

# ***Preliminary Invertebrate Survey of Bwlch Corog, Ceredigion: June-October 2018***

Report V 1.0



Conducted by:

John Dobson BSc MSc MCIEEM FRES

**Make Natural Ltd (Ecological Services)**

[contact@makenatural.co.uk](mailto:contact@makenatural.co.uk)

For:

**Wales Wild Land Foundation CIO**



**Cover Photo:**

View of Bwlch Corog showing *Molina* grassland and ancient woodland. 31 May 2018. Photo © J.R. Dobson.

***Preliminary Invertebrate Survey of  
Bwlch Corog, Ceredigion:  
June-October 2018***  
Report V1.0

Conducted by: John Dobson BSc MSc MCIEEM FRES: Make Natural Ltd (Ecological Services)  
contact@makenatural.co.uk

For: Wales Wild Land Foundation CIO

## CONTENTS

SECTION	PAGE
EXECUTIVE SUMMARY	1
1. INTRODUCTION	1
2. METHODS	3
3. LIMITATIONS OF SURVEY	10
4. RESULTS	12
5. DISCUSSION	21
6. RECOMMENDATIONS	24
7. REFERENCES & BIBLIOGRAPHY	26
8. APPENDIX 1: MAP SHOWING SAMPLING LOCATIONS	30
9. APPENDIX 2: TAXONOMIC CHECKLIST OF INVERTEBRATES RECORDED BY THE SURVEY	31
10. APPENDIX 3: ADDITIONAL RECORDS	39
11. APPENDIX 4: PHOTOGRAPHS OF HABITATS SAMPLED FOR INVERTEBRATES	40
12. APPENDIX 5: GLOSSARY	44
13. APPENDIX 6: RISK ASSESSMENT	46

## EXECUTIVE SUMMARY

Make Natural Ltd (ecological Services) was appointed by Wales Wild Land Foundation to carry out seasonal surveys of terrestrial invertebrates at Bwlch Corog, Ceredigion. These were carried out during the period June to October 2018, and included spring, summer and autumn surveys. Samples of invertebrates were taken from eight agreed habitat types (Tables 2 & 3) using sweep netting, hand-netting, hand searching, beating and tussocking. These specimens were subsequently identified during the winter of 2018-2019 (see Methods).

These data were added to a spreadsheet (MNP0296\_BwCo\_Invert\_Spp\_Data\_2018.xlsx) which accompanies this report.

The 730 specimens which were identified resolved to c.281 species/species aggregates. Of these, 9 species were designated in the UK due to their scarcity and/or decline. A further 21 species are highlighted in this report as being scarce and local and therefore of significance to the site and its management. The overall yield of invertebrate species was low, and this is ascribed primarily to the suboptimal weather conditions which occurred during the survey (table 4) rather than to any limitations in the sampled habitats.

The species data was subject to various analyses using Pantheon (see Methods) in order to present clear data on the resource- and habitat dependencies of the recorded invertebrate fauna.

Although some recommendations are included, the site management recommendations normally included in invertebrate survey reports are excluded at the request of the client.

## 1. INTRODUCTION

John Dobson of Make Natural Ltd was appointed by Cambrian Wildwood (Wales Wild Land Foundation) in an email from Simon Ayres dated 25 April 2018 to carry out a preliminary invertebrate survey of Bwlch Corog, Ceredigion.

### Background

The background to the overall project and to this survey is laid out in the Cambrian Wildwood website (see References) and is summarised here.

“Bwlch Corog, previously known as Cefn Coch, was acquired for Cambrian Wildwood in May 2017. Wales Wild Land Foundation hold the land on a 125-year lease from Woodland Trust, who purchased the freehold at this time. The site is 350 acres (140 hectares) of moorland dominated by purple moor grass (*Molinia caerulea*) with a relatively small area of ancient woodland alongside two upland streams in the northern corner of the site.

The aim for Bwlch Corog is for native woodland to colonise naturally. This will be assisted by planting around 8,000 native trees in small groups across the site, to provide a seed source in this relatively treeless upland landscape, and to bring back tree species that are no longer present locally but used to grow here. We envisage that the existing woodland will spread into the bracken and up the slopes, with scattered trees on the moorland. Other initial work will include the blocking of drainage grips throughout the 12km network criss-crossing the site. The large swathes of purple moor grass will revert to blanket bog and heather moorland, some of which will be mixed with native woodland or occasional trees.

The site was not grazed for about six years, prior to our acquisition. We introduced wild horses, 5 mares and 1 stallion, in April and June 2018. Other large herbivores are a longer-term plan and subject to proper investigation of the appropriateness and practicalities.

The first priority is to carry out surveys to see what birds, mammals, plants and invertebrates are present – providing baseline data to see how things change over the years.”

### **Aim of the Survey**

The aim of the survey was to conduct a preliminary audit of the invertebrate fauna associated with nominated key invertebrate habitats at the site (see Methods) prior to the onset of ecological management works. Seasonal surveys (spring, summer and autumn) were carried-out in order to sample invertebrate taxa which were present as adults in each season.

The resulting species data can be utilised:

- To compare the invertebrate faunas between habitats and between seasons, and subject to follow-up survey, before and after initial management works at that site.
- To allow for analysis of invertebrate habitat associations at the site using Pantheon methodology (Webb *et al.* 2017), thus informing long-term management priorities.
- To contribute to the overall knowledge and understanding of the site’s invertebrate fauna.

## 2. METHODS

### Scope of the Survey

Samples were taken from eight habitats as agreed on site with Simon Ayres (Table 2). Sampling was carried out seasonally (spring, summer and autumn) in order to record taxa occurring as adults at different times of the year.

### Taxonomic Scope.

Some of the key groups targeted by the survey are highlighted below. These included a wide variety of taxa of terrestrial invertebrates, as set out in the method statement. The numbers in brackets represent the approximate (rounded) number of known UK species (spp.) in each group.

1. A range of beetle (Coleoptera) (4000 spp.) families including for example ground beetles (Carabidae), click beetles (Elateridae), soldier beetles (Cantharidae) and others.
2. A range of fly (Diptera) (7000 spp.) families including for example hoverflies (Syrphidae), soldier flies (Stratiomyidae), crane flies (Tipulidae etc.), picture-winged flies (Tephritidae etc.), parasitoid flies (Tachinidae) and others.
3. A range of families of true bugs (Hemiptera) (600 spp.) including for example shield bugs (Pentatomidae), squash bugs (Coreidae) and others.
4. Bees, wasps and ants (Aculeate Hymenoptera) (600 spp.).
5. Adult Riverflies such as mayflies (Ephemeroptera) (50 spp.), Stoneflies (Plecoptera) (30 spp.) and caddisflies (Trichoptera) (200 spp.). Aquatic sampling was not included in the survey specification.
6. Butterflies (Lepidoptera-Rhopalocera) (60 spp.) to be recorded in the field. Moths (Lepidoptera-Heterocera) were not included in the survey.
7. Small insect Orders such as grasshoppers & crickets (Orthoptera) (40 spp.) and lacewings (Neuroptera) (80 spp.).
8. Non-insect invertebrates such as spiders (Arachnida), centipedes and millipedes (Myriapoda) and woodlice (Terrestrial Isopoda).
9. Other taxa as found which were considered likely to be of particular relevance in this context.

### Field Survey Methods

A preliminary site visit for reconnaissance purposes was made 28 May 2018, the day preceding the commencement of the formal surveys (Table 3).

Sampling areas were selected by the surveyor on site to include 8 habitat types as agreed (Table 2). During each seasonal survey different areas of similar habitat were selected in some instances (see Scope of Survey, Table 3, and Map 1).

The position of each survey area was recorded as a 10-figure grid reference using a high sensitivity hand-held recording GPS unit (3m maximum resolution). These sites are indicated in Map 1, and photographs of typical survey areas appear in Appendix 4.

Each of the three seasonal surveys comprised two site visits with the aim of sampling four of the eight selected habitats on each day. Due to suboptimal weather conditions (Table 4) this was not achievable in every instance. However, 19 of the 24 targeted samples were collected along with a further 3 'casual' samples, totalling 22 samples (see Table 4 and Limitations of Survey).

In each recording area invertebrate specimens were collected using a range of techniques:

1. Sweeping, and individual capture using a hand net and pooter.
2. Using a beating tray to sample specimens dislodged from trees and shrubs.
3. Searching on the ground, including beneath debris and logs etc.
4. Searching features such as tree trunks and stumps etc.
5. Tussocking: Individual grass tussocks were cut off at their bases and sorted-through using a tray to record invertebrates using that habitat, for example as a refuge).

The fields surveys were conducted in accordance with the Invertebrate Link code of conduct for collecting invertebrates (Invertebrate Link, 2002).

With few exceptions microscopic examination of preserved specimens was required for accurate identification of the invertebrate species. Specimens were therefore killed on site using Ethyl Acetate (the most commonly utilised killing agent). Specimens were then sorted off-site into those requiring preservation in alcohol and those best preserved dry. In order to preserve the integrity of the specimens and data the specimens were transferred for storage into suitable individually labelled containers. Dry specimens were initially preserved in a portable freezer, and subsequently transferred to a dedicated home freezer pending detailed examination.

#### Laboratory Processing of samples

1. Specimens were preserved frozen at -20°C (dry specimens) or in 70% isopropyl alcohol + 5% glycerol (wet specimens). Identification was carried out over the winter of 2018-19.
2. Identifications were carried out using the most current appropriate English language keys (see References and Bibliography) and the surveyor's extensive reference collection.
3. Due to the large number of species of British macro-invertebrates (c. 37,000) input from sub-specialists was required for accurate and reliable identification of some groups. In this survey the spiders, beetles, ants and fungus gnats were identified by reputable specialists, details of whom appear in Table 1.

**Table 1: Specialists who carried out identification of invertebrate specimens for the Preliminary Invertebrate Survey of Bwlch Corog, Ceredigion (2018)**

Taxon	Specialist	Notes
Spiders	Edward Milner	Spider Recorder for Greater London
Beetles	Norman Heal	An acknowledged authority on the group
Ants	Phil Attewell	Ant Recorder for Hertfordshire
Fungus Gnats	Peter Chandler	An acknowledged authority on the group
All other taxa	John Dobson	Consultant Ecologist

4. Specimens were examined and where required dissected using a Leica 6.4-128x zoom stereomicroscope equipped with a Leica LED ring-light and twin Schott LED spots.
5. Specimens were subsequently archived and will be retained for QA purposes for a minimum of one year from the date of the survey.

#### Data Processing

The resulting species records were entered into a spreadsheet in a format compatible with usage by LRCs etc (MNP0296\_BwCo\_Invert\_Spp\_Data\_2018.xlsx).



## Nomenclature

The scientific names of invertebrates follow those recommended on the NBN Atlas (References) which is compliant with the NHM species dictionary (References). Botanical nomenclature follows Stace (2010).

## Sampled Habitats

**Table 2: Summary of sampled habitat types.**

Locations are shown on Map 1 and Photos appear in Appendix 4.

<p><b>Transitional Zone</b> (Photos 9, 10)</p> <p>This term refers in general to edge habitats, where one habitat grades into another. Such areas are frequently found to be hot-spots for invertebrate activity, and may attract invertebrates primarily associated with a wide variety of locally occurring habitats. Familiar examples of transitional zones (ecoclines) might occur for example at woodland- and heathland edges. At Bwlch Corog the selected transitional zone was the pathway running westwards from the main access gate (see Table 3). This area included a range of sub-habitats transitioning between <i>Molinia</i> grassland and off-site scrub and trees. Additional features of potential importance for invertebrates included:</p> <ul style="list-style-type: none"><li>• The relative shelter due to the topography and the adjacent vegetation, giving rise to comparatively still air and local microclimates,</li><li>• Short turf and bare earth habitats on and around the pathway,</li><li>• A relative abundance of nectar- and pollen-bearing flora.</li></ul>
<p><b>Ancient Woodland</b> (Photos 1, 2)</p> <p>An area of Oak (<i>Quercus</i> spp.) dominated woodland (Table 3) which had been designated as ancient based on botanical and historical criteria. The multiple attributes of ancient woodland for invertebrates include not only presence of decaying timber but also other important factors such as the long-term stability of the included habitats.</p>
<p><b>Plantation Woodland</b> (Photos 3, 4)</p> <p>An area of young (c.25-year-old) planted Oak trees (<i>Quercus</i> sp.) situated within the curtilage of the Ancient Woodland (Table 3).</p>
<p><b>Isolated Trees</b> (Photos 16, 17)</p> <p>Trees growing outside of woodland may grow in a more open, spreading habit than those growing within woodland and surrounded by other trees. Open-grown trees also experience a different climate (sun, wind and rain) than woodland trees. For those reasons their invertebrate faunas may differ significantly from woodland trees. In addition, open-grown trees may act as landmarks and assembly points, attracting invertebrates engaged for example in swarming, mate-finding and hunting for prey. Isolated oaks (<i>Quercus</i> sp.) and Ash (<i>Fraxinus excelsior</i>) were sampled during the survey (Table 3).</p>

**Table 2: Summary of sampled habitat types (Continued)**

<p><b>Marsh/Flush</b> (Photos 13, 14 &amp; 15)</p> <p>Flushes are wetland features which occur where water flows relatively slowly across the surface or through the subsurface of soil, where the flow is insufficient to form a channel but sufficient to give rise to distinct habitats. At Bwlch Corog, where there was an increased residence time, the flushing water had sometimes seeped laterally to form localised marshes. These features were typically dominated by rushes (<i>Juncus</i> spp.) and Sphagnum mosses (<i>Sphagnum</i> spp.) along with frequent Deergrass (<i>Trichophorum</i> sp.). See Table 3.</p>
<p><b><i>Molinia</i> (flat with Grip)</b> (Photos 5, 6)</p> <p>These were areas of relatively flat and level Purple Moor-grass (<i>Molinia cerulea</i>) where a grip was present in the sampling area (Table 3). The grips at Bwlch Corog are historically excavated drainage ditches. These represent habitats which are likely to become significantly wetter once the grips have been blocked as part of the habitat restoration plan (see References: Cambrian Wildwood website). During the survey grips were often cryptic features, concealed beneath rank growth of <i>Molinia</i> and other grasses.</p>
<p><b><i>Molinia</i> (slope with Grip)</b> (Photos 7, 8)</p> <p>As above, but areas situated on slopes which, due to the topography are unlikely to become significantly wetter once grip blocking has taken place (Table 3).</p>
<p><b>Riparian Zone</b> (Photos 11, 12)</p> <p>Riparian zones are bankside habitats which are influenced to some degree by the adjacent water body. At Bwlch Corog sampling was carried out on grassland and scrub within c.4m of a fast-flowing stream (Table 3).</p>

**Table 3: Dates locations and of invertebrate sampling.**

Note that in some instances different examples of these habitats were selected for sampling during each seasonal survey (Table 3, Map 1).

Date	Habitat	Location	Notes
28 May 2018	[Hillside stream]	SN 739 960	Reconnaissance visit (casual sampling)
28 May 2018	Transitional Zone	SN 74195 96003- SN 73968 96280	Reconnaissance visit (casual sampling)
29 May 2018	Ancient Woodland	SN 74026 96347	Spring Survey
29 May 2018	Marsh/Flush	SN 73953 96424	Spring Survey
29 May 2018	Transitional habitat	SN 74195 96003- SN 73968 96280	Spring Survey
31 May 2018	Molinia (flat with Grip)	SN 73599 96086	Spring Survey
31 May 2018	Isolated trees	SN 74029 96115	Spring Survey
31 May 2018	Molinia (slope with Grip)	SN 73735 96245	Spring Survey
31 May 2018	Riparian Zone	SN 73843 96313	Spring Survey
31 May 2018	Transitional habitat	SN 74195 96003- SN 73968 96280	Spring Survey
10 July 2018	[Between Molinia and Marsh/Flush samples]	SN 737 959	Summer Survey (casual sampling)
10 July 2018	Marsh/Flush	SN 73745 96260	Summer Survey
10 July 2018	Molinia (flat with Grip)	SN 73531 95472	Summer Survey
10 July 2018	Molinia (slope with Grip)	SN 73479 95516	Summer Survey
10 July 2018	Isolated trees	SN 73919 96290	Summer Survey
12 July 2018	Transitional habitat	SN 74195 96003- SN 73968 96280	Summer Survey
12 July 2018	Ancient Woodland	SN 74053 96292	Summer Survey
12 July 2018	Plantation Woodland	SN 74036 96237	Summer Survey
10 October 2018	Molinia (flat with Grip)	SN 73579 96289	Autumn Survey
10 October 2018	Molinia (slope with Grip)	SN 73689 96250	Autumn Survey
10 October 2018	Isolated trees	SN 73927 96290	Autumn Survey
10 October 2018	Marsh/Flush	SN 73744 96258	Autumn Survey

**Table 4: Summary of weather condition during the survey.**

Date	Cloud cover %	Wind (Beaufort)	Notes
29 May 2018	60-80	4; 2 later	Acceptable
31 May 2018	95-100	3-5	Suboptimal
10 July 2018	50	2-3, gusting 4	Acceptable
12 July 2018	100	1-2	Suboptimal. Rain in the afternoon
9 October 2018	Vegetation wet due to rain on 8 October; survey postponed to 10 October		
10 October 2018	15	5-6	Suboptimal. Sampling confined to sheltered areas due to wind
11 October 2018	Raining, and vegetation wet from the outset: survey abandoned.		

### Pantheon Analysis

Pantheon analysis (Webb *et al.* 2017) was carried out in order to gain a detailed overview of the habitat and resource dependencies of the recorded invertebrate fauna.

Pantheon is a database tool developed by Natural England and the Centre for Ecology & Hydrology to analyse invertebrate sample data. The analyses supported by Pantheon improve understanding of the resources and structures used by invertebrates within the sample locations and thus aids their conservation (Webb *et al.* 2017, and BRC/Pantheon website).

Lists of invertebrates (called “samples”) are imported into Pantheon, which then analyses the sample, attaching associated habitats and resources, assemblage types, conservation status, habitat fidelity scores and other information against them. The analysis then displays a lot of this data as numerical scores. This information can be used to determine site quality by revealing whether the species list is indicative of good quality habitat, inform on species ecology and assist in management decisions by revealing the key ecological resources. Pantheon also helps to establish a shared terminology for describing invertebrate interest which greatly augments invertebrate nature conservation.

Not all macro-invertebrate taxa are included in the database. At the time of these analyses, c.13,000 species have been typed, this being about a quarter of the total macro-invertebrate fauna of the British Isles (estimated at 37,000). It remains limited to those taxa and families where there is enough ecological information to give a fair level of coding accuracy. These include species such as beetles, flies, true bugs, moths, bees and many more. Pantheon focuses primarily on the invertebrate fauna of England.

The outputs of Pantheon analysis include a range of data fields, the following of which are included in this report:

- Analysed category
- A total count of species in each category.
- The number of species represented in each category which have a conservation status.
- Percentage Representation: The number of species belonging to each category as a percentage of the total number of coded species belonging to each category.
- SQI (Species Quality Index): The total of the Species Quality Scores (SQS) in a sample, divided by the total number of species in the sample (see Glossary).
- The number of species with a conservation status; and a list of those statuses (Glossary: Appendix 5).

Specific Assemblage Types (SATs) are also included in the outputs. These are the lowest hierarchical divisions, and provide granular data which is used primarily for Condition Assessment of SSSIs. For that reason, SATs are not discussed further in this report.

Individual species may be classified under more than one category in accordance with different stages of their life histories, and thus may appear in more than one category in the analysis tables in this report.

The survey data was analysed using Pantheon Version 3.7.6.

### **Health & Safety**

A risk assessment was carried out prior to the field survey in accordance with normal good practice (Appendix 6). Lone working was not a factor as the surveyor was accompanied by an experienced hill walker at all times.

### 3. LIMITATIONS OF SURVEY

**Limitations of Sampling:** No traps or lures were deployed during the survey as per the Method Statement. Taxa whose habits render them susceptible to capture by sweeping, hand netting and manual searches of substrates are therefore significantly more strongly represented in the outcomes than those which are better sampled by other means. Examples of under-sampled faunal elements are nocturnally active or otherwise cryptic epigeic species of Ground Beetles (Carabidae) and Rove Beetles (Staphylinidae), where pitfall trapping would be a preferred recording method.

**Weather.** Suboptimal weather conditions generally lead to reduced invertebrate activity and therefore sampling efficiency. Examples of these include; overcast conditions, windy and gusty conditions, rain and wet vegetation due to previous rain. For example, extensive cloud cover not only reduces overall invertebrate activity but also restricts their diurnal period of activity, which can effectively limit the recording window to say mid-morning to mid-afternoon. The weather conditions encountered during the survey are summarised in Table 4.

**Time Limitations and Access.** In order to achieve the sampling target of four habitats per day it was necessary to minimise the time taken to access the sampling locations from the site entrances at the north end of the site. For this reason, the habitats selected for sampling were all located in the northern area of the site. These sampling sites are shown in Map 1 and Table 3.

**Low Species Acquisition Ratios.** When a subsite is sampled *ad lib*, on any particular day the acquisition of new species tends to fall with time, as a greater proportion of the catch eventually comprises duplicates of species already taken (diminishing returns). One measure of survey efficiency, the species acquisition ratio, is obtained by dividing the total number of identified specimens by the total number of identified species. In the current survey these ratios are generally around 0.5 (Table 5) i.e. only half the specimens were duplicate species. This indicates that additional sampling time would have almost certainly resulted in a significant increase in the number of recorded taxa, providing a more thorough representation of each subsite's invertebrate biodiversity. These ratios merely provide a rough indication of the comprehensiveness of the survey, and do not distinguish between multiple influencing factors such as the weather, time spent collecting and the intrinsic biodiversity of a site, although the latter is discounted here as a negative factor due to the quality and extent of the habitats present.

**Table 5: Species acquisition ratios (SAR) as indicated by the number of identified species as a proportion of the number of identified specimens for each sampled habitat type.**

Sampled Habitat	Total number of identified specimens (A)	Total number of identified species (B)	SAR (B/A)
Transitional Habitat	206	115	0.558
Riparian Zone	60	29	0.483
Plantation woodland	59	53	0.530
Ancient Woodland	100	21	0.355
Marsh/Flush	104	53	0.509
Molinia (slope with Grip)	90	50	0.555
Molinia (flat with Grip)	84	49	0.583
Isolated trees	28	21	0.750
<b>TOTALS</b>	<b>731</b>	<b>391</b>	<b>Average = 0.534</b>

**Identifications.** In a few cases, specimens could not be identified to species with the requisite high degree of confidence. This is a circumstance routinely encountered in invertebrate identification, and may be due to the sex of a specimen (where for example only males can be identified with certainty), the condition of a specimen, its immaturity, or where it is a member of an intrinsically critical taxon or species aggregate. The 18 taxa falling into this category are annotated in a dedicated field (Provisional Determination) in the accompanying spreadsheet (MNP0296\_BwCo\_Invert\_Spp\_Data\_2018.xlsx). For the purpose of Pantheon analyses it has been assumed that these determinations are correct.

**Pantheon Analysis (1).** Samples for Pantheon analysis should ideally be collected using a structured, formal and comprehensive sampling regime. The sampling carried out for this survey was therefore non-compliant in that respect, and the results of the Pantheon analysis should be assessed in that light.

**Pantheon Analysis (2).** Pantheon was designed specifically for analysing species lists resulting from surveys carried out in England. The surveyor is not aware however of any reason why that limitation should impact significantly on the current analyses of Welsh material.

## **4. RESULTS**

### **Species Data**

Following completion of the field surveys c.750 specimens were examined of which c.730 were identified. These resolved to c.470 species records comprising c.281 species/species aggregates. The uncertainty over the number of species arises from a small number of provisional determinations. In addition, not all species are categorised by Pantheon (see Methods) and do not appear in the analysis tables in this section.

The full records are included in the accompanying spreadsheet which also includes notes on the status and ecology of each taxon: (MNP0296\_BwCo\_Invert\_Spp\_Data\_2018.xlsx). The spreadsheet also includes a checklist of the recorded species and a breakdown by Order of the survey yield.

Moths (Lepidoptera-Heterocera) were excluded from the survey as agreed in the Method Statement: see Methods; Taxonomic Scope.

### **Designated Species**

Species accounts of taxa which are designated in the UK due to their scarcity and/or decline are set out in Table 6.



**Table 6: Species with national designations due to their scarcity/decline** (Glossary: Appendix 5).

Species	Record(s)
<i>Coenonympha pamphilus</i> (Small Heath Butterfly)	Transitional Habitat, 29 May 2018. Molinia slope, 31 May 2018
<b>Near Threatened</b> (Fox et al., 2010). Species of Principal Importance in Wales (Section 42, NERC, 2006). A widespread butterfly which has declined significantly, and which lost over half its UK population and colonies between 1976 and 2014. In the latter years of this period there may have been a slight recovery in its populations, while the number of colonies continued to decline (UK Butterflies). The adults show a preference for areas of short sward and bare soil. The larvae feed on a range of grasses including Bents ( <i>Agrostis</i> spp.), Fescues ( <i>Festuca</i> spp.) and Meadow-grasses ( <i>Poa</i> spp.). It overwinters as a larva.	
<i>Ephemerella notata</i> (Yellow Hawk Mayfly)	Riparian Zone, 31 May 2018
<b>Nationally Scarce</b> (Macadam, 2016). The adults swarm at dusk and breed in streams and rivers where the larvae are found among stones, gravel and submerged vegetation. There is one generation per year and the adults emerge in May-June. An uncommon and local species which has extended its range northwards in recent decades (Macadam and Bennett, 2010).	
<i>Dolichopus phaeopus</i> (A Long-legged Fly)	Transitional Zone, 12 July 2018
<b>Nationally Scarce</b> (Drake, 2018). A widespread but very patchily distributed fly found mainly in western upland Britain and a few in southern England and East Anglia. A wetland species found in hill-side seepages, acid to base-rich mires, and well-vegetated margins of ponds and ditches on grazing marsh. There may be an association with peat soils. There is no indication of a change in its distribution	
<i>Pterostichus anthracinus</i> (A Ground Beetle)	Ancient Woodland, 29 May 2018
<b>Nationally Scarce</b> (Telfer, 2016). A scarce and local Ground Beetle of marshy habitats whose populations are likely to suffer from habitat fragmentation. A particularly local species in Wales (Duff, 2012).	
<i>Dactylolabis transversa</i> (A Short-palped Crane fly)	Ancient Woodland, 29 May 2018
<b>Nationally Notable</b> (Falk, 1991). An uncommon crane fly often associated with wet rocks.	
<i>Diogma glabrata</i> (A Long-bodied Crane fly)	Plantation Woodland, 12 July 2018
<b>Nationally Notable</b> (Falk, 1991). A scarce and local crane fly of damp woodlands where the larvae live in mosses.	
<i>Eloeophila trimaculata</i> (A Short-palped Crane fly)	Hillside Stream, 28 May 2018 (reccé visit). <i>Molinia</i> slope with grip, 31 May 2018.
<b>Nationally Notable</b> (Falk 1991; as <i>Limnophila trimaculata</i> ). A scarce crane fly found mainly around peaty upland streams.	
<i>Tasiocera robusta</i> (A Short-palped Crane fly)	Ancient Woodland, 29 May 2018. Open-grown Trees ( <i>Quercus</i> sp.), 31 May 2018
<b>Nationally Notable</b> (Falk 1991). A tiny and scarce species of woodland crane fly, whose life-history is unknown.	
<i>Tricyphona unicolor</i> (A Hairy-eyed Crane fly)	Marsh/Flush, 29 May 2018
<b>Nationally Notable</b> (Falk, 1991; as <i>Pedicia unicolor</i> ). A very uncommon crane fly of upland bog habitats.	

### Uncommon and local Species

The following undesignated species are selected here for further treatment due to their regional scarcity or localised distribution (Table 7).

Local species are generally of conservation concern as the limited extent of suitable habitat at a site may render them vulnerable to local extinctions.

**Table 7: Undesignated scarce and local species recorded by the survey.**

Species	Record(s)
<i>Silometopus elegans</i> (A Spider)	Molinia (slope with Grip), 10 October 2018
An uncommon money spider of northern and western heathland.	
<i>Cercyon terminatus</i> (A Beetle)	Transitional Habitat, 12 July 2018
A scarce and local beetle, often in dung, and this record was from horse dung.	
<i>Anaspis rufilabris</i> (A False Flower Beetle)	Transitional Habitat, 29 May 2018. Molinia (flat with Grip), 31 May 2018
An uncommon and local False Flower Beetle which breeds in decaying timber.	
<i>Quedius curtipennis</i> (A Rove Beetle)	Transitional Habitat, 29 May 2018
A widespread but very local Rove Beetle; mainly lowland but scarcer in upland habitats.	
<i>Chelifera preclatoria</i> (An Empid Fly)	Molinia (slope with Grip), 31 May 2018
A local predatory fly; it has been suggested that the larvae may live in fast-flowing watercourses.	
<i>Rhamphomyia stigmata</i> (An Empid Fly)	Riparian Zone, 31 May 2018
An uncommon and local predatory fly, mainly in upland habitats.	
<i>Ornithomya chloropus</i> (A Ked Fly)	Molinia (flat with Grip), 10 July 2018
A highly modified bird parasite. Uncommon and more-or-less confined to uplands and offshore islands. It is probably under-recorded.	
<i>Sericomyia lappona</i> (A Hoverfly)	Molinia (slope with Grip), 31 May 2018
A very local hoverfly of boggy heathland habitats.	
<i>Tachina grossa</i> (A Parasitoid Fly)	Transitional Habitat, 12 July 2018
A very large and distinctive fly with a black bristly body and yellow head, which may therefore come to the attention of non-entomologists. Very local in occurrence in heathland and open woodland habitats where its larvae attack the larvae of Lasiocampid moths.	
<i>Cixius simplex</i> (A Plant-hopper)	Transitional Habitat, 12 July 2018
A local and rather uncommon plant-hopper which is associated with a variety of habitats includes woodland and saltmarshes.	
<i>Dicranophragma separatum</i> (A Short-palped Crane fly)	Ancient Woodland and Marsh/Flush, 29 May 2018
An uncommon crane fly of upland peaty habitats.	
<i>Euphyllidorea aperta</i> (A Short-palped Crane fly)	Marsh/Flush, 10 July 2018
An uncommon crane fly associated with flushes.	
<i>Euphyllidorea phaeostigma</i> (A Short-palped Crane fly)	Molinia (slope with Grip) and Riparian Zone, 31 May 2018
An uncommon crane fly; perhaps associated with boggy ground with Cottongrasses ( <i>Eriophorum</i> spp.) and Deergrasses ( <i>Trichophorum</i> spp.).	

*Continued*

**Table 7: Undesignated scarce and local species recorded by the survey (Continued).**

<i>Gonomyia dentata</i> (A Short-palped Crane fly)	Ancient Woodland, 29 May 2018
A local crane fly of wet upland habitats.	
<i>Molophilus occultus</i> (A Short-palped Crane fly)	Molinia (flat with Grip), 10 July 2018
An uncommon crane fly which is restricted to acid bogs.	
<i>Molophilus undulatus</i> (A Short-palped Crane fly)	Ancient Woodland, 29 May 2018
A local crane fly of woodland with stream margins.	
<i>Neolimnomyia filata</i> (A Short-palped Crane fly)	Ancient Woodland, 29 May 2018. Riparian Zone, 31 May 2018
A local crane fly of wet woodland habitats.	
<i>Pedicia occulta</i> (A Hairy-eyed Crane fly)	Hillside stream, 28 May 2018. Marsh/Flush, 29 May 2018
An uncommon crane fly normally associated with streams.	
<i>Pedicia rivosa</i> (A Hairy-eyed Crane fly)	Marsh/Flush, 29 May 2018
A local species of wetland crane fly. This large and distinctive species with patterned wings may draw the attention of non-entomologists.	
<i>Tricyphona schummeli</i> (A Hairy-eyed Crane fly)	Hillside stream, 28 May 2018. Marsh/Flush, 29 May 2018. Riparian Zone, 31 May 2018
An uncommon crane fly of bog habitats.	
<i>Tipula variicornis</i> (A Long-palped Crane fly)	Marsh/Flush, 29 May 2018
A very local 'daddy long-legs' crane fly, particularly associated with wet woodland.	

### Analysis of Records of Designated, and Scarce and Local Species

The numbers of designated and scarce species recorded within each of the sampled habitats is shown in Table 8.

This table is indicative and not objective due the differing survey effort between the selected areas (Table 3).

**Table 8: Designated scarce and local species recorded by the survey: Associations with sampled habitats.**

Sampling Habitat	No. of Designated & Scarce & Local spp.
Marsh/Flush	8
<i>Molinia</i> (slope with Grip)	8
Ancient Woodland	7
Transitional Habitat	7
Riparian Zone	5
<i>Molinia</i> (flat with Grip)	3
Hillside Stream/Flush (reconnaissance visit)	3
Open-grown Trees	1
Plantation Woodland	1

### Pantheon Analysis

See Methods for background on Pantheon.

### Broad Biotopes

Broad Biotopes sit at the top of the hierarchical analysis provided by Pantheon, and the recorded invertebrate fauna at Bwlch Corog falls into four of these Broad Biotopes (Table 9). Note that Pantheon has not ascribed Broad Biotopes to all taxa recorded by the survey.

**Table 9: Pantheon Analysis of the Broad Biotopes utilised by invertebrates recorded at Bwlch Corog.**

Broad biotope	No. of species	SQI	Species with conservation status	Conservation statuses
<b>Open Habitats</b>	109	103	2	S42 Priority Species, NT, Notable #2
<b>Tree-associated</b>	68	119	4	Notable # 4
<b>Wetland</b>	66	127	7	Notable # 4, NS #3
<b>Coastal</b>	1	100	0	-

The conservation statuses of each designated species are set out in Table 6, as they appear in the most recent taxon-based reviews of scarce and threatened species of the British Isles (JNCC etc., various dates).

## Habitat Assemblages

The Pantheon hierarchy divides each Broad Biotope into a series of Habitats, and Table 10 sets out the analysis of these Habitat assemblages for the species analysed by Pantheon.

**Table 10: Results of the Pantheon Analysis of invertebrate Habitat assemblages at Bwlch Corog.**

Broad biotope	Habitat	No. of species	SQL	Species with conservation status	Conservation status
<b>Open Habitats</b>	Tall Sward & Scrub	87	103	1	Notable
<b>Tree-associated</b>	Shaded Woodland Floor	44	130	4	Notable #4
<b>Wetland</b>	Peatland	30	110	1	NS
<b>Wetland</b>	Running Water	24	150	4	NS, Notable #3
<b>Wetland</b>	Marshland	20	115	2	Notable, NS
<b>Tree-associated</b>	Decaying Wood	15	100	0	-
<b>Tree-associated</b>	Wet Woodland	14	143	2	Notable #2
<b>Wetland</b>	Wet Woodland	14	143	2	Notable #2
<b>Open habitats</b>	Short Sward & Bare Ground	10	100	1	S42 Priority Species, NT
<b>Tree-associated</b>	Arboreal	10	100	0	-
<b>Open Habitats</b>	Upland	2	100	0	-
<b>Coastal</b>	Saltmarsh	1	100	0	-
	<b>TOTAL</b>	<b>257</b>			

Note that species associated with the Wet Woodland assemblage are placed by Pantheon in both Wetland and Tree-associated broad biotopes, and the species total has been adjusted accordingly.

Natural England treat an SQL score (Species Quality Index; see Glossary) of 150 as an approximate threshold corresponding to a 'good' site supporting a regionally important invertebrate fauna. SQLs are invalid for assemblages of <15 species. Assemblages with values below that are included here for information, but the associated SQLs are invalid.

## Feeding Guilds

Table 11 shows the feeding guilds represented by the species data arising from the survey. The feeding habits of the adults and larvae of each species may differ markedly, and each resource must be present for a population of a species population to be viable at a site. Pantheon returned data on the adult feeding guilds of 213 species and on the larval feeding guilds of 220 of the recorded species.

**Table 11. Feeding guilds of species recorded at Bwlch Corog**

Stage	Guild	No. of species	% return
adult	predator	77	29
adult	nectivore	45	17
adult	does not feed	39	14
adult	saprophagous	23	8
adult	herbivore	20	7
adult	phytosaprophagous	6	2
adult	haematophagous	1	0
adult	does not feed?	1	0
adult	unknown	1	0
larva	predator	96	36
larva	saprophagous	63	24
larva	herbivore	40	15
larva	nectivore	8	3
larva	parasitoid	6	2
larva	xylophagous	2	0
larva	fungivore	2	0
larva	necrophagous	1	0
larva	coprophagous	1	0
larva	algivore	1	0

**Table 12 shows the feeding guilds of the subset of designated local and uncommon species.**

Stage	Guild	No. of species	% return
adult	does not feed	17	56
adult	predator	7	23
adult	nectivore	2	6
larva	saprophagous	17	56
larva	predator	8	26
larva	herbivore	2	6

### Pantheon Analysis of selected Sampling Habitats

The recorded invertebrate fauna of two of the sampled habits were analysed further. This was primarily to illustrate that many motile invertebrates are not strictly spatially confined by their resource dependencies, and in addition that even relatively uniform sampling areas are generally heterogenous to some degree to invertebrates, and thus may support species with a range of dependencies. These two factors are contributory to Tables 13 and 14 but are not analysed further on the basis of available data.

### Transitional Habitat

Areas where adjacent habitats merge may be of particular value to invertebrates. These may comprise structurally simple ecoclines or as in this case a more complex structural mosaic including multiple ecoclines (photos 9 and 10) (Tables 13 and 13a.). The north path (Map 1) was selected for sampling as an example of (a complex of) transitional habitats during the reconnaissance visit on 28 May 2018, as a good quality and extensive example of this habitat type.

**Table 13: Transitional Habitat species Broad Biotopes and Habitats**

Broad Biotope	Habitat	No. of Species	SQI	Species with Conservation Status	Conservation Status
Open Habitats	Tall Sward & Scrub	47	100	1	Notable
Tree-associated	Shaded Woodland Floor	13	100		
Wetland	Peatland	11	127	1	NS
Tree-associated	Decaying Wood	7	100		
Wetland	Marshland	7	100	1	Notable
Wetland	Wet Woodland	4	100		
Open Habitats	Short Sward & Bare Ground	4	100	1	NT, S42 Species
Tree-associated	Wet Woodland	4	100		
Tree-associated	Arboreal	3	100		
Wetland	Running Water	3	100		
Coastal	Saltmarsh	1	100		

**Table 13a: Summary table showing the number of species recorded from Transitional Habitat associated with each of the Broad Biotopes represented.**

Broad biotope	Habitat	No. of species
Open Habitats	All	51
Tree-associated	All	27
Wetland	All	25

Table 10 shows that 115 (42%) of the 270 species recorded during the survey were recorded from the Transition Habitat (although several not exclusively from that Sampling Habitat). Of these 115 species, 104 were analysed by Pantheon. 51 of those species were associated with the Broad Biotope Open Habitats. The remaining 53 species (51%) were associated with 9 Habitats, the latter divided more-or-less equally between the Tree-associated Broad Biotope (27 spp.) and Wetland (25 spp.).

### ***Molinia* grassland with Grips**

One of the aims of this survey was to examine the invertebrate faunas of *Molinia* grassland in the vicinity of Grips, in advance of their being dammed/filled-in in line with the habitat restoration project. Areas adjacent to Grips running through flat *Molinia* grassland were likely to be subject to flooding and conversion to wetland habitat following the planned works. Areas adjacent to Grips running through sloping *Molinia* grassland were however not thought to be susceptible to flooding due to accelerated run-off in those circumstances. Pantheon analysis of the Broad Biotores and Habitat Associations of the invertebrate faunas in these areas was therefore carried out prior to commencement of works in order to provide an assessment of the relative contributions of wetland and grassland invertebrate faunas at this stage. The results of analysis of the combined species data from the sampling habitats *Molinia* (flat with Grip) and *Molinia* (slope with Grip) are set out in Tables 14 and 14a.

**Table 14: Broad Biotores and Habitat Association of species recorded from *Molinia* grassland with Grips.**

Broad biotope	Habitat	No. of species	SQI	Species with conservation status	Conservation status
Open Habitats	Tall Sward & Scrub	32	100		
Open Habitats	Short Sward & Bare Ground	4	100	1	S42 sp. NT
Open Habitats	Upland	1	100		
Wetland	Peatland	15	100		
Wetland	Marshland	8	100		
Wetland	Running Water	6	150	1	Notable
Wetland	Wet Woodland	2	100		
Tree-associated	Shaded Woodland Floor	8	100		
Tree-associated	Decaying Wood	2	100		
Tree-associated	Wet Woodland	2	100		
Tree-associated	Arboreal	1	100		

**Table 14a: Summary table showing the number of species recorded from *Molinia* grassland with Grips associated with each of the Broad Biotores represented.**

Broad biotope	Habitat	No. of species
Open Habitats	All	37
Wetland	All	31
Tree-associated	All	13

Table 14a shows that the majority of the fauna recorded from the *Molinia* habitats was more-or less evenly split between Open Habitats (37 spp.) and Wetland (31 spp.). Almost all of the Open Habitat species were associated with Tall Sward & Scrub. The Wetland Species however included significant faunas associated with each of Peatland, Marshland and Running Water.



## 5. DISCUSSION

### The recorded taxa

Approximately 750 specimens of invertebrates were examined of which c.730 were identified. These resolved to c.470 species records comprising c.281 species/species aggregates.

Of these 281 taxa, 241 were associated with broad biotopes by Pantheon analysis (Table 9). Open habitats were represented by 109 species; 68 tree-associated species and 66 wetland species were present, and a single coastal species was recorded.

Table 10 shows a breakdown of the representation of invertebrate habitat assemblages among these broad biotopes. As might be expected at the site, a large majority of the open habitat species were associated with tall sward and scrub. Most of the tree-associated species were associated with shaded woodland floor, the remainder being distributed fairly evenly between other tree-associated assemblages. The wetland species were again distributed among the 4 represented wetland habitat assemblages. The single coastal species was associated with the saltmarsh assemblage.

9 species were designated due to their scarcity and/or national decline (Table 6). A further 21 species are highlighted by this report as scarce and local species (Table 7) which should therefore be included in management considerations, and some of which could be subject to scarcity designations in the future.

The origins of these designated and scarce species among the 8 sampled habitats is set out in Table 8. It can be seen that 5 of these habitats had a reasonable representation (5 to 8 species) of scarce/local species, whilst these were poorly represented (1 to 3 species) in the remaining 3 habitats: *Molinia* (flat with Grip), open-grown trees and plantation woodland.

In addition, the species accounts of designated species (Table 6) and of scarce and local species (Table 7) indicate that 6 of the 9 designated species and 11 of the 21 scarce and local species are associated with wetland habitats occurring in upland and open situation. The populations of most of these species are therefore likely to benefit from the blocking of the grips and subsequent expansion of wetland habitats. The populations of those wetland species associated with running water could however be negatively impacted.

It can be seen from Tables 6 and 7 that 5 of the 9 designated species and 11 of the 21 scarce/local species were craneflies. During overcast or windy conditions, cranefly species often perch on or among low vegetation and scrub, rendering them particularly susceptible to capture through sweep netting. The usage of records of wetland craneflies as a proxy for the quality assessment of wetland Diptera at a site has been advocated in the past by a number of British authorities. Studies in other countries have however not generally supported that hypothesis (e.g. Salmela, 2011).

The feeding guilds of the adults and larvae of all species recognised by Pantheon are shown in Table 11, while those of the designated and uncommon species which were recorded are listed in Table 12. These tables are provided for comparative purposes; e.g. with other sites or with the current site following the planned landscape-scale management (Wales Wild Land Foundation, 2017).

Tables 13 and 14 show more detailed breakdowns of the habitat assemblages recorded from examples of the sampled habitats: the transitional zone, and *Molinia* grassland with grips (flat- and sloping are combined in this example). Coincidentally, both sampled habitats yielded invertebrates associated with 10 habitat assemblages, although many of these were represented by low numbers of species. These data exemplify a

basic tenet of invertebrate recording; that motile species are frequently recorded away from their associated habitats, and conversely that recording the presence of a species within a habitat does not demonstrate an association between the two.

## Survey Yield

Considering the extent of the survey, the yield of 750 specimens and c.281 species were lower than might have been expected. Much of the low yield can be ascribed to the weather conditions which were never 'good' or 'favourable', but 'suboptimal' or at best 'acceptable' throughout the surveys (See Limitations of Survey and Table 4).

It is noteworthy that no Orthoptera (grasshoppers & crickets) were recorded, either by capture of specimens or through their songs, which were not heard by the surveyor. A number of widespread species would be expected to be common in the site's habitats and the absence of records is ascribed to the dull and generally unfavourable weather. Similarly, an extremely low number of species (16) of aculeate Hymenoptera (bees, wasp and ants) were recorded (see spreadsheet), including only one species of solitary wasp and none of the common social wasps. This is also ascribable to- and indicative of the unfavourable weather.

Another contributory factor was the low invertebrate harvest from certain of the sampled habitats (Table 5) for example, the particularly low yield of 21 species from the isolated trees. The low yield of species in the ancient woodland samples (21 species) compared to that from the plantation woodland (53 species) is unexplained, although it is thought likely to be related to the increased accessibility of the tree canopy to the sweep net among the smaller trees in the plantation woodland. It is also noted that the plantation woodland comprised a relatively small area nested within a large area of ancient woodland. Considering the predominantly motile faunas sampled by hand-net and pooter, the sampling was unable to discriminate between the faunas intrinsic to each of these habitats. In such circumstances, habitat associations are most effectively resolved through Pantheon analysis of species data.

The riparian zone habitat was in fact quite productive, and the low number of species (29) an artefact as it was sampled on only one occasion due to weather conditions (Table 4).

The low to moderate yield from the densely-growing and uniform *Molinia* grassland at the site is thought likely to be a genuine reflection of its invertebrate diversity at the time of the survey (although see the comments above on the influence of weather). *Molinia* grassland can be highly productive for invertebrates, although such good quality habitats generally comprise a fine mosaic of grassland, flowering plants, bare earth and perhaps multiple small wetland features. In contrast, large areas of the *Molinia* grassland at the site comprised a near monoculture of dense *Molinia* tussocks. It is intended that the current program of horse-grazing will substantially enhance the mosaic content of the *Molina* grassland, with consequent benefits to its invertebrate fauna.

## Species Acquisition Ratios

These are shown in Table 5 and defined in the paragraph preceding the table. In the current survey these ratios are broadly around 0.5. That is to say that only around half of the specimens recorded were duplicate species. This indicates that additional sampling time in each of these habitats would have almost certainly resulted in a significant increase in the number of recorded taxa, providing a more thorough representation of each subsite's invertebrate biodiversity. This ratio would progressively fall with additional survey effort; for example, to 0.1, at which point one in ten identified species would be new to the sample.

## 6 RECOMMENDATIONS

### Recommendations for Site Management

In view of the fully developed 5-year management plan for the period 2017-2022 (Wales Wild Land Foundation, 2017), site management recommendations which would normally be included in a survey report of this kind, were specifically excluded by the client (Simon Ayres, pers. comm.) and so do not appear in this report.

The site's invertebrate fauna as recorded in this and any other sources, and in particular their resource requirements, should be taken closely into account in the development of future revisions and iterations of the management plan.

### Recommendations for Further Survey

Following the current tranche of landscape-scale management, and following a suitable period for the invertebrate fauna to respond to the subsequent changes to habitats and resource availability, a repeat survey is planned with the aim of documenting those changes (Simon Ayres, pers. Comm.).

Considering two aspects of the current survey (see Discussion):

1. The samplings of isolated trees using a hand net and pooter were particularly unproductive of invertebrate fauna (Table 5).
2. The plantation woodland comprised a relatively small area nested within a large area of ancient woodland. Considering the predominantly motile faunas sampled by hand-net and pooter, the sampling was unable to discriminate between the faunas intrinsic to each of these habitats.

Considering also that the allocated sampling time (four habitats per day) has been demonstrated to be insufficient for thorough sampling (Discussion: Species acquisition ratios).

It is therefore proposed that in a repeat survey, the habitat 'isolated trees' should be excluded from the sampling. In addition, it is proposed that the habitats 'ancient woodland' and 'plantation woodland' should be sampled as a single habitat 'woodland'.

These measures would tend to focus the sampling, and by reducing the number of habitats to be sampled from 8 (4 per day) to 6 (3 per day) would allow additional sampling effort in each of the selected habitats.

Certain invertebrate faunas were excluded or under-sampled by the current survey. Moths (Lepidoptera-Heterocera) were excluded in the Method Statement. It is recommended therefore that moth trapping should be carried out at the site where the opportunity presents itself. In addition, no sampling of the aquatic invertebrates inhabiting open-water habitats in the grips and streams was undertaken, and this deficit should be addressed at a future date.

In addition, the current survey included no trapping (see Method Statement). This would have had the effect of under-sampling certain invertebrate faunas, in particular ground-dwelling (epigeic) taxa, and saproxylic invertebrates. In order to address these deficits, It is therefore recommended that a program of trapping should be carried out at the site when the opportunity arises, in particular using pitfall traps and vane traps.

As a general consideration, the current survey represents a relatively low-intensity survey of a very large site, and therefore provides only a preliminary snapshot of its invertebrate fauna. All opportunities for additional reliable invertebrate surveys should therefore be taken-up, continuing into the long-term future.

## 7 REFERENCES & BIBLIOGRAPHY

- Archer, M.E. (2014). The Vespid Wasps (Tiphidae, Mutillidae, Sapygidae, Scoliidae and Vespidae) of the British Isles. Handbooks for the Identification of British Insects. 6 (6). Royal Entomological Society, St. Albans.
- Assis-Fonseca, E.C.M. D'. (1978). Diptera Orthorrhapha, Brachycera. Dolichopodidae. Handbooks for the Identification of British Insects. 9 (5). Royal Entomological Society, London.
- Ball, S.G. (2007). Key to the British Scathophagidae (Diptera). V3.1. Unpublished draft.
- Barber, A.D. (2008). Key to the identification of British Centipedes. Field Studies Council, Shrewsbury.
- Belshaw, R. (1993). Tachinid Flies: Diptera: Tachinidae. Handbooks for the Identification of British Insects. 10 (4a(ii)). Royal Entomological Society, London.
- BRC (Biological Records Centre)/Pantheon Website: <https://www.brc.ac.uk/pantheon/>
- Brusca, R.C., Moore, W., Shuster, S.M. (3rd Edn., 2016). *Invertebrates*. Sinauer Associates Inc. Publishers. Sunderland, Massachusetts U.S.A.
- Buglife. <https://www.buglife.org.uk/resources/habitat-management/purple-moor-grass-and-rush-pastures-culm-grassland-devon-and-cornwall/>
- Cambrian Wildwood website. <https://www.cambrianwildwood.org/our-land-bwlch-corog>.
- Cameron, R. (2003). Land Snails in the British Isles. Field Studies Council.
- Chandler, P.J. (1986). The British species of *Diastata* Meigen and *Campichoeta* Macquart (Diptera: Drosophilidae). Proceedings and Transactions of the British Entomological and Natural History Society. 19: 9-16.
- Chandler, P.J. (1990). Notes on *Macrocera meigen* (Mycetophilidae, Keroplatidae) including *M. nigropicea* Lundström new to Britain. Dipterists Digest 3: 27-31.
- Collin, J.E. (1948). A short synopsis of the British Saproxyzidae (Diptera). The Transactions of the Royal Entomological Society of London. 99 (5): 225-242.
- Collin, J.E. (1961). British Flies: Volume 6; Empididae. Cambridge University Press.
- Drake, M. (1993). A review of the British Opomyzidae (Diptera). British Journal of Entomology and Natural History 6: 159-176.
- Drake, C.M. (2018). A review of the status of the Dolichopodidae flies of Great Britain - Species Status No.30. Natural England Commissioned Reports, Number195.
- Duff, A.G. (2012). Beetles of Britain and Ireland. Volume 1: Sphaeriidae to Silphidae. A. G. Duff Publishing, West Runton, Norfolk.
- Duff, A. G. (2016). Beetles of Britain and Ireland. Volume 4: Cerambycidae to Curculionidae. A. G. Duff Publishing, West Runton, Norfolk.
- Else, G.R. and Edwards, M. (2018). Handbook of the Bees of the British Isles (Vols. 1 & 2). The Ray Society, London.

- Falk, S. (1991). A review of the scarce and threatened flies of Great Britain (part1). Research & Survey in Nature Conservation, number 39. NCC.
- Falk, S.J. (Undated). A Revised Key to British *Minettia* (Diptera: Lauxaniidae) incorporating *M. Desmometopa* (De Meijere, 1907). Unpublished Draft.
- Fox, R., Warren, M.S., and Brereton, T.M. (2010). A new Red List of British Butterflies, Species Status 12; 1-32. Joint Nature Conservation Committee, Peterborough.
- Freeman, P. and Lane, R.P. (1985). Bibionid and Scatopsid flies Diptera: Bibionidae and Scatopsidae. Handbooks for the Identification of British Insects. 9 (7). Royal Entomological Society, London.
- Gregor, F., Rozkošný, R., Bartak, M. and; Vanhara, J. (2002). The Muscidae (Diptera) of Central Europe. Masaryk University, Brno.
- Hackston, M. (2016). Key to the British species of family Aphrophoridae. Adapted from Le Quesne, W.J. (1965). Hemiptera Cicadomorpha (excluding Deltocephalinae and Typhlocybinae). Handbooks for the Identification of British Insects 2 (2a).
- Hopkin, S. (1991). A key to the Woodlice of Britain and Ireland. Reprinted from Field Studies 7 (4). Field Studies Council, Shrewsbury.
- Hynes, H.B.N. (1977). Adults and Nymphs of British Stoneflies (Plecoptera) (3rd edn.). Freshwater Biological Association: Scientific Publication No. 17.
- Invertebrate Link. (2002). *A code of conduct for collecting insects and other invertebrates*. British Journal of Entomology and Natural History, 15(1): 1-6.
- JNCC (various dates): Reviews of Scarce and Threatened Species of the British Isles:  
<https://hub.jncc.gov.uk/search?q=reviews+of+scarce+and+threatened&k=http%3A%2F%2Fvocab.jncc.gov.uk%2Fjncc-category%2FJNCC+Publications>
- Joy, N.H. (1932). A practical handbook of British beetles. H.F. & G. Witherby.
- Kirby, P. (2015). British Heteroptera: Keys to terrestrial families other than Miridae. Unpublished Draft.
- Lee, P. (2007). Provisional Keys to British Millipedes. Unpublished draft. Version 3.0.
- Legg, G. and Jones, R.E. (1988). Pseudoscorpions. Synopses of the British Fauna 40. E.J. Brill/Dr. W. Backhuys.
- Macadam, C.R. (2016). A review of the status of the mayflies (Ephemeroptera) of Great Britain - Species Status No.28. Natural England Commissioned Reports, Number193.
- Macadam, C. and Bennett, C. (2010). A Pictorial Guide to British Ephemeroptera. Field Studies Council, Shrewsbury.
- NBN (National Biodiversity Network) Atlas: <https://species.nbnatlas.org/search?q=>
- Natural Environment and Rural Communities Act (2006). Species of Principal Importance in England (section 41).
- Natural Environment and Rural Communities Act (2006a). Species of Principal Importance in Wales (Section 42).

NHM (Natural History Museum) Species Dictionary: <https://www.nhm.ac.uk/our-science/data/uk-species/species/index.html>

Nau, B.S. (2012). Keys to Miridae. Unpublished Draft.

Plant, C.W. (1997). A key to the adults of British lacewings and their allies. Reprinted from Field Studies 9 (1): 179-269. Field Studies Council, Shrewsbury.

Pollet, M., Persson, M., Bøggild, E., & Crossley, R. (2015). A long-lasting taxonomic problem in European *Sympycnus* resolved, with the description of a new species and data on habitat preferences. Zootaxa 4032 (1): 081–102.

Roberts, M.J. (1993). The Spiders of Great Britain and Ireland (Pts 1 & 2). Harley Books, Colchester.

Rognes, K. (1991). Blowflies (Diptera, Calliphoridae) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica 24. E. J. Brill/Scandinavian Science Press Ltd.

Roháček, J. (2006). A monograph of Palaearctic Anthomyzidae (Diptera), Part 1. Cas. Slez. Muz. Opava (A), 55, suppl.1: 1-328.

Roháček, J. (2009). A monograph of Palaearctic Anthomyzidae (Diptera), Part 2. Cas. Slez. Muz. Opava (A), 58, suppl.1: 1-180.

Rozkošný, R. (1984). The Sciomyzidae (Diptera) of Fennoscandia and Denmark. Fauna Entomologica Scandinavica 14. E. J. Brill/Scandinavian Science Press Ltd. Leiden & Copenhagen.

Salmela, J. (2011). The semiaquatic nematoceran fly assemblages of three wetland habitats and concordance with plant species composition, a case study from subalpine Fennoscandia. Journal of Insect Science: Vol. 11; Article 35.

Skinner, G.J. and Allen, G.W. (1996). Ants. Naturalists' Handbooks (24). The Richmond Publishing Co. Ltd. Slough.

Smallshire, D. and Swash, A. (2014). Britain's Dragonflies. Princeton University Press, Woodstock.

Smith, K.G.V. (1969). Diptera: Lonchopteridae. Handbooks for the Identification of British Insects. 10 (2ai). Royal Entomological Society, London.

Stace, C. (2010). New Flora of the British Isles. 3<sup>rd</sup> Edn. Cambridge University Press.

Stubbs, A.E. (1988). Draft keys to British Pipunculidae. (Unpublished draft.).

Stubbs, A.E. and Drake, M. (2014). British Soldierflies and their allies (2nd ed.). BENHS, Hurst.

Stubbs, A.E. & Falk, S.J. (2002). British Hoverflies; an Illustrated Identification Guide (2nd ed.). BENHS, Hurst.

Sumner, D. (2009). Diopsoidea. (Unpublished ms.).

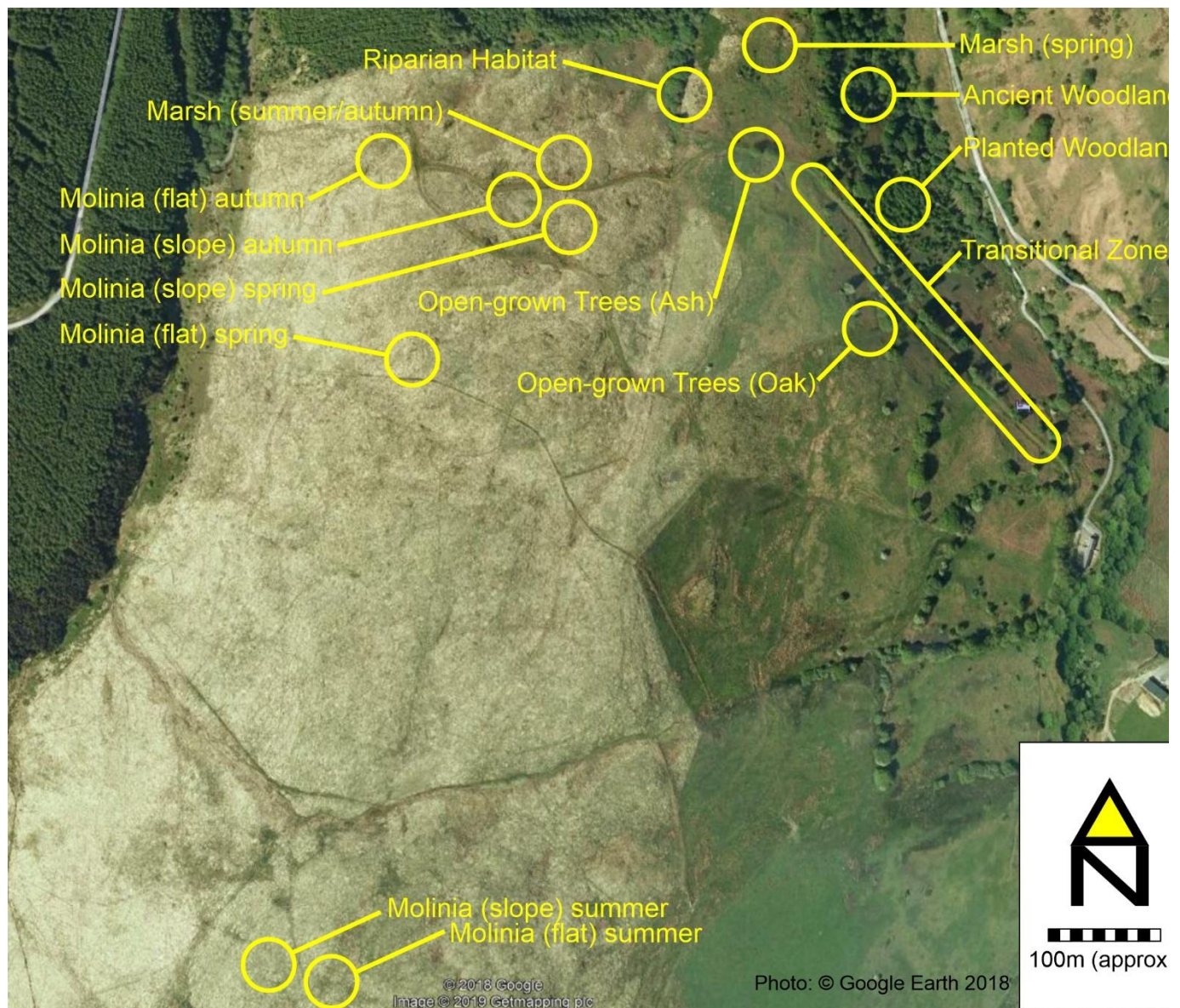
Stubbs, A.E. and Kramer, J. (2016). Revised Draft keys to British Craneflies. (unpublished ms.).

Telfer, M.G. (2013). Joy's keys to Elateridae, Eucnemidae and Throscidae (version 1.5, 7th December 2013); as adapted from: Joy, N.H. (1932). A practical handbook of British beetles (2 Volumes). H.F. & G. Witherby.

Telfer, M.G. (2016). A review of the beetles of Great Britain: Ground Beetles (Carabidae): Species Status No.25. Natural England Commissioned Reports, Number 189.



- Thorogood, A. (2017). Bwlch Corog: Ancient Woodland Survey and Recommendations for Management. Woodland Trust.
- Tolman. T. (2008). Collins Butterfly Guide. Harper Collins, London.
- UK Butterflies: <https://www.ukbutterflies.co.uk/species.php?species=pamphilus>
- Wales Wild Land Foundation (Sefydliad Tir Gwyllt Cymru) (September 2017). Bwlch Corog: Management Plan; Plan Period 2017 - 2022. Produced for Woodland Trust (Coed Cadw).
- Webb, J., Heaver, D., Lott, D., Dean, H.J., van Breda, J., Curson, J., Harvey, M., Gurney, M., Roy, D.B., van Breda, A., Drake, M., Alexander, K.N.A. and Foster, G. (2017). *Pantheon - database version 3.7.4*: <http://www.brc.ac.uk/pantheon/>.
- White, I.M. (1988). Tephritid Flies. Diptera: Tephritidae. Handbooks for the Identification of British Insects. 10 (5a). Royal Entomological Society, London.
- Whitmore, D. (2017). Key to adults of British Sarcophagidae. Unpublished draft.
- Wildlife and Countryside Act (1981) as amended.



**Map 1:** Sampled areas at Bwlch Corog, 2018

## APPENDIX 2: TAXONOMIC CHECKLIST OF INVERTEBRATES RECORDED BY THE SURVEY

The higher taxa of the recorded species are arranged according to Brusca *et al.*, 2016. Families and Species (# 270) are arranged alphabetically. Taxa where the determination is provisional are included, but these are annotated in the accompanying spreadsheet of species records (MNP0296\_BwCo\_Invert\_Spp\_Data\_2018.xlsx) which also includes brief accounts of each taxon. Scientific names follow the NBN species dictionary (see References); vernacular names are from a range of sources.

### Pulmonate Molluscs (part) (Pulmonata)

Family	Species	Vernacular Name
Oxychilidae	<i>Aegopinella nitidula</i>	Smooth Glass Snail

### Pulmonate Molluscs (part) (Stylommatophora)

Family	Species	Vernacular Name
Zonitidae	<i>Zonitoides excavatus</i>	A Land Snail

### Woodlice (Isopoda)

Family	Species	Vernacular Name
Oniscidae	<i>Oniscus asellus</i>	Common Shiny Woodlouse
Philosciidae	<i>Philoscia muscorum</i>	Common Striped Woodlouse
Porcellionidae	<i>Porcellio scaber</i>	Common Rough Woodlouse

### Mayflies (Ephemeroptera)

Family	Species	Vernacular Name
Ephemerellidae	<i>Ephemerella notata</i>	Yellow Hawk

### Dragonflies & Damselflies (Odonata)

Family	Species	Vernacular Name
Coenagrionidae	<i>Pyrrhosoma nymphula</i>	Large Red Damselfly
Libellulidae	<i>Libellula depressa</i>	Broad-bodied Chaser

### Stoneflies (Plecoptera)

Family	Species	Vernacular Name
Chloroperlidae	<i>Siphonoperla torrentium</i>	Small Yellow Sally
Leuctridae	<i>Leuctra nigra</i>	A Stonefly
Nemouridae	<i>Nemoura cinerea</i>	A Stonefly

### True Bugs (part) (Hemiptera-Auchenorrhyncha)

Family	Species	Vernacular Name
Aphrophoridae	<i>Neophilaenus lineatus</i>	A Froghopper
Cercopidae	<i>Cercopis vulnerata</i>	Red-and-black Froghopper
Cicadellidae	<i>Oncopsis flavicollis</i>	A Leaf-hopper
Cixiidae	<i>Cixius simplex</i>	A Plant-hopper
Cixiidae	<i>Tachycixius pilosus</i>	A Plant-hopper
Pentatomidae	<i>Aelia acuminata</i>	Bishop's Mitre Shieldbug

## APPENDIX 2 (Continued): TAXONOMIC CHECKLIST OF INVERTEBRATES RECORDED BY THE SURVEY

### True Bugs (part) (Hemiptera-Heteroptera)

Family	Species	Vernacular Name
Anthocoridae	<i>Anthocoris nemorum</i>	A Flower Bug
Anthocoridae	<i>Temnostethus pusillus</i>	A Plant bug
Lygaeidae	<i>Drymus brunneus</i>	A Ground-bug
Miridae	<i>Mecomma ambulans</i>	A Grass-bug
Miridae	<i>Monalocoris filicis</i>	Bracken Bug
Miridae	<i>Orthocephalus saltator</i>	A Plant bug
Miridae	<i>Psallus</i> nr. <i>assimilis</i>	A Plant Bug
Miridae	<i>Psallus</i> nr. <i>varians</i>	A Plant Bug
Miridae	<i>Stenodema calcarata</i>	A Grass-bug
Miridae	<i>Stenodema holsata</i>	A Grass-bug
Miridae	<i>Stenodema laevigata</i>	A Grass-bug
Nabiidae	<i>Nabis limbatus</i>	Marsh Damsel-bug
Pentatomidae	<i>Picromerus bidens</i>	Spiked Shield-bug

### Beetles (Coleoptera)

Family	Species	Vernacular Name
Apionidae	<i>Exapion ulicis</i>	A Weevil
Apionidae	<i>Perapion curtirostre</i>	A Weevil
Apionidae	<i>Perapion marchicum</i>	A Weevil
Byrrhidae	<i>Byrrhus pilula</i>	A Pill Beetle
Cantharidae	<i>Cantharis cryptica</i>	A Soldier Beetle
Cantharidae	<i>Cantharis pellucida</i>	A Soldier Beetle
Cantharidae	<i>Cantharis rustica</i>	A Soldier Beetle
Cantharidae	<i>Rhagonycha fulva</i>	A Soldier Beetle
Cantharidae	<i>Rhagonycha lignosa</i>	A Soldier Beetle
Cantharidae	<i>Rhagonycha limbata</i>	A Soldier Beetle
Cantharidae	<i>Rhagonycha testacea</i>	A Soldier Beetle
Carabidae	<i>Bradycellus sharpi</i>	A Ground Beetle
Carabidae	<i>Notiophilus biguttatus</i>	A Ground Beetle
Carabidae	<i>Pterostichus anthracinus</i>	A Ground Beetle
Carabidae	<i>Pterostichus strenuus</i>	A Ground Beetle
Cerambycidae	<i>Rhagium bifasciatum</i>	A Longhorn beetle
Chrysomelidae	<i>Crepidodera fulvicornis</i>	A Leaf Beetle
Chrysomelidae	<i>Luperus longicornis</i>	A Leaf Beetle
Chrysomelidae	<i>Neocrepidodera transversa</i>	A Leaf Beetle
Chrysomelidae	<i>Oulema obscura</i>	A Leaf Beetle
Curculionidae	<i>Barypeithes araneiformis</i>	The Spider Weevil
Curculionidae	<i>Euophryum confine</i>	A Weevil
Curculionidae	<i>Phyllobius argentatus</i>	A Weevil
Curculionidae	<i>Polydrusus pterygomalis</i>	A Weevil

### Beetles (Coleoptera) (Continued)

Family	Species	Vernacular Name
Elateridae	<i>Agriotes pallidulus</i>	A Click Beetle
Elateridae	<i>Aplotarsus incanus</i>	A Click Beetle
Elateridae	<i>Athous haemorrhoidalis</i>	A Click Beetle
Elateridae	<i>Dalopius marginatus</i>	A Click Beetle
Elateridae	<i>Denticollis linearis</i>	A Click beetle
Hydrophilidae	<i>Cercyon melanocephalus</i>	A Beetle
Hydrophilidae	<i>Cercyon terminatus</i>	A Beetle
Hydrophilidae	<i>Megasternum concinnum</i>	A Beetle
Nitidulidae	<i>Meligethes aeneus</i>	A Pollen Beetle
Oedemeridae	<i>Oedemera lurida</i>	A False Blister Beetle
Scirtidae	<i>Cyphon ochraceus</i>	A Beetle
Scraptiidae	<i>Anaspis frontalis</i>	A False Flower Beetle
Scraptiidae	<i>Anaspis rufilabris</i>	A False Flower Beetle
Staphylinidae	<i>Bisnius fimetarius</i>	A Rove Beetle
Staphylinidae	<i>Datomicra nigra</i>	A Rove Beetle
Staphylinidae	<i>Oxytelus laqueatus</i>	A Rove Beetle
Staphylinidae	<i>Philonthus marginatus</i>	A Rove Beetle
Staphylinidae	<i>Philonthus varians</i>	A Rove Beetle
Staphylinidae	<i>Quedius curtipennis</i>	A Rove Beetle
Staphylinidae	<i>Stenus aceris</i>	A Rove Beetle
Staphylinidae	<i>Stenus impressus</i>	A Rove Beetle
Staphylinidae	<i>Tachinus marginellus</i>	A Rove Beetle
Staphylinidae	<i>Tachyporus chrysomelinus</i>	A Rove Beetle
Staphylinidae	<i>Tachyporus dispar</i>	A Rove Beetle
Staphylinidae	<i>Tachyporus hypnorum</i>	A Rove Beetle

### Scorpion Flies (Mecoptera)

Family	Species	Vernacular Name
Panorpidae	<i>Panorpa communis</i>	A Scorpion Fly



### True Flies (Diptera)

Family	Species	Vernacular Name
Acartophthalmidae	<i>Acartophthalmus nigrinus</i>	An acalyprate fly
Anthomyzidae	<i>Anthomyza elbergi</i>	An acalyprate fly
Anthomyziidae	<i>Anthomyza gracilis</i>	An acalyprate fly
Bibionidae	<i>Biblio lepidus</i>	A March Fly
Calliphoridae	<i>Lucilia caesar</i>	A Greenbottle
Calliphoridae	<i>Pollenia amentaria</i>	Black-bellied Clusterfly
Calliphoridae	<i>Pollenia rudis</i>	Common Clusterfly
Cylindrotomidae	<i>Diogma glabrata</i>	A Long-bodied Crane fly
Diastatidae	<i>Diastata costata</i>	An acalyprate fly
Dolichopodidae	<i>Campsicnemus loripes</i>	A Long-legged fly
Dolichopodidae	<i>Chrysotus gramineus</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus discifer</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus phaeopus</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus plumipes</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus simplex</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus unguatus</i>	A Long-legged fly
Dolichopodidae	<i>Dolichopus urbanus</i>	A Long-legged fly
Dolichopodidae	<i>Gymnopternus aerosus</i> ( <i>Hercostomus aerosus</i> )	A Long-legged fly
Dolichopodidae	<i>Hercostomus metallicus</i>	A Long-legged fly
Dolichopodidae	<i>Hercostomus nigripennis</i>	A Long-legged fly
Dolichopodidae	<i>Sciapus platypterus</i>	A Long-legged fly
Dolichopodidae	<i>Sympycnus pulicarius</i> ( <i>S. desoutteri</i> in part)	A Long-legged fly
Dolichopodidae	<i>Sympycnus pulicarius</i> / <i>septentrionalis</i> fem. ident. ( <i>S. desoutteri</i> in part)	A Long-legged fly
Empididae	<i>Chelifera precatória</i>	An Empid fly
Empididae	<i>Dolichocephala irrorata</i>	An Empid fly
Empididae	<i>Empis stercorea</i>	An Empid fly
Empididae	<i>Empis tessellata</i>	An Empid fly
Empididae	<i>Rhamphomyia stigmata</i>	An Empid fly
Empididae	<i>Rhamphomyia tarsata</i>	An Empid fly
Hippoboscidae	<i>Ornithomya chloropus</i>	A Ked fly
Hybotidae	<i>Bicellaria vana</i>	An Empid fly
Hybotidae	<i>Hybos culiciformis</i>	An Empid fly
Hybotidae	<i>Hybos grossipes</i>	An Empid fly
Hybotidae	<i>Leptopeza flavipes</i>	An Empid fly
Hybotidae	<i>Ocydromia glabricula</i>	An Empid fly
Hybotidae	<i>Tachypeza nubila</i>	An Empid fly

### True Flies (Diptera) (Continued)

Family	Species	Vernacular Name
Keroplastidae	<i>Macrocera parva</i>	A Fungus Gnat
Keroplastidae	<i>Macrocera stigma</i>	A Fungus Gnat
Keroplastidae	<i>Macrocera stigmoides</i>	A Fungus Gnat
Keroplastidae	<i>Macrocera vittata</i>	A Fungus Gnat
Keroplastidae	<i>Platyura marginata</i>	A Fungus Gnat
Lauxaniidae	<i>Lyciella rorida</i>	A saprophytic fly
Lauxaniidae	<i>Meiosimyza platycephala</i>	A saprophytic fly
Lauxaniidae	<i>Meiosimyza rorida</i>	A saprophytic fly
Lauxaniidae	<i>Minettia rivos</i>	A saprophytic fly
Lauxaniidae	<i>Sapromyza sexpunctata</i>	A saprophytic fly
Limoniidae	<i>Austrolimnophila ochracea</i>	A Short-palped Crane fly
Limoniidae	<i>Cheilotrichia cinerascens</i>	A Short-palped Crane fly
Limoniidae	<i>Dicranophragma nemorale</i>	A Short-palped Crane fly
Limoniidae	<i>Dicranophragma separatum</i>	A short-palped crane fly
Limoniidae	<i>Eloeophila trimaculata</i>	A short-palped crane fly
Limoniidae	<i>Epiphragma ocellare</i>	A short-palped crane fly
Limoniidae	<i>Erioptera lutea</i>	A short-palped crane fly
Limoniidae	<i>Euphylidorea aperta</i>	A short-palped crane fly
Limoniidae	<i>Euphylidorea phaeostigma</i>	A short-palped crane fly
Limoniidae	<i>Gonomyia dentata</i>	A short-palped crane fly
Limoniidae	<i>Helius longirostris</i>	A short-palped crane fly
Limoniidae	<i>Molophilus appendiculatus</i>	A short-palped crane fly
Limoniidae	<i>Molophilus ater</i>	A Short-palped Crane fly
Limoniidae	<i>Molophilus crassipygus</i>	A short-palped crane fly
Limoniidae	<i>Molophilus occultus</i>	A short-palped crane fly
Limoniidae	<i>Molophilus undulatus</i>	A short-palped crane fly
Limoniidae	<i>Molophilus</i> nr. <i>obscurus</i> f. ident.	A short-palped crane fly
Limoniidae	<i>Neolimnomyia filata</i>	A short-palped crane fly
Limoniidae	<i>Ormosia</i> sp. female ident.	A short-palped crane fly
Limoniidae	<i>Phylidorea fulvonervosa</i>	A short-palped crane fly
Limoniidae	<i>Tasiocera robusta</i>	A short-palped crane fly
Limoniidae	<i>Dactylolabis transversa</i>	A Short-palped Crane fly
Lonchopteridae	<i>Lonchoptera lutea</i>	A spear-winged fly
Muscidae	<i>Eudasyphora cyanicolor</i>	A Greenbottle-like fly
Mycetophilidae	<i>Exechia</i> sp.	A Fungus Gnat
Mycetophilidae	<i>Neuratelia nemoralis</i>	A Fungus Gnat
Mycetophilidae	<i>Rymosia fasciata</i>	A Fungus Gnat
Mycetophilidae	<i>Tetragoneura sylvatica</i>	A Fungus Gnat
Opomyzidae	<i>Geomyza tripunctata</i>	A Picture-winged Fly
Opomyzidae	<i>Opomyza germinationis</i>	A Picture-winged Fly

### True Flies (Diptera) (Continued)

Family	Species	Vernacular Name
Pediciidae	<i>Pedicia occulta</i>	A Hairy-eyed Crane-fly
Pediciidae	<i>Pedicia rivosa</i>	A Hairy-eyed Crane-fly
Pediciidae	<i>Tricyphona immaculata</i>	A Hairy-eyed Crane-fly
Pediciidae	<i>Tricyphona schummeli</i>	A Hairy-eyed Crane-fly
Pediciidae	<i>Tricyphona unicolor</i>	A Hairy-eyed Crane-fly
Piophilidae	<i>Stearibia nigriceps</i>	A Skipper Fly
Pipunculidae	<i>Pipunculus campestris</i> agg.	A Big-headed fly
Pipunculidae	<i>Verrallia aucta</i>	A Big-headed fly
Psilidae	<i>Chamaepsila humeralis?</i>	A root-boring fly
Rhagionidae	<i>Chrysopilus cristatus</i>	A Snipe Fly
Rhagionidae	<i>Rhagio lineola</i>	A Snipe Fly
Rhagionidae	<i>Rhagio scolopacea</i>	A Snipe Fly
Sarcophagidae	<i>Parasarcophaga aratrix</i>	A Flesh fly
Scathophagidae	<i>Scathophaga stercoraria</i>	Common Yellow Dung-fly
Sciomyzidae	<i>Pherbellia cinerella</i>	A Snail-killing fly
Sciomyzidae	<i>Tetanocera elata</i>	A Snail-killing fly
Stratiomyidae	<i>Microchrysa flavicornis</i>	Green Gem
Syrphidae	<i>Cheilosia albitarsis</i> ss	A Hoverfly
Syrphidae	<i>Chrysogaster cemiteriorum</i>	A Hoverfly
Syrphidae	<i>Criorhina floccosa</i>	A Hoverfly
Syrphidae	<i>Episyrphus balteatus</i>	A Hoverfly
Syrphidae	<i>Eristalis horticola</i>	A Hoverfly
Syrphidae	<i>Eristalis pertinax</i>	A Hoverfly
Syrphidae	<i>Eristalis tenax</i>	A Hoverfly
Syrphidae	<i>Eupeodes corollae</i>	A Hoverfly
Syrphidae	<i>Eupeodes luniger</i>	A Hoverfly
Syrphidae	<i>Melanostoma mellinum</i>	A Hoverfly
Syrphidae	<i>Melanostoma scalare</i>	A Hoverfly
Syrphidae	<i>Meliscaeva cinctella</i>	A Hoverfly
Syrphidae	<i>Neoascia tenax</i>	A Hoverfly
Syrphidae	<i>Orthonevra nobilis</i>	A Hoverfly
Syrphidae	<i>Platycheirus albimanus</i>	A Hoverfly
Syrphidae	<i>Platycheirus angustatus</i>	A Hoverfly
Syrphidae	<i>Platycheirus ramsarensis</i>	A Hoverfly
Syrphidae	<i>Platycheirus rosarum</i>	A Hoverfly
Syrphidae	<i>Sericomyia lappona</i>	A Hoverfly
Syrphidae	<i>Sericomyia silentis</i>	A Hoverfly
Syrphidae	<i>Sphaerophoria scripta</i>	A Hoverfly
Syrphidae	<i>Sphegina clunipes</i>	A Hoverfly
Syrphidae	<i>Syrpitta pipiens</i>	A Hoverfly
Syrphidae	<i>Xylota florum</i>	A Hoverfly
Syrphidae	<i>Xylota segnis</i>	A Hoverfly



### True Flies (Diptera) (Continued)

Family	Species	Vernacular Name
Tabinidae	<i>Haematopota pluvialis</i>	A Horsefly
Tachinidae	<i>Phryxe nemea</i>	A parasitoid fly
Tachinidae	<i>Tachina grossa</i>	A parasitoid fly
Tephritidae	<i>Tephritis vespertina</i>	A Picture-winged fly
Tipulidae	<i>Tipula montium</i>	A Long-palped Crane fly
Tipulidae	<i>Tipula oleracea</i>	A Long-palped Crane fly
Tipulidae	<i>Tipula paludosa</i>	A Long-palped Crane fly
Tipulidae	<i>Tipula variicornis</i>	A Long-palped Crane fly
Ulidiidae	<i>Herina frondescentiae</i>	A Picture-winged fly

### Butterflies (Lepidoptera-Rhopalocera)

Family	Species	Vernacular Name
Hesperiidae	<i>Thymelicus sylvestris</i>	Small Skipper Butterfly
Nymphalidae	<i>Aphantopus hyperantus</i>	Ringlet Butterfly
Nymphalidae	<i>Coenonympha pamphilus</i>	Small Heath Butterfly
Nymphalidae	<i>Maniola jurtina</i>	Meadow Brown Butterfly
Nymphalidae	<i>Vanessa atalanta</i>	Red Admiral Butterfly
Pieridae	<i>Pieris brassicae</i>	Large White Butterfly
Pieridae	<i>Pieris napi</i>	Green-veined White Butterfly
Pieridae	<i>Pieris rapae</i>	Small White Butterfly

### Bees, Wasps & Ants (Hymenoptera)

Family	Species	Vernacular Name
Apidae	<i>Andrena helvola</i>	Coppice Mining Bee
Apidae	<i>Andrena minutula</i>	Common Mini-miner
Apidae	<i>Apis mellifera</i>	Honeybee
Apidae	<i>Bombus hortorum</i>	A Bumblebee
Apidae	<i>Bombus lucorum agg./terrestris</i>	A Bumblebee
Apidae	<i>Bombus monticola</i>	Mountain Bumblebee
Apidae	<i>Bombus pascuorum</i>	Common Carder Bee
Apidae	<i>Bombus pratorum</i>	Early Bumblebee
Apidae	<i>Lasioglossum calceatum</i>	Common Furrow Bee
Apidae	<i>Lasioglossum fratellum</i>	Smooth-faced Furrow Bee
Crabronidae	<i>Nysson spinosus</i>	Large Spurred Digger Wasp
Formicidae	<i>Formica lemani</i>	A Black Ant
Formicidae	<i>Lasius flavus</i>	Yellow Meadow-ant
Formicidae	<i>Myrmica rubra</i>	A Red Ant
Formicidae	<i>Myrmica ruginodis</i>	A Red Ant
Formicidae	<i>Myrmica scabrinodis</i>	Common Elbowed Red Ant

### Centipedes (in part) (Lithobiomorpha)

Family	Species	Vernacular Name
Lithobiidae	<i>Lithobius borealis</i>	A Centipede
Lithobiidae	<i>Lithobius melanops</i>	A Centipede

### Millipedes (in part) (various Orders)

Family	Species	Vernacular Name
Chordeumatidae	<i>Chordeuma proximum</i>	A Millipede
Glomeridae	<i>Glomeris marginata</i>	A Pill Millipede
Blaniulidae	<i>Proteroiulus fuscus</i>	A Snake Millipede
Julidae	<i>Cylindroiulus londinensis</i>	A Millipede
Polydesmidae	<i>Polydesmus angustus</i>	A Flat-backed Millipede

### Spiders (Araneae)

Family	Species	Vernacular Name
Agelenidae	<i>Agelena? labyrinthica</i>	A Spider
Araneidae	<i>Araenus quadratus</i>	A Spider
Araneidae	<i>Araneus diadematus</i>	A Spider
Araneidae	<i>Araniella ?cucurbitina</i>	A Spider
Clubionidae	<i>Clubiona ?reclusa</i>	A Spider
Hahniidae	<i>Hahnina nava</i>	A Spider
Linyphidae	<i>Araeoncus humilis</i>	A Spider
Linyphidae	<i>Linyphia ?triangularis</i>	A Spider
Linyphidae	<i>Linyphia hortensis</i>	A Spider
Linyphidae	<i>Linyphia triangularis</i>	A Spider
Linyphidae	<i>Micrargus herbigradus sensu stricto</i>	A Spider
Linyphidae	<i>Nerienne peltata</i>	A Spider
Linyphidae	<i>Oedothorax fuscus</i>	A Spider
Linyphidae	<i>Saarietia abnormis</i>	A Spider
Linyphidae	<i>Walckenaeria nudipalpis</i>	A Spider
Linyphiidae	<i>Erigone atra</i>	A Spider
Linyphiidae	<i>Microlinyphia pusilla</i>	A Spider
Linyphiidae	<i>Oedothorax retusus</i>	A Spider
Linyphiidae	<i>Silometopus elegans</i>	A Spider
Lycosidae	<i>Pardosa palustris</i>	A Spider
Lycosidae	<i>Pardosa pullata</i>	A Spider
Lycosidae	<i>Pirata uliginosus</i>	A Spider
Philodromidae	<i>Philodromus ?aureolus</i>	A Spider
Philodromidae	<i>Tibellus oblongus</i>	A Spider

### Spiders (Araneae) (Continued)

Family	Species	Vernacular Name
Tetragnathidae	<i>Metellina ?segmentata</i>	A Spider
Tetragnathidae	<i>Metellina menzei</i>	A Spider
Tetragnathidae	<i>Metellina segmentata</i>	A Spider
Tetragnathidae	<i>Pachygnatha clercki</i>	A Spider
Tetragnathidae	<i>Tetragnatha extensa</i>	A Spider
Theridiidae	<i>Pholcomma gibbum</i>	A Spider
Theridiidae	<i>Theridion</i> sp.	A Spider

### False Scorpions (Pseudoscorpiones)

Family	Species	Vernacular Name
Neobisiidae	<i>Neobisium carcinoides</i>	Moss Neobisiid

## APPENDIX 3: ADDITIONAL RECORDS

The following invertebrate records were provided by undocumented third parties and are not included in this analysis.

	Vernacular Name	Date	Grid Ref	Notes	UK Status
<i>Aeshna cyanea</i>	Southern hawker dragonfly	Summer 2019	SN 736 963	Over newly created pond on blocked grip	Least Concern
<i>Synanthedon vespiformis</i>	Welsh clearwing moth	Summer 2017	SN 740 966	On isolated birch in open ground	Section 42 (Wales) RDB3
<i>Cladius grandis</i>	Poplar sawfly	Summer 2017	SN 740 966	On aspen in ancient woodland	Widespread but local

The following reptile was recorded by the surveyor.

	Vernacular Name	Date	Grid Ref	Notes	UK Status
<i>Zootoca vivipara</i>	Common Lizard	12 July 2018	SN 7418 9601	1 juvenile near east end of Transitional Habitat	W&C Act S42



#### APPENDIX 4: PHOTOGRAPHS OF HABITATS SAMPLED FOR INVERTEBRATES AT BWYLCH COROG, 2018

All photos © J.R. Dobson except where stated



**Photo 1:** Ancient Woodland,  
12 July2018



**Photo 2:** Ancient Woodland,  
12 July2018



**Photo 3:** Plantation Woodland,  
12 July2018



**Photo 4:** Plantation Woodland (background), proximal  
to Ancient Woodland, 12 July2018





**Photo 5** Flat *Molina* grassland with grip,  
31 May 2018



**Photo 6** Flat *Molina* grassland with grip (concealed  
beneath rank grasses),  
10 July 2018



**Photo 7:** Inclined *Molina* grassland with grip,  
31 May 2018



**Photo 8:** Inclined *Molina* grassland with grip,  
10 October 2018





**Photo 9:** Transitional Habitat  
29 May 2018



**Photo 10:** Transitional Habitat  
12 July 2018



**Photo 11:** Riparian Habitat,  
31 May 2018



**Photo 12:** Riparian Habitat,  
31 May 2018



**Appendix 4 (Continued): Photographs of Habitats Sampled for Invertebrates at Bwylch Corog, 2018**



**Photo 13:** Marsh/Flush Habitat  
31 May 2018



**Photo 14:** Sampling debris from Marsh/Flush Habitat,  
10 July 2018. Photo © Mike Kay



**Photo 15:** Sweep-sampling from Marsh/Flush Habitat,  
8 June 2018. Photo © Mike Kay



**Photo 16:** Open-grown Trees Habitat,  
8 June 2018. Photo © Mike Kay



**Photo 17:** Open-grown Trees Habitat,  
28 May 2018

## APPENDIX 5: GLOSSARY

### **Alate**

Having wings. Usually applies to members of insect groups such as Ants or Aphids where winged- and wingless forms of the same caste may both be present.

### **Caste**

In some social insects (such as ants) caste refers to physically distinct individuals or group of individuals specialized to perform certain functions in the colony.

### **Epigeic**

Referring to an organism living on the soil surface.

### **Fossorial**

Referring to an organism which burrows in to the soil.

### **Guild**

A group of species that exploits the same kinds of resources in comparable ways. Members of a guild may- or may not be taxonomically related; for example, invertebrate species belonging to the nectar feeding guild include examples of bees, flies, beetles and others.

### **Gyne**

A female social insect that has the potential to become a reproductive queen, in contrast to a sterile worker. It is used to describe members of the reproductive caste in for example ants before they have mated and founded a colony. Colloquially Gynes are sometimes known as 'Princesses'.

### **Indicator Species**

"An Indicator Species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem." (Encyclopaedia of Life).

In practice indicator groups are selected on these bases:

- The included species have been well studied, so that information on their distribution and life-histories is available.
- The included species are associated with a wide range of different habitats.
- The included species display the full range of statuses from very common to very rare.
- The included species can be accurately identified by a competent person.

### **Invertebrate Habitat Potential (IHP).**

A preliminary assessment of the degree of potential ability of an area of habitat to support invertebrate species and communities. IHP assessment takes multiple factors into account, and these are detailed by Dobson, J. and Fairclough, J. (in prep.).

### **Parasitoid**

A parasitic species where the larva rather than the adult lives as a parasite.

### **Partial habitats**

Each invertebrate species occupies a number of partial habitats, each of which provides an essential component for the completion of the life-cycle. Although all the partial habitat components may sometimes be found in close proximity and may equate to a botanically-defined habitat, they may also be physically discrete and be defined in other terms e.g. by structure rather than botany.

Examples of Partial Habitats include: Adult feeding habitat, larval feeding habitat, habitat for display and/or territory holding, habitat for mate-seeking, habitat for mating, oviposition habitat and overwintering habitat etc.



### **Percentage Representation**

The number of species belonging to each (Pantheon) category as a percentage of the total number of coded species belonging to each category.

**Sensu lato (s.l.):** In the broadest sense. Appended to a scientific name where it refers to a species complex. It infers that the definition ('circumscription' in taxonomy) of the taxonomic group (species, family, class, order) is broader than that originally defined or accepted.

**Sensu stricto (s.s.):** In the strictest sense. Appended to a scientific name where it refers to a particular member of a species complex. It follows the name of a taxonomic group (species, family, class, order) and indicates that the name is being used either in the sense of the original description or definition of that group, or that it is being used in the sense of exclusion of other groups (species etc.) with which it may be closely associated or related.

### **SQL (Species Quality Index)**

The total of the Species Quality Scores (SQS) in a sample, divided by the total number of species in the sample.

## **SPECIES DESIGNATIONS AND STATUSES**

### **S41 (Section 41); S42 (Section 42)**

See References: Natural Environment and Rural Communities Act. England (2006) & Wales (2006a).

### **Red Data Book 3(RDB 3); Rare.**

Taxa with small populations that are not at present Endangered or Vulnerable, but are at risk. (In GB, this was interpreted as species which exist in fifteen or fewer 10km squares).

### **Nationally Notable A (Na)**

Species estimated to occur within the range of 16 to 30 10-kilometre squares of the National Grid System.

### **Nationally Notable B (Nb)**

Species estimated to occur within the range 31 to 100 10-kilometre squares of the National Grid System.

The above designations follow Shreeve (1987). They were superseded by new IUCN categories in 1994, but are still applicable to lists that have not been reviewed since that date.

### **Local Species**

The term Local has a particular importance, as it highlights those species which are less likely to be found generally in surrounding areas, and which are thus likely to be dependent locally on resources present in the surveyed area. The term is used broadly to include degrees of (sub-designation) scarcity in the range: 'widely dispersed but confined to particular habitats' to 'very uncommon indeed'; Local species may therefore be regionally widespread or far more restricted in occurrence. The presence of Local species is therefore a significant factor in assessing the quality of a site for invertebrates, and these species and their habitats should be a consideration in conservation management, alongside any designated species.

## Risk Assessment

## Make Natural Ltd. (Ecological Services)

**Risk Ranking:** Likelihood x Severity = Risk (High, Medium, Low)

Likelihood	Severity		
	Low	Medium	High
Low	Low	Low	Medium
Medium	Low	Medium	Medium
High	Medium	Medium	High

<b>Project:</b> Preliminary Invertebrate Survey of Bwlch Corog, Ceredigion 2018	
<b>Activity:</b> Sweeping, pooting, beating, hand-netting and hand-searching.	<b>Risk Assessment carried out by:</b> John Dobson (Director)
<b>Other personnel:</b> Mike Kay	
<b>Project Ref:</b> MNP0296	<b>Dates:</b> 28/05; 29/05; 31/05; 10/07; 12/07; 9/10; 10/10; 11/10/2018.
<b>Site:</b>	Bwlch Corog, Ceredigion

Activity	Hazard	Who's at risk	Controls in place	Risk	Further controls required	Residual Risk
Fieldwork	Lone working	n/a	n/a: The surveyor was accompanied throughout by an experienced hill walker, both with mobile phones.	na	na	na
Fieldwork	Minor scratches, stings, bruises	All	Both are experienced in the field. First-aid kit carried.	L	na	na
Fieldwork	Falls and injuries	All	Both are experienced in the field. Both with mobile phones. Simon Ayres informed whenever on site.	L	na	na
Fieldwork	Horses on site	All	Proximity of horses monitored and no activities near the horses likely to cause disturbance.	L	na	na
Fieldwork	Navigation errors	All	Both are experienced in the field. Hand-held recording GPS unit with OS tiles carried throughout.	L	na	na
Fieldwork	Severe weather	All	Weather monitored both prior to commencement and in the field.	L	na	na

