Biosffer Dyfi Prosiect Ymchwil Gweithredu dan Arweiniad y Gymuned

A oes perthynas glir rhwng iechyd afonydd a goroesiad y wennol ddu (*Apus apus*)?

Cyhoeddwyd:
Mis Medi 2025

Ysgrifennwyd gan:
Bryn Hall

Gyda chymorth gan:
James Cass, Ben Porter, Elfyn Pugh, Jenny Lampard, Keith Halcrow

Wedi'i ariannu gan:
Cymru Wledig Local Policy Innovation Partnership (LPIP) Rural Wales *sy'n cael ei ariannu gan* UK Research and Innovation

(C) Ben Porter

Biosffer Dyfi Biosphere

CYMRU WLEDIG LPIP RURAL WALES

UK Research and Innovation

Crynodeb

Dros y 30 mlynedd ddiwethaf mae poblogaethau gwenoliaid duon cyffredin sy'n nythu (Apus apus) wedi gostwng 76% yng Nghymru. Er ein bod yn gwybod mai colli safleoedd nythu, y gostyngiad cyflym mewn pryfed sy'n gyflenwad bwyd ac effeithiau newid hinsawdd yw'r prif ffactorau sy'n gyrru dirywiad yr aderyn ymfudol hwn, mae'n hanfodol adnabod pa un o'r ffactorau hyn sydd fwyaf arwyddocaol yn ystod cyfnod bridio'r adar mewn gwledydd megis Cymru. Mae gwybodaeth o'r fath yn bwysig er mwyn gallu canolbwyntio ymdrechion cadwraeth lleol yn ôl yr hyn a ddysgir i sicrhau bod y rhywogaeth hon yn goroesi. A hwythau yn bryfysolion awyr, mae gwenoliaid duon yn dibynnu ar gyflenwad digonol o bryfed sy'n hedfan er mwyn goroesi a magu eu cywion yn llwyddiannus; mae afonydd yn gynefin allweddol i lawer o bryfed awyr sy'n dechrau eu bywydau yn y dŵr, yn ogystal â chynefinoedd ar lannau afonydd cyfagos, a rhaid iddynt fod mewn iechyd da i gynnal ystod amrywiol o anifeiliaid-di-asgwrn-cefn a digonedd ohonyn nhw. Wrth gynnal arolygon o boblogaethau gwenoliaid duon ac iechyd afonydd ar draws Biosffer Dyfi yng Nghymru mae'n bosib sefydlu set ddata sylfaenol gan fonitro newid dros amser i geisio ateb y cwestiwn: "a oes perthynas glir rhwng iechyd afonydd a goroesiad y wennol ddu gyffredin?"

Casglwyd data am boblogaeth gwenoliaid duon ac am iechyd afonydd gan grwpiau cymunedol o fewn Biosffer Dyfi, gan ddefnyddio dull ymchwil weithredol a arweinir gan y gymuned. Galwyd gwyddonwyr lleyg at y gwaith o adnabod a chofnodi safleoedd nythu'r gwenoliaid duon, 'partïon sgrechian' y gwenoliaid duon a'u hymddygiad bwydo; ac ar yr un pryd, i gynnal profion afonydd yn rheolaidd mewn 10 lleoliad allweddol, gan gynnwys samplu cic a chyfrif dwysedd y pryfed yn yr awyr. Nodwyd 125 o nythod gwenoliaid duon yn gyfan gwbl yn yr ymchwil, gan sefydlu sylfaen bwysig o safleoedd nythu naturiol ac artiffisial yn y biosffer. Datgelodd y profion dŵr fod y rhan fwyaf o afonydd Biosffer Dyfi yn ymddangos mewn iechyd da ar y cyfan, fodd bynnag, mae'r dalgylch yn fwy asidig na'r cyfartaledd. Roedd canlyniadau'r samplu cic wedi tynnu sylw at ystod dda o rywogaethau sensitif i lygredd yn bresennol yn yr afonydd; fodd bynnag, roedd safle rhai afonydd o hyd yn wael, gydag amodau asidig yn debygol o fod yn brif ffactor i atal rhai rhywogaethau macro-di-asgwrn-cefn rhag ffynnu.

Er nad yw'n bosibl defnyddio'r data sydd ar gael ar hyn o bryd i sefydlu perthynas ystadegol rhwng goroesiad y wennol ddu gyffredin ac iechyd afonydd, mae'n bosib y bydd rhagor o ymchwil (megis dadansoddi bolws y gwenoliaid duon) yn helpu i adeiladu cysylltiadau ecolegol cliriach ac arwyddocaol rhwng y ddau. Mae'r ymchwil hon yn darparu set ddata sylfaenol pwysig fel man cychwyn ar gyfer ymchwil cymunedol ac academaidd ym maes gwenoliaid duon ac afonydd ym Miosffer Dyfi yn y dyfodol.

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I'd like to recognise and thank Cymru Wledig LPIP Rural Wales for enabling this community-led action research project. Without recognition of the value communities can provide to research, the availability of resources, and empowerment for them to act, valuable projects like this are not possible. I would especially like to thank the LPIP Rural Wales academic mentors and the guidance they provided throughout.

The Screams & Streams project was devised and co-steered by the Dyfi Biosphere Swift Project and Lab Dŵr Dyffryn Dyfi, without whom this project would never have begun or achieved the level of success it has. I would like to extend special thanks to the individual members of this steering group, Ben Porter and Elfyn Pugh, of the Dyfi Biosphere Swift Project; Jenny Lampard and Keith Halcrow, of Lab Dŵr Dyffryn Dyfi; for each being a huge inspiration, giving an extensive amount of their time, energy, and passion into making this project a reality.

This endeavour would not have been possible without the 45 plus volunteers that gave their free time to survey swifts, test water quality or spread the word of the project, all of whom deserve a considerable amount of thanks and awe. I hope the project has been valuable to them in connecting even more closely with the communities, swifts, and rivers of the biosphere and beyond. I would especially like to acknowledge the highly engaged volunteers who made it possible to consistently record data at 10 different locations across the Dyfi Biosphere.

Thanks should also go to all the property and landowners that allowed our volunteers to access the riverbank across the different sites. Their willingness to work with us made the project possible. I'd like to specially thank those that enabled survey work to happen at Aberangell, Borth, Bont Dolgadfan, Ceinws, Llanymawddwy, and Machynlleth.

Another special thanks goes to the New Dovey Fisheries Association, for working with the project team closely providing valuable insights throughout, gathering and sharing data, and attaining land access permissions at several locations. This partnership has been invaluable to the project and stands testament to the value of community collaboration for future research."

Bryn Hall

Project Coordinator: Screams & Streams

28th August 2025

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Rhagymadrodd

(C) Ben Porter

Introduction

The decline of bird populations across the UK has been well documented, with it estimated there were 73 million fewer birds present across the four nations in 2023 compared to 1970 (British Trust for Ornithology, 2023). One bird that has seen a significant population decline in this time is the Common Swift *(Apus apus - Gwennol ddu in Welsh*), which in 2021 was added to the UK's Birds of Conservation Concern red list (British Trust for Ornithology, 2021). A particularly notable decline in swift numbers has been in Wales, where the species declined by 76% between 1995 and 2023 (British Trust for Ornithology et al., 2024).

Swifts are migratory birds that embark on an approximately 14,000 mile round trip from Africa to Wales's shores each summer to nest and breed. Swifts are aerial insectivores, feeding solely on aerial insects and other airborne invertebrates carried on the wind - often referred to as aerial 'plankton'. A swift can consume between 1,000 and 20,000 insects per day, and as such are valuable indicators of insect populations and wider ecosystem health. Wales has seen a decline of 79% in the abundance of insect prey between 2004 and 2023 (Buglife, 2024) which is one of the key drivers of swift declines nationally (British Trust for Ornithology, 2025).

Whilst declining insect numbers, increasingly poor weather conditions due to climate change, and loss of nesting sites are known to be key reasons for the reduction in swift numbers globally (Finch et al., 2023; Zoological Society of London, 2023), it can be hard to directly attribute which of these factors is the key driver on a regional level. More research and data collection in targeted regions is essential to understand the complex connection between local habitats and swift survival and identifying the most effective approaches to focus species conservation efforts at crucial points of their migratory cycle, such as breeding sites in Wales (Vickery et al., 2023).

Alongside the change in swift populations, half of Wales's rivers have been failing to meet phosphate targets. Whilst seeing some improvements over previous years, only 43% of rivers in Wales were considered to be of 'good or better' condition in 2024 (Natural Resources Wales, 2025). When freshwater systems such as rivers are in poor condition there can often be a wider ecosystem impact (Vári et al., 2022). Polluted or unhealthy rivers can especially impact emergent insects which can make up a significant part of the diet of many aerial insectivores, such as swifts (Finch et al., 2023; Kautza and Sullivan, 2015).

The survival of swifts and health of rivers have been key topics in the news across Wales and the UK at large over the past few years, and both are parts of a wider ecosystem that resonate deeply with their immediate human communities. This resonance has empowered many communities to establish local groups that can help monitor and protect these parts of the ecosystem. An example of two such groups from mid Wales are the Dyfi Biosphere Swift Project and Lab Dŵr Dyffryn Dyfi, both based in the Dyfi Biosphere.

Background and Funding

The Dyfi Biosphere is Wales's only UNESCO biosphere reserve (Figure 1) but is part of a network of sites in the UK and a family of biospheres around the world. UNESCO Biospheres are 'learning places for sustainable development', working towards viable futures by connecting people and nature. They are sites for learning and research, testing local solutions to global challenges and encouraging innovation for a sustainable future. The Afon Dyfi flows through the centre of the Biosphere, and is the main river in the catchment, rising in the Aran mountain range of Eryri before meeting the sea at Ynys Las in Ceredigion.

> "*From April to September of 2025 the Dyfi Biosphere received funding from, Cymru Wledig Local Policy Innovation Partnership (LPIP) Rural Wales, to deliver the Screams & Streams Project whose results are explored in this report. This kind of funding is vital to the Biosphere as it allows us to bring together citizen scientists with interested organisations and academics in order to protect the natural systems that are of vital importance to everyone.*"
>
> James Cass - Interim Biosphere Manager

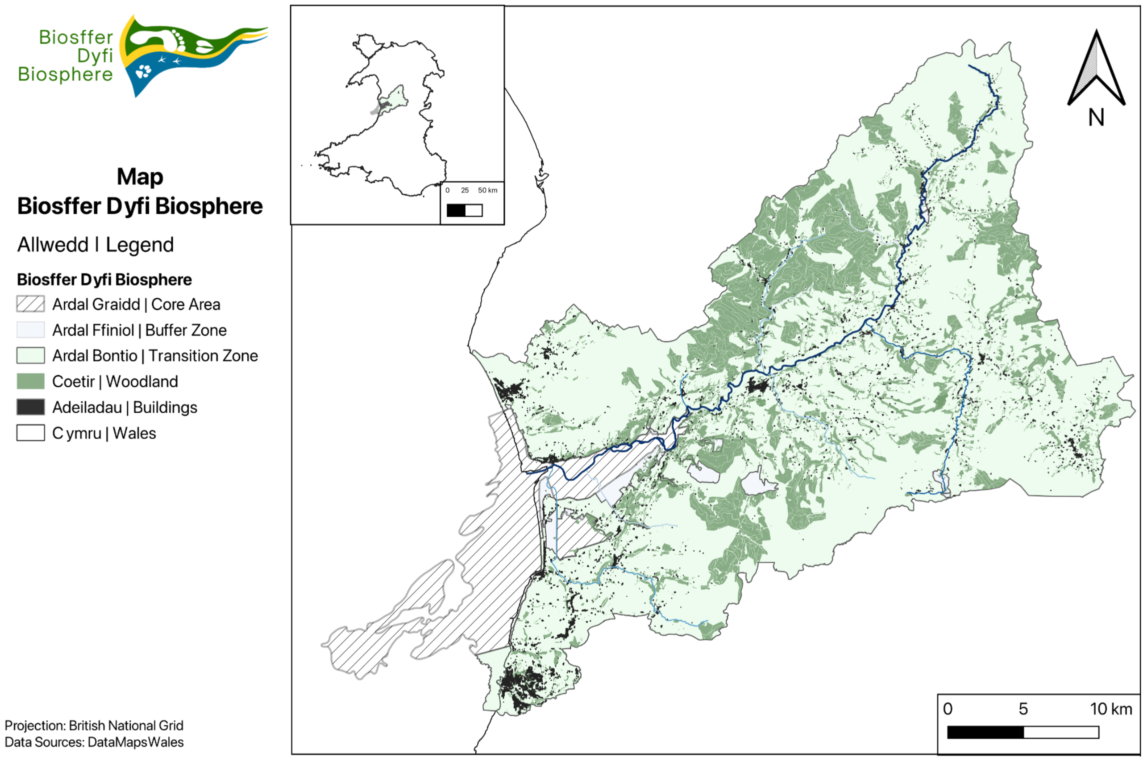


Figure 1 - Map of the Dyfi Biosphere

"*Cymru Wledig LPIP Rural Wales brings together researchers, stakeholders and communities to generate, share and apply evidence to enhance local policy and innovation for inclusive, sustainable growth in Rural Wales. It aims to realise the vision of a 'wellbeing economy' that prioritises an economy designed to deliver social justice for current and future generations on a healthy planet in which citizens are actively engaged in their communities. The vision is approached through four themes: 'Building a Regenerative Economy', 'Supporting the Net Zero Transition', 'Enhancing Wellbeing in Place' and 'Empowering Communities for Cultural Recovery'.*" (Cymru Wledig LPIP Rural Wales, 2025). Through LPIP and this project the Dyfi Biosphere has partnered with Aberystwyth University for support and advice.

Key Objectives

The purpose of this report is to compile a benchmark set of data on swift numbers and their nest site locations across the Dyfi Biosphere, whilst simultaneously gathering data on river quality, and emergent and aerial insect numbers along the main river systems in the project area.

- Engage with local communities in a survey of swift colonies in key locations to understand a) how many pairs are nesting in each site, and b) where the breeding swifts are travelling to feed.
- Survey river health at ten key locations across the Afon Dyfi watershed where there is close overlap with nearby nesting colonies of swifts or potential feeding sites.

- Use the project as a platform to engage local communities in the importance of river health and the plight of the swift, by involving as many people as possible in both the water testing and the swift surveying; with the legacy of independent community surveying in upcoming years.

Advocacy

The Dyfi Biosphere and its partners would like this research to be a valuable first step in advocacy with: Welsh Government and its agencies; landowners whose working practices can affect insect populations and nesting sites; and additionally, the people of the Dyfi Valley without whose support swifts will likely continue to face further decline. In line with the community-led action research approach, this research is designed to be accessible and usable by the communities that helped to realise it, as well as communities sharing similar challenges.

One of the subsequent ambitions of the Screams and Streams project is to encourage more people, from the Dyfi Biosphere as well as beyond, to care for and engage with their local environment, from swifts to rivers, and empower them to be more sustainable and take action to protect their surrounding ecosystem; in-line with the Dyfi Biosphere's sustainability objective to live at least in balance with the environment.

Methodoleg

Methodology

Community-led Action Research

This project has taken a community-led action research approach, which means the research area is chosen, designed, and carried out by the community to enable action on a subject that is important to the community (Scottish Community Development Centre, 2025). This was initially done through open recruitment of community groups by the Dyfi Biosphere and Cymru Wledig LPIP Rural Wales, leading to the response and involvement of the community groups: The Dyfi Biosphere Swift Project and Lab Dŵr Dyffryn Dyfi.
As well as discussing the findings of the research conducted, this report will explore the method of community-led action research used and how it can be replicated and improved in future years and for similar projects.

Around the Afon Dyfi and its main tributaries there are already at least three separate groups/organisations, recording and storing valuable river data - including New Dovey Fisheries Association, North Wales Rivers Trust, and Lab Dŵr Dyffryn Dyfi. The challenge is that not all this data is widely shared and easily available to the public. Part of the Screams and Streams project objective has been to make the data being gathered as accessible and consolidated as possible so rather than being another group gathering data, it is also shared with the existing groups and more widely to the local population and researchers.

One of the key challenges faced by any ecological study of this scale is ensuring that high quality, meaningful data is gathered on a large enough scale and over a long enough time period to ensure it can be used effectively. Communities such as those within the Dyfi Biosphere are made up of a diverse group of people and groups who bring a range of skills and influence to projects of this type. For this project, the Dyfi Biosphere partnered with the Dyfi Biosphere Swift Project and Lab Dŵr Dyffryn Dyfi; also working closely with New Dovey Fisheries Association.

Key Partners

The Dyfi Biosphere Swift Project was created after discussions within the Machynlleth Town Council Biodiversity Group in 2021. Since then, it has been hosted from within the Biosphere with initial funding from Garthgwynion Charities, and support from the Machynlleth Rotary Club amongst a number of others who have supported the project. To date they have installed over 250 swift boxes across the biosphere and worked with the Machynlleth Co-op store to install external artificial boxes as well as infographics about swifts inside and outside the premises.

Lab Dŵr Dyffryn Dyfi, established in 2024, is a community group that records river quality across the Dyffryn Dyfi catchment using the North Wales Rivers Trust system to store and gather their data. The group was formed to empower the local community to take action for its rivers and report upon potential water quality concerns.

The **New Dovey Fisheries Association** (NDFA) have owned a 15 mile stretch of the Afon Dyfi from Llugwy to Cwn Llinau since 1929 and have been responsible for managing their stretch of the river including the fishing and access rights upon it. This is unique in its ownership because it actually owns the riverbed. The NDFA have worked alongside the Dyfi Biosphere to enable land access along much of the Afon Dyfi itself for water quality testing for this project. Access to the test points along the Dyfi's main tributaries was obtained in direct cooperation with landowners.

Citizen Science Statement

An important phase of any citizen science project is to establish methods that can be easily replicated by various community members of differing experience levels, whilst also ensuring the data produced is reliable and accurate. As with any research, errors can occur, and, to minimise these training and data entry systems were implemented from the start. The focus of this research is in part, to build a baseline dataset to identify where future and/or more in-depth research efforts should be focused, making site comparability one of the key outcomes of this research project. It is for these reasons that each of the selected methods was implemented and, in some instances, modified.

Data Gathering

Project Area

The project area sits within the Dyfi Biosphere, focussing on 10 key locations (Figure 2), each chosen for specific reasons which were:

- **Llanymawddwy** - Closest to where the Afon Dyfi rises it should provide a sample with minimal human impact, and the surrounding habitat may be a potential feeding site for common swifts.
- **Dinas Mawddwy** - A location known to have nesting swifts in previous years and located at the upper end of the Afon Dyfi's first sizable settlement.
- **Aberangell** - Believed to have previous swift occupancy in locality and to offer a potential feeding site.
- **Bont Dolgadfan** - Location with known nest site for swifts in previous years and on one of the Dyfi's major joining rivers, the Afon Twymyn.
- **Cemaes** - Not far downstream of Aberangell and home to previously recorded nests and screaming parties.

- **Ceinws** - Another major tributary of the Afon Dyfi, Ceinws is situated on the Afon Dulas North and known to have a strong population of swifts in past years.
- **Machynlleth** - The centre of the project area and hub of swift boxes and previous nesting activity, this is also the largest settlement in the main project area.
- **Pennal** - Another location on a tributary, the Afon Pennal, with known previous swift nest box occupancy and activity.
- **Tre'r-ddol** - Chosen as the closest significant stream and potential feeding site to Taliesin, an area known to have previous swift occupancy and nest boxes. Situated on the Afon Cletwr.
- **Borth** - This site was selected due to its closeness to Cors Fochno (Borth Bog), which is at the end of the Afon Dyfi. It is one of the core areas in the Dyfi Biosphere and has the potential to provide substantial insect mass due to the type of habitat. There are two water quality test points here, one above and one below the Dŵr Cymru sewage treatment works discharge point. These are located on the Afon Leri.

See Figure 2 for specific site locations and Table 1 for river characteristics.

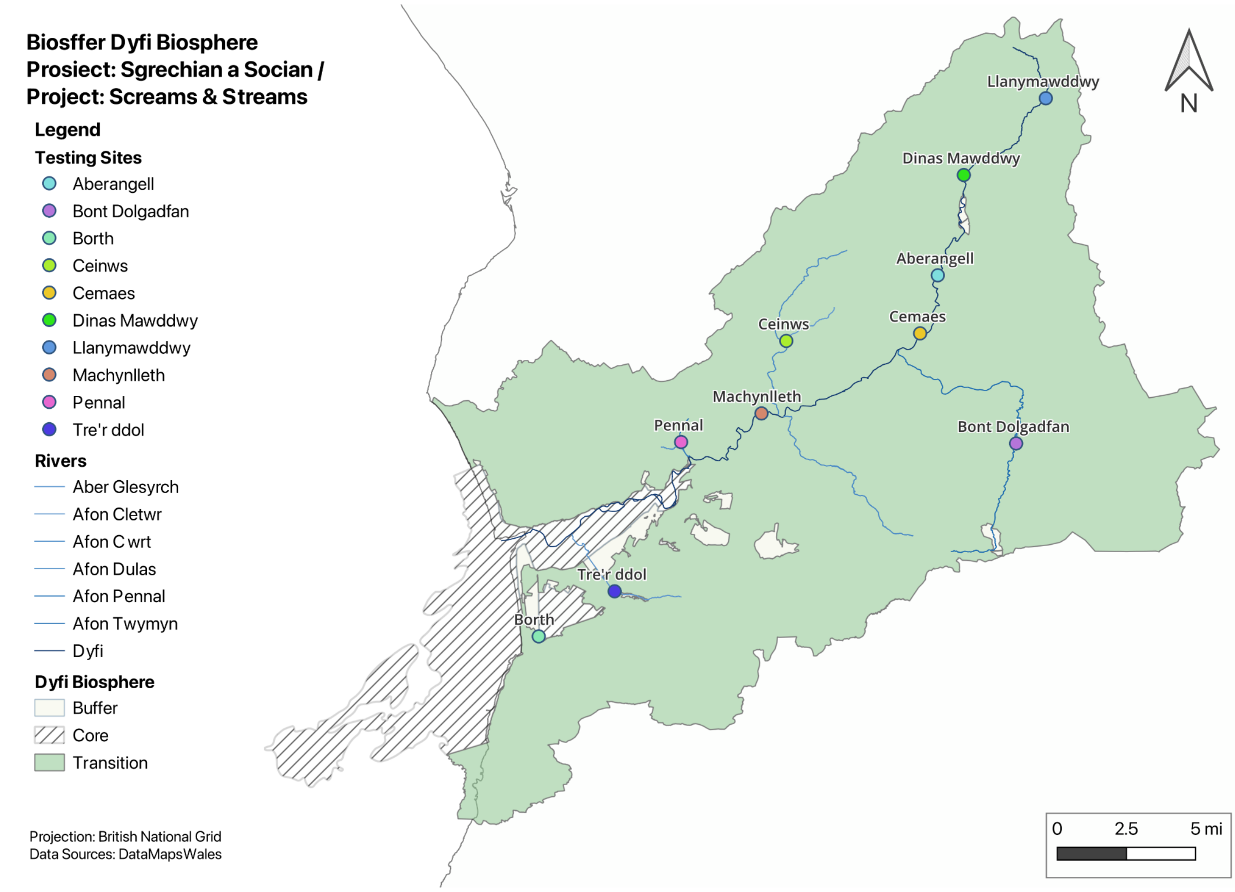


Figure 2 - Dyfi Catchment: River testing locations

Table 1 - Key characteristics of river testing locations

Water Testing Locations – Sorted by Distance from Source				
Location	**NGR**	**River Name**	**Distance from Source (km)**	**Altitude (m)**
Pennal	SH 69886 00478	Pennal	4.1	8.2
Tre'r-ddol	SN 65959 92212	Cletwr	5.8	20
Llanymawddwy	SH 90705 19067	Dyfi	6.7	141
Ceinws	SH 75925 05916	Dulas North	9.9	50
Bont Dolgadfan	SN 88594 99877	Twymyn	10.9	119
Dinas Mawddwy	SH 86059 14921	Dyfi	14.3	78
Borth (Above Outlet)	SN 61377 89488	Leri	16.6	4.8
Borth (Below Outlet)	SN 61637 89869	Leri (brackish water)	17	2.7
Aberangell	SH 84478 09357	Dyfi	22.3	43
Cemaes	SH 83372 06124	Dyfi	27.5	28
Machynlleth	SH 74446 01930	Dyfi	38.6	6.4

Swift / Gwenoliaid duon (*Apus apus*) Data

Swift surveying and feeding behaviours

Swift surveying was carried out and coordinated by the Dyfi Biosphere Swift Project team, in tandem with the project coordinator, involving citizen scientists across the Dyfi catchment with a focus on the 10 key sites. During the project, the Dyfi Biosphere held 8 events, including evening walks and presentations across the key villages and towns to provide training for community members wanting to participate in swift surveying, detailing how to identify swifts and where to record sightings.

The surveying encompassed three main elements:

1. **Identifying and quantifying swift breeding populations at each site**
   Swifts are difficult birds to survey as they spend almost all their time in the air, and their nests are concealed in small cracks and crevices in buildings. They return to and enter their nests at high speed and make relatively little sound once inside. Further to this, they can travel extensive distances to feed - sometimes in excess of 60kms - and may visit locations they are not actually nesting (RSPB, 2025b; Thompson, 2006). Their high top speeds of almost 70mph (Cook, 2022) also means they can travel between locations in a very short period of time, making it almost impossible to ensure two sightings

within a reasonable proximity of each other are not of the same bird, even if recorded within a similar timeframe. In light of these challenges, two approaches were used to build a picture of local swift populations:

'Screaming parties'

The first method was to survey 'screaming parties', where two or more swifts exhibiting their distinctive screeching call can be seen swooping at high speed through towns and often near to buildings. These flocks, which often occur at dusk, can help to identify areas in which swifts are nesting but have not yet been recorded.

Locating and monitoring nest sites

The second method used to estimate local swift population size was to locate and count active nest sites. Whilst hard to do because of the speeds and irregularity in which swifts enter and leave a nest, if done well it can build a clear picture of the population size and distribution of that population. The objective of this was to try and establish exactly where swifts were nesting in buildings and/or swift boxes and to record this in a standardised way. These nest sites can then be checked each year on year to establish whether there is returning occupancy.

2. **Identifying where swifts are feeding**
   A second key aspect to the swift research work was to carry out surveys of swift feeding behaviour at chosen sites close to each of the villages/towns. These feeding surveys were carried out at each site fortnightly in tandem with water testing and involved visual observation of swifts in the local area to try and identify where they were flying and feeding nearby - whether they were clearly hawking for insects over the nearby river system, for instance, or whether they were instead over other habitats, e.g. woodland canopies. The objective here was for this data to help inform whether the birds are indeed highly dependent directly on the river systems for their foraging activities, or whether they feed much wider than riparian areas.

3. **Success of swift nestboxes installed by Dyfi Biosphere Swift Project**
   A third aspect to the survey work was to carry out an important stock-take of the success of swift nestboxes installed across the Dyfi Biosphere. These have been installed by volunteers in the group over the last three years, with over 250 to date. The boxes provide a nesting site for swifts where perhaps there were no suitable areas before, or where their existing nest sites were in danger of being lost through building renovations. Survey forms were circulated around the community to encourage box owners to check their

boxes and report back on swift occupancy; box owners were also encouraged to submit their nest boxes to one of the recording databases.

Data collection and storage

The swift data for this project was gathered using two key citizen science data recording systems (Cofnod and SwiftMapper) that both depend on data entry from the public, which can include experts as well as people new to swift identification. To try and ensure sightings of swifts and nesting activity entered were accurate, there were several social media posts, community evenings and public engagement events to raise awareness for the project, how the public can effectively submit data, and how to tell the difference between swifts and other birds such as swallows and house martins. This however does not completely eliminate the possibility of false sightings or misidentifications; this should be taken into account when utilising this dataset.

Cofnod (Cofnod, 2025)

Cofnod is one of four Local Environmental Records Centres (LERCs) in Wales forming part of a national network. Cofnod extends across the whole of North Wales, not quite extending South into Ceredigion or South/East into Powys. For this reason a project agreement with Cofnod has been arranged to allow data from the 'A Swift Recovery' project set up by North Wales Wildlife Trust to be shared with Biosffer Dyfi Biosphere and for data entry to extend further South and South/East to cover the entire Biosphere.

The data primarily being taken from the Cofnod database includes:

1. **Screaming parties**: Excited groups of two, three or more swifts in low-level fast flight and screaming calls.
2. **Prospecting**: Birds flying up to inspect buildings close-up, sometimes clinging temporarily to walls below eaves.
3. **Nesting attempts**: Actually entering through cracks under eaves etc. - These will be counted as nest sites.
4. **Flying near buildings**: Birds seen repeatedly over built-up area, circling or flying at roof-height, but not screaming, clinging or going right up to eaves.
5. **Feeding behaviour**: Bird(s) seen feeding – making tight circles in a group, or slower flights with abrupt dips or swoops – over e.g. lake/wetland/river/crop-field.

SwiftMapper (RSPB, 2025a)

SwiftMapper is a UK national conservation mapping tool run by the RSPB. It is open access, meaning anyone can submit and access records of swift activity.

1. **Occupied Nest**: Where swifts are observed using a nest site cavity.
2. **Previously Occupied**: Where swifts were known to nest previously, but no longer do so.
3. **Nest Box**: Nesting sites deliberately provided for swifts - nest boxes, nest bricks, etc. Whether occupied yet or not.
4. **Screaming Party**: Records of swifts flying at around roof height, often flying fast in groups, and often giving loud screaming calls. This behaviour indicates that swifts are breeding nearby.

There are some differences in the data gathered and definitions used between the two systems, however the fundamental data they are gathering is the same. For this project, citizen scientists were trained in accordance with Cofnod's system and encouraged to enter data directly onto that system specifically.

There was also the possibility of additional data entries from people not directly involved in the citizen science project into both SwiftMapper and Cofnod. Whilst it may not be possible to verify the accuracy of these additional entries in line with the project, both systems are clear with their definitions and data gathered would all be validated to the best ability before analysis.

Water Data

Water data was gathered by a combination of new and existing volunteers who have been trained by Lab Dŵr Dyffryn Dyfi and Biosffer Dyfi Biosphere to ensure consistent data gathering technique. The equipment used has been supplied by Biosffer Dyfi Biosphere to ensure all equipment is the same for consistent comparison.

Fortnightly water testing was carried out across the 10 test locations for:

1. Temperature
2. pH
3. Nitrates and nitrites
4. Phosphates
5. Conductivity
6. Total dissolved solids
7. Dissolved oxygen
8. Turbidity

This took place from May to late July, encompassing the key breeding period for swifts as they arrived and set about rearing their young.

For each test, a bucket is rinsed with water from the sample site and then used to collect a sample for analysis. Testing of the sample is usually completed within 45 minutes or within up to 1 hour. Where possible testing with probe/meter devices is done straight from the water body, i.e. to ensure ambient conditions (rain, air temperature, etc.) don't alter the composition of the sample and thus skew the results.

The metrics being measured and methods used are:

1. **Temperature** (Degrees Celsius) - This is measured using a ‘HM Digital COM-100 Waterproof EC / TDS / Temp Combo Meter’ with a temperature resolution of 0.1 °C. The result is taken once the temperature reading has stabilised, usually after 1-3 minutes.

Table 2 - Temperature equipment range, resolution and accuracy

Measurement Function	Measurement Range	Resolution	Accuracy
Temperature	0-80°C	0.1°C	±2%

2. **pH** (scalar units) - The pH reading is taken using simple colour test strips ‘WaterWorks Extended Range pH (2-12pH) (NCW-481104)’. The strip is used by submerging the coloured pads into the sample and gently moving back and forth for 10 seconds. It is shaken once upon removal and compared to a range colour chart after 20 seconds of development time. The test range extends: 2, 3, 4, 5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 11, 12.

3. **Nitrate & Nitrite** (mg/L) - This is measured using ‘Test strips: Nitrate 0 - 50 mg/L and Nitrite 0 - 3 mg/L’. The result is gained by submerging the test strip in sample for 1 second, removing without shaking and then waiting 30 seconds for the strip to develop. After 30 seconds the paper must be compared to the colour chart within 10 seconds for an accurate reading.
    a. *Nitrate*: test range extends: 0, 1, 2, 5, 10, 20, 50 mg/L NO_3-N
    b. *Nitrite*: test range extends: 0, 0.15, 0.3, 1, 1.5, 3 mg/L NO_2-N

4. **Phosphate** (ppm) - This test is completed using a ‘Hanna HI-713 Phosphate Low Range Checker for Marine and Freshwater’. The method involves filling both test vials with the sample water to the fill line, one vial then has ‘HI-713-25 Reagent’ powder added and is agitated for 2 minutes or until the reagent is fully dissolved. Whilst this happens the sample with no reagent is used to calibrate the checker, upon completion the reagent sample is put into the checker and a 3 minute analysis begins. Both vials must be wiped clean of any marks before inserting into the upright phosphate checker. If upon completion the reading is 0.00 another check is done to confirm. If the results do not match, more tests are done until there is a match or close match. The checker has an accuracy margin for error of ±0.04ppm.

Table 3 - Phosphate checker range, resolution and accuracy

Measurement Function	Measurement Range	Resolution	Accuracy
Phosphates	0-2.5ppm	0.01ppm	±0.4ppm

5. **Total Dissolved Solids** (ppm) – Total Dissolved Solids (TDS) refers to the total amount of substances (organic and inorganic) in a water sample besides H2O itself. As, within the remits of this project, it is not possible to measure this using the laboratory method of completely evaporating the liquid and measuring what remains, TDS is measured using a 'HM Digital COM-100 Waterproof EC / TDS / Temp Combo Meter' with a range of 0 - 8560 ppm (mg/L). This total is worked out with a conversion factor of 0.7 based upon the total electrical conductivity and temperature coefficient. This is explained in detail by the manufacturer here. Readings are taken by submerging the probe into the sample and gently stirring for a couple of minutes or until the reading stabilises, which may take longer.

Table 4 - Total Dissolved Solids probe range, resolution and accuracy

Measurement Function	Measurement Range	Resolution	Accuracy
Total Dissolved Solids	0 - 8560 ppm (mg/L)	0.1ppm	±2%

6. **Electrical Conductivity** (μS/cm) -This is measured using a 'HM Digital COM-100 Waterproof EC / TDS / Temp Combo Meter' with an EC Range: 0 - 9990 μS. Readings are taken by submerging the probe into the sample and gently stirring for a couple of minutes or until the reading stabilises, which may take longer.

Table 5 - Electrical conductivity probe range, resolution and accuracy

Measurement Function	Measurement Range	Resolution	Accuracy
Electrical Conductivity	0 - 9990 μS	0.1μS	±2%

7. **Dissolved Oxygen** (mg/L) - This is measured using a 'Dissolved Oxygen Meter PCE-DOM 10' The meter has a measurement range of 0-20mg/L, a resolution of 0.1mg/L and accuracy of ±0.4mg/L. Readings are taken by submerging the probe into the sample and gently stirring for a couple of minutes or until the reading stabilises, which may take longer.

Table 6 - Dissolved oxygen probe range, resolution and accuracy

Measurement Function	Measurement Range	Resolution	Accuracy
Oxygen in Liquids	0-20mg/L	0.1mg/L	±0.4mg/L

8. **Turbidity** (Jackson Turbidity Units) - This test is done using a 'Palintest Turbidity Tube' which has been calibrated to Jackson turbidity units. The tube is filled straight from the water body and read by looking straight down the tube. If the 'X' at the bottom is visible when the tube is full, the reading is <30JTU. If the 'X' is not visible then the sample gradually is emptied away until visible again, a reading is then taken off the side of the tube.

Water Framework Directive Thresholds

In sections of the Results and Discussion where a ranking is being assigned from High/Good to Poor/Bad, it is being done so using Water Framework Directive (WFD) thresholds for England and Wales. This scoring system assigns that a river that reaches a minimum of 'Good' ecological status to achieve a 'Pass' and any river ranking 'Moderate' or lower is a 'Fail' (Defra, 2009). Whilst the results of this report may not be able to provide a definitive 'Pass' or 'Fail' for each of the test locations, it can provide an overall picture of the catchment health and provide information on where more focused and long-term surveying efforts should be had.

Macroinvertebrate Data

Flying Insect Density

The flying insect density count is an experimental implementation of an adapted active visual spot count method (Montgomery et al., 2021) to allow comparison between flying insect numbers present at the different river sites being surveyed. The method uses the same style of recording data as the existing FIT Counts method for pollinating insects (UK Pollinator Monitoring Scheme, 2025) and has two elements:

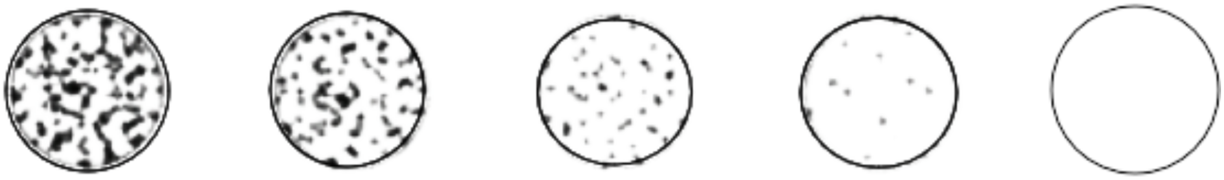
1. **Timed Count** - *Large flying insects (>3mm)*:

The surveyor will stand parallel to the river, facing across to the opposite bank. Once ready to start, a 10 minute timer is set and the count will take place during that time. Every insect that flies past from the surveyors point, or within a metre either side of them, on the riverbank is recorded, if the insect is identifiable (i.e hoverfly, mayfly, etc.) it is recorded as such, unknown or unidentifiable species are recorded as 'Other Insect'.

2. **Non-timed density analysis of small, flying insects (<3mm)**:

This is a visual estimate of the number of present small flying insects from 1 to 5, with 1 being plentiful and 5 being none visible, explained below and highlighted in Figure 3:

1. Plentiful (Large swarm/mass)
2. Present in small groups (small clusters)
3. Present in small numbers (very small clusters)
4. Very few (light masses or just a few visible)
5. None Visible



1 2 3 4 5

Figure 3 - Small flying insect mass scale

The survey also gathers information on the immediate surrounding habitat (woodland, grassland, arable crop, etc.), weather conditions, temperate range, wind strength (visual observation based on tree/plant movements) and shade cover.

Kick Sampling - WHPT

The method used to gather a kick sample is a standardised approach adapted from the Whalley Hawkes Paisley Trigg (Water Framework Directive, 2014a) and Shropshire Wildlife Trust (Shropshire Wildlife Trust, 2016). The following equipment is required:

- 300mm wide net with a 250μm mesh
- 2x large white trays
- Clear sample pots
    - Hand Lens
    - Waders
    - Identification/dichotomous guides

The ideal is to collect two samples per year, one in the spring and one in the autumn, however for this project the samples are being collected just once per site throughout June and July.

Gathering the sample:

The process involves entering the river to disturb the sediment across the river bed. This is done by standing in one spot whilst facing upstream and using your heel to disturb the sediment. The net should be held on the benthos about 1-5 inches downstream to capture any released macroinvertebrates, whilst reducing the amount of silt and rock that enters the net.

The kick is performed for a total of 3 minutes, split into 30 second kicks. Upon completion of each 30 second kick, the net is carefully emptied into a large white tray pre-filled with water.

Over the 3 minutes, time is divided as proportionately as possible between varying habitats and substrates within the waterbody. For example, where there are only changes in substrate, if 50% of the substrate is cobbles and 50% is gravel the time should be split evenly between those areas. This also applies to riffles, pools and vegetated areas.

Counting the sample:

Both trays should be filled with water from the river prior to the kick. Once the kick sample is in one of the trays, the sample pots can be used to carefully transfer the species from the sample tray to the other water-filled tray. During this process the species present are identified and counted, if possible, using Latin names to ensure accurate interpretation and data usability. Where species level identification is not possible, family level is used.

Where an exact specimen count may not be possible due to large abundance an estimate is given, for this method it is worked out by:

1. Identifying the abundant species
2. Moving a portion of that species from one sample tray to the other, counting each individual as it is done
3. Visually estimate the proportion/percentage of that species moved from the original sample tray into the second tray
4. Calculate the total:
    a. If there are 60 specimens in the second tray and approximately 6x more in the original sample tray calculate 60 X 6 = 360
    b. Add 360 to the 60 in the second sample tray for the estimated total: 360 + 60 = 420. Wherever possible an exact number should be used over an estimate

Once identification and count are complete both trays should be carefully emptied back into the same section of the waterbody. It is advisable to take clear pictures of each species for later identification, especially for harder to identify species.

Analysing the data:

Hill's Number & Evenness

The Shannon Weiner Index (H') has been used to calculate the Hill's Number of Abundant Species (N_1) and the Evenness (E_1) for each of the kick sample sites and the flying insect data, the equations are shown below in Figure 4, Figure 5, and Figure 6.

$$H' = -\sum \left[\left(\frac{n_i}{N}\right) \ln\left(\frac{n_i}{N}\right) \right]$$

where	H'	= Shannon Weiner Diversity Index (Ludwig and Reynolds, Statistical Ecology,1988)
	ln	= natural logarithm
	n_i	= number of individual for species i
	N	= total number of individuals in sample

Figure 4- Shannon Weiner Index Calculation

$$N_1 = e^{H'}$$

Figure 5 - Hill's Number Calculation

$$E_1 = \frac{H}{\ln(S)}$$

Figure 6 - Evenness Calculation

River Invertebrate Classification Tool

Once collected and counted the species are assigned a score based on the Walley, Hawkes, Paisley & Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT) version 3.1.8 (Freshwater Biological Association, 2025a). This metric assigns a score to each present invertebrate species based upon its abundance and tolerance, it can then be used to compare rivers to what they should be under pristine conditions.

"*The [RICT] classification comprises two metrics that are assessed separately and then combined in a "worst of" approach to provide the overall invertebrate classification; WHPT ASPT (Average Score Per Taxon) WHPT NTAXA (Number of taxa contributing to the assessment) RICT output includes an EQR (Ecological Quality Ratio), a face value classification and an estimate of the probability of the result belonging to any of the WFD classes. This is provided individually for both of the metrics."* (Water Framework Directive, 2014b).

In order to enter data into RICT a range of Environmental Variables (EV) need to be gathered, explained in Table 7. For the purpose of this research, they have been gathered using straightforward methodology, that in future research should be further refined.

Table 7 - List of environmental variables and how they are collected for RICT analysis

Name	**Unit**	**Comments**
National Grid Reference (NGR)		This is displayed as two letters followed by 6 digit Easting and 6 digit Northing. This was obtained for each site using OS mapping software
Altitude	M	This was obtained for each site using OS mapping software
Slope	m/km	One of the more complicated metrics. This was gathered by measuring the rise using ranging poles over a 2m run. Where the river bed featured a more complicated bed slope a longer run was used for an average. The equation used is Slope = Rise (in m) / Run (in km). I.e. Rise of 18mm over 2m - 0.018/0.002 = 9m/km
Discharge Category	Numeric (1-10)	Found using data from local environmental data from the UK Centre for Ecology & Hydrology (UK Centre for Ecology & Hydrology, 2025a). Where not available velocity was measured 3 times from the centre of the river bed over 5m and the median average velocity used (See Appendices Table 20 & Table 21).
Distance from Source	km	Calculated using mapping software
Stream Width	m	Measured from bank full to bank full on a transect representative of the surrounding riverbed. In future tests an average should be done across the site to reduce potential bias.
Stream Depth	cm	Measured at three points along the river width transect, at 1/3, 1/2, and 2/3 of the way across.
Alkalinity / Conductivity	$CaCo_3$ / µS/cm	Taken from NRW data available from DataMapWales. Where not available the median electrical conductivity was taken from a minimum of 5 samples over the project period.
% cover boulders & cobbles		The remaining metrics were visually estimated across the river transect and given as a % to total to 100%. >64mm - Half fist size or larger
% cover pebbles & gravel		2-64mm - Instant coffee granule to half first size
% cover sand		0.06-2mm - Smaller than instant coffee granules and, unlike silt/clay, abrasive to hands when rubbed
% cover silt & clay		<0.06mm - Soft in texture and not abrasive to the hands when rubbed

For this study the method has been slightly adapted, so anything identified to family level but not to species is given a score at the mean average of all the scores for that family. Worked example shown in Table 8 and Table 9 below. Whilst not a perfect method it better allows for errors in identification of more complex species to be evened out. When an identification was not possible in the field, a macro lens was used to document and later ID the specimen.

Table 8 - WHPT family level identification actual scores

	AB1	AB2	AB3	AB4
ODONATA (Damselflies)				
Calopterygidae (= Agriidae)	**5.9**	**6.2**	**6.2**	**6.2**
Platycnemididae	**6.0**	**6.0**	**6.0**	**6.0**
Coenagrionidae (= Coenagriidae)	**3.4**	**3.8**	**3.8**	**3.8**

Table 9 - WHPT family level identification average score, worked example

Worked Example - Mean Averages of actual scores above	AB1	AB2	AB3	AB4
Unknown Odonata Sp.	5.1	5.3	5.3	5.3

To allow for more accurate evenness calculations, where two specimens are known to be different species, but belong in the same family, they are recorded as two separate entries with the averaged out WHPT score.

Community Involvement

For this project to truly work as a community-led action research project community involvement was key. This was approached in several ways:

A. **Steering Group**: The steering group was created to guide the project as it progressed and formed a direct link between the research and the community. It consisted of the Dyfi Biosphere, Dyfi Biosphere Swift Project, Lab Dŵr Dyffryn Dyfi, and the project coordinator. This group met for 2 hours once each week over the course of the project and communicated throughout via email and group chat to share project updates, questions and feedback. This group also had access to several academic mentors through Cymru Wledig LPIP Rural Wales, who were there to offer feedback on method, progress and next steps throughout.

B. **Social Media**: To raise awareness for the project and subsequent events the Dyfi Biosphere's existing social media (Instagram and Facebook) channels were used frequently to promote activities. These were done bilingually through the mediums of Welsh and English as frequently as possible, and consisted of a combination of static posts, carousels and one video to promote Swift Awareness Week. Most posts were not financially promoted; however, several Facebook event posts were assigned a budget to promote within the project area. Information was also made available on the Dyfi Biosphere website.

C. **Personal/Community Group Connections:** Alongside social media, some volunteers were recruited from the two community groups' existing volunteer network directly. Many of these volunteers were already at least trained and had some experience in the methods of research employed for this project, making them easy to mobilise.
Land access permissions were also largely attained via personal and professional connections held by the Dyfi Biosphere, Lab Dŵr Dyffryn Dyfi, and New Dovey Fisheries Association.

D. **Training & Engagement Events**: The Screams & Streams project launched with a community training and engagement event at the Centre for Alternative Technology (CAT). This involved introductory talks on the project, community involvement opportunities, swift identification and data entry and water quality training.
   - *Water Quality Training* - Following the event at CAT all additional training for project volunteers was carried out during testing by an experienced project team member. In situ training was also used for the insect density count and kick sampling.
   - *Swift Survey Training* - Beyond the event at CAT swift recording training was provided across five community presentation events, held in Pennal, Dinas Mawddwy, Llanbrynmair, Tre'r-ddol, and Machynlleth. The objective of these events was to enthuse the community into the need for surveying before equipping them with the knowledge and methods on how to submit surveys. There were also several community swift walks in key areas around the project where community members were invited to help identify nesting sites.

E. **Community Councils**: Effort was made to reach out to and communicate with community councils throughout the project area. This was done later into the project and formed part of the effort to ensure surveying efforts did not cease once the research period concluded.

F. **Communication**: Additional means of community communication employed during this project included:
    - *Email* - Most participants signed up to receive emails from the project coordinator. This mostly consisted of a weekly email detailing the project progress, participation opportunities and any additional relevant information.
    - *Group chat* - Once a volunteer base had been established, a WhatsApp group chat was created, and project participants were offered to join. The purpose of this group chat was to allow quicker communication between coordinators and volunteers, to enable a direct means of contact for people wanting to car share to a location, share updates and ask questions. It also acted as a direct way of reaching participants who were less active on email or social media. All volunteers were asked before being added to the group chat as all group chat members would have access to the other group chat members' phone numbers.

G. **Project App**: One of the key components of the data gathering process was creation and use of the Screams and Streams app, Figure 26. A free online app creation tool was used to provide a place where survey forms, help sheets and important project links, such as risk assessments, printable resources, and the collected data, could be openly accessed. The app is still accessible here and sample images are in Figure 26.

Canlyniadau a Thrafodaeth

(C) Ben Porter

Results and Discussion

When considering all of the following data, one thing that should be noted is that as of writing the report, early figures show that Wales has experienced its third warmest June on record, with the summer season as a whole being especially dry and warm for the country (Met Office, 2025). This will have undoubtedly had an impact on the data retrieved from the rivers, as well as on insects and subsequently swift populations.

Swift Survey Results

Result of Citizen Science Data

Over the course of the project, citizen scientists and community members of the Dyfi Biosphere engaged with the project in various ways: 45 volunteers registered to help with the survey work, and many more were involved externally; there were 168 individual recordings of swifts and swift nest sites submitted; 126 of these were submitted via Cofnod and 42 logged on SwiftMapper. This volume of data collection enabled the recording of over 100 nest sites and 63 screaming parties. It also made it possible to identify the minimum percentage of occupancy of the 270 installed swift boxes across the Dyfi Biosphere.

Swift nest sites and screaming parties

Over the surveying period 107 individual swift nests were recorded across the Dyfi Biosphere, of which just over 65% are known to be 'natural' nests (within a cavity or gap in a building) and approximately 26% were within artificial boxes, with 8% unknown either way. This is highlighted in Table 10, which also lists the number of recorded swift boxes installed, many by the Dyfi Biosphere Swift Project (DBSP), in the region. Whilst each of these figures is likely an underestimation, due to unrecorded nest sites and private swift box installations, it provides a baseline figure and shows at least 10% of known nest boxes have been occupied by swifts. What this does not mean is that the boxes without swifts are completely unoccupied. Many swift box owners and site surveys showed that some boxes were occupied by other birds, such as house sparrows (*Passer domesticus*), another red listed species in the UK (RSPB, 2025c). Whilst exact figures of this non-swift occupancy are not readily available, this provides an area of suggested further study.

Table 10 - Total number of recorded nest sites and installed swift boxes

Total Known Occupied Nests	107 (70 natural, 28 artificial, 9 unknown nest type)
Installed Boxes (DBSP and Others)	270

Figure 7 shows heatmaps of the recorded screaming parties and nest sites recorded across the Dyfi Biosphere during the project, with an outline of the data for each site in Table 11. Whilst it is likely there were unrecorded screaming parties in the Biosphere, it appears from these data that almost everywhere screaming parties have been reported, nests have also been logged. This suggests a good coverage of nest site distribution. In fact, in most locations' nests have been recorded even when screaming parties have not, eliminating that step entirely. One exception is seen in Map Overlay 1 for Maps A and B (Figure 7), where two screaming parties have been recorded in a small village (Llancynfelin), but no nest sites have been logged. This suggests the presence of nest sites that should be looked into in future years. Aberystwyth and Llanbadarn in the southernmost point of the biosphere also shows recordings of screaming parties in areas with no reported nests. Because of the scale of the town of Aberystwyth and the population size the best course of action may be to establish, if not already existing, a group dedicated to surveying the town's swift population. Overall, this display of data appears positive in terms of giving a representative figure of where swifts are nesting, whilst showing at least one site which needs more attention.

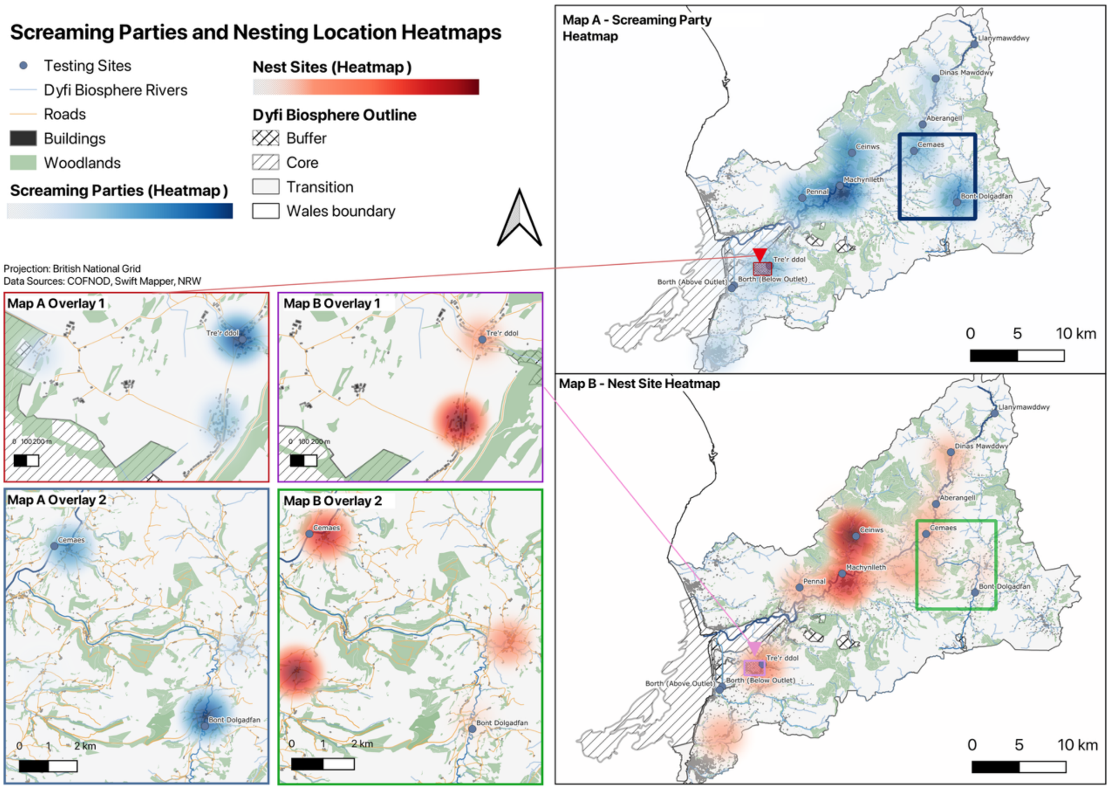


Figure 7 - Heatmaps showing screaming party (blue) and known nest recordings (red)

Table 11 – Nest Sites and nest boxes

Key Nest Locations, Recorded Nests and Artificial Boxes			
Location	**Number of Recorded Nests**	**Boxes Installed**	**Boxes Occupied**
Aberangell	4	10	4
Borth	0	0	-
Bont Dolgadfan / Llanbrynmair	4	12	0
Ceinws	16	5	0
Cemaes	5	7	0
Dinas Mawddwy / Minllyn	5	3	0
Llanymawddwy	0	0	-
Machynlleth	17	72	11
Pennal	8	3	3
Tre'r-ddol / Taliesin	10	9	1

Distribution across the Dyfi Biosphere

Figure 8 illustrates the distribution and numbers of occupied nests across the Dyfi Biosphere, and the key survey locations, which is further broken down in Table 11.

Machynlleth had the most reported nests at 17, of which at least 11 are artificial boxes. This may suggest one of three main things that should be investigated. First it could mean that there are fewer potential natural nest sites in Machynlleth, likely due to style of buildings and renovation works, meaning that swifts must nest in boxes. Second, and perhaps most probable, it could mean that due to the size of the settlement, difficulty of locating natural nest sites over such a large area, and more time needed surveying each potential nest site, means that the swift boxes were simply easier to survey and record. Finally, it could mean that swifts in that town have preference of the artificial swift boxes as potential nest sites, or simply that they outnumber the available nest sites, as the location with the greatest density of installed swift boxes (approximately 72), shown in Table 11 and on Figure 9. There is also the possibility that all three of these options play some role in the proportion of occupied artificial/natural nests in Machynlleth. One of the nest sites in Machynlleth which has 9 occupied boxes was formerly a natural nest site where boxes were installed following rendering work which blocked off their nest entrances. As site-loyal birds it appears that the displaced birds took up occupancy of these boxes upon their migratory return, showing some efficacy of remedial nest site work, should building work block off existing nests.

The greatest area density of nesting swifts was recorded in Ceinws (in the mid-Northwest area of the Biosphere), with 16 nests recorded overall (Figure 8, Table 11). This number of recorded nests may in part be due to the community's strong engagement with the project and a more consistent input of recording effort there. Ceinws saw a lot of community collaboration, with local business and homeowners working together to locate and record nest sites. This should be kept in mind when comparing to other settlements, as Ceinws is likely closer to the actual number of nesting swifts than the other sites. If the drive to map out nesting sites continues in future years, Ceinws may continue to provide a particularly valuable and complete dataset of the village's swift population, which may be of particular value for further research. It should also be noted that all of the known nest sites in Ceinws are logged as natural nest sites, despite there being 5 installed boxes, suggesting preference for natural nests, which may be a useful additional point of comparison between the other sites. It is also worth noting that there were multiple duplicate entries for several of the nest sites at Ceinws which had to be filtered, this may be one of the challenges of having greater numbers of surveyors, however it also illustrates the value of mobilising a coordinator for future projects that has capacity to work closely with communities to prevent doubling up on recordings.

The villages of Tre'r-ddol and Taliesin to the South have been grouped together due to their geographical proximity. Together they have a total of 10 recorded nests, conversely to Machynlleth, only 1 of which is artificial. As with Ceinws this could suggest a preference for natural nest sites when that is an option over artificial nest boxes.

Cemaes, Bont Dolgadfan/Llanbrynmair and Dinas Mawddwy/Minllyn all share a similar picture in terms of nesting. All have installed boxes without recorded occupancy, and all have between 4-5 natural nests, again suggesting the potential preference for natural nest sites.
Conversely, in Aberangell, all 4 recorded nests are artificial. This is likely for similar reasons to those discussed for Machynlleth, however, as a smaller settlement, this may be easier to validate in future years.

Pennal has 8 recorded nests, and 3 swift boxes, all of which are occupied. A suggestion here may be to install further boxes, as whilst there are clearly natural nest sites in Pennal, the installation of further boxes may enable greater numbers to populate the village. An anecdotal note for Pennal, and more broadly all the sites, is that during the project other swift nests were located by residents close to Pennal but never ended up being recorded. There could be any reason for them not being recorded but this emphasises the importance of community involvement and discussion during projects such as this to ensure as much data as possible is captured and recorded.

There were no recorded nest sites in either Borth or Llanymawddwy (see Figure 8 and Table 11), which matches up with the lack of sighted screaming parties recorded at either site. For Llanymawddwy, this is also supported by anecdotal evidence from within the project's team that swifts have not been spotted that far up the valley for at least 4 years. The reasons for this are not known but could be from lack of nesting locations available to lack of recording. Verbal reports from a resident in Borth suggest that there were previously nests on at least one building which were lost due to renovation works, however without historic records to match up the events this information can easily get lost. A call of action to this effect should be to ensure that existing nest sites continue to be monitored and loss of existing sites logged whenever possible.

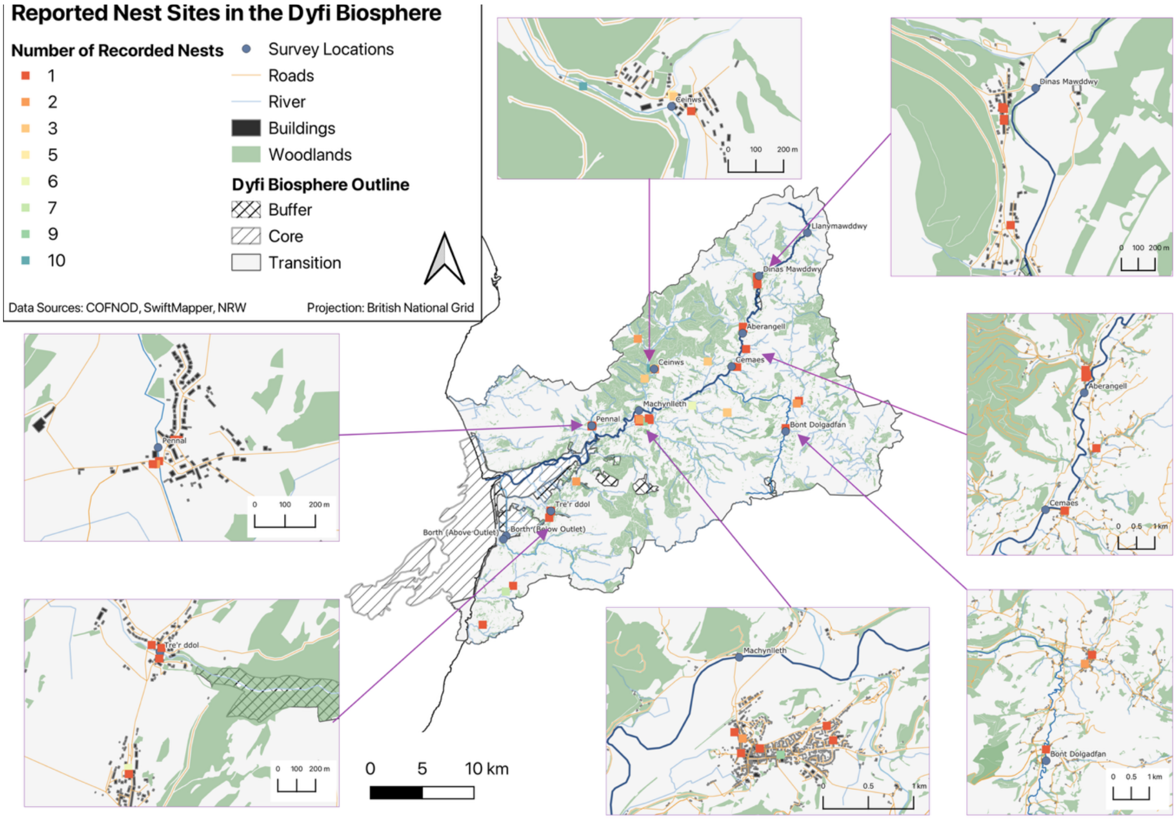


Figure 8 - Reported Nest Sites for the Dyfi Biosphere

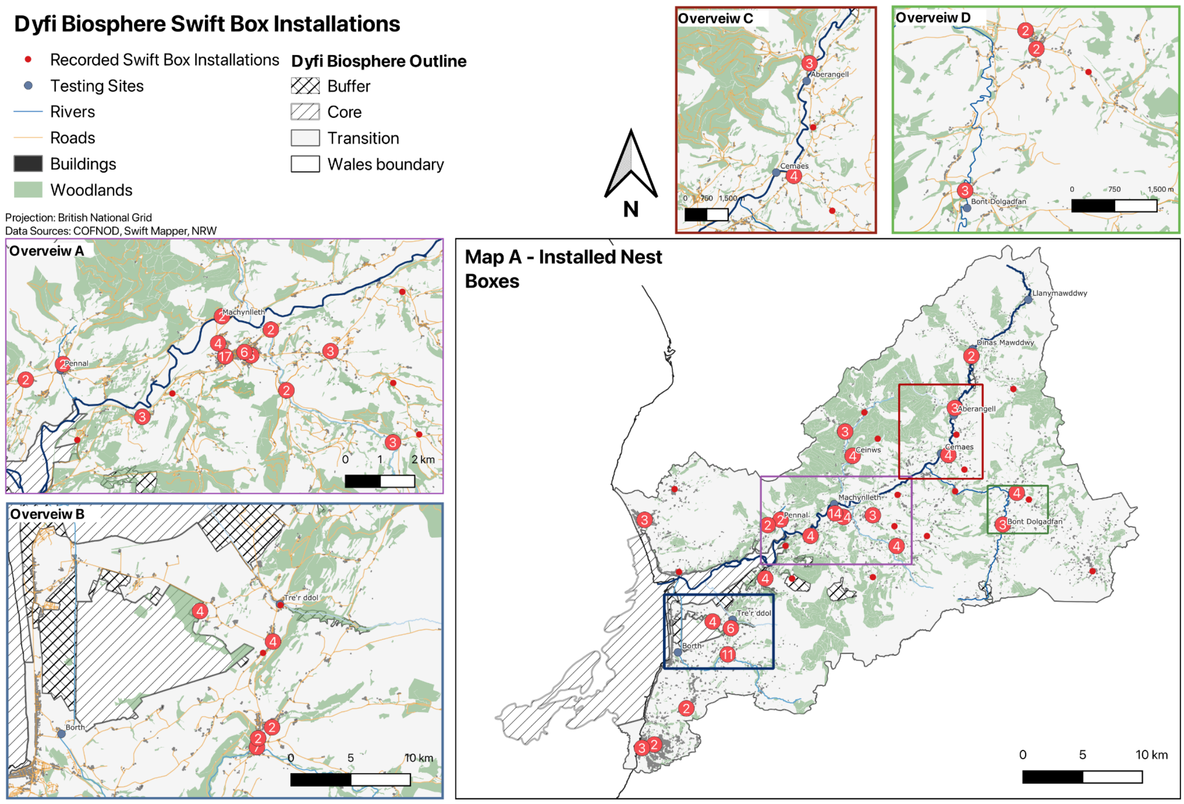


Figure 9 - Swift Box Installations

Swift feeding behaviour

Early in this report's research it was decided to try and monitor swift feeding behaviour, to establish where swifts spent the most time feeding and establish their reliance on waterways. However, it became evident that the challenge of implementing this over the project area was too great within the short period of this project; without greater numbers of regular surveyors spending a significant amount of time at key sites, this aspect of the project would not work in the context of this study. A future suggestion to establish the connection between river health and common swift survival might be to closely survey swift diets, via pellets and boluses. Analysis of these might help to determine what approximate percentage of the swifts' diet is made up of emergent insects. If done over different geographical areas with varying river health, it might help to identify potential stresses applied to swift survival if river quality is lower.

Future recommendations for swift surveying

Screaming parties should continue to be recorded via either the Cofnod 'A Swift Recovery' project or the RSPB's SwiftMapper app. Continued recordings will mean that even if nest sites are not re-surveyed in future years, evidence of that nesting activity is still available. It may also help to identify further nesting locations that were not captured this year.

An important ongoing process with these sites will be to continue recording of the existing nest sites. This will allow comparisons to be made between this baseline dataset and future changes in population sizes across the key sites. As a minimum the identified nesting locations should be reinspected annually and recorded; however, ideally the dataset will be expanded, by recording nest sites that may have been missed this year and thus expanding the dataset. SwiftMapper allows surveyors to report how long a nest site has been in a location for; where this data is available it can help to establish what nests might be new and which have been occupied for multiple years.

A crucial element for future survey work will be to 'record the zeros', especially for artificial swift nest boxes, meaning that any unoccupied artificial nests or previously occupied but now empty natural nests should be recorded as such. This can be done via SwiftMapper and is suggested to be the best way forward for citizen scientists to log nesting data. This data may allow future work to better understand the impact of building development and the efficacy of swift box installations for common swift survival.

Community engagement across the project area is vital for a comparable dataset in coming years. The best approach may be to encourage each community to establish community groups that log the locations of nest sites in their local area and submit them via a widely accessible database such as SwiftMapper or Cofnod. Another important step is to encourage swift box owners to survey and record their own boxes annually. This will help 'spread the load' in terms of surveying efforts and reduce the chances of data on boxes being recorded twice.

In addition to nest sites and screaming parties, data on prospecting birds, feeding behaviour and grounded swifts can be submitted via the Cofnod 'A Swift Recovery' project. This is valuable data and citizen scientists are encouraged to log recordings; however, it is advised that priority should be given to thorough nest and screaming party surveys to ensure that surveying is as accessible and consistent as possible for the broadest range of people.

River Health

Temperature

Figure 10 shows the temperature ranges and medians for each of the test sites. As a baseline dataset there is nothing of significance to note besides the probable impact of 2025's warmer than average temperatures in Wales (Met Office, 2025). This will likely have resulted in higher temperatures in the rivers than in some past years. The recorded data shows typically lower temperatures closer to the river source and in deeper, faster flowing or shaded parts of the river. Machynlleth saw the highest range in temperature, likely down to its relative width, depth and direct sun exposure; it is also the test site furthest from its source. It is possible that overall higher seasonal temperatures seen in 2025 may have resulted in warmer waters and subsequently slightly lower pH (Atlas Scientific, 2023); however at a basic level of analysis there does not seem to be a direct correlation between water temperature and pH across the test sites, however over a longer time period it could be explored in more detail.

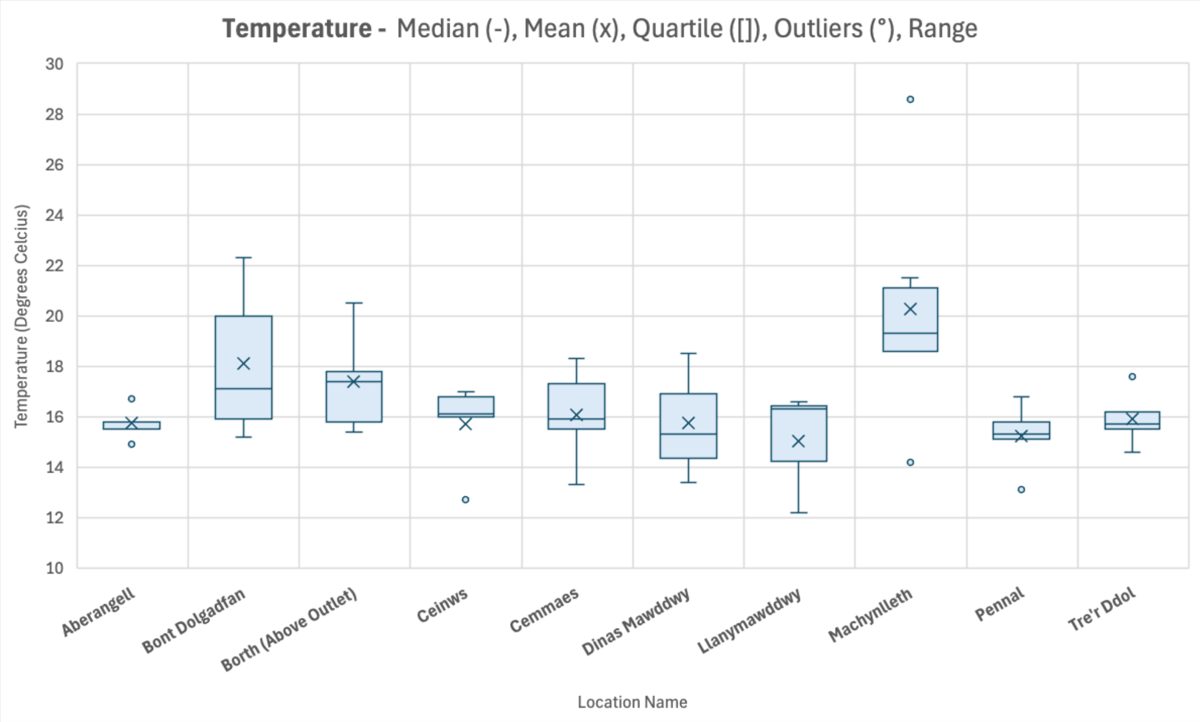


Figure 10 - River Temperature

pH

One of the key recurrent characteristics of rivers in the Dyfi catchment is low pH. Testing fortnightly at each site from late May to the end of July, has provided between 3 and 6 datasets per site, which shows pH was commonly acidic over this period.

Table 12 lists and Figure 11 illustrates the pH averages, outliers/quartiles and minimums (or most acidic) across the testing locations. Using the median for each site, the most representative pH across the sites would be 6, with over half the sites recording fluctuations where pH conditions were 10 times more acidic, recorded as 5. The pH is notable as it can play a key role in limiting the species present within a waterbody, typically a pH between 6.5-8 is habitable for most freshwater species (United States Environmental Protection Agency, 2015). Whilst a pH of 6-6.5 is not always considered 'low' in certain systems, regular measurements below 6 or significant fluctuations can be harmful to river life.

Quartiles, seen with Bont Dolgadfan and Machynlleth in Figure 11, break the data found into even parts; they help identify whether data is skewed by outlier data. The boxes in Figure 11 show the range from the first to the third quartiles, in other words, half of the data points will be found within the box. The sites where quartiles are not displayed, is either because there was less variation in readings or the variations were outliers. Outliers represent readings that deviate significantly from the quartile range, for a better understanding of quartiles readers can refer here (Turney, 2023). Whilst the recording of pH 5 are outliers in the dataset, only being recorded once at each site, variability like this, even if only temporary, can cause disruption to river habitats.

Table 12 - pH Average, Median, Range and Minimum for Dyfi Catchment, May - July 2025

pH Measurements: May - July 2025				
Location	**Average**	**Median**	**Range**	**Minimum**
Aberangell	5.89	6	1	5
Bont Dolgadfan	6.25	6.25	0.5	6
Borth (Below Outlet) - Brackish	6	6	1	5.5
Borth (Above Outlet)	6	6	1.5	5
Ceinws	6	6	2	5
Cemaes	5.8	6	1	5
Dinas Mawddwy	6	6	0	6
Llanymawddwy	6	6	0	6
Machynlleth	6.25	6.25	0.5	6
Pennal	5.8	6	1	5
Tre'r-ddol	5.8	6	1	5

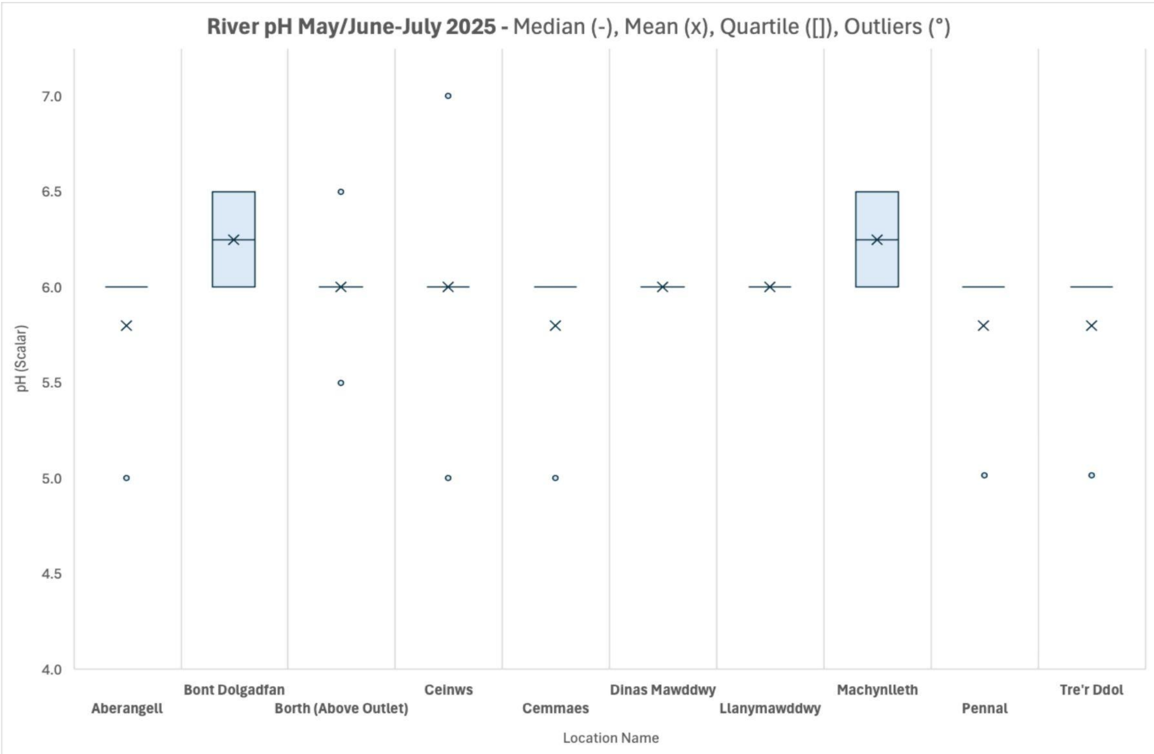


Figure 11 - Dyfi catchment pH box and whisker chart

Ceinws, the only site on the Afon Dulas North, saw the greatest fluctuations in pH with an overall range of 2, suggesting a potential source for variation that should be explored further; however, the highest reading of 7 pH was after significant precipitation, when the river was higher than normal, likely attributable to the increase.

Borth (Below Outlet) also saw a notable fluctuation in pH, especially when compared to the slightly upstream site on the same river, however it being a brackish waterbody influenced by tidal regimes is likely a factor in this variation.

By UK Technical Advisory Group (UKTAG)'s standard boundaries (Duncan et al., 2012), Table 13, Table 14, the majority of the sites would be ranked as 'good' over the test period, with Cemaes, Pennal and Tre'r-ddol ranking moderate. As it is brackish rather than freshwater, Borth (Below Outlet) does not rank on this scale.

Table 13 - Proposed Environmental Standard Boundaries and their Derivation (factor used to determine threshold) in Clear Waters

Boundary	pH (Mean)	Derivation
H/G	6.6	Fish (inverts)
G/M	5.95	Inverts (Fish)
M/P	5.44	Inverts
P/B	4.89	Inverts

Table 14 - Dyfi catchment rivers ranking on average pH conditions: May - July 2025

Site	pH (Mean)	Score
Aberangell	5.98	G
Bont Dolgadfan	6.25	G
Borth (Above Outlet)	6	G
Ceinws	6	G
Cemaes	5.8	M
Dinas Mawddwy	6	G
Llanymawddwy	6	G
Machynlleth	6.25	G
Pennal	5.8	M
Tre'r-ddol	5.8	M

This result only considers pH recordings from summer 2025 and should be monitored over a longer period to ensure greater accuracy and a more annually representative finding. However, this result is likely characteristic of typical environmental conditions of the catchment, which is largely covered with acidic soils and in parts slightly acidic bedrock (Pratt et al., 1995), particularly in its upland areas, illustrated in Figure 12.

Many of the most acidic soils in the catchment align closely with coniferous forest, seen in Figure 13, and in the upland areas, with bog/bare peat habitat; Cors Fochno saltmarsh is also an area of greater acidity. Whilst they may not be the sole contributor to acid conditions in the Dyfi catchment rivers, acidic soils, accentuated by land cover usage, are likely the overwhelming contributor to low river pH.

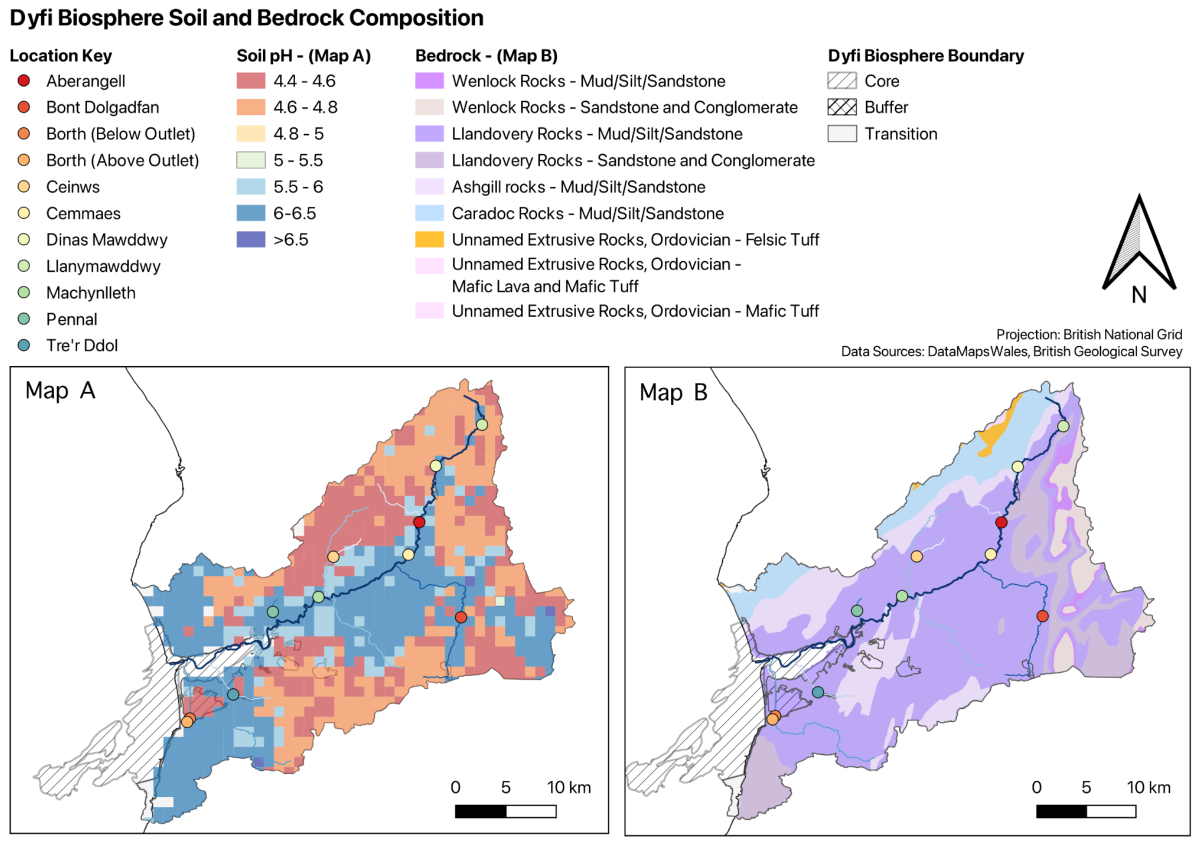


Figure 12 - Soil and Bedrock Geology of the Dyfi Biosphere

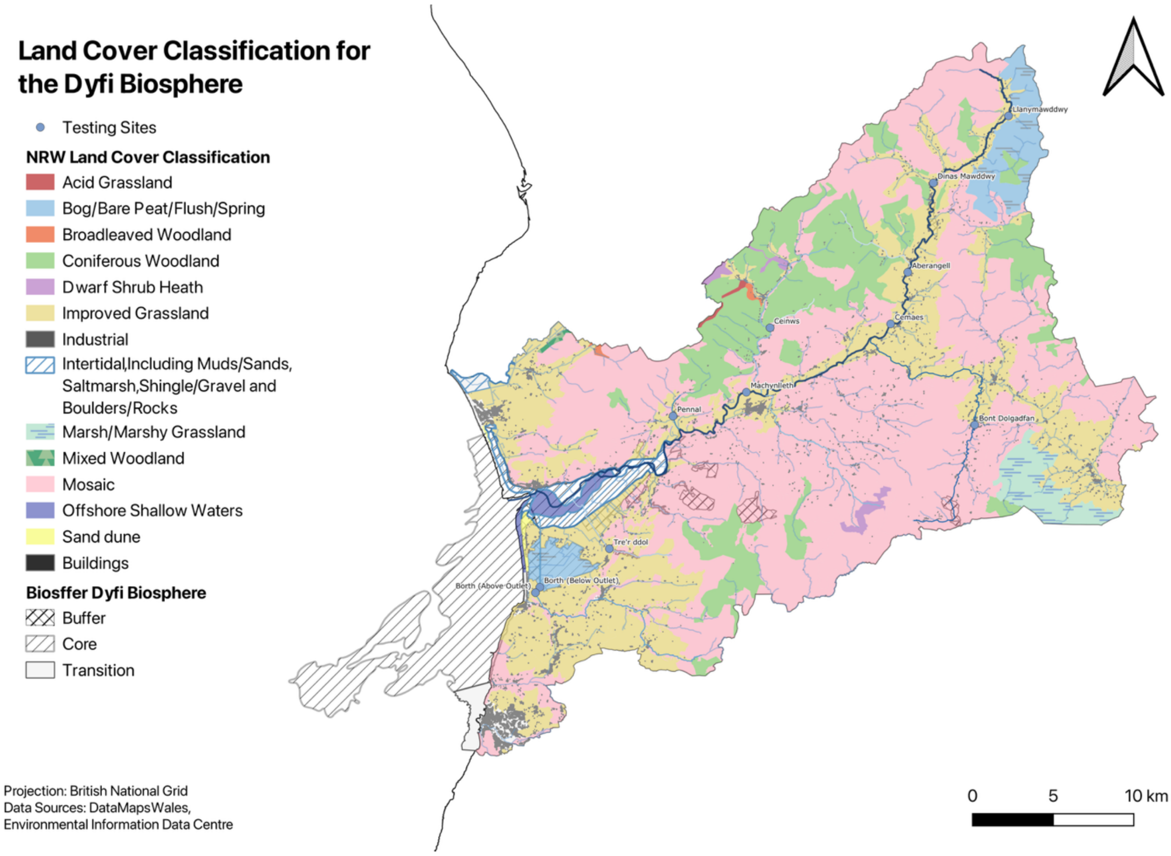


Figure 13 - Dyfi Biosphere Land Cover Classification

An additional factor to consider in relation to levels of acidity in the Dyfi catchment is the historic mining and potential impacts of acid mine drainage (AMD) on the area's rivers. AMD can not only increase acidity in waterbodies, but it also often leads to potentially harmful heavy metals (HMs) entering the system. When this occurs in tandem with higher water temperature the effect of acidification can be intensified; resultantly, heavy metals in the water column and sediment become more bio-available and thus harmful to aquatic life (United States Environmental Protection Agency, 2015). This is especially relevant to more vulnerable benthic species, such as emergent insects.

There is a particular density of disused mines located along the Afon Leri, as seen in Figure 14, which should be investigated further in relation to water quality. Elsewhere in the catchment, one mine of note is disused lead and zinc mine at Dylife. The Afon Twymyn, which feeds into the Dyfi, is fed by water from the Dylife mine which has been previously documented as having especially high concentrations of HMs in the sediment close to the mine (Byrne et al., 2010). National Resources Wales and The Mining Remediation Authority are undertaking remedial work on a number of disused mines to tackle HM pollution (National Resources Wales, 2023), this will take time to implement and make a difference. However, diversion of AMD in Mynydd Parys on Ynys Môn has shown diversity improvements (Dean et al., 2025) and other successful clean-up operations have been able to return formerly AMD contaminated rivers to a more natural state in 10-15 years (University of California, 2021). The amount of time this will actually take will depend on the actions taken and should be monitored to better understand the level of the remedial actions impact. Heavy metals should be assessed alongside water temperature and pH monitoring, as if warmer summers become more typical in Wales, the potential impact on pH and subsequently mobilisation of HMs may impact the health of some of the Dyfi Biosphere's rivers (Li et al., 2013).

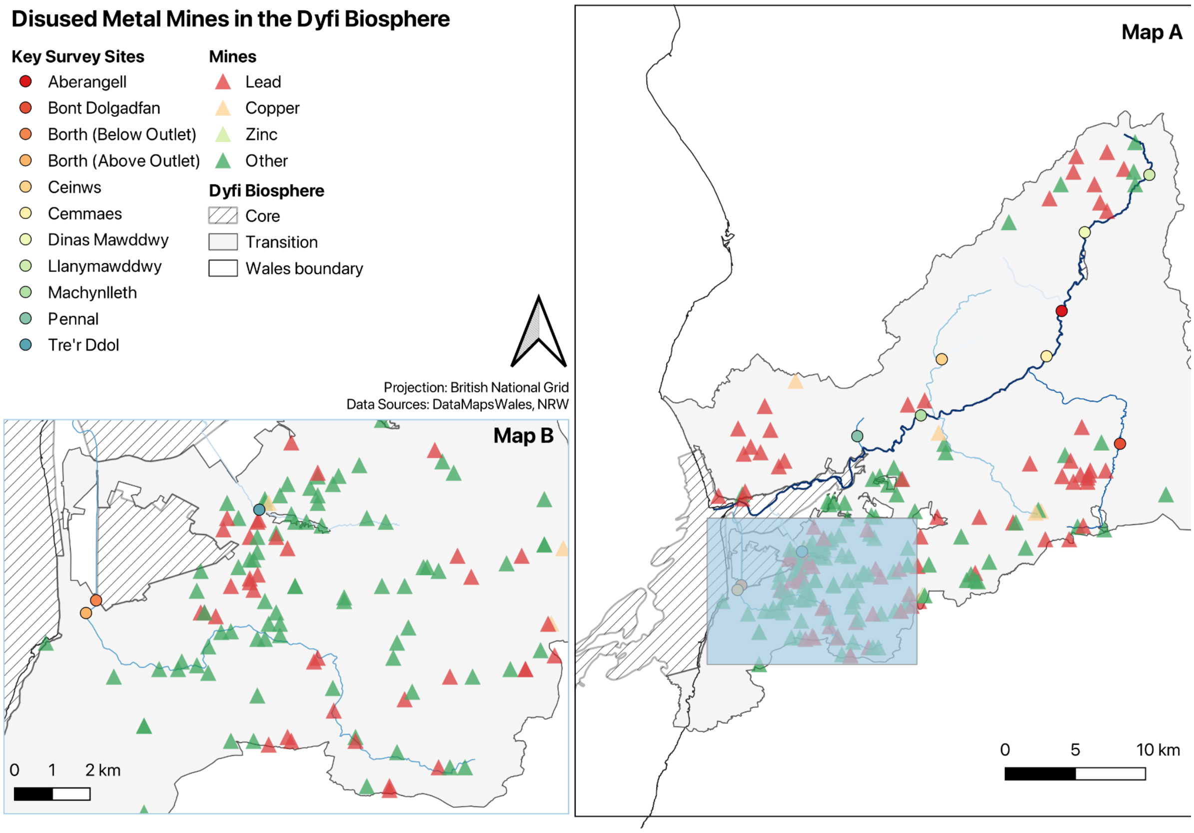


Figure 14 - Disused metal mine locations in the Dyfi Biosphere

Dissolved Oxygen

Dissolved oxygen (DO) is essential for life in rivers and many species such as fish, macro invertebrates and plants require certain minimum levels to survive, making it an important indicator for water quality (Natural Resources Wales, 2020). A range of 6.5mg/L to 8mg/L is considered to be a healthy range for most rivers (Atlas Scientific, 2024). It is worth noting that the majority of river testing took place between 5pm and 8pm, which can be important as aquatic plants photosynthesize and produce the most oxygen during the day, meaning it is unlikely that an absolute true minimum for any of the sites would be recorded, especially during days with greater amounts of sunlight (Queen Mary, University of London, 2025a).

The DO never drops below the critical threshold of concern for aquatic life, 5mg/L (Environment Agency, 2014), at any of the sites, Figure 15.

Borth (Below Outlet) shows the greatest variation in DO of all the sites, varying between highs of 8.5mg/L and 6mg/L. It also has the lowest median value of 7.1mg/L compared to above the outlet in Borth at 7.9mg/L. Tidal regimes should again be considered here as should the potential impact of the outlet, whilst not a significant cause for concern on its own, the DO of this site should continue to be monitored.

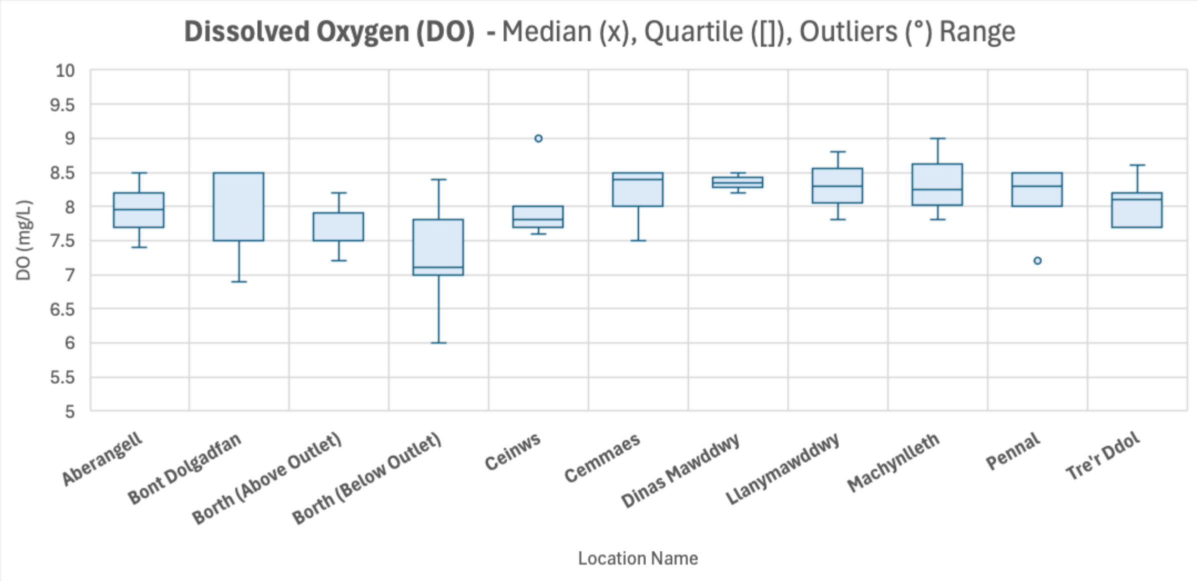


Figure 15 - Dissolved Oxygen recordings for Dyfi catchment rivers

Electrical Conductivity

Electrical conductivity (EC) is the water's ability to carry an electrical charge based on the presence of conductive ions (dissolved inorganic salts) its baseline is influenced largely by bedrock and soil geology (United States Environmental Protection Agency, 2013). EC can increase with a greater presence of dissolved inorganic substances and decrease with dilution from rainwater or addition of substances that prevent a charge being carried, such as oil.

The EC across the project area shows relatively low values, Figure 16, especially in relation to seasonally high water temperatures This could be attributed to a number of factors reliant on the environmental factors, such as geology, soil, rainfall and flow rate (Queen Mary, University of London, 2025b). It can also be impacted by human activity, including sewage discharge which typically raises EC, or heavy metals which can raise or lower EC. If further long-term testing finds this to be the normal state for these rivers it may not raise any particular concern, especially as fluctuations between most locations was low over the test period.

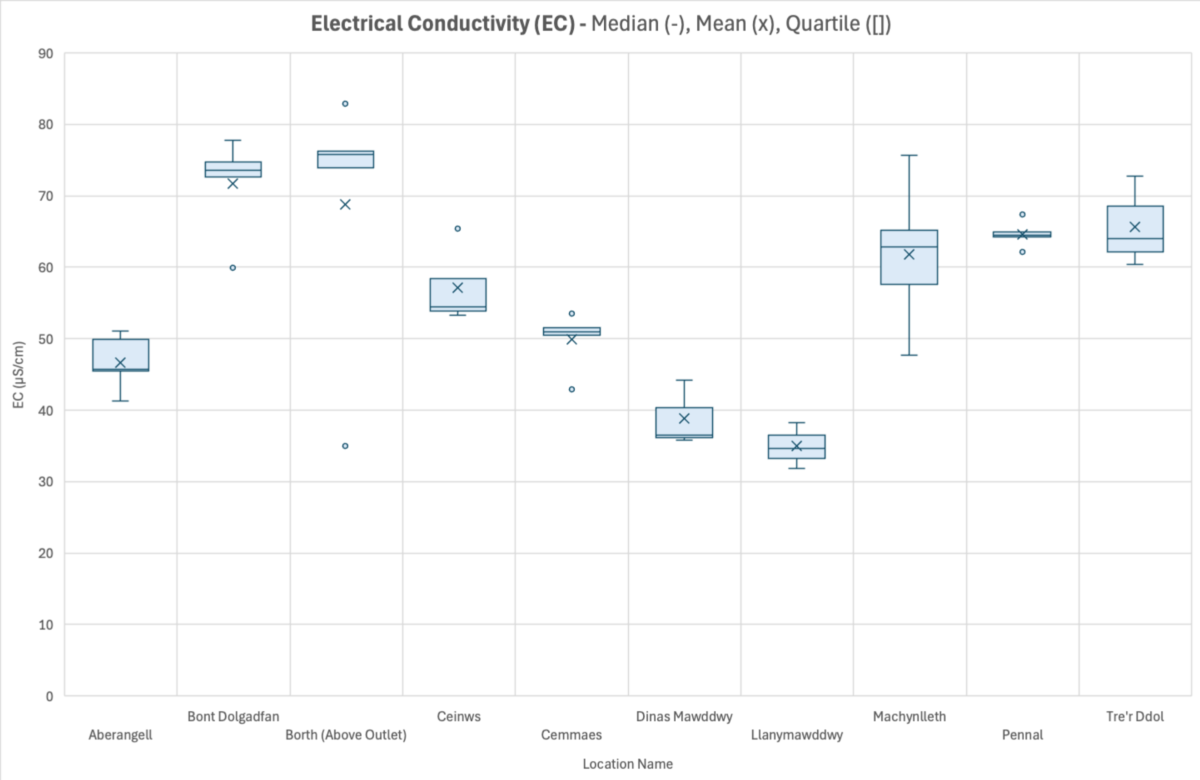


Figure 16 - Electrical Conductivity recordings for Dyfi Catchment

Figure 17 shows the difference in EC between the two sites at Borth, it highlights a variation in EC which is likely down to the brackish nature of the water at Borth (Below Outlet), with spikes likely being down to higher tide times. Future testing above the outlet may be done in location closer to the downstream site, this would help to reduce variations as both test locations would be brackish, allowing for better comparison.

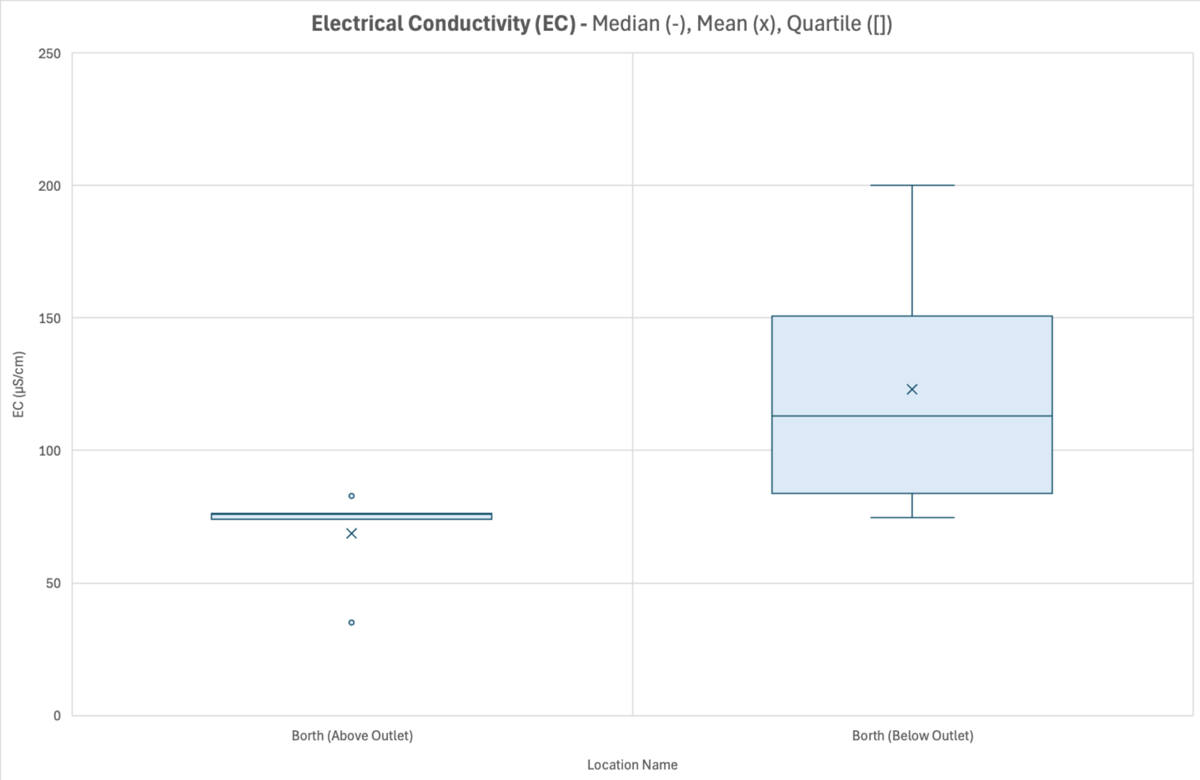


Figure 17 - EC at both Borth sites (note: Borth (Above Outlet) is freshwater and Borth (Below Outlet) is brackish)

Nitrogen: Nitrate and Nitrite

Both nitrate (NO3) and nitrite (NO2) are stages of the nitrogen cycle that are essential for plant life, but in excess can cause water quality issues. In natural systems nitrate is normally present in low volumes below 1ppm, whilst nitrite is often lower still, below 0.5ppm, with larger volumes of nitrite being toxic to aquatic life (UK Centre for Ecology & Hydrology, 2025).

Whilst there are some instances of recorded nitrates at the sites other than Borth (Below Outlet), Figure 18, they are few, and low enough to not be of significant concern over this period.

For nitrites the focus will be on Borth (Below Outlet), nitrites were not recorded at any other site. Figure 19 shows the only recordings of nitrite at Borth (Below Outlet). The levels of nitrite should be of concern for the health of the river. Without testing at more points along the brackish stretch of the Afon Leri it is not possible to attribute the cause of these increased levels to the outlet or another specific source, however this should be investigated.

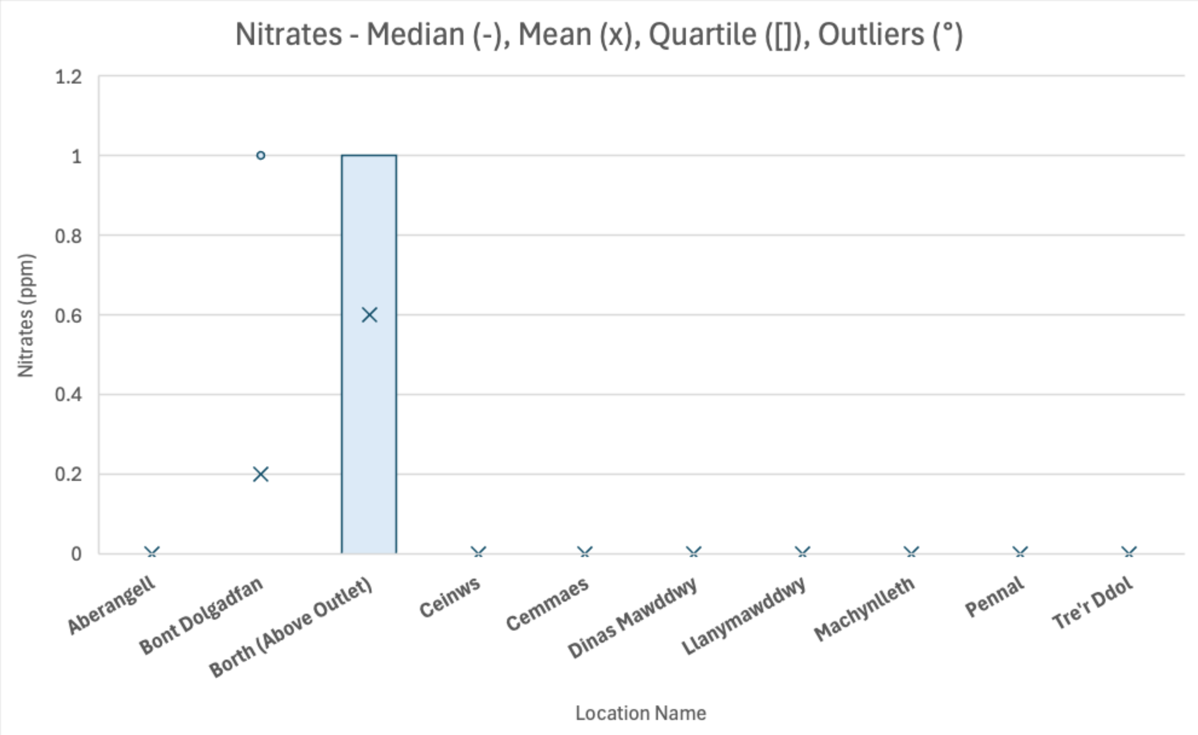


Figure 18 - Recorded Nitrates for Dyfi Catchment

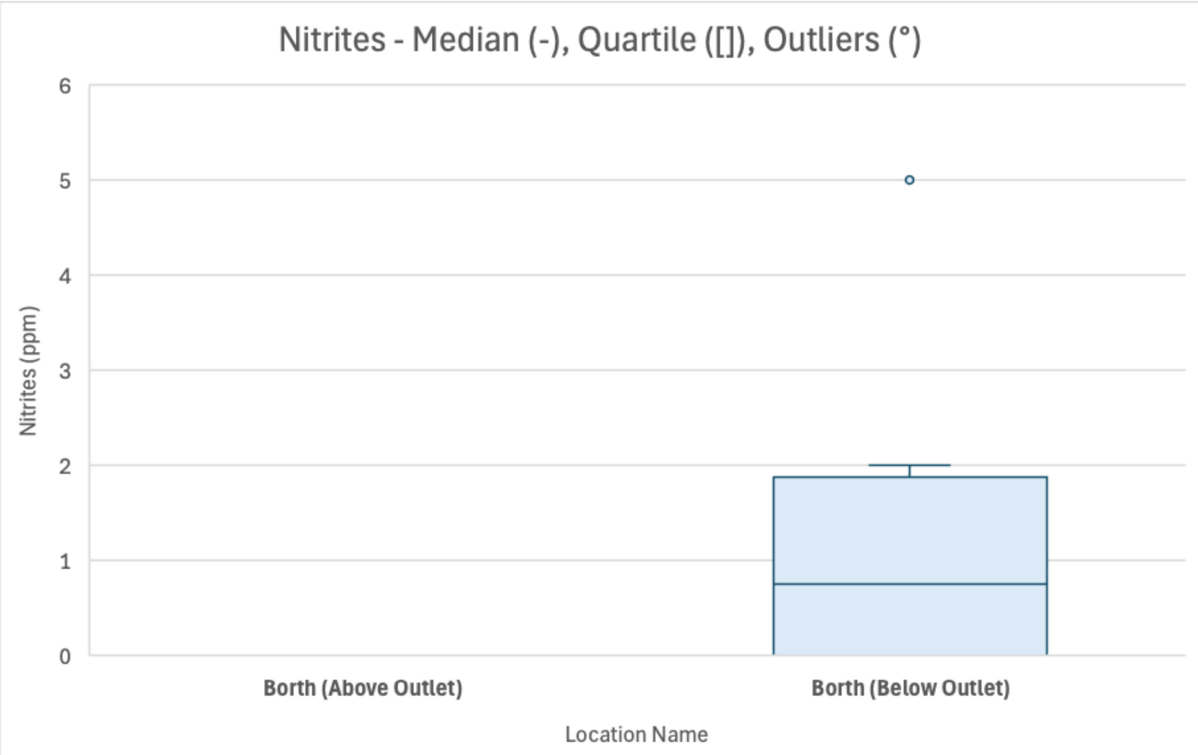


Figure 19 - Recorded Nitrite for Borth (note: Borth (Above Outlet) is freshwater and Borth (Below Outlet) is brackish)

Phosphorus

Phosphorus is commonly the limiting nutrient in many aquatic habitats, and thus it is often present in lower volumes compared to nitrogen in natural water bodies; excessive input of phosphorus can lead to eutrophic conditions and trigger algal blooms when there is also an abundance of nitrogen (The Open University, 2025). Figure 20 and Figure 21 show the median results from the testing done, by converting the phosphate (PO_4) measurements taken to reactive phosphorus (PO_4-P), with the equation $PO_4\text{-}P = PO_4 / 3.006$. Figure 21 highlights that Borth (Below Outlet) has higher recorded values than that at Borth (Above Outlet), and higher than that typically expected. As with the nitrates, at Borth (Below Outlet) this cannot be directly compared to the other sites as tidal regimes potentially play a part in bringing PO_4-P upstream from the estuary or disturbing and releasing the phosphates in the riverbed.

Figure 20 shows that the Afon Leri in general appears to experience much higher PO_4-P levels than the other freshwater rivers in the catchment. This is another factor that should be explored with further testing along the river to better understand potential sources of raised PO_4-P levels and whether it is an annual or seasonal occurrence.

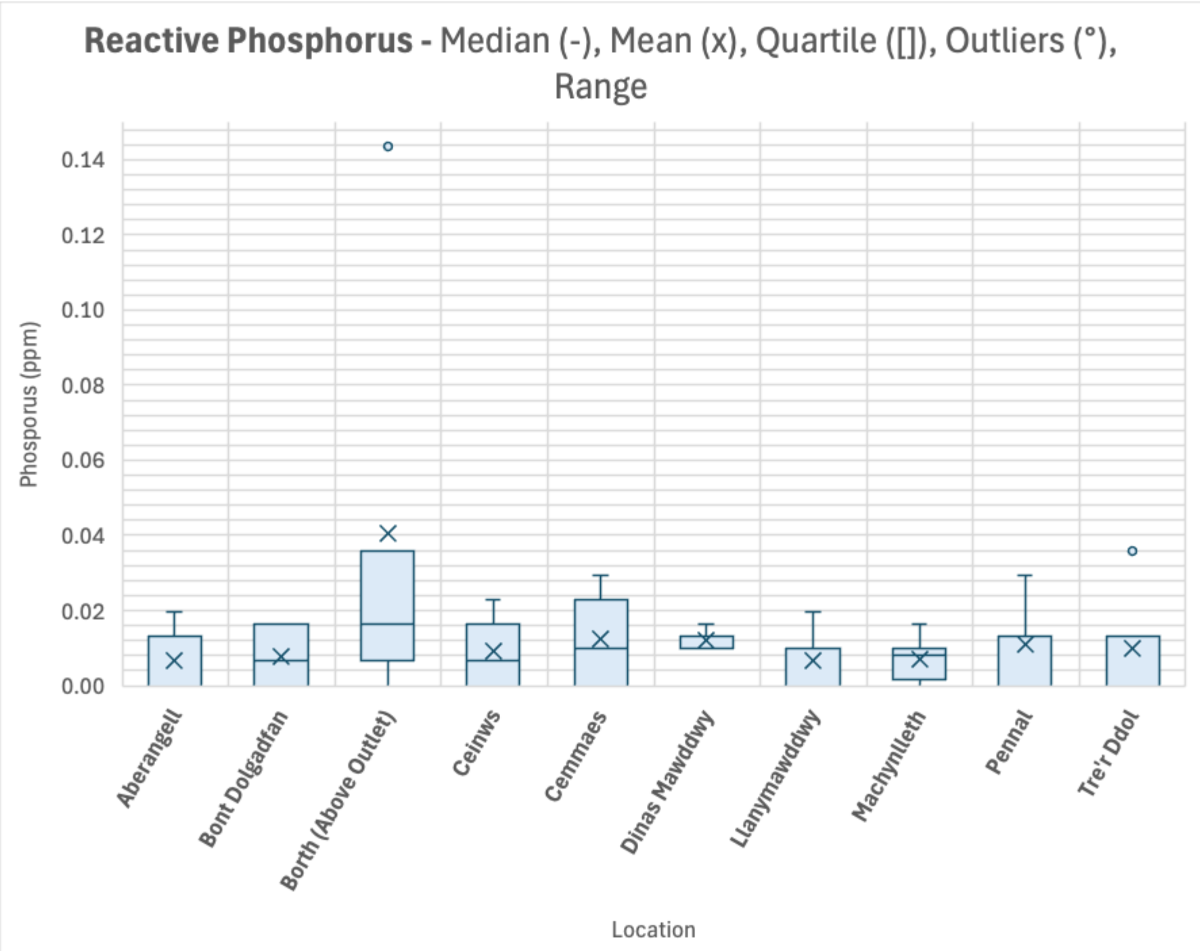


Figure 20 - Reactive Phosphorus in the Dyfi catchment

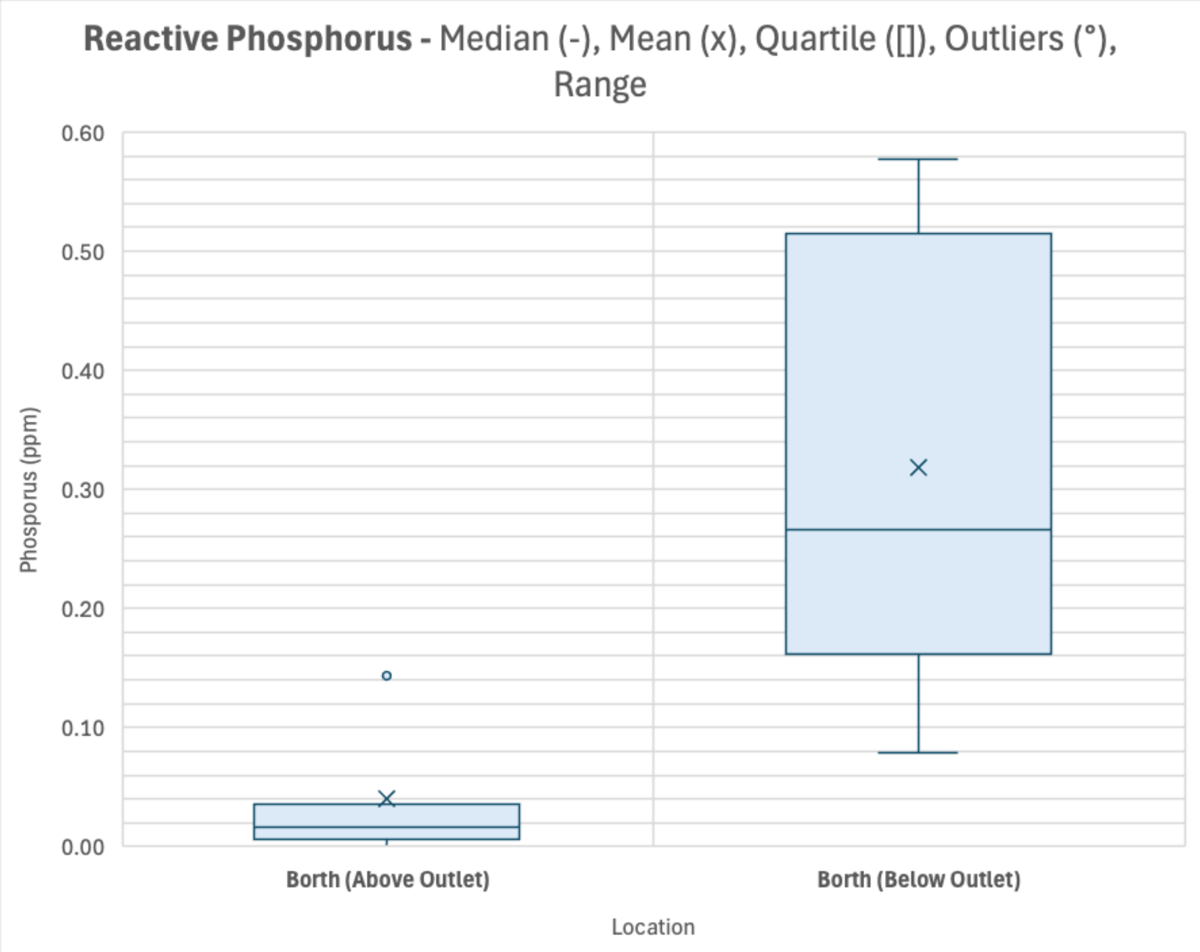


Figure 21 - Reactive Phosphorous levels at Borth (note: Borth (Above Outlet) is freshwater and Borth (Below Outlet) is brackish)

The UK Water Framework Directive (WFD, 2013) has a set of phosphorus standards, Table 15, that apply to England and Wales which can be used against the annual mean of reactive phosphorus to assign a quality rank from High to Poor; the WFD's objective is for all waterbodies to achieve at least 'Good' ecological status by 2027. Based on the limitations on analysis available due to only having data from one season and not a complete mean average for the year, it is not possible to do a definitive analysis of where the rivers truly sit in regards to WFD's standards; however, this should be done in future years. As it stands, for the one season that recordings have been taken, if there is limited variation for the rest of the annual period, most of the sites ranked 'High', Table 16; whilst Borth (Above Outlet) achieves a 'Good/Moderate' score, which may be considered a narrow 'fail' by WFD standards. Monitoring of phosphates should continue at all the listed sites, especially along the Afon Leri.

Table 15 - UK Water Framework Directive Phosphorus Standards - (Water Framework Directive, 2013)

Annual Mean of Reactive Phosphorus (mg/L PO_4-P) Standards				
Type	**High**	**Good**	**Moderate**	**Poor**
Lowland, low alkalinity	0.019	0.040	0.114	0.842
Upland, low alkalinity	0.013	0.028	0.870	0.752
Lowland" means less than or equal to 80 metres above mean sea level. "Upland" means more than 80 metres above mean sea level. "Low alkalinity" with a concentration CaCO3 of less than 50 mg per litre.				

Table 16 - Sites applied to UK Water Framework Directive Phosphorus Standards

Phosphorus Standard May - July 2025 (ppm)		
Site	**Mean**	**Score**
Aberangell	0.007	H
Bont Dolgadfan	0.008	H
Borth (Above Outlet)	0.063	G/M
Ceinws	0.347	H
Cemaes	0.009	H
Dinas Mawddwy	0.012	H
Llanymawddwy	0.012	H
Machynlleth	0.007	H
Pennal	0.007	H
Tre'r-ddol	0.011	H

Future considerations regarding river health

An emerging concern in some parts of Wales, and a topic that has been raised by volunteers during this project, is the distribution of pharmaceutical compounds (domestic and agricultural) in rivers. There is already some evidence of this in South Wales (Omerod, 2024) but it is not clear what the levels or impacts of this are elsewhere in the country. Whilst the laboratory equipment required to test for these compounds at scale can be hard for citizen scientists to access, one method of assessing potential impact of pharmaceuticals, should they be present, is to assess variance in microbial activity up and downstream of set sites. This can be done via a method that uses leaf litter as a bioindicator (Lin et al., 2020). The method involves oven drying leaf litter at 60 degrees Celsius over 48 hours and splitting them into evenly weighted groups. These are then placed in a fine mesh bag and nailed to the riverbed at each site for a set amount of time, before being retrieved, re-dried and weighed.

The rate of leaf breakdown at each site can then be calculated to compare the microbial activity between similar sites. This method could be explored in the Dyfi Biosphere as, for future citizen scientists, it is low cost and easy to implement in partnership with a local school/university or other establishment that may be willing to share use of their equipment for the leaf drying process.

Macroinvertebrates

Macro invertebrates can provide a good measure of the general health of a river, emergent insects in particular are typically less pollution tolerant than non-emergent macro invertebrates (Manning and Sullivan, 2021). This means river health is vital if they are to enter the food chain as potential prey for aerial insectivores such as swifts. Whilst there is not a lot of existing research into what portion of the diet of a swift is made up of specifically emergent insects, broader research shows a presence of many families of emergent insects in swift diets in Italy (Cucco et al., 1913) and the UK (Romanowski et al., 2024), making them a potentially important ecological factor to consider and survey when studying swift survival.

Flying Insect Data

The aerial insect surveying element of this study aimed to build a picture of aerial insect density across the sites. This element presents challenges as many of the most effective methods of insect survey involve capture and potentially harming of the insects being surveyed, which was to be avoided where possible. With this in mind an ‘Active Visual’ point counting method (Montgomery et al., 2021) was chosen, see method section. This method was effective in providing numbers and density of flying insects at each of the sites but presented challenges with certain insects that are hard to identify or differentiate whilst in flight. This means that without establishing a bias algorithm it will be hard to compare the diversity and species abundance across each site, however, this is something that could warrant further study. For this reason, density will be the main element discussed in this section, with suggestions of how this method should be adjusted and used in the future.

There are a vast range of environmental factors that can affect the abundance of insects in any given location at any given time and controls that can be put in place to help limit variabilities for data analysis when surveying specific species. For this study however an insect abundance was required that represented the whole seasonal period, which meant insect data was collected in tandem with every water testing survey, alongside environmental data for better future analysis. What was kept consistent was the time of surveying, each taking place between 4:30pm-8:30pm. Table 17 displays the key findings for each location, including median and mean abundance of large flying insects, the range, number of days below 15 degrees Celsius, to account for potential drop in active pollinators, and the calculated survey area and insect density. It also lists the type of habitat surrounding each site which will be further discussed.

The mean average results can be used to give a perspective on insect densities that somewhat account for spikes in insect numbers, perhaps due to weather or large numbers of emerging insects such as mayflies. The median will give a more representative picture of the whole season, which in year-on-year comparisons may be more useful to understand the impacts of weather on each location's insect communities. More in depth analysis could also consider the upper and lower 25/75th percentiles to more thoroughly analyse outlier recordings.

Large flying insects (>3mm)

Figure 22 displays the median insect abundance and density of each of the survey locations from the data in Table 17. It shows a fairly consistent density across many of the sites, with exception of Machynlleth which is the lowest and Llanymawddwy and Tre'r-ddol which have the highest density.

Tre'r-ddol's habitat cover is largely sheltered and half wooded; Similarly, Llanymawddwy is also a sheltered woodland site. Besides Pennal, Tre'r-ddol and Llanymawddwy also have the smallest survey area. All of this combined makes the density results align with what may be expected of these two sites. The second most recorded species of flying insects at these two sites, after 'Other/Unidentified', were mayflies (Figure 23), suggesting successful emergence from the river, which can be compared in future years.

Table 17 - Insect and Location Data

Location	Insect Abundance (Median)	Insect Abundance (Mean)	Insect Abundance (Range)	Days Below 15°C	Survey Area (sq/m)	Density (per (sq/m) - derived from median	Habitat Cover
Aberangell	35	47	96	2	60	0.58	Amenity grassland (usually mown short) Farm crops or grassy pastures Grassland with wildflowers Woodland
Bont Dolgadfan	15	15	23	1	20	0.56	Woodland Farm crops or grassy pastures Grassland with wildflowers
Borth (Above Outlet)	16	30	70	1	21	0.78	Woodland Farm crops or grassy pastures Lowland heath Grassland with wildflowers
Borth (Below Outlet)	16	32	113	2	25	0.64	Farm crops or grassy pastures Lowland heath Grassland with Woodland
Ceinws	16	31	111	1	29	1.44	Woodland Other habitat type
Cemaes	12	33	104	0	65	1.08	Farm crops or grassy pastures Woodland
Dinas Mawddwy	25	23	22	1	42	0.60	Farm crops or grassy pastures Grassland with wildflowers Woodland
Llanymawddwy	40	39	31	1	13	3.05	Farm crops or grassy pastures Grassland with wildflowers Woodland
Machynlleth	17	17	9	1	120	0.13	Farm crops or grassy pastures
Pennal	16	20	23	3	9	1.38	Amenity grassland (usually mown short) Farm crops or grassy pastures
Tre'r-ddol	33	49	75	0	10	3.30	Woodland Other habitat type: residential with bridge - river bed sheltered by walls

Pennal shows a much lower insect density when compared to Tre'r-ddol and Llanymawddwy, this may be for a number of reasons, firstly the habitat cover is not woodland, which may provide better habitat for a range of flying insects than grassland and pastures. Secondly is the possibility that environmental factors such as temperature had a strong role to play, as all but one survey date at Pennal recorded temperatures below 16 degrees Celsius, with the one day above that temperature recording over twice as many total insects.

The two sites at Borth are worth discussing next as they display a difference in water type, habitat and species spotted. Borth (Below Outlet) is less wooded and sheltered than the Borth (Above Outlet), which sees a slight increase in density. As would be expected there are far less mayflies recorded at the Borth (Below Outlet) site, likely in part due to the brackish water conditions. The results will also potentially differ as

Borth (Below Outlet) has one additional survey date, which took place on a day below 16 degrees Celsius, which explains the similar density despite having a greater abundance range overall.

Ceinws is another site to note, as despite its low scoring during kick sampling, it had the largest recorded volume of mayflies on one occasion, approximately 150, and the second highest quartiles after Cemaes, Figure 23; suggesting a good habitat for mayflies to emerge from. Further kick sampling and water testing should be carried out at the Ceinws site and the two rivers (Dulas North and Aber Glesyrch) that join at that site, to identify whether all sections are habitable for emergent insects such as mayflies or whether they may be emerging from one of the two joining rivers and migrating to the testing site.

Cemaes has slightly lower total insect density than Ceinws, Figure 22, but had the highest recorded 1st/3rd quartile for mayflies, suggesting consistent abundance during surveying, Figure 23. This appears to be a good sign for the river health in terms of mayfly abundance in absence of comparable kick sampling data. Whilst this may not be definitive proof of the health of this site considering the results from Ceinws, it may be possible to use as a positive health indicator for sensitive emergent species.

Machynlleth sees the lowest insect density, likely in part due to the survey area size and surrounding habitat. The distance from the opposite bank of the river was also significant enough that counting insects was more challenging, therefore the lower density is not necessarily to be of concern.

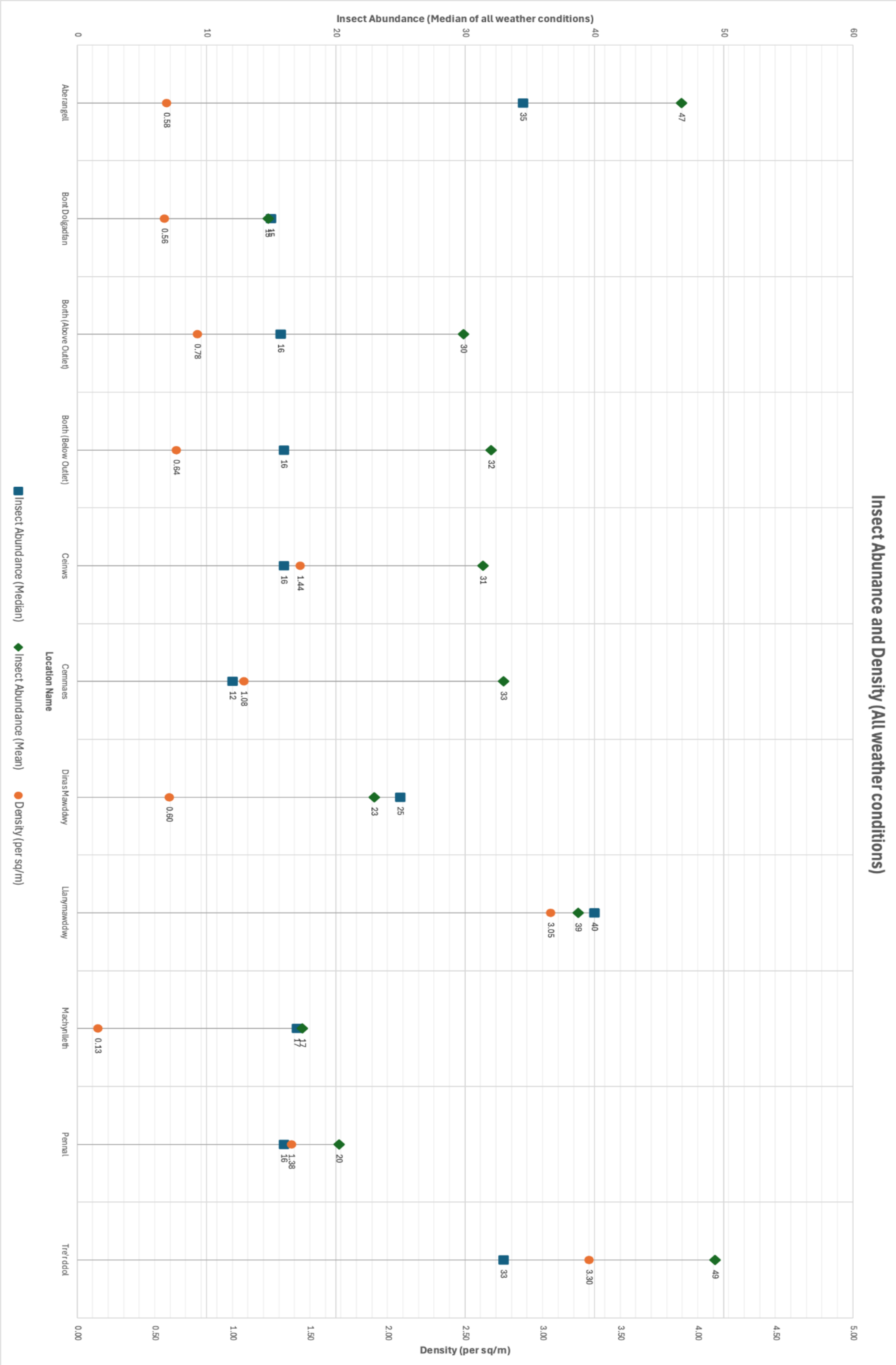


Figure 22 - Insect abundance (median and mean) and density of insects across all weather conditions

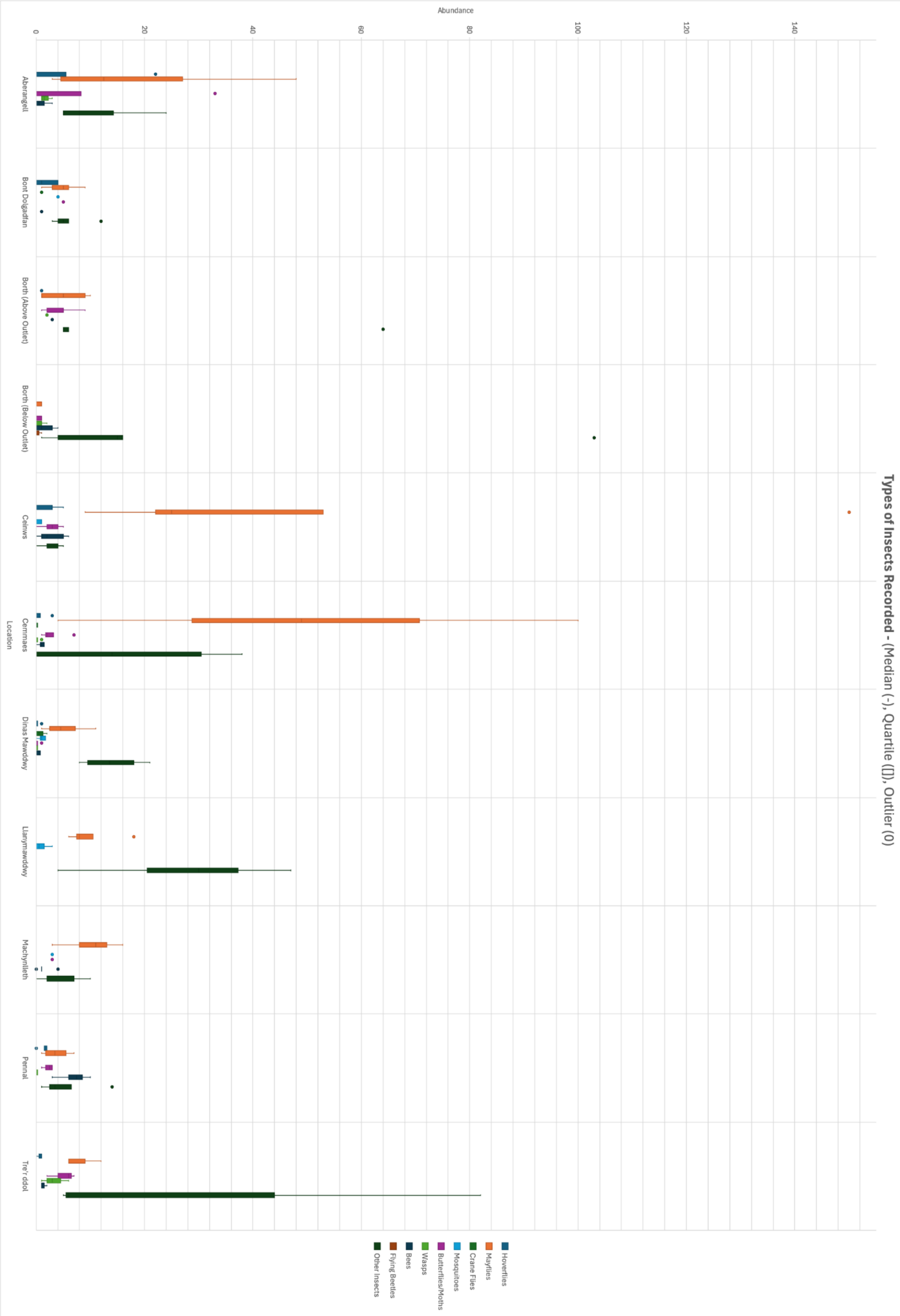


Figure 23 - Recorded large flying insect abundance

Small flying insects (<3mm)

For insects smaller than 3mm a visual density scale was used. Whilst there is not an estimated number of these insects associated to the scale, it allows for some simple comparability between sites. Figure 24 shows the median recorded densities for each site, with 1 being plentiful (large swarms/mass) to 4 being very few (light masses or just a few visible) and 5 being none visible at all. As small insects are often highly impacted by wind speeds, surveys where strong winds were recorded have been excluded.

On a basic level Figure 24 shows that the majority of the sites have similar levels of small flying insects, typically in small numbers. The main exception is Ceinws, which stands out with a median score of 1, suggesting plentiful swarms/masses of small flying insects. This data alone does not show that Ceinws is either healthy or not healthy, but it calls for further kick testing to identify the Chironomidae (midge) in the river to a species level. This is important as some midge species are pollution tolerant, whilst others are not (Prat and Castro-López, 2023), which in conjunction overall 'moderate' kick sampling scores at Ceinws are needed to better understand the health of the Afon Dulas North.

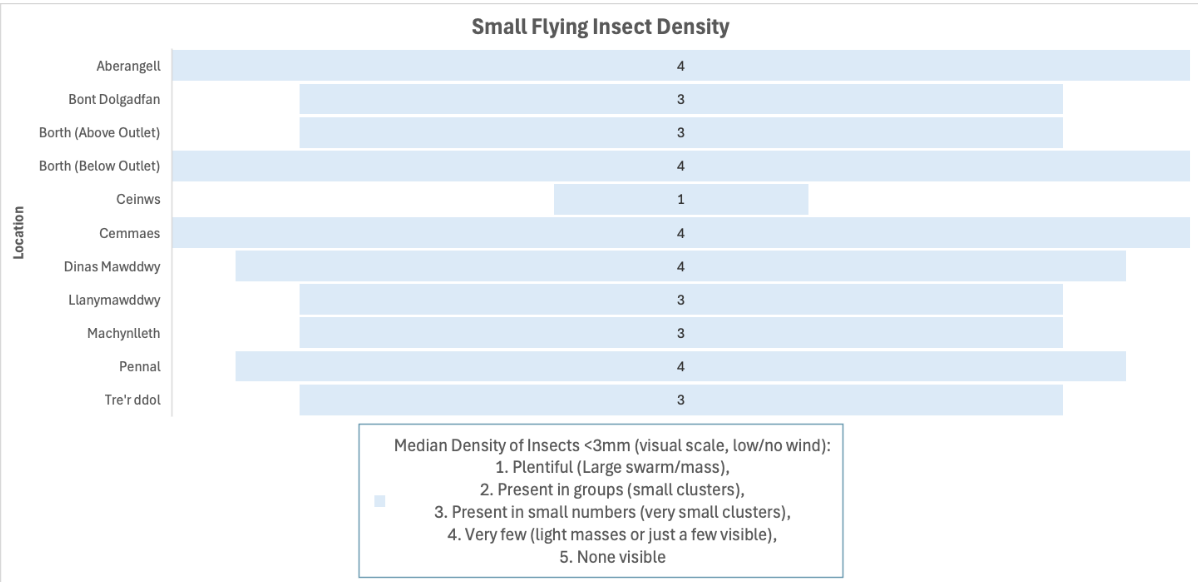


Figure 24 - Density of Insects below 3mm

Future considerations for flying insect surveys

One suggestion for future insect point counts is for citizen scientists to survey flying insect numbers in groups of 2 to 3 people, to ensure counting is done as accurately as possible. For rivers with particularly wide sections, one surveyor should use binoculars to view and count on the other bank, whilst another counts the insects, they can see closer to the bank they are positioned on. Where possible surveyors

could be trained in how to net insects, catching insects that are difficult to identify in flight to get a more expansive picture of the insect diversity.
Weather data should be recorded as accurately as possible; a luminosity meter could be used to gather useful readings. Exact wind speed and more precise temperature recordings within 1-2 degree ranges could also be implemented.

The small insect density scale is a good talking point and useful for identifying sites with standout volumes or lack of small insects. Therefore, this method could continue to be used in conjunction with large aerial insect counts, for, if nothing else, to identify where kick sampling may be beneficial based on either extreme.

Kick sampling Results

Borth (Below Outlet) cannot be used in comparison to the other sites, due the brackish environment providing differing habitat and species. The kick sampling results are still included in the appendices Table 23, and it should be noted that only 1 species was recorded as abundant, whilst it is probable that the identification of that species as 'freshwater shrimp' was likely inaccurate, instead it was likely a saltwater species.

Diversity, evenness and abundance

Using the Shannon Weiner Index, Table 18 it is possible to compare the species diversity across the sites where kick sampling was carried out. Cemaes and Machynlleth, are excluded from this particular analysis due to the differing method employed, however they can be compared with each other.
This analysis shows the greatest diversity, number of abundant species (expressed as Hill's Number) and evenness of species distribution is seen at Aberangell, suggesting comparatively good conditions for a range of macroinvertebrates.

Bont Dolgadfan, Dinas Mawddwy, Llanymawddwy, Tre'r-ddol and Pennal all score notably lower than Aberangell, however all share a comparable abundance of species, between 4 and 6 and similar evenness. This would suggest each of those sites share similar habitableness for macroinvertebrates.

The key sites to note here are at Borth (Above Outlet) and Ceinws.
Borth (Above Outlet) ranks poorly in comparison to the other sites in all the collected macro invertebrate metrics, suggesting more investigation is needed along the Afon Leri as a whole. Borth (Above the Outlet) had 15 species recorded (including *hydrachnidia*) with an abundance of freshwater shrimp (*Gammaridae*), known for their role vital in shredding organic matter and detritus (Gerhardt et al., 2011). This may correlate with the higher abundance of nitrates and phosphates along the Leri in

general, which in excess can result in highly active plant life and algal growth, ideal for shredders such as Gammaridae.

Ceinws scores low in diversity in comparison to all but Borth, which suggests less adequate conditions for macro invertebrate life. The number of abundant species is low, only 2 out of the 14 recorded (including *hydrachnidia*) and the evenness is comparable to that of Borth (Above Outlet), 0.343 and 0.322 respectively. Ceinws is the only test location on the Afon Dulas and lower macroinvertebrate diversity and evenness be down to several factors which should be further investigated. Although not experiencing significantly lower water pH than the other sites, Ceinws is in one of the most acidic soil conditioned locations of all the catchment test sites, which may be a factor in the health of benthic macro invertebrates.
The test site is also notably different to many of the sites, in that it is located where two water bodies meet, the Aber Glesyrch and the Dulas itself, which may introduce some complications in potential sources of disturbance. The site is also much deeper in places than some of the others, with a deep pool surrounded by steep rapids on either end, which may lead to variations in habitability for some species.

Table 18 - Recorded Species Diversity, Abundance and Evenness

Shannon Weiner Species Diversity Index Results				
Site	**Shannon Weiner Index**	**Hill's Number**	**Evenness**	
Aberangell	2.113	8	0.881	
Bont Dolgadfan	1.330	4	0.491	
Borth - Above Outlet	0.872	2	0.322	
Ceinws	0.906	2	0.343	
Dinas Mawddwy	1.861	6	0.586	
Llanymawddwy	1.661	5	0.586	
Pennal	1.491	4	0.622	
Tre'r-ddol	1.568	5	0.515	
Cemaes	2.387	11	0.931	*
Machynlleth	2.240	9	0.873	*
*Less precise count and only 2-minute kick - not directly comparable to other sites				
Shannon Weiner Index: This is a species diversity index. A higher number indicates greater diversity, thus a greater number of species with a more even distribution.				
Hill's Number: Represents the number of abundant species within the sample area.				
Evenness: This represents how evenly distributed the species are, a lower number represents less evenness and thus a less balanced weighting of species distribution.				

Comparison between Machynlleth and Cemaes shows that Cemaes features greater diversity, species abundance and evenness than Machynlleth. This however may not be unexpected as both sections of the river differ in habitat due to several abiotic factors, with Cemaes being a narrower riverbed, with lower discharge, differing riverbed substrate, and more riparian vegetation. A recommendation would be to perform a standardised kick sampling session at both Machynlleth and Cemaes that allows for better comparison across the catchment and more accurate analysis using the River Invertebrate Classification Tool (RICT).

River Invertebrate Classification Tool (RICT)

By using RICT (Freshwater Biological Association, 2025b), it is possible to get another picture of the river's health by assessing for general degradation and organic pollution in the Dyfi Catchment. It should be noted that this analysis is best performed with laboratory-based invertebrate identification and samples taken over two different seasons. For this reason, this analysis is most useful for site comparison/ranking and to inform where further research may be most valuable.

The RICT results, Table 19 and Figure 25, show a mixed picture for the sites tested.

The Average Score Per Taxon (ASPT) Ecological Quality Ratio (EQR) compares the average score of what macroinvertebrates were recorded at each location to what would be expected there in pristine conditions based on recorded abiotic factors. Each site’s ASPT EQR is given a rank by the RICT system, shown as the ASPT Rank. This shows all the sites, besides Ceinws, as receiving a minimum ‘Good’ rank. By WFD standards this would yield a ‘Pass’. This suggests that most of the sites are broadly in good ecological condition for pollution sensitive macroinvertebrates.

Table 19 - RICT scores for survey locations

River Invertebrate Classification Tool (RICT 3.1.8) results for sites surveyed					
Site	**ASPT EQR**	**ASPT Rank**	**NTAXA EQR**	**NTAXA Rank**	**MINTA WHPT**
Aberangell	0.88	G	0.42	B	B
Bont Dolgadfan	0.93	G	0.69	M	G
Borth (Above Outlet)	0.87	G	0.56	M	M
Ceinws	0.79	M	0.82	H	M
Dinas Mawddwy	0.9	G	0.97	H	G
Llanymawddwy	0.86	G	0.96	H	M
Pennal	0.96	G	0.51	B	B
Tre'r-ddol	0.9	G	0.82	H	G
Cemaes	NTAXA and MINTA not displayed for these sites due to recording method not matching required standards				
Machynlleth					
H = high, G = Good, M = moderate, P = poor, B = bad					
Average Score Per Taxon (ASPT) - The average score of all recorded species					
Number of Taxon (NTAXA) - Number of different species recorded					
MINTA WHPT - Definitive classification as a 'worst of' score					
Environmental Quality Ratio (EQR) - How the recorded score rates next to the 'pristine' score					

Ceinws only ranked as 'Moderate' on ASPT. This would be classed as a 'Fail' and may suggest water quality issues that are inhibiting the diversity of species present in that river, the Afon Dulas North.

Cemaes and Machynlleth could not be entered into RICT due to the differing method in sample collection and processing, future sampling is recommended here for comparison to the other sites.

The Number of Different Taxa (NTAXA) EQR is a score provided based on the number of different species recorded, next to the number that would be expected to be present in that river. The result given may be worse than the actual true figure, due to limitations in the ability to identify certain species, but again provides a good comparison. The results show that Ceinws, Dinas Mawddwy, Llanymawddwy, and Tre'r-ddol all have a 'High' rank for the number of species recorded, showing a seemingly healthy range of diversity.
All the remaining sites would be classified as a 'Fail', by not managing to reach a minimum of a 'Good' ranking. Bont Dolgadfan and Borth (Above Outlet) scored as

'Moderate', meaning there was a lack of diversity in comparison to what would be expected at those locations.

Pennal and Aberangell score the lowest, at 'Bad', due to having a limited number of differing recorded taxa to what would be expected. All the recorded sites that did not achieve a 'Pass' status should be re-examined in depth with further kick sampling to identify why these sites scored so low in comparison to the four sites that achieved a 'Pass', and whether this score accurately represents the condition of that waterbody. Aberangell scored highest in the Shannon Weiner Index for diversity but is in the bottom two for NTAXA and MINTA WHPT. This is likely due to RICT comparing the waterbody to others of the same type, as whilst Aberangell may have comparatively greater diversity than the other sites, it does not mean it should not have an even greater range of species when compared to rivers with similar characteristics. There is also a chance that the river is more acidic than RICT is designed to deal with, resulting in a score that is lower than might be expected due to the river's chemistry. This however would likely also impact on the ranks given to many of the other rivers in this catchment.

The Minimum of Number of Taxa and ASPT (MINTA) WHPT, uses a 'worst of' approach, combining the ASPT and NTAXA EQRs to provide an overall classification for each of the sites. This shows what each site is in the worst-case scenario based on the data gathered and entered into the system. This metric shows that overall, Bont Dolgadfan, Dinas Mawddwy and Tre'r-ddol can be considered in 'Good' ecological condition for macroinvertebrate life.

Borth (Above Outlet), Ceinws and Llanymawddwy just fail with a 'Moderate' rank; whilst Aberangell and Pennal 'Fail' with a 'Poor' ranking. Based on this metric, the sites that 'failed' should be given priority for further testing to better understand the reason for these scores. It appears that whilst the majority of the rivers rank well in terms of low organic enrichment-based pollution, there may be other environmental factors influencing the diversity of species that are present at some of the sites.

Borth and Ceinws are especially interesting as whilst they rank as 'Moderate' in MINTA WHPT, Table 19, they both displayed the lowest diversity and species evenness in comparison to the other sites, this may present an additional avenue for further investigation into what the potential reason for this variation might be and whether there are additional stressors at play.

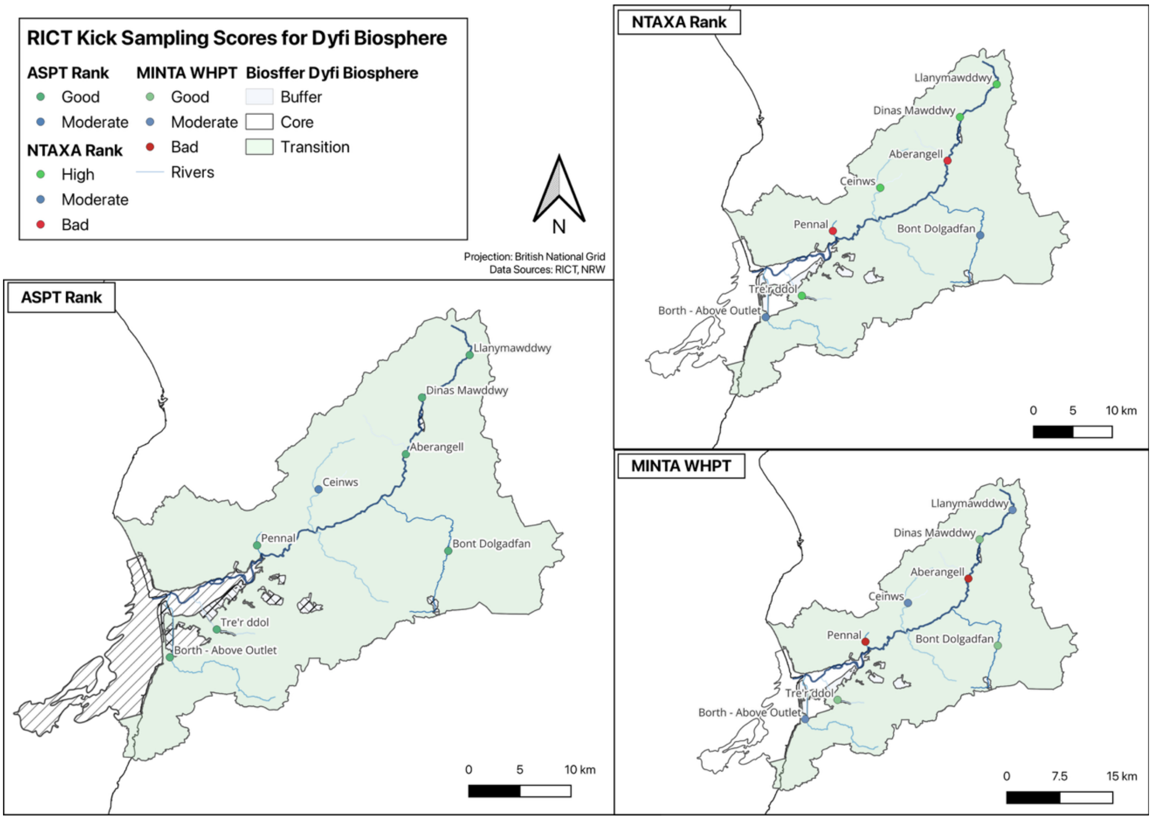


Figure 25 - RICT rankings for kick sample locations

One element of the RICT system to note is that it is not designed for specifically acidic catchments. This may mean that it does not give completely accurate EQRs for more naturally acidic catchments. What it does seem to show overall is that there is likely a limited impact on macroinvertebrate species from pollutants in most of the sampled rivers. However, it does call for further sampling to understand why some of the sites ranked better for NTAXA and MINTA WHPT than others and what factors may be causing that.

Bearing this in mind, the acidic pH conditions are likely a key factor in the results of species found along this catchment. At six out of the ten sites, stonefly (plecoptera) was the most or second most abundant species present. Whilst this often indicates good water quality in terms of low levels of pollution, plecoptera occurring in this relative abundance may be indicative of acidic water conditions, due to some stonefly species being considered acid tolerant (Feeley et al., 2016).

At the same number of sites baetidae or other unidentified species within the order of Ephemeroptera, were found to be the most or second most abundant species. Ephemeroptera are commonly characterised as acid intolerant, however some species from the family baetidae are more acid tolerant or fluctuation tolerant than others (Kelly-Quinn and Regan, 2012; Willoughby, 1988). Because of this, it is recommended that further investigation be made into the specific species of plecoptera and baetidae/Ephemeroptera at each site, in the form of in-depth sampling and identification, for a better understanding of how the catchment acidity impacts what species are present.

Limitations

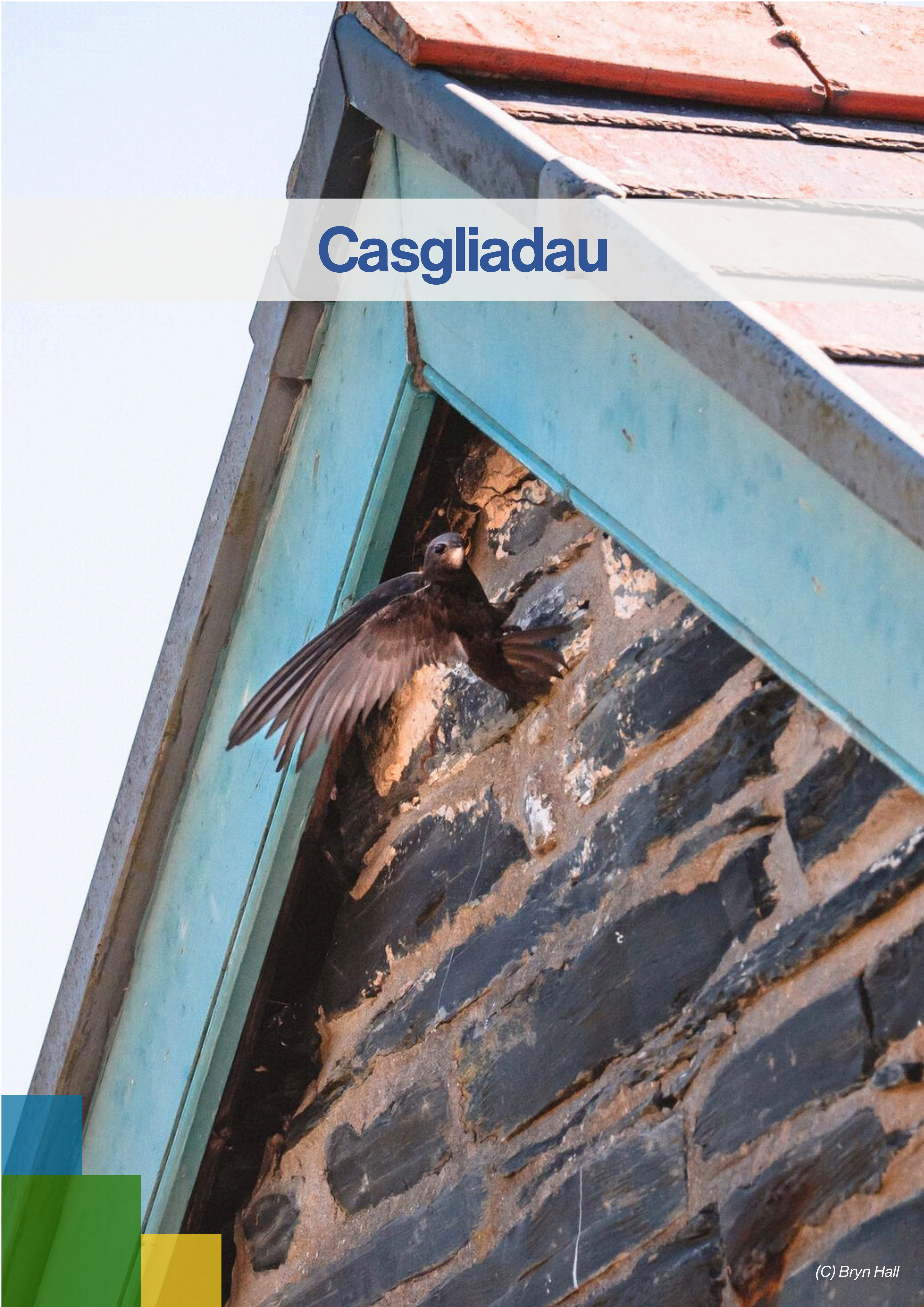
Kick Sampling – Cemaes and Machynlleth

During the kick sampling process there was a period of adjustment in establishing the method. Because of this the first two sites sampled, Cemaes and Machynlleth, were done using a variation on the same method, the differences were:

- Kick sample duration: Kick sampling only took place for 2 minutes instead of 3 minutes. Therefore, the number of specimens gathered will doubtlessly be lower than had the kick been done for 3 minutes. However, whilst 3 minutes is advised for a more robust test, the WHPT-Average Score Per Taxon (ASPT), should be relatively stable after 2 minutes of kick sampling (Stubbington et al., 2025).
- Species identification and counting: The method used meant species identification relied upon use of common/regional rather than scientific names. Counting was only done as an estimate instead of exact, within ranges of: 0, 1-5, 6-10, >10. For the analysis, a 'worst of' approach was taken, so if a species had >10, the number entered was 11, as the lowest value available. This does mean the evenness and abundance calculations for Cemaes and Machynlleth will be skewed.

Borth (Below Outlet)

One factor that was discussed throughout is that after completion of data gathering, Borth (Below Outlet) was found to be a brackish waterbody, despite being above the recorded mean high water mark, for this reason it is not directly comparable to the other test sites or able to be analysed using certain metrics designed for freshwater.



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(C) Bryn Hall

Conclusions

The quantity and quality of research that was conducted by citizen scientists as part of the Screams and Streams project has enabled the collection of baseline data on swift populations and river health across the Dyfi Biosphere, highlighting the value of citizen science and community-led research. These data will be most valuable if continually gathered year on year for further comparison and trend mapping, for which continued community support and empowerment will be vital. Within this project there has been valuable learning in regard to the research methods employed and possible next steps.

Swift surveys

For swift populations in particular, a clearer picture now exists of the number and distribution of nesting sites. With 107 nests recorded, it provides a 'minimum' number across the Dyfi Biosphere, which can be monitored and used to inform further research in future years. The current research shows that almost 66% of recorded nests are 'natural'. As many of these sites as possible should be monitored and if a property containing a nest site is being developed, efforts should be made to allow returning swifts to be able to nest; whether this is by installing artificial nests in place or ensuring the original crevice remains intact.

The Dyfi Biosphere has at least 270 artificial nests installed, of which approximately 10% are known to be occupied by swifts. The research highlights the need for a more thorough assessment of the occupation status of artificial swift boxes, whether occupied by swifts or not, in order to establish a more precise record of the number of and long-term efficacy of the boxes for swifts and other bird species. This will also be an important avenue of research for informing the future efforts of swift groups such as the Dyfi Biosphere Swift Project.

Nest data is ideally recorded to a single public database such as SwiftMapper, and more complex data in the Dyfi Biosphere and North Wales regions should be recorded via the Cofnod project 'A Swift Recovery'. A vital note is the importance of 'counting the zeros' and encouraging artificial box owners to log empty, as well as occupied, boxes; known previously occupied nest sites should also be recorded in order to track population change over time. Communities should also be encouraged to record screaming parties, as in the absence of nest data, it can help inform where swifts might be nesting and give a picture of distribution.

In the case of Ceinws, local community involvement has proved to enable greater capacity of data collection and nest site identification. Finding ways in which to bring communities into research like this may be a pivotal way of effectively counting and mapping hard to survey species such as swifts, that would otherwise require a significant quantity of resources. If this level of community engagement can be replicated and coordinated elsewhere it may enable a greater breadth and quantity of quality data to be collected.

Monitoring the feeding behaviour of swifts is something that could be explored further, however, it presented a challenge during this research due to the extremely transient nature of the common swift. Whilst this research has not been able to identify a direct statistical relationship between river health and common swift survival on this basis, there are some further research metrics that could be employed to identify a link between river health and swifts. Further research conducted into the diet of swifts, via laboratory analysis of their bolus may present the most insightful data. With enough bolus specimens from within the Dyfi Biosphere, it may be possible to reveal what typical percentage of their diet is composed of river originating emergent insects. If this reveals a proportionately significant enough result, it may help to guide further river monitoring and protection, or direct further research into different insect supporting habitats.
This could be led by citizen scientists in partnership with a local academic institution or researcher; however, funding would be required to run this style of research in order to ensure effective coordination and implementation of repeatable and robust study.

> "*The common swift is a truly iconic and emblematic bird of a British summer, but it is in decline in Wales. The Dyfi Biosphere Swift Project joined forces with Lab Dŵr Dyffryn Dyfi and Biosffer Dyfi through the Screams & Streams project and it has been an exciting and productive partnership involving volunteers from the local communities engaging as citizen scientists gathering data on water quality from water courses running into the main Dyfi river and conducting swift surveys.*
>
> *As a result of the dedicated effort exerted by project volunteers through the spring and summer season of 2025, we have gained a better understanding of the swift breeding population in the Dyfi Valley. The valuable data collected and stored for posterity on the SwiftMapper and Cofnod 'A Swift Recovery' databases will form the basis for future conservation work in the Dyfi Valley to help our common swifts. This will probably involve seeking funding from various sources to acquire swift boxes to put up in our widely spread communities.*
>
> *This is truly the most effective way forward to help our declining swift population.*"
>
> Elfyn Pugh - Dyfi Biosphere Swift Project & Steering Group Member on the Dyfi Biosphere Screams & Streams Project

"*Swifts are in real trouble nationally, and so projects like this are invaluable to raise awareness about their plight and understand more about our local populations. Screams and Streams has provided some very important baseline data on swift nest sites across the Dyfi Biosphere, and has given a much greater understanding of the success of swift boxes that have been installed over the last few years. I hope the momentum provided by this project will help galvanise more action to help swift populations across the Dyfi Biosphere and beyond.*"

Ben Porter - Dyfi Biosphere Swift Project & Steering Group Member on the Dyfi Biosphere Screams & Streams Project

River health

Recording fundamental water quality metrics has shown that the overall picture for river health in the Dyfi catchment over the project period appears to be good, with some exceptions calling for further monitoring. The catchment is largely acidic, which is most attributable to the soil and land use, with additional potential impact from abandoned mines and climate conditions. Whilst acidic conditions may not be unusual for this specific catchment, it should be closely monitored and where possible managed. The rivers' low alkalinity will make it more vulnerable to changes in acidity which can greatly harm aquatic life, such as emergent insects, making responsible land use management important for the future of this catchment's rivers. If the averages recorded over the year align with the results from the project, Cemaes, Pennal and Tre'r-ddol would all 'fail' to meet the UK Technical Advisory Group (UKTAG) Water Framework Directive (WFD) standards for healthy freshwater pH levels. As results from a single season, this is certainly not definitive but suggests a need for further monitoring.

Nutrient levels at most of the sites are within healthy levels over the testing period, again with some areas that need to be monitored. Borth (Above Outlet) on the Afon Leri records the highest nitrate load, which whilst not above the level of concern, frequently recorded higher nitrate levels than the other catchment rivers, further monitoring is required to understand potential causes and long-term nitrate levels. Borth (Below Outlet) showed raised nitrate, nitrite and phosphorus levels at times, which may be influenced by tidal regime disturbance, however further testing should also be carried out along the brackish section of the Leri to explore the potential source of this.
Most of the sites would pass WFD standards for phosphorus, however Borth (Above Outlet) is on the cusp of failing. Further monitoring here is required to establish if these levels do fail to meet WFD standards over an annual period or not.

In addition to the testing that has taken place during this project, the community may want to consider research into pharmaceutical compounds (domestic and agricultural) in the Dyfi catchment rivers as another increasingly discussed metric of river health. The 'leaf litter bag' method is suggested for this line of research, which would require citizen scientists to partner with an academic facility with specialist temperature-controlled ovens.

Another avenue of water quality testing that might be considered is heavy metal testing. There is a notable density of disused mines located around the Biosphere, with particular density around the Afon Leri, Afon Twymyn and Afon Cletwr. It may be valuable to assess the impact and potential levels of Acid Mine Drainage (AMD) on these rivers, especially as a measurement of potential change brought about by remedial action being implemented at mines such as Dylife and changing environmental factors such as warmer summers.

Macroinvertebrates: Flying Insects

The flying insect data shows some potentially interesting and additional areas of research. The method for insect data collection needs some revision, however the data gathered gives good density comparisons between sites. In future iterations, additional precise environmental data would be valuable, including luminosity, which can be recorded using inexpensive meters. The insect density should be compared year on year between sites to establish patterns of change, which is influenced by habitat cover, weather time of day, and many other variables. This could be valuable research in connection with swift bolus data over time for drawing clearer connections between swift feeding habits and river health.

It would also be valuable to assign a numerical value to the small flying insect density scale, as this would allow more in-depth analysis.

Macroinvertebrates: Kick sampling

The River Invertebrate Classification Tool (RICT) revealed general macroinvertebrate life in the Dyfi catchment appears to be mostly unaffected by pollution, with all but one site achieving a 'Pass' score for the Average Score Per Taxon (ASPT) in comparison to 'pristine' conditions. This would suggest an abundance of pollution sensitive species, which is a good sign for the river's overall health suggesting low levels of general degradation and organic pollution. A site that did not meet a 'Pass' for ASPT however, was Ceinws, which also showed comparatively low species diversity and evenness. It is possible that this might suggest a potential pollution source to be impacting the benthic species in the river; further monitoring at this site as well as up and down stream is recommended to clarify.

RICT rankings for the number of different species present (NTAXA) and definitive classification (MINTA WHPT) showed a varied picture across the sites, with only

Bont Dolgadfan, Dinas Mawddwy and Tre'r-ddol achieving a 'Pass' grade. As a laboratory invertebrate identification method was not used, *this does not definitively mean that the other sites 'fail' to meet the expected standard*. It does provide a comparison between the sites and for future kick sampling. Additionally, the MINTA WHPT scores returned by RICT are 'worst of', meaning the actual rank of the rivers is likely better than the scores may indicate, what these ranks offer is a 'minimum' score, suggesting they are at least as good as the results show. This highlights the need for further sampling to take place, perhaps with the assistance of a laboratory for more definitive rankings. Pennal and Aberangell are key sites to return to for kick sampling, whilst both displayed comparably well in diversity and species evenness, both ranked 'Bad' for NTAXA and on the MINTA WHPT. Borth, Ceinws and Llanymawddwy, whilst supporting pollution sensitive species, would all need to score higher to meet a 'Pass' rank. Borth and Ceinws were also the lowest ranking in terms of species diversity and evenness using Shannon Weiner and should be re-assessed and further examined on this basis. The research has also noted the potential limitations of systems such as RICT for acidic catchments and the need for further development to help adjust for those conditions.

> "*Lab Dŵr Dyffyn Dyfi came together in 2025 to increase community care and knowledge for the waters of the Dyfi Valley, in part through water testing and citizen science. Linking air and water - swifts and rivers adds another layer to our understanding that each one influences the other, it deepens our understanding of nature. However, there is also the personal and shared experiences of working together on a shared interest. With collective, informed and shared experience we strengthen ourselves individually and collectively. The project approach meant that people with little or no knowledge could become involved and valued member of the team. Having the swifts and water testing also meant people had a choice in how they were involved whether part of a water testing group to an individual recording swift activity from their village.*
>
> *Whilst Screams and Streams was a science based project it also has a very profound human side to it. We might not have otherwise connected with the people from our communities. Each such project small or large, long or short term has so much potential to build our community connections and exchanges and thereby strengthening our communities on a number of different levels. Seeing the volunteers, and our own knowledge and confidence grow has been rewarding and interesting. Even the simplest experiences of travelling to places that we may not have previously visited in our community increasing our appreciation of the valley; to the quiet exchanges during the peaceful 10 minutes surveying flying insects help to develop appreciation. It has also led to more people wanting to regularly test the rivers; and recording swift activity, when they return next year*."
>
> Jenny Lampard – Lab Dŵr Dyffryn Dyfi & Steering Group Member on the Dyfi Biosphere Screams & Streams Project

"*There is an urgent need for all of us to take an active interest in our environment to allow us to influence the decisions made on our behalf by politicians. Having been initially sceptical on how the Screams and Streams project could achieve something tangible in such a short time I am very pleased to say my caution was misplaced. The work of gathering the evidence has been great fun, educational and most importantly productive. This report is a testament to that and lays a foundation for further data gathering, research and learning which is fundamental to support our biosphere and our place within it.*"

Keith Halcrow – Lab Dŵr Dyffryn Dyfi & Steering Group Member on the Dyfi Biosphere Screams & Streams Project

Key Recommendations and next steps

Whilst this research does not statistically connect river health to common swift survival, it does provide collated baseline datasets that would otherwise be difficult to draw out for further research. Presented here are several key recommendations for those wanting to carry on the research and/or data collection.

This research has been valuable in bringing different community members together for the shared purpose of swift and river data collection during the summer of 2025 and the next steps are ultimately in the community's hands. Bearing this in mind there are a few key recommendations below for continuation now that the initial Screams & Streams project has come to an end:

1. **Common swift research:**
    a. Recording nest sites is vital for understanding population change and the local human impact. To do this, SwiftMapper provides an accessible and intuitive tool for collating and sharing the data. If possible, all swift box owners should use this to enter the status of their boxes every year, whether occupied by swifts or not. An empty swift box should be logged as such as 'reporting the zeros' is essential for tracking community change over time. This will also allow for a more accurate round-up and efficacy report on artificial swift boxes. Natural nest sites should be surveyed each year and if a nest site is abandoned or destroyed it is important to record this change.
    b. Community members should continue to log flying swifts, especially those in screaming parties, as this is vital in locating new or previously undiscovered nest sites. Screaming parties can be logged via SwiftMapper and more complex recordings can be entered into the Cofnod project 'A Swift Recovery' if within the Dyfi Biosphere, or more broadly, North Wales.

c. To establish a link between rivers and swift survival, a study into the composition of Dyfi Biosphere swift boluses could be conducted. This may help to provide a picture of how many river emergent insects they feed and can be used to inform where future research efforts could be placed.

2. **River surveying:**
   a. River surveying will ideally carry on at each location on at least a monthly basis to establish annual averages that can be monitored over time. The current advice for those in the Dyfi Biosphere is to record this data into a single location, such as the North Wales Rivers Trust database, for a collated dataset. Special interest should be paid to the Afon Leri and if possible, testing should be performed in multiple places along the brackish sections and freshwater further upstream.
   b. The Community may wish to perform testing to investigate potential pharmaceutical compounds within the rivers around the Dyfi Biosphere to establish the current status. This can be done using the 'Leaf litter bag method'.
   c. Heavy metal content testing is suggested in collaboration with a laboratory along the reaches of the Dyfi catchment, to monitor the effectiveness of remedial work at major disused mines, and to identify if there should be any concern, now or future, around heavy metal content in the rivers.

3. **Flying insect surveying:**
   a. Whilst the method needs some development, flying insect surveying would be valuable to continue alongside and in addition to ongoing river testing, the data gathered can be compared to this year's data for ongoing analysis. It is also recommended to gather additional data on luminosity, precise air temperature and wind speeds, for which more equipment may be required.

4. **Kick sampling:**
   a. Kick sampling should continue annually, if possible, in spring and autumn for a two-season average, but if not once per year in the summer for direct comparison.
   b. If possible, data entry into RICT and calculations for the Shannon Weiner Index should be done annually to compare change between sites year on year. Whilst species present overall doesn't suggest an issue with general degradation or organic pollution in the rivers, acidity amongst other variables may be factors limiting higher RICT rankings and resulting in lower diversity scores at some of the sites.

c. Laboratory identification would be recommended to attain a definitive RICT ranking for each site, focussing on the sites which didn't achieve a 'pass' this season.

The data analysed in this project and methods implemented were designed to be openly available to communities and researchers for future, use and development. If used as a source in literature, please ensure to cite the report and credit the Dyfi Biosphere community that enabled its creation.

The Dyfi Biosphere and its community still need citizen scientists to carry on this research, to access the data and find out more visit the Dyfi Biosphere Screams & Streams project page:

Gwefan Cymraeg   English Webpage

Cyfeiriadau

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Atodiadau

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Appendices

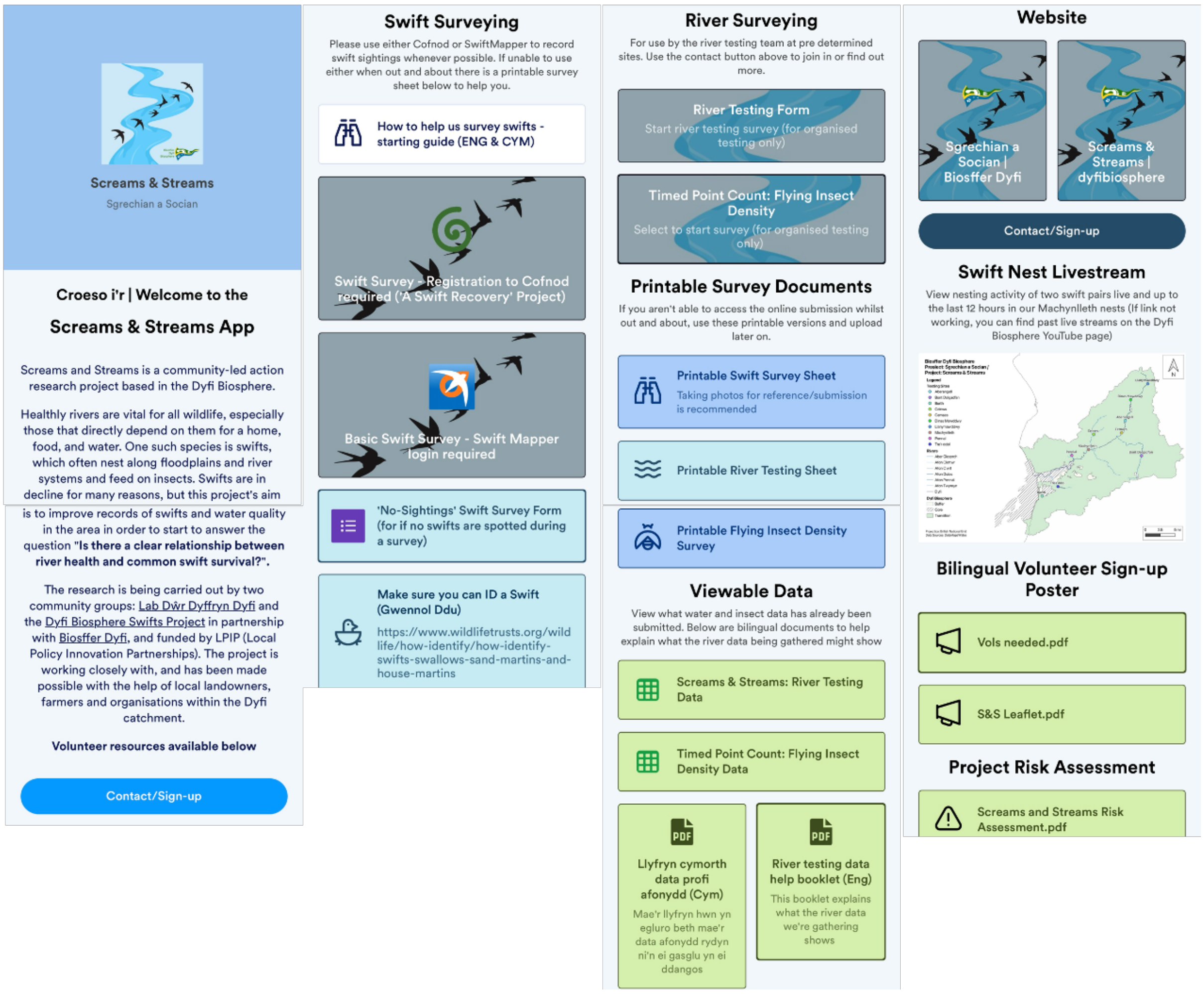

Figure 26 - Screenshots of the Screams & Streams Project App

Table 20 - Discharge Category table for RICT

Discharge Category (where annual data is available)	**Mean Annual Discharge** (cubic metres per second)
1	<0.31
2	0.31 - 0.62
3	0.62 - 1.25
4	1.25 - 2.50
5	2.50 - 5.00
6	5.00 - 10.00
7	10.00 - 20.00
8	20.00 - 40.00
9	40.00 - 80.00
10	>80.00

Table 21 - Discharge Category from velocity table for RICT

Velocity Category (where no annual data is available)	**Current Velocity** (cm/s)
1	<=10
2	>10 - 25
3	>25 - 50
4	>50 - 100
5	>100

Table 22 - WHPT values for each logarithmic abundance category extracted from EA, Walley Hawkes Paisley Trigg (WHPT) index of river invertebrate quality and its use in assessing ecological status, Brief guide Version 11 (Environment Agency, 2024)

	AB1	AB2	AB3	AB4
TRICLADA (Flatworms)	1-10	11-100	101-1000	>1000
Dendrocoelidae	3.0	2.6	2.6	2.6
Dugesiidae	2.8	3.1	3.1	3.1
Planariidae	4.7	5.4	5.4	5.4
MOLLUSCA (Snails, Limpets and Mussels)				
Neritidae	6.4	6.5	6.9	6.9
Viviparidae	5.2	6.7	6.7	6.7
Unionidae	5.2	6.8	6.8	6.8
Sphaeriidae (Pea mussels)	4.4	3.5	3.4	2.3
Lymnaeidae	3.6	2.5	1.2	1.2
Planorbidae (excluding Ancylus group)	3.2	3.0	2.4	2.4
Valvatidae	3.3	3.1	2.7	2.7
Physidae	2.7	2.0	0.4	0.4
Acroloxidae	3.6	3.8	3.8	3.8
Ancylus group (= Ancylidae)	5.8	5.5	5.5	5.5
Bithyniidae	3.6	3.8	3.3	3.3

Dreissenidae	3.7	3.7	3.7	3.7
Hydrobiidae (including Bythinellidae & Tateidae)	4.1	4.2	4.6	3.7
OLIGOCHAETA (worms)				
Oligochaeta	3.6	2.3	1.4	-0.6
HIRUDINIA (Leeches)				
Piscicolidae	5.2	4.9	4.9	4.9
Glossiphoniidae	3.4	2.5	0.8	0.8
Erpobdellidae	3.6	2.0	-0.8	-0.8
Hirudinidae	-0.8	-0.8	-0.8	-0.8
CRUSTACEA (Crayfish, Shrimps and Slaters)				
Astacidae (including non-native species)	7.9	7.9	7.9	7.9
Corophiidae	5.7	5.8	5.8	5.8
Asellidae	4.0	2.3	0.8	-1.6
Crangonyctidae	3.8	4.0	3.6	3.6
Gammaridae	4.2	4.5	4.6	3.9
Niphargidae	6.3	6.3	6.3	6.3
EPHEMEROPTERA (Mayflies)				
Siphlonuridae (including Ameletidae)	11.3	12.2	12.2	12.2
Heptageniidae (including Arthropleidae)	8.5	10.3	11.1	11.1

Ephemeridae	8.3	8.8	9.4	9.4
Leptophlebiidae	8.8	9.1	9.2	9.2
Ephemerellidae	7.9	8.5	9.0	9.0
Potamanthidae	9.8	10.4	10.4	10.4
Caenidae	6.5	6.5	6.5	6.5
Baetidae	3.6	5.9	7.2	7.5
PLECOPTERA (Stoneflies)				
Perlidae	12.6	13.0	13.0	13.0
Chloroperlidae	11.4	12.2	12.2	12.2
Taeniopterygidae	11.0	11.9	12.1	12.1
Perlodidae	10.5	11.5	11.5	11.5
Capniidae	9.7	9.4	9.4	9.4
Leuctridae	9.3	10.6	10.6	10.6
Nemouridae	8.7	10.7	10.7	10.7
ODONATA (Damselflies)				
Calopterygidae (= Agriidae)	5.9	6.2	6.2	6.2
Platycnemididae	6.0	6.0	6.0	6.0
Coenagrionidae (= Coenagriidae)	3.4	3.8	3.8	3.8
ODONATA (Dragonflies)				

Cordulegastridae (= Cordulegasteridae)	9.8	9.8	9.8	9.8
Aeshnidae	4.7	4.7	4.7	4.7
Libellulidae	4.1	4.1	4.1	4.1
HEMIPTERA (Bugs)				
Aphelocheiridae	8.6	8.5	8.0	8.0
Hydrometridae	4.3	4.3	4.3	4.3
Gerridae	5.2	5.5	5.5	5.5
Mesoveliidae	4.7	4.7	4.7	4.7
Nepidae	2.9	2.9	2.9	2.9
Naucoridae	3.7	3.7	3.7	3.7
Pleidae	3.3	3.3	3.3	3.3
Notonectidae	3.4	3.9	3.9	3.9
Corixidae	3.7	3.9	3.7	3.7
Veliidae	4.5	3.9	3.9	3.9
COLEOPTERA (Beetles)				
Gyrinidae	8.1	9.0	9.0	9.0
Scirtidae (= Helododae)	6.9	6.8	6.8	6.8
Dryopidae	6.0	6.0	6.0	6.0
Elmidae	5.3	7.4	8.3	8.3

Haliplidae	3.6	3.4	3.4	3.4
Paelobiidae (= Hygrobiidae)	3.8	3.8	3.8	3.8
Dytiscidae	4.5	4.8	4.8	4.8
Hydraenidae	8.5	10.5	10.5	10.5
Hydrophilidae (including Georissidae, Helophoridae & Hydrochidae)	5.8	8.8	8.8	8.8
Noteridae	3.2	3.2	3.2	3.2
MEGALOPTERA				
Sialidae	4.2	4.4	4.4	4.4
NEUROPTERA, PLANIPENNIA				
Sisyridae	5.7	5.7	5.7	5.7
TRICHOPTERA (Caddis-flies - caseless)				
Philopotamidae	11.2	11.1	11.1	11.1
Polycentropodidae	8.2	8.1	8.1	8.1
Hydropsychidae	5.8	7.2	7.4	7.4
Glossosomatidae	7.8	7.6	7.2	7.2
Psychomyiidae	5.8	5.7	5.7	5.7
Rhyacophilidae	8.1	9.2	8.3	8.3
TRICHOPTERA (Caddis-flies - cased)				
Odontoceridae	11.1	10.3	10.3	10.3

Lepidostomatidae	9.9	10.3	10.2	10.2
Goeridae	8.8	8.8	9.4	9.4
Brachycentridae	9.6	9.5	8.9	8.9
Sericostomatidae	8.9	9.4	9.5	9.5
Beraeidae	8.8	7.3	7.3	7.3
Molannidae	6.5	7.6	7.6	7.6
Leptoceridae	6.7	6.9	7.1	7.1
Phryganeidae	5.5	5.5	5.5	5.5
Limnephilidae (including Apataniidae)	5.9	6.9	6.9	6.9
Hydroptilidae	6.1	6.5	6.8	6.8
DIPTERA (True flies)				
Simuliidae	5.5	6.1	5.8	3.9
Tipulidae (including Cylindrotomidae, Limoniidae & Pediciidae)	5.4	6.9	6.9	7.1
Chironomidae	1.2	1.3	-0.9	-0.9
Athericidae	9.3	9.5	9.5	9.5
Ceratopogonidae	5.4	5.5	5.5	5.5
Chaoboridae	3.0	3.0	3.0	3.0
Culicidae	2.0	1.9	1.9	1.9
Dixidae	7.0	7.0	7.0	7.0

Dolichopodidae	4.9	4.9	4.9	4.9
Empididae	7.0	7.6	7.6	7.6
Ephydridae	4.4	4.4	4.4	4.4
Muscidae	4.0	2.6	2.6	2.6
Psychodidae	4.5	3.0	3.0	3.0
Ptychopteridae	6.4	6.4	6.4	6.4
Rhagionidae	9.6	9.6	9.6	9.6
Sciomyzidae	3.4	3.4	3.4	3.4
Stratiomyidae	3.6	3.6	3.6	3.6
Syrphidae	1.9	1.9	1.9	1.9
Tabanidae	7.1	7.3	7.3	7.3

Table 23 - Borth (Below Outlet) Kick Sample Results

Date	18/07/2025	
Time	7:00 PM	
River Name	Leri	
Location	Borth (Below Outlet) - SN 61377 89488	
Common Name	**Latin Name**	**Estimate of total present in sample**
Shrimp	Gammaridae	3000
Caseless Caddis Green	Rhyacophila	1
Beetle Larvae	Elmidae	14
True Worm	Oligochaeta	20
Midge Larvae	Chironomidae	3
Long Horned Caddisfly	Leptoceridae	9
Riffle Beetle	Elmidae	1
Cranefly	Limoniidae	1
Unidentified Beetle Larvae	Coleoptera	1

Figure 27 - Aberangell: Cranefly Larvae (Tipulidae)

Figure 28 - Aberangell: Stonefly Nymph (Plecoptera)

Figure 29 - Aberangell: Mayfly Nymph (identified as Baetidae)


Figure 30 - Bont Dolgadfan: Blackfly (Simuliidae) and Marsh Beetle (Scirtidae)


Figure 31 - Bont Dolgadfan: Caseless Caddis Green (Rhyacophila)

Figure 32 - Bont Dolgadfan: Caseless Caddis Net Spinner (Hydropsychidae)

Figure 33 - Bont Dolgadfan: Variety of cranfly larvae (Tipulidae)

Figure 34 - Borth (Above Outlet): Trumpet-net Caseless Caddis (Polycentropodidae) and trueworm (Oligochaeta)

Figure 35 - Borth (Above Outlet): Identified as Type of Water Snipe Aquatic Fly Larvae (Athericidae)

Figure 36 - Borth (Below Outlet): Elmidae Larvae

Figure 37 - Borth (Below Outlet): Shrimp (Likely Gammaridae)

Figure 38 - Borth (Below Outlet): Identified as Cantharidae sp.

Figure 39 - Borth (Below Outlet): Elmidae Larvae 2

Figure 40 - Borth (Below Outlet): dentified as Type of Cranefly (Limoniidae)

Figure 41 - Ceinws: Cased Caddis (Lepidostomatidae)

Figure 42 - Ceinws: Cranfly Larvae (Limoniidae)

Figure 43 - Ceinws: Detritus Worm (Oligochaeta)

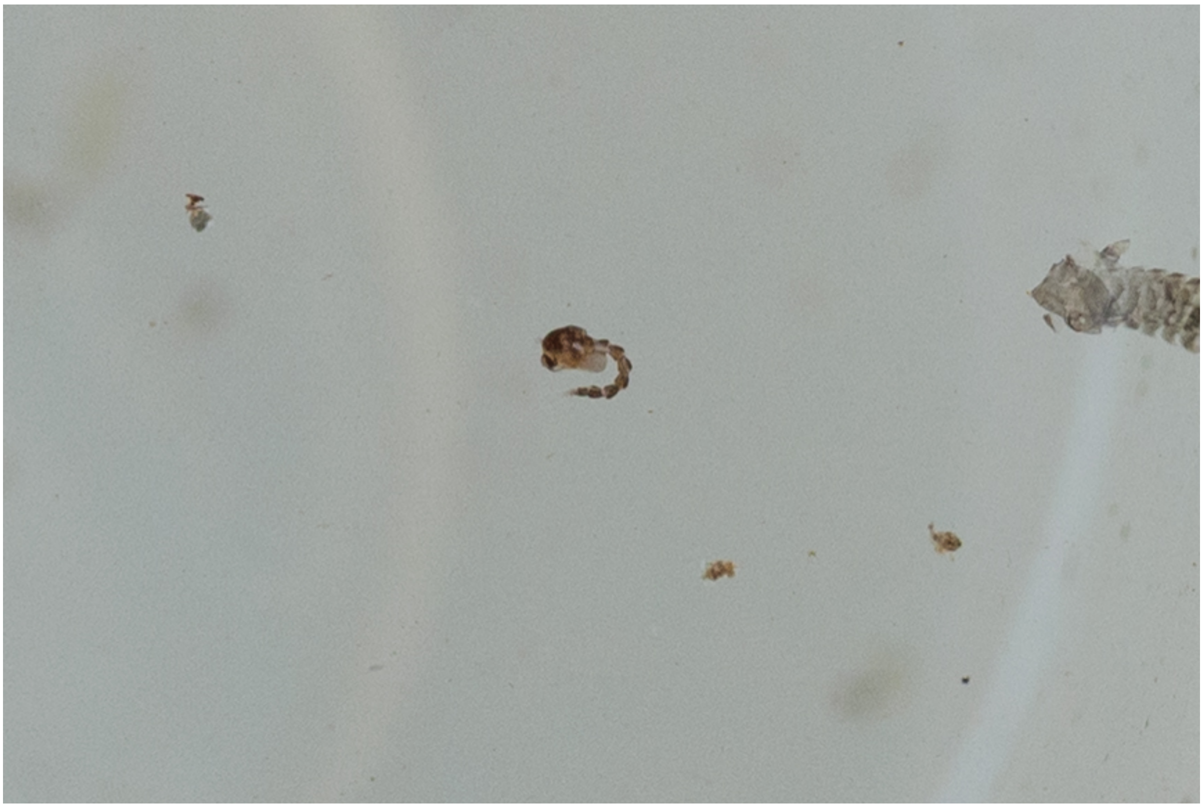

Figure 44 - Ceinws: Mosquito Pupa (Culicidae)

Figure 45 - Ceinws: Non-biting midge larvae (Chironomidae)

Figure 46- Ceinws: Swimming Mayfly Nymph (Baetidae)

Figure 47 - Ceinws: True Worm (Oligochaeta)

Figure 48 - Dinas Mawddwy: Chironomidae

Figure 49 - Dinas Mawddwy: Caseless Caddis (Glossosomatidae)

Figure 50 - Dinas Mawddwy: Mayfly (Baetidae) and unidentified True Fly (Diptera)

Figure 51 - Dinas Mawddwy: Likely Horsefly Larvae (Tabanidae)

Figure 52 - Dinas Mawddwy: Cranfly Larvae (Tipilidae)

Figure 53 - Llanymawddwy: Mayfly Nymph (Baetidae)

Figure 54 - Llanymawddwy: Diving Beetle (Dytiscidae)

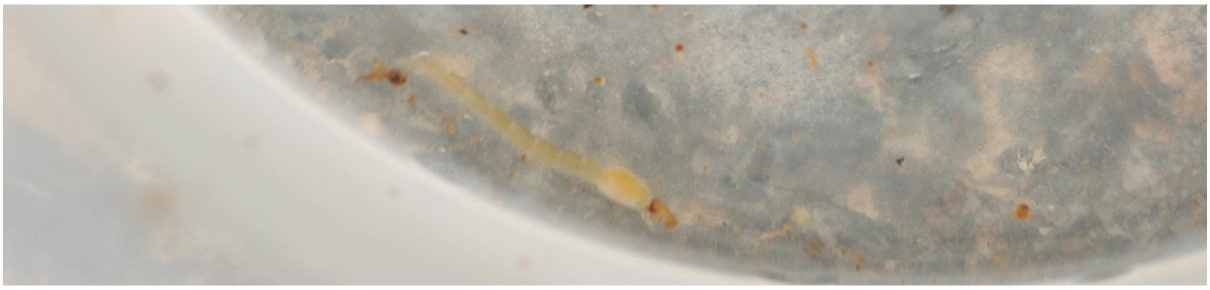

Figure 55 - Tre'r-ddol: Midge Larvae (Chironomidae)

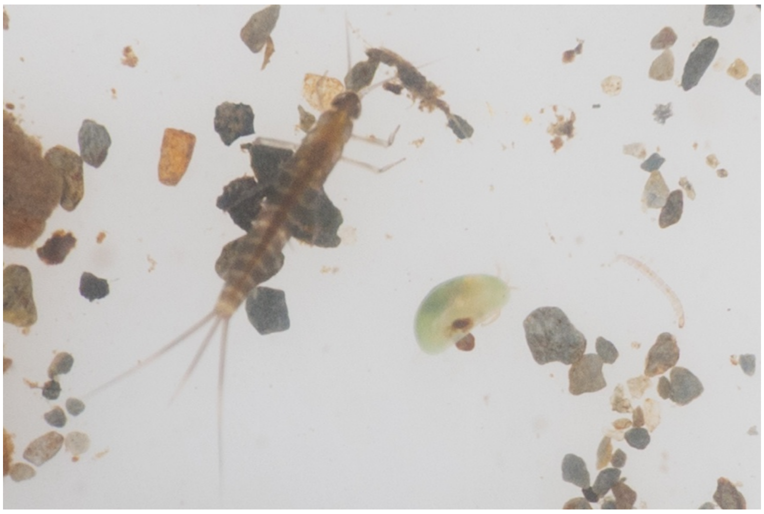

Figure 56 - Tre'r-ddol: Mayfly (Baetidae) and Ostracod (Cyprididae)

Figure 57 - Tre'r-ddol: Bladder Snail (Physidae)

Figure 58 - Tre'r-ddol: Caseless Caddis Brown (Hydropsychidae)

Figure 59 - Tre'r-ddol: Dragonfly Nymph (Cordulegasteridae)

Figure 60 - Tre'r-ddol: Flatworm (Triclada)

Figure 61 - Tre'r-ddol: Hairy Eyed Craneflies (Pedicidae) and two stoneflies (plectoptera)

Figure 62 - Tre'r-ddol: Identified as Chironominae (Chironomidae)

Figure 63 - Tre'r-ddol: Identified as Mosquito Pupa (Culicidae)

Figure 64 - Tre'r-ddol: Identified as Water Snipe Fly (Athericidae)

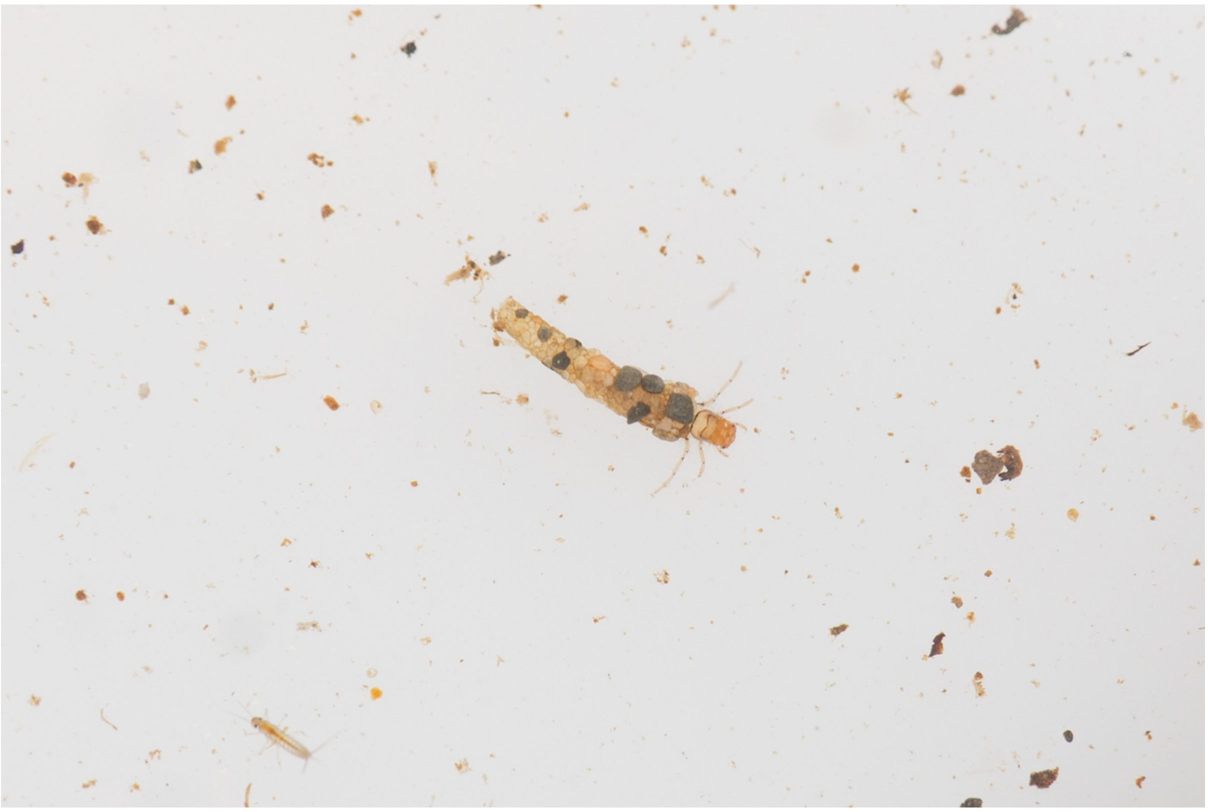

Figure 65 - Tre'r-ddol: Long Horned Caddisfly (Leptoceridae)

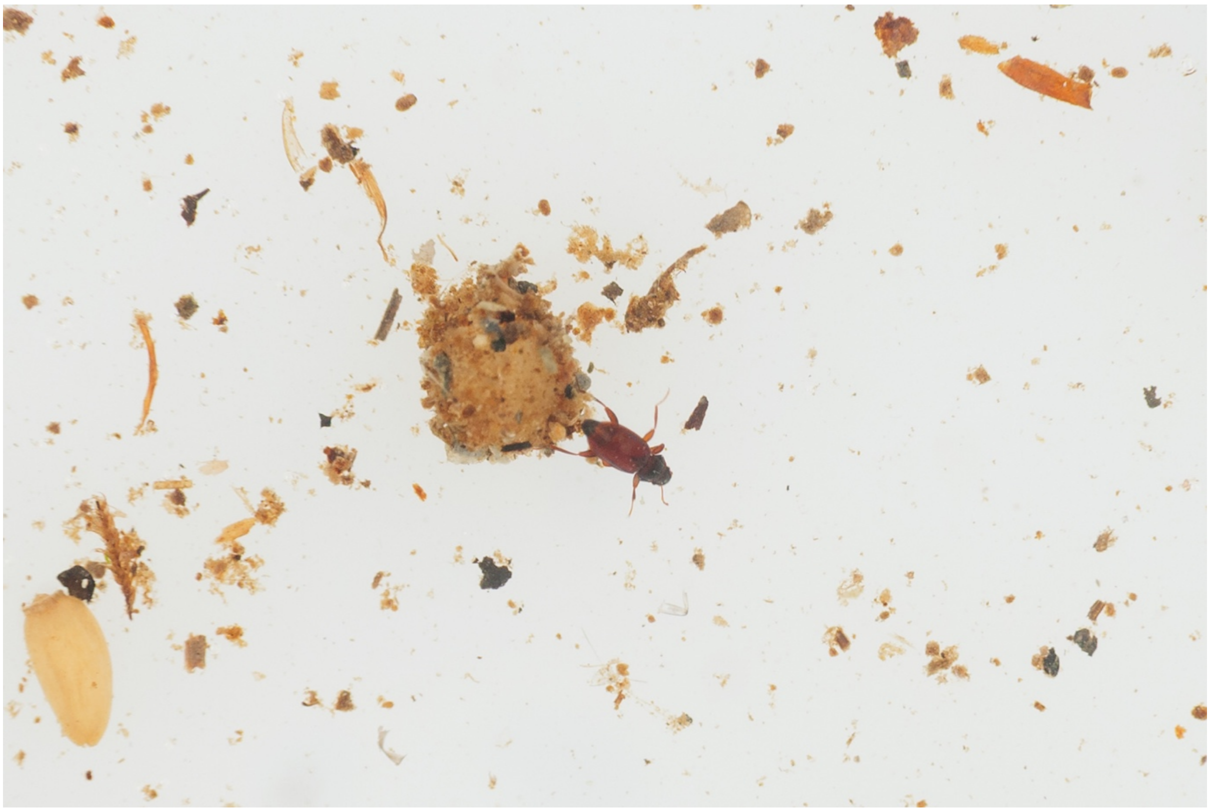

Figure 66 - Tre'r-ddol: Riffle Beetle (Elmidae)

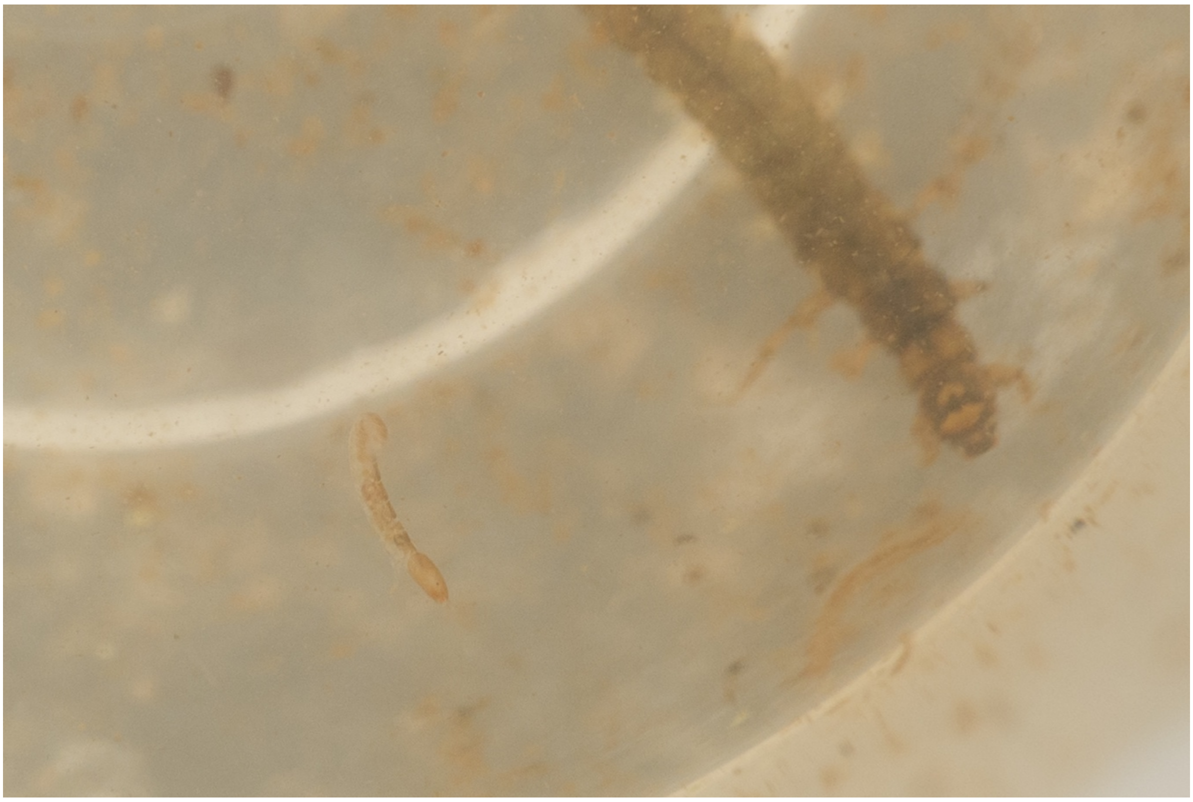

Figure 67 - Tre'r-ddol: Small Chironomidae next to Caseless Caddis Brown (Hydropsychidae)

Figure 68 - Tre'r-ddol: Stoney Cased Caddis (Tricoptera)

Figure 69 - Tre'r-ddol: Water Snipe Fly (Athericidae)

Figure 70 - Image by Ben Porter (Porter, 2025)