

# Assessment of plant community attribute of ‘Ranunculon river habitat’ Annex 1 Habitat (H3260) and Floating water-plantain *Luronium natans* Annex II Species (S1831) of the Afon Gwyrfai a Llyn Cwellyn SAC

Report No: 966

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Report series: Evidence Report

Report number: 966

Publication date: February 2026

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Title: **Assessment of plant community attribute of ‘Ranunculion river habitat’ Annex 1 Habitat (H3260) and Floating water-plantain *Luronium natans* Annex II Species (S1831) of the Afon Gwyrfai ac Llyn Cwellyn SAC**

Author(s): R.V. Lansdown, S. Hearn and F. Sanchez

Technical editor: Suzanne Hearn

Quality assurance: Tier 3

Peer reviewer(s): Jennifer Owen

Approved by: R. Thomas and R. Cardwell

Restrictions: None

## Recommended citation for this volume:

Lansdown, R.V. Hearn, S. Sanchez, F. 2026. Assessment of plant community attribute of ‘*Ranunculion* river habitat’ Annex 1 Habitat (H3260) and Floating water-plantain *Luronium natans* Annex II Species (S1831) of the Afon Gwyrfai ac Llyn Cwellyn SAC. Evidence Report, Report No: 966, 61pp, NRW, Bangor.

## Acknowledgements

The author is profoundly grateful to Francesca Sanchez, Suzanne Hearn and Heather Garrett for their help with access, location of sites and with the actual survey, as well as with preparation of this report.

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## Crynodeb gweithredol

Mae Cyfoeth Naturiol Cymru (CNC) yn gyfrifol am ddynodi, monitro a rheoli Ardaloedd Cadwraeth Arbennig (ACA) o dan Reoliad 9(2) o Reoliadau Cadwraeth Cynefinoedd a Rhywogaethau 2017 (cyfieithiad y DU o'r Gyfarwyddeb Cynefinoedd). Mae cynefin afon *Ranunculus* yn cael ei adnabod yn fwy ffurfiol fel "Cyrsgiau dŵr o lefelau gwastadedd i fynyddig gyda llystyfiant *Ranunculus fluitantis* a *Callitricho-Batrachion*" (cod cynefin yr UE 3260) ac mae wedi'i restru yn Atodiad I i'r Gyfarwyddeb Cynefinoedd. Mae *Luronium natans* (cod rhywogaeth yr UE 1831) yn nodwedd rhywogaeth a restrir yn Atodiad II i'r Gyfarwyddeb Cynefinoedd.

Mae'n ofynnol i CNC werthuso statws cadwraeth cynefin afon *Ranunculus* a nodweddion *Luronium natans* gan ddefnyddio canllawiau Monitro Safonau Cyffredin (CSM) (JNCC 2016; JNCC 2004). Asesir y nodwedd yn erbyn wyth priodoledd; llif, ansawdd dŵr, strwythur cynefin, gwaddod mân, dangosyddion negyddol, casgliadau biolegol, dangosyddion o hynodrwydd lleol ac aflonyddwch dynol uniongyrchol, yn ogystal asesir priodoledd poblogaeth y rhywogaeth ar gyfer *Luronium natans*. Gall fod gan bob priodoledd fwy nag un is-briodoledd ac mae'r asesiad cyffredinol o nodwedd fel un ai "Ffafriol" neu "Anffafriol" yn seiliedig ar gasgliad o'r holl ddsbarthiadau priodoleddau (Llwyddo neu Fethu) (JNCC, 2016).

Mae Afon Gwryfai a Llyn Cwellyn yn un o saith afon yng Nghymru sydd wedi'u dynodi ar gyfer cynefin *Ranunculus* ac mae'r adroddiad hwn yn asesu'r priodoledd macroffyt ochr yn ochr â phriodoledd poblogaeth y nodwedd *Luronium natans*.

Casglwyd data gan ddefnyddio arolygon LEAFPACS a'u dadansoddi gan ddefnyddio'r ddwy daenlen awtomataidd gysylltiedig. Casglwyd data ac aseswyd cyflwr *L. natans* gan ddefnyddio arolygon wedi'u teilwra.

Mae arolygon yn dangos bod y priodoleddau a aseswyd yn pasio eu trothwyon. Roedd digonedd o algâu ffilamentaidd ger Betws Garmon (Adran 4) yn uwch nag yn yr adrannau eraill, gan awgrymu y gallai'r darn hwn fod mewn perygl ac mae'n haeddu ymchwiliad. O bosibl bu dirywiad hefyd yn niferoedd rhai rhywogaethau nodweddiadol, a dylid cadarnhau hynny drwy ailadrodd arolygon.

Mae'r adroddiad hefyd yn ystyried rhinweddau'r gwahanol offer a ddefnyddir i asesu cyflwr dyfroedd sy'n llifo. Mae hyn yn cynnwys adolygiad o opsiynau ar gyfer casglu data a allai alluogi asesiad mwy cadarn.

## Executive summary

Natural Resources Wales (NRW) is responsible for the designation, monitoring and management of Special Areas of Conservation (SACs) under Reg 9(2) of the Habitats and Species Regulations 2017 (UK translation of the Habitats Directive). Ranuncion river habitat is more formally known as “Water courses of plain to montane levels with the Ranuncion fluitantis and Callitricho-Batrachion vegetation” (EU habitat code 3260) and it is listed in Annex I of the Habitats Directive. Floating water-plantain, *Luronium natans* (EU species code 1831) is a species feature listed in Annex II of the Habitats Directive.

NRW is required to evaluate the conservation status of the Ranuncion river habitat and *Luronium natans* features using Common Standards Monitoring (CSM) guidance (JNCC 2016; JNCC 2004). The feature is assessed against eight attributes; flow, water quality, habitat structure, fine sediment, negative indicators, biological assemblages, indicators of local distinctiveness and direct human disturbance, in addition the species population attribute is assessed for *Luronium natans*. Each attribute may have more than one sub-attribute and the overall assessment of a feature as either “Favourable” or “Unfavourable” is based on a collation of all the attribute classifications (Pass or Fail) (JNCC, 2016).

The Afon Gwyrfai ac Llyn Cwellyn is one of seven rivers in Wales that are designated for Ranuncion habitat and this report assesses the macrophyte attribute alongside the population attribute of the *Luronium natans* feature.

Data were collected using River LEAFPACS surveys and analysed using the two associated automated spreadsheets. Data were collected and assessed on the condition of *L. natans* using tailored surveys.

Surveys show that the attributes assessed pass their thresholds. Abundance of filamentous algae near Betws Garmon (Section 4) was higher than in the other sections, suggesting that this stretch may be at risk of eutrophication and merits investigation. Potentially there has also been a decline in the abundance of some characteristic species which should be confirmed by repeat surveys.

The report also presents consideration of the merits of the different tools used for assessment of the condition of flowing waters. This includes a review of options for data collection which might enable more robust assessment.

## Introduction

The Afon Gwyrfai ac Llyn Cwellyn SSSI/SAC is in Gwynedd, North Wales and partly in Eryri National Park. The SSSI was notified in 2003 for its geological and biological features including running and standing waters, aquatic plant assemblages, floating water-plantain (*Luronium natans*), Arctic charr (*Salvelinus alpinus*), Atlantic salmon (*Salmo salar*) and otter (*Lutra lutra*). The Afon Gwyrfai ac Llyn Cwellyn SAC was designated in 2004 for its Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoëto-Nanojuncetea; water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation; Atlantic salmon; floating water-plantain; and otter (NRW 2022).

The Afon Gwyrfai is approximately 21 km long, from its source at Llyn y Gader through Llyn Cwellyn to its mouth on the Menai Strait, with a catchment area of 47.9 km<sup>2</sup>. The solid geology of the SSSI/SAC consists of Precambrian tuffs, Cambrian grits, Ordovician shales and tuffs, and a doleritic intrusion, while the drift geology consists of areas of glacial till with alluvium along the floodplain and riverbed. The river flows through unimproved and semi-improved grassland in its upstream reaches, with some broad-leaved woodland and improved grassland downstream.

The Afon Gwyrfai “is considered to be one of the best examples in the United Kingdom of an oligotrophic to mesotrophic river with submerged beds of aquatic plants, especially its Callitricho-Batrachion vegetation community. In the Gwyrfai this is composed primarily of extensive beds of intermediate water-starwort (*Callitriche hamulata*), water mosses (*Fontinalis* spp.), and alternate water-milfoil (*Myriophyllum alterniflorum*). Locally, patches of bog pondweed (*Potamogeton polygonifolius*) and stream water-crowfoot (*Ranunculus penicillatus* ssp. *penicillatus*) are also prominent. Shoreweed (*Littorella uniflora*), characteristically a lake species, is quite common along the river. Populations of *Luronium natans* which occur in reaches downstream of the outflow from Llyn Cwellyn are of national importance” (Countryside Council for Wales, 2003, SSSI citation). Table 1 presents a list of the plant species noted in the citation as characteristic of the SSSI.

**Table 1.** Plant taxa named as characteristic species of the Afon Gwyrfai on the SSSI citation

<b>Submerged</b>	<b>Emergent</b>	<b>Lower plants</b>
<i>Callitriche brutia</i> subsp. <i>Hamulate</i>	<i>Equisetum fluviatile</i>	<i>Hygrohypnum ochraceum</i>
<i>Fontinalis antipyretica</i>	<i>Helosciadium inundatum</i>	<i>Isoethecium holtii</i>
<i>Fontinalis squamosa</i>	<i>Oenanthe crocata</i>	<i>Leptodictyum riparium</i>
<i>Myriophyllum alterniflorum</i>	<i>Phalaris arundinacea</i>	<i>Porella pinnata</i>
<i>Potamogeton polygonifolius</i>	<i>Ranunculus flammula</i>	<i>Rhynchostegium riparioides</i>
<i>Ranunculus penicillatus</i> subsp. <i>penicillatus</i>	<i>Ranunculus omiophyllus</i>	<i>Scapania undulata</i>
-	-	<i>Sphagnum auriculatum</i>

NRW is required to evaluate the conservation status of the Ranunculion river habitat and *Luronium natans* features using Common Standards Monitoring (CSM) guidance (JNCC 2016; JNCC 2004). The Ranunculion feature is assessed against eight attributes:

- flow
- water quality
- habitat structure
- fine sediment
- negative indicators
- biological assemblages (plant community and macroinvertebrate)
- indicators of local distinctiveness
- direct human disturbance

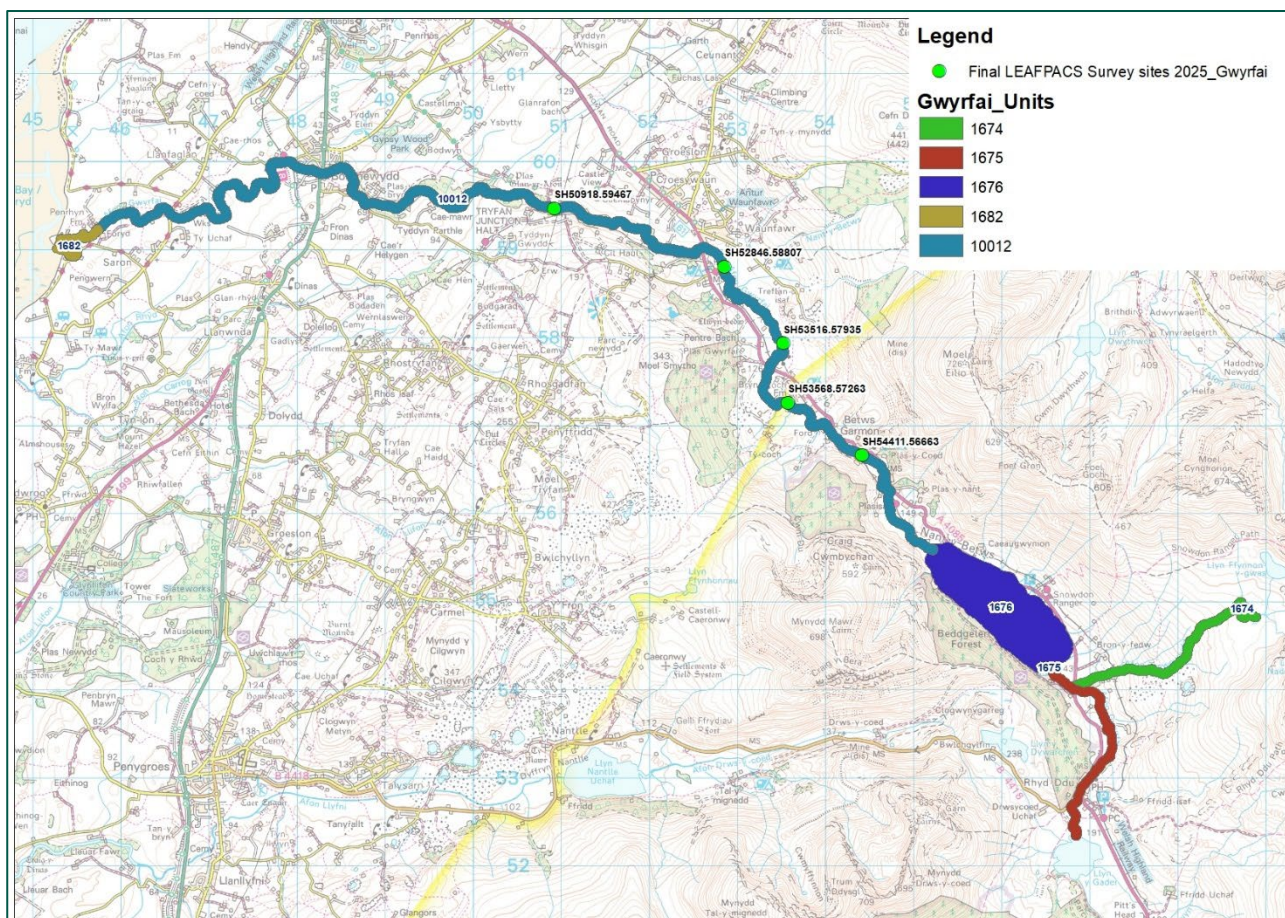
Each attribute above may have more than one sub-attribute and the overall assessment of the Ranunculion river habitat feature as either “Favourable” or “Unfavourable” is based on a collation of all the attribute classifications (Pass or Fail) (JNCC, 2016).

This report assesses the data against the targets for the plant community sub-attribute (part of the biological assemblages attribute) and the species population attribute for *Luronium natans* only. The full condition assessment for the SAC freshwater features: Ranunculion river habitat and *L. natans* will be carried out at a later date by NRW, which will include an analysis of the other attributes listed above to reach a conclusion of either Favourable or Unfavourable condition.

This report also includes an assessment of the Ranunculion river habitat using the former CSM method set out by JNCC (2005), enabling comparison of the 2025 results with the 2008 survey (Broughton & Southey, 2008) to determine whether any change has occurred over this period.

For monitoring and reporting purposes areas, known as units or water bodies, are used. The Afon Gwyrfaï a Llyn Cwellyn SAC has five units and four Water Framework Directive (WFD) Regulations water bodies (Figure 1, Table 2). Surveys were undertaken within a single SAC Unit (10012) and water body (GB110065054190). Monitoring of the water bodies is also required under the WFD Regulations legislation and is not covered in this report.

**Figure 1.** Afon Gwyrfai SAC units, showing the location of sections surveyed in 2025



**Table 2.** Afon Gwyrfai a Llyn Cwellyn SSSI and SAC units, and water bodies, and which ones are included in the assessment.

SSSI/SAC unit name and ID	Water body name and ID	Included in assessment?
Afon Treweunydd 1674	Within the catchment of Gwyrfai - upstream of Cwellyn GB110065054191	no
Gwyrfai - upstream of Cwellyn 1675	Gwyrfai - upstream of Cwellyn GB110065054191	no
Llyn Cwellyn 1676	Llyn Cwellyn GB31034002 (WFD Lake ID)	no
Gwyrfai - downstream of Cwellyn 10012	Gwyrfai - downstream of Cwellyn GB110065054190	yes
Estuary 1682	Y Foryd GB521006501200 (Transitional)	no

This report presents data collected toward an assessment of the condition of two features of the Afon Gwyrfaï a Llyn Cwellyn SAC:

- Water courses of plain to montane levels with the *Ranunculus fluitans* and *Callitriche-Batrachion* vegetation;
- *Luronium natans*

It summarises the plant species recorded during a survey of five 100m LEAFPAC sections along the Afon Gwyrfaï (Figure 1) all within the SAC unit Gwyrfaï - downstream of Cwellyn 10012 which aligns with the water body Gwyrfaï - downstream of Cwellyn GB110065054190.

**Figure 2.** Part of the Afon Gwyrfaï SSSI/SAC, showing the location of sections surveyed in 2025 (image Google Earth 2025)



## Materials and methods

Surveys were carried out on the 23<sup>rd</sup> and 24<sup>th</sup> September 2025 by R.V. Lansdown, with F. Sanchez, S. Hearn and H. Garrett. The weather during the surveys was dry and fine to overcast, following two dry days preceded by heavy rain. Water levels were consequently high, but surveys could still be safely conducted and the water was clear, with good visibility of submerged plants. Where higher flow may have affected recording, this is discussed in the report. All identifications were made by R.V. Lansdown and no herbarium specimens were collected.

Two survey types were carried out. River Ecological Assessment using Physical and Chemical Standards (LEAFPACS) data were collected to inform assessment of the vegetation, while the distribution of *Luronium natans* was assessed against survey sections documented by Jarvis *et al.* (2011).

### Rananculion river habitat (LEAFPACS survey) method

LEAFPACS surveys were carried out on five 100 m sections (Table 3, Figure 1). Data collection followed the standard method (JNCC 2016) including simplistic records of habitat features, while all vascular plants, bryophytes, lichens and macroalgae were recorded against a nine-point scale of abundance:

- 1 = <0.1 % cover
- 2 = 0.1–1 % cover
- 3 = 1–2.5 % cover
- 4 = 2.5–5 % cover
- 5 = 5–10 % cover
- 6 = 10–25 % cover
- 7 = 25–50 % cover
- 8 = 50–75 % cover
- 9 = >75 % cover

In all cases the river was walked or snorkel-surveyed within the channel and records made by eye, either wearing thigh waders or a dry suit with a throw rope available with surveyors on the bankside (Table 3) depending on depth and flow. Even when using the dry suit, not all parts of the channel could be directly accessed. Table 3 provides an indication of the percentage of the channel accessed on each section.

**Table 3.** Location of sections surveyed and the proportion of the channel accessed

No.	Section code	Grid references	Method	% survey
1	91503 EF25NORM065	SH52846.58807-SH52810.58890	dry suit	60
2	180005 EF25NORM064	SH50918.59467-SH50827.59482	waders	40
3	EFNO8 EF25NORM069	SH53568.57263-SH53980.57266	waders	90

No.	Section code	Grid references	Method	% survey
4	EFNW269 EF25NORM066	SH53516.57935-SH53462.57997	dry suit	100
5	EFNW271 EF25NORM068	SH54411.56663-SH54327.56705	dry suit	100

Sections 1 and 4 are deep, with very fast flow, making both walking within the channel and snorkel survey challenging. Section 2 is broad and braided, with mainly shallow water but extremely fast flow, consequently locating and identifying submerged bryophytes (which dominated the vegetation) was challenging. Sections 3 and 5 are largely accessible, with a few deeper areas which could be viewed adequately from the accessible areas.

LEAFPACS data were analysed using a combination of the River LEAFPACS2 survey metric calculator and River LEAFPACS2 class calculator spreadsheets (accessible from WFD UKTAG), to assess the ecological status of each section surveyed and for the SAC unit / water body as a whole (Table 4: JNCC 2016). The SAC unit / water body is considered to pass the target if it is classed by LEAFPACS as High ecological status. Supporting information was provided by additional assessment reviewing the cover values of species recorded against attributes forming part of Favourable Condition tables (Table 5: JNCC 2005) and by comparison with data from 2007 (Broughton and Southey 2008).

**Table 4.** Target for plant community part of the biological assemblages attribute (JNCC 2016)

Targets for plant community	Method of assessment
LEAFPACS tool should give a result of high ecological status for the assessment unit	LEAFPACS method, with 3-5 sections per assessment unit surveyed depending on its size. More variable assessment units may require more surveys.

**Table 5.** Extract of the Favourable Condition Tables for rivers including attributes and targets relevant to the vegetation with notes on the application in these surveys (JNCC 2005)

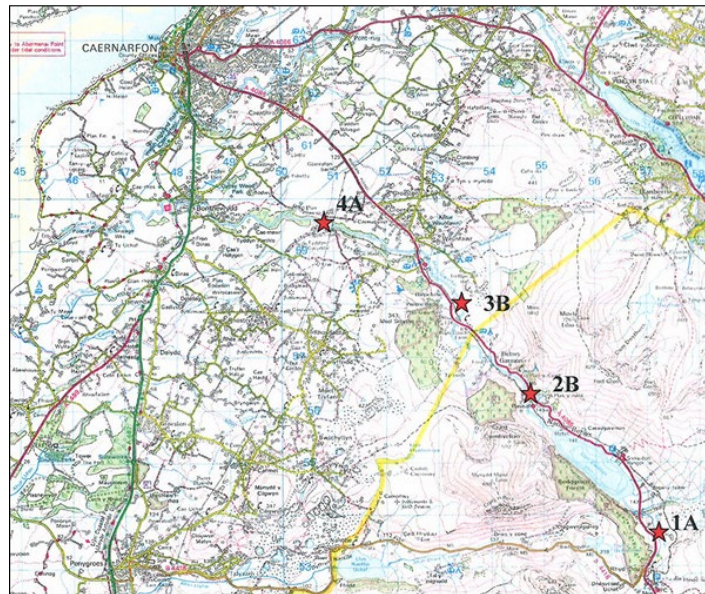
Attribute	Target and survey specific application
Plant community: Species composition and abundance	<p>(i) <u>Species Composition</u></p> <p>The difference in survey length between the method required for river typification (JNCC 2005) and LEAFPACS means that all sections would fail this target. Therefore, this target was assessed by comparison with the species listed on the SSSI citation.</p> <p>(ii) <u>Loss of species</u></p> <p>60% of species with cover &gt;1 in the initial baseline survey should be at least present and all species recorded as dominant in the initial baseline survey should still be present.</p> <p>(iii) <u>Abundant species</u></p> <p>At least 25-35% of species recorded as dominant in the initial baseline survey should still be recorded as dominant.</p>
Plant community: Reproduction	<p>A sufficient proportion of all aquatic macrophytes should be allowed to reproduce in suitable habitat, unaffected by river management. This attribute was not assessed as the survey was carried out late in the season when most plants were likely to have stopped flowering.</p>

Attribute	Target and survey specific application
<p>Negative indicators: Native species</p>	<p>Targets should be set to register high or increasing cover as unfavourable.</p> <p><b>i) For blanketweed, epiphytic or other algae, Fennel Pondweed (<i>Potamogeton pectinatus</i>) or Horned Pondweed (<i>Zannichellia palustris</i>):</b></p> <p>Cover values over 25% should be considered unfavourable but should trigger further investigation.</p> <p>Cover values should not increase significantly from an established baseline.</p> <p><b>ii) For taxa with Species Trophic Ranks (STR) as follows:</b></p> <p>River Types I, II, III – STR 1 or 2</p> <p>River Types V, VI, VII – STR 1-3</p> <p>River Types VIII, IX, X-STR 1-4</p> <p>Cover values over 25% should be considered unfavourable but should trigger further investigation.</p> <p>Cover values should not increase significantly from an established baseline.</p>
<p>Negative indicators: Alien/introduced species</p>	<p>No impact on native biota from alien or introduced species</p> <p><b>Aquatic and marginal macrophytes</b></p> <p>The mean System for Evaluating Rivers for Conservation (SERCON) score for naturalness (derived from individual survey sites) should be 4 or 5.</p> <p><b>Other organisms</b></p> <p>No alien/introduced species present at levels likely to be detrimental to the characteristic biological community.</p>
<p>Indicators of local distinctiveness</p>	<p>Maintain distinctive elements (e.g. rare species, habitat features) at current extent/levels and/or in current locations</p>

Three of the sections surveyed in 2025 overlapped part of sections surveyed in 2007, as follows:

- Section 2 overlapped the downstream part of the Section 4a surveyed in 2007.
- Section 4 overlapped the downstream part of the Section 3B surveyed in 2007.
- Section 5 overlapped the upstream part of the Section 2B surveyed in 2007.

**Figure 3.** Location of the sections surveyed in 2007 (from Broughton and Southey 2008).



Data from 2007 (Broughton and Southey 2008) have been treated as the established baseline. There are significant differences between the survey methods used in 2007 and 2025, summarised as follows:

- Channel lengths. In 2007, surveys were carried out over 500 m lengths of channel, whereas in 2025 they covered 100 m lengths.
- Recording typology. In 2007, records were split into “channel”, involving all plants occurring in a zone likely to be submerged (or at least their basal parts) from 50-80% of the time and “bank”, involving plants likely to be submerged up to 50% of the time. In 2025 following the LEAFPACS method, plants were recorded in the area likely to be submerged for over 50% of the time, thus equating to the “channel” records from 2007.
- Plant population recording. In 2007, plant populations were recorded in two ways; the “abundance”, approximating to a DAFOR (D – Dominant, A – Abundant, F – Frequent, O – Occasional, R – Rare) scale and “cover” representing up to 100 % of the relevant recording zone, where 1 = <0.1 % cover, 2 = 0.1-5.0 % cover and 3 = >5.0 % cover. In 2025, plants were recorded as a single measure of abundance on a nine-point scale (see above). For comparative purposes, only the channel records from 2007 were used and the nine-point scale was converted to 3 points (where 1 = LEAFPACS abundance values 1-3; 2 = LEAFPACS abundance value 4; and 3 = LEAFPACS abundance values 5-9).

- Survey equipment. In 2007 data were collected from the banks using a bathyscope. In 2025 either thigh waders were used to access the channel, employing a bathyscope to view submerged plant populations where practical, or a dry suit was used to enable access to deeper water, with a snorkel and mask where the channel could not be walked.

It should be noted that loss of characteristic species can only be assessed at a very superficial level because species occurring only on the banks are specifically excluded from LEAFPACS survey and the change from 500 m to 100 m survey lengths would also result in recording fewer species. Abundant species were assessed both by comparison with records made by Broughton and Southey (2008) to assess change and by review of which species were classed as Abundant in 2025. From 2025 data, taxa recorded at values of 5 or more were considered to be Abundant.

## **Luronium natans method**

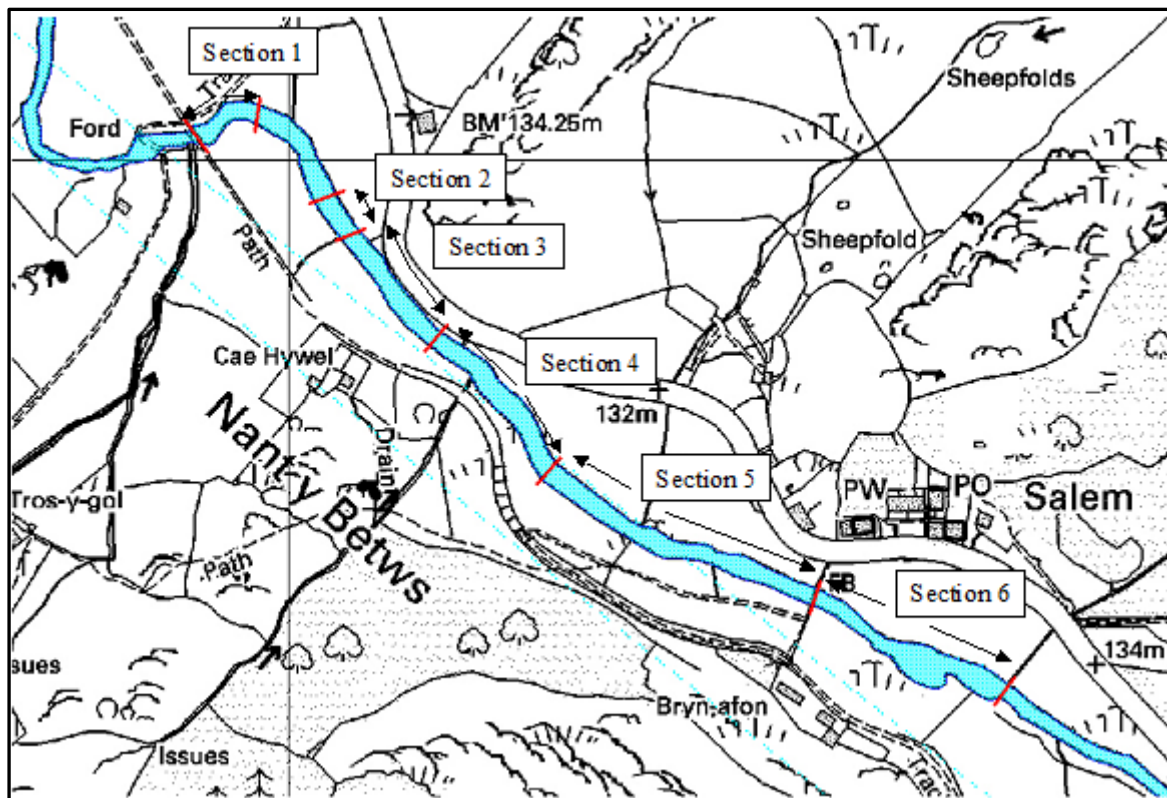
In 2025, the opportunity was taken to collect data on *L. natans* populations. Survey of *Luronium natans* applied the SAC target performance indicators outlined by Jarvis *et al.* (2011) and in the Core Management Plan (NRW 2022). No measure of the extent of the *L. natans* stands was collected in 2025 due to time constraints. Data were recorded by eye and the simple presence of *L. natans* plants within each of the six sections, was considered sufficient to inform the assessment.

Performance indicators for *Luronium natans* were set in 2005 and are presented in Table 6 (JNCC 2004; NRW, 2022). In addition, two discretionary attributes are described by Jarvis *et al.* (2011) (Table 7). Time constrains meant that it was only possible to collect data against the presence of *L. natans* in the six survey sections on the Afon Gwyrfai (see map in Jarvis *et al.* 2011) and not from Llyn Cwellyn. Data were collected as part of the LEAFPACS survey for Section 5 (equating to the *L. natans* sections 5 and 6) from the channel, using a dry suit for access. Data for the *L. natans* sections 1-4 were collected by walking along the bank, inspecting the margins (sections 1-3 on the right bank and 4 on the left bank).

**Table 6.** The performance indicators for maintenance of favourable condition of *Luronium natans* within Afon Gwyrfai a Llyn Cwellyn SAC (NRW, 2022) with site-specific descriptions (Jarvis *et al.* 2011).

Performance indicators for <i>Luronium natans</i> in Afon Gwyrfai a Llyn Cwellyn SAC	<i>Luronium natans</i> will be in favourable condition when:
Species extent and abundance	<p>Upper limit: None set</p> <p>Lower limit: <i>Luronium natans</i> will be present at Site 1 on the periphery of Llyn Cwellyn</p> <p>AND</p> <p><i>Luronium natans</i> will be present within each of Sections 1-6 as identified in the maps in monitoring report (CCW, 2005). (Figure 3)</p>
Site-specific descriptions	<p>Plant that is attached to substrate. Detached fragments (unless obviously detached during monitoring) not counted.</p> <p>The populations of <i>Luronium natans</i> in all six river sections should remain intact.</p> <p>There should be no overall decline in the extent of area of <i>Luronium natans</i></p>

**Figure 4.** Location of the *Luronium natans* sections surveyed in 2005 and 2011 (from Jarvis *et al.* 2011).



## Taxonomy

There is a more or less constant process of improving and correcting the names used to refer to different organisms, as well as a degree of clarification or description of new species. This can cause confusion, particularly where guidance on survey or analysis methods employs particular names. Table 8 sets out the current and former names for taxa recorded and/referred to in this report for which other names are or have been used. In this report the current names as listed here are employed throughout, except on LEAFPACS forms where the name from the LEAFPACS list is used.

**Table 7.** Current and former names of taxa referred to in this report.

Current name	Former names
<i>Helosciadium nodiflorum</i>	<i>Apium inundatum</i>
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	<i>Callitriche brutia</i> , <i>Callitriche brutia</i> var. <i>hamulata</i>
<i>Dermatocarpon fluviatile</i>	<i>Dermatocarpon luridum</i>
<i>Rhynchostegium riparioides</i>	<i>Platyhypnidium riparioides</i>
<i>Ranunculus</i> (Sect <i>Batrachian</i> ) sp.	On the Afon Gwyrfai, all records can be interpreted to refer to <i>Ranunculus penicillatus</i> subsp. <i>penicillatus</i>
Zygnematalean alga	Filamentous green algae

## Results overview

### Assessment of plant community attribute using CSM (JNCC 2016)

Overall, the SAC Unit / water body is classed as high ecological status (Table 8), and therefore passes the monitoring target of the plant community attribute of the assessment (JNCC 2016). This conclusion was derived from the LEAFPACS assessment using the LEAFPACS class calculator spreadsheet and the VISCOUS<sup>1</sup> tool to derive a single class for the SAC Unit / water body.

**Table 8.** The overall results of classification of 2025 survey data for the SAC Unit (10012), water body (GB110065054190), using the VISCOUS tool.  
\*% = confidence of class assessment for mean EQR

SAC Unit / Water body ID	Mean EQR	Mean class	%: Bad	%: Poor	%: Moderate	%: Good	%: High
10012, GB110065054190	0.876	High	0	0	0.2	11.7	88.0

Table 9 presents the results of classification of the 2025 data for each survey section, together with the confidence given to the class assigned. It can be seen that Section 1 is strongly assigned to Good status, while Section 2 is split between Good and High status and the other Sections are clearly assigned to High status.

**Table 9.** The results of classification of 2025 survey data against LEAFPACS criteria  
\*% = confidence of class assessment for mean EQR

No.	Code	Mean EQR	Mean class	%: Bad	%: Poor	%: Moderate	%: Good	%: High
1	91503 EF25NORM05	0.659	Good	0.0	0.0	20.2	79.0	0.8
2	180005 EF25NORM064	0.799	Good	0.0	0.0	0.1	50.8	49.1
3	EFN08 EF25NORM069	0.924	High	0.0	0.0	0.0	0.8	99.2
4	EFNW269 EF25NORM066	1.000	High	0.0	0.0	0.0	0.0	100
5	EFNW271 EF25NORM068	1.000	High	0.0	0.0	0.0	0.0	100.0

<sup>1</sup> VISCOUS (Variability in Spatial Component Objectively Unified Statistically) is a spreadsheet tool designed to take account of spatial variation when classifying water bodies on the basis of Ecological Quality Ratio (EQR) results.

## Assessment of plant community attribute using CSM (JNCC 2005)

Assessment against the CSM attributes (JNCC 2005) (Table 10) shows that all sections pass, but that two are considered to be “at risk”. Comparison of the species recorded in 2007 and 2025 shows major differences, however due to the different lengths surveyed, it is not possible to be confident that these represent a real change. Section 3 is considered to be at risk because of elevated populations of filamentous algae.

**Table 10.** Results of assessment against the Common Standards attributes for all sections

Attribute	Section 1	Section 2	Section 3	Section 4	Section 5
<b>Plant community</b> i Presence of characteristic species	Pass	Pass	Pass	Pass	Pass
<b>Plant community</b> ii No loss of species	N/A	Pass	N/A	Pass	Pass
<b>Plant community</b> iii Abundant species	Pass	Pass	Pass	Pass	Pass (at risk)
<b>Negative indicators</b> i Native species	Pass	Pass	Pass (at risk)	Pass	Pass
<b>Negative indicators</b> ii Alien/introduced species	Pass	Pass	Pass	Pass	Pass
<b>Indicators of local distinctiveness</b>	Pass	Pass	Pass	Pass	Pass

36 taxa which have scores on the LEAFPACS list (JNCC 2005) were recorded (Table 11) in 2025. All of the taxa listed on the SSSI/SAC citation for the Afon Gwyrfa were recorded except *Hygrohypnum ochraceum*, *Leptodictyum riparium*, *Ranunculus omiophyllus* and *Sphagnum auriculatum*. Given that the lengths surveyed represent only a small proportion of the length of the river, this suggests that the characteristic vegetation is still well represented. Of the taxa not recorded, *Ranunculus omiophyllus* and *Sphagnum auriculatum* are not species which are typically found along rivers and are more strongly associated with bog pools or rills. It is quite possible that they persist in areas outside the survey sections. It is likely that the other two species listed on the citation were simply overlooked in 2025, possibly due to high water levels.

**Table 11.** Taxa recorded on survey sections with abundance (TVC) scores. Note: “-“ indicates that the taxa were not recorded in that survey section.

Macroalgae LEAFPACS scoring taxa	91503 EF25 NORM065	180005 EF25 NORM064	EFNO8 EF25 NORM069	EFNW269 EF25 NORM066	EFNW271 EF25 NORM068
<i>Batrachospermum</i> sp(p)	1	-	-	-	-
<i>Heribaudiella fluviatilis</i>	5	3	3	-	-
Zygnematalean alga	2	1	5	-	2

<b>Bryophytes LEAFPACS scoring taxa</b>	<b>91503 EF25 NORM065</b>	<b>180005 EF25 NORM064</b>	<b>EFNO8 EF25 NORM069</b>	<b>EFNW269 EF25 NORM066</b>	<b>EFNW271 EF25 NORM068</b>
<i>Brachythecium plumosum</i>	-	1	2	-	-
<i>Bryum pseudotriquetrum</i>	-	-	-	-	1
<i>Chiloscyphus polyanthos</i>	-	2	-	-	-
<i>Fontinalis antipyretica</i>	-	-	-	-	2
<i>Fontinalis squamosa</i>	4	7	6	1	1
<i>Marsupella emarginata</i>	-	-	-	-	1
<i>Pellia epiphylla</i>	-	2	1	-	-
<i>Platyhypnidium riparioides</i>	-	5	-	-	2
<i>Porella pinnata</i>	-	2	-	-	-
<i>Racomitrium aciculare</i>	-	1	1	-	-
<i>Riccardia chamaedryfolia</i>	-	-	-	-	2
<i>Scapania undulata</i>	-	1	1	-	2
<i>Schistidium rivulare</i>	-	1	-	-	-
<i>Thamnobryum alopecurum</i>	-	4	-	-	-

<b>Lichens LEAFPACS scoring taxa</b>	<b>91503 EF25 NORM065</b>	<b>180005 EF25 NORM064</b>	<b>EFNO8 EF25 NORM069</b>	<b>EFNW269 EF25 NORM066</b>	<b>EFNW271 EF25 NORM068</b>
<i>Dermatocarpon</i> sp(p)*	1	1	1	-	-

<b>Vascular plants LEAFPACS scoring taxa</b>	<b>91503 EF25 NORM065</b>	<b>180005 EF25 NORM064</b>	<b>EFNO8 EF25 NORM069</b>	<b>EFNW269 EF25 NORM066</b>	<b>EFNW271 EF25 NORM068</b>
<i>Apium inundatum</i>	5	-	5	3	6
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	5	1	6	-	2
<i>Carex rostrata</i>	-	-	-	-	1
<i>Equisetum fluviatile</i>	1	-	-	-	1
<i>Isoetes lacustris</i>	-	-	-	-	6
<i>Littorella uniflora</i>	-	-	2	-	7
<i>Luronium natans</i>	-	-	-	-	1
<i>Mentha aquatica</i>	1	-	-	-	-
<i>Menyanthes trifoliata</i>	-	-	-	-	1
<i>Myriophyllum alterniflorum</i>	6	-	4	7	7
<i>Oenanthe crocata</i>	2	1	2	1	1
<i>Persicaria hydropiper</i>	1	1	-	1	-
<i>Phalaris arundinacea</i>	2	-	2	2	2
<i>Potamogeton natans</i>	-	-	-	7	-
<i>Potamogeton polygonifolius</i>	-	-	-	7	4
<i>Ranunculus</i> (sect <i>Batrachium</i> )	6	1	-	-	1
<i>Ranunculus flammula</i>	-	1	1	-	1
<i>Sparganium erectum</i>	2	-	-	1	-
<i>Sparganium</i> sp.	1	-	-	-	1

<b>Additional Species</b>	<b>91503 EF25 NORM065</b>	<b>180005 EF25 NORM064</b>	<b>EFNO8 EF25 NORM069</b>	<b>EFNW269 EF25 NORM066</b>	<b>EFNW271 EF25 NORM068</b>
<i>Angelica sylvestris</i>	-	-	1	-	-
<i>Chaetophora pisum</i>	-	-	-	1	-
<i>Dialytrichia mucronata</i>	-	-	1	-	-
<i>Filipendula ulmaria</i>	-	-	-	1	-
<i>Galium palustre</i>	-	-	1	-	-
<i>Isoethecium holtii</i>	-	2	-	-	-
<i>Juncus acutiflorus</i>	-	-	2	-	2
<i>Juncus effusus</i>	2	-	2	1	1
<i>Verrucaria</i> sp(p).	7	2	5	-	-

**Table 12.** Typification of survey data collected in 2025, compared to those collected in 2007, from upstream to downstream.

<b>2025</b>	<b>2025</b>	<b>2025</b>	<b>2027</b>	<b>2007</b>	<b>2027</b>
<b>Section no.</b>	<b>Type derived by key</b>	<b>Assigned type</b>	<b>Equivalent 2007 survey section</b>	<b>Type derived by key</b>	<b>Assigned type</b>
None	None	None	1A	VIIIb	Xe
5	VIIId	VIIIb	2B	IXc	IXc
3	VIIIb	VIIIb	None	None	None
4	VIIc	VIIIa	3B	IX or X	IX
1	Vd	VIIIb	None	None	None
2	VIIIa	VIIIa	4A	VIIIa	VIIIa

Table 12 presents the results of typification of plant data against the key (JNCC 2005). River macrophyte data are typified by river community, meaning that data are interpreted in relation to the expected species assemblage for that river type. In both years, simple application of the key to the data led to some sections being assigned to anomalous types. In 2025, a review made it clear that simple omission of one or two taxa by the surveyor (typically due to fast, deep flow) explained why the data were assigned to an inappropriate class. The resultant typification presents a logical classification of all five sections surveyed, with all sections assigned to Type VIII Oligotrophic rivers and data fluctuating between a. Steep-gradient, low altitude sand/shale rivers and b. Moderate-gradient sand/shale rivers below uplands. The differences between the two sub-types mainly results from records of two or more of: *Dermatocarpon luridum*, *Juncus acutiflorus* “agg.”, *Mentha aquatica*, *Myriophyllum alterniflorum*, *Phalaris arundinacea* (at abundance 3) and *Ranunculus flammula*. In other words it is influenced by the extent to which marginal species and those typical of marshland occur within the recording zone.

The typification from 2005 suggests that the river type changes as follows:

- X Ultra-oligotrophic rivers e. Small, shallow oligotrophic rivers
- IX Oligotrophic low-altitude rivers c. Base-poor rivers with mixed communities.
- IX Oligotrophic low-altitude rivers
- VIII Oligotrophic rivers a. Steep-gradient, low altitude sand/shale rivers

Unfortunately, as the guidance provides no means of either establishing whether a section may be “mis-typed” or how to correct such “mis-typing”, there is no way to determine which of these is correct.

## Description and assessment of each section using CSM (JNCC 2005)

### Section 1. 91503 EF25NORM065

#### Location

Site 1 is located on the margin of a field used for camping and caravans at Waunfawr Station, to the west and semi-improved grassland to the east, from SH5284.5880 to SH5281.5889.

#### Physical characteristics

This is a broad and quite uniform section, with very fast, deep, flow, mostly over 1 m deep, except toward the downstream end where the depth declines toward a riffle downstream of the section. The banks are steep to vertical throughout. The substrate is mainly gravel and pebbles, with some deposits of sand and a little silt or clay in places. Toward the upstream end, the section is wider with characteristics of a pool. The profile of the river and lack of connection to adjacent habitats suggests that it may have been deepened and channelised in the past.

#### Vegetation characteristics

The section supports dense and extensive beds of vascular plants, more or less dominated by *Callitriche brutia* subsp. *hamulata*, *Helosciadium inundatum*, *Myriophyllum alterniflorum* and a *Ranunculus* of Sect. *Batrachium*. The speed of flow and depth, together with steep banks, made survey quite challenging and it is likely that some taxa were overlooked. Data from this section key out to V Sandstone, mudstone and hard limestone rivers of England and Wales. d. Western stable rivers on sandstone and shales (JNCC 2005). This appears to be because marginal and bank species were not recorded due to high flow. If either *Pellia epiphylla* or *Ranunculus flammula* (both of which were present in the vicinity) had been recorded, then this section would have been assigned to VIII Oligotrophic rivers. b. Moderate-gradient sand/shale rivers below uplands, which is more likely to be an accurate reflection of the river vegetation.

## CSM Assessment of Section 1 (JNCC 2005)

#### Plant community

- i. Presence of characteristic species

This section supports extensive populations of seven of the species listed on the SSSI citation. These species represent most of the channel vegetation and therefore this section may be considered to pass this attribute of the Favourable Condition assessment.

ii. No loss of species

There is no basis by which to assess this attribute as the 2007 survey (Broughton and Southey 2008) did not include this section and no other previous data are available.

iii. Abundant species

There is no basis by which to assess change in this attribute as the 2007 survey (Broughton and Southey 2008) did not include this section and no other previous data are available. The following were recorded as abundant in 2025: *Callitriche brutia* subsp. *hamulata*, *Helosciadium inundatum*, *Heribaudiella fluviatilis*, *Myriophyllum alterniflorum*, *Ranunculus* Sect. *Batrachium* and lichens of the genus *Verrucaria*. A combination of four species of large vascular plants, as well as encrusting algae and lichens dominate the vegetation. This diversity of species and growth forms suggests that the vegetation is in good condition. This section should therefore be considered to pass this attribute of the Favourable Condition assessment.

### Negative Indicators

i. Native species

Algae were sparse in the section, with Zygnematalean algae recorded as 0.1-1 % cover and *Batrachospermum gelatinosum* at less than 1 % cover. The encrusting alga *Heribaudiella fluviatilis* was abundant, at 5—10 % cover but this is a taxon which is more strongly associated with gravel substrates than nutrient levels. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

ii. Alien/introduced species

No non-native species were recorded in the section. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### Indicators of local distinctiveness

Seven taxa listed as characteristic of the Afon Gwyrfa within the SSSI and SAC were recorded: *Callitriche brutia* subsp. *hamulata*, *Equisetum fluviatile*, *Helosciadium inundatum*, *Myriophyllum alterniflorum*, *Oenanthe crocata*, *Phalaris arundinacea* and *Ranunculus* of Sect. *Batrachium* (interpreted for the purposes of analysis as *R. penicillatus* subsp. *penicillatus*). The section may therefore be considered to pass this attribute of the Favourable Condition assessment. The Afon Gwyrfa is unusual among British rivers for the extensive populations of *H. inundatum*, which is declining throughout much of its range and classed as Endangered on the British Red List (Stroh *et al.* 2025). This section supports healthy flowering populations of *H. inundatum*.

## Recommendations

The only negative issue apparent on this section is the indication that the channel has been deepened and probably re-aligned in the past, leading to a disconnect between the river and the floodplain. Work could be undertaken to restore the relationship between the river and floodplain but there is a need to assess potential for flooding, as well as for mobilisation of sediment and nutrient through such works.

## Section 2. 180005 EF25NORM064

### Location

Section 2 runs upstream from just below the footbridge at Plas Glan-yr-Afon, from SH5091.5946 to SH5077.5949. It overlaps part of the Section 4A surveyed by Broughton and Southey (2008). The river braids around islands throughout much of the section, with very diverse in-channel and marginal habitats, including marginal inundation pans.

### Physical characteristics

This section is characterised by a broad, shallow channel over boulders, cobbles and pebbles, with frequent large, exposed boulders. The banks are quite low and in places water is able to flow out into the margins and adjoining habitats during high flows. This section differs from the other four surveyed in 2025 in the following ways:

- It flows through woodland with a more or less closed canopy and so is much more shaded.
- It is fairly broad and shallow, although this meant that flow was extremely fast at the time of survey, making it difficult to survey some areas, particularly where mats of bryophytes occur in zones between boulders.
- The vegetation is heavily dominated by bryophytes.

### Vegetation characteristics

The vegetation of the section is overwhelmingly dominated by bryophytes, with extensive carpets of *Fontinalis squamosa* and *Rhynchostegium riparioides* submerged at the time of survey. Vascular plants in the channel are represented by scattered stands of *Callitriche brutia* subsp. *hamulata*, *Oenanthe crocata* and a *Ranunculus* of Sect. *Batrachium*. Boulders along the margins and scattered in the channel support dense cover of pleurocarpous mosses, particularly *Thamnobryum alopecurum* and *Isothecium holtii*, with locally abundant patches of the Nationally Scarce (Pescott 2016) liverwort *Porella pinnata*. The elevated flow due to rains shortly before the survey almost certainly led to some bryophytes species being overlooked during the survey.

The margins and banks are low enough to allow water to flood into bays and shallow pans. These areas support a diverse range of mosses such as *Thamnobryum alopecurum*, *Thuidium tamariscinum* and *Mnium hornum*, as well as the liverworts *Conocephalum conicum* and *Pellia epiphylla*. A few species of vascular plant such as *Oenanthe crocata*, *Persicaria hydropiper* and *Ranunculus flammula* also occur in some of these areas.

Despite the difference in survey length, data from 2025 clearly assign this section to Type VIII Oligo-mesotrophic rivers. a. Steep gradient, low-altitude, sand/shale rivers.

## CSM assessment of Section 2 (JNCC 2005)

### Plant community

#### i. Presence of characteristic species

This section supports eight of the species listed on the SSSI citation and these species are dominant within the vegetation. In particular, both *Isothecium holtii* and *Porella pinnata* are abundant on boulders at and above the water level. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

#### ii. No loss of species

Table 13 shows a comparison of the species recorded in the “channel” zone in 2007 and all records from 2025. Three species were recorded in 2007 which are predominantly terrestrial and typically have no ecological relationship to the river; *Mnium hornum*, *Plagiomnium undulatum* and *Thuidium tamariscinum*. The fact that they were recorded as occurring in the channel suggests that water levels were very high at the time of survey in 2007. In spite of the different lengths of river surveyed, there is remarkably good agreement between the two surveys. It is likely that *Hygrohypnum luridum* and *H. ochraceum* were present in 2025 but overlooked due to fast flow. *Conocephalum conicum* was abundant on the banks in 2025, but was not considered to occur within the recording zone.

The only difference between the surveys which cannot be explained due to high water levels is that two of the taxa characteristic of the Afon Gwyrfai; *Isothecium holtii* and *Porella pinnata* were not recorded in 2007. Given their abundance in 2025 it is highly likely that they were present in 2007, but must have been overlooked or mis-identified.

**Table 13.** Comparison of taxa (Cover Values equivalent that were used in the 2007 season) and recorded in 2007 and 2025 on Section 2

NB. *Mnium hornum*, *Plagiomnium undulatum* and *Thuidium tamariscinum* are excluded as they are terrestrial taxa with no ecological relationship with the river.

Taxa recorded - Macroalgae	2007	2025
Zygnematalean algae	1	1
<i>Heribaudiella fluviatilis</i>	-	2

Taxa recorded - Lichens	2007	2025
<i>Dermatocarpon</i> sp(p)*	2	-
<i>Verrucaria</i> sp(p).	2	1

Taxa recorded - Bryophytes	2007	2025
<i>Brachythecium plumosum</i>	-	1

<b>Taxa recorded - Bryophytes</b>	<b>2007</b>	<b>2025</b>
<i>Chiloscyphus polyanthos</i>	2	1
<i>Conocephalum conicum</i>	1	-
<i>Fissidens sp.</i>	1	-
<i>Fontinalis squamosa</i>	3	3
<i>Hygrohypnum luridum</i>	3	-
<i>Hygrohypnum ochraceum</i>	1	-
<i>Isothecium holtii</i>	-	1
<i>Pellia epiphylla</i>	2	1
<i>Platyhypnidium riparioides</i>	3	3
<i>Porella pinnata</i>	-	1
<i>Racomitrium aciculare</i>	2	1
<i>Riccardia sp.</i>	1	-
<i>Scapania undulata</i>	1	1
<i>Schistidium rivulare</i>	-	1
<i>Thamnobryum alopecurum</i>	-	2

<b>Taxa recorded - Vascular plants</b>	<b>2007</b>	<b>2025</b>
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	-	1
<i>Callitriche stagnalis</i>	1	-
<i>Caltha palustris</i>	1	-
<i>Galium palustre</i>	1	-
<i>Oenanthe crocata</i>	2	1
<i>Persicaria hydropiper</i>	1	1
<i>Phalaris arundinacea</i>	1	-
<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp	1	1
<i>Ranunculus flammula</i>	1	1
<i>Senecio aquaticus</i>	1	-

The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### iii. Abundant species

Only one of the species (*Hygrohypnum luridum*) recorded as abundant in 2007, was not recorded in 2025 and it is likely that this species was present in 2025 but overlooked among other bryophytes in areas of fast flow. *Thamnobryum alopecurum* was recorded as abundant on the bank in 2007 and within the recording zone in 2025, the difference is likely to be a product of the different recording methods. In 2025 only two species were recorded as abundant: *Fontinalis squamosa* and *Rhynchostegium riparioides*. This suggests relatively simple vegetation, however species diversity was high. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Negative indicators

### i. Native species

No native taxa considered to be negative indicators were recorded, apart from very sparse Zygnematalean algae caught on submerged bryophytes. The section may be considered to pass this attribute of the Favourable Condition assessment.

ii. Alien/introduced species

No non-native species were recorded in the section. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### Indicators of local distinctiveness

As noted above, this section supports eight of the species listed as characteristic of the Afon Gwyrfai on the SSSI citation. These eight species are also the most abundant species in the section. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Recommendations

No negative issues were observed on the section and there is no obvious need for restorative action or change in management.

## Section 3. EFNO8 EF25NORM069

### Location

Section 3 runs alongside the caravan site at Betws Garmon to the north and a field of improved grassland to the south, a short distance downstream of the footbridge, from SH5356.5726 to SH5348.5726. There is a dense hedge with occasional gaps along the north bank, the south bank is open except for occasional trees.

### Physical characteristics

This section is mainly quite broad and shallow, with a deeper area along the outside of the bend. The substrate involves clean gravels more or less throughout, with occasional sand deposits. There is no obvious connection between the channel and the floodplain habitats alongside the section. The banks are relatively low and more or less vertical.

### Vegetation characteristics

Channel vegetation is characterised by discrete stands of *Callitriche brutia* subsp. *hamulata*, *Helosciadium inundatum* and *Myriophyllum alterniflorum*, with dense carpets of *Fontinalis squamosa* in the deeper, faster flow. Vegetation stands are separated by extensive areas of clean gravels. Backwaters support flocs of Zygnematalean algae, which also occur caught on submerged plants. Very sparse populations of bryophytes grow on the lower parts of the trees growing along the banks.

## CSM assessment of Section 3 (JNCC 2005)

### Plant community

#### i. Presence of characteristic species

This section supports seven of the characteristic species listed on the SSSI citation. In particular, the channel is dominated by four species considered to be characteristic of the Afon Gwyrfai: *Callitriche brutia* subsp. *hamulata*, *Fontinalis squamosa*, *Helosciadium inundatum* and *Myriophyllum alterniflorum*.

This section keys out to VIII Oligo-mesotrophic rivers. b. Moderate-gradient shale/sandstone rivers below uplands (JNCC 2005). All the species recorded are listed as characteristic of this river type (JNCC 2005), except *Dermatocarpon luridum*, *Verrucaria* species, although encrusting lichens are listed, and *Diallytrichia mucronata* which was recorded on a tree trunk within the humidity zone of the channel. *D. mucronata* is typical of humid habitats but is not a species typically associated with rivers. There is no reason to consider that there has been any loss of characteristic species and the section may therefore be considered to pass this attribute of the Favourable Condition assessment.

#### ii. No loss of species

The 2007 survey did not include this section and no directly comparable data are available to inform assessment of change in the abundance of species.

#### iii. Abundant species

The 2007 survey did not include this section and no directly comparable data are available to inform assessment of changes in species. In 2025 *Callitriche brutia* subsp. *hamulata*, *Fontinalis squamosa*, *Helosciadium inundatum*, lichens of the genus *Verrucaria* and Zygnematalean algae were recorded as abundant. This shows a diverse flora with abundant bryophytes, lichens and vascular plants, suggesting that the vegetation is in good condition. However, the abundance of Zygnematalean algae is of concern. The section may therefore be considered to pass this attribute of the Favourable Condition assessment as the abundance of filamentous algae was below the threshold, but should be considered to be at risk.

### Negative indicators

#### i. Native species

No baseline is available for comparison with previous conditions. Zygnematalean algae were recorded at an abundance of 5 (5-10 % cover). This is the only section surveyed on the Gwyrfai on which filamentous algae were recorded as abundant. It appears that there may be a factor local to the section which is causing elevated nutrient levels. The abundance of filamentous algae was below the threshold and the section may therefore be considered to pass this attribute of the Favourable Condition assessment, but should be considered to be at risk.

#### ii. Alien/introduced species

No non-native species were recorded in the section. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### Indicators of local distinctiveness

As noted above, this section supports seven of the characteristic species listed on the SSSI citation and four of these dominate the channel vegetation. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Recommendations

There is a need to investigate the reason for the occurrence of elevated populations of filamentous algae and if possible prevent it from continuing or repeating. Within the section, the channel is in good condition with diverse flow structure and habitats, as well as diverse vegetation characteristic of the river as a whole. However, the banks and channel are species-poor and disconnected from the river. Opportunities to reduce agricultural management intensity in adjacent habitats could be beneficial.

## Section 4. EFNW269 EF25NORM066

### Location

Section 4 lies on a bend in the Afon Gwyrfaï approximately 300 m north of the church in Betws Garmon, between SH5351.5793 and SH5346.5799. This overlaps with the upstream 100 m of the section 3B surveyed in 2007. At this point the river is deep (mainly over 1 m deep at the time of survey) and very fast-flowing, making accurate survey challenging. Throughout the section, the river flows through unimproved/semi-improved wet grassland with scattered solitary or clumps of *Salix cinerea*. As noted by Broughton and Southey (2008) the current structure of the channel suggests that it has been modified and probably dredged in the past.

### Physical characteristics

Throughout the section, the channel is relatively broad and deep (80 % over 1 m deep) with fast, clear flow over clean gravels with some sand deposits. The banks are steep to vertical throughout. There appears to be little or no connection between the channel and floodplain, although it is clear that adjacent land still floods upstream and downstream of the section.

### Vegetation characteristics

The section supports extensive, dense submerged beds of vascular plants, some of which form floating leaves in backwaters. The dominant species are *Myriophyllum alterniflorum*, *Potamogeton natans* and *P. polygonifolius* which form dense beds with *Callitriche brutia* subsp. *hamulata*, *Helosciadium inundatum* and *Ranunculus* Sect. *Batrachium*. The only bryophyte recorded was *Fontinalis squamosa*.

## CSM assessment of Section 4 (JNCC 2005)

### Plant community

#### i. Presence of characteristic species

Seven species listed as characteristic of the Afon Gwyrfai on the SSSI citation were recorded in this section. The channel is heavily dominated by these species, as well as by *Potamogeton natans*. The abundance of vascular plants in the channel is quite remarkable, although classed as occurring at 60 % cover to ensure realistic recognition of the extent of bare gravels, many beds were up to 1 m deep and thus represent a very high biomass.

The section keys out to Type VII Mesotrophic rivers dominated by gravels, pebbles and cobbles. c. Lowland, mesotrophic rivers with acidic feeders. However this appears to be because *Verrucaria* sp(p). were not recorded. If *Verrucaria* sp(p). are treated as present, then the section keys out to Type VIII Oligo-mesotrophic rivers. a. Steep-gradient, low-altitude sand/shale rivers, which conforms well with other sections on the Afon Gwyrfai (see Discussion) and is more likely to be accurate. It is very likely that *Verrucaria* species were missed because of the difficulty of recording lichens encrusting stones on the bed in fast, deep flow with abundant vascular plant cover.

Comparison of data from 2007 and 2025, although the survey lengths and recording zones are very different, shows no significant change in the characteristic species. All taxa recorded at an abundance of 3 in 2007 were recorded at the same abundance in 2025, as were three taxa recorded at an abundance of 2 and two at an abundance of 1 (Table 14). The main differences lie in the range of species recorded, for example *Nitella* sp., which occurred at an abundance of 1 in 2007 was not recorded in 2025. *Carex vesicaria*, *Equisetum fluviatile*, *Juncus acutiflorus*, *Littorella uniflora* and *Luronium natans* were recorded at an abundance of 2 in 2007 but not recorded in 2025. It can only be assumed that these species were not represented in the section surveyed in 2025 and although not all species are indicated, this is borne out by the map presented by Broughton and Southey (2008: 36). The absence of *Helosciadium inundatum* in 2007 but present at an abundance of 3 in 2025 is again striking.

**Table 14.** Comparison of taxa (Cover Value equivalent that were used in the 2007 season) recorded in 2007 and 2025 on Section 4

Taxa recorded - Macroalgae	2007	2025
FGA	1	-
<i>Nitella</i> sp.	1	-
<i>Chaetophora pisum</i>	-	1

Taxa recorded - Lichens	2007	2025
<i>Foliose lichens</i>	1	-

Taxa recorded - Bryophytes	2007	2025
<i>Bryum pseudotriquetrum</i>	1	-

<b>Taxa recorded - Bryophytes</b>	<b>2007</b>	<b>2025</b>
<i>Conocephalum conicum</i>	1	-
<i>Fontinalis squamosa</i>	2	1
<i>Pellia epiphylla</i>	2	-
<i>Scapania undulata</i>	1	-

<b>Taxa recorded - Vascular plants</b>	<b>2007</b>	<b>2025</b>
<i>Apium inundatum</i>	-	3
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	2	2
<i>Callitriche stagnalis</i>	1	-
<i>Carex vesicaria</i>	2	-
<i>Deschampsia cespitosa</i>	1	-
<i>Equisetum fluviatile</i>	2	-
<i>Filipendula ulmaria</i>	1	1
<i>Galium palustre</i>	1	-
<i>Glyceria fluitans</i>	1	-
<i>Iris pseudacorus</i>	1	-
<i>Juncus acutiflorus</i>	2	-
<i>Juncus effusus</i>	2	1
<i>Juncus bulbosus</i>	1	-
<i>Littorella uniflora</i>	2	-
<i>Luronium natans</i>	2	-
<i>Myriophyllum alterniflorum</i>	3	3
<i>Oenanthe crocata</i>	1	1
<i>Persicaria hydropiper</i>	-	1
<i>Phalaris arundinacea</i>	2	2
<i>Potamogeton natans</i>	3	3
<i>Potamogeton polygonifolius</i>	3	3
<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp	-	-
<i>Ranunculus flammula</i>	1	-
<i>Ranunculus penicillatus</i>	2	2
<i>Sparganium emersum</i>	2	-
<i>Sparganium erectum</i>	2	1

The agreement between records from 2007 and 2025, as well as the representation of characteristic species and (adjusted) agreement in the typification between this section and those upstream in 2025, suggest that there has been no significant change in the presence of species characteristic of the Afon Gwyrfa SAC. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

ii. No loss of species

As noted above, whilst comparison of species lists from 2007 and 2025 might suggest that there have been significant changes in the vegetation, when the map presented by Broughton and Southey (2008: 36) is compared with the species from 2025, it can be seen

that many of the differences can be accounted for by plants occurring downstream of the section surveyed in 2025. Fundamentally, apart from *Nitella* sp., *Juncus bulbosus*, *Littorella uniflora* and *Luronium natans*, (indicated as growing downstream of the 2025 section), all the characteristic aquatic species recorded in 2007 were also recorded in 2025. Most of the species recorded in 2007 but not in 2025 are more typical of the banks and adjacent habitat. Therefore, although no direct comparison is truly valid, there is no evidence to suggest that species have been lost from this section. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### iii. Abundant species

All species recorded in the channel with a score of 3 in 2007 were recorded in 2025 with a similar value. In 2025 *Myriophyllum alterniflorum*, *Potamogeton natans* and *P. polygonifolius* were recorded as abundant. This indicates that the vegetation is well-developed and dominated by native species, which are not indicative of nutrient-enrichment. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Negative indicators

### i. Native species

No native negative indicator species were recorded in the section in 2025. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### ii. Alien/introduced species

No non-native species were recorded in the section in 2025. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Indicators of local distinctiveness

This section supports seven of the species listed as characteristic of the Afon Gwyrfai SSSI. Five of these species were classed as abundant or frequent within the channel. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Recommendations

The only negative issue apparent on this section is the indication that the channel may have been deepened and re-aligned in the past, leading to a disconnect between the river and the floodplain. Work could be undertaken to restore the relationship between the river and floodplain but there is a need to assess potential for flooding, in areas where this could cause problems, and for mobilisation of sediment and nutrient through such works.

## Section 5. EFNW271 EF25NORM068

### Location

Section 5 runs from the downstream end of a wide reach of river, past the footbridge at Betws Garmon and for a short distance downstream, between SH5441.5666 and SH5432.5670. The section is clearly affected by the footbridge, both due to the non-native substrate in and alongside the channel, and almost certainly by the bridge preventing channel dynamism. Throughout the section, the river flows through unimproved or semi-improved grassland grading into rush pasture.

### Physical characteristics

This section is characterised by a broad, deep, fast-flowing and relatively uniform channel, with steep to vertical banks, flowing over gravel and pebbles with some sand and silt deposits. There is little or no connection between the channel and floodplain, but downstream the margins and banks become less well-defined, grading into the channel in places.

### Vegetation characteristics

This section supports extensive, dense, submerged beds of vascular plants, including lawns of *Littorella uniflora* and *Isoetes lacustris*, together with patches of *Luronium natans*. The dominant species are *Callitriche brutia* subsp. *hamulata*, *Littorella uniflora* and *Myriophyllum alterniflorum*, with *Potamogeton polygonifolius* abundant toward the upstream end. Bricks and stones beneath and around the footbridge support a range of bryophytes, including *Bryum pseudotriquetrum*, *Fontinalis antipyretica*, *Marsupella emarginata*, *Rhynchostegium riparioides* and *Scapania undulata* which would probably not occur in the section if the bridge was not there, although they are listed as characteristic of the Afon Gwyrfaï on the SSSI citation. In contrast, *Fontinalis squamosa* and *Riccardia chamaedryfolia* occur among stands of vascular plants in places away from the bridge.

The banks and margins support a range of species typical of wet, acid, unimproved to semi-improved grassland. These include extensive stands of rush pasture dominated by *Juncus acutiflorus* and *J. effusus*.

## CSM assessment of Section 5 (JNCC 2005)

### Plant community

#### i. Presence of characteristic species

This section supports 13 of the species listed as characteristic of the Afon Gwyrfaï in the SSSI citation and overlaps part of the section 2B surveyed in 2007 (Broughton and Southey 2008). In particular, the channel vegetation is dominated by three of the species listed: *Callitriche brutia* subsp. *hamulata*, *Littorella uniflora* and *Myriophyllum alterniflorum*, while the occurrence of extensive stands both of isoetids (*Littorella uniflora* and *Isoetes lacustris*) and *Luronium natans* is unusual in British rivers, but a particular characteristic of the Afon Gwyrfaï. This section may therefore be considered to pass this attribute of the Favourable Condition assessment.

#### ii. No loss of species

Comparison of lists from 2007 and 2025 show a very strong agreement between the two data-sets (Table 16). It appears likely that *Carex vesicaria*, *Isoetes echinospora* and *Sparganium angustifolium*, recorded in 2007 equate to *Carex rostrata*, *Isoetes lacustris* and *Sparganium* sp. respectively, recorded in 2025. If records for these taxa are combined (Table 15), the main differences involve the bankside species recorded in 2007 (again suggesting that water levels must have been very high for these species to have been recorded as in the channel) and the bryophytes recorded in association with the footbridge in 2025 (the bridge and immediate area were explicitly excluded from the section in 2007) (Broughton and Southey 2008). Taxa such as *Glyceria fluitans* and *Juncus bulbosus* apparently occurred in 2007 downstream of the section surveyed in 2025. An inexplicable difference is the abundance of *Helosciadium inundatum* and the small stand of *Ranunculus* Sect. *Batrachium* in 2025. Both of these taxa could have been missed in 2007 due to the use of a bathyscope from the bank in 2007, rather than survey from within the channel in 2025.

**Table 15.** Comparison of taxa (Cover Value equivalent that were used in the 2007 season) recorded in 2007 and 2025. NB. identification differences resolved, bankside species marked with (b) and highlighted in grey, see text.

Taxa recorded - Macroalgae	2007	2025
Zygnematalean alga	2	1

Taxa recorded - Lichens	2007	2025
<i>Dermatocarpon</i> sp(p)*	1	1

Taxa recorded - Bryophytes	2007	2025
<i>Bryum pseudotriquetrum</i>	-	1
<i>Fontinalis antipyretica</i>	-	1
<i>Fontinalis squamosa</i>	2	1
<i>Hygrohypnum ochraceum</i>	1	-
<i>Marsupella emarginata</i>	-	1
<i>Platyhypnidium riparioides</i>	1	1
<i>Riccardia chamaedryfolia</i>	-	1
<i>Scapania undulata</i>	-	1
<i>Sphagnum auriculatum</i>	2	-

Taxa recorded - Vascular plants	2007	2025
<i>Apium inundatum</i>	-	3
<i>Callitriche brutia subsp. hamulata</i>	2	1
<i>Carex rostrata</i>	2	1
<i>Deschampsia cespitosa</i> (b)	2	-
<i>Eleocharis palustris</i> (b)	2	-
<i>Equisetum fluviatile</i>	2	1
<i>Galium palustre</i> (b)	2	-
<i>Glyceria fluitans</i> (b)	1	-
<i>Hydrocotyle vulgaris</i> (b)	2	-

<i>Isoetes</i> sp.	2	3
<i>Juncus acutiflorus</i>	2	1
<i>Juncus bulbosus</i>	2	-
<i>Juncus effusus</i>	2	1
<i>Littorella uniflora</i>	3	3
<i>Luronium natans</i>	3	1
<i>Mentha aquatica</i> (b)	1	-
<i>Menyanthes trifoliata</i>	2	1
<i>Myriophyllum alterniflorum</i>	2	3
<i>Oenanthe crocata</i>	1	1
<i>Persicaria hydropiper</i> (b)	-	2
<i>Phalaris arundinacea</i>	2	1
<i>Potamogeton natans</i>	-	2
<i>Potamogeton polygonifolius</i>	2	2
<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp.	-	1
<i>Ranunculus flammula</i>	2	1
<i>Senecio aquaticus</i> (b)	-	1
<i>Sparganium</i> sp.	2	1
<i>Viola palustris</i> (b)	-	1

It seems reasonable to conclude that there has been no significant loss of species from this section. This section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### iii. Abundant species

There are clear differences in the abundance of species between 2007 and 2025 (Table 15). In particular, *Fontinalis squamosa*, *Callitriche brutia* subsp. *hamulata*, *Equisetum fluviatile*, *Juncus acutiflorus*, *J. effusus*, *Luronium natans*, *Menyanthes trifoliata*, *Phalaris arundinacea* and *Ranunculus flammula* were all recorded at a higher abundance in 2007 than in 2025. Given that these species were all present in both years and that there is no evident loss of species, it may be that the difference is due to the different recording areas, however the possibility that there has been a real decline cannot be discounted. Four species were recorded as abundant in 2025: *Helosciadium inundatum*, *Isoetes lacustris*, *Littorella uniflora* and *Myriophyllum alterniflorum*. These indicate that the vegetation is well-developed and dominated by native species which are not indicative of high nutrient status. This section may therefore be considered to pass this attribute of the Favourable Condition assessment but to be “at risk”.

## Negative indicators

### i. Native species

The only native negative indicator species recorded in the section was filamentous algae (recorded as Zygnematalean algae in 2025). This was recorded at a cover of less than 5 % in both years which falls below the threshold to fail this section. This section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## ii. Alien/introduced species

No non-native species were recorded in the section in 2025. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

### Indicators of local distinctiveness

As noted above, this section supports 13 of the species listed as characteristic of the Afon Gwyrfai SSSI on the citation. The presence of isoetid swards is an additional positive feature, as is the presence of fruiting populations of *Luronium natans*. The section may therefore be considered to pass this attribute of the Favourable Condition assessment.

## Recommendations

The only negative issue apparent on this section is the indication that the channel has possibly been deepened and probably re-aligned in the past (although this would need to be confirmed before any action is taken), leading to a disconnect between the river and the floodplain. Work could be undertaken to restore the relationship between the river and floodplain but there is a need to assess potential for flooding of areas where this could cause problems, as well as for mobilisation of sediment and nutrient through such works.

## Assessment of floating water-plantain (*Luronium natans*)

*Luronium natans* was found in all six of the *L. natans* sections set out by Jarvis *et al.* (2011) (Table 16, Figure 4). Therefore, the *L. natans* species population attribute can be considered to have met the performance indicators and passed the target, as set out in Table 6 & 7.

In *L. natans* sections 5 and 6, where surveys covered most of the channel, it occurred as scattered patches throughout, among other vascular plants, including isoetids. In *L. natans* section 5, plants were found which were developing what appeared to be fully-formed fruit, which is rare in a native British population. Seeds were collected under licence No. S095465/2 for the Millennium Seed Bank.

**Table 16.** Location of *Luronium natans* populations documented in 2025

<b><i>L. natans</i> section</b>	<b>Grid reference</b>	<b>Notes</b>
Afon Gwyrfai ac Llyn Cwellyn SAC 1	SH53972.57046	N/A
Afon Gwyrfai ac Llyn Cwellyn SAC 2	SH54028.56992	N/A
Afon Gwyrfai ac Llyn Cwellyn SAC 3	SH54068.56934	N/A
Afon Gwyrfai ac Llyn Cwellyn SAC 4	SH54142.56037	N/A

<b>L. natans section</b>	<b>Grid reference</b>	<b>Notes</b>
Afon Gwyrfai ac Llyn Cwellyn SAC 5	SH54270.56722	fertile, seed collected for MSB
Afon Gwyrfai ac Llyn Cwellyn SAC LEAFPACS Section 5 and L natans Section 6	SH54425.56652	N/A

## Discussion

### The influence of scour events on algae and LEAFPACS scores

The abundance of filamentous algae is the single most important influence on the Ecological Quality Data (EQR) and consequently, the ecological status assigned by the LEAFPACS class calculator. Research has shown that the abundance of filamentous algae in a river is very strongly influenced by scour events due to the potential to remove a high proportion of the biomass of filamentous algae, such that periphyton data in gravel-bed rivers should not be interpreted without reference to the recent flow history of the site (Biggs and Close 1989, cited in Mainstone 2010). The maximum doubling time of algae is in the order of two days (Mainstone 2010) and therefore an interval of at least 4-6 days would be required before periphyton populations will re-establish, although biomass development is faster in nutrient-rich conditions and the longer the interval between scour events, the higher the potential abundance of filamentous algae.

Surveys for this report were undertaken on 23rd and 24th September 2025 and for two days beforehand, the weather was dry, however more than 140 mm of rain fell between the 17<sup>th</sup> and the 20<sup>th</sup> September (data from the Afon Colwyn rain gauge:). This scour event was too recent for periphyton biomass to have recovered before surveys. Therefore, values recorded for filamentous algae must be treated as potentially unrepresentative, with the possibility that surveys following a longer period since a major scour event would show higher abundance of filamentous algae. Notably section 3 is classified as “at risk” because of values for filamentous algae, even following a scour event. Therefore the risk may have been shown to be more severe if there had been no scour event beforehand.

More frequent recording of LEAFPACS data, or even spot-checks of the abundance of filamentous algae during extended low-flow or drought periods would enable a better understanding of the reliability of records of filamentous algae made during routine monitoring. Such additional recording could serve to “calibrate” routine monitoring records.

### Attribute assessment

Overall, the data analysis using LEAFPACS Survey Metric Calculator and rationalised for the whole SAC unit / water body using VISCOUS classed the SAC Unit / water body as High ecological status, meaning that it meets the target for the unit (JNCC 2016). The analysis classed Section 1 as Good, Section 2 as between Good and High and Sections 3-

5 as High (Table 9). It is not clear why Sections 1 and 2 were assigned a lower class than the other sections, but it may be partly due to water levels and flow which were higher at the start of the survey and declined during the survey period. This may have influenced recording and therefore the number and range of taxa recorded. Certainly, neither a subjective assessment of the appearance of these two sections, nor the species recorded, support that these sections are in worse condition than sections 3-5.

Assessment of the vegetation recorded against the attributes (using JNCC 2005 guidance) shows that all five sections passed, although slightly elevated populations of Zygnematalean algae were present in Section 3 which should be investigated, while possible declines in some species between 2007 and 2025 in Section 5 require another monitoring round for confirmation.

Monitoring of the distribution of *Luronium natans* showed that it persists in all six sections from which it was documented in 2011 (Jarvis *et al.* 2011). Although no record was made of the abundance of *L. natans* in 2025, the continued representation of populations and the presence of an apparently fully-fertile population of *L. natans* in Section 5 near Betws Garmon suggest that the population of *L. natans* in the Afon Gwyrfai should be considered to be in favourable condition. The population(s) of *L. natans* recorded by Broughton and Southey (2008) north of Betws Garmon on their section 3B was not surveyed in 2011 or 2025.

Overall the plant community and *Luronium natans* attributes of the Afon Gwyrfai ac Llyn Cwellyn SAC Condition Assessment have passed their targets.

As noted by Broughton and Southey (2008), some sections appear to have been modified, probably by dredging and possibly realignment in the past, reducing the connection between the channel and floodplain habitats. If confirmed, it is possible that the effects of any historic modification could be rectified and connection between the river and the floodplain restored. However, there is a need for caution in this action to ensure no adverse effects on people, property or services from flooding or on the river itself from factors such as mobilisation of sediment or nutrients. It is also possible that the apparent disconnect is not due to past modification, but is a natural morphology for this river.

## Surveys and the survey methods

### Different methods used in 2007 and 2025

As described in the individual section accounts, despite the differences in recording methods and approach, there is surprisingly good agreement between the data-sets collected in 2007 and 2025. The most significant difference being the three taxa listed on the Afon Gwyrfai ac Llyn Cwellyn SSSI/SAC citation which were not recorded in 2007, but were present or even abundant in 2025: *Helosciadium nodiflorum*, *Isothecium holtii* and *Porella pinnata*. The lack of records does not appear to have affected the Condition Assessment, but the presence of all of these species in 2025 supports assessment of the river as having passed the plant attribute target.

One factor which is evident from review of the data-set collected in 2007 is that at least some of the surveys carried out in 2007 were done when water levels were high enough to influence recording. This can be seen from the fact that the moss *Thuidium tamariscinum*, a terrestrial taxon, with no ecological relationship with the river, often occurring in quite dry situations and intolerant of prolonged submersion, was recorded in the “channel” zone. That this recording does not appear to have affected the condition assessment is likely to be due to the experience and expertise of the surveyors.

Water levels were also high in 2025 to the extent that access was difficult to some parts of the channel, particularly in Sections 1, 2 and 4. On Section 2 fast flow made recording of species representation in submerged bryophyte stands difficult. In Sections 1 and 4 the depth of the water meant that the surveyor had to swim, but the speed of flow was not such that the surveyor was endangered or carried downstream fast enough to compromise recording. It appears likely that issues of depth and flow will always affect Common Standards Monitoring on the Afon Gwyrfaï ac Llyn Cwellyn SAC and it may not be possible to collect comprehensive, reliable data. However, the timing of surveys could be managed to minimise the potential influence of high flows, as well as scour events.

## River Typification

The River Typification developed by Nigel Holmes was designed to be employed to analyse data collected over two abutted 500 m lengths of river (JNCC 2005). The survey was subsequently modified to involve only a single 500 m survey length, but has not normally been applied to data collected over a single 100 m survey. When the data collected on the Afon Gwyrfaï ac Llyn Cwellyn SAC in 2025 are typed according to the key, they provide a surprisingly credible classification of the sections (Table 10).

The method (JNCC 2005) provides very little information on how to recognise whether a section is mis-typed or how to resolve such mis-typification. Both in Broughton and Southey (2008) and here, revision of the types is based partly on intuition and judgement, through an understanding both of the conditions during data collection and of the typification process. The final typification in 2025 has a certain consistency and logic, but the difference between this and the typification derived in 2007, combined with a lack of guidance on how to reach a decision on the “correct” typification is frustrating. This is particularly so when this decision could affect the assessment against favourable condition attributes, where the river type is used to assess the presence of characteristic species. However, it does not affect assessment against the 2016 targets (JNCC 2016).

## Potential to improve recording for Condition Assessment of flowing waters

Use of assessment methods for both standing and flowing waters highlights significant differences between the two methods. The strength of the standing water assessment lies in the collection of quantitative, objective data from more than 100 points (including the boat, wader and walked perimeter transect data) where the size and form of the water body allow. These data are usually divided into four groups collected at separate locations which should include representation of different habitats, while the number of groups

should be increased to ensure representation of different habitats or on larger water bodies. Even when circumstances prevent collection of the full data-set, comparisons and analysis of any data remain valid. Even when there are differences in identification of critical taxa, water levels etc., these do not typically significantly affect analysis and interpretation of the data.

In contrast, assessment for flowing waters is typically derived from 100 m sections of the water course, typically separated by a regular distance along the water course and ideally but not always selected to characterise different landscape-scale features of the catchment but with no reference to channel habitats. Each of these 100 m sections involves a single sample and therefore even the largest water courses are typically assessed based on fewer than 50 samples while many rivers are assessed based on a single sample. Factors such as difficulty of access to parts of the channel due to deep, fast flow, turbidity, poor weather conditions and water levels are known to affect recording, while identification of critical taxa and differences in assessment of cover values can have a significant effect on the outcome of data analysis. For example, small changes in the abundance of species of *Ranunculus* Sect. *Batrachium* can have a very strong effect on the ultimate class assigned, as can the name given to such plants, but there is little consistency between surveyors in identification and naming of plants in Section *Batrachium*. Another weak element of the River LEAFPACS method is that it involves 100 m lengths of river, irrespective of the width of the channel. Thus, the area sampled for a river less than 5 m wide is 500 m<sup>2</sup>, and the area sampled on a river 200 m wide is 20,000 m<sup>2</sup>. Data collected from such widely varying sample sizes cannot be directly comparable.

It is clear that the condition assessment method for flowing waters could be strengthened by collecting multiple samples, rather than collecting a single data-set at each location, as well as by aligning such sampling with the scale of the water course. Thus, for example, on a river 100m wide, five lines of evenly-spaced 4 m<sup>2</sup> samples could be recorded across the channel at 20 m intervals on a 100 m length of channel to give 100 comparable samples. On a river less than 50 m wide, samples could be 2 m<sup>2</sup> and on rivers less than 10 m wide, 1 m<sup>2</sup>. On rivers 1-2 m wide it would be necessary to record 1 m<sup>2</sup> samples along the length of the river. This would increase the time needed for recording, but would measurably enhance the rigour and replicability of data collection.

LEAFPACS also gives no recognition to different habitats within rivers. The inclusion of a rock outcrop or bridge abutment in a survey of a river flowing through an alluvial floodplain will very strongly influence the results. In-channel habitats on rivers support characteristic suites of plant species and it would be possible to develop a classification of these, which would then enable assessment of whether in-channel habitats support the expected suite of species, including notable taxa, to complement the assessment of characteristic species. However, development of such a classification would be time-consuming and expensive. Recording the data, in addition to standard LEAFPACS surveys, would add to the cost of condition assessment and is unlikely to be considered practical.

Another area where LEAFPACS fails to enable recognition of differences in vegetation is in the overall biomass, because surveyors are required to treat the channel as 100 % cover, excluding the potential to record multiple canopies or tall stands of plants in deep water. In sections such as Section 4 on the Afon Gwyrfa, the depth of the water means that even at a total cover of 60 %, vegetation biomass was extremely high. In contrast, in parts of

Section 2, the water was shallow enough that 60% cover of bryophytes actually involved only a shallow carpet of vegetation.

It is increasingly clear that there are not enough surveyors available in the UK who are capable of recognising all taxa potentially encountered in rivers. Further to this, it appears likely that the availability of trained surveyors is decreasing. It is critical that all monitoring rounds employ methods and surveyors who are capable of ensuring that this does not compromise the results. It is clear that we need survey methods which are:

1. Not critically dependent upon surveyors being able to identify *all* of the scoring taxa in the field. It is actually not certain that any British surveyor has the ability to identify all of the LEAFPACS scoring taxa.
2. Capable of providing the information needed, even when surveyors or surveying conditions generate data which may contain gaps.

Some river sections will always be difficult to survey comprehensively. The survey and analysis methods must be sufficiently robust that challenging recording conditions do not compromise potential to assess the condition of the river.

## Recommendations for site management / restoration

### Section 1 - Reconnection with floodplain

The main issue is historic channel deepening and realignment, causing disconnection from the floodplain. Restoration could improve river - floodplain interaction, but potential flood risk and mobilisation of sediment and nutrients must be assessed.

### Section 2 - None

No negative issues were observed.

### Section 3 - Measures to reduce nutrient levels

Investigate causes of elevated filamentous algae and prevent recurrence. The channel itself supports diverse flow and habitat features, but banks and channel margins are species-poor and disconnected. Reducing agricultural intensity in adjacent habitats may help.

### Section 4 - Reconnection with floodplain

Historic deepening and realignment have likely disconnected the channel from the floodplain. Restoration is possible but requires assessing flood risk in sensitive areas and the potential mobilisation of sediment and nutrients.

## Section 5 - Reconnection with floodplain

Possible historical deepening and realignment have reduced floodplain connectivity. Restoration should only proceed after evaluating flood risk and risks of sediment and nutrient mobilisation.

## Recommendations for future monitoring

Conduct frequent recording of LEAFPACS data on the Afon Gwyrri, or even spot-checks of the abundance of filamentous algae during extended low-flow or drought periods. This would enable a better understanding of the reliability of records of filamentous algae made during routine monitoring. Such additional recording could serve to “calibrate” routine monitoring records.

Manage timing of surveys to minimise the potential influence of high flows, as well as scour events.

Investigate elevated levels of filamentous algae in Section 3.

In the long term and working across the UK, develop methods which are not critically dependent upon surveyors being able to identify all of the scoring taxa in the field and that are capable of providing the information needed, even when surveyors or surveying conditions generate data which may contain gaps.

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## Appendices

### Appendix A Completed survey forms and photographs

#### Section 1. 91503 EF25NORM065

Figure 5. Section 1 photo taken from near the downstream end, looking upstream



**Figure 6.** Section 1 photo taken from near the upstream end, looking downstream



### **Physical variables**

**River:** Gwyrfai

**Surveyor:** R.V. Lansdown

**\*NGR top:** SH52846.58807

**\*NGR bottom:** SH52810.58890

**Site:** 91503 EF25NORM065

**Date:** 23 September 2025

**% wadeable:** 0

**Total % cover of macrophytes:** 60

**Total % cover of filamentous algae (not included in total above):** 1

**Photo no. or reference upstream:** Gwyrfai 1 us

**Photo no. or reference downstream:** Gwyrfai 1 ds

**Typicality:** A

A <25% of data on this form compromised  
B 25-50% of data on this form compromised  
C >50% of data on this form compromised

Width (m)	%
<1	0
1-5	0
5-10	90
10-20	10
>20	0

Depth (m)	%
<0.25	0
0.25-0.5	0
0.5-1	20
>1	80

Clarity	%	Shading (left bank)	%	Shading (right bank)	%
Clear	100	None	60	None	85
Turbid	0	Broken	0	Broken	15
Cloudy	0	Dense	40	Dense	0

Substrate	%	Bed stability	%	Habitats	%
Bedrock	0	Solid/firm	60	Pool	0
Boulders/cobbles	5	Unstable	40	Run	100
Pebbles/gravel	82	Stable	0	Riffle	0
Sand	10	Soft/sinking	0	Slack	0
Silt/clay	3	-	-	Glide	0
Peat	0	-	-	-	-

**Notes/comments:** Water levels high following heavy rain in preceding week, very deep and fast flow. Survey in channel using dry suit, >60 % of channel directly accessed, the remainder viewed from adjacent channel and left bank.

Taxa (synonym)	TCV	Taxa (synonym)	TCV
<b>Macroalgae</b>	-	-	-
<i>Batrachospermum</i> sp(p)	C1	Zygnematalean alga	C2
<i>Heribaudiella fluviatilis</i>	C5	-	-
<b>Bryophytes</b>	-	-	-
<i>Fontinalis squamosa</i>	C4	-	-
<b>Vascular plants</b>	-	-	-
<i>Apium inundatum</i>	C5	<i>Persicaria hydropiper</i>	C1
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	C5	<i>Phalaris arundinacea</i>	C2
<i>Equisetum fluviatile</i>	C1	<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp.	C6
<i>Mentha aquatica</i>	C1	<i>Sparganium erectum</i>	C2
<i>Myriophyllum alterniflorum</i>	C6	<i>Sparganium</i> sp.	C1
<i>Oenanthe crocata</i>	C2	-	-
<b>Species</b>	<b>TCV</b>	-	<b>TCV</b>
<i>Juncus effusus</i>	C2	<i>Verrucaria</i> sp(p).	C7

## Section 2. 180005 EF25NORM064

Figure 7. Section 2 photo taken from the downstream end, looking upstream



### Physical variables

River: Gwyrfai

Surveyor: R.V. Lansdown

\*NGR top: SH50918.59467

\*NGR bottom: SH50778.59497

Site: 180005 EF25NORM064

Date: 23 September 2025

% wadeable: 40

Total % cover of macrophytes: 50

Total % cover of filamentous algae (not included in total above): 0

Photo no. or reference upstream: Gwyrfai 2 us

**Photo no. or reference downstream:** Gwyrfai 2 ds

**Typicality:** A

A <25% of data on this form compromised  
 B 25-50% of data on this form compromised  
 C >50% of data on this form compromised

Width (m)	%
<1	0
1-5	0
5-10	5
10-20	95
>20	0

Depth (m)	%
<0.25	0
0.25-0.5	50
0.5-1	40
>1	10

Clarity	%	Shading (left bank)	%	Shading (right bank)	%
Clear	100	None	0	None	0
Turbid	0	Broken	0	Broken	0
Cloudy	0	Dense	100	Dense	100

Substrate	%	Bed stability	%	Habitats	%
Bedrock	0	Solid/firm	0	Pool	0
Boulders/cobbles	60	Unstable	0	Run	50
Pebbles/gravel	35	Stable	100	Riffle	50
Sand	2	Soft/sinking	0	Slack	0
Silt/clay	3	-	-	Glide	0
Peat	0	-	-	-	-

**Notes/comments:** Easy access from and along RB. High, fast flow due to rain in preceding week made access to deeper areas risky. Site surveyed in thigh waders, 30-40% of channel accessed directly, the remainder viewed from the bank and adjacent channel.

**Figure 8.** Section 2 photo taken from near the upstream end, looking downstream



<b>Taxa (synonym)</b>	<b>TCV</b>	<b>Taxa (synonym)</b>	<b>TCV</b>
<b>Macroalgae</b>	-	-	-
<i>Heribaudiella fluviatilis</i>	C3	Zygnematalean alga	C1
<b>Bryophytes</b>	-	-	-
<i>Brachythecium plumosum</i>	C1	<i>Porella pinnata</i>	C2
<i>Chiloscyphus polyanthos</i>	C2	<i>Racomitrium aciculare</i>	C1
<i>Fontinalis squamosa</i>	C7	<i>Scapania undulata</i>	C1
<i>Pellia epiphylla</i>	C2	<i>Schistidium rivulare</i>	C1
<i>Platyhypnidium riparioides</i>	C5	<i>Thamnobryum alopecurum</i>	C4
<b>Lichens</b>	-	-	-
<i>Dermatocarpon</i> sp(p)*	C1	-	-
<b>Vascular plants</b>	-	-	-
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	C1	<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp.	C1
<i>Oenanthe crocata</i>	C1	<i>Ranunculus flammula</i>	C1
<i>Persicaria hydropiper</i>	C1	-	-
<b>Additional species</b>	<b>TCV</b>	<b>Additional species</b>	<b>TCV</b>
<i>Isoetecium holtii</i>	C2	<i>Verrucaria</i> sp.	C2

## Section 3. EFNO8 EF25NORM069

Figure 9. Section 3 photo taken from near the downstream end, looking upstream



### Physical variables

**River:** Gwyrfai

**Surveyor:** R.V. Lansdown

**\*NGR top:** SH53568.57263

**\*NGR bottom:** SH53480.57266

**Site:** EFNO8 EF25NORM069

**Date:** 23 September 2025

**% wadeable:** 80

**Total % cover of macrophytes:** 50

**Total % cover of filamentous algae (not included in total above):** 6

**Photo no. or reference upstream:** Gwyrfai 3 us

**Photo no. or reference downstream:** -

**Typicality:** A

A <25% of data on this form compromised  
 B 25-50% of data on this form compromised  
 C >50% of data on this form compromised

Width (m)	%
<1	0
1-5	0
5-10	100
10-20	0
>20	0

Depth (m)	%
<0.25	0
0.25-0.5	10
0.5-1	80
>1	10

Clarity	%	Shading (left bank)	%	Shading (right bank)	%
Clear	100	None	100	None	100
Turbid	0	Broken	0	Broken	0
Cloudy	0	Dense	0	Dense	0

Substrate	%	Bed stability	%	Habitats	%
Bedrock	0	Solid/firm	0	Pool	0
Boulders/cobbles	5	Unstable	0	Run	90
Pebbles/gravel	90	Stable	100	Riffle	10
Sand	5	Soft/sinking	0	Slack	0
Silt/clay	0	-	-	Glide	0
Peat	0	-	-	-	-

Taxa (synonym)	TCV	Taxa (synonym)	TCV
<b>Macroalgae</b>	-	-	-
<i>Heribaudiella fluviatilis</i>	C3	Zygnematalean alga	C5
<b>Bryophytes</b>	-	-	-
<i>Brachythecium plumosum</i>	C2	<i>Racomitrium aciculare</i>	C1
<i>Fontinalis squamosa</i>	C6	<i>Scapania undulata</i>	C1
<i>Pellia epiphylla</i>	C1	-	-
<b>Lichens</b>	-	-	-
<i>Dermatocarpon</i> sp(p)*	C1	-	-
<b>Vascular plants</b>	-	-	-
<i>Apium inundatum</i>	C5	<i>Oenanthe crocata</i>	C2
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	C6	<i>Phalaris arundinacea</i>	C2
<i>Littorella uniflora</i>	C2	<i>Ranunculus flammula</i>	C1
<i>Myriophyllum alterniflorum</i>	C4	-	-
<b>Additional species</b>	<b>TVC</b>	<b>Additional species</b>	<b>TVC</b>
<i>Angelica sylvestris</i>	C1	<i>Juncus acutiflorus</i>	C2
<i>Dialytrichia mucronata</i>	C1	<i>Juncus effusus</i>	C2
<i>Galium palustre</i>	C1	<i>Verrucaria</i> sp.	C5

## Section 4. EFNW269 EF25NORM066

**Figure 10.** Section 4 photo taken from near the downstream end, looking upstream



**Figure 11.** Section 4 photo taken from near the upstream end, looking downstream



## Physical variables

**River:** Gwyrfai

**Surveyor:** R.V. Lansdown

**\*NGR top:** SH53516.57935

**\*NGR bottom:** SH53462.57997

**Site:** EFNW269 EF25NORM066

**Date:** 24 September 2025

**% wadeable:** 20

**Total % cover of macrophytes:** 60

**Total % cover of filamentous algae (not included in total above):** 0

**Photo no. or reference upstream:** Gwyrfai 4 us

**Photo no. or reference downstream:** Gwyrfai 4 ds

**Typicality:** A

A <25% of data on this form compromised

B 25-50% of data on this form compromised

C >50% of data on this form compromised

Width (m)	%	Depth (m)	%
<1	0	<0.25	0
1-5	0	0.25-0.5	0
5-10	100	0.5-1	20
10-20	0	>1	80
>20	0		

Clarity	%	Shading (left bank)	%	Shading (right bank)	%
Clear	100	None	95	None	100
Turbid	0	Broken	0	Broken	0
Cloudy	0	Dense	5	Dense	0

Substrate	%	Bed stability	%	Habitats	%
Bedrock	0	Solid/firm	0	Pool	0
Boulders/cobbles	1	Unstable	0	Run	100
Pebbles/gravel	75	Stable	75	Riffle	0
Sand	24	Soft/sinking	25	Slack	0
Silt/clay	0	-	-	Glide	0
Peat	0	-	-	-	-

**Notes/comments:** Water levels high, flow fast due to rain in preceding week. Survey carried out using a dry suit, entire channel accessed.

Taxa (synonym)	TCV	Taxa (synonym)	TCV
<b>Bryophytes</b>	-	-	-
<i>Fontinalis squamosa</i>	C1	-	-
<b>Vascular plants</b>	-	-	-
<i>Apium inundatum</i>	C3	<i>Phalaris arundinacea</i>	C2
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	C4	<i>Potamogeton natans</i>	C7
<i>Myriophyllum alterniflorum</i>	C7	<i>Potamogeton polygonifolius</i>	C7
<i>Oenanthe crocata</i>	C1	<i>Ranunculus</i> (sect <i>Batrachian</i> ) sp.	C1
<i>Persicaria hydropiper</i>	C1	<i>Sparganium erectum</i>	C1
<b>Additional species</b>	<b>TCV</b>	<b>Additional species</b>	<b>TCV</b>
<i>Chaetophora pisum</i>	C1	<i>Juncus effusus</i>	C1
<i>Filipendula ulmaria</i>	C1	-	-

## Section 5. EFNW271 EF25NORM068

**Figure 12.** Section 5 photo taken from near the downstream end, looking upstream



**Figure 13.** Section 5 photo taken from near the upstream end, looking downstream



**Physical variables**

**River:** Gwyrfai

**Surveyor:** R.V. Lansdown

**\*NGR top:** SH54411.56663

**\*NGR bottom:** SH54327.56705

**Site:** EFNW271 EF25NORM068

**Date:** 24 September 2025

**% wadeable:** 50

**Total % cover of macrophytes:** 90

**Total % cover of filamentous algae (not included in total above):** 1

**Photo no. or reference upstream:** Gwyrfai 5 us

**Photo no. or reference downstream:** Gwyrfai 5 ds

**Typicality:** A

A <25% of data on this form compromised  
 B 25-50% of data on this form compromised  
 C >50% of data on this form compromised

Width (m)	%
<1	0
1-5	0
5-10	100
10-20	0
>20	0

Depth (m)	%
<0.25	0
0.25-0.5	0
0.5-1	80
>1	20

Clarity	%	Shading (left bank)	%	Shading (right bank)	%
Clear	100	None	100	None	50
Turbid	0	Broken	0	Broken	20
Cloudy	0	Dense	0	Dense	30

Substrate	%	Bed stability	%	Habitats	%
Bedrock	0	Solid/firm	0	Pool	0
Boulders/cobbles	2	Unstable	40	Run	100
Pebbles/gravel	93	Stable	60	Riffle	0
Sand	1	Soft/sinking	0	Slack	0
Silt/clay	4	-	-	Glide	0

**Notes/comments:** Water levels high, flow very fast. Survey carried out using a dry suit, entire channel accessed.

Taxa (synonym)	TCV	Taxa (synonym)	TCV
<b>Macroalgae</b>	-	-	-
Zygnematalean alga	C2	-	-
<b>Bryophytes</b>	-	-	-
<i>Bryum pseudotriquetrum</i>	C1	<i>Platyhypnidium riparioides</i>	C2
<i>Fontinalis antipyretica</i>	C2	<i>Riccardia chamaedryfolia</i>	C2
<i>Fontinalis squamosa</i>	C1	<i>Scapania undulata</i>	C2
<i>Marsupella emarginata</i>	C1	-	-
<b>Vascular plants</b>	-	-	-
<i>Apium inundatum</i>	C6	<i>Menyanthes trifoliata</i>	C1
<i>Callitriche brutia</i> subsp. <i>hamulata</i>	C2	<i>Myriophyllum alterniflorum</i>	C7
<i>Carex rostrata</i>	C1	<i>Oenanthe crocata</i>	C1
<i>Equisetum fluviatile</i>	C1	<i>Phalaris arundinacea</i>	C2
<i>Isoetes lacustris</i>	C6	<i>Potamogeton polygonifolius</i>	C4
<i>Littorella uniflora</i>	C7	<i>Ranunculus flammula</i>	C1
<i>Luronium natans</i>	C1	<i>Sparganium</i> sp.	C1
<b>Additional species</b>	<b>TCV</b>	<b>Additional species</b>	<b>TCV</b>
<i>Juncus acutiflorus</i>	C2	<i>Juncus effusus</i>	C1

## Data Archive Appendix

Data outputs associated with this project are archived in NRW's Document Management System and KiECO.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] A full set of photos in JPEG format.

[C] Spreadsheets used to calculate the LEAFPACS class.

Metadata for this project is publicly accessible through Natural Resources Wales' Data Discovery Service <https://metadata.naturalresources.wales/geonetwork/srv> (English version) and <https://metadata.cyfoethnaturiol.cymru/geonetwork/cym/> (Welsh Version). The metadata is held as record no NRW\_DS161485.

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