored). (These can be very accurately relocated with a Garrett Pro-Pointer® All Terrain hand-held metal detector). Experience gained elsewhere shows that the use of rawl plugs alone is quite insufficient since a great deal of time and effort with a probing knitting needle needs to be utilised in order to relocate corner quadrat markers. This also can create a great deal of damage to the very bryophyte sward that is being measured. In any event, relocation of the quadrat corner markers, once the general area has been found with a metal detector, is best achieved by gentle probing with a knitting needle.

6. A 220mm double point knitting needle was inserted into each of the two rawl-plugged holes. The top left and right corners of the quadrat (**Photo 1**) can be accurately positioned against the knitting needles or hung from them if the quadrat has been placed off the horizontal.
7. Each quadrat is divided into a grid of 100 x 2.5cm^2 squares and all species found in each square were noted.
8. A close-up photograph of each quadrat was taken (see **Photo 1**, for example) but it was considered unnecessary to repeat the close-up photographs during the 2022 monitoring.
9. Stainless steel screws were screwed into rawl-plugs once bryophyte distribution had been recorded.

Photo 1: Quadrat 4 *in situ.*

3.0 RESULTS

The results of the repeat quadrat analysis are shown in Appendix 1. All the five quadrats were relocated but, for ease of relocation, it is recommended that **Photo 1** above is used to relocate the exact position of Quadrat 4 in the future.

The data from the five quadrats has been summarised and compared with the baseline (2020) monitoring in **Table 1**.

	Q1		Q2		Q3		Q4		Q5	
	2020	2022	2020	2022	2020	2022	2020	2022	2020	2022
Racomitrium macounii	35	39	36	37	28	28	73	79	12	12
Racomitrium aciculare	6	12	56	62	39	43	35	46	1	1
Racomitrium heterostichum							2	3	41	44
Sciuro-hypnum plumosum	2	2	4	4	10	12	2	8	10	16
Pogonatum urnigerum			2	1	7	29				
Bryum pseudotriquetrum			1	1						
Fissidens taxifolius								2		
Polypodium vulgare								2		
Thamnobryum alopecurum							24	29	3	3
Campylopus flexuosus									30	33
Marsupella emarginata									8	17
Cladonia subcervicornis										11

Table 1: Summary results of 2020 (baseline) and 2022 monitoring.

4.0 DISCUSSION

- It is interesting to note that all species found in the quadrats either remained stable or increased in abundance over the two-year period.
- **Racomitrium macounii ssp. alpinum:** It is interesting to note that this critical species has remained unchanged in abundance in Quadrat 3 and 5 between 2020 and 2022, and actually increased in the other three quadrats. Since this is the species of most concern in this reserve, being the rarest, this result is gratifying. However, it is not clear whether the increase is the result of natural growth rates or can be attributed to some other external cause. A reduction in abundance would be of some concern since it might have been attributable to water abstraction during the running of the HEP scheme. It is also interesting to note the general (if slight) increase in abundance given the very dry summer we have experienced this year. Clearly, this species, being isolated to rocks very close to the Afon Tywi and physiologically dependent on the resultant higher humidities, is thriving despite water abstraction. Whether the variable flow rate, modified by the presence of the Llyn Brianne dam upstream, has a measurable influence on the growth rates (abundance and distribution) of this species is difficult to ascertain at this early stage.

- **Racomitrium aciculare:** This species increased in abundance in four out of the five quadrats. It is known from monitoring exercises conducted on other HEP schemes that this species is a rapid coloniser of bare rock, so it is hardly surprising that it has increased in abundance. This is most likely to be a natural process completely independent of whether water abstraction is occurring or not.

- **Sciuro-hypnum plumosum:** The abundance of this species has either remained the same or actually increased in the five quadrats in two years. Again, experience has shown that *S. plumosum* is an efficient coloniser of bare rock so its increase is to be expected.

- **Pogonatum urnigerum:** The dramatic increase of this species in Quadrat 3 is difficult to explain but may be a natural phenomenon. Its spread should be carefully monitored to determine whether this robust species has a negative influence on the abundance of *R. macounii ssp. alpinum*, which has remained to date at the same abundance in this quadrat.

- **Polypodium vulgare:** The Common Polpody fern is colonising Quadrat 4. This is considered to be a natural process and suggests the density of (dead) organic matter is accumulating in the bryophyte sward. However, it is unclear whether this will have a negative impact on the abundance of *R. macounii ssp. alpinum*, which in this quadrat has increased in abundance more than in any of the other quadrats (73 2.5 cm^2 squares to 79). *R. macounii ssp. alpinum* is not a robust species and, while it does grow into more or less compact swards, is nevertheless considered to be vulnerable to what appears to be the natural successional process of fern colonisation. Time will tell.

- **Cladonia sp (probably subcervicornis):** This lichen is colonising Quadrat 5. Although considered to be a natural phenomenon, its encroachment may have an impact on the abundance of *R. macounii ssp. alpinum*.

- There is bare rock in all the five quadrats selected and this will provide niches for the spread of *R. macounii ssp. alpinum* in the future.

5.0 CONCLUSION

The stable or increased abundance of *R. macounii ssp. alpinum*, on the face of it, does not appear to be being negatively affected by either abstraction from the HEP scheme nor the artificially variable flows caused by the Llyn Brianne dam a little upstream. However, it must be considered to be far too soon to say with any certainty whether this is a sign of a long-term trend. Two years' monitoring for slow growing bryophyte species is too short a time to detect any meaningful trend and it is recommended that a further monitoring exercise is carried out in 2024.

The change in abundance of several of the other species identified within the quadrats (and also general species composition) suggests that bryophyte swards growing so close to the river, being subjected to periods of desiccation, scour and inundation, represent a very dynamic community. It is impossible in the short term to be able to say whatever influences these changes are due to man-made causes or simply represent so-called natural dynamics.

It should be noted too that any conclusion postulated must be treated with some caution since no control swards of *R. macounii ssp. alpinum* have been identified outwith the reach affected by the HEP scheme.

It is also worth noting that all the surveys for this species to date have focussed on the eastern side of the river. A survey of the west bank might reveal more healthy stands. If the species is found to be equally abundant on the west side of the river, the population as a whole might be considered to be less vulnerable.

6.0 REFERENCES

Bosanquet, S.D. & Dines, T. (2011). *A Bryophyte Red Data List for Wales.* Salisbury, Plantlife.

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Newton, M.E. (2011). *Bryophytes and the potential hydroelectric scheme on the Afon Tywi.* Unpublished Report.

Pescott, O. (2016). *Revised list of nationally rare and scarce bryophytes for Britain*. Field Bryology **115: 22-30**.

7.0 APPENDIX 1

Quadrat	1
Date	25.8.22
Height of bottom edge above water level (mm)	500
Aspect (faces)(°)	82
Screws	Top two corners
NGR	SN78210 46944
Photos	
Level (°)	18.8

	1	2	3	4	5	6	7	8	9	10	
A						Ra	Ra				Ra=2
B								Ra	Ra		Ra=2
C		Ra				Ra	Rm	Rm	Ra		Ra=3 Rm=2
D	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm		Rm	Rm=9
E	Rm	Rm	Rm	Rm	Rm	Rm	Rm		Rm	Rm	Rm=9
F	Rm	Rm	Rm	Rm Shp	Rm Shp					Rm	Rm=6 Shp=2
G	Rm	Rm	Rm	Rm	Rm	Rm	Rm	Rm			Rm=8
H				Rm	Rm	Rm	Rm Ra	Rm Ra		Ra	Rm=5 Ra=3
I							Ra				Ra=1
J			Ra								Ra=1

Abbreviations: Ra = Racomitrium aciculare, Rm= Racomitrium macounii ssp. alpinum, Shp = Sciuro-hypnum plumosum.

Notes: Whole rock is covered in sediment from a flash event. Waders needed to survey this site.

Quadrat	2
Date	25.8.22
Height of bottom edge above water level (mm)	300
Aspect (faces)(°)	As Q1
Screws	Top two corners
NGR	As Q1
Photos	
Level (°)	24

	1	2	3	4	5	6	7	8	9	10	
A		Ra	Ra					Ra	Ra		Ra=4
B	Ra		Ra	Ra				Ra		Ra	Ra=5
C	Ra				Ra				Ra	Ra	Ra=4
D	Shp Ra Pu	Shp Ra			Ra	Ra	Ra		Ra	Ra	Ra=7 Shp=2 Pu=1
E	Pu Ra	Ra	Ra	Ra	Ra				Ra		Ra=6 Pu=1
F	Ra	Ra Rm	Ra Rm	Ra	Ra	Ra	Ra	Shp	Ra		Ra=8 Shp=1 Rm=2
G	Ra Rm	Ra Rm	Rm	Ra Rm	Ra Rm	Ra Rm	Ra Rm	Ra	Ra	Ra	Ra=9 Rm=7
H	Rm	Rm	Rm	Rm	Rm Ra	Rm Ra	Ra	Ra Rm	Ra Rm	Rm	Rm=9 Ra=5
I	Bs Ra Rm	Ra Rm	Rm	Rm Shp	Ra Rm	Ra Rm	Ra Rm	Ra Rm	Rm	Ra Rm	Bs=1 Ra=7 Rm=10 Shp=1
J	Ra	Ra Rm	Ra Rm	Ra Rm	Ra Rm	Rm	Rm	Rm Ra	Rm	Ra Rm	Ra=7 Rm=9

Abbreviations: Rm =Racomitrium macounii ssp. alpinum, Ra = Racomitrium aciculare, Shp = Sciuro-hypnum plumosum, Bs = Bryum pseudotriquetrum, Pu = Pogonatum urnigerum.
Notes: Whole rock is covered in sediment from a flash event. Waders needed to survey this site.

Quadrat	3
Date	25.8.22
Height of bottom edge above water level (mm)	500
Aspect (faces)(°)	31
Screws	Top two corners
NGR	As Q1 and Q2
Photos	
Level (°)	3.8 (almost horizontal)

	1	2	3	4	5	6	7	8	9	10	
A			Ra	Ra							Ra=2
B				Ra							Ra=1
C		Ra	Ra	Ra			Ra				Ra=4
D	Ra	Ra			Ra	Pu Ra	Ra Rm Pu	Ra Pu	Ra		Ra=7 Rm=1 Pu=2
E	Ra	Ra	Ra	Ra		Rm Pu	Ra Rm Pu	Ra Rm	Ra		Ra=7 Rm=3 Pu=2
F		Shp	Shp Pu	Ra Pu	Ra Pu	Ra Rm	Ra Pu Rm	Ra Pu	Ra		Shp=2 Pu=5 Ra=6 Rm=2
G		Shp	Ra Shp Rm Pu	Ra Rm Pu	Rm Pu	Pu Rm	Pu Rm	Rm Ra Pu	Ra		Shp=2 Ra=4 Rm=6 Pu=6
H			Rm Pu	Pu Ra Rm	Pu Rm	Rm Pu	Rm Pu	Rm Pu	Shp	Ra	Rm=6 Ra=2 Shp=1 Pu=6
I			Ra Rm Pu	Ra Rm Pu	Rm Pu	Rm Pu	Shp Rm Pu	Shp Rm Pu	Shp	Ra	Ra=3 Rm=6 Pu=6

											Shp=3
J			Ra Pu	Ra Rm Pu	Ra Rm	Ra Rm	Shp Ra Rm	Shp Ra	Shp	Shp Ra	Ra=7 Pu=2 Rm=4 Shp=4
Abbreviations: Rm =Racomitrium macounii ssp. alpinum, Ra = Racomitrium aciculare, Shp = Sciuro-hypnum plumosum, Pu = Pogonatum urnigerum.											
Notes: Whole rock is covered in sediment from a flash event. Waders needed to survey this site. Note the colonisation of *P. urnigerum* over the entire quadrat.											

Quadrat	4
Date	25.8.22
Height of bottom edge above water level (mm)	1005
Aspect (faces)(°)	350
Screws	Top two corners
NGR	SN78149 46982
Photos	
Level (°)	28

	1	2	3	4	5	6	7	8	9	10	
A	Rm	Rm	Ra Rm	Ra	Rm	Ra Rm	Ra Rm	Ra Rm	Ra Rm	Ra	Ra=7 Rm=8
B	Ra Rm	Ra Rm	Ra Rm	Ra Rm	Ta Ra Rm	Ta Ra Rm	Ta Ra Rm	Ta Ra Rm	Ra Rm	Ra	Ra=10 Rm=9 Ta=4
C	Rm	Rm	Ra Rm	Ra Rm	Ta Rm	Ta Rm	Ta Rm	Ta Ra Rm	Rm	Ra Rm	Ra=4 Ta=4 Rm=10
D	Ra Rm	Ra Rm	Ra Rm	Ra Rm Pv	Ra Rm Ta	Ta Rm	Ta Rm Ra	Ta Rm	Ta Rm	Ra Rm	Ra=7 Rm=10 Ta=5 Pv=1
E	Rm Ra	Ta Rm	Rm Ra	Ra Rm	Ra Rm Ta	Ta Rm Ra	Ta Rm Shp	Ta Rm Ft	Ta Rm Ft	Rm Shp	Ra=5 Ta=6 Rm=10 Shp=2 Ft=2
F	Rm Shp Ra	Ta Rm	Rm	Rm	Rm	Ta Rm Pv	Rm Ta	Rm Ta	Ta Rm Ra	Ra	Ra=3 Shp=1 Rm=9 Pv=1 Ta=5

G	Rm	Rm Ta	Rm	Rm	Rm	Rm	Rm Ta Shp	Rm	Rh	Ra	Rm=8 Ta=2 Ra=1 Shp=1 Rh=1
H	Ta Rm	Ta Rm	Rm	Rm	Rm	Rm Ta	Rm	Rm Ra	Rh		Ta=3 Ra=1 Rm=8 Rh=1
I	Ra	Rm	Rm	Rm	Rm	Rm Ra	Rm	Rm Ra	Ra Shp Rh	Shp	Ra=4 Shp=2 Rm=7 Rh=1
J	Ra			Shp		Shp		Ra	Ra	Ra	Ra=4 Shp=2
Abbreviations: Rm =Racomitrium macounii ssp. alpinum, Ra = Racomitrium aciculare, Shp = Sciuro-hypnum plumosum, Pv = Polypodium vulgare, Rh = Racomitrium heterostichum, Ta = Thamnobryum alopecurum, Ft = Fissidens taxifolius.											
Notes: Q4 is one meter upstream of small *Salix cinerea.* There is a large patch of Rm thriving to the left of the quadrat.											

Quadrat	5
Date	25.8.22
Height of bottom edge above water level (mm)	1380
Aspect (faces)(°)	100
Screws	Top two corners
NGR	As Q 4
Photos	
Level (°)	45

	1	2	3	4	5	6	7	8	9	10	
A	Ta	Ta Cf Clad	Ta Cf Clad	Cf Me Clad	Me Cf	Me	Me	Me	Me	Cf Me	Ta=3 Clad=3 Cf=5 Me=7
B	Shp	Shp Cf Clad	Shp Cf Clad	Shp Cf Clad	Cf	Cf Shp Me	Shp Me	Cf Shp Clad	Cf Clad	Cf Me	Shp=7 Cf=8 Clad=5 Me=3
C	Rh Shp Cf	Shp Cf Clad	Shp Cf Clad	Rh Cf	Shp Cf	Cf	Shp Rh	Rh Cf Me	Cf Me		Rh=4 Shp=5 Cf=8 Clad=2 Me=2

D	Cf	Rm Me	Rm Clad Me	Rm Shp	Rm Shp	Rm Shp	Cf Rh	Rh Me	Rh Me	Rh	Cf=2 Rm=5 Me=4 Rh=4 Clad=1 Shp=3
E	Cf Rh	Cf Rh Rm	Rm	Rm	Rm	Rm	Rh	Rh	Rh	Shp	Cf=2 Rh=5 Rm=5 Shp=1
F	Ra Rh Cf	Rh Cf	Rh Cf	Rm	Rh Rm	Rh		Rh	Rh	Rh	Ra=1 Rh=8 Rm=2 Cf=3
G	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh	Rh Cf	Rh=10 Cf=1
H		Rh	Rh	Rh Cf	Rh	Rh	Rh	Rh	Rh	Rh	Rh=9 Cf=1
I					Rh		Cf	Cf Me			Rh=1 Cf=2 Me=1
J	Rh							Rh Cf	Rh		Rh=3 Cf=1
Abbreviations: Rm =Racomitrium macounii ssp. alpinum, Ra = Racomitrium aciculare, Shp = Sciuro-hypnum plumosum, Rh = Racomitrium heterostichum, Ta = Thamnobryum alopecurum, Clad = Cladonia sp., Cf = Campylopus flexuosus, Me = Marsupella emarginata.											
Notes: Me appears to be senescing despite increase since 2020.											