National Botanic Garden of Wales
Gardd Fotaneg Genedlaethol Cymru

# Regency Landscape Restoration Project

# ECOLOGICAL SURVEYS

## and

# ASSESSMENT

## VOLUME 1: REPORT

Revision of 18th April 2016


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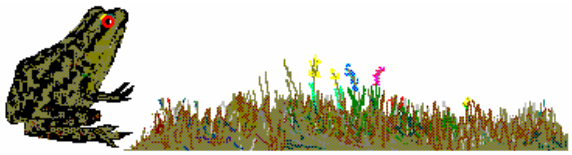


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# SUMMARY OF SIGNIFICANT ECOLOGICAL ISSUES

1. This document reports on the ecological surveys and assessment work carried out between April 2015 and April 2016, commissioned to inform the proposal to restore the early 19th century Regency Landscape parkland at Middleton Hall, Carmarthenshire, now the site of the National Botanic Garden of Wales (NBGW). For the purposes of the ecological assessment, the Garden estate was divided into Survey Zones, the boundaries of which, are shown on the figures.

2. **Protected and Designated Sites**

2.1 The site includes the Waun-Las National Nature Reserve (NNR), parts of which are included within the landscape restoration project area and it is inevitable that some areas of the NNR will be disturbed. However, the project offers a significant opportunity to bring parts of the NNR that have suffered due to under-resourced estate-management in the past, towards a more favourable conservation status. The management of other parts of the NNR has achieved enhanced conservation status in recent years and this enhancement-management will continue.

2.2. The Afon Tywi Special Area of Conservation is located some 2km north of the Garden estate and surface water from the estate drains into the Tywi. Otter is a reason for the selection of this SAC and animals which visit the estate form part of the Tywi Otter population. However, the impact of the proposed landscape restoration project on the SAC is considered to be minimal.

2.3. No other Special Areas of Conservation, Sites of Special Scientific Interest or other protected sites will be affected by the project.

2.4. Designated areas of Ancient Woodland: The restoration of Llyn Felin-gât, together with proposed woodland management will affect the designated Ancient Woodland at Pont Felin-gât but no other Ancient Woodlands will be impacted by the scheme.

2.5. No other sites designated for their ecological significance will be affected by the proposals.

3. **Habitats of European Significance** listed at Annex I of the EC Habitats Directive that are present within the Garden estate are as follows.

- Old Oak woods with *Ilex* and *Blechnum* in the British Isles. This habitat is extensively modified at NBGW and there are more extensive and typical examples located in the vicinity. It is therefore judged that no woodland of this type which is sufficiently pristine or undisturbed to be of European significance will be affected by the proposed work.
- *Molinia* meadows on chalk and clay (Eu-Molinion). Only very small areas of Purple Moor-grass dominated vegetation are present within the Garden estate and none will be affected by the landscape proposals except that the project offers the opportunity for them to be effectively managed to bring them into favourable conservation status in the future.

No other habitats of European significance will be affected by the proposals.

4. **Section 42 *Habitats of Principal Importance***[1] and **UK Biodiversity Action Plan Priority Habitats** that are present within the Garden estate are as follows.
   - Wood pasture and parkland (included in Broadleaved, mixed and yew woodland)
   - Wet woodland (included in Broadleaved, mixed and yew woodland)
   - Lowland mixed deciduous woodland (included in Broadleaved, mixed and yew woodland)
   - Hedgerows and boundary tree-lines (included in Boundary and linear features)
   - Arable field margins (included in Arable and horticultural)
   - Lowland meadows (included in Neutral grassland)
   - Lowland dry acid grassland (included in Acid grassland)
   - Purple moorgrass and rush pastures (included in Fen, marsh and swamp)
   - Reedbeds (included in Fen, marsh and swamp)
   - Rivers and streams
   - Eutrophic standing waters

   All of these habitats will be impacted to a greater or lesser extent by the project but there is potential for many to substantially benefit, particularly by the introduction of positive habitat management after completion of the works.

5. **Local Biodiversity Action Plan Priority Habitats** that are present within the Garden estate and additional to the habitats listed at paragraph 4 are:
   - Veteran Trees
   - Ffridd and bracken slopes

   Both of these habitats will benefit substantially from the project by the introduction of positive habitat management.

6. **Important Hedgerows.** Only ten hedgerows within Survey Zones 1 and 2 satisfy the definition of 'hedgerow' as stated in the *Hedgerow Regulations,* eight of which qualify as Important Hedgerows as defined in the *Regulations*. Some of these, principally around the boundaries of the estate, stand to benefit from the project proposals by the implementation of better conservation management but it may be necessary to remove some others to restore the open parkland landscape as depicted in the Horner paintings.

7. **Non-designated Habitats.** Other habitats which could be affected include semi-improved neutral grassland, amenity grassland, improved grassland, tall-herb vegetation, walls, buildings, tracks, hardstandings, etc. Some disturbance to these features may occur but none are of particular ecological interest.

[1] *Habitats of Principal Importance for Conservation of Biological Diversity* in Wales were identified at Section 74 of the Countryside and Rights of Way Act 2000 and reviewed under section 40 of the Natural Environment and Rural Communities Act 2006 and listed under section 42 of that Act. These habitats, by their listing under section 42, whilst not protected, are a material consideration through the planning process. There is generally a requirement to ensure their retention and future management or, if they cannot be retained, acceptable mitigation will need to be agreed and implemented.

8. **Plants and Vegetation** of significance include Bluebell which is partially protected under schedule 8 of the Wildlife and Countryside Act 1981 (as amended). Whorled Caraway and Primrose are both Globally Threatened species defined by the Countryside Council for Wales. The lichen Sticta sylvatica is present in the area where Llyn Felin-gât is to be reinstated and is a component of the Lobarian Lichen Community, a Section 42 *Species Group of Principal Importance*. Some individuals of these species will be disturbed as a result of the project but the effect on local populations of all but the *Sticta* lichen will be insignificant. Efforts will be made to translocate any *Sticta* plants which it may be necessary to disturb to suitable safe areas.

   Twelve additional plant species of county or local significance were identified during the surveys, most of which will not be significantly effected by the project. Those that will be disturbed will be mainly as a result of reflooding the Llyn Mawr lake-bed but the design of the new lake will ensure that populations of these species will be maintained around the new lake margins.

9. **Fungi**. The Botanic Garden has become a hub of mycological study in recent years, initially built upon the exceptional 'waxcap grasslands' that are present within the NNR. As research continues, more fungal interest is emerging and numerous areas of significance have been identified within the estate. The great majority of these areas will not be disturbed by the landscape restoration project. On the contrary, the project offers potential for appropriate habitat management to promote the mycological significance of the site.

10. **Faunal *European Protected Species*** (EPS) found to occur within or around the NBGW estate include
    - Bats. At least eight species of bats, three of which roost in Waun Las farmhouse, that, at the time of writing, it is proposed to demolish. A replacement roost will be required before the house is disturbed. No other roosts have been detected within the project area, either in built-structures or in trees.
    - Dormouse. Habitat which supports Dormice is extensive within the site and will be affected by the proposed work. Its disturbance will need to be mitigated by the provision of like-for-like habitat elsewhere within the site.
    - Otter. The survey results indicate that that the project is unlikely to have any significant effect on Otters.
    - Bullhead is certain to occur in the Afon Gwynon below Pont Felin-gât and could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. The reinstatement of the lakes as planned will, in the longer term, result in a potential increase in the extent of suitable habitat available to this species.
    - Marsh Fritillary butterfly is known to occur in the general area but not within the Garden estate or its vicinity. The project will not impact upon this species.

    Where licencing is required to disturb the resting places or habitats of European Protected Species, propsed mitigation will be informed by the results of the 2015-16 surveys together with any additional survey or assessment work that might be required.

11. **Nationally protected faunal species** which occur within or around the Garden estate include
    - Badger. Several setts are located around the banks of the former Llyn Mawr at just above the water level of the lake before it was drained in c.2000. These setts are extant and in use. It may be possible to retain them in their existing locations or

temporarily close them during site operations. Current bait-marking survey work will inform the likely future course of action. Additional setts are also located around the Garden estate but will not be significantly affected by the proposed landscape project.

- Birds. No fully protected birds were found to be nesting within the Garden estate although Barn Owl regularly roosts at Waun Las and a breeding pair is likely, therefore, to be present in the vicinity. Red Kites were seen flying over during the survey but no breeding was recorded. Kingfisher is also an infrequent visitor to the site.

  The effect of the project on foraging resources for winter visiting birds such as Fieldfare and Redwing will be minimal.

  It should be noted that the nests of all bird species are protected when in occupation or under construction.
- Reptiles and amphibians. A single Grass-snake, low numbers of Common Lizard, frequent Common Toads, occasional Common Frogs and a single Palmate Newt were recorded in Survey Zones 1 and 2. The remainder of the estate was not surveyed for these groups. A mitigation plan will be required to minimize their disturbance resulting from the landscape project.
- No other nationally protected species were found to be present within the Garden estate.

12. **Faunal Species of Principal Importance**[2] and UK Biodiversity Action Plan Species.

- Birds: Eleven Section 42 and UKBAP bird species were found to be holding 83 breeding territories within the Garden estate during 2015. Of these, only about five territories (out of 22) of Song Thrush and two (out of six) of Marsh tit, are likely be affected by the proposed works; no other section 42 bird territories recorded are located within the area of planned site operations. Habitat enhancements elsewhere within the estate will, in the medium to longer term, provide replacement habitat for that lost.
- Hedgehogs are likely to be displaced during site operations but in the long term, the project is unlikely to significantly affect this species.
- Eel is known to occur in the Afon Gwynon below Pont Felin-gât and could well access the water courses upstream of the Pont Felin-gât in-channel rock and masonry impediments. It is proposed that habitat enhancements will improve the potential for Eels the access the upper Gwynon and Gwynon tributary.

13. **Other significant fauna**.

- Birds. Several additional species included on the RSPB Red and Amber lists of conservation concern were found to be nesting during the 2015 survey but only small numbers will be affected by the project work.
- Invertebrates. Tthe overall value of the habitats for invertebrates within the Garden estate as a whole is considered to be of 'County' significance. Some of these habitas will be disturbed as a result of the project but the implementation of a whole-estate Habitat Management Plan will facilitate the maintenance of the present invertebrate diversity.
- No other significant species will be impacted by the proposals.

[2] Included under Section 42 of the Natural Environment and Rural Communities Act 2006 as *Species of Principal Importance for Conservation of Biological Diversity* in Wales which causes them to be a material consideration through the planning process.

14. An **Ecological Constraints Plan** showing constraints to the landscape restoration project resulting from the presence of existing and potential ecological features has been prepared and is presented at figure 11.1. The detailed proposed layout and operations of the scheme will be finalised in consultation with the site ecologist team in order to minimise disturbance to all ecological features of interest. Where appropriate, prior to the commencement of site operations (including, in particular, all enabling works), the site ecologist will identify on the ground, features which need to be protected.

15. An **Ecological Management Plan** will be drawn-up and implemented to cover all ecological aspects of the site during site operations and to ensure that they are appropriately maintained after the completion of the work. Maintenance of the wildlife interests of the whole Garden estate will be greatly facilitated by the drafting and implementation of an estate-wide Ecological Management Plan, in particular, where the Regency Restoration works might have wider impact as in the case of species such as Dormouse, bats and Badger.

    Future management of the whole estate should include all staff, whether Garden staff, horticultural workers or agricultural and farm workers and must bear due regard to the wellbeing of individual species as well as whole habitats, also including the consideration of the importance of vegetation in supporting faunal populations.

    The success of the Ecological Management Plan will further depend upon future regular monitoring of the effects of management practices and flexibility must be incorporated within the plan to permit its easy amendment to alter management prescriptions as required.

16. More **detailed recommendations** for habitat and species management are included at section 11, below.

17. **Licences** will need to be procured from Natural Resources Wales to enable the legal disturbance of protected species including bats, Dormice and Badger. Additional checks will need to be made immediately prior to the commencement of site operations to ensure that these species, as well as reptiles and amphibians, will not be disturbed.

18. **Alien Invasive Plants**. Although no Japanese Knotweed and only a minimal amount of Indian Balsam was recorded during the surveys, other invasive alien species including Great Duckweed and three species of waterweed are present in the lakes. Particular care will need to be taken to ensure that no propagules of any alien invasive species are spread during site operations, whether within the site or by exporting to, or importing from other sites, including on vehicle wheels, tracks, etc. The control and eradication of different invasive species involves the implementation of different approved methods and sufficient time should be allowed to ensure that successful treatment is accomplished.

19. **Vegetation Clearance**. As far as possible, all clearance and disturbance to vegetation should be undertaken in September or October as potential disturbance to breeding birds, bats, Dormice and reptiles will be minimised at this time. Detailed method statements for such work will be provided by the site ecologist team, in particular where such work might disturb potential Dormouse habitat. No works will be commenced during the bird-breeding season (March to August inclusive) unless, immediately prior to the commencement of such works, it is judged by a qualified ornithologist, that the area does not support any nests. In potential reptile habitat, eg open, sunny, south-facing grassy areas, vegetation clearance

will be carried out when reptiles are active in the warmer months (April to October inclusive) but dense vegetation, such as bramble thicket, may support Dormice or birds nests so will need to be inspected prior to disturbance.

20. **Staff Commitment**. There will be input from a qualified ecologist at all stages of the project. Careful planning and supervision of site personnel will seek to ensure that disturbance to all existing habitats and species is kept to an absolute minimum. Future site maintenance should bear due regard to the well-being of all habitats, flora and fauna and comply with the directions made in the Ecological Management plan.

    All site personnel will be made familiar with the ecological requirements of the site at induction courses and tool-box talks particularly as regards their obligations to protect protected and other significant species and habitats.

    Attention is drawn to additional recommendations made at section 11 of this report.

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## **CONTENTS** (continued)

**List of Appendices** (printed in volume 2)

# 1. INTRODUCTION

Pryce Consultant Ecologists (PCE) was commissioned on 15th April 2015 by the National Botanic Garden of Wales (NBGW) to undertake the required ecological assessment work in order to progress the implementation of the proposed Regency Landscape Restoration Project at the Garden.

NBGW is located on the southern side of the Tywi valley, some 2 – 3km south of Llanarthne and 1 – 2km north of Porthyrhyd, 11km east of Carmarthen, Carmarthenshire. All parts of the site are within the Watsonian vice-county of Carmarthenshire (vc44) and the 10km Square (hectad) SN51 (22/51). The Garden occupies an area of 230ha and has been developed around the estate and parklands of the former Middleton Hall. The main public entrance is located at O.S. grid location SN518176.

The Garden estate is situated in the historic parkland of the Middleton estate which is included on the Cadw/ICOMOS Register of Parks and Gardens of Special Historic Interest in Wales and is Grade II listed on account of the surviving remains of a Regency water park. The estate was bought by William Paxton in the 1780s. A neo-classical mansion was designed by Samuel Pepys Cockerell in 1793 and completed in 1795. A waterpark was created by Samuel Lapidge within view of the mansion, creating a chain of lakes along the generally north-south running tributary of the Afon Gwynon. Within the valley of the main east-west running Afon Gwynon, waterfalls, cascades and other features were created. The water park declined rapidly, and a map of 1847 shows a gradual silting up of the lakes and an increasingly wooded landscape. By 1948 none of the lakes held standing water. The mansion was mostly destroyed by fire in 1931 and was demolished by 1954 (National Botanic Garden of Wales, 2015).

Work began on the construction of the botanic garden in 1996 and a range of ecological surveys was carried out at that time, mostly by staff and students of Aberystwyth University and a lichen survey of much of the site was carried out in 1997 by Alan Orange.

The estate is mainly underlain by Devonian rocks (Old Red Sandstone) with upper Silurian strata under the Pont Felin-gât woodlands in the north-western corner. However, most of the solid rocks are masked by a layer of glacial boulder clay with alluvium in the valleys occupied, or formerly occupied by lakes. The wooded valley of the Afon Gwynon, a tributary of the Tywi, runs east to west through the northern part of the estate and is joined on its left bank by a tributary stream near Pont Felin-gât. This stream drains the majority of the estate, the valley of which was dammed at various locations to form the string of artificial lakes which were a principal feature of the Middleton Hall parkland. The southern part of the estate is drained by a southward-flowing tributary of the Afon Gwendraeth fach which rises in an extensive wet area occupied by swamp vegetation and wet-woodland.

The majority of the estate is currently occupied by pasture fields, most of which have been agriculturally improved to varying degrees in the past. Much of this land is now farmed organically and its ecological interest and the conservation of its wildlife features are primary management objectives. Woodlands occupy the valleys in the north of the estate. These were substantially modified during the creation of the parkland by replanting with beech, hornbeam and other species which replaced much of the dominant oak wood. Small areas of planted and established woodlands also occur within the parkland area, established to

provide the planned picturesque landscape. Wet woodlands are also present, including an extensive block in the south of the site and also those established on the beds of now-drained lakes and ponds or associated with the margins of the extant lakes.

The estate is mainly surrounded by land subject to intensive pastoral farming with small isolated woodlands to the west and more extensive woodland to the east and north.

The intention of the Regency Restoration Project is to recreate the features of Samuel Lapidge's late eighteenth-century designed landscape which were extant at the time of Thomas Horner's 1815 paintings. In particular, the restoration of Llyn Mawr (at that time known as Pond Du) and the lake near Pont Felin-gât (Llyn Felin-gât), will constitute two of the major features of the project and will require considerable earthworks and habitat disturbance. The work is likely to include the re-excavation and re-lining of the lakes (with the removal of swamp vegetation and wet woodland now occupying the lake beds), the removal of trees along the lake margins that do not conform to the designed views, planting of trees to reinstate former designed clumps and woods, reinstatement of features such as cascades, bridges, and paths and removal of some modern agricultural features such as fences and hedges established since the designed landscape fell into disrepair.

The landscape restoration project, whilst potentially disruptive of some existing ecological features, also offers considerable opportunities for the enhancement of habitats which will have potential for displaced species to recolonise as well as offering species which are currently rare in the Garden estate or absent from it, opportunities for establishment.

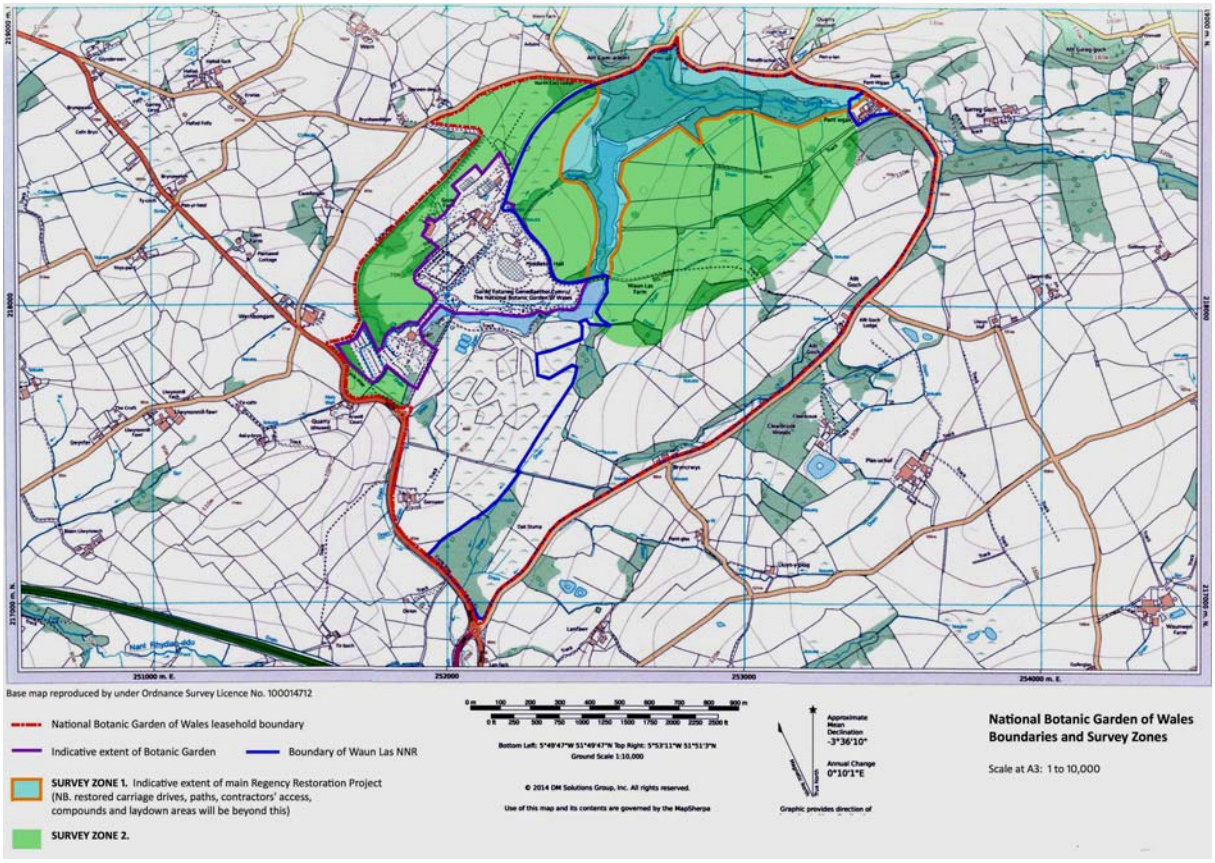



**Figure 1.1 Ecological Survey Zones**

For the purposes of the ecological assessment, the Garden estate has been divided into survey zones, each to receive a varying intensity of assessment depending upon its proximity to the proposed work. The Garden estate is shown outlined in red on figure 1.1. and the survey zones are as follows.

1. Survey Zone 1 includes the bed and shores of the former Llyn Mawr and the valley of the Afon Gwynon and is the most intensively assessed as it contains the areas where most landscape work will be necessary. Outlined orange and shaded light blue on figure 1.1.
2. Survey Zone 2 comprises mainly of areas of pasture and small woodlands in the northern and western parts of the site and is likely to be subject to more localized or smaller amounts of disturbance. Shaded green on figure 1.1.
3. The remainder of the farmland/parkland. Unshaded on figure 1.1.
4. The formal garden which will remain undisturbed during the restoration project. Unshaded but outlined purple on figure 1.1.

The Waun Las National Nature Reserve (NNR) is outlined in blue on figure 1.1.

The brief specified that the assessment should include the following elements:

- Desk study and collation of all past ecological information (whole site)
- Phase 1 habitat survey (whole estate excluding formal garden)
- Update of existing National Vegetation Classification map (Zones 1 & 2)
- Bryophyte sampling (Zones 1 & 2)
- Lichen sampling (Zones 1 & 2)
- Fungi sampling (Zones 1 & 2)
- Hedgerow survey (Zones 1 & 2)
- Breeding bird survey (whole estate excluding formal garden)
- Winter bird survey (whole estate excluding formal garden)
- Bat assessment (Zones 1 & 2 principally)
- Dormouse assessment (Zones 1 & 2 principally)
- Otter Survey (whole estate)
- Badger survey (whole estate)
- Reptile survey (Zones 1 & 2)
- Amphibian survey (Zones 1 & 2 principally)
- Invertebrate sampling (Zone 1 principally)
- Other species of concern assessment (whole estate)

This report includes the findings of these surveys together with an assessment of the likely impacts that the planned works will have on the ecological features surveyed.

The surveys and assessments commenced in April 2015 and continued throughout the year with the final report submitted in April 2016.

Several of the PCE surveyors were already familiar with the site, having undertaken botanical and faunal surveys there and in its vicinity in the past. The present work also draws upon these existing records and knowledge.

Past records held both at the Garden and the West Wales Biological Information Centre at Whitland, have also been invaluable in the preparation of the assessment.

# 2. COLLATION OF EXISTING ECOLOGICAL DATA (Richard Pryce)

## 2.1 Context and Third Party Consultations

2.1.1 In addition to the new floral and faunal data collected for the Regency landscape restoration ecological assessment, past information relevant to the project held by the following organisations was sourced and consulted.

- archive files and reports held at the National Botanic Garden of Wales
- records made over the past few years by the NBGW's Volunteer Biodiversity Group
- ecological data held by the West Wales Biological Information Centre, Whitland
- the database held and maintained by the County Recorder of the Botanical Society of Britain and Ireland.

Existing data has been reviewed by the various subject authors of this report and where relevant, consolidated into the various sections of the report.

2.1.2 Reference to early edition Ordnance Survey maps was made which show the locations not only of woodlands, hedgerows, lakes and other topographic features, but also individual hedgerow trees and parkland trees which, if extant, can be identified on today's aerial photographs.

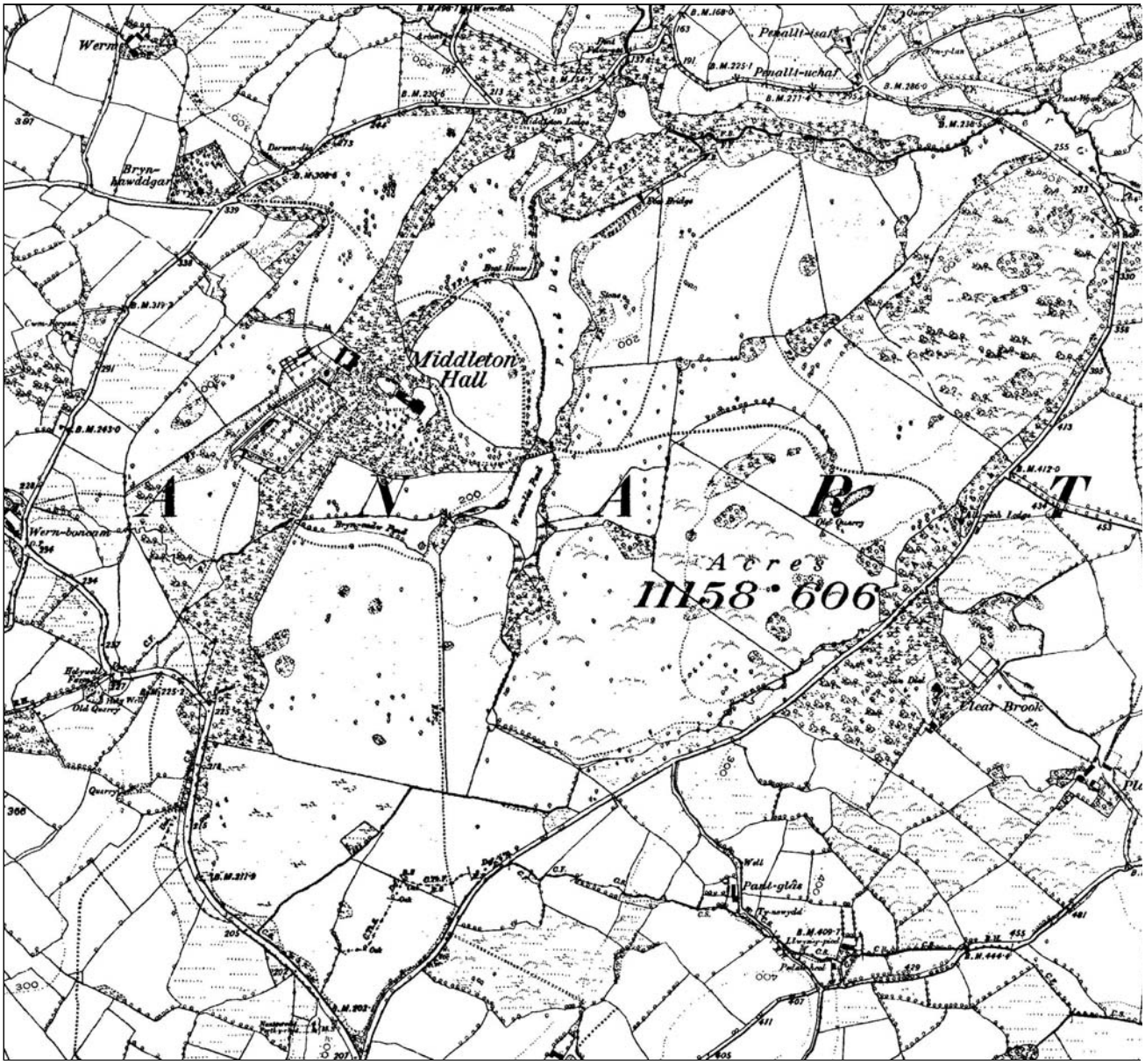



**Figure 2.1 First edition 25 inch Ordnance Survey map of c.1843 - 1890**

2.1.3 The Countryside Council for Wales Phase 1 Habitat Survey maps produced in about 1990 and CCW statutory protected site citations were also consulted. The Phase 1 map (see figure 2.2) is revealing as it shows the majority of the land within the NBGW estate as agriculturally improved grassland (unshaded annotated "I"), where some meadows, due to wildlife-conservation management, can now be regarded as having regained an increasing degree of species diversity (cf the current Phase 1 Habitat map).

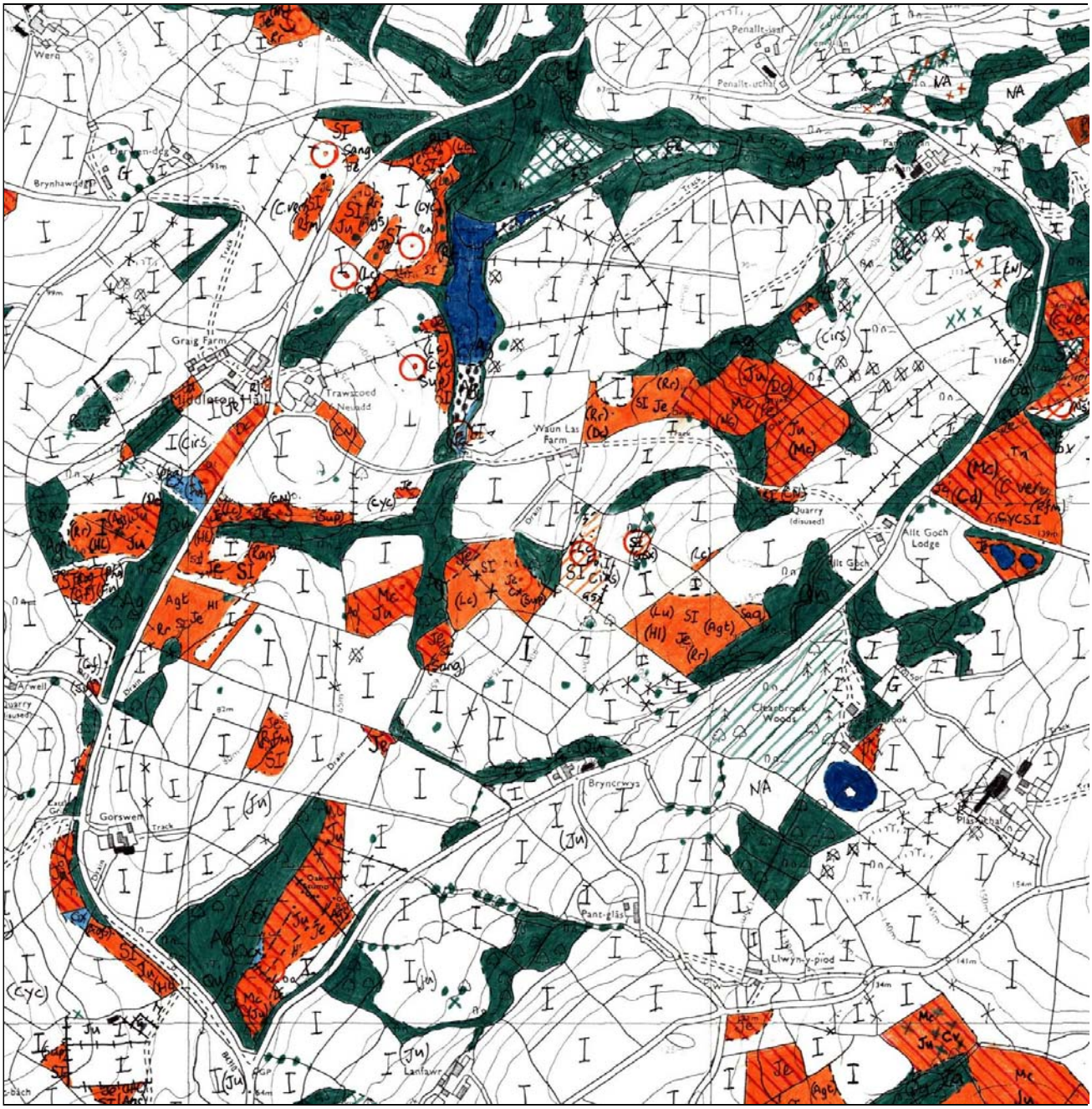



**Figure 2.2 Countryside Council for Wales Phase 1 habitat map of c.1990**.

The land shown in orange (generally with SI superimposed) represents agriculturally semi-improved neutral grassland pasture which is by-and-large extant.

The land shown as orange hatched purple is termed "marshy grassland" which includes a range of wet grassland types such as damp or wet rush-dominated grassland, Purple Moor-grass dominated vegetation and Meadowsweet dominated tall-herb stands. These areas are also very largely extant, although parts of the fields in the extreme south of the site and some other areas elsewhere have now partly developed into Lesser Pond-sedge-dominated fen with encroaching Alder carr.

The small area of white hatched orange near the centre of the site represents dry acid grassland.

2.1.4 The whole of the farmed area of the NBGW estate together with most of the woodlands are included in the Waun Las National Nature Reserve, established in August 2008 in order to conserve and maintain existing habitats of ecological significance and restore ecological diversity to areas which had undergone agricultural improvement in the past but, by means of appropriate management, could be encouraged to again realize their former species-richness and wildlife value. The NNR is also intended to act as a model to the agricultural community of how, with appropriate management, wildlife can live in harmony with a modern agricultural enterprise.

Sam Bosanquet, who carried out a detailed vegetation survey of the Waun Las National Nature Reserve for the Countryside Council for Wales in 2007-11 introduced his report as follows. The land "*has been organically farmed since the late 1990s and was one of the first farms to join the Tir Gofal agri-environment scheme. Before that, most fields were part of a deer farm, and deer fences still surround the core of the site, excluding only compartments 21, 24–26b, 29–30 and 32–34* [see figure 2.3]. *Subsequently, the difficulties of moving cattle have lead to most fields being stocked with sheep according to the farmer* [at that time]*, Tim Bevan. The deer grazing is thought to have caused significant declines in grassland herb abundance, which has not been helped by later sheep grazing. Ponies or cattle were put on to the central marshy grassland (compartments 12 & 15) occasionally, but the Purple Moor-grass pastures were left almost unmanaged and have therefore become very rank.*

*Under the Tir Gofal agreement, fences were erected in the early 2000s to separate off some of the* [ecologically] *richer areas of grassland – such as compartment 18 from 19, and part of 12 from the rest of the field – allowing separate management or targeted grazing. Unfortunately three areas of marshy grassland on the western and southern sides of 26a and 26b were fenced-off without gates being put in, and are now being left to turn to wet woodland, significantly damaging the already small area of good marshy grassland on the site.*

*Three woodland clearings – compartment 32, the swampy 33 and 34 – are unmanaged, and the last holds some degraded neutral grassland that is rapidly being lost to bramble invasion. Compartment 25 held two pigs in May 2008 and appeared very disturbed and heavily grazed.*

*The abundance of Yellow-rattle and other herbs has increased dramatically in the sward according to Tim Bevan.*

*Spoil from the building of the adjacent gardens was dumped on the upper half of compartment 29, which now holds various anomalous semi-improved swards and areas of regressing rush pasture (NVC MG10)".*

2.1.5 No other statutory or non-statutory protected sites (including nature reserves or other designated sites of nature conservation interest) are located within the NBGW estate but the Wernbongham stream section and quarry Site of Special Scientific Interest (SSSI) is located only some 125m from its north-western boundary (see Nationally protected sites, below).

2.1.6 Designated sites of international, national, county or local importance located within about 5km of the NBGW estate or which might be impacted by the proposal to restore the Regency landscape are listed below.

Internationally protected sites

Several sites which are protected in an international context are located in the area. These include Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar Sites and are listed below. The sites, which could be affected by the proposed landscape restoration project include the following.

- The **Afon Tywi/River Towy SAC** runs within about 2km to the north of the NBGW estate but none of the Tywi tributaries are included in the SAC designation. The Afon Gwynon and its tributaries which drain NBGW land flow directly into the Tywi. Otter is one of the qualifying reasons for the selection of this SAC and animals use, not only the Tywi, but also its tributaries, including, infrequently, the Gwynon and connected watercourses and riparian habitat within NBGW. The other qualifying reasons include the presence of a range of fish species including lampreys and shads, as well as Bullhead. Bullhead is certain to occur in the Gwynon and could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. However, any disturbance to this population is unlikely to adversely affect the Tywi population due to its isolation. Furthermore, the reinstatement of the lakes as planned will, in the longer term, result in a substantial increase in the extent of suitable habitat available to this species.

  All these species could be adversely affected by a temporary deterioration in water quality should run-off or other potential pollution incidents not be contained during the restoration works.

  The Afon Tywi flows into the **Carmarthen Bay and Estuaries SAC** which extends to Pibwrlwyd, just downstream of Carmarthen, some 11km west of the NBGW estate. Otter is also a qualifying reason for the selection of this SAC. The Carmarthen Bay and Estuaries SAC encompasses the **Burry Inlet SPA** and the **Burry Inlet Ramsar Site** which are designated for their ornithological interest.

- The **Cernydd Carmel SAC** extends to within some 3.5km south-east of the NBGW estate. The Pentregwenlais Turloch is the primary reason for the selection of this SAC with wet and dry heath, active raised bog and Tilio-Acerion woodland as qualifying features.

- The **Caeau Mynydd Mawr SAC** extends to within some 7km south-east of the NBGW estate. The population of Marsh Fritillary butterfly is the primary reason for the selection of this site with Molinia meadows being a qualifying feature.

The citations of these internationally protected site are reproduced at appendix 11.

Nationally protected sites

Sites of Special Scientific Interest (SSSI) located within about 5km of the NBGW estate are as follows. Sites are listed in order of increasing distance from the estate.

- Wernbongham stream section and quarry SSSI is notified for its important exposure of rocks straddling the Silurian – Devonian boundary critical in the interpretation of the change from marine to non-marine environments. It is located only some 125m from the north-western boundary of the NBGW estate. The earthworks associated with the Regency landscape restoration project may provide the opportunity for the development of fresh rock exposures which could offer the chance for further research into this aspect of Welsh geological history.
- Afon Tywi SSSI includes the river channel and banks between Llandovery to below Carmarthen. Its closest point is located some 2km to the north of NBGW.
- Cwm-yr Abbey stream section SSSI is a geological site exposing rocks of Arenig age yielding an important trilobite fauna and is located 2km to the north-west of NBGW.
- Coedydd-y-Garn SSSI primarily comprises of woodland growing on Carboniferous Limestone and supports a wide range of characteristic flora and fauna. It is located some 2.5km to the south-southwest of NBGW.
- Gweunydd a Choed Pen-ty (Pen-ty Pastures & Wood) SSSI is of botanical and entomological importance and is located 3.25km to the west-southwest of NBGW.
- Ynys Uchaf SSSI is a mire occupying part of the Gwendraeth Fach flood-plain and is located 3.5km to the south-west of NBGW.
- Allt-y-Gaer SSSI was notified for its large heronry and is located some 4.1km to the north-east of NBGW.
- Mynydd Llangyndeyrn SSSI is an extensive area grassland, heath and rock outcrops on the Millstone grit ridge near Crwbin and is located some 4.1km to the south-west of NBGW.
- Waun-fawr SSSI is a small basin mire located some 4.1km to the south-west of NBGW.
- Cernydd Carmel SSSI includes a diverse range of habitats developed on Carboniferous Limestone and Millstone Grit including woodland, various types of grasslands, heaths and mires, as well as disused limestone quarries. It is located some 4.25km to the east-southeast of NBGW.
- Caeau Rhyd-y-Gwiail SSSI near Gorslas supports neutral and wet grassland vegetation, wet heath and scrub and is located some 4.5km to the south-east of NBGW.
- Llyn Llech Owain SSSI on the Millstone Grit ridge near Gorslas is an acid lake exhibiting upland features although situated at relatively low altitude, and located some 4.75km to the south-east of NBGW.

Nature Reserves and other sites of nature conservation interest

- Carmel Woods National Nature Reserve includes parts of Cernydd Carmel SAC and SSSI (see above) and is located some 4.25 km to the east-southeast of NBGW.

Designated areas of Semi-Natural Ancient Woodland located within about 3km of the NBGW estate are as follows. Designated areas are listed in order of increasing distance from the estate. It should be noted that ancient woodland sites must extend to a minimum area of 2ha to qualify for designation but that many additional woodlands of ancient character and provenance but of lesser area may also be present within the area of search.

- Pont Felin-gât woodland, within NBGW, occupies much of the area north and north-east of the site of Llyn Mawr and extends north-westwards outside the Garden estate along the course of the Afon Gwynon for about 300m.
- Garreg Goch isaf wood adjoins the north-eastern boundary of NBGW (on the opposite side of the Allt Goch Lodge – Pantwgan road) and extends a further c.500m eastwards.
- Allt fawr is located some 1.1km to the north-east of NBGW.
- Allt Cae-blawd and Dan-yr-Allt wood is located some 1.25km to the north of NBGW.
- Allt Clos-glas wood is located some 1.25km to the east of NBGW beyond Garreg Goch isaf wood.
- Cwm-du wood is located some 1.25km to the north-west of NBGW.
- Cwmeiddon wood, Foelgastell, is located some 2km to the south-east of NBGW.
- Penybanc wood, Foelgastell, is located some 2km to the south-east of NBGW.
- Allt Rhyder-Wen is located some 2.1km to the east-northeast of NBGW.
- Wern-las – Capel Begewdin – Llawrcwrt woodlands are located some 2.3km to the south-southwest of NBGW.
- Banc-y-Mansel wood is located some 2.5km to the south-southeast of NBGW.
- Cwmisgwyn wood, Llanddarog, is located some 2.5km to the south-west of NBGW.
- Llethr Llestri wood, Cwmisfael, is located some 2.5km to the south-west of NBGW.
- Pen-y-banc-isaf wood, north of Y Polin, is located some 2.6km to the west-northwest of NBGW.
- Allt Pant-mawr is located some 2.9km to the east-northeast of NBGW.
- Kincoed wood, Abercothi, is located some 2.9km to the north-west of NBGW.
- Ty Picca wood, Cwmisfael, is located some 2.9km to the west-southwest of NBGW.

2.1.4 Staff at the West Wales Biological Information Centre were consulted and supplied protected-sites and significant species data held on its database from the Garden estate and within a 2km zone drawn beyond the circumference of the estate boundary. The results of their search produced 3245 species records which are reproduced at appendix 18 (note there are access restrictions to this data under the conditions applied by WWBIC).

These records have been examined and species which have been recorded within the Garden estate or, if recorded within 2km, are sufficiently mobile to be likely to occur within the estate are listed below. Very old records, eg the Wood White butterfly recorded in 1915, have been excluded.

The list includes the following protected species.

European Protected Species

| | |
|---|---|
| Common Pipistrelle bat | *Pipistrellus pipistrellus* |
| Soprano Pipistrelle bat | *Pipistrellus pygmaeus* |
| Brown Long-eared Bat | *Plecotus auritus* |
| Hazel Dormouse | *Muscardinus avellanarius* |
| European Otter | *Lutra lutra* |

Nationally Protected Species additional to the above

| | |
|---|---|
| Eurasian Badger | *Meles meles* |

| | |
|---|---|
| Adder | *Vipera berus* |
| Common Toad | *Bufo bufo* |
| Common Frog | *Rana temporaria* |
| Palmate Newt | *Lissotriton helveticus* |
| Red Kite | *Milvus milvus* |
| Barn Owl | *Tyto alba* |
| Small Blue | *Cupido minimus* |

Other significant species additional to the above are as follows.

Section 42 *Species of Principal Importance*[3] additional to the above

| | |
|---|---|
| Brown Hare | *Lepus europaeus* |
| West European Hedgehog | *Erinaceus europaeus* |
| Lesser Redpoll | *Acanthis cabaret* |
| Reed Bunting | *Emberiza schoeniclus* |
| Kestrel | *Falco tinnunculus* |
| Pied Flycatcher | *Ficedula hypoleuca* |
| Grasshopper Warbler | *Locustella naevia* |
| Yellow Wagtail | *Motacilla flava* |
| Spotted Flycatcher | *Muscicapa striata* |
| House Sparrow | *Passer domesticus* |
| Tree Sparrow | *Passer montanus* |
| Willow Tit | *Poecile montana* |
| Marsh Tit | *Poecile palustris* |
| Song Thrush | *Turdus philomelos* |
| Pink Waxcap fungus | *Hygrocybe calyptriformis* var. *calyptriformis* |
| Brown Hairstreak butterfly | *Thecla betulae* |
| Grey Dagger moth | *Acronicta psi* |
| Knot Grass moth | *Acronicta rumicis* |
| Ear Moth | *Amphipoea oculea* |
| Dusky Brocade moth | *Apamea remissa* |
| Garden Tiger moth | *Arctia caja* |
| Mottled Rustic moth | *Caradrina morpheus* |
| Small Square-spot moth | *Diarsia rubi* |
| Small Phoenix moth | *Ecliptopera silaceata* |
| August Thorn moth | *Ennomos quercinaria* |
| Ghost Moth | *Hepialus humuli* |
| Rosy Rustic moth | *Hydraecia micacea* |
| Brindled Beauty moth | *Lycia hirtaria* |
| Dot Moth | *Melanchra persicariae* |
| Shoulder-striped Wainscot moth | *Mythimna comma* |
| Oblique Carpet moth | *Orthonama vittata* |
| Powdered Quaker moth | *Orthosia gracilis* |
| Grass Rivulet moth | *Perizoma albulata* |
| Shaded Broad-bar moth | *Scotopteryx chenopodiata* |
| White Ermine moth | *Spilosoma lubricipeda* |
| Buff Ermine moth | *Spilosoma luteum* |

[3] *Species of Principal Importance for Conservation of Biological Diversity* in Wales, listed under section 42 of the Natural Environment and Rural Communities Act 2006.

| | |
|---|---|
| Blood-Vein moth | *Timandra comae* |
| Cinnabar moth | *Tyria jacobaeae* |
| Oak Hook-tip moth | *Watsonalla binaria* |
| Dark-barred Twin-spot Carpet moth | *Xanthorhoe ferrugata* |

In addition, a significant number of other species designated because of their rarity or population decline have been recorded from the Garden estate and within a zone 2km around its perimeter. These include Stoat, Hairy Dragonfly, 8 moths, 3 true flies, 3 vascular plants, Dotted Hornwort, 21 lichens, 2 liverworts and 15 mosses.

2.1.5 The Carmarthenshire Flora database (which also includes many faunal records) maintained by the County Recorder of the Botanical Society of Britain and Ireland was interrogated and records abstracted of species held on the database from within the Garden estate and a 2km zone drawn beyond the circumference of the estate boundary. Species abstracted are listed at appendices 5 and 6 (these lists exclude the records made during the present survey).

These records have been examined and species which have been recorded within the Garden estate or, if recorded within 2km, are sufficiently mobile to be likely to occur within the estate are listed below.

The list includes the following protected or Section 42 species additional to those included in the WWBIC data (highlighted in yellow at appendices 5 and 6).

No additional European Protected Species are held on the database

Nationally Protected Species additional to the above

| | |
|---|---|
| Fieldfare | *Turdus pilaris* |
| Little Ringed Plover | *Charadrius dubius* |

Section 42 *Species of Principal Importance*[4] additional to the above (highlighted in orange on appendices 5 and 6)

| | |
|---|---|
| Dark Brocade | *Blephianta adusta* |
| Common Bullfinch | *Pyrrhula pyrrhula* |
| Common Linnet | *Carduelis cannabina* |
| Hedge Accentor/Dunnock | *Prunella modularis* |
| Sky Lark | *Alauda arvensis* |

In addition, a number of other species designated because of their rarity or population declines have been recorded from the Garden estate and within a zone 2km around its perimeter. These are annotated on appendices 5 and 6.

2.1.6 Additional protected or significant species are also likely to occur in the vicinity of the Garden although no past records are held on either the WWBIC or Carmarthenshire Flora databases. These include, for instance, Peregrine, Kingfisher, Cuckoo, Redwing, Pied Flycatcher, Starling and Reed Bunting.

[4] *Species of Principal Importance for Conservation of Biological Diversity* in Wales, listed under section 42 of the Natural Environment and Rural Communities Act 2006.

2.1.7 Records and reports held in the archives of the National Botanic Garden of Wales have also been consulted and have been used to inform the present ecological surveys. In particular, in addition to the National Vegetation Classification (NVC) Survey undertaken by Sam Bosanquet for the Countryside Council for Wales in 2007-11, the map of *Surviving Trees, Field Archaeology, Lakes, Ponds and Views* produced by Christopher Gallagher dated August 1990 has been consulted in order to locate parkland trees recorded at that time and to determine whether they remain extant.

2.1.8 Field names have been collated by Bruce Langridge (Information Officer at NBGW) and have, as far as possible, been correlated with the numbered compartments used by Sam Bosanquet for his NVC Survey. These are shown on figure 2.3 and have been used in the text that follows.

# 3. HABITATS AND VEGETATION (Richard Pryce)

## 3.1 Survey Objectives

The objectives of this survey were

- To identify and map the habitat types occurring within the Garden estate using techniques based upon the NCC Phase 1 Habitat Survey methodology.
- To update and extend the existing National Vegetation Classification map and report produced by CCW in 2009-11. The CCW survey was confined to the land within the Waun Las National Nature Reserve but the present survey extends this to include survey zones 1 and 2 as well as much of the other land within the Garden estate.
- To assess potential impacts to the habitats and vegetation types which might result from the proposed landscape restoration works.
- To identify constraints which might be imposed upon the project in order to retain and conserve habitats and vegetation of significance.
- To identify opportunities for habitat conservation and enhancement which might be presented as a result of the project.

## 3.2 Phase 1 Survey Methodology

The vegetation types present within the site were mapped by Richard Pryce at 1:2500 scale using methodology based on that described in the *Handbook for Phase 1 habitat survey - a technique for environmental audit.* (Nature Conservancy Council, 1990). The results of the habitat survey are presented primarily in plan form at figure 3.1.1 (showing dominant and significant species locations), figure 3.1.2 (showing the locations of Target Notes) and as a GIS layer on the Botanic Garden's IT system. Brief descriptions of each habitat type are given below in the order set out in the *Handbook*, and Target Notes (TN), including comprehensive species lists (including their Latin names), are reproduced at appendix 2 and located on figure 3.1.2. Target Notes are also plotted on the GIS layer where the habitat descriptions and species lists attached to each, together with photographs taken at each location, are also included. Incidental observations of faunal taxa were also noted and are either included in the target notes or are referred to in the text. Lists of all species collated from the target notes are also included at appendix 3.

The survey was carried out principally by Richard Pryce between 29th April and October 2015. On various dates, assistance was received from Kath Pryce, Sam Bosanquet, Barry Stewart, Stephen and Ann Coker, Margot Godfrey, Jenny Fode, Sam Thomas, members of the Botanical Society of Britain and Ireland and the Garden Biodiversity Volunteer Group.

## 3.3 National Vegetation Classification

Helen Bird of Aberystwyth University carried out a "*NVC Vegetation Classification Analysis*" in 1997 but the drawing she produced at the time only plotted the locations of her survey quadrats and made no attempt to map the vegetation communities she had identified. Some of the vegetation community types selected by the computer software she used to apply to her field-survey results appear open to question and were not confirmed by subsequent surveys. The occurrences of some vegetation communities should therefore not be accepted without further enquiry.

Sam Bosanquet of the Countryside Council for Wales resurveyed the land within Waun Las National Nature Reserve in 2007-11. The NVC map and report he produced have been

used as the basis of the present NVC work which included the identification of vegetation changes that have taken place since the 2007-11 survey and extending his map to cover Survey Zone 2 and other areas of the Garden estate. Formal quadrats were not recorded during the 2015 survey but species listed in target notes, together with the surveyor's long experience of previous vegetation surveys in the local area were used to identify the NVC communities. Results of the 2015 resurvey are reproduced at figure 3.2 and as a GIS layer on the Botanic Garden's IT system.

Each broad vegetation type as listed in the Phase 1 Habitat hierarchy is described in a separate section below, with details of NVC communities also included. It is hoped that combining Phase 1 and NVC descriptions in this way has resulted in a more concise and less confusing account with all vegetation descriptions grouped together in their relevant sections.

Christopher Gallagher's map of *Middleton: Surviving Trees, Field Archaeology, Lakes, Ponds and Views,* dated August 1990 has been consulted in order to relocate parkland trees recorded at that time and to determine which remain extant. The results of this work are recorded at figure 3.3.

## DESCRIPTIONS OF HABITATS AND VEGETATION

### 3.4 Woodland and scrub

3.4.1 Many woodlands within the NBGW Estate which had been in existence prior to the creation of the Regency Landscape were considerably modified by the introduction of non-native broadleaved species, principally Beech and Hornbeam with some Sweet Chestnut, to create the parkland woodlands as we see them now. Rarely were coniferous species planted as the original plantings predated the introduction to this country of most of today's familiar conifers. The few conifers that are present post-date the original Regency plantings.

Woodland types identified during the survey generally grade into one another and the situation is further complicated by the fact that very few oaks survive from the pre-parkland oak-dominated woodland, the canopy now generally being dominated by planted and self-sown Beech, Hornbeam and Ash. Although the mapping of the various woodland communities has been attempted at figure 3.2, the delineation of sub-communities has generally been found to be impractical.

3.4.2 *Dry, formerly oak-dominated woodlands*

Prior to this modification, the majority of the woods within the NBGW Estate would have been similar to woodlands in the area which currently remain unmodified, by having a canopy dominated by native Pedunculate Oak (or probably more commonly, hybrid Pedunculate x Sessile Oak) with less frequent but locally abundant, Ash, an understorey dominated by Hazel, Hawthorn, Holly and Honeysuckle and a sub-shrub layer with frequent Bramble. It is the herb layer which gives the clues to the types of woodland which would have existed before parkland tree-planting and the presence of herb-layer species characteristic of the dominant National Vegetation Classification (NVC) W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* woodland, point to the predominance of this community. This is reflected in the NVC mapping at figure 3.2, although no attempt has been made to map the intricate mosaic of the various sub-communities which depends upon factors such as small-scale variations in soil chemistry and wetness. Where possible, NVC sub-communities have been identified in each Target Note and are shown on the NVC layer of the QGIS mapping. Herb-layer species vary from Wood Sorrel, Wood Sage and Bluebell

in more acid conditions to Dog's Mercury, Yellow Archangel, Wood Anemone, Sanicle, Wood Speedwell and Wood Sedge where the soil is more base-rich, whilst locally, in flushed or swampy areas, Opposite-leaved Golden Saxifrage and Remote Sedge may occur.

Less modified oak woodland occurs along the valley parallel to the south-eastern boundary of the Estate but, even here, Ash is frequent in the canopy, perhaps indicating, following felling operations, the relative ease with which Ash regenerates in the relatively base-rich soil conditions when compared with oak.

Sub-communities of the W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* woodland identified during the survey include the W10a typical sub-community where acid soils often encourage the growth of extensive stands of Bluebell, the W10b *Anemone nemorosa* sub-community characteristic of more damp, base-rich conditions, and the W10c *Hedera helix* sub-community on more acid soil where Bluebell is not dominant in the herb layer.

The lichen *Sticta sylvatica*, a member of the rare Lobarian lichen community, grows on willow, ash and hazel trunks/stems at three locations within the Llyn Felin-gat woodland (TN15024, TN15029 and TN15030). These are shown on figure 11.1.

3.4.3 *Ash dominated woodlands*

In south-west Wales, Ash-dominated woodlands are generally associated with the calcareous outcrops of Carboniferous Limestone but within the Garden estate, on the relatively base-rich Devonian marl soils, on sloping, flushed valley-sides where base-enrichment of the soil occurs, Ash may become dominant and small areas of the W9 *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland may be present within the more ubiquitous oak woodland. In common with this latter type, Ash stands have also been subject to human intervention but Ash, both planted and self-sown, has become an abundant canopy species throughout much of the former oak woodland by taking advantage of the creation of woodland gaps in the past and, as such, has replaced much of the previous oak-dominated canopy. Hazel is the dominant shrub-layer species with occasional Wych Elm, Downy Birch and rarely Rowan and characteristic herb-layer plants include Dog's Mercury, False Oat-grass and Primrose although many species present in W10 also occur in W9.

Although Ash (with non-native Beech and Hornbeam) now dominates, the principal NVC type of these partly-anthropogenic woodlands remains as a modified version of W10 although small areas of W9 may have been present in more base-rich areas, particularly where Dog's Mercury continues to dominate in the herb layer. Within most of the NBGW woodlands, therefore, it is not possible with certainty to separate W10 from W9 and this has necessitated mapping the major woodlands as W10 with only the small strip near the propagation houses singled out as best-fitting W9 of the more lowland, southern W9a typical sub-community.

3.4.4 *Wet, Alder-dominated woodland*

Wet and waterlogged soils in the valley bottoms, often comprising only of intermittent narrow strips but also including areas within the lake beds of Middle Pond, Llyn Felin-gat and Llyn Gwynon, may be dominated by Common Alder or, at least, support a significant component of that species, mixed with Ash and locally abundant Grey Willow. Alder can attain a high canopy, particularly where it is associated with Ash, but more generally, eg at Llyn Gwynon,

reaches a medium height, forming a woodland of open character which has allowed the establishment of a rather grassy herb-layer.

The extensive Alder-dominated woodland which includes a significant component of Grey Willow, located in the southern part of the NBGW estate, is relatively young, having colonised previously open, Lesser Pond-sedge-dominated sedge-fen due to the cessation of grazing. This woodland will continue to encroach upon the open fen vegetation unless it is managed. Bramble is locally abundant as a sub-shrub layer and, in addition to the often dominant herb layer of Lesser Pond-sedge, Water Horsetail, Meadow-sweet and Greater Tussock-sedge are also prominent in some areas, together with the uncommon Marsh Cinquefoil and Marsh Valerian, the latter recorded at two sites (TN15197 and TN15232).

There are also smaller areas of Alder-dominated woodland located in the vicinity of the main public car-parks where the vegetation is often edged by communities more characteristic of drier ground such as the W10 oak woodland. Here, again, this woodland is frequently associated with Grey Willow and some has also originated by the colonisation of Lesser Pond-sedge stands. However, more commonly, the Alder stands in this part of the Garden are associated with stream-side and valley-bottom wetlands and flushes.

The Alder-dominated woodlands within the Garden estate are classified as the NVC W7 *Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland community with the majority, where a sub-community was identified, being the W7a *Urtica dioica* sub-community but a small area of the characteristically wetter W7c *Deschampsia cespitosa* sub-community occurs south of the Aqua-lab.

3.4.5 *Willow scrub-woodland*

The most extensive stands of willow-dominated scrub-woodland occupy the land which was used for the deposition of silt dredged from Llyn Uchaf and Llyn Canol prior to the opening of the Garden to the public. Here Grey Willow forms a near pure canopy of low to medium-height with a somewhat impoverished herb-layer due to the dense shade cast by the willows in summer. Where there are open areas, in addition to characteristic native species such as Opposite-leaved Golden-saxifrage and Remote Sedge, the comfrey *Symphytum* 'Hidcote Blue' is often extensively naturalised to the exclusion of other species and elsewhere, Fringe-cups is also naturalised (TN15146)

Since its draining, considerable areas of the bed of the former Llyn Mawr have also become colonised by Grey Willow-dominated scrub-woodland which has generally attained a low to medium-height canopy and is often associated with Alder-dominated stands.

Elsewhere, willow-dominated scrub-woodland occurs in smaller stands where it occupies wet areas, particularly at the edges of formerly grazed damp fields (eg in the area between North Lodge and the main Garden buildings) or at the edges of recently fenced, mature woodland blocks.

The Grey Willow dominated woodland occurring at NBGW belongs to the W1 *Salix cinerea – Galium palustre* woodland community. There are no sub-communities.

An extensive plantation of Grey Willow established for biomass is located adjacent to the north-west of the Woods of the World site centred at TN15572 (see paragraph 3.6.6).

3.4.6 *Hawthorn scrub*

Small areas of Hawthorn dominated scrub are found primarily on woodland margins but none were sufficiently extensive to have been mapped separately. These belong to the NVC W21 *Crataegus monogyna - Hedera helix* scrub community.

3.4.7 *Blackthorn scrub*

Although Blackthorn was recorded (though relatively infrequently) as a hedgerow component, only one small area of monospecific Blackthorn scrub was recorded during the survey. This is located at TN1536, near the eastern boundary of the Garden estate about 250m west-southwest of Allt Goch Lodge where the 10m Blackthorn canopy is associated with an Ivy-dominated ground layer and occasional *Dryopteris* ferns.

This vegetation is identified as the NVC W22a *Prunus spinosa – Rubus fruticosus* scrub, *Hedera helix – Silene dioica* sub-community.

3.4.8 *Gorse scrub*

Although Common Gorse is occasionally present in hedgerows and as a component of scrub, there are few stands of pure gorse within the Garden estate and those that are present are mainly of small extent. During the 2007-11 survey, Bosanquet found that Gorse scrub was concentrated in Cae Banc (compartments 11 and 12) and Compartment 15. This remains the case with the largest areas being located on the acid, north-facing slope south of Pantwgan, but by the time of the 2015 survey, most had been cut to ground-level (TN15460) (NB cut stands are mapped with different ornamentation to other stands on figure 3.2). Examination of this slope on the 2000, 2006 and 2009 aerial photographs shows a progressive removal of what was previously, a substantial area of gorse scrub which would have provided an additional valuable habitat, a habitat which is now almost absent from within the Garden estate. Gorse scrub is invariably associated with Bramble and/or Bracken and this is true of the remaining small NBGW stands.

The gorse-dominated vegetation within the Garden estate is identified as the NVC W23a *Ulex europaeus – Rubus fruticosus* scrub, *Anthoxanthum odoratum* sub-community.

3.4.9 *Bramble scrub*

Several large bramble thickets, as well as many smaller stands, are widespread within the Garden estate, most of which have become established around woodland and hedgerow margins and by the colonisation of previously open grassland areas and unmanaged land which, due to lack of resources, have not been regularly cut during the past few years. These bramble thickets, in the absence of management, represent an early stage of succession to oak woodland and provide invaluable faunal habitat and refuge offering abundant foraging for birds and small mammals such as Dormice, as well as nesting and resting sites, whilst in riparian situations, dense bramble may be used by Otters for lying-up.

Associated species of these stands include Common Nettle, Creeping Thistle and Rose-bay Willowherb, the coarse grasses Cock's-foot and False Oat-grass, as well as the scrambler, Cleavers. In damper areas Meadow-sweet and Great Willowherb may be prominent.

These bramble stands are identified as the NVC W24 *Rubus fruticosus – Holcus lanatus* underscrub community. Both sub-communities are present, the W24a *Cirsium arvense – Cirsium vulgare* sub-community where bramble has encroached upon open often recently disturbed ground and the *Arrhenatherum elatius – Heracleum sphondylium* sub-community

characteristic of abandoned grassland, being successional, following the establishment of coarse grassland subsequent to the cessation of grazing.

The larger bramble stands have been mapped at figures 3.1.1, 3.1.2 and figure 3.2 but it has not been possible to differentiate narrow woodland-margin stands and stands associated with hedgerows at the mapping scale used.

3.4.10 Native tree and other woody species recorded at NBGW mainly during the 2012-2015 surveys

| Scientific Name | Vernacular Name | Notes |
|---|---|---|
| *Alnus glutinosa* | Alder | |
| *Betula pendula* | Silver Birch | |
| *Betula pubescens* | Downy Birch | |
| *Betula* x *aurata* | hibrid birch | |
| *Corylus avellana* | Hazel | |
| *Crataegus monogyna* | Hawthorn | |
| *Fraxinus excelsior* | Ash | |
| *Hedera helix* | Ivy | |
| *Ilex aquifolium* | Holly | |
| *Ligustrum vulgare* | Wild Privet | Local interest |
| *Lonicera periclymenum* | Honeysuckle | |
| *Populus tremula* | Aspen | |
| *Prunus avium* | Wild Cherry | |
| *Prunus spinosa* | Blackthorn | |
| *Quercus robur* | Pedunculate Oak | |
| *Quercus* x *rosacea* | hybrid oak | |
| *Rhamnus cathartica* | Buckthorn | Local interest |
| *Ribes rubrum* | Red Currant | |
| *Rosa arvensis* | Field-rose | |
| *Rosa canina* agg. | Dog Rose | |
| *Rubus fruticosus* | Bramble | |
| *Rubus idaeus* | Raspberry | |
| *Salix caprea* | Goat Willow | |
| *Salix cinerea* subsp. *oleifolia* | Rusty Willow | |
| *Salix pentandra* | Bay Willow | Local interest, possibly planted |
| *Salix repens* | Creeping Willow | Local interest |
| *Sambucus nigra* | Elder | |
| *Sorbus aucuparia* | Rowan | |
| *Ulex europaeus* | Gorse | |
| *Ulmus* aggregate | Elm | |
| *Ulmus glabra* | Wych Elm | |
| *Ulmus procera* | English Elm | |
| *Viburnum opulus* | Guelder-rose | |

## 3.5 Parkland trees

Numerous mature and ancient parkland trees are scattered around the Garden estate, many now past maturity and showing signs of senescence, frequently having shed branches or with dead, stag-headed crowns. Some trees present in the park today, date back to or before the Regency period and are shown on early estate maps. Beech and Pedunculate Oak are the most frequent parkland species with Lime, Sweet Chestnut, Ash, Horse Chestnut and Hornbeam also recorded. Some are still magnificent trees of high visual and landscape value but several noted by Gallagher in 1990, including several oaks

and Beeches, appear to have since been lost or are now just stumps, and no trace was found of trees such as the Cedar of Lebanon on the western side of Llyn Mawr that he recorded as being dead at that time. Figure 3.3 compares the trees recorded by Gallagher with those which still exist. Note that Gallagher only recorded the northern part of the Estate.

Many specimen trees have been planted in recent years to replace those that have died or can be expected to die in the relatively near-future.

Trees in open pastoral situations are often very important in providing substrate on which lichens become established and thrive. Where similar trees have been fenced, typically at the edges of woodland, the absence of grazing around them has permitted the establishment of undergrowth, scrub and, in particular, trunk-cladding Ivy, preventing light from reaching the trees and killing many lichens. Further recommendations on lichen conservation are included at paragraphs 6.3 and 6.5.

### 3.6 Plantation woodland, planted and non-native trees and shrubs

3.6.1 As noted above (section 3.4), much of the existing mature woodland within the Garden estate could be regarded as, or, at least, contains an element of plantation woodland, the original habitat having been partially replanted with both native and non-native, mainly broad-leaf species.

However, since the Garden has been established, several additional new woodlands have been planted. These fall into two broad types: the first to provide shelter, screening along boundaries and around car-parks, and the second, to grow biomass. These are in addition to the demonstration plantings in the Woods of the World and within the formal garden area.

3.6.2 A belt of woodland comprising of both native and non-native species was planted into pastureland along the north-western boundary when the Garden was under construction in the late 1990s to provide a screen and shelter from adjacent open farmland and the newly-constructed cycleway. The canopy and shrub layer species include Pedunculate Oak, Ash, Hazel, Hawthorn, apple, birch, Rowan, Wild Cherry, Beech, Garden Privet and Dogwood, apparently planted in random monospecific blocks and, although now well established, the woodland habitat has yet to develop a diverse herb-layer: species such as Bluebell, Lords-and-Ladies, Red Campion, Ground-ivy and Wood Avens are becoming established from the original boundary hedge but the local abundance of Common Nettle and Creeping Buttercup reflect the grassland origin of the habitat. Grey Willow, Common Alder and Blackthorn may also have been planted but, together with Elder and Bramble, have also become self-established, particularly within the north-eastern section and along the southern boundary of the woodland belt.

The establishment of this woodland belt links existing woodland blocks at its north-eastern and south-western ends resulting in significantly increased habitat connectivity around the northern periphery of the Garden. It is already judged to provide good Dormouse habitat with Dormouse signs having been recorded during the 2015 survey.

3.6.3 The knoll south of Pantwgan farmstead supports mature mixed woodland but has, in recent years, been extended by planting into previously bracken-dominated land and extending the existing woodland along its southern and western margins. The area extending the southern margin (TN15583) includes Silver Birch, Hawthorn, Pedunculate Oak, Wild Cherry, Ash and Sweet Chestnut. Bracken remains in some areas and parts are becoming

overgrown with Bramble, but the Bluebell which would have thrived under the Bracken canopy in the past remains to kick-start the future woodland herb-layer: Enchanter's Nightshade and Broad-leaved Willowherb are other characteristic herb-layer species which were recorded in small numbers during the survey. This area is already judged to provide optimum habitat for Dormice.

3.6.4 The planted area south of Pantwgan farmstead (TN15586) had grown to 3m – 4m in height at the time of the 2015 survey and includes Pedunculate Oak, Ash, Guelder Rose and larch but it was impossible to penetrate far into the plantation due to the dense growth of Bramble, Bracken and tall-herb species. This area fills-in a previously open, east-facing slope between two mature woodland blocks and currently, with its abundance of herbaceous species, Bramble and general scrubby nature, provides a very productive habitat that supports a wide range of invertebrates and other fauna. As the plantation matures so the habitat will change and the fauna it supports will be replaced by characteristic woodland species. In particular, it will continue to develop to provide a substantial area of additional habitat suitable to support Dormice.

3.6.5 An area of approximately 60 acres of open grassland to the south and east of the Woods of the World was planted with native species in 2012-13 to commemorate Her Majesty the Queen's Diamond Jubilee and is known as the Diamond Wood. At the time of the 2015 survey, this area remained dominantly as grass or rush-dominated grassland and has been mapped as such on figure 3.2. Tree and shrub species planted include Hazel, Hawthorn, Pedunculate Oak, Ash, Common Alder, Rowan, Silver Birch, Holly, Guelder Rose and Wild Cherry and within about ten or fifteen years, it is anticipated that these will close canopy, converting the habitat predominantly to young woodland. In common with the new Pantwgan plantations, as this woodland becomes established it will provide a very considerable addition to the faunal holding capacity of habitats within The Garden. In particular, as it matures, it will develop to provide a substantial area of additional habitat suitable to support Dormice which will contribute to mitigating habitat losses sustained by the Regency Landscape restoration works.

3.6.6 Smaller, though still significant woodland plantings have been made around the car-park near the main entrance of the Garden. Here, the planted areas include a significant element of densely-growing ornamental species in addition to, for example, Common Alder, Ash, Grey Willow and Sycamore and serve to visually break-up the discrete parking areas.

3.6.7 Two principal biomass plantations are present within the Garden estate. The most extensive is dominated by Grey Willow and is located adjacent to the north-west of the Woods of the World site (centred at TN15572) and is plotted as W1 willow scrub-woodland on figure 3.2. This stand, at least in part, has been planted into former fen-vegetation dominated by Lesser Pond-sedge, a species which is still abundant in the herb-layer. Rare self-sown Common Alder and Pedunculate Oak were also noted here.

The second biomass plantation is located north-east of the main Garden buildings-complex (including TN15478 and TN15479). Various willow species and varieties have been planted here including Osier, White Willow, Green-leaved Willow and Purple Willow. Common Alder and Grey Willow may also have been planted but are also becoming naturally established together with rank growth of Bramble and tall-herb species around the margins. A small plot of Silver-grass (*Miscanthus* cf x *giganteus*) has also been planted on the north edge of this plantation.

### 3.6.8 Non-native tree and shrub species recorded at NBGW mainly during the 2012-2015 surveys

Coniferous species are shown in blue

| Scientific Name | Vernacular Name | Notes |
|---|---|---|
| *Acer campestre* | Field Maple | planted in new woodlands |
| *Acer pseudoplatanus* cv.*purpureum* | Sycamore (purple leaved) | specimen tree |
| *Acer pseudoplatanus* | Sycamore | regenerating in woods |
| *Aesculus hippocastanum* | Horse-chestnut | originally planted |
| *Alnus cordata* | Italian Alder | planted in new woodlands |
| *Araucaria araucana* | Monkey-puzzle | planted in Woods of the World |
| *Buddleja davidii* | Butterfly-bush | originally planted |
| *Buxus sempervirens* | Box | planted |
| *Carpinus betulus* | Hornbeam | originally planted |
| *Castanea sativa* | Sweet Chestnut | originally planted |
| *Cornus sanguinea* | Dogwood | originally planted |
| *Cornus sericea* | Red-osier Dogwood | originally planted |
| *Cotoneaster dielsianus* | Diels' Cotoneaster | self-sown |
| *Cotoneaster integrifolius* | Small-leaved Cotoneaster | self sown |
| *Cytisus scoparius* | Broom | planted and native? |
| *Fagus sylvatica* | Beech | originally planted |
| *Hedera helix hibernica* | Irish Ivy | planted & naturalized |
| *Hippophae rhamnoides* | Sea-buckthorn | planted |
| *Larix kaempferi* | Japanese Larch | planted |
| *Ligustrum ovalifolium* | Garden Privet | originally planted |
| *Lonicera nitida* | Wilson's Honeysuckle | originally planted |
| *Malus domestica* | Apple | originally planted |
| *Metasequoia glyptostroboides* | Dawn Redwood | planted |
| *Picea abies* | Norway Spruce | planted |
| *Pinus nigra* | Black Pine, Corsican Pine | originally planted |
| *Pinus sylvestris* | Scots Pine | planted |
| *Prunus avium* | Wild Cherry | planted and native? |
| *Prunus laurocerasus* | Cherry Laurel | regenerating in woods |
| *Pseudosasa japonica* | Arrow Bamboo | planted |
| *Pseudotsuga menziesii* | Douglas Fir | planted |
| *Pyrus communis* | Pear | planted in Walled Garden |
| *Rhamnus alaternus* | Mediterranean Buckthorn | planted |
| *Rhamnus cathartica* | Buckthorn | planted and native? |
| *Rhododendron ponticum* | Rhododendron | originally planted |
| *Ribes nigrum* | Black Currant | probably originally planted |
| *Ribes rubrum* | Red Currant | planted and native? |
| *Ribes uva-crispa* | Gooseberry | probably originally planted |
| *Rosa rugosa* | Japanese Rose | planted and self sown |
| *Salix alba* var. *vitellina* | White Willow | planted |
| *Salix alba* | White Willow | planted |
| *Salix purpurea* | Purple Willow | planted |
| *Salix viminalis* | Osier | planted |
| *Salix* x *rubra* | Green-leaved Willow | planted? |
| *Sorbus leyana* | Ley's Whitebeam | planted by Broad Walk |
| *Taxus baccata* | Yew | planted & self-sown |
| *Tilia* x *europaea* | Lime | planted |
| *Tsuga heterophylla* | Western Hemlock-spruce | planted & self-sown |
| *Ulmus* x *vegeta* | Huntingdon Elm | probably planted |

## 3.7 Hedgerows and treelines

Very few hedgerows occur within the Garden estate and only six hedgerows which conform to the definition cited in the Hedgerow Regulations 1997 are present within the Regency Project area although a number of tree-belts occur, some of which may have originated as hedgerows but have developed into narrow woodland-like habitat. Elsewhere, several additional hedgerows occur, many along the Estate boundaries: these are shown in black on figure 8.1. The lack of hedgerows presumably reflects the parkland history of the land and is in stark contrast to most of the farmland in the area outside the Estate.

The boundary hedgerows are the most typical of the area and are generally regularly trimmed to 1.5m – 2m in height, or lower, to maintain their density, but often, individual trees have been allowed to grow to maturity within the hedgeline. Characteristic woody species include Hazel, Hawthorn, Ash, Pedunculate Oak, Holly, Ivy, Sycamore, Grey Willow and Common Alder. Wych Elm occurs less commonly and Beech has occasionally been planted. The roadside hedge lining the eastern Estate boundary (TN15170, TN15171, TN15306) has been augmented by plantings of native species which include uncharacteristically large proportions of Guelder Rose and Alder Buckthorn. Bramble is a ubiquitous constituent of the hedgerows and provides a valuable habitat for faunal cover and foraging, in particular for Dormice.

Hedges are generally established on banks c.1m in height which have been formed from the arisings from ditches which run parallel and form an integral part of the hedgerow. In most instances the ditches are overgrown and shaded by hedgebank vegetation and do not support additional (eg aquatic) plant species.

Hedgebottom plants include a range of species such as Lesser Celandine, Cow Parsley, Common Nettle, Red Campion, Meadowsweet, Herb Robert, Greater Stitchwort and Cleavers, ferns such as Lady-fern, Polypody, Hart's-tongue, Soft Shield-fern, Scaly Male-fern, Male-fern and Broad Buckler-fern and numerous grasses such as Yorkshire-fog, False-brome, Cock's-foot and False Oat-grass. Less commonly Greater Burnet (TN15573, TN15574, TN15603), Wood Horsetail (eg TN15306) and Smooth-stalked Sedge (TN15603) were recorded. Early Purple-orchid is a characteristic plant occasionally seen on hedgebanks on the Old Red Sandstone in Carmarthenshire but was not recorded within the Estate during the survey although four flowering spikes were noted at TN15170 on the opposite side of the road to the NBGW boundary.

Some treelines within the Estate have been deliberately planted as landscape features and often follow topographical features such as steep slopes or stream courses. Their species composition reflects their planted origin by the incorporation of non-natives including Beech, Hornbeam and Sweet Chestnut as well as native (although probably planted) oak. Ash and oak have also become self-established in these areas and now form part of the mature canopy. In addition, shrub-layer species, principally Hazel and Hawthorn, are likely to have been planted but additional species such as Grey Willow and Holly are now also established. Where fenced, treelines are often overgrown with a sub-shrub layer of impenetrable bramble which has suppressed herb-layer plants. Where not fenced, grazing has also suppressed the ground-layer vegetation which is generally grass-dominated with frequent patches of poaching and soil disturbance where farm stock has sought shelter.

In addition to originally planted treelines, some field-boundary hedgerows have been allowed to grow to form lines of mature trees, a practice which, although providing a prominent landscape feature, has sometimes resulted in a very thin and gappy shrub layer of little use as a stock-proof boundary. Hedgerows H1, H2, H3 and H4 (figure 8.1) mostly

fall into this type. The boundary bank may then become exposed and supports only a desiccated, impoverished, floral community comprising of just a few calcifugous species.

Hedgerows and treelines provide essential connecting habitat to permit the travel of many faunal species. Over much of the Garden estate, habitat connectivity is reduced by the paucity of hedges and treelines and even where these features are present, there are numerous, often considerable gaps between individual hedges and treelines which cause further dislocation of the connected habitat. However, in recent years, connectivity for some species including some small mammals, has been enhanced to some degree by the increase in rank grassland associated with bramble and scrub encroachment in some parts of the Estate.

## 3.8 Grassland

3.8.1 During 2007-11, Sam Bosanquet of the (then) Countryside Council for Wales, completed a National Vegetation Classification (NVC) survey of most of the grassland within the farmed NBGW Estate which was to provide baseline data following the declaration of the land as a National Nature Reserve. Prior to that survey, in 1997, during the establishment of NBGW, a NVC survey was carried out by Helen Bird from Aberystwyth University which included the sampling of more than 350 quadrats. Her dataset potentially should have enabled a comparison to be made with the 2007-11 and the current surveys but as no vegetation map was produced, only broad comparisons are possible. Furthermore, additional uncertainty was introduced by the fact that some of the NVC communities identified by the computer program used during her analysis are doubtful, having not been recorded within the Garden estate, nor in the county, either before or since. However, both Bosanquet and the current surveyor agree that overall, the species-richness and habitat diversity appear to have decreased in the years between the surveys, although this might be because the 1997 survey focused on richer patches of vegetation.

Bosanquet stated that there had been a clear decline in the quality of Purple Moor-grass-dominated marshy grassland through neglect, a trend that has continued and was confirmed during the current survey. This is also true of some of the rush-dominated and swampy grasslands in the south-western corner of the Estate where lack of grazing and encroachment of willow and Alder scrub continues to diminish the value of the open vegetation.

Bosanquet also stated that in some of the dry grassland pastures, there had been an apparent decline perhaps due to heavy sheep grazing. However, this appears not to have been so evident over the period between the 2007-11 and the 2015 surveys: in two fields in particular (North Trawscoed Meadow and Cae Tegeirianau), there has been a definite increase in species diversity as a result of the resumption of traditional hay-meadow management comprising of the taking of a late-summer hay crop followed by aftermath grazing.

Decline also appears to have occurred in the Woods of the World and Diamond Wood plantings, areas which were not covered during the 2007-11 survey. Here, grazing has ceased since tree-planting and the former semi-improved pastures are now mainly rank and only infrequently cut between the newly planted trees. These areas, of course, will in any case, loose their open grassland nature as they develop into woodland in the near future.

The report of the 2007-11 survey includes detailed descriptions of the vegetation types written by Sam Bosanquet, one of the most experienced NVC surveyors currently practicing.

The present report draws on, but abridges this text, for which due acknowledgement is given herewith. Field names and compartment numbers are shown on figure 2.3.

3.8.2 *Neutral grasslands*

Much of the land within the Garden estate is occupied by dry, neutral grassland swards dominated by Common Bent *Agrostis capillaris*, Sweet Vernal-grass *Anthoxanthum odoratum*, Red Fescue *Festuca rubra* and varying quantities of Crested Dog's-tail *Cynosurus cristatus* and Yorkshire-fog *Holcus lanatus*, although the great majority is agriculturally modified and was recorded as either semi-improved or improved.

3.8.2.1 *Unimproved Neutral grasslands*

The most species-rich neutral grasslands and thus those of greatest conservation value (with the exception of "waxcap meadows") are those which have been least modified by agricultural practices, allowing them to retain a good representation of grasses and grassland herbs. Common Bird's-foot Trefoil *Lotus corniculatus*, Common Knapweed *Centaurea nigra* and Red Clover *Trifolium pratense* are indicators of unimproved neutral grassland in this area and were used as the principal markers in identifying this vegetation, which belongs to the NVC MG5 *Centaurea nigra* - *Cynosurus cristatus* grassland community.

The MG5 community is most prominent in North Trawscoed Meadow (compartment 30), with small or very small areas found during the present survey in Cae Pont (compartment 1), Cae Tegeirianau (compartment 13), compartment 17, Cae Waun Las (compartment 18) and Cae Bess (compartment 22). Common Bird's-foot Trefoil is generally rare throughout the Garden estate but the abundance of Common Knapweed and Red Clover relative to other herbs in the sward and the absence of Perennial Rye-grass *Lolium perenne* are sufficient to assign the vegetation in parts of these compartments to MG5. Swards without Common Bird's-foot Trefoil and with patchy Common Knapweed and Red Clover were considered to be semi-improved (see below). The hay meadow management now practiced in the southern part of North Trawscoed Meadow (compartment 30) appears to have sufficiently increased the species diversity of much of the area to allow the placement of a larger part of the meadow into the MG5 community than that mapped by Bosanquet. However, the north-eastern part of the meadow previously mapped as tall MG5 has become rank and overgrown due to the absence of mowing or grazing. Cae Tegeirianau (compartment 13), although now improving in species diversity, remains as MG6 due to its lack of the marker species and presence of some Perennial Rye-grass but with continuing 'haymeadow' management may well revert to MG5 in the future. Tiny areas of grassland on steeply sloping ground with Common Bird's-foot Trefoil were found in Cae Pont (compartment 1) and Cae Bess (compartment 22) have been mapped as MG5 but were not recorded in the 2007-11 survey.

Due to the poor representation of sub-community identifiers, the allocation of MG5 vegetation to sub-communities was often found to be problematic. The majority has been included within the MG5a *Lathyrus pratensis* sub-community with slightly more acidic swards (principally in a small part of Cae Tegeirianau (compartment 13)) as MG5c *Danthonia decumbens* sub-community where two sub-community preferentials, Tormentil *Potentilla erecta* and Devil's-bit Scabious *Succisa pratensis*, are frequent. Some MG5 in North Trawscoed Meadow (compartment 30) supports occasional to frequent *Devil's-bit Scabious* and occasional Tormentil and these areas have been separated by the present author as MG5c although the lack of Tormentil recorded during the 2007-11 survey

countered the referral of any vegetation in this compartment to MG5c at that time. Tormentil was recorded relatively frequently during the present survey but its presence is insufficient on its own for the referral of swards where it is present to MG5c.

Bosanquet noted that North Trawscoed Meadow (compartment 30) supports the most diverse MG5a and is the only area in which Common Knapweed is constant in the sub-community. The majority has a higher cover of Greater Bird's-foot Trefoil *Lotus pedunculatus* than Common Bird's-foot Trefoil, although the latter is at least locally frequent, and holds abundant Ribwort Plantain *Plantago lanceolata*, frequent Cat's-ear *Hypochaeris radicata*, Meadow Vetchling *Lathyrus pratensis*, Field Wood-rush *Luzula campestris* and Meadow Buttercup *Ranunculus acris*, and occasional Germander Speedwell *Veronica chamaedrys*. Haymeadow management since 2007-11 has considerably increased the abundance of Cat's-ear and encouraged proliferation of a large population of Greater Butterfly Orchid *Platanthera chlorantha* and locally abundant dactylorchids *Dactylorhiza* spp.

The abundance of Greater Bird's-foot Trefoil, which is characteristic of damper ground than Common Bird's-foot Trefoil, is echoed by occasional Meadowsweet *Filipendula ulmaria* and Meadow Foxtail *Alopecurus pratensis*, the last two combining with occasional to frequent Greater Burnet *Sanguisorba officinalis* to suggest affinities to the scarce NVC MG4 *Alopecurus pratensis - Sanguisorba officinalis* flood meadow community. However, despite the apparent increasing abundance of Greater Burnet in recent years, the overall frequency of these three MG4 constants is insufficient for placement there.

Flushing near the south-western corner of the field encourages sedge growth, where it forms intricate mosaics with M23 *Juncus effusus/ acutiflorus - Galium palustre* rush-pasture vegetation. Bosanquet also noted that Glaucous Sedge *Carex flacca* was locally abundant in this flushed MG5a (his quadrat 1), whilst Common Sedge *C. nigra*, Oval Sedge *C. ovalis* and Carnation Sedge *C. panicea* were all occasional (Bird also reported Common Quaking-grass *Briza media*). Glaucous Sedge and Common Sedge have also been recorded by the present author in this area (although not necessarily during the 2015 survey). Silverweed *Potentilla anserina*, Devil's-bit Scabious and Changing Forget-me-not *Myosotis discolour* were also recorded here together with rare Whorled Caraway *Carum verticillatum*.

The north-eastern part of the North Trawcoed Meadow noted by Bosanquet as tall MG5 has become rank and overgrown due to the absence of mowing or grazing and has declined to NVC MG1 rank grassland or been colonised by extensive rush-dominated vegetation (NVC M23) (see below) although still supports some Red Clover and rare Whorled Caraway and Pignut *Conopodium majus*.

The 2007-11 survey report concluded that about three quarters of the MG5a vegetation in North Trawscoed Meadow (compartment 30) was of reasonably good floristic quality, whilst the remainder had too little Common Bird's-foot Trefoil and too much Common Mouse-ear *Cerastium fontanum* to be of more than moderate quality. This situation has probably not changed much in NVC terms but the vegetation appears to have responded to recent 'haymeadow' management which has encouraged an abundance of Cat's-ear and Yellow Rattle together with a substantial increase and spread of the population of Greater Butterfly Orchid as well as apparent increases in Greater Burnet.

The north-western part of the Grow the Future field has also been mapped as MG5a and in addition to abundant Common Knapweed and Red Clover, also has occasional Common Bird's-foot Trefoil, as well as Meadow Vetchling, Greater Burnet and abundant Yellow Rattle. The north-eastern corner of this field has become rank in recent years but several

plants of Greater Butterfly-orchid were recorded here in 2015 together with Whorled Caraway in the damper eastern edge where it adjoins rush-pasture vegetation.

The most significant area of the NVC MG5c community is in a roughly triangular area within low earth banks near the foot of the slope in the north-western corner of Cae Tegeirianau (compartment 13) where Common Bird's-foot Trefoil is abundant and Tormentil and Devil's-bit Scabious frequent along with Pignut, Field Woodrush, Cat's-ear, Meadow Buttercup and Bulbous Buttercup *Ranunculus bulbosus.* Common Lousewort *Pedicularis sylvatica* is also frequent and a particular feature of this area. Bosanquet notes "the presence of Red Clover and absence of Sheep-s Fescue *Festuca ovina*, Heath Bedstraw *Galium saxatile* and acidophilous bryophytes are indicative of MG5 rather than the more acidic NVC U4 *Festuca ovina - Agrostis capillaris - Galium saxatile* grassland, although this is somewhat equivocal. The species count is too low for the stand to be of the highest floristic quality, but it is reasonably good and is one of the richest pieces of grassland on the site".

3.8.2.2 Semi-improved Neutral Grasslands

Semi-improved Neutral Grasslands have been mapped as the NVC MG6 *Lolium perenne – Cynosurus cristatus* grassland community or to 'dry semi-improved grassland' depending on the presence or absence of *L. perenne* respectively.

Most of Cae Tegeirianau (compartment 13) (excluding the MG5c described above), supports the most diverse MG6 in the site. This was recorded as the NVC MG6b *Anthoxanthum odoratum* sub-community and, as Bosanquet notes, "is floristically close to MG5 as it is moderately species-rich and holds abundant to frequent Red Clover, but it lacks Common Bird's-foot Trefoil and has frequent Perennial Rye-grass at low cover". Yellow Rattle, Cat's-ear, Meadow Buttercup, White Clover *Trifolium repens* and Ribwort Plantain are also abundant.

Other MG6 within the Estate is generally less diverse and ranges between the relatively unimproved, species-rich MG6b of Cae Tegeirianau through varying degrees of agricultural improvement to the overwhelmingly grassy, species-poor MG6a Typical sub-community. The southern part of Cae Banc (compartment 12) supports the richest stands of MG6b and has moderate forb diversity but similar, though somewhat less diverse swards also occur in several other fields. This vegetation includes occasional Red Clover, abundant Ribwort Plantain and locally frequent Pignut, while Whorled Caraway, Field Woodrush, Bulbous Buttercup and Greater Bird's-foot Trefoil may also be frequent. All stands are, however, generally very grassy. In addition to the MG6b grassland in Cae Tegeirianau (compartment 13) already targetted for grassland restoration, the better quality stands, particularly in Cae Banc (compartment 12), Cae Allt Goch (compartment 16) and compartment 17, would also be suitable to concentrate on grassland restoration as they are closest to unimproved MG5 swards Several areas within the Woods of the World site would also be suitable but would need to be taken into appropriate management soon, before their vegetation becomes more rank and regresses further.

Species-poor, overwhelmingly grassy MG6 swards dominate most of the remainder of the areas mapped as this community. They contain few forbs other than frequent to abundant White Clover and occasional Dandelion *Taraxacum officinale,* accompanied by abundant Sweet Vernal-grass *Anthoxanthum odoratum*. However, Red Clover and Common Knapweed were recorded in several of these fields during the 2015 survey and, although no Common Bird's-foot Trefoil was recorded, Greater Bird's-foot Trefoil was sometimes frequent and Greater Burnet rare to occasional.

The 2015 survey followed the methodology used by Bosanquet in 2007-11 who used the term 'Dry semi-improved grassland' to describe vegetation that parallels MG6 in terms of species-richness and differs from it only in the absence of Perennial Rye-grass. He noted that it seems likely that some of these semi-improved swards have become impoverished through heavy sheep and deer grazing, rather than through high applications of inorganic fertiliser. He identified a range of different forms of 'dry semi-improved grassland' in North Trawscoed Meadow (compartment 30) and Cae Blaen (South Trawscoed, compartment 29) and went on to note that "the former has stands with the closest links to MG5, holding locally frequent Common Knapweed and Greater Bird's-foot Trefoil and rare Red Clover in a thin sward that also includes frequent to abundant Field Woodrush, frequent Common Mouse-ear, and abundant Ribwort Plantain and Meadow Buttercup". The 2015 survey findings record an apparent increase in the frequency of Red Clover and Common Knapweed together with the presence of Common Bird's-foot Trefoil and a general increase in species diversity. This has been sufficient in the present author's opinion to elevate most of this vegetation located in the eastern section of the field to NVC MG5a grassland.

The eastern side of Cae Blaen (compartment 29) has similar vegetation, but with additional locally frequent Greater Burnet and locally frequent Meadow Foxtail (during the 2007-11 this was recorded as occasional), again echoing the rare NVC MG4 flood-plain community but lacking Meadowsweet. Meadow Foxtail is more abundant further west in the field, where 'dry semi-improved grassland' intergrades with NVC MG10 *Holcus lanatus* - *Juncus effusus* rush-pasture vegetation particularly where the substrate is less free draining, perhaps due to past poaching by farm-stock. Further areas of 'dry semi-improved grassland' eg in Compartment 31 and Cae Waun (compartment 24), both damp variants, and in drier 'dry semi-improved grassland' have generally been mapped during the present survey as NVC MG6 as Perennial Rye-grass was recorded rarely, perhaps due to recent changes in farm management. The drier areas sometimes support abundant populations of Pignut particularly on the steeper slopes of Compartment 17 and peripheral parts of Cae Gwair (compartment 14).

The semi-improved neutral grasslands include some of the richest areas for waxcap fungi (*Hygrocybe* spp.) and associated grassland fungi on the estate (see section 7).

3.8.2.3 *Rank Neutral Grasslands*

The small, rank areas of 'other neutral grassland' mapped by Bosanquet have largely not been differentiated from MG6 during the present survey. He noted that "they usually occur near field margins, and have close affinities to the Pignut-rich form of 'dry semi-improved grassland'. Most hold abundant Pignut and several stands have Bluebell *Hyacinthoides non-scriptus* growing in them. They differ subtly from the 'dry semi-improved grassland' in having Yorkshire-fog *Holcus lanatus* and Cock's-foot *Dactylis glomerata* as the principal grasses in place of Common Bent *Agrostis capillaris*, Crested Dog's-tail *Cynosurus cristatus* and Red Fescue *Festuca rubra*, but the separation is not clear-cut and recent management clearly has a major effect on their floristics. The absence of various key species, such as False Oat-grass *Arrhenatherum elatius*, Perennial Rye-grass and Common Bird's-foot Trefoil, prevents referral of these species-poor swards to an NVC community".

Similarly rank grassland and tall-herb vegetation occurs on inaccessible neglected field margins, for example in the northern part of Trawscoed North Meadow (compartment 30) (TN15278) and along the boundary of the same meadow with Trawscoed Wood. Similar vegetation also occurs in the unmanaged field south-west of the overflow car-parks near the main entrance (TN15244). These grasslands have been derived from other neutral

grassland types, in particular MG6, where management has ceased, allowing the establishment of rank grasses and encroachment of bramble. This vegetation is identified as the NVC MG1b *Arrhenatherum elatius* grassland, *Centaurea nigra* sub-community.

Rank, nettle-infested swards were recorded in a few infrequently managed locations including at the northern periphery of the Woods of the World (TN15621) and in the vicinities of farmsteads at Waun Las and Allt Goch Lodge. False Oat-grass and Common Nettle *Urtica dioica* are constants in this vegetation and are associated with, for example, Yorkshire-fog, Broad-leaved Dock *Rumex obtusifolius,* Creeping Thistle *Cirsium arvense,* Hogweed *Heracleum sphondylium* and Common Hemp-nettle *Galeopsis tetrahit*. This vegetation can be assigned to the NVC MG1b *Arrhenatherum elatius* grassland, *Urtica dioica* sub-community. A relatively extensive stand, also tentatively identified as this sub-community is located in the field between the Gatehouse and the Double Walled Garden. Here, False Oat-grass is frequent with Yorkshire-fog, Cock's-foot, Ribwort Plantain, Hogweed, Common Nettle and Common Knapweed. It occupies damp ground between a stand of rather coarse NVC MG6 grassland to the north and wet rush, Meadowsweet and Lesser Pond-sedge dominated communities to the south.

3.8.2.4 *Regressing agriculturally improved and semi-improved grassland on damp/wet soil*

Where previously improved or semi-improved grassland is located on naturally drainage-impeded soils and where artificial drainage has been neglected or stock-poaching or compaction has damaged the soil, rush-infested neutral grassland that has close affinities to, or that was originally derived from, the rush-dominated marshy grassland M23 community (see below) occur. These are identified as the NVC MG10 *Holcus lanatus - Juncus effusus* rush-pasture community. Soft Rush *Juncus effusus* is nearly ubiquitous in this widespread vegetation together with Creeping Bent *Agrostis stolonifera* and Yorkshire-fog, areas of which are present in the Woods of the World area among and around some of the recent tree plantings. However, Sharp-flowered Rush *Juncus acutiflorus* dominates a stand in the south-western part of Cae Derwen (compartment 26a) which was mapped in the 2007-11 survey as 'damp semi-improved grassland' and is shown as such on figure 3.2 and probably reflects reversion from an agriculturally improved sward originally derived from NVC M23a. Wetland herbs that characterise M23 are mainly absent from MG10 rush-pasture, so little other than, Common Sorrel *Rumex acetosa*, Creeping Buttercup, Ribwort Plantain and locally, Meadow Foxtail grow as associates of the rush. However, as the vegetation continues to regress closer to M23, it becomes more diverse and several target notes record this higher species diversity which is not typical of MG10 eg in Cae Blaen (compartment 29). The NVC MG10 vegetation at NBGW belongs to the MG10a Typical sub-community.

3.8.2.5 *Agriculturally Improved Grasslands including reseeded grasslands*

The fields located to the west of Pantwgan farmstead (compartments 2 – 9) include Perennial Rye-grass dominated reseeded leys in their rotational management. During 2015, Cae Du Dau (compartment 4) was reseeded whilst the other fields were down to rye-grass in varying stages of the rotation. These were mapped as 'improved grassland' and are placed in the NVC MG7 *Lolium perenne* leys and related grasslands community. The southern end of compartment 31 was mapped by Bosanquet in 2007-11 as holding a weed-infested but overwhelmingly grassy sward with frequent Creeping Thistle and Broad-leaved Dock set in a species-poor sward of Yorkshire-fog and Sweet Vernal-grass. By 2015, this sward was found to be wetter and somewhat more diverse with developing rush-pasture

and Meadowsweet dominated vegetation in the western part and MG6 neutral grassland in the eastern part.

3.8.2.6 *Amenity Grassland*

This term applies to grasslands which are subject to intensive management, including regular mowing, to provide amenities such as lawns, parks and sportsfields. This type of grassland is mainly confined to the formal part of the Garden estate where much was derived from reseeding following the extensive construction work completed prior to the opening of the Garden in 2000. There are, however, areas which are probably derived more-or-less directly from pasture land which would have been left undisturbed by the work and which would have been brought into the intensive management regime. Frequent mowing including leaving the arisings to rot-down where they fall, increases the soil nutrient status which favours the growth of grass-dominated vegetation at the expense of broad-leaved forbs, thus greatly reducing the wild flower diversity and content of the sward. Recent practice within the Garden has sought to reduce the frequency of mowing whilst also removing arisings, emulating a traditional hay-meadow form of management. Sowing of Yellow-rattle seed has also been undertaken as this species is a semi-parasite on grasses, thus reducing competition and facilitating natural colonisation by other wild-flower species. This, in time, will restore the plant species diversity which will also attract a range of fauna including pollinating insects, whilst also providing a more striking and educational experience for human visitors.

Amenity grassland has been mapped as such on the Phase 1 plan but has been rather arbitrarily included as either MG7 or MG6 grasslands on the NVC plan, much depending on its species diversity which was masked by recent mowing during the survey. In general, however, after only a few seasons of 'haymeadow management' and Yellow Rattle sowing, wild flower species such as Cat's-ear, Common Knapweed and Greater Bird's-foot Trefoil have started to return as well as a few prominent species such as dactylorchids. Also, and most notably, a single Greater Butterfly-orchid was recorded in 2015 south of the Great glasshouse at TN15542.

The 'Wild Garden' was created when NBGW was established and the species planted sought to demonstrate a South African savannah-type grassland. Many of the introduced species are now well-established and remain in the sward but native British species have also colonised over the years which has resulted in a confusing vegetation community but one which always provides a talking-point among visiting botanists.

3.8.3 *Dry acidic grasslands*

Bosanquet summed-up the small areas of dry, acidic grassland which are present within the Garden estate as follows. "Weakly-characterised acid grassland replaces neutral swards in a few places in compartment 15, where it occupies low ridges set within a matrix of M23. The principal marker is Tormentil *Potentilla erecta*, which is indicative of the NVC U4 *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland in the absence of the MG5 mesotrophic constants Crested Dog's-tail *Cynosurus cristatus*, Common Knapweed *Centaurea nigra* and Red Clover *Trifolium pratense*. Tormentil is frequent to abundant in a sward composed of Velvet bent *Agrostis canina*, Common Bent *A. capillaris*, Sweet Vernal-grass *Anthoxanthum odoratum* and field Woodrush *Luzula campestris*, with occasional Mat-grass *Nardus stricta* and, in one stand, Purple Moor-grass *Molinia caerulea* at very low cover. Most of the U4 also holds abundant Whorled Caraway *Carum verticillatum* and Greater Bird's-foot Trefoil *Lotus pedunculatus*, the latter reflecting affinities to M23, and a

few near the top of the field have additional occasional Common Bird's-foot Trefoil *Lotus corniculatus* and patchy Ribwort Plantain *Plantago lanceolata* (these were mapped as U4b 'lowland form', but are doubtfully distinct). The slightly mesotrophic appearance of this U4 allows referral to the NVC U4b *Holcus lanatus - Trifolium repens* sub-community, although it is as poorly-marked at the sub-community level as at the community level. It seems likely that the U4b is derived from MG5c, perhaps through sheep-induced impoverishment, rather than reflecting highly acidic soil conditions." There appears to have been little change to this situation in the intervening period between his survey and the 2015 survey. No additional stands of U4 were noted during the 2015 survey.

3.8.4 *Acidic 'Marshy grasslands'*

3.8.4.1 *Rush dominated swards*

Rush dominated marshy grassland (NVC M23) is the commonest type within the Garden estate and is distributed within the National Nature Reserve, the Woods of the World area and peripheral parts of the formal garden. Purple Moor-grass dominated grassland (NVC M25) is also present but confined to much smaller areas and present only near the southern extremity of the NNR in Morfa Du (compartment 26b) and some small stands in Snipe Marsh (compartment 28). The tiny area of Purple Moor-grass – Meadow Thistle grassland (NVC M24) recorded in Snipe Marsh during the 2007-11 survey (which at that time had apparently decreased from the time of Bird's survey) has now been completely subsumed by Meadowsweet dominated vegetation due to lack of management. Also classified as marshy grassland, wet tall-herb vegetation overwhelmingly dominated by Meadowsweet (NVC M27) occurs in numerous locations over the Garden estate but often in stands too small to map or mixed with other vegetation. The largest stands are in Snipe Marsh, the bottom of the wet field north of the Gatehouse and west of The Broadwalk, Compartment 32 and in the north of the Grow the Future field.

NVC M23 *Juncus effusus/acutiflorus – Galium palustre* rush-pasture includes frequent to abundant wetland herbs which distinguish it from the NVC MG10 which is more widespread and of much less ecological interest (see paragraph 3.8.2.4.). Although a range of herbs may be present, Bosanquet found that only Cuckoo-flower *Cardamine pratensis*, Marsh Bedstraw *Galium palustre* and Greater Bird's-foot Trefoil were constant in M23 stands in the NNR, which was generally confirmed during the 2015 survey although much of the 2015 fieldwork was undertaken too late in the season to easily detect Cuckoo-flower.

Sharp-flowered Rush *Juncus acutiflorus* is frequent to abundant in the NVC M23a *Juncus acutiflorus* sub-community which is more abundant than the NVC M23b *Juncus effusus* sub-community within the NNR land but M23a predominates in the parts of the estate outside the NNR (mainly Woods of the World and the fenced-off eastern part of the Grow the Future field). Most of the M23a also holds frequent to abundant Soft Rush although it is absent from some stands, but the M23 area in North Trawscoed Meadow (compartment 30) mapped by Bosanquet as M23a in 2007-11 appears to have since become more dominated by Soft Rush and has been mapped as M23b in the present survey.

Bosanquet found the most species-rich M23a in three locations. The first, to the south of Pantwgan farm, comprises of a small stand in a fenced-off area of Cae Banc (compartment 12), which has Marsh Thistle *Cirsium palustre*, Whorled Caraway, Lesser Spearwort *Ranunculus flammula* and Marsh Ragwort *Senecio aquaticus* in addition to the three constants Cuckoo-flower, Marsh Bedstraw and Greater Bird's-foot Trefoil, but has a carpet of the moss *Calliergonella cuspidata* in place of the grassy ground layer characteristic of

much of the NVC M23a in other parts of the NNR. In the second, Snipe Marsh (compartment 28), the substrate is wetter and includes frequent Marsh Marigold *Caltha palustris*, whilst in the third, Morfa Du (compartment 26b) frequent Marsh Marigold, Short-fruited Willowherb *Epilobium obscurum* and Marsh Cinquefoil *Potentilla palustris,* together with occasional Bottle Sedge *Carex rostrata* and Water Horsetail *Equisetum fluviatile*, enrich some of the NVC M23a vegetation. He also reported Bottle Sedge and Water Horsetail in the centre of Snipe Marsh but these were only found in a flushed area between adjacent M25 and M27 communities at the eastern margin of the field during the 2015 survey. Marsh Cinquefoil*,* Bottle Sedge and Water Horsetail allowed Bosanquet to distinguish this vegetation as the 'swampy variant' of NVC M23a that has been widely recorded by CCW in lowland Wales and is floristically close to NVC S27 *Carex rostrata - Potentilla palustris* tall-herb fen vegetation.

The current survey confirmed Bosanquet's findings that elsewhere within the NNR, "extensive and relatively unvarying stands of grassy, rather low quality M23a occur that have a carpet of abundant Velvet Bent *Agrostis canina* below the tall rushes, and holds locally frequent Sweet Vernal-grass *Anthoxanthum odoratum*, Oval Sedge *Carex ovalis*, Common Sedge *C. nigra* and Heath Woodrush *Luzula multiflora"*. He concluded that although "abundant Whorled Caraway *Carum verticillatum* gives this low quality M23a a degree of conservation interest", the present state of "this vegetation is likely to be a reflection of past disturbance and attempts at drainage rather than being a particularly positive facet of the vegetation: old drainage lines are still easily visible in the extensive areas of M23a in Compartment 15." He continued by mentioning a further area of poorly-managed vegetation in the northern half of Morfa Du (compartment 26b), where he identified an "even lower quality coarse M23a, with abundant tussocks of Soft Rush, locally abundant Common Nettle *Urtica dioica,* and frequent Wild Angelica *Angelica sylvestris* and Marsh Thistle *Cirsium palustre*". These were also very prominent during the 2015 survey and are probably the result of the cessation of grazing in this part of the NNR.

Bosanquet found all of the NVC M23b *Juncus effusus/acutiflorus – Galium palustre* rush-pasture, *Juncus effusus* sub-community within the NNR to be of rather low quality, either because of its grassy floristic make-up or because of its coarseness with frequent Common Nettle. This state was confirmed during the 2015 survey and generally extended into the areas not covered by the 2007-11 survey.

3.8.4.2 *Purple Moor-grass dominated swards*

The species-rich, NVC M24 *Molinia caerulea - Cirsium dissectum* fen-meadow is dominated by Purple Moor-grass *Molinia caerulea* with constant Meadow Thistle *Cirsium dissectum* and was found to be extremely rare in the 2007-11 survey, being confined to a small area within Snipe Marsh (compartment 28). However, in 1997, Bird recorded it in three quadrats distributed over the northern half of Snipe Marsh and in nine quadrats located across the western third of Morfa Du (compartment 26b): at that time, much of the Morfa Du area which is now colonised by Alder and willow woodland, would have been open marshy grassland. She also recorded Meadow Thistle in one quadrat in the northern part of compartment 17 near its boundary with Hangman's Wood in vegetation recorded as dry semi-improved grassland by Bosanquet in 2007-11 and NVC MG6b during the 2015 survey.

In 2007-11, the key community constant, Meadow Thistle *C. dissectum*, was found by Bosanquet to be restricted to Snipe Marsh where he recorded about 16 plants in the north-eastern quarter of the field. He noted that other M24 markers, such as Tawny Sedge *Carex hostiana* and Flea Sedge *C. pulicaris*, appeared to be absent but he was able to place the

vegetation into the NVC M24b Typical sub-community because of the high frequency of Meadowsweet *Filipendula ulmaria* and occasional Common Knapweed in the absence of Sharp-flowered Rush. Patchy associates included Tormentil, Whorled Caraway, Bitter Vetch *Lathyrus linifolius*, Saw-wort *Serratula tinctoria* and Betony *Stachys officinalis*, whilst Devil's bit Scabious *Succisa pratensis* was slightly more frequent. He judged that the high cover of Purple Moor-grass and its litter meant that the patches of M24 were then of only moderate floristic quality, but predicted that recent litter removal and proposed regular grazing should increase the quality.

No Meadow Thistle was found in Snipe Marsh during the 2015 survey despite a special effort to try to refind it, neither was Saw-wort or Bitter Vetch (or the markers, Tawny Sedge or Flea Sedge), although Tormentil, Whorled Caraway, Betony and Devil's-bit Scabious were extant. Meadow Thistle and Saw-wort appear to have been recorded here last on 21st July 2008 during a field meeting of the Botanical Society of the British Isles when the hybrid between Meadow Thistle and Marsh Thistle, *Cirsium* x *forsteri*, was also noted.

Bosanquet expressed concern over the very extensive area of Meadowsweet-dominated vegetation belonging to the NVC M27 *Filipendula ulmaria - Angelica sylvestris* mire community, as this vegetation often indicates nutrient-enrichment and it appeared to him that ditches diverting some enriched water may be the only things preventing the loss of the last remaining Purple Moor-grass stands. The 2015 survey found the extent of the Meadowsweet stands to be broadly similar to that recorded in 2007-11 but the field has continued to be ungrazed which has resulted in the increasing coarseness of the vegetation, principally of Meadowsweet, rushes and Purple Moor-grass. This, together with possible soil nutrient-enrichment are the most likely reasons for the loss of the Meadow Thistle fen-meadow community.

The only site within the Garden estate where Meadow Thistle can still be seen is in the wet, western side of Cae Derwen (compartment 26a) which received a patch of M24c grassland, 300m$^2$ in area, translocated from the sports field at Tycroes School when the school buildings were being extended. The vegetation was transported as 1m x 1m turves approximately 150mm thick between 26th and 29th October 2009 and carefully replaced at NBGW. They bedded-in remarkably successfully and, by the following season, had 'knitted together' well with plant species apparently in good condition and flowering profusely. However, in the past two or three years, there appears to have been some deterioration in the quality of the vegetation with cattle poaching encouraging the proliferation of rushes and a decline in the cover of Meadow Thistle and other desirable species. In June 2015, only 19 flowering stems were counted which extended within an area of about 6m x 8m, some of which were putative hybrid *Cirsium* x *forsteri* plants.

The only areas of Purple Moor-grass dominated grassland remaining within the Garden estate are located in Snipe Marsh (compartment 28) and Morfa Du (compartment 26b). This vegetation is included in the NVC M25 *Molinia caerulea - Potentilla erecta* mire. The constant associate Tormentil is joined by Wild Angelica *Angelica sylvestris*, Marsh Thistle *Cirsium palustre* and Common Valerian *Valeriana officinalis* which are preferentials for the NVC M25c *Angelica sylvestris* sub-community and are frequent over much of Morfa Du (compartment 26b) and in a small part of Snipe Marsh. Bosanquet noted that Lesser Pond-sedge *Carex acutiformis* was invading some of the stands in the former field, facilitated by the fencing-off of the enclosure's western edge, threatening to convert them to NVC S7 *Carex acutiformis* sedge-swamp, unless willow encroachment smothered them first or if management were to intervene. Since the 2007-11 survey, no positive management has

been undertaken in this area and willow and Alder have continued to encroach from the wet woodland on the margins of these Purple Moor-grass stands. The woodland-edge and areas already subsumed by woodland resulting in the occurrence of an increasingly moribund Purple Moor-grass-dominated ground layer still support a few plants of the uncommon Marsh Valerian *Valeriana dioica* and occasional tussocks of Greater Tussock-sedge *Carex paniculata*.

Much of the NVC M25 in both fields is overwhelmingly dominated by Purple Moor-grass having a paucity of associate species (particularly in Snipe Marsh) and Bosanquet therefore identified them as degraded 'species-poor' NVC M25. Bosanquet is of the opinion that the relatively extensive areas of NVC M24 Purple Moor-grass - Meadow Thistle fen meadow recorded in both Morfa Du and Snipe Marsh by Bird in 1997 have been replaced, at least in part, by this species-poor community through rampant growth of Purple Moor-grass. With the introduction of appropriate management, it might be possible to restore the former species diversity of this vegetation but would take intensive and concentrated effort and could prove expensive.

3.8.4.3 *Meadowsweet dominated swards*

Meadowsweet *Filipendula ulmaria* dominates the western half to two-thirds of Snipe Marsh (compartment 28) in vegetation where Sharp-flowered Rush is also abundant. The few additional species present are very much less prominent but include Common Marsh Bedstraw *Galium palustre*, Wild Angelica *Angelica sylvestris*, Marsh Marigold *Caltha palustris* and Lesser Spearwort *Ranunculus flammula* and only rarely, Sneezewort *Achillea ptarmica* and Whorled Caraway. This vegetation is included within the NVC M27 *Filipendula ulmaria – Angelica sylvestris* mire community and the scarcity of associated species places it into the M27a *Valeriana officinalis – Rumex acetosa* sub-community.

Further smaller stands of this community are present within the NNR, eg in Morfa Du (compartment 26b), the western edge of Cae Derwen (compartment 26a), the rank, unmanaged clearing at the southern edge of Coed Nant (compartment 32). Outside the NNR, extensive stands are present in the northern, fenced-off part of the Grow the Future field and nearby biomass plots as well as Gatehouse Marsh. The latter two locations are being colonised by willow and other scrub and tall-herb species.

## 3.9 Tall-Herb and Fern Vegetation

3.9.1 Small areas of tall-herb and fern vegetation are scattered throughout the Garden estate, most stands being too small to represent at the scale mapped.

3.9.2 Three weed communities associated with wet grassland vegetation and enriched ground were identified by Bosanquet during his 2007-11 survey of the NNR, particularly in Snipe Marsh (compartment 28), namely, Common Nettle stands belonging to the NVC OV24: *Urtica dioica - Galium aparine* community, vegetation with prominent Great Willowherb included in the NVC OV26 *Epilobium hirsutum* community and Creeping Bent - Creeping Buttercup dominated, short, mat-like vegetation of the NVC OV28 *Agrostis stolonifera - Ranunculus repens* community. These communities were also found to be scattered elsewhere during the 2015 survey, OV24, in particular being found in the vicinity of the horticultural greenhouses and on a pile of decomposing hay bales/dung in the south of Cae Derwen (compartment 26a).

Another tall-herb community of wetlands is dominated by Great Willowherb which was found, for instance, in the overgrown bed of Llyn Mawr as well as Gatehouse Marsh. In

addition to the dominant willowherb, Common Nettle and Meadowsweet are also frequent and Creeping Thistle occasional. It is classified as the NVC OV26 *Epilobium hirsutum* Community.

Weed patches of Common Nettle associated with Creeping Thistle were recorded, for example, at Pantwgan farmstead which are identified as the NVC OV25 *Urtica dioica – Cirsium arvense* community and very small stands of Rosebay Willowherb belong to the OV27 *Epilobium angustifolium* community but were found only rarely, for instance on the northern margin of Compartment 15 (TN15426).

3.9.3 *Bracken dominated vegetation*

Few extensive areas of Bracken-dominated vegetation are present within the NBGW estate. The largest stands are on the steep north-west facing slope of Cae Banc (compartments 11 and 12), on the south-east facing Icehouse Bank and some areas encroaching into the northern margin of North Trawscoed Meadow (compartment 30). These stands belong to the NVC W25 *Pteridium aquilinum – Rubus fruticosus* underscrub community. Elsewhere, Bracken is often present in hedge bottoms and in some locations is encroaching into the adjacent grassland. These stands were too small to be mapped at the scale of the survey.

Bracken also forms a significant component of the dense, impenetrable vegetation in the recently planted woodland extensions to Coed Pantwgan on the bank south of Pantwgan farmstead (TN15583 and TN15586). Here Bramble is more abundant than Bracken, although relatively small stands of Bracken dominate locally, and has been mapped as NVC W24.

## 3.10 Open water habitats

3.10.1 *Rivers and streams*

The Afon Gwynon which runs north-east to join the Afon Tywi near Llanarthne, is the main watercourse that drains the northern part of the Garden estate, its catchment including the 'Afon Gwynon tributary' along which the principal lakes of the Regency landscape were created. One branch of the tributary, along which Llyn Uchaf and Pwll-yr-ardd are situated, rises to the west and runs through Wernbongham before entering the estate. The other branch rises near Allt Goch Lodge, runs south-westwards inside the estate boundary and passes Bryncrwys farmhouse before turning northwards to join the other branch in Llyn Canol.

These water-courses, away from their impounded reaches, mostly run through woodland and are generally fast flowing, running in silt, gravel or cobble-lined channels. No in-stream vascular-plant species were recorded although the moss *Fontinalis* was noted in some locations. Typical species recorded along the stream banks through the northern woodlands (eg TN15025) include Hemlock Water-dropwort, Meadowsweet, Wavy Bitter-cress, Opposite-leaved Golden-saxifrage and Remote Sedge, often under a canopy of Common Alder and Grey Willow with Ash locally. The Allt Goch Lodge – Bryncrwys branch of the Gwynon tributary also mainly runs through wooded riparian habitat but much is in a shallow, narrow gorge with soil-clad dry banks rising steeply away from the channel (eg TN15602). Here, the humid atmosphere encourages the growth of liverworts and ferns.

The southern corner of the Garden estate is drained by an un-named stream which rises in the Diamond Wood area and flows along a ditched channel generally south-westwards along the north-western boundary of, and through the southern part of the wet Coed Morfa woodland, before leaving the estate, flowing under the A48 Garden junction and joining the

Afon Gwendraeth Fach north-west of Porthyrhyd. Water from the swampy Coed Morfa and Morfa Du (compartment 26b) drains into this watercourse. Except for Fool's Water-cress, no in-stream vascular plants were recorded but characteristic bank-side plants include Marsh Marigold, Opposite-leaved Golden-saxifrage, Broad Buckler-fern and Lady-fern which generally occupy a slightly more elevated, drier position than the extensive area of former Lesser Pond-sedge swamp that has now been overwhelmed by Alder and willow of which the majority of this woodland comprises.

3.10.2 *Lakes and ponds*

3.10.2.1 Llyn Canol and Llyn Uchaf were restored by desilting and Pwll-yr-ardd newly created during the development of the Garden prior to its public opening in 2000. These lakes, being on-line with, and connected by the Gwynon tributary, have similar biological character and support similar vegetation. Dominant aquatic species are Broad-leaved Pondweed *Potamogeton natans* and Nuttal's Waterweed *Elodea nuttallii* although Canadian Pondweed *Elodea canadensis* was also recorded. Other pond plants present include Alternate Water-milfoil *Myriophyllum alterniflorum* from near the southern shore of Llyn Canol (TN15539) and a few strands of a narrow-leaved pondweed growing from near its north-eastern end which were provisionally determined as Small Pondweed *Potamogeton berchtoldii*[5] (TN15541). Ornamental water-lilies have also been planted into the lakes. Duckweeds recorded include small amounts of Common Duckweed *Lemna minor* and Ivy-leaved Duckweed *L. trisulca* and an overwhelming, choking profusion of Greater Duckweed *Spirodela polyrhiza* which has only appeared in the lakes in the last few years.

The submerged and floating vegetation growing in all three lakes is best placed into the NVC A15 *Elodea canadensis* community, although in this case *E. nuttallii* is the abundant species. This vegetation probably succeeded NVC A9 *Potamogeton natans* community which is still present but was formerly more dominant before the introduction and recent proliferation of *Elodea*. The Potamogeton community may be best placed into the A9b *Elodea canadensis* sub-community which may have developed from the NVC A9c *Myriophyllum alterniflorum* sub-community following the proliferation of *Elodea*.

Greater Duckweed should be treated as an alien invasive species at this site.

Marginal vegetation is very varied and its diversity has been increased by garden plantings. In addition to frequent small willow and Alder stands, established native herbaceous species include Reed Canary-grass, Common Spike-rush, Bulrush, Branched Bur-reed, Lesser Pond-sedge, Great Willowherb, Meadowsweet and Water Horsetail, whilst introductions include Galingale and, in one location on the south-eastern shore of Llyn Canol, Flowering Rush. Also, the originally introduced hybrid musk *Mimulus* x *robertsii,* is frequent, its colourful addition to water-side vegetation being maintained by prolific self-seeding. This vegetation belongs to several NVC communities, most stands of which extend to no great area but together form a diverse and eye-catching mix of species: only the relatively extensive Common Spike-rush stands in the NVC S19 *Eleocharis palustris* swamp community located at the southern end of Llyn Canol were large enough to map.

3.10.2.2 Adjacent to the Gwynon tributary a pond has been constructed near the north-west side of the Gatehouse to trap silt before it enters the ornamental lakes. This pond is regularly de-silted but at the time of the 2015 survey held a prolific growth of Nuttal's Waterweed: no other submerged or floating aquatic species were noted. A small stand of Great Willowherb

[5] A specimen was taken and has been sent to the BSBI referee for confirmation or redetermination.

occurs on the southern side of the pond but elsewhere the vegetation reflects the disturbed nature of the ground and includes for instance, abundant Colt's-foot, Creeping Thistle and Creeping Buttercup. TN15068 and TN15069a list the species noted on the banks of this pond.

3.10.2.3 The Bog Garden had been reconstructed in the year previous to the survey to include two small ponds. In addition to new marginal plantings such as Giant-rhubarb, Bog-bean, Marsh Marigold, Flowering Rush and Purple Iris, these waterbodies are becoming naturally colonised by species such as Water Plantain, Reed Canary-grass, Water-mint, Bulrush and Lesser Pond-sedge. In common with the other water-bodies surveyed, the originally introduced hybrid musk *Mimulus* x *robertsii* is becoming well established by abundant self-seeding.

Few submerged or floating plants were noted but, in addition to small amounts of Common Duckweed and Greater Duckweed, a narrow-leaved pondweed provisionally determined as Lesser Pondweed *Potamogeton pusillus*[6] was found in the northern pond.

3.10.2.4 Two half-circular, dipping pools are located near the Aqualab which have been planted and colonised with a variety of aquatic plants. They have walled edges on one side facilitating easy access for children to study aquatic life whilst on the other side, more-natural margins allow access for amphibians and other fauna. The eastern of the two pools mainly had open water at the time of the survey and supports small amounts of Canadian Waterweed, Curly Waterweed and *cf* Lesser Pondweed with emergent species such as Yellow Iris, Branched Bur-reed, Square-stalked St.John's-wort and Sharp-flowered Rush. This pool is located adjacent to an open grassed area.

The western pool is less open and adjoins a somewhat overhanging Alder-dominated wooded area, rather overgrown by Bramble. It contains a variety of tall-fen species demonstrating a markedly different wetland habitat for visitors. Planted species include Cypress Sedge, Galingale and Pickerelweed which are accompanied by self-sown hybrid musk and naturally colonised Marsh Bedstraw, Wild Angelica, Great Willowherb and Sharp-flowered Rush.

3.10.2.5 The four ornamental, vertical-sided lily tanks in the centre of the Double Walled Garden were where Greater Duckweed was first recorded in the Garden in 2008 whilst another, less prolific, alien duckweed, *Lemna valdiviana*, was first noticed in 2014. These, together with Common Duckweed and another alien, the Lesser Duckweed, form floating mats over the surfaces of the tanks, particularly towards the end of the year. They are probably the source of the infestation of Greater Duckweed in the lakes (Mallards were noted swimming in the lily tanks having flown-in from outside the walled garden and are likely to be the vector). Broad-leaved Pondweed and Small Pondweed are also present in one or more of the four tanks.

### 3.11 Swamp vegetation

3.11.1 Two distinct swamp areas are present within the Garden estate. The small discrete areas in the southern and western part of the estate encompass one type and the drained Llyn Mawr contains the other.

3.11.2 The generally small areas of swamp vegetation in the southern and western part of the Garden estate are all that remain of a larger expanse of this type of vegetation that would

[6] A specimen was taken and has been sent to the BSBI referee for confirmation or redetermination.

have been more widespread prior to drainage and other agricultural improvements. Much of this now-fragmented surviving wetland has since been colonised, and continues to be colonised by wet Alder and willow woodland. Lesser Pond-sedge dominates these areas and in parts of Morfa Du (compartment 26b) appears to have converted the Purple Moor-grass NVC M24 and NVC M25 vegetation to NVC S7 *Carex acutiformis* swamp. Also in Morfa Du, a stand of Water Horsetail NVC S10 *Equisetum fluviatile* swamp with locally abundant Fool's Watercress occurs associated with the line of an old, now-choked drainage ditch where Sharp-flowered Rush, Great Willowherb and Water Mint are also frequent and which Bosanquet identified as NVC S23 Other water-margin vegetation. Also swampy variants of NVC M27 Meadowsweet-dominated and NVC M23a Soft Rush-dominated vegetation occupy some of the central, wettest and flushed part of the compartment. Bosanquet noted that the M23a swampy variant is partly dominated by Bottle Sedge *Carex rostrata* and partly by Water Horsetail but Bottle Sedge, whilst recorded during a visit in 2012, was not seen here during the 2015 survey.

Elsewhere, Purple Moor-grass was not found to be associated with the Lesser Pond Sedge: in Holy Well Marsh, Lesser Pond-sedge overwhelmingly dominates although there are also local subordinate stands of Reed Canary-grass and Meadowsweet with Common Hemp-nettle also a prominent feature in some areas, whilst in Gatehouse Marsh, a discrete stand of the sedge appears to occupy a more flushed substrate with occasional Wild Angelica and Tufted Hair-grass and dominant stands of Meadowsweet adjacent.

NVC S7 is a scarce community in Carmarthenshire and Lloyd *et al.* (2004) indicate it to have a predominantly coastal distribution. The extant areas of swamp are therefore a valuable ecological asset which need to be retained and managed to prevent the continuing threat of scrubbing-over and to enhance their existing diversity. However, Bosanquet points out that the denseness of the NVC S7 and lack of associates on Morfa Du (compartment 26b) make it an undesirable part of the floristic make-up at the Waun Las NNR and, because it has colonised and replaced the more desirable and locally more-rare M24 Meadow Thistle community, its management should seek to restore the more valuable Meadow Thistle vegetation.

3.11.3 The bed of the former Llyn Mawr (compartment 33) also supports a range of swamp vegetation, much of which has developed since the lake was drained in 2000 but which, in more recent years, has become degraded by its colonisation with wet woodland. Bosanquet, in 2007-11, identified tall Bulrush-dominated *Typha latifolia* swamp (S12), Common Reed-dominated *Phragmites australis* - *Urtica dioica* tall-herb fen (S26) and Reed Canary-grass-dominated *Phalaris arundinacea* tall-herb fen (S28) in the former lake basin, habitats that at that time were absent from elsewhere in the NNR.

Apart from the increasingly abundant willow scrub, Reed Canary-grass NVC S28 was, and remains the most abundant community. The high frequency of Great Willowherb and Common Nettle indicate that this belongs to the nutrient-rich S28b *Epilobium hirsutum* - *Urtica dioica* sub-community and includes local stands of Branched Bur-reed and Bulrush and some dominant areas of Hemlock Water-dropwort which is also frequent along the banks of the stream draining the lake-bed.

Common Reed swamp (NVC S26) replaces Reed Canary-grass in the south of the lake-bed. This community is floristically similar, but with Common Reed replacing Reed Canary-grass. Common Nettle is abundant here also. Bosanquet found that Bulrush-dominated swamp (NVC S12) with associated Branched Bur-reed and Great Willowherb was restricted

to the northern end of the former lake basin but small areas of Bulrush were more prominent towards its centre in 2015.

Several small stands of Bladder Sedge *Carex vesicaria* are also present in the centre of the northern lake bed. These are identified as the NVC S11 *Carex vesicaria* swamp community but have not been mapped separately.

3.11.4 The three former settlement lagoons located east of the Gatehouse have developed distinctive, secondary swamp and tall-herb communities since their abandonment. Each of the three is surrounded by willow scrub-woodland and is distinctively different: two support vegetation of considerable interest.

The southern lagoon is driest and of least interest being dominated by tall-herb vegetation including Great Willowherb and Common Nettle dominated communities belonging respectively to the NVC OV26e *Epilobium hirsutum* community, *Urtica dioica-Cirsium arvense* sub-community and the NVC OV24 *Urtica dioica - Galium aparine* community surrounded by NVC W1 Salix cinerea - Galium palustre woodland.

The central lagoon had water about 0.15m deep at the time of the survey and was densely colonised with tall fen vegetation dominated by Bulrush in the centre with wide marginal zones of Lesser Pond-sedge and Great Willowherb belonging respectively to the NVC S12b *Typha latifolia* swamp, *Mentha aquatica* sub-community, NVC S7 *Carex acutiformis* swamp and NVC OV26 *Epilobium hirsutum* community. Water Horsetail and Meadowsweet are also abundant in this lagoon.

The northern lagoon was generally drier and colonised by tall herb fen vegetation including stands of Bulrush belonging to the NVC S12b *Typha latifolia* swamp *Mentha aquatica* sub-community and Lesser Pond-sedge of the NVC S7 *Carex acutiformis* swamp community. At least six self-established plants of Cyperus Sedge and single plants of Bottle Sedge and Northern Yellow-cress were also recorded here.

### 3.12 Rock exposures

Several quarries are scattered over the Garden estate. All are well vegetated and most host mature tree growth having been allowed to grow into small spinneys or incorporated within larger areas of woodland. None of the quarries examined had any particular botanical interest, their plant communities reflecting those of the local woodlands

Shallow soil with small rock exposures occurs within semi-improved neutral grassland pasture on the crest of the hill in the eastern part of Cae Banc (compartment 11). The potential characteristic plant community is impoverished here by sheep grazing and the only typical species noted were the few plants of Common Bird's-foot Trefoil, Yarrow, Slender St.John's-wort, Sheep's Sorrel and Soft-brome (TN15455 – TN15459).

Rock exposed at the surface in front of the Science Block supports a substantial population of Common Cudweed *Filago vulgaris* (TN15415) which also extended on to the nearby gravel-surface car-park in 2014. The cutting created to prepare a level surface for the Science Block also supports species characteristic of well-draining, often rocky habitats including for instance Mouse-ear Hawkweed and Perforate St. John's-wort.

### 3.13 Tracks, hard-standings, etc

The network of roads and tracks through the Garden estate have limited botanical interest. Characteristic short weed vegetation including Procumbent Pearlwort, Annual Meadow-grass and Great Plantain belonging to the NVC OV20 *Poa annua - Sagina procumbens*

community and NVC OV21 *Poa annua - Plantago major* community were noted on track and road surfaces. Notable species growing on roadside and trackside banks include the population of Great Lettuce which grows in gravelly ground on both sides of the access road to the Science Block.

Gravel-surfaced hard-standings in the vicinity of the propagation glasshouses support a significant range of casual and self-sown alien species including Water Bent, first recorded in Carmarthenshire 2009, now quite abundant in Llanelli and more recently well established at NBGW. Also around the propagation houses, a single plant of the nationally rare Jersey Cudweed was noted in 2014 and several more in 2015. Other self-sown casual species recorded include Upright Spurge, American Speedwell, Bilbaoan Fleabane, Keeled-fruited Cornsalad, Great Lettuce and the hybrid bent-grass x *Agropogon robinsonii,* the latter discovered in 2014 by Sam Thomas whilst undertaking research for his PhD, the first Welsh record of this intergeneric hybrid.

The gravel-surfaced car-parks at the main entrance, near Principality House and by the Science Block also support weed communities. Species noted in this habitat at NBGW have included Bilbaoan Fleabane, Slender Rush and Field Pansy.

The cobble-surfaced courtyard between the Apothecary's Hall and Theatr Botanica has an abundant naturalized population of Corsican Mint growing in the cracks between the cobbles together with other self-established species such as Blinks, the lady's-mantle *Alchemilla mollis*, Sea Mouse-ear, Common Whitlowgrass, Bilbaoan Cudweed and Water Bent.

Pantwgan Farmyards are notable for the abundance of Northern Yellowcress they support (additional single plants were also seen in the Grow the Future area and the northern settlement lagoon (paragraph 3.11.4).

3.14 **Arable headlands**

Although small areas of 'arable' field margin vegetation were recorded during the Phase 1 habitat survey (eg TN15413), they are extremely small, mainly confined to the vicinity of field gateways and of very limited species composition when compared with good examples of this habitat type. These areas necessarily depend on soil disturbance and any temporary losses of disturbed substrate will be replaced in different locations each year depending upon which fields are ploughed and seeded. The quality of this habitat at NBGW does not qualify it to be of national, regional or county interest, nor even of local interest.

3.15 **Stone boundary walls and stone buildings**

Characteristic mural fern communities occur on many stone-walls within the Garden estate: most frequent species are Maidenhair Spleenwort and Wall-rue which is identified as the NVC OV39 *Asplenium trichomanes – Asplenium ruta-muraria* community. Good examples of this vegetation occur on the currently rather tumble-down section of the outer wall of the Double Walled Garden below the Graig Fawr farmhouse as well as on parts of the old boundary wall in the Pont Felin-gat area although, in both these cases, dense Ivy growth has often outgrown and displaced the open mural fern community.

Another characteristic open, wall community is the NVC OV42 *Cymbalaria muralis* community which comprises of individual crevice-growing Ivy-leaved Toadflax plants, rarely forming any large areas of closed vegetation. The toadflax is often accompanied by the two ferns mentioned above as well as a range of additional species including, for example, Dandelion, Prickly Sow-thistle, Red Fescue and many more. This community, together with

NVC OV39, is common on the walls of both the Double Walled Garden and the Wallace Garden.

The first Carmarthenshire record of self-established House Holly-fern *Cyrtomium falcatus* was made late in 2015 when about six small plants ranging in size from 5cm to c.30cm across were found growing in the stonework of the wall at the southern end of the Double Walled Garden.

## 3.16 Conclusion and summary

3.16.1 Bosanquet concluded that the Waun Las NNR "holds a large area of grassland that has not been ploughed, reseeded or treated with inorganic fertilizers since at least the late 1990s. A few small stands of reasonably good-quality unimproved neutral grassland (NVC MG5) and fragments of Meadow Thistle – Purple Moor-grass grassland (NVC M24) are the most notable grassland communities on the site, but these habitats are restricted to three fields on the western edge of the survey area, which are therefore of high conservation value". The 2015 survey found that although the areas of MG5 are largely unchanged (or enhanced at North Trawscoed Meadow (compartment 30)), the M24 has been lost as a result of the continued absence of grazing management. It might be possible, however, to restore this vegetation with appropriate but intensive management, strictly controlled by a member of the farm staff with experience in such conservation restoration practices.

He continued "the vast majority of the site is occupied by semi-improved grassland of various kinds, including NVC MG6b and 'dry semi-improved grassland' (no NVC), with low quality M23 rush-pasture in a few areas. Overall, Waun Las NNR is of moderate to high conservation value for its lowland grassland and wetland communities in its current state, although this conservation value is largely restricted to the western fields". Since the 2007-11 survey Cae Tregeirianau (compartment 13) has certainly gained species diversity such that it is now approaching a return to NVC MG5 from its current NVC MG6b as a result of the introduction of 'traditional haymeadow' management and is now of almost as significant conservation value as North Trawscoed Meadow (compartment 30). This approach should be introduced in other suitable fields elsewhere within the estate. Despite the abundance of Whorled Caraway in Cae Brwyn and Compartment 15, the rush pasture in these fields remains of generally rather low quality and is likely to benefit from more intense grazing whilst taking care not to overstock or poach the ground by strictly controlling the management on a day-to-day basis .

He concluded that "there is clearly potential for grassland restoration. A number of the fields appear not to have been highly enriched and may well be species-poor primarily because of past heavy deer and sheep grazing, although this would need confirmation through soil analysis. The re-establishment of regular grazing by heavy livestock (ideally cattle) on the areas of marshy grassland should also be considered a high priority".

Management is particularly urgently needed in Snipe Marsh (compartment 28) and Morfa Du (compartment 26b) where initial mechanical clearance of rank vegetation including dense rush "thatch" and tussocky Purple Moor-grass would need to precede the re-introduction of hardy-cattle grazing. A similar management approach is also needed in Holy Well Marsh, the northern part of North Trawscoed Meadow, and the formerly open grassland area of Coed North Lodge in order to restore the grassland vegetation to favourable status.

3.16.2 Most woodlands are fenced to prevent grazing stock from entering. This has often been detrimental to the condition of the largely herbaceous, ground flora as it has allowed Bramble to colonise and smother-out the more desirable, less aggressive species. This has been to the benefit of species such as Dormouse which must now be assumed to occupy all this new habitat to such a degree that if the open-nature of the woodlands is to be restored, mitigation in the form of like-for-like Dormouse habitat will need to be provided.

3.16.3 Swamps and, as mentioned above, the most valuable marshy grassland habitats, have degraded considerably in the past ten to fifteen years due to cessation of grazing exacerbated in the southern corner of the estate by new fencing preventing stock access and allowing the continuing colonisation by willow and Alder scrub. This has resulted in the loss of the rare Meadow Thistle community and the homogenisation of previously diverse wetland swards to be replaced by rank, dominant Purple Moor-grass or Lesser Pond-sedge vegetation. The Regency Restoration Project may provide an opportunity of reversing this trend and restoring swamp and wetland diversity.

The swamp vegetation that has colonised the bed of Llyn Mawr over the past fifteen years will largely be lost when the lake is reinstated but it will be possible to retain small areas around the lake margins, particularly where the banks are of shallow gradient at its southern end.

3.16.4 Nutrient-rich water reaching the lakes currently results in aquatic algal growth and exacerbates the dominance of the floating carpet of Greater Duckweed in summer and autumn. In order to preserve and maintain the diversity of flora and fauna within the lakes, consideration should be given to determine whether the nutrient level of incoming waters could be reduced whilst also employing a means to mechanically remove Greater Duckweed to reduce its effect on other wildlife.

## 4. SIGNIFICANT VASCULAR PLANTS (Richard Pryce)

4.1 The following paragraphs summarise protected and other significant plant species which were recorded mainly during the 2015 survey.

4.2 Schedule 8 of the Wildlife and Countryside Act 1981 (as amended)
Bluebell *Hyacinthoides non-scripta* is protected against unlicenced sale by its inclusion on schedule 8 of the Wildlife and Countryside Act 1981 (as amended) and was frequently recorded in woodland, formerly wooded areas and hedge-bottoms during the present survey.

4.3 CCW Globally Threatened Plants Category A
Whorled Caraway *Carum verticillatum* is included in category A of the Countryside Council's List of Globally Threatened Plants. Abundant in marshy grassland habitat in compartments 15 and 17 and scattered elsewhere eg in North Trawcoed Meadow (compartment 30), Horse Field (compartment 20), Cae Waun (compartment 24), Snipe Marsh (compartment 28), Gatehouse Marsh and Coed North Lodge.

4.4 CCW Globally Threatened Plants Category B
Primrose *Primula vulgaris* is included in category B of the Countryside Council's List of Globally Threatened Plants and is widespread but not common in woodlands at NBGW.

4.5 Section 42 plant Species
No section 42 plant *Species of Principal Importance for Conservation of Biological Diversity* in Wales were recorded during the 2015 survey but

*Euphrasia anglica* English Eyebright: was recorded in North Trawscoed Meadow in 2010.

4.6 Species endemic to Britain

*Euphrasia anglica* English Eyebright: recorded in North Trawscoed Meadow in 2010.

*Taraxacum cambricum.* A rare dandelion of section Celtica with its population centre in Breconshire. Recorded in North Trawscoed Meadow and on the Llyn Mawr earth-dam in 2015, determined by John Richards, December 2015.

*Taraxacum celticum.* A dandelion of section Celtica with population centres in north-east and south-east Wales. Recorded on the bank of the "silt-trap pond" in 2015, determined by John Richards, December 2015.

*Taraxacum stenacrum.* A dandelion of section Ruderalia with populations scattered mainly in England and Wales. Recorded in grazed pasture in Cae Waun (compartment 24) in 2015; John Richards, December 2015, thought that the specimen could be this taxon.

4.7 Nationally Rare and Scarce Species
Plants of UK/National importance, ie those which are listed as 'Nationally Rare' (recorded from 15 or fewer 10km grid squares in the British Isles) or Nationally Scarce (recorded from 16 - 100 10km grid squares in the British Isles) which were recorded during the 2015 survey are as follows:

Nationally Rare

*Gnaphalium luteoalbum* Jersey Cudweed: critically endangered in the wild: one plant in 2014 and about 20 in 2015 self-sown in gravel between the horticultural glass

houses. This species was probably introduced with imported planting or seed stock and is only a casual at NBGW although its population may continue to increase where conditions currently suit it.

Nationally Scarce

*Rorippa islandica* Northern Yellow-cress Abundant in Pantwgan farmyard and single plants in the Grow the Future area and disused lagoons.

4.8 Plants of county importance

Plants of county importance are divided into 'County Rare' (recorded from 5 or fewer sites in the county) or 'County Scarce' (recorded from 6 - 15 sites in the county). Species in these categories found during the 2015 survey are as follows

County Rare

*Carex pseudocyperus* Cyperus Sedge: self established in one of the disused lagoons possibly from plantings in the bog garden or dipping pools. The only native population in the county is at Pendine.

*Cyrtomium falcatum* House Holly-fern: about six self-established plants of this non-native fern found in the wall of the Double Walled Garden. Only county record.

*Lactuca virosa* Great Lettuce. Now well established in the propagation area and by the access road to the Science Block: the only record for the county until a few plants were found by Barry Stewart near Kidwelly in August 2015. Non native in Carms.

*Mentha requienii* Corsican Mint: this non-native is well established in cracks in the cobbles in the Theatr Botanica courtyard. Only one other record in the county.

*Salix* x *rubra* Green-leaved Willow: one bush probably this hybrid in the Llyn Mawr lake-bed. Two other records in the county.

*Spirodela polyrhiza* Greater Duckweed: first recorded in the lily tanks in the Double walled Garden in 2008. First seen in Llyn Canol and Llyn Uchaf in 2014 (Sam Thomas, pers. com.) and abundant in Llyn Canol and Llyn Uchaf and locally abundant in Pwll-yr-Ardd by late summer 2015. Known elsewhere in the county only from the Wildfowl and Wetlands Trust Centre in Llanelli but, at NBGW, a worrying alien invasive species although native elsewhere in Britain

*Veronica peregrina* American Speedwell: a few plants in the propagation area in 2014 and 2015. Four other county records of this alien casual.

County Scarce

*Bromus racemosus* Smooth Brome was collected by Sam Bosanquet in 2007 from NVC M23a at the top of Cae Treillon (compartment 14) but was not refound during the 2015 survey.

*Calamagrostis epigejos* Wood Small-reed: two clumps noted in the Wild Garden.

*Cirsium* x *forsteri* a hybrid thistle: now only present in the Tycroes school sportsfield recipient plot (TN15343).

*Clematis vitalba* Traveller's-joy: one large tangle on the south-eastern estate boundary at the edge of Coed Allt Goch.

*Conyza floribunda* (*C.bilbaoana*) Bilbaoanan Fleabane: becoming a frequent weed in the propagation area.

*Conyza sumatrensis* Guernsey Fleabane: occasional in the propagation area and near the Science Block.

*Dryopteris carthusiana* Narrow Buckler-fern: one plant found in Snipe Marsh (compartment 28) in 2007, not refound since.

*Elodea canadensis* Canadian Waterweed: Recorded in the Bog Garden ponds and Dipping Pools and on one occasion in Llyn Uchaf.

*Elodea nuttallii* Nuttall's Waterweed: abundant in Llyn Canol, Llyn Uchaf and Pwll-yr-Ardd and also in the "Silt-trap Pond".

*Epilobium* x *interjectum* (*E. montanum* x *E. ciliatum*) a hybrid willowherb: Noted in scrubby, rank northern part of Coed North Lodge.

*Euphorbia exigua* Dwarf Spurge: Rare casual in propagation area.

*Filago vulgaris* Common Cudweed: Large population of this plant in the thin soil south-east of the Science Block and (in 2014) in the nearby car-park. Only three other post 2000 records in the county.

*Geum* x *intermedium* Hybrid Avens: one plant (probably a natural hybrid) on the north bank of Llyn Canol.

*Juncus* x *kern-reichgeltii* a hybrid rush: recorded once in the scrubby area south of the Coed North Lodge biomass plots but probably more widespread and frequent than this might indicate.

*Lemna trisulca* Ivy-leaved Duckweed: A small amount found in Llyn Canol but may also be in the other lakes. Five other post 2000 records from natural sites in Carms.

*Mimulus* x *robertsii* Hybrid Monkeyflower: abundantly naturalised around lake margins and in secondary swampy ground eg on the banks of the stream running through the bed of Llyn Mawr and in the Disused Lagoons.

*Polypogon viridis* Water Bent: a now well-established casual in the propagation area.

*Valerianella carinata* Keeled-fruited Cornsalad: a casual in the propagation area.

4.9 Plants of local interest

Plants of local interest by virtue of their scarcity or restricted distribution when viewed in a local context which were found during the 2015 survey are as follows.

*Carex acutiformis* Lesser Pond-sedge dominates swamp vegetation in Morfa Du (compartment 26b), Holy Well Marsh, Gatehouse Marsh and the area in which the biomass plantation adjacent to the Gatehouse was planted, whilst it is also frequent over parts of the bed of Llyn Mawr. This species appears to be relatively frequent in the central Tywi valley area.

*Carex laevigata* Smooth-stalked sedge: Bosanquet found a single small patch of this species in the fenced-off part of Cae Banc (compartment 12) which was new to the site; five additional locations for the plant were found in 2015 mainly in woodland or woodland-edge situations.

*Carex muricata* subsp. *lamprocarpa* Small-fruited Prickly-sedge: one plant was found in the scrubby, rank marshy area south of the biomass plots in Coed North Lodge

*Carex rostrata* Bottle Sedge was found by Bosanquet to form a dense patch in Morfa Du (compartment 26b) with several stands also in Snipe Marsh (compartment 28). It was not refound at the former location in 2015, it having last been seen in 2012, but in Snipe Marsh it is still fairly plentiful. One plant was also seen in the northernmost disused lagoon.

*Carex vesicaria* Bladder Sedge: This was first recorded in Llyn Mawr by Ian Morgan in 1994 and Bosanquet recorded a 3m x 3 m patch at the southern end of the drained lake-bed (compartment 33) and ten more plants at the northern end. The 2015 survey found it to be quite widespread over the former lake bed. It has not been found elsewhere within the Garden estate.

*Catapodium marinum* Sea Fern-grass. A casual in potted plants and on gravelly ground the propagation area, otherwise known in Carms from sandy ground at the coast.

*Cirsium dissectum* Meadow Thistle: In 1997, Bird recorded this species in three quadrats distributed over the northern half of Snipe Marsh (compartment 28) and at least sixteen plants were found by Bosanquet during the 2007 survey but confined to a small area within Snipe Marsh. A few plants were also found by a visiting Botanical Society (BSBI) group in 2008 but Meadow Thistle has not been seen there since. Bird also recorded the species in nine quadrats across the western third of Morfa Du (compartment 26b) when much of the area would have been more diverse open marshy grassland but, by 2007, it appeared to have been overwhelmed by Purple Moor-grass or Lesser Pond-sedge. Since that time, the area has continued to be colonised by Alder and willow woodland, which is exacerbated by the fencing-out of grazing stock. Bird also recorded Meadow Thistle in one quadrat in the northern part of compartment 17 near its boundary with Hangman's Wood. Today, Meadow Thistle can only be seen within the Garden estate in the Tycroes School sportsfield recipient plot at the western edge of Cae Derwen (compartment 22a).

*Dactylorhiza praetermissa* Southern Marsh-orchid: Bosanquet noted a small population of non-flowering plants probably of this species in North Trawscoed Meadow (compartment 30) and it is likely he would have recorded more if his survey had coincided with the flowing-time of the species. It was also found to be frequent during the 2015 survey at the western end of Cae Tegeirianau (compartment 13) and scattered over the infrequently-mown grasslands south and east of the Great Glasshouse and the Wild Garden.

*Dactylorhiza* x *grandis* a hybrid marsh-orchid: plants having characters of this widespread hybrid were found during the 2015 survey in North Trawscoed Meadow (compartment 30), Cae Blaen (compartment 29) and Cae Tegeirianau (compartment 13).

*Dactylorhiza* x *transiens* a hybrid marsh-orchid: plants having characters of this widespread hybrid were found during the 2015 survey along the eastern edge of the Grow the Future field and in Cae Tegeirianau (compartment 13).

*Epilobium ciliatum* x *obscurum* a hybrid willowherb: a plant, probably this taxon, was recorded during the 2015 survey on the western edge of the Diamond Wood plantings. It was also recorded by Geoffrey Kitchener (the BSBI *Epilobium* referee) at the northern corner of the main car-park and on the northern bank of Llyn Uchaf in July 2006.

*Euonymus europaeus* Spindle: only recorded from the Diamond Wood plantings although it was recorded by a group of Botanical Society (BSBI) botanists in May 1998 during the construction phase of Garden development.

*Lamium album* White Dead-nettle: mainly coastal in Carmarthenshire but recorded in disturbed ground at Gorwen farmstead during the 2015 survey.

*Lemna minuta* Least Duckweed: this alien so far only recorded from the Double Walled Garden lily tanks.

*Persicaria amphibia* Amphibious Bistort: mainly recoprded along the Tywi and on the coastal flats in Carms, a plant was found in the grassy ditch that traverses Cae Treillon (compartment 14) during a BSBI meeting in 2008 and a small stand, during the 2015 survey, on the north bank of Llyn Uchaf (TN15564).

*Picris echioides* Bristly Oxtongue: occasional weed in the propagation area.

*Platanthera chlorantha* Greater Butterfly-orchid: the first record from the Garden estate land was made by Chris Fuller in July 1980 from the northern tip of the (now) Grow the Future field; a single plant was found in the same area during the 2015 survey (TN15474).

The species was first found in North Trawcoed Meadow (compartment 30) by Ian Morgan in June 1992 when he recorded 65+ plants in the central-east part of the field and another six in the northern part. Bosanquet reported that Greater Butterfly-orchid had been recorded in small quantity in the eastern part of North Trawcoed in the past but was not seen during his 2007-11 survey. However, the more recent introduction of traditional haymeadow management had promoted an increase in the size of the population to many thousands by 2014 and 2015.

A further small population had been known to Garden staff in a small area in the north of Cae Tegeirianau (compartment 13) since at least 2007. Again, the recent introduction of traditional haymeadow management had, by 2015, promoted an increase in the size of this population to several hundreds and an expansion in its area to cover much of the meadow.

*Potamogeton berchtoldii* Small Pondweed: a few strands, provisionally identified as this species, were dredged from Llyn Canol during 2015. Additional plants were present in the Double Walled Garden lily tanks.

*Rorippa sylvestris* Creeping Yellow-cress: one plant was found as a weed in a cropped vegetable bed in the Grow the Future area in July 2015 (TN15469).

*Salix* x *reichardtii* a hybrid willow: Scattered around the Garden estate, probably more common than the records show.

*Salix* x *smithiana* Silky-leaved Osier: a bush, tentatively identified as this hybrid was found on the bed of Llyn Mawr in April 2015 (TN15011).

*Sanguisorba officinalis* Great Burnet: Bosanquet reported this species to be relatively widespread across the NNR and to be one of the most interesting features of Waun Las because it suggests affinities to flood-meadow grassland. He stated it to be particularly frequent in NVC MG5 neutral grassland but was also growing in 'dry semi-improved grassland'". These dry communities do not correspond well with such a flood-meadow affinity in Carmarthenshire, particularly as elsewhere in the county the species is invariably a component of relatively dry neutral grassland or, in the uplands, of flushes and on wet rocks. Bosanquet in 2007-11 noted the largest colonies to be in Cae Waun Las (compartment 18), Cae Blaen (compartment 29) and North Trawscoed Meadow (compartment 30), but there were also smaller populations in Cae Calch (compartment 23) and Cae Waun (compartment 24). None was seen in Cae Calch during the 2015 survey when it was found to be confined to the less disturbed, north-eastern section of Cae Blaen but was widespread in the damper parts of North Trawscoed and extant in Cae Waun. It was also frequent in the northern parts of the Grow the Future field and Coed North Lodge. It was also recorded in Snipe Marsh (compartment 28), Cae Du Dau (compartment 4), Cae Tegeirianau (compartment 13), Cae Derwen (compartment 26a), the Woods of the World and Diamond Wood plantings, the field and roadside boundary west of the main car-park, in the Wild Garden and near the Great Glasshouse.

*Valeriana dioica* Marsh Valerian was first recorded in the Morfa Du (compartment 26b) area during the CCW Phase 1 survey by Morfydd Lloyd in 1994. About fifteen flowering plants of this uncommon Carmarthenshire species were refound during the 2015 survey in Morfa Du (TN15232) and a further small stand covering c.3m x 3m in the north of Coed Morfa (TN15197). A few more plants were seen in a flush at the western edge of Cae Waun Las (TN15534a).

*Vulpia myuros* Rat's-tail Fescue: occasional weed in the propagation area.

4.10 Charophytes (Stoneworts)

Charophytes are a small group of freshwater algae (ie not vascular plants) that are included in the groups of plants studied by the Botanical Society of Britain and Ireland (BSBI). Plantlife have designated much of the coastal flatlands around the Carmarthenshire coast as an "*Important Stonewort Area*" where plants occur in many duneland pools. Stoneworts are also found in the county away from the coast, particularly where they have colonised limestone quarry ponds, whilst they are also present in a few naturally-formed lakes.

At the end of November 2015, a population of stonewort was found in the vertically-sided, circular water-feature at the head of the Broadwalk Rill (TN15676, TN15677). The plants form dense growths across the bottoms of both levels of the feature and were provisionally identified as Delicate Stonewort *Chara virgata* in the upper-level pool and Fragile Stonewort *Chara globularis* in the lower level. Specimens have been sent to Nick Stewart, the national Charophyte expert, and await his expert confirmation/revision.

4.11 Conclusion

Additional plant species are likely to be recorded as time passes.

Estate management should bear due regard to the wellbeing of individual species as well as whole vegetation communities and must also consider the importance of vegetation in supporting faunal populations. For instance, excessive and over-frequent cutting of hedgerows should be avoided and areas that support wetland and grassland plants that are dependent upon the maintenance of open swards need to be managed by grazing or regular cutting and removing the arisings. Maintenance of the wildlife interests of the whole Garden estate will be greatly facilitated by the drafting and implementation of an estate-wide conservation management plan, the success of which will further depend upon future regular monitoring of the results of management practices.

## 5. BRYOPHYTE SURVEY (Barry Stewart)

5.1 The Garden estate supports a wide range of habitat types occupied by bryophytes including broad-leaved woodland, parkland, hedgerows, unimproved to improved neutral grasslands, tall-herb fen, standing water, streams, buildings, walls and, of course, the complex of garden habitats. Whilst collectively these habitats are diverse, the southern geographical location, low altitude, lack of rock exposures and mostly neutral soil chemistry are all attributes that generally support few species of special note. Nevertheless bryophytes are a very important component of the communities occupying these lowland habitats and the 2015 survey provides a baseline that describes the diversity of hornworts, liverworts and mosses found across the Middleton estate.

5.2 **Previous bryophyte recording**

The only bryologist to record at the Middleton estate prior to the 2015 survey was Sam Bosanquet, Natural Resources Wales' Senior Habitat Survey, Evaluation & Non-Vascular Plant Ecologist, who produced close to 400 bryophyte records of 156 species. The majority of records were collected in 2001, when an extensive bryological survey was undertaken (Bosanquet, 2001). Otherwise casual recording was undertaken by him at various locations in 2013 and all years from 2008 to 2013. *The Mosses and Liverworts of Carmarthenshire* (Bosanquet, *et al,* 2005) includes the 2001 to 2003 records and identifies the "Alder carr at Middleton Hall" as being notable for *Oxyrrhynchium specoisum* and *Plagiomnium ellipticum*.

Whilst the main habitats in the Garden estate support a good range of species, no GB or Welsh Red List bryophytes were recorded but several species of county interest were recorded during this period: additional elements of the Alder carr assemblage that are of local interest include *Chiloscyphus pallescens* and *Plagiothecium denticulatum* var. *denticulatum*, with *Fissidens crassipes* and *Fissidens rivularis* being found along the water courses. The diversity of trees, varied topography and shelter provide a wide range of opportunities for epiphytic species with *Lejeunea cavifolia, Neckera pumila, Orthotrichum striatum* and *Zygodon rupestris* being some of the more noteworthy species identified. Dead wood was found to support most of the widespread species associated with this bryophyte-friendly niche, but *Aulacomnium androgynum* on a dead Alder trunk by Llyn Mawr was perhaps the most significant record as this species is particularly rare in Carmarthenshire, being close to the western limit of its range. *Weissia brachycarpa* var. *obliqua* is uncommon in Carmarthenshire and was recorded from the flowerbeds within the ornamental gardens. Also within the gardens, *Leptobarbula berica* was found on wall mortar by the Science Building and is one of only three Carmarthenshire records (Bosanquet & Dines, 2011). *Seligeria recurvata* was yet another good 'garden' record, discovered in the rockery in 2010 on imported stone, the location well removed from the east Carmarthenshire stronghold in the uplands. Other interesting wall species noted included *Eucladium verticillatum*, *Gymnostomum viridulum*, *Pseudocrossidium revolutum* and *Tortella tortuosa,* found not just within the estate, but along the boundary walls around Pont Felin-gat. Lowland, semi-improved, neutral grasslands generally have limited bryological interest but poached ground and/or ditches provide niches for species such as *Anthoceros punctatus* and *Fossombronia pusilla*, both of which were recorded along a ditch at Cae Gwair east of Llyn Canol.

## 5.3 The 2015 field survey

The survey commenced on the 29th April when a site meeting, attended by Sam Bosanquet, Richard Pryce and Barry Stewart was convened to help inform and direct recording effort for the year. The survey period extended to January 2016 during which 854 records were largely produced by BS. No attempt was made to provide comprehensive lists for each of the compartments shown on figure 2.3 but recording was aimed at sampling those habitats considered likely to provide the most bryological interest, both in terms of diversity and potential for supporting notable species. The surveys involved a walk-over across all areas of the Garden estate with more detailed hands-and-knees and trunk searching in areas of particular interest. Specimens requiring microscopic examination, such as *Cephaloziella* and *Fossombronia* spp., were collected for checking. A few voucher specimens of notable taxa were retained for verification by British Bryological Society (BBS) referees. Appendix 12 lists all records made during the survey period, with details including location, habitat and abundance.

## 5.4 Results

Table 5.1. includes all bryophyte species recorded within the Garden estate. Those only recorded prior to the 2015 survey are indicated †, those recorded both prior to and during the 2015 survey are marked ‡ and those recorded for the first time in 2015 are marked +. Species are listed alphabetically, with hornworts, liverworts and mosses in separate sections. Taxonomy and nomenclature follow Hill *et al.* (2008). Table 5.1 is a summary of the source data listed at Appendix 12 which have been submitted to the BBS and incorporated into the national data set.

**Table 5.1 List of all bryophytes recorded within the NBGW estate**

### Hornworts

† *Anthoceros punctatus*

### Liverworts

‡ *Calypogeia arguta*
‡ *Calypogeia fissa*
+ *Calypogeia muelleriana*
+ *Cephalozia bicuspidata*
+ *Cephalozia lunulifolia*
+ *Cephaloziella divaricata*
‡ *Chiloscyphus pallescens*
‡ *Chiloscyphus polyanthos*
‡ *Cololejeunea minutissima*
‡ *Conocephalum conicum*
‡ *Diplophyllum albicans*
+ *Fossombronia incurva*
† *Fossombronia pusilla*
‡ *Frullania dilatata*
‡ *Frullania tamarisci*
‡ *Lejeunea cavifolia*
‡ *Lejeunea lamacerina*
‡ *Lepidozia reptans*
‡ *Lophocolea bidentata*
‡ *Lophocolea heterophylla*
‡ *Lunularia cruciata*
‡ *Marchantia polymorpha subsp. ruderalis*
‡ *Metzgeria consanguinea*
‡ *Metzgeria furcata*
‡ *Metzgeria violacea*
‡ *Microlejeunea ulicina*
‡ *Nowellia curvifolia*
‡ *Pellia endiviifolia*
‡ *Pellia epiphylla*
‡ *Plagiochila asplenioides*
+ *Plagiochila britannica*
‡ *Plagiochila porelloides*
‡ *Radula complanata*
‡ *Riccardia chamedryfolia*
† *Riccia glauca*
+ *Riccia sorocarpa*

### Mosses

‡ *Amblystegium serpens var. serpens*
‡ *Atrichum undulatum*
† *Aulacomnium androgynum*
‡ *Barbula convoluta var. convoluta*
‡ *Barbula convoluta var. sardoa*
‡ *Barbula unguiculata*
‡ *Brachytheciastrum velutinum*
‡ *Brachythecium rivulare*

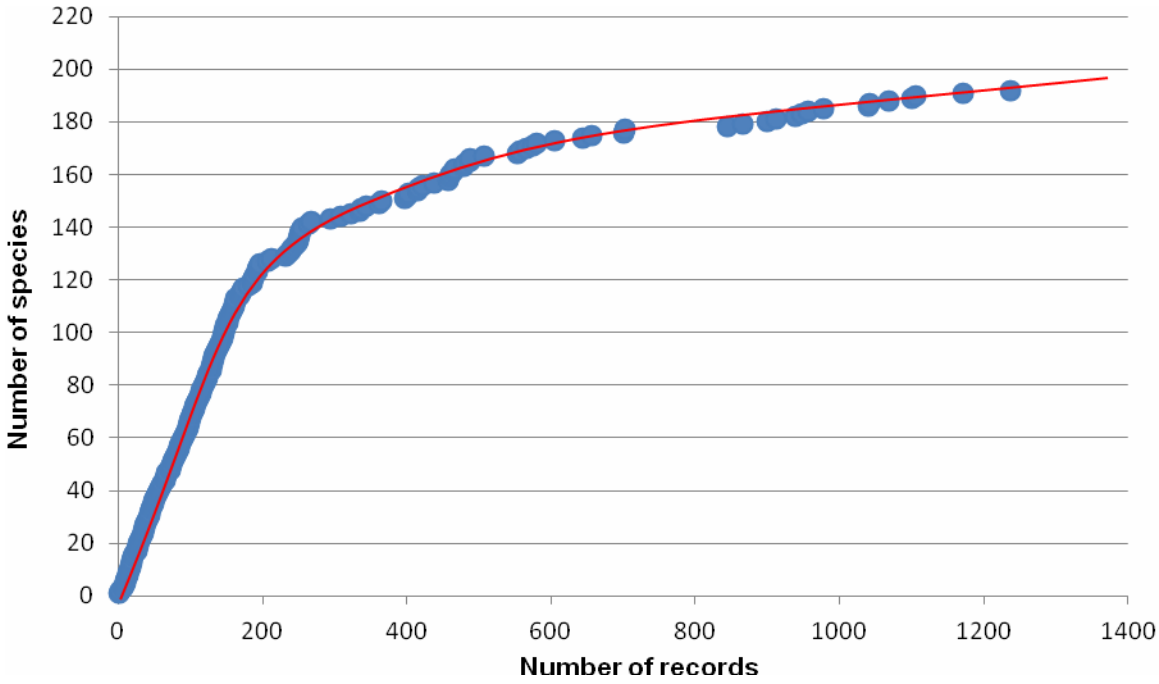
‡ *Brachythecium rutabulum*
‡ *Bryoerythrophyllum recurvirostrum*
‡ *Bryum argenteum*
† *Bryum caespiticium sens. lat.*
‡ *Bryum capillare var. capillare*
‡ *Bryum dichotomum*
† *Bryum radiculosum*
‡ *Bryum rubens*
† *Bryum ruderale*
‡ *Calliergonella cuspidata*
+ *Campylopus flexuosus*
‡ *Campylopus introflexus*
‡ *Ceratodon purpureus*
+ *Cinclidotus fontinaloides*
‡ *Cirriphyllum piliferum*
‡ *Cratoneuron filicinum*
‡ *Cryphaea heteromalla*
+ *Ctenidium molluscum var. molluscum*
+ *Cyathophorum bulbosum*
+ *Dichodontium pellucidum sens. lat.*
‡ *Dicranella heteromalla*
† *Dicranella schreberiana*
‡ *Dicranella staphylina*
† *Dicranella varia*
+ *Dicranoloma menziesii*
‡ *Dicranoweisia cirrata*
‡ *Dicranum scoparium*
‡ *Didymodon fallax*
‡ *Didymodon insulanus*
+ *Didymodon luridus*
‡ *Didymodon nicholsonii*
‡ *Didymodon rigidulus*
† *Didymodon sinuosus*
‡ *Didymodon tophaceus*
‡ *Encalypta streptocarpa*
† *Eucladium verticillatum*
‡ *Eurhynchium striatum*
† *Fissidens adianthoides*
‡ *Fissidens bryoides var. bryoides*
+ *Fissidens celticus*
† *Fissidens crassipes*
‡ *Fissidens dubius*
+ *Fissidens exilis*
‡ *Fissidens incurvus*
+ *Fissidens pusillus*
‡ *Fissidens rivularis*
‡ *Fissidens taxifolius var. taxifolius*
‡ *Fissidens viridulus*
† *Fontinalis antipyretica var. antipyretica*
‡ *Funaria hygrometrica*
‡ *Grimmia pulvinata var. pulvinata*
+ *Gymnostomum aeruginosum*
† *Gymnostomum viridulum*
+ *Gyroweisia tenuis*
+ *Heterocladium heteropterum var. heterop.*
† *Homalia trichomanoides*
‡ *Homalothecium sericeum*
‡ *Hookeria lucens*
‡ *Hygroamblystegium fluviatile*
‡ *Hygroamblystegium tenax*
+ *Hygrohypnum luridum*
‡ *Hypnum andoi*
‡ *Hypnum cupressiforme var. cupressiforme*
‡ *Hypnum cupressiforme var. resupinatum*
+ *Hypnum jutlandicum*
‡ *Isothecium alopecuroides*
‡ *Isothecium myosuroides var. myosuroides*
‡ *Kindbergia praelonga*
† *Leptobarbula berica*
‡ *Leptodictyum riparium*
+ *Leskea polycarpa*
‡ *Mnium hornum*
‡ *Mnium stellare*
‡ *Neckera complanata*
‡ *Neckera pumila*
‡ *Orthodontium lineare*
‡ *Orthotrichum affine*
+ *Orthotrichum cupulatum*
† *Orthotrichum diaphanum*
‡ *Orthotrichum lyellii*
‡ *Orthotrichum pulchellum*
‡ *Orthotrichum stramineum*
‡ *Orthotrichum striatum*
+ *Orthotrichum tenellum*
‡ *Oxyrrhynchium hians*
‡ *Oxyrrhynchium pumilum*
† *Oxyrrhynchium speciosum*
‡ *Philonotis fontana*
† *Physcomitrium pyriforme*
+ *Plagiomnium affine*
† *Plagiomnium elatum*
‡ *Plagiomnium undulatum*
‡ *Plagiothecium denticulatum v. denticulatum*
+ *Plagiothecium nemorale*
‡ *Plagiothecium succulentum*
+ *Plagiothecium undulatum*
‡ *Platyhypnidium riparioides*
+ *Pleuridium acuminatum*
† *Pleuridium subulatum*
‡ *Pogonatum aloides*
‡ *Pohlia melanodon*
‡ *Pohlia wahlenbergii var. wahlenbergii*
‡ *Polytrichastrum formosum*
‡ *Polytrichum juniperinum*
+ *Pseudephemerum nitidum*
‡ *Pseudocrossidium hornschuchianum*

† *Pseudocrossidium revolutum*
‡ *Pseudoscleropodium purum*
‡ *Pseudotaxiphyllum elegans*
† *Ptychomitrium polyphyllum*
+ *Ptychomnion aciculare*
‡ *Racomitrium aciculare*
‡ *Racomitrium ericoides*
† *Racomitrium fasciculare*
† *Racomitrium heterostichum*
‡ *Rhizomnium punctatum*
‡ *Rhynchostegiella tenella*
‡ *Rhynchostegiella teneriffae*
‡ *Rhynchostegium confertum*
+ *Rhytidiadelphus loreus*
‡ *Rhytidiadelphus squarrosus*
‡ *Rhytidiadelphus triquetrus*
‡ *Schistidium crassipilum*
‡ *Sciuro-hypnum plumosum*
‡ *Sciuro-hypnum populeum*
† *Seligeria recurvata*
+ *Sematophyllum substrumulosum*
+ *Sphagnum squarrosum*
† *Syntrichia latifolia*
‡ *Syntrichia montana*
‡ *Tetraphis pellucida*
‡ *Thamnobryum alopecurum*
‡ *Thuidium tamariscinum*
‡ *Tortella tortuosa*
‡ *Tortula muralis var. muralis*
‡ *Tortula truncata*
‡ *Ulota bruchii*
+ *Ulota calvescens*
‡ *Ulota crispa*
‡ *Ulota phyllantha*
† *Weissia brachycarpa var. brachycarpa*
† *Weissia brachycarpa var. obliqua*
† *Weissia controversa var. controversa*
‡ *Zygodon conoideus*
† *Zygodon rupestris*
‡ *Zygodon viridissimus var. viridissimus*

At the time of writing 1,222 bryophyte records have been collated from the Garden estate, comprising of 192 taxa. The species curve produced at figure 5.1, based on the cumulative totals of species plotted against records, shows some levelling off, but provides a good indication that additional species can be expected to be added to the site list with further targeted recording. It is very likely the site supports in excess of 200 species, which equates to approximately ⅓ of Carmarthenshire's bryophyte flora, listed as 578 species (603 taxa) by Bosanquet *et al* (2005), though it is likely the county total will now be somewhat higher than this.

Potential additions to the NBGW list that might be found with targeted effort include: *Amblystegium radicale, Brachythecium albicans, Bryum bornholmense, B. klinggraeffii, B. pseudotriquetrum, B. violaceum, Cirriphyllum crassinervium, Climacium dendroides, Colura calyptrifolia, Dialytrichia mucronata, Dicranella rufescens, Drepanocladus aduncus, Entosthodon fascicularis, Ephemerum* spp*., Epipterygium tozeri, Leptobryum pyriforme, Leucodon sciuroides, Marchantia polymorpha* subsp*. polymorpha, Orthotrichum anomalum, Phascum cuspidatum, Plagiomnium rostratum, Pohlia annotina, Rhynchostegium murale, Scapania undulata, Schistidium elegantulum, Syntrichia laevipila, S. papillosa, S. ruralis, Trichodon cylindricus, Trichostomum crispulum & Weissia controversa* var*. densifolia*.

**Figure 5.2.**
**Cumulative number of bryophyte species recorded, plotted against the cumulative number of bryophyte records at NBGW during the period 2001-2016.**




Biogeography

The bryophyte flora of the Garden estate is drawn from a wide spread of biogeographic elements as shown in table 5.2. With the exception of the Arctic-montane element, representative species from all the other major biomes have been recorded. The most frequent biome categories are Boreal-temperate and Temperate with 63 and 61 species respectively. The most frequent eastern limit category is Circumpolar with 73 species, the next highest being European with 56. The oceanic categories combined produce a total of 50 species, although most lie within the Suboceanic category, a reflection of the site's westerly position at low altitude.

**Table 5.2**:
**Frequency of biogeographic elements relating to bryophytes recorded at NBGW**

| Major biome | Eastern limit category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 Hyperoceanic | 1 Oceanic | 2 Suboceanic | 3 European | 4 Eurosiberian | 5 Eurasian | 6 Circumpolar | **Totals** |
| 1 Arctic-montane | | | | | | | | **0** |
| 2 Boreo-arctic montane | | | | | | | 1 | **1** |
| 3 Wide-boreal | | | 1 | | | | 6 | **7** |
| 4 Boreal-montane | | | | | | | | **0** |
| 5 Boreal-temperate | | 1 | 9 | 15 | 2 | 1 | 35 | **63** |
| 6 Wide-temperate | | | | 1 | 1 | | 9 | **11** |
| 7 Temperate | | 3 | 14 | 31 | 1 | | 12 | **61** |
| 8 Southern-temperate | 2 | 2 | | 9 | 2 | 2 | 10 | **27** |
| 9 Mediterranean-Atlantic | | 4 | 14 | | | | | **16** |
| **Totals =** | **2** | **10** | **38** | **56** | **6** | **3** | **73** | |

Habitats and notable species

The habitats at the NBGW estate are generally widespread throughout much of lowland Britain and only two GB or Wales Red Data List species were recorded, *Sematophyllum substrumulosum* (found only indoors and most likely an import on hot-house logs) and *Ulota calvescens* (an epiphyte undergoing a range expansion). The site does however support a diverse assemblage of characteristic lowland bryophytes and the following habitats are considered to be locally important:

Broad-leaved woodland

The complex of woodland habitats offer shelter and higher levels of humidity, especially where there are associated ponds, water courses and waterlogged ground. Consequently much of the site's diversity and several species of local interest were recorded in woodland habitats. The Coed Morfa Alder carr, already mentioned as supporting *Oxyrrhynchium specoisum* and *Plagiomnium ellipticum* is of particular note. This is the only part of the estate where *Sphagnum* was found, this limited to just one species, *S. squarrosum,* which is

growing under willow and Alder scrub along with other locally restricted species such as *Calypogeia muelleriana* on sedge tussocks and *Homalia trichomanoides* on tree bases. Wet woodland is also developed in the defunct Middle Pond basin, where characteristic species include *Brachythecium rivulare*, *Pellia epiphylla, Rhizomnium punctatum* and *Riccardia chamedryfolia.*

Drier ground conditions were experienced in most other woodland compartments, but bryophytes remain prominent throughout, the most abundant species including *Eurhynchium striatum, Kindbergia praelonga, Thamnobryum alopecurum* and *Thuidium tamariscinum.* Localised base-enrichment, especially at localities where there is some exposed rock, saw the appearance of a few calcicoles such as *Ctenidium molluscum* var. *molluscum* and *Plagiochila britannica*. However, for the most part, widespread species characteristic of neutral to mildly acidic ground conditions were encountered throughout most woodland compartments away from water.

The watercourses flowing through the woodlands, most notably the Afon Gwynon, were found to support a suite of aquatic *Fissidens* species including *crassipes* and *rivularis*. Other species of local interest noted within and along the banks of watercourses include small quantities of *Cinclidotus fontinaloides, Fissidens exilis, F. celticus, Hookeria lucens* and *Nowellia curvifolia,* with *Gyroweisia tenuis* and *Mnium stellare* noted on the derelict Llyn Felin-gat dam remnant and *Rhynchostegiella teneriffae* on the rocks immediately adjacent to the weir.

Parkland and Hedgerows

Opportunities for epiphytes are widespread with a wide range of host species available in a varied landscape. Although listed as Endangered in Wales (Bosanquet & Dines, 2011) *Ulota calvescens* is a species that has increased it's range dramatically in Wales in recent years, although is still uncommon in the county and the only record within the estate was a single tuft on an ash tree in the woodland next to Middle Pond. Other epiphytes noted of local interest (with the number of records in parentheses) include *Brachytheciastrum velutinum* (2), *Lejeunea cavifolia* (4)*, Leskea polycarpa* (2), *Neckera pumila* (6), *Orthotrichum lyellii* (2), *O. striatum* (7) and *Zygodon rupestris* (1).

*Aulacomnium androgynum* found by Bosanquet on a dead Alder trunk at Llyn Mawr was the only notable species recorded. The list for species found on logs and stumps is otherwise limited to widespread species such as *Cephalozia lunulifolia*, *Lepidozia reptans, Nowellia curvifolia*, *Orthodontium lineare* and *Tetraphis pellucida.*

Fen and unimproved to improved neutral grasslands

Rank tall-fen and lowland, semi-improved, neutral grasslands generally provide limited bryological interest. A ditch with bare soil at Cae Gwair provided the only real interest from these poorly recorded habitats in the form of the uncommon *Anthoceros punctatus* and the more widespread *Fossombronia pusilla*. Both were recorded by Bosanquet in 2009.

Buildings, walls and other man-made structures

The range of unusual, often imported substrates within the Garden estate, has provided a succession of unusual records. The significance of these 'curios' is generally considered to be of low ecological importance, although recording the occurence of non-natives and out of context species in our landscape is of importance. Several saxicolous species that appear

to have been imported with rock material, for example *Seligeria recurvata, Racomitrium aciculare, R. fasiculare, R. heterostichum* and *Ptychomitrium polyphyllum* are present on several boulders brought in from Heol Senni Quarry. *Leptobarbula berica* on wall mortar by the Science Building has better credentials as a natural colonist along with other wall species of note which are found more extensively around the buildings and walls of the estate; these include *Didymodon sinuosus, Eucladium verticillatum*, *Gymnostomum aeruginosum, G. viridulum*, *Hygrohypnum luridum, Lejeunea cavifolia, Mnium stellar, Orthotrichum cupulatum, Pseudocrossidium revolutum* and *Schistidium apocarpum*.

Garden habitats

The flowerbeds support elements of an arable bryoflora, although the only species noted of local significance was *Weissia brachycarpa* var. *obliqua*. The sandy, drought-prone soils of the corporate car park provide conditions rarely found elsewhere within the estate and the species list includes *Riccia glauca*, *R*. *sorocarpa* and the uncommon *Fossombronia incurva*.

The assemblage of epiphytes on nine New Zealand tree-fern *Dicksonia* stumps that have been dead for over six years, but left in-situ in the Wallace Garden, is somewhat unique. Alien species identified to date are *Dicranoloma menziesii* (Dicranaceae), *Cyathophorum bulbosum* (Hypopterygiaceae) and *Ptychomnion aciculare* (Ptychomniaceae), the former is long-established on tree-ferns in Ireland but the latter two appear not to have been previously recorded elsewhere in Britain and Ireland. All have persisted outdoors at the Garden for more than six years although only the *D. menziesii* could be described as looking in a healthy state.

A small colony of *Sematophyllum substrumulosum* established and persisting on a log in the hot house in the Double Walled Garden is presumed to be an import of a species listed as Vulnerable in Wales (Bosanquet & Dines, 2011).

## 6. LICHEN SURVEY (Alan Orange)

### 6.1. Introduction

The Regency landscape restoration project aims to reinstate the features of the late eighteenth-century designed landscape which may necessitate the dredging of the silted or drained lakes, including removal of swamp vegetation and wet woodland currently occupying them, removal of trees along the lake margins, planting of trees to reinstate former clumps and woods, reinstatement of features such as cascades, bridges, and paths and the removal of some modern agricultural features such as fences. All these features have potential to support and provide substrate upon which, lichens can become established.

Work began on the construction of the botanic garden in 1996 and a lichen survey of much of the site was carried out to inform the project at that time (Orange 1997). The present lichen survey forms part of an ecological impact assessment of the area potentially affected by the proposed Regency landscape restoration project.

### 6.2. Lichen Survey Methods

The site was visited on 10th, 15th and 16th June 2015, in dry weather. All substrates were potentially examined for lichens. A number of specimens were collected for identification in the laboratory. Taxonomy and nomenclature of lichens follows Smith *et al*. (2009) unless stated. Locations were recorded using a hand-held GPS receiver.

Lichen species were regarded as 'notable' and potentially of conservation concern if they met any of the following criteria:

- Graded as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient in the Welsh red data list (Woods 2010).
- Graded as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient in the Great Britain red data list (Woods & Coppins 2012).
- Indicated as Nationally Rare (recorded in 1-15 hectads in Great Britain) or Nationally Scarce (in 16-100 hectads in Great Britain) in Woods & Coppins (2012).
- Indicated as International Responsibility (British populations considered to be of international importance due to their abundance in Britain compared to the rest of the world) in Woods & Coppins (2012).
- Listed on the list of *Species of Principal Importance for Conservation of Biological Diversity* in Wales under section 42 of the Natural Environment and Rural Communities Act 2006 (http://biodiversitywales.org.uk/Section-42-Lists).
- Used in the calculation of the New Index of Ecological Continuity (NIEC) (Coppins & Coppins 2002). Sites containing a high number of species from a list of indicator species are considered to have a high likelihood of ancient origin, but individual NIEC species are not necessarily of conservation interest.

### 6.3. Lichen Survey Results

A total of 120 lichen species was recorded in Survey Zones 1 and 2, including 104 on bark and wood (table 6.1). Notable species are listed at table 6.2. Lichen Survey Target notes (including some localities of common species) are shown at table 6.3. A combined list of all

records from the National Botanic Garden is given in appendix 13, with notable species in appendix 14.

The woodland in the valley of the Afon Gwynon is composed largely of young trees, their youth, in part being due to felling in the twentieth century. Light levels are generally low and the lichen diversity correspondingly poor. However, the old-forest macrolichen *Sticta sylvatica* occurs on a number of trees in the Pont Felin-gât woodland in light shade, including on willow, ash and hazel on damp ground beside the stream located at Phase 1 survey Target Notes TN15024, TN15029 and TN15030. These are shown on figure 11.1. This species was not seen in 1997 and it is likely that it has colonised the site since then or was previously present as only minute thalli (figures 6.2 and 6.3). The smooth bark of hazel supports a number of relatively shade-tolerant species including *Arthonia cinnabarina*, *A. elegans*, *Eopyrenula grandicula*, *Graphis scripta*, *Porina aenea* and *P. leptalea*.

The silted bed of Llyn Mawr is largely occupied by wet willow woodland (figures 6.4 and 6.6). A few notable species were recorded here on willow, namely *Byssoloma marginatum*, *Catillaria nigroclavata* (probably an overlooked species) and *Lecanora jamesii*. The old-forest Section 42 species *Usnea florida* recorded in 1997 was not refound.

Mature oaks occur along the margins of Llyn Mawr but these are mostly heavily shaded by surrounding trees and shrubs or are covered by ivy. No notable species were detected (although notable species including *Cresponea premnea* occur by Llyn Canol a little outside Survey Zone 2). A number of large stumps remain from twentieth century fellings and several of these support *Cladonia parasitica* (figure 6.5). A fallen oak trunk beside Llyn Mawr supports a sterile colony of *Chaenotheca stemonea*.

Mature oaks in pasture carry a relatively species-poor flora including *Amandinea punctata*, *Lecidella expallens*, *Parmelia sulcata*, *Pertusaria albescens*, and *Punctelia subrudecta* (figure 6.8). Trees fenced from pasture are mostly very shaded and lichen-poor (figure 6.8); some of these are hedgerow trees, others occur at the margins of woodland and, in some cases, may have been recently fenced off from grazing (figure 6.10). Small woodlands are mostly heavily shaded, often with much ivy but some less-shaded woodlands are, nevertheless, overgrown with bramble due to lack of grazing. The farmland landscape around Waun Las Farm has mature trees in hedges (figure 6.7), but these are often well-fenced from grazing and covered by ivy.

The old stonework of bridges and cascades along the valley of the Afon Gwynon carries a relatively species-poor lichen flora comprising of shade-tolerant species, including *Bacidia arnoldiana*, *B. fuscovirens* and *Botryolepraria lesdainii*.

## 6.4. Notable Lichen Species

In all, ten species were ‘notable’ according to the criteria above (listed at paragraph 6.2).

*Anisomeridium ranunculosporum* an old-forest species widespread in Wales, but largely restricted to sites with some ecological continuity.

*Bacidia fuscoviridis* a Nationally Scarce species of shaded calcareous rocks and stonework, probably somewhat under-recorded.

*Byssoloma marginatum* a Nationally Scarce species of bark in humid habitats in western Britain.

*Chaenotheca stemonea* a Nationally Scarce old-forest species graded as Vulnerable in Wales by Woods (2010) due to the small number of known sites. This species may be slightly under-recorded, as sterile material may be overlooked.

*Cladonia parasitica* an old-forest species typically found on hard dead oak wood, widespread in Wales but largely restricted to sites with some ecological continuity.

*Eopyrenula grandicula* a Nationally Scarce species, probably widespread in good-quality humid sites but probably somewhat under-recorded.

*Lecanora jamesii* an old-forest species typical of twigs in humid sites.

*Lepraria umbricola* a Nationally Scarce species typical of oak and Alder trunks and stumps in shady humid sites.

*Pertusaria multipuncta* one of the less-demanding old-forest species, often on smooth bark.

*Sticta sylvatica* a relatively demanding old-forest species on trees and shrubs in sites with good ecological continuity, in Wales mainly in the north and west; graded as Near Threatened by Woods (2010) and a constituent of the *Lobarian lichen community*, a section 42 *Species* [group] *of Principal Importance* in Wales.

## 6.5. Discussion

Comparison of the present survey with the earlier lichen survey) carried out by the same surveyor eighteen years previously (Orange 1997, shows a broadly similar picture, with most of the differences being attributable to the different areas of the site covered (the 1997 survey also examined the walled garden area), the role of chance in finding small or uncommon species, and some small changes in taxonomy over the intervening years. Some differences indicate genuine change: in 1997 *Lecanora conizaeoides* was described as '*occasional to frequent on wooden posts, also on wood of dead standing pine*', whereas this species was not found in 2015. This reflects a nationwide trend to less acidified substrates following the reduction in sulphur dioxide levels towards the end of the last century and the effect of agricultural and industrial nitrogen compounds in raising pH and nutrient levels. Other species which appear to have decreased in abundance at the site, and for the same reason, include *Fuscidea lightfootii*, *Hypocenomyce scalaris*, *Mycoblastus fucatus*, *Ochrolechia microstictoides*, *Platismatia glauca*, *Usnea florida* and *U. subfloridana*. The surveys are not sufficiently quantitative to discern a corresponding increase in species of contrasting needs. However, *Flavoparmelia soredians* was found once on twigs; this is a species which has greatly expanded its range in Wales since the 1980s. A significant addition to the site is *Sticta sylvatica*, on a number of trees near Pont Felin-gât. It seems unlikely that this was overlooked in 1997, though it could have been present as very small colonies. This is usually regarded as a poor coloniser (and hence one of a suite of old-forest indicators) and could have colonised from nearby areas of the stream valley.

There are relatively few notable species within Survey Zones 1 and 2. The most significant component may be the old-forest indicator species (shown as NIEC in table 6.2). In the Garden estate as a whole there are 14 such species, and the site scores 11 on the NIEC. This is a relatively low score and is not considered to indicate a site of high conservation importance in the context of its lichen flora diversity (Coppins & Coppins 2002) but it is significant on a local or regional scale. Some old-forest species may have been lost as a result of the felling of parkland trees and woodland fellings in the twentieth century and others could have been lost through shading from scrub growth and ivy. Parts of the

woodlands bordering the Afon Gwynon are considered to be of ancient origin and it is to be hoped that the existing old-forest lichens at the site will recolonise the woodland and parkland trees so that a more natural flora is reinstated.

Wet willow woodland can be a valuable lichen habitat but only a few notable species were recorded on this phorophyte. *Sticta sylvatica* was the most significant find, as this is an old-forest macrolichen. Other notable species recorded included *Byssoloma marginatum*, *Catillaria nigroclavata* (probably an overlooked species), and *Lecanora jamesii*. The old-forest Section 42 species *Usnea florida* was recorded in 1997 by Llyn Mawr but was not recorded in 2015. It is possible that it has declined due to the likely increase in bark pH since 1997 or it may have been overlooked on canopy twigs. Although *S. sylvatica* is currently restricted to the Afon Gwynon valley, there appears to be no reason why it should not colonise other areas of damp woodland at the site such as those on the western margin. Retention of areas of wet willow woodland would provide potentially useful lichen habitat.

Although there are some well-lit parkland oaks at the site, many mature oaks are excessively shaded due to scrub and ivy growth. It would be an advantage to remove some of the scrub around mature oaks but retain some degree of shelter. Certain other trees could be rescued from being swallowed up by woodland, for instance those shown on figure 6.10. The woodlands at the site are mostly very shady and some have abundant ivy and brambles. Intermittent or light grazing of some of the woodlands would help to maintain more open conditions. When clearing the margins of the silted lake, large stumps and logs should be retained and whenever possible kept in light shade. All dead wood is potentially valuable, especially that of oak.

The lichen flora of the woodland beside the Afon Gwynon would benefit from the woodland being allowed to mature. However, some opening-up of the canopy to create glades would be of potential value. This is not urgent, as there are no or few light-demanding notable species currently present apart from *Sticta sylvatica* but some tree felling in connection with restoration of the regency features is clearly not a problem. However, at least one tree supporting *Sticta* has been felled recently, so indiscriminant felling should not be encouraged. The valley of the Afon Gwynon is the most natural area of the site, and it is suggested that non-native species should be controlled here. A non-native shrub thought to be *Cornus* sp. beside the stream is currently creating a dense thicket that is detrimental both to lichens and ground flora, and it is suggested that this should be removed (figure 6.11), and no further alien species introduced.

Broad management recommendations for the site can be summarised as:

1. Allow well-lit conditions around mature oaks. Scrub and ivy should be removed. If possible grazing should be allowed around the trees, either by removing fences or allowing some grazing in woodland. However, avoid removing all shelter near to trees, especially if they already have notable species..
2. Maintain some areas of wet willow woodland around Llyn Mawr if possible.
3. Retain dead wood *in situ*, in light shade.
4. Create or maintain glades in dense woodland.
5. Remove invasive non-native species along the valley of the Afon Gwynon.

**Table 6.1. Lichen species recorded in Survey Zones 1 and 2 in 2015.**

| Species | Notes |
|---|---|
| *Amandinea punctata* | On well-lit bark by fields, occasional. (14 Q, 16/2 Q, |
| *Anisomeridium polypori* | On shaded bark, occasional. (1 Fe, 5 Fe). |
| *Anisomeridium ranunculosporum* | On mature, well-lit oak trunks, rare. (15/2 Q, 15/3 Q). |
| *Arthonia cinnabarina* | On hazel, rarely other trees, in damp woodland. (1 Ca, 4 Ap, 17 Ca). |
| *Arthonia elegans* | On hazel in woodland, frequent. (7 Ca, 17 Ca). |
| *Arthonia radiata* | On twigs, frequent. (12 Ag br, 15/2 Q br, 22/1 Q br). |
| *Arthonia spadicea* | On shaded oak trunk, (14 Q). |
| *Arthopyrenia analepta* | On twigs, probably frequent. (8 Q br). |
| *Arthopyrenia salicis* | On hazel. (17). |
| *Bacidia arnoldiana* | On shady stonework by cascade. (2/1). |
| *Bacidia fuscoviridis* | On shady vertical stonework by cascade. (2/1). |
| *Bacidia phacodes* | On shaded ash trunk. (5 Fe). |
| *Bacidia viridifarinosa* | On rain-sheltered stones, bark and wood, rare to occasional. (10 stones on ditchside, 10/3, 11 Q wood). |
| *Botryolepraria lesdainii* | On shady, rain-sheltered stonework in woodland, occasional. (2/1). |
| *Buellia griseovirens* | On hard dead oak wood and on fenceposts, frequent. (12/3 Q wood, 15/1 Pinus wood, 16/1 gate). |
| *Byssoloma marginatum* | On willow, rare or overlooked. (6). |
| *Caloplaca cerina* | On elder twigs. (23/1). |
| *Caloplaca cerinella* | On elder twigs. (23/1). |
| *Caloplaca flavescens* | On limestone gatepost. (16). |
| *Caloplaca oasis* | On limestone gatepost. (16). |
| *Caloplaca obscurella* | On elder twigs. (23/1). |
| *Candelariella reflexa* | On wood of fencepost, rare. (14). |
| *Catillaria nigroclavata* | On willow twig, rare or overlooked. (12). |
| *Chaenotheca stemonea* | On old fallen oak in carr, rare; sterile. (7/6). |
| *Chrysothrix candelaris* | On dry bark of well-lit mature oaks, occasional. (15/3 Q very rare on dry bark, 18/1 Q). |
| *Chrysothrix flavovirens* | On dry wood, rare. (12/3 Q wood c.fr., 15/1 Pinus wood c.fr.). |
| *Cladonia coniocraea* | On acid bark and on wood, occasional. (10 Ag, 12/3 Q wood, 15/1 Pinus wood). |
| *Cladonia ochrochlora* | On log on marshy ground. (7 wood). |
| *Cladonia parasitica* | On hard wood of old oak stumps, local. (7/7 Q wood, 7 Q wood, 13/2 Q wood, 17/1 Q wood). |
| *Cladonia polydactyla* | On acid bark and wood, occasional to frequent. (5, 5 Ag, 7 log, 10 Ag, 12/3 Q wood). |
| *Cladonia pyxidata* | On mature ash. (20/1). |
| *Cliostomum griffithii* | On dry side of isolated mature oak in meadow. (18/1). |

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| *Dimerella pineti* | On Alder bark and oak stump. (5 Q wood, 5 Ag). |
| *Enterographa hutchinsiae* | On somewhat rain-sheltered shady rocks, rarely on roots, rare to occasional. (2/2, 10/3, 11/1 Fs). |
| *Eopyrenula grandicula* | On smooth bark of hazel, sometimes fertile, frequent. (6 Ca, 7 Ca, 17 Ca, 19 Ca). |
| *Evernia prunastri* | On well-lit tree trunks and twigs, frequent. (4 Ca, 8 Q br). |
| *Flavoparmelia caperata* | On trunks and branches, occasional to frequent. (7 Scin, 8 Scin, 12 Q br, 14 Fe, 18/1 Q, 22/1 Q br, 23 Q). |
| *Flavoparmelia soredians* | On dead twigs of fallen oak branch. (22/1). |
| *Fuscidea lightfootii* | On twigs, rare. (7 Scin, 22/1 Q br). |
| *Graphis elegans* | On bark, occasional. (10 Ag, 12 Q br, 12 Ag br). |
| *Graphis scripta* | On smooth bark, especially hazel; frequent. (1 Fe, 4 Ca, 17 Ca, 19 Ca). |
| *Hyogymnia tubulosa* | On twigs, occasional. (12 Q br, 13 Q br, 22/1 Q br). |
| *Hypocenomyce scalaris* | On hard wood of oak and rarely chestnut, rare to occasional. (7 Q wood, 14/2 Castanea sativa wood). |
| *Hypogymnia physodes* | On twigs, occasional. (12 Ag br, 16/1 gate, 22/1 Q br). |
| *Hypotrachyna afrorevoluta* | On well-lit tree trunks and twigs, frequent. (4 Ca, 7 Scin, 12 Q br, 12 Ag br, 16/1 gate, 18 ?Q dead br). |
| *Hypotrachyna revoluta s.s.* | On willow; rare. (7 Scin). |
| *Japewiella tavaresiana* | On trunk of willow in carr; rare (7 Scin). |
| *Lecania cuprea* | On mortared wall. (10 wall). |
| *Lecanora albescens* | On limestone gatepost. (16). |
| *Lecanora argentata* | On well-lit tree trunks, occasional. (4 Ca, 14 Q). |
| *Lecanora chlarotera* | On tree trunks and twigs, frequent. (1 Fe, 8 Q br,12 Q br, 12 Ag br). |
| *Lecanora confusa* | On well-lit wood, occasional. (12/3 Q wood, 15/1 Pinus wood, 20 fence post). |
| *Lecanora expallens* | On well-lit oak trunks. (16/2 Q c.fr., 18/1 Q). |
| *Lecanora jamesii* | On twigs and brances, rare to occasional. (7 Scin, 12 Q br). |
| *Lecanora symmicta* | On fence post. (20). |
| *Lecidella elaeochroma* | On well-lit twigs and fence posts, frequent. (4 Ca, 12 Q br, 12 Ag br, 20 wood). |
| *Lepraria incana* | On dry bark of mature oaks. (13/2, 14/1 Q, 15/2 Q, 18/1 Q). |
| *Lepraria lobificans* | On rain-sheltered bark and stonework, frequent. (1 Fe, 5 Ag, 10 Scin). |
| *Lepraria rigidula* | On dry bark of willow, rare. (7 Scin, 8 Scin). |
| *Lepraria sylvicola* | On old ash in woodland; rare. (2)., |
| *Lepraria umbricola* | On old oak stumps and logs, rare. (17/1, by 21/1). |
| *Megalaria pulverea* | On shaded bark in woodland; occasional. (1 Fe, 8 Scin, 10 Scin, 10 Ag c.fr.). |
| *Melanelixia glabratula* | On well-lit tree trunks and twigs, frequent. (4 Ca, 12 Q, 15/2 Q, 18/1 Q). |
| *Melanelixia subaurifera* | (7 Scin, 12 Q br, 16/1 gate, 18 ?Q dead br). |
| *Melanohalea exasperata* | On dead twigs of fallen oak branch. (22/1). |

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|---|---|
| *Melanohalea exasperatula* | On dead twigs of fallen oak branch. (22/1). |
| *Melanohalea laciniatula* | On dead twigs of fallen oak branch. (22/1). |
| *Micarea lignaria var. lignaria* | On fencepost. (14). |
| *Micarea prasina* | On oak stumps in shade, frequent. (2, 10 Ag). |
| *Normandina pulchella* | On shaded bark, occasional. (1 Fe, 5 Ag, 7 Scin, 8 Scin, 19 Ca). |
| *Ochrolechia androgyna* | On trunks of well-lit oaks, rare. (15/1, 18/1 Q). |
| *Opegrapha ochrocheila* | On wood of 2 dead trees on lake bed. (7 wood). |
| *Opegrapha sorediifera* | On shaded base of large oak by lake. (13/1). Outside Zones 1 and 2. |
| *Opegrapha vermicellifera* | On base of large oak at edge of woodland. (21/1). Outside Zones 1 and 2. |
| *Opegrapha vulgata* | On smooth bark of ash and hazel, frequent in woodland. (1 Fe, Ca, 6 Ca, 11 Ca, 17 Ca, 19 Ap, 20/1 Fe). |
| *Parmelia saxatilis* | On bark, occasional. (8 Scin, 15/2 Q, 23 Q). |
| *Parmelia sulcata s.l.* | On well-lit tree trunks and twigs, and on fence-posts, frequent. (4 Ca, 8 Q br, 12 Q br, 12 Q, 13 Q br, 16/1 gate). |
| *Parmotrema perlatum* | On well-lit tree trunks and twigs, frequent. (4 Ca, 7Scin, 8 Q br, 8 Scin, 12 Ag br, 18/1 Q, 18 ?Q dead br). |
| *Peltigera hymenina* | On log in carr and on willow. (7 wood, 8 Scin, 23/2 Scin). |
| *Peltigera membranacea* | On tree bases and logs in damp woodland, occasional. (1 Fe). |
| *Peltigera praetextata* | On tree bases, logs and rocks in woodland, occasional (1 Fe, 7 Scin). |
| *Pertusaria albescens* | On well-lit bark, especially on mature trunks. (7 Scin, 12 Q, 14 Fe, 16/2 Q, 18/1 Q, 20/1 Fe). |
| *Pertusaria hymenea* | On bark, rare. (7 Ca, 14/1 Q). |
| *Pertusaria leioplaca* | On hazel. (1 Ca). |
| *Pertusaria multipuncta* | On ash. (1 Fe). |
| *Pertusaria pertusa* | On mature ash. (20/1). |
| *Phlyctis argena* | On bark, occasional. (1 Ap, 7 Scin). |
| *Physcia aipolia* | On twigs. (12 Q br, 22/1 Q br). |
| *Physcia stellaris* | On wood of fences, occasional. (13, 20). |
| *Physcia tenella* | On twigs and fenceposts, occasional to frequent. (18 ?Q dead br). |
| *Placynthiella icmalea* | On hard dead oak wood and on fenceposts, occasional. (12/3 Q wood, 14 fencepost, 16/1 gate, 20 fence post). |
| *Platismatia glauca* | On willow and on wood of gate; rare. (8 Scin, 16/1 gate). |
| *Porina aenea* | On hazel in damp woodland. (1 Ca, 19 Ca). |
| *Porina chlorotica* | On shady stones and stonework in woodland, occasional. (2/1, by 13/1, 14). |
| *Porina leptalea* | On smooth bark of hazel. (17). |
| *Protoblastenia rupestris* | On stonework. (14, |

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|---|---|
| *Psoroglaena stigonemoides* | On elder. (19). |
| *Punctelia jeckeri* | On twigs, occasional.(18 ?Q dead twigs, 22/1 Q br). |
| *Punctelia subrudecta* | On well-lit tree trunks and twigs, frequent. (4 Ca, 13 Q br, 22/1 Q br). |
| *Pyrenula chlorospila* | On smooth bark in woodland; rare. (7 young Fe). |
| *Pyrenula macrospora* | On smooth bark in woodland; rare to occasional. (7 young Fe, 10 young Fe, |
| *Pyrrhospora quernea* | On well-lit oaks. (7/4 Q, 12 Q, 15/2 Q). |
| *Ramalina farinacea* | On well-lit tree trunks and twigs, frequent. (4 Ca, 7 Scin, 8 Q br, 12 Q br, 13 Q br, 18 ?Q dead br). |
| *Ramalina fastigiata* | On twigs, occasional. (12 Q br). |
| *Schismatomma decolorans* | On dry side of isolated mature oak in meadow; rare. (18/1). |
| *Sticta sylvatica* | Very locally frequent on willow and ash in damp woodland beside Afon Gwynon near Pont Felin-gât. (1/2 Fe, 1/3 Fe, 1/4 Fe, 1/5 Scin, 10/1 Scin (several)). |
| *Trapelia corticola* | On acid bark, rare. (5 Ag). |
| *Trapeliopsis flexuosa* | On hard dead oak wood and on fenceposts, occasional. (12/3 Q wood, 16/1 gate). |
| *Trapeliopsis granulosa* | On Alder. (5 Ag). |
| *Trapeliopsis pseudogranulosa* | On oak stumps, occasional. (5). |
| *Usnea cornuta* | On willow, rare. (23/2 Scin). |
| *Usnea flammea* | On oak trunks, rare and mostly in small quantity. (14/1 Q, 15/2 Q, 15/3 Q frequent on N side). |
| *Usnea subfloridana* | On twigs, rare and in small quantity. (8 Q br, 13 Q br, 22/1 Q br). |
| *Verrucaria baldensis s.l.* | Limestone facing of well. (10). |
| *Verrucaria elaeina* | On shady stonework, locally frequent. (2/1, 10). |
| *Verrucaria hydrophila* | On stones in streamlets, occasional. (10, 14). |
| *Verrucaria nigrescens* | On limestone gatepost. (16). |
| *Verrucaria praetermissa* | On stones in streams in shade, frequent. (2, 10, by 22/1). |
| *Verrucaria rheitrophila* | On stones in unshaded or shaded streamlets. (14, by 22/1). |
| *Xanthoria parietina* | On trunks and twigs, occasional, in small quantities. (12 Scin, 12 Q, 14 Q br, 18 ?Q dead br, 22/1 Q br, 23/1 elder). |

| | |
|---|---|
| Number of species: | 120 |
| Number of species on bark and wood: | 104 |

Numbers in parentheses refer to field localities (see table 6.3).
Abbreviations: Ag = Alnus glutinosa, Ca = Corylus avellana,
Q = Quercus petraea/robur, Scin = Salix cinerea.
br = branch or twig, c.fr. = with fruiting bodies (where of note).

**Table 6.2. Notable lichen species recorded in Zones 1 and 2 in 2015.**

| | Woods (2010) Wales | Woods & Coppins (2012) GB | NR/NS | IR (Woods & Coppins 2012) | Sect. 42 | NIEC (Coppins & Coppins 2002) |
|---|---|---|---|---|---|---|
| *Chaenotheca stemonea* | VU | | NS | | | NIEC |
| *Sticta sylvatica* | NT | | | IR | S42 | NIEC |
| *Bacidia fuscoviridis* | | | NS | | | |
| *Byssoloma marginatum* | | | NS | | | |
| *Eopyrenula grandicula* | | | NS | IR | | |
| *Lepraria umbricola* | | | NS | | | |
| *Anisomeridium ranunculosporum* | | | | | | NIEC |
| *Cladonia parasitica* | | | | | | NIEC |
| *Lecanora jamesii* | | | | | | NIEC |
| *Pertusaria multipuncta* | | | | | | NIEC |

Abbreviations (see Methods section for full explanation):
NT = Near Threatened, VU = Vulnerable.
IR = International Responsibility.
NR = Nationally Rare (Great Britain), NS = Nationally Scarce.
NIEC = species used in calculation of New Index of Ecological Continuity.

**Table 6. 3. List of temporary locality numbers**

These are numbers assigned during the field survey, and may be referred to in the report.

| number | GPS | GPS accuracy (± m) | notes | date |
|---|---|---|---|---|
| 1/1 | 52711.18802 | 11 | | 2015 06 10 |
| 1/2 | 52711.18802 | | Ash: Sticta sylvatica | 2015 06 10 |
| 1/3 | 52711.18802 | | Ash: Pert mul, Sticta sylvatica | 2015 06 10 |
| 1/4 | 52729.18771 | 8 | Willow: Sticta sylvatica. | 2015 06 10 |
| 2/1 | 52831.18698 | 11 | Old mortared walls. | 2015 06 10 |
| 2/2 | 52970.18698 | 12 | Ente hut near falls. | 2015 06 10 |
| 3 | | | Pasture N of Afon Gwynon. | 2015 06 10 |
| 4 | | | Scrub at W end of 4. | 2015 06 10 |

| | | | | |
|---|---|---|---|---|
| 5 | | | N side of Gwynon upstream of bridge. | 2015 06 10 |
| 6 | 53171.18655 | 7 | Fenced enclosure with carr. | 2015 06 10 |
| 7 | | | S side of Gwynon. | 2015 06 10 |
| 7/1 | | | Mature birch. | 2015 06 10 |
| 7/2 | 52589.18495 | | | 2015 06 10 |
| 7/3 | 52551.18478 | 6 | Willow: Jape tav, Leca jam. | 2015 06 10 |
| 7/4 | 52572.18423 | 6 | Large oak by old lake. | 2015 06 10 |
| 7/6 | 52574.18303 | 7 | Chaen ste on large fallen oak. | 2015 06 10 |
| 7/7 | 52573.18230 | 6 | Large oak stump in light shade, with Clad par, and two more nearby. | 2015 06 10 |
| 8 | | | W side of Llyn Mawr. | 2015 06 10 |
| 10/1 | 52686.18791 | 10 | Sticta sylvatica on leaning willow | 2015 06 15 |
| 10/2 | 52662.18721 | 9 | Carr of Alder and some willow. | 2015 06 15 |
| 10/3 | 52566.18055 | 10 | Old shady quarry: Baci vir, Ente hut. | 2015 06 15 |
| 11/1 | 52513.18535 | 10 | Ente hut on beech root by Llyn Mawr. | 2015 06 15 |
| 11/2 | 52515.18483 | 10 | Oak log. | 2015 06 15 |
| 12/1 | 52465.18382 | 7 | Isolated oak. | 2015 06 15 |
| 12/2 | 52354.18111 | 5 | Dead oak. | 2015 06 15 |
| 13/1 | 52532.18041 | 10 | Mature oak. | 2015 06 15 |
| 13/2 | 52535.18050 | 6 | Clad par on oak stump. | 2015 06 15 |
| 14 | | | Willow carr near lake. | 2015 06 15 |
| 14b | 52824.18027 | | Small wood. | 2015 06 15 |
| 14/1 | 52960.18170 | | Unshaded oak by pasture. | 2015 06 15 |
| 14/2 | 53019.18093 | 7 | Castanea stump. | 2015 06 15 |
| 15/1 | 53136.18210 | | Dead pine. | 2015 06 15 |
| 15/2 | 53031.18223 | | Oak in pasture, Arth ran. | 2015 06 15 |
| 15/3 | | | Large oak. | 2015 06 15 |
| 16 | | | N of Waun Las. | 2015 06 15 |
| 16/1 | 52628.18351 | | Gate. | 2015 06 15 |
| 16/2 | 52720.18562 | 7 | Oaks at edge of pasture. | 2015 06 15 |
| 17/1 | 52633.18769 | 10 | Old stump with Clad par. | 2015 06 16 |
| 18/1 | 52430.18607 | 10 | Isolated oak in meadow. | 2015 06 16 |
| 19 | 51722.17971 | | Shady woodland. | 2015 06 16 |
| 20/1 | 52742.17985 | 9 | Large ash S of Waun Las Farm. | 2015 06 16 |
| 21/1 | 52508.17822 | 8 | Arth vin, Cres pre on large oak (outside Zones 1 and 2). | 2015 06 16 |
| 22/1 | 53218.18280 | 7 | Large oak. | 2015 06 16 |
| 23/1 | 58248.18332 | | Elders with Calo cer. | 2015 06 16 |
| 23/2 | 53189.18419 | | Mature oak on old boundary bank. | 2015 06 16 |

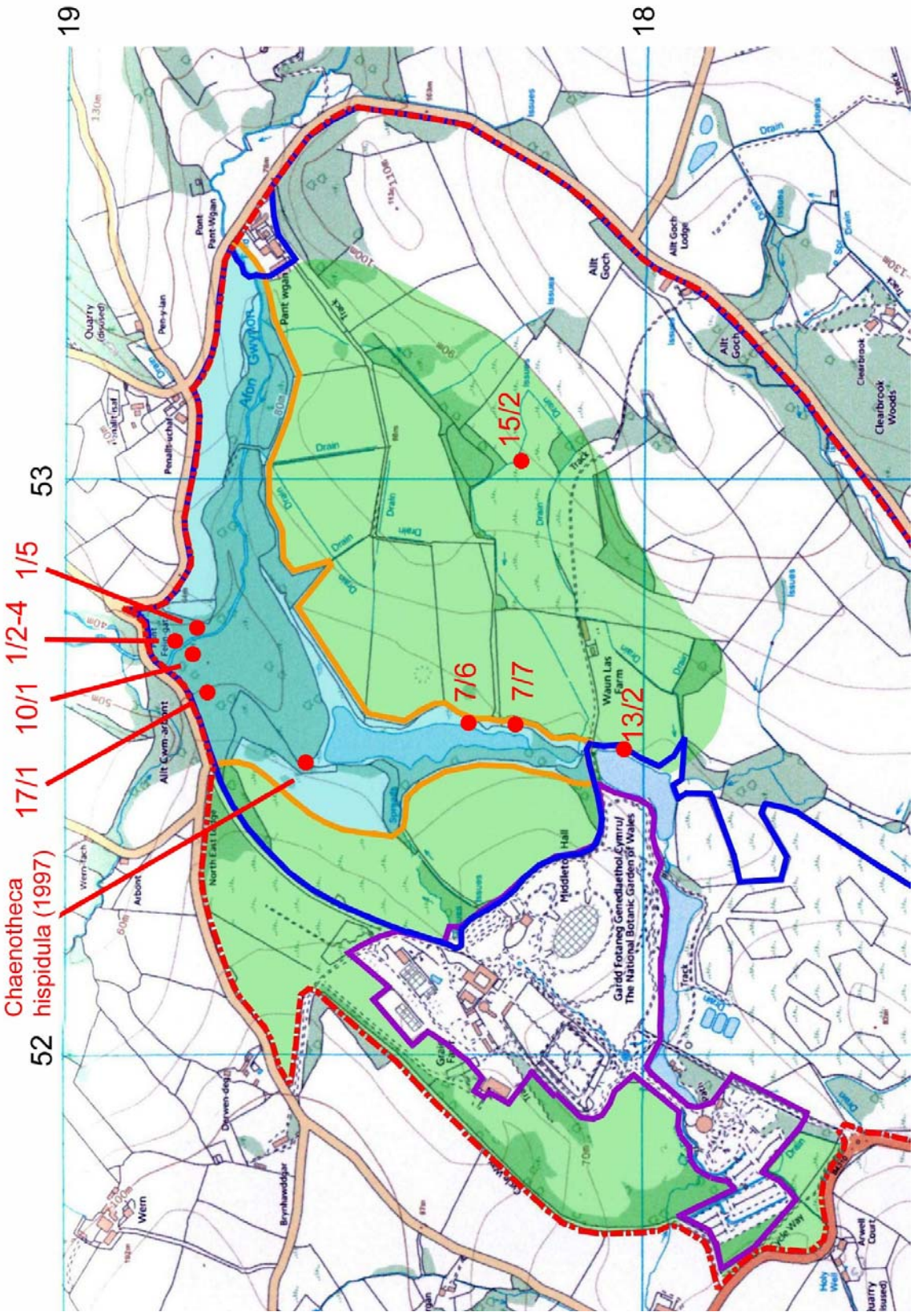



**Figure 6.1. Zone 1 (blue overlay) and Zone 2 (green overlay), with approximate position of selected notable lichen records from these zones. *Anisomeridium ranunulosporum*: 15/2; *Chaenotheca stemonea*: 7/6; *Cladonia parasitica*: 7/7, 13/2, 17/1; *Sticta sylvatica*: 1/2-5, 10/1. The record of *Chaenotheca hispidula* is from 1997.**

**Figure 6.2. Willow supporting *Sticta sylvatica*, on damp ground in moderate shade, near Pont Felin-gât.**

**Figure 6.3. *Sticta sylvatica* on willow.**

**Figure 6.4. Silted bed of Llyn Mawr looking south from bridge. Woodland in foreground has been cut and some shrubs and trees cleared from the right embankment.**

**Figure 6.5. The hard wood of felled oaks provides a substrate for *Cladonia parasitica*.**

**Figure 6.6. Wet woodland of relatively young willow, on silted lake bed.**

**Figure 6.7. The landscape of pasture, hedges and hedgerow trees around Waun Las Farm.**

**Figure 6.8. An oak in pasture, with a well-lit, ivy-free trunk.**

**Figure 6.9. An oak fenced off from pasture, the trunk covered by ivy.**

**Figure 6.10. These 'parkland' oaks have been fenced off from grazing animals, and the trunks will soon be shaded by the growth of saplings and/or bramble.**

**Figure 6.11. Non-native *Cornus* shrub thicket beside the Afon Gwynon, creating a dense shady thicket.**

## 7. FUNGI (Bruce Langridge and Richard Pryce)

7.1 The following commentary on the mycological interest of the Garden estate is largely based upon the personal observations of Bruce Langridge (Head of Interpretation, NBGW), as well as comments and records made by occasional visiting mycological experts and observations by Garden volunteers and visitors.

Within NBGW, until now, there has been no formal mechanism for recording fungi and the lists of mycological records reproduced at Tables 7.1 and 7.2 are based on surveys completed by Maurice Rotheroe in 1997 and Debbie Evans in 2007 and 2008. These lists have been augmented in Table 7.3 by more recent records, principally those of David Mitchel. The tables list many of the fungus species that occur in the Garden estate but cannot be regarded as exhaustive and it is hoped that they may act as a stimulus to promote the further recording of fungi at the Garden in the future.

### 7.2 Fungus-rich Areas of Waun Las National Nature Reserve

Areas of Fungal Importance are shown in yellow on figure 7.1.

F1. Trawscoed Wood.
With a good collection of hornbeam, beech and wood piles, this is rich in a wide variety of woodland fungi. The highlight is *Strobilomyces strobileceus* which is mycorrhizal with hornbeam, is rarely recorded in Wales and first fruited in 2013. Other species of interest include *Clavulina rugosa, Cyathus striatus, Hydnum rufescens* and a fairy ring of *Lactarius blennius*.

F2. North Trawscoed Meadow
This hay meadow has gradually increased in visible fungal interest over the past 5 years. It has a 3m wide fairy ring of *Entoloma porphyrophaeum* which was featured on Radio 4's Living Planet in 2014. In the exceptionally mild and wet late autumn of 2015, a whole new community of 5/6 waxcap species fruited in a section of meadow dominated by Bulbous Buttercup *Ranunculus bulbosus*. These included *Hygrocybe calyptriformis* and *H. punicea*, two species which strongly indicate that this area of the field has not been fertilised or ploughed for decades.

F3. Coed Felin-gat
The marked area of this extensive woodland indicates where several rare species of *Cortinarius* fungi were recorded by Maurice Rotheroe in 1994 (based on the memory of Philip Jones who was there at the time). These have not been recorded since but they are hard to identify and were not deliberately looked for again until 2015. The species recorded here were *Cortinarius largus, Cortinarius parvannulatus, Cortinarius rubricosus and Cortinarius safranopes.*

F4. Cae Treillon
Along the western side of this field, adjacent to the fence separating it from Llyn Mawr, a decent quality of waxcap fungi have been recorded over the past four years including *Hygrocybe calyptriformis* and large numbers of *Hygrocybe psittacina*. Although not exceptional, this area is often used for fungus forays because, compared to the more species-rich waxcap field (area F9), it is less far to walk and is usually more intensively grazed, making fungi stand out more clearly.

F5. Cae Brwyn

There is a 5m wide fairy ring of *Hygrocybe pratensis* on the south east section of the old fishpond. Advice from Dr Gareth Griffiths of Aberystwyth University, who has studied the growth rates of *Hygrocybe pratensis* fairy rings, suggests that this may of a significant age, likely to be at least 100 years old. Fungi in this field have only been noted over the past three years but other features of interest are a wide variety of fungi tethered across 20m around the old beech tree on the edge of the fishpond, a prominent large patch of *Clavulinopsis corniculata* and hints of a rich waxcap population.

F6. Cae Banc

The thin soils of the upper slope of Cae Banc contain several waxcap species but they have not been checked for a few years.

F7. Cae Tegeiranau

An area of this species-rich hay meadow has a distinctive population of waxcap fungi including a 3m wide *Hygrocybe pratensis* fairy ring as well as *Hygrocybe calyptriformis* and *H. punicea*, two species which strongly indicate that this area of the field has not been fertilised or ploughed for decades.

F8. Cae Brwyn East

This north-west facing bank contains a large population of *Hygrocybe pratensis*, one of the more common types of waxcap.

F9. Waxcap Field (Cae Waxcap)

This was first identified as a meadow of international importance for fungi in the mid-1990s by Maurice Rotheroe, a mycologist who significantly increased awareness of the importance of grassland fungi in the UK. This west facing bank has been surveyed fairly regularly since then for what are known as **'CHEGD'** species. The **CHEGD** group is comprised of members of the genera ***H****ygrocybe* (Waxcaps) and ***E****ntoloma* (Pinkgills); and the families ***C****lavariaceae* (Fairy Clubs) and ***G****eoglossaceae* (Earthtongues). The **D** element includes the genera ***D****ermoloma*, *Porpoloma*, and *Camarophyllopsis.* The five groups of fungi are unrelated but appear to have similar ecological requirements. The colourful and charismatic *Hygrocybe* species, called 'waxcaps' because of the waxy texture of the fruiting bodies, are the most visible component of the grassland fungi and have attracted the most attention. Good sites in Britain have become known as 'Waxcap Grasslands' and these are typically undisturbed, semi-improved or unimproved grasslands that are fairly short, grazed or mown, well drained and often with a high moss content. This habitat and consequently the fungi it supports are now rare in much of lowland Britain as a result of agricultural intensification and both are of conservation concern. These fungi thrive in nutrient poor swards and are intolerant of agricultural improvement including the use of fertilisers, ploughing, reseeding etc. and will quickly disappear if subjected to such treatment. They may not return for decades if ever, even if there is no further intervention.

Thirty nine CHEGD species have been recorded on this waxcap meadow over the past twenty years. This high figure possibly places it in the top 10-20 waxcap grasslands in Wales and given that Wales is the richest region for waxcaps in the UK, and the UK is the richest region for waxcaps in Europe, then context can be made. New methodologies are being developed to rank the quality of CHEGD species but it is not yet clear if one methodology is yet universally accepted. A ranking list, with

suggested weighting, was produced in 2008 by freelance mycologist Debbie Evans (see Table 7.2).

We've also recently discovered an 8m wide fairy ring of *Hygrocybe pratensis* on this field which may be over 200 years old. This field has suffered from persistent undergrazing over the past few years but the new partnership with Coleg Sir Gar's Gelli Aur Campus should result in far greater livestock numbers to allow us to more effectively graze this meadow.

F10. Hangman's Wood
Indications are that this is good for woodland fungi but it has yet to be intensively investigated.

F11. Horse Field
Fruiting bodies of waxcap fungi appear scattered across the drier parts of this wet meadow in most years and include the relatively rare *Hygrocybe punicea.*

## 7.3 Fungus-rich Areas outside of Waun Las NNR

The following areas also have mycological interest in the 'formal' Garden area.

F12. The wooded parts of Springwoods and around the Aqualab can produce a wide variety of autumnal fruiting bodies.

F13. Some of the more common waxcaps, such as *Hygrocybe virginia*, *H. psittacina* and *H. ceracea*, regularly fruit in the lawned areas fringing the Great Glasshouse, the site of Middleton Hall and the Stable Block. Here, we've recently recorded a Wales first record for *Abortiporus biennis*, which is tethered to the *Quercus robur* tree on the lawn. Interesting fungi are also regularly found tethered to beech, oak and birch trees on our lawns.

F14. Flower beds can occasionally produce interesting fruiting bodies such as the Wales first record, and UK rarity, *Stropharia rugosoannulata,* which has regularly fruited amongst our mulched flower beds since 2014. There have also been impressive colonies of *Cyathus olla* and large fairy rings of *Clitocybe nebularis*.

F15. In autumn 2015, isolated single fruiting bodies of *Hygrocybe calyptriformis,* until recently considered a red data species, were found in the upper part of the Growing the Future field and on the top part of the Wild Garden.

F16. The Great Glasshouse and Tropical House occasionally produce fruiting bodies that have rarely been recorded in the UK such as *Leucocoprinus heinenmannii* and *Leucocoprinus brebissonii,* but these are likely to have been introduced from bought-in horticultural specimens so are little conservation interest.

F17. An interesting variety of fungi are starting to colonise the Ghost Forest which is made up of tree roots from the tropical rainforests of Ghana. In years to come they should provide a fascinating study.

## 7.4 Conclusion

Whilst a great deal of further research is needed to determine the status of mycological interest at the Garden, it is evident that the estate supports a wide diversity of species in numerous different habitats. Existing areas of interest shown on figure 7.1. should therefore be managed with this interest in mind and, in particular, consideration should be given to their avoidance during the implementation of the Regency Landscape Restoration project.

**Table 7.1.**
**Species of Grassland Fungi recorded at the National Botanic Garden of Wales by Maurice Rotheroe in 1998, (Rotheroe, 1999)**

| No | Scientific Name | English Name | Habitat Quality Indicator |
|---|---|---|---|
| | **Clavariaceae (3)** | **Fairy Clubs** | |
| 1 | *Clavulinopsis corniculata* | Meadow Coral | **C** |
| 2 | *Clavulinopsis fusiformis* | Golden Spindles | **C** |
| 3 | *Clavulinopsis helvola* | Yellow Club | **C** |
| | | | |
| | ***Hygrocybe* species (14)** | **Waxcaps** | |
| 1 | *Hygrocybe chlorophana* | Golden Waxcap | **C** |
| 2 | *Hygrocybe citrinovirens* | Citrine Waxcap | **B** |
| 3 | *Hygrocybe coccinea* | Scarlet Waxcap | **C** |
| 4 | *Hygrocybe colemanniana* | Toasted Waxcap | **B** |
| 5 | *Hygrocybe glutinipes* | Glutinous Waxcap | **B** |
| 6 | *Hygrocybe insipida* | Spangle Waxcap | **C** |
| 7 | *Hygrocybe nitrata* | Nitrous Waxcap | **A** |
| 8 | *Hygrocybe pratensis* | Meadow Waxcap | **C** |
| 9 | *Hygrocybe psittacina* | Parrot Waxcap | **C** |
| 10 | *Hygrocybe punicea* | Crimson Waxcap | **A** |
| 11 | *Hygrocybe reidii* | Honey Waxcap | **C** |
| 12 | *Hygrocybe russocoriacea* | Cedarwood Waxcap | **C** |
| 13 | *Hygrocybe splendidissima* | Splendid Waxcap | **A** |
| 14 | *Hygrocybe virginea* | Snowy Waxcap | **C** |
| | | | |
| | **Entolomataceae (2)** | **Pinkgills** | |
| 1 | *Entoloma porphyrophaeum* | Lilac Pinkgill | **B** |
| 2 | *Entoloma serrulatum* | Blue Edge Pinkgill | **C** |

The site was visited on 4 occasions: 2/10/1998, 21/10/1998. 2/11/1998, 20/11/1998

Total Number of CHEGD species recorded in 1998 = 19: C3, H14, E2, G0, D0 (**A3 B4 C12**)

**Cumulative total for site recorded by Rotheroe, 1996 – 1998,** (Rotheroe, 1999)
**CHEG species = 33: C4, 22, E7, G0**

**Table 7.2.**
**Cumulative List of Grassland Fungi recorded at the National Botanic Garden of Wales by Maurice Rotheroe in 1998, (Rotheroe, 1999) in addition to surveys by Debbie Evans *et al* in 2007 and 2008**

| No | Scientific Name | English Name | Dates Recorded |
|---|---|---|---|
| | **Clavariaceae (8)** | **Fairy Clubs** | |
| 1 | *Clavaria fragilis* | White Spindles | 2007 |
| 2 | *Clavaria straminea* | Straw Club | 2008 |
| 3 | *Clavulinopsis corniculata* | Meadow Coral | 1998, 2007 |
| 4 | *Clavulinopsis fusiformis* | Golden Spindles | 1998, 2007 |
| 5 | *Clavulinopsis helvola* | Yellow Club | 1998, 2007, 2008 |
| 6 | *Clavulinopsis laeticolor* | Handsome Club | 2007, 2008 |
| 7 | *Clavulinopsis luteoalba* | Apricot Club | 2007, 2008 |
| 8 | *Clavulinopsis umbrinella* | Beige Coral | 2007 |
| | ***Hygrocybe* species (23)** | **Waxcaps** | |
| 1 | *Hygrocybe calyptriformis* | Pink Waxcap | 2007, 2008 |
| 2 | *Hygrocybe ceracea* | Butter Waxcap | 2007, 2008 |
| 3 | *Hygrocybe chlorophana* | Golden Waxcap | 1998, 2007, 2008 |
| 4 | *Hygrocybe citrinovirens* | Citrine Waxcap | 1998, 2008 |
| 5 | *Hygrocybe coccinea* | Scarlet Waxcap | 1998, 2007, 2008 |
| 6 | *Hygrocybe colemanniana* | Toasted Waxcap | 1998, 2007 |
| 7 | *Hygrocybe conica* | Blackening Waxcap | 2007 |
| 8 | *Hygrocybe flavipes* | Yellow Foot Waxcap | 2008 |
| 9 | *Hygrocybe fornicata* | Earthy Waxcap | 2007 |
| 10 | *Hygrocybe glutinipes* | Glutinous Waxcap | 1998, 2007, 2008 |
| 11 | *Hygrocybe ingrata* | | 2008 |
| 12 | *Hygrocybe insipida* | Spangle Waxcap | 1998, 2007, 2008 |
| 13 | *Hygrocybe intermedia* | Fibrous Waxcap | 2008 |
| 14 | *Hygrocybe irrigata* | Slimy Waxcap | 2007, 2008 |
| 15 | *Hygrocybe nitrata* | Nitrous Waxcap | 1998 |
| 16 | *Hygrocybe pratensis* | Meadow Waxcap | 1998, 2007, 2008 |
| 17 | *Hygrocybe psittacina* | Parrot Waxcap | 1998, 2007, 2008 |
| 18 | *Hygrocybe punicea* | Crimson Waxcap | 1998, 2007, 2008 |
| 19 | *Hygrocybe quieta* | Oily Waxcap | 2007 |
| 20 | *Hygrocybe reidii* | Honey Waxcap | 1998, 2007, 2008 |
| 21 | *Hygrocybe russocoriacea* | Cedarwood Waxcap | 1998 |
| 22 | *Hygrocybe splendidissima* | Splendid Waxcap | 1998, 2007, 2008 |
| 23 | *Hygrocybe virginea* | Snowy Waxcap | 1998, 2007, 2008 |

| | **Entolomataceae (4)** | **Pinkgills** | |
|---|---|---|---|
| 1 | *Entoloma atrocoeruleum* | A Pinkgill | 2008 |
| 2 | *Entoloma conferendum* | Star Pinkgill | 2007, 2008 |
| 3 | *Entoloma porphyrophaeum* | Lilac Pinkgill | 1998, 2007 |
| 4 | *Entoloma serrulatum* | Blue Edge Pinkgill | 1998 |
| | | | |
| | ***Dermoloma* species (1)** | | |
| 1 | *Dermoloma cuneifolium* | Crazed Cap | 2007 |

**Total CHEGD species recorded 1998, 2007, 2008 = 36: C8, H23, E4, G0, D1**

## Table 7.3.
## Cumulative List of all fungi recorded at the National Botanic Garden of Wales

The following list is derived from all sources currently available but is mostly abstracted from the database held by the West Wales Biodiversity Information Centre, Whitland, which includes the records of Debbie Evans (2007 & 2008) (listed in Table 7.2, above) and David Mitchel (2013 & 2014). Few of Maurice Rotheroe's records (1998) are held by WWBIC but these have been added from the records in Table 7.1. Additional records from the present 2015 survey or made during occasional field meetings such as the annual National Fungus Days or by local interest groups such as the Llanelli Naturalists, have also been included. It is hoped that this list may act as a stimulus to promote further future recording of fungi at the Garden.

| Vernacular Name | Code | Common Name | No of times recorded | Lastyear | Firstyear |
|---|---|---|---|---|---|
| | 176 | *Amandinea punctata* | 1 | 2010 | 2010 |
| | 224 | *Anisomeridium polypori* | 1 | 2010 | 2010 |
| | 683 | *Aspicilia contorta* subsp. *contorta* | 1 | 2010 | 2010 |
| | 684 | *Aspicilia contorta* subsp. *hoffmanniana* | 1 | 2010 | 2010 |
| | 1002 | *Buellia ocellata* | 1 | 2010 | 2010 |
| | 1092 | *Caloplaca crenulatella* | 1 | 2010 | 2010 |
| | 1096 | *Caloplaca flavescens* | 3 | 2010 | 2010 |
| | 1118 | *Caloplaca polycarpa* | 1 | 2010 | 2010 |
| | 1165 | *Calycellina populina* | 1 | 2014 | 2014 |
| | 1216 | *Candelariella aurella* f. *aurella* | 1 | 2010 | 2010 |
| | 1225 | *Candelariella vitellina* f. *vitellina* | 1 | 2010 | 2010 |
| | 1616 | *Chrysothrix flavovirens* | 1 | 2010 | 2010 |
| | 1793 | *Clauzadea monticola* | 1 | 2010 | 2010 |
| | 2494 | *Diatrypella favacea* | 1 | 2014 | 2014 |
| | 2495 | *Diatrypella quercina* | 1 | 2014 | 2014 |
| | 3078 | *Flavoparmelia caperata* | 2 | 2010 | 2010 |
| | 3079 | *Flavoparmelia soredians* | 2 | 2010 | 2010 |
| | 3795 | *Hyperphyscia adglutinata* | 1 | 2010 | 2010 |
| | 3870 | *Hypotrachyna revoluta* | 2 | 2010 | 2010 |
| | 3961 | *Japewiella tavaresiana* | 1 | 2010 | 2010 |
| | 4222 | *Lecania sylvestris* | 1 | 2010 | 2010 |
| | 4233 | *Lecanora agardhiana* | 1 | 2010 | 2010 |
| | 4243 | *Lecanora barkmaniana* | 1 | 2010 | 2010 |
| | 4246 | *Lecanora campestris* subsp. *campestris* | 3 | 2010 | 2010 |

| | | | | | |
|---|---|---|---|---|---|
| | 4388 | *Lecidella elaeochroma* f. *elaeochroma* | 2 | 2010 | 2010 |
| | 4389 | *Lecidella elaeochroma* f. *soralifera* | 2 | 2010 | 2010 |
| | 4465 | *Leptogium gelatinosum* | 1 | 2010 | 2010 |
| | 5900 | *Paecilomyces marquandii* | 1 | 2008 | 2008 |
| | 5937 | *Parmelina pastillifera* | 1 | 2010 | 2010 |
| | 5979 | *Peltigera lactucifolia* | 1 | 2015 | 2015 |
| | 6134 | *Pertusaria amara* f. *amara* | 1 | 2010 | 2010 |
| | 6905 | *Placynthiella icmalea* | 1 | 2010 | 2010 |
| | 7111 | *Porina chlorotica* f. *chlorotica* | 2 | 2010 | 2010 |
| | 7138 | *Porpidia crustulata* | 2 | 2010 | 2010 |
| | 7148 | *Porpidia soredizodes* | 1 | 2010 | 2010 |
| | 7153 | *Porpidia tuberculosa* | 1 | 2010 | 2010 |
| | 7359 | *Punctelia subrudecta* | 1 | 2010 | 2010 |
| | 7501 | *Ramalina fastigiata* | 2 | 2010 | 2010 |
| | 7717 | *Rhizocarpon petraeum* | 1 | 2010 | 2010 |
| | 7720 | *Rhizocarpon reductum* | 3 | 2010 | 2010 |
| | 7796 | *Rinodina oleae* | 1 | 2010 | 2010 |
| | 7816 | *Rosellinia aquila* | 1 | 2014 | 2014 |
| | 7916 | *Sarcoscypha coccinea* | 5 | 2016 | 2012 |
| | 7992 | *Scoliciosporum umbrinum* | 2 | 2010 | 2010 |
| | 8595 | *Sticta sylvatica* | 2 | 2015 | 2015 |
| | 8938 | *Trapelia coarctata* | 3 | 2010 | 2010 |
| | 8944 | *Trapeliopsis flexuosa* | 1 | 2010 | 2010 |
| | 9193 | *Usnea cornuta* | 1 | 2010 | 2010 |
| | 9302 | *Verrucaria elaeina* | 1 | 2010 | 2010 |
| | 10084 | *Conocybe rugosa* | 1 | 2014 | 2014 |
| | 10285 | *Psathyrella laevissima* | 1 | 2014 | 2014 |
| | 10385 | *Hygrocybe calyptriformis* f. *calyptriformis* | 1 | 2008 | 2008 |
| | 10395 | *Hygrocybe ingrata* | 1 | 2008 | 2008 |
| | 10424 | *Hygrocybe pratensis* var. *pratensis* | 1 | 2013 | 2013 |
| | 10427 | *Hygrocybe psittacina* var. *psittacina* | 1 | 2013 | 2013 |
| | 10696 | *Stropharia rugosoannulata* | 2 | 2014 | 2013 |
| | 11675 | *Amanita rubescens* var. *rubescens* | 1 | 2013 | 2013 |
| | 11713 | *Entoloma atrocoeruleum* | 1 | 2008 | 2008 |
| | 12115 | *Cortinarius balteatocumatilis* | 1 | 0 | 0 |
| | 12371 | *Cortinarius safranopes* | 1 | 0 | 0 |
| | 12517 | *Hebeloma sinuosum* | 1 | 2013 | 2013 |
| | 13661 | *Russula solaris* | 1 | 0 | 0 |
| | 13767 | *Exidia plana* | 1 | 2014 | 2014 |
| | 14328 | *Puccinia adoxae* | 1 | 2015 | 2015 |
| | 14331 | *Puccinia albescens* | 1 | 2015 | 2015 |
| | 14390 | *Puccinia cnici-oleracei* | 1 | 2007 | 2007 |
| | 14538 | *Puccinia sessilis* | 2 | 2015 | 2015 |
| Alder Bracket | 11947 | *Inonotus radiatus* | 1 | 2014 | 2014 |
| Amethyst Deceiver | 10925 | *Laccaria amethystina* | 1 | 2012 | 2012 |
| Apricot Club | 12847 | *Clavulinopsis luteoalba* | 3 | 2008 | 2007 |
| Artist's Bracket | 13162 | *Ganoderma applanatum* | 1 | 2007 | 2007 |
| Beech Milkcap | 13434 | *Lactarius blennius* | 1 | 2013 | 2013 |
| Beechmast Candlesnuff | 9467 | *Xylaria carpophila* | 1 | 2014 | 2014 |
| Beige Coral | 12852 | *Clavulinopsis umbrinella* | 1 | 2007 | 2007 |
| Birch Polypore / Razorstrop Fungus | 13282 | *Piptoporus betulinus* | 1 | 2014 | 2014 |
| Black Bulgar | 1023 | *Bulgaria inquinans* | 1 | 2014 | 2014 |
| Blackening Waxcap | 10365 | *Hygrocybe conica* | 5 | 2013 | 2007 |
| Bleeding Broadleaf Crust | 14161 | *Stereum rugosum* | 1 | 2014 | 2014 |

| | | | | |
|---|---|---|---|---|
| Bleeding Oak Crust | 14157 | *Stereum gausapatum* | 1 | 2014 2014 |
| Blusher | 11673 | *Amanita rubescens* | 1 | 2007 2007 |
| Blue Edge Pinkgill | | *Entoloma serrulatum* | 1 | 1998 1998 |
| Brown Mottlegill | 10265 | *Panaeolina foenisecii* | 1 | 2013 2013 |
| Bulbous Honey Fungus | 10707 | *Armillaria gallica* | 1 | 2013 2013 |
| Butter Waxcap | 10390 | *Hygrocybe ceracea* | 3 | 2008 2007 |
| Cedarwood Waxcap | | *Hygrocybe russocoriacea* | 1 | 1998 1998 |
| Charcoal Burner | 13490 | *Russula cyanoxantha* | 3 | 2013 2007 |
| Citrine Waxcap | 10393 | *Hygrocybe citrinovirens* | 2 | 2008 1998 |
| Collared Earthstar | 12088 | *Geastrum triplex* | 1 | 2014 2014 |
| Common Funnel | 10780 | *Clitocybe gibba* | 1 | 2013 2013 |
| Common Mazegill | 13243 | *Datronia mollis* | 1 | 2014 2014 |
| Coral Spot | 5486 | *Nectria cinnabarina* | 1 | 2014 2014 |
| Crazed Cap | 10847 | *Dermoloma cuneifolium* | 3 | 2013 2007 |
| Crimson Waxcap | 10428 | *Hygrocybe punicea* | 4 | 2008 1998 |
| Deceiver | 10927 | *Laccaria laccata* | 2 | 2013 2007 |
| Dusky Puffball | 12061 | *Lycoperdon nigrescens* | 1 | 2007 2007 |
| Earthy Powdercap | 11463 | *Cystoderma amianthinum* | 5 | 2013 2007 |
| Earthy Waxcap | 10371 | *Hygrocybe fornicata* | 3 | 2007 2007 |
| False Saffron Milkcap | 13369 | *Lactarius deterrimus* | 1 | 2007 2007 |
| Fibrous Waxcap | 10399 | *Hygrocybe intermedia* | 1 | 2013 2008 |
| Field Bird's Nest | 13185 | *Cyathus olla* | 1 | 2014 2014 |
| Geranium Brittlegill | 13511 | *Russula fellea* | 1 | 2007 2007 |
| Glue Crust | 11934 | *Hymenochaete corrugata* | 1 | 2015 2015 |
| Glutinous Waxcap | 10374 | *Hygrocybe glutinipes* | 3 | 2008 1998 |
| Golden Spindles | 12860 | *Clavulinopsis fusiformis* | 3 | 2007 1998 |
| Golden Waxcap | 10391 | *Hygrocybe chlorophana* | 10 | 2013 1998 |
| Grisette | 11651 | *Amanita vaginata* | 2 | 2007 2007 |
| Hairy Curtain Crust | 14158 | *Stereum hirsutum* | 1 | 2014 2014 |
| Handsome Club | 12845 | *Clavulinopsis laeticolor* | 4 | 2008 2007 |
| Hazel Woodwart | 3877 | *Hypoxylon fuscum* | 1 | 2014 2014 |
| Holly Speckle | 9078 | *Trochila ilicina* | 1 | 2014 2014 |
| Honey Fungus | 10708 | *Armillaria mellea* | 1 | 2013 2013 |
| Honey Waxcap | 10431 | *Hygrocybe reidii* | 5 | 2013 1998 |
| Jelly Ear | 13142 | *Auricularia auricula-judae* | 1 | 2014 2014 |
| King Alfred's Cakes / Cramp Balls | 2274 | *Daldinia concentrica* | 1 | 2014 2014 |
| Lilac Pinkgill | 11779 | *Entoloma porphyrophaeum* | 5 | 2013 1998 |
| Magic Mushroom / Liberty Cap | 10680 | *Psilocybe semilanceata* | 6 | 2013 2007 |
| Meadow Coral | 12859 | *Clavulinopsis corniculata* | 4 | 2013 1998 |
| Meadow Waxcap | 10422 | *Hygrocybe pratensis* | 11 | 2008 1998 |
| Mealy Bonnet | 11145 | *Mycena cinerella* | 1 | 2007 2007 |
| Nitrous Waxcap | | *Hygrocybe nitrata* | 1 | 1998 1998 |
| Oak Curtain Crust | 11938 | *Hymenochaete rubiginosa* | 1 | 2014 2014 |
| Oily Waxcap | 10429 | *Hygrocybe quieta* | 4 | 2007 2007 |
| Pale Waxcap | 10423 | *Hygrocybe pratensis* var. *pallida* | 1 | 2013 2013 |
| Parrot Waxcap | 10425 | *Hygrocybe psittacina* | 9 | 2008 1998 |
| Pestle Puffball | 12044 | *Handkea excipuliformis* | 1 | 2007 2007 |
| Petticoat Mottlegill | 10264 | *Panaeolus papilionaceus* | 1 | 2013 2013 |
| Pink Waxcap | 10384 | *Hygrocybe calyptriformis* | 2 | 2015 2007 |
| Redlead Roundhead | 10688 | *Stropharia aurantiaca* | 2 | 2014 2013 |
| Redspored Dapperling | 11619 | *Melanophyllum haematospermum* | 1 | 2014 2014 |
| Rosy Crust | 14058 | *Peniophora incarnata* | 1 | 2014 2014 |
| Scarlet Caterpillarclub | 1967 | *Cordyceps militaris* | 2 | 2008 2007 |
| Scarlet Waxcap | 10394 | *Hygrocybe coccinea* | 5 | 2013 1998 |

| | | | | | |
|---|---|---|---|---|---|
| Scurfy Twiglet | 12788 | *Tubaria furfuracea* | 1 | 2014 | 2014 |
| Shaggy Scalycap | 10633 | *Pholiota squarrosa* | 1 | 2013 | 2013 |
| Slimy Waxcap | 10400 | *Hygrocybe irrigata* | 5 | 2013 | 2007 |
| Slippery Jack | 13055 | *Suillus luteus* | 1 | 2007 | 2007 |
| Smoky Bracket | 13228 | *Bjerkandera adusta* | 2 | 2014 | 2013 |
| Snowy Waxcap | 10444 | *Hygrocybe virginea* | 7 | 2013 | 1998 |
| Southern Bracket | 13163 | *Ganoderma australe* | 1 | 2014 | 2014 |
| Spangle Waxcap | 10396 | *Hygrocybe insipida* | 3 | 2013 | 1998 |
| Splendid Waxcap | 10436 | *Hygrocybe splendidissima* | 4 | 2008 | 1998 |
| Star Pinkgill | 11824 | *Entoloma conferendum* | 6 | 2008 | 2007 |
| Straw Club | 12842 | *Clavaria straminea* | 1 | 2008 | 1998 |
| Stubble Rosegill | 10538 | *Volvariella gloiocephala* | 1 | 2013 | 2013 |
| Stump Puffball | 12065 | *Lycoperdon pyriforme* | 1 | 2007 | 2007 |
| Sulphur Tuft | 10565 | *Hypholoma fasciculare* | 1 | 2013 | 2013 |
| The Flirt | 13600 | *Russula vesca* | 1 | 2007 | 2007 |
| Toasted Waxcap | | *Hygrocybe colemanniana* | 1 | 2007 | 1998 |
| Turkeytail | 13319 | *Trametes versicolor* | 2 | 2014 | 2013 |
| Variable Oysterling | 12758 | *Crepidotus variabilis* | 1 | 2014 | 2014 |
| Variable Webcap | 12097 | *Cortinarius anomalus* | 1 | 0 | 0 |
| Violet Bramble Rust | 14303 | *Phragmidium violaceum* | 1 | 2014 | 2014 |
| White Brain | 13771 | *Exidia thuretiana* | 1 | 2014 | 2014 |
| White Spindles | | *Clavaria fragilis* | 1 | 2007 | 2007 |
| Yellow Brain | 13729 | *Tremella mesenterica* | 1 | 2014 | 2014 |
| Yellow Club | 12844 | *Clavulinopsis helvola* | 5 | 2008 | 1998 |
| Yellow Foot Waxcap | 10370 | *Hygrocybe flavipes* | 1 | 2013 | 2008 |
| | | *Strobilomyces strobileceus* | 1 | 2013 | 2013 |
| | | *Clavulina rugosa* | | | |
| | | *Cyathus striatus* | | | |
| | | *Hydnum rufescens* | | | |
| | | *Cortinarius largus* | 1 | 1994 | 1994 |
| | | *Cortinarius parvannulatus* | 1 | 1994 | 1994 |
| | | *Cortinarius rubricosus* | 1 | 1994 | 1994 |
| | | *Cortinarius safranopes* | 1 | 1994 | 1994 |
| | | *Abortiporus biennis* | 1 | 2015 | 2015 |
| | | *Clitocybe nebularis* | 1 | 2015 | 2015 |
| | | *Leucocoprinus heinenmannii* | 1 | 2015 | 2015 |
| | | *Leucocoprinus brebissonii* | 1 | 2015 | 2015 |

Total no. of species = 169.

## 8. HEDGEROW SURVEY (Jacqueline Hartley)

### 8.1. Introduction

Only ten boundaries are marked by hedgerows within Survey Zones 1 and 2 of the Garden estate that meet the definition of 'hedgerow' as stated in the Hedgerow Regulations 1997. All ten were surveyed by Jacqueline Hartley during June and July 2015 in order to determine whether they qualify as *Important Hedgerows* under the terms of the Regulations. All hedgerows surveyed are located either along the site boundaries or within the body of the estate.

### 8.2 Context

Ancient and/or Species-rich Hedgerows is a *UK Biodiversity Action Plan Priority Habitat* and a *Habitat of Principal Importance for Conservation of Biological Diversity* in Wales under section 42 of Natural Environment and Rural Communities Act 2006. It is also a habitat for which a Habitat Action Plan has been implemented in the Carmarthenshire Local Biodiversity Action Plan.

### 8.3 Hedgerow Survey Rationale

All of the hedgerows within Survey Zones 1 and 2 were surveyed in order to determine the extent to which they meet the criteria affording them protection by the Hedgerow Regulations 1997. The assessment of hedgerow importance reported here is based upon the biological and physical criteria listed in the Hedgerow Regulations which can be recorded in the field. Historical and archaeological data have not been fully considered but form an important part of the Regulations and should be researched if any hedgerows are to be affected by proposed works, particularly if hedgerows 'nearly qualify' on biological criteria alone (marked in yellow on figure 8.1). Moreover, a hedgerow qualifies as an *Important Hedgerow* if it supports any protected species (eg Bluebell or Dormouse). Except where protected species are known to occur or have been proven to occur during the present surveys, the assessment of hedgerows to prove their support of protected species is outside the scope of the present survey.

The Regulations were drawn-up to give protection to approximately the best 15% of hedgerows nationally.

### 8.4 Hedgerow Survey Methodology

The survey was undertaken in July 2015. A synopsis of the methodology is as follows.

- The Regulations apply to any hedgerow growing in or adjacent to any common land, protected land, or land used for agriculture, forestry or the breeding or keeping of horses, ponies or donkeys. The Regulations do not apply to any hedgerows within or marking the boundary of a dwelling house and these are not included within the assessment.
- The hedgerow must have existed for 30 years or more.
- Assessment of woody and woodland species is confined to the central 30m within any hedgerow of 100m length or less. Lists of qualifying woody and woodland species are printed at table 8.1.
- Hedgerows greater than 100m in length are divided into 100m lengths and the central 30m lengths evaluated separately and the results averaged.
- Physical features are assessed over the whole length of a hedgerow.

Hedgerows that qualify for designation as Important Hedgerows under the Regulations must include one of the following:

- support at least 7 woody species
- support at least 6 woody species and have at least 3 additional features from the list below
- support at least 5 woody species and have at least 4 additional features from the list below, or
- support at least 6 woody species with 1 of those species being Black-poplar (*Populus nigra* ssp. *betulifolia*), Large-leaved Lime *(Tilia platyphyllos*), Small-leaved Lime (*Tilia cordata*) or Wild Service Tree (*Sorbus torminalis*).
- at least 4 woody species and 2 features from the list below if the hedge is adjacent to a bridleway, footpath, a road used as a public path or a byway open to all traffic.

Additional features referred to above are:

- a bank or wall for at least half of the hedgerow length
- at least 1 standard tree for every 50m of hedgerow
- at least 3 woodland species within 1m of the hedge
- a ditch that runs along the hedge for at least one half of its length
- at least 4 connections: in this context, a connection with another hedge scores 1, a connection with a woodland or pond scores 2
- a parallel hedge within 15m of the hedge being assessed

Each hedgerow length was assigned a number and its location is shown on figure 8.1. The survey data is reproduced at table 8.1.

Figure 8.1 shows the hedgerows as follows:

- Qualifying hedgerows (red line)
- Nearly qualifying hedgerows (yellow line) ie those hedgerows which with the addition of one other feature eg its proven ancient provenance or the fact that it supports a protected species which was not evident at the time of the survey
- There are no non-qualifying hedgerows,
- Ditches, banks, post & wire fences and boundaries which do not fit the definition of hedgerow under the Regulations (uncoloured).

Limitations of Survey
The survey was undertaken July when identification of some woodland species is more difficult as they may have started to die-down. It is possible, therefore, that some species may have been under recorded. This will only affect the assessment where the presence of an additional feature would mean the hedgerow would qualify as an Important Hedgerow.

## 8.5 Hedgerow Survey Results

The majority of all surveyed hedges are shown as boundaries on the Ordnance Survey 1:2500 map of c.1890 and they have changed very little since that date. The exceptions are those dividing of the former parkland landscape to form fields of a more convenient size for

agricultural use. Two new hedgerows are also present along the former minor road to North Lodge.

Between three and ten woody species were recorded from the hedgerows surveyed. The most common species recorded throughout the site were Hawthorn (*Crataegus monogyna*), and Hazel (*Corylus avellana*). Pedunculate Oak (*Quercus robur*), rose species (*Rosa* sp.) Holly (*Ilex aquifolium*), Ash (*Fraxinus excelsior*) and Grey Willow (*Salix cinerea*) were recorded less frequently. A number of woody species such as Beech (*Fagus sylvatica*), Blackthorn (*Prunus* spinosa) and Hornbeam (*Carpinus betulus*) were each recorded in a small number of hedgerows.

Six hedgerows: 5, 6 and 7, 8, 9 and 10 are adjacent to 'a public byway' and are parallel to a hedge within 15m. All the hedgerows with the exception of hedges 5 and 6 were on banks. Three of the hedgerows: numbers 2, 3 and 4, mainly located around Waun Las Farm, were also associated with ditches.

Most of the hedgerows are managed to some degree and the majority have one standard tree for every 50m of hedgerow with the exception of hedges 5 and 10.

Woodland species were recorded within 1m of six of the hedgerows, two of which had at least three woodland species within 1m of the hedge.

The majority of the hedgerows had between one and two connections to another hedge or broad-leaved woodland.

Many surveyed hedgerows contain large mature trees, some of which may offer bat roost potential and most offer habitat suitable to harbour dormice, if not permanently, then as a travel corridor. Any hedgerow which is known to support protected species such as bats qualifies as an Important Hedgerow as defined in the Regulations.

8.6 **Hedgerow Assessment**

All of the hedgerows surveyed either qualify or nearly qualify. Nine (90%) of the hedges qualify as Important and a further one (10%) would qualify if one additional qualifying feature (eg historical or protected species criteria not assessed by this survey) were to be present.

Hedgerows 5, 6, 7 and 8 are directly connected to woodland that is known to support dormice and are therefore highly likely to contain this protected species. These hedgerows therefore qualify as Important.

Hedgerows 9 and 10 are adjacent to a public byway which means that the criteria for qualifying are four woody species and two additional features. As these have a minimum of four woody species and at least two additional features they are considered to qualify as Important Hedgerows.

Hedgerows 1 and 2 have a minimum of seven woody species. As a hedgerow qualifies if only seven woody species are present, these qualify on this criterion alone.

Hedgerow 3 has five woody species and four additional features and therefore qualifies. Hedgerow 4 has four woody species but only three additional features and therefore would qualify with the addition of one extra feature.

Any archaeological or historical significance would increase the likelihood of qualification of those hedgerows which would be Important Hedgerows were one extra feature to be present and proven protected species occurrence would also increase the number of hedgerows that qualify.

The importance of hedgerows in landscape character terms is not identified by the Regulations and is a factor that should not be ignored.

# HEDGEROW SURVEY DATA

| Date of Survey: June/July 2015 | Hedgerow Numbers | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Qualifying as Important Hedgerow (red) OR Important if 1 extra feature found (yellow) | 1 | 1a | 2 | 3 | 4 | 4a | 5 | 5a | 6 | 6a |
| Feature / Species | | | | | | | | | | |
| At least **30 years old** | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Adjacent to what type of land? (not garden) | | | | | | | | | | |
| How **long?** At least **20m?** (Note 1) | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| OR < 20m? Meets other hedge BOTH ends | | | | | | | | | | |
| **Hedgerow trees** av. 1 in 50m | Y | Y | Y | Y | Y | Y | | Y | Y | Y |
| **Ditch** along at least half the length | | | Y | Y | Y | | | | | |
| **Bank** along at least half of length | Y | Y | Y | Y | Y | Y | | | | |
| **Wall** along at least half of length | | | | | | | | | | |
| **Parallel hedge** within 15m of hedgerow | | | | | | | Y | Y | Y | Y |
| **Adjacent public road**/track/bridleway/ftpath | | | | | | | Y | Y | Y | Y |
| **Connection** with (broadleaved) **Woodland** | Y | | Y | | Y | Y | Y | Y | Y | Y |
| **Connection** with a **pond** | | | | | | | | | | |
| **Connection** to another **hedge** | Y | Y | Y | Y | Y | Y | | | | |
| **Continuous** hedge or less than 10% **Gaps** | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| **Bluebell** present | | | | | | | | | | |
| **Badger** (S sett, F foraging, L latrine, R run) | | | | | | | | | | |
| Other **protected species** | | | | | | | | | | |
| Any **large old potential bat roost trees?** | | | Y | | | Y | | | | |
| | | | | | | | | | | |
| **Woody Species listed in Hedgerow Regulations criteria** ( DAFOR scale) | | | | | | | | - See Note 3 | | |
| **Alder** | | | | | | | | | | |
| **Apple** | | | R | | | | | | | |
| **Ash** | O | | O | O | | O | O | O | | |
| **Aspen** | | | | | | | | | | |
| **Beech** | | O | F | | | | | | R | |
| **Birch, Downy** | | | | | | | | | | |
| **Birch, Silver** | | | | | R | | | | | |
| **BLACK-POPLAR** | | | | | | | | | | |
| **Blackthorn** | F | R | | | | | | | | R |
| **Broom** | | | | | | | | | | |
| **Buckthorn** | | | | | | | | | | |
| **Cherry, Bird** | | | | | | | | | | |
| **Cherry, Wild** | | | | | | | | | | |
| **Dogwood** | | | | | | | | | | |
| **Elder** | R | | | | | | | | | |
| **elm spp.** | | | | | | | | | | |
| **Gooseberry** | | | | | | | | | | |
| **Gorse, Common** | | | | | | | | | | |
| **Gorse, Western** | | | | | | | | | | |
| **Guelder Rose** | | | | | | | | | | |
| **Hawthorn** | O | O | O | O | O | O | | O | F | F |
| **Hazel** | O | O | O | F | F | F | O | O | F | O |
| **Holly** | | O | O | O | R | | | | R | |
| **Hornbeam** | R | | | | | | | R | | R |
| **LIME, LARGE-LEAVED** | | | | | | | | | | |
| **LIME, SMALL-LEAVED** | | | | | | | | | | |
| **Maple, Field** | | | | | | | | | R | |
| **Mezerion** | | | | | | | | | | |
| **Oak, Pedunculate** | R | O | O | O | | R | R | O | O | |
| **Oak, Sessile** | | | | | | | | | | |
| **Osier** | | | | | | | | | | |
| **Poplar, (G Grey, W White)** | | | | | | | | | | |
| **Privet, Wild** | | | | | | | | | | |
| **rose spp.** | R | R | O | | | | O | O | O | O |
| **Rowan** | | | | | | | | | | |
| **Sea-buckthorn** | | | | | | | | | | |
| **SERVICE TREE, WILD** | | | | | | | | | | |
| **Spindle** | | | | | | | | | | |
| **Spurge-laurel** | | | | | | | | | | |
| **Walnut** | | | | | | | | | | |
| **Wayfaring-tree** | | | R | | | | | | | |
| **whitebeam spp.** | | | | | | | | | | |
| **Willow, (C Crack, G Goat, W White)** | | | | | | | O | O | O | O |
| **Willow, Grey** | | R | O | | | | F | O | | |
| **Yew** | | | | | | | | | | |

| Qualifying as Important Hedgerow (red) OR Important if 1 extra feature found (yellow) | Hedgerow Numbers | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1a | 2 | 3 | 4 | 5 | 5a | 6 | 6a | |
| Feature / Species | | | | | | | | | | |
| **Woodland Species listed in Hedgerow Regulations criteria** (DAFOR scale) | | | | | | | | - See Note 4 | | |
| **Barren Strawberry** | | | | | | | | | | |
| **Bluebell** | | | | | | | | | | |
| **Broad Buckler-fern** | | R | O | | | O | O | | | |
| **Broad-leaved Helleborine** | | | | | | | | | | |
| **Bugle** | | | | | | | | | | |
| **Common Cow-wheat** | | | | | | | | | | |
| **Common Dog-violet** | | | | | | | | | | |
| **Common Polypody** | | | | | | | | | | |
| **Dog's Mercury** | | | | | | | | | | |
| **Early Dog Violet** | | R | | | | | | | | |
| **Early Purple-orchid** | | | | | | | | | | |
| **Enchanter's-nightsahde** | | | | | | | | | | |
| **Giant Fescue** | | | | | | | | | | |
| **Greater Woodrush** | | | | | | | | | | |
| **Hairy Brome** | | | | | | | | | | |
| **Hairy Woodrush** | | | | | | | | | | |
| **Hard Fern** | | | | | | | | | | |
| **Hard Shield-fern** | | | | | | | | | | |
| **Heart's-tongue** | | | | | | R | | | | |
| **Heath Bedstraw** | | | | | | | | | | |
| **Herb Paris** | | | | | | | | | | |
| **Herb Robert** | O | R | | O | O | O | O | | O | |
| **Lady Fern** | | | | | | | | R | | |
| **Lords and Ladies** | | | | | | | | | | |
| **Male Fern** | | R | O | | | O | O | | | |
| **Moschatel** | | | | | | | | | | |
| **Narrow Buckler-fern** | | | | | | | | | | |
| **Pignut** | | | | | | | | | | |
| **Primrose** | | | | | | | | | | |
| **Ramsons** | | | | | | | | | | |
| **Sanicle** | | | | | | | | | | |
| **Scaly Male-fern** | | | | | | | | | | |
| **Soft Shield-fern** | | | | | | | | | | |
| **Sweet Violet** | | | | | | | | | | |
| **Toothwort** | | | | | | | | | | |
| **Tormentil** | | | | | | | | | | |
| **Wild Strawberry** | | | | | | R | | | | |
| **Wood Anemone** | | | | | | | | | | |
| **Wood Avens** | | | | | | | | | | |
| **Wood False-brome** *Brach.sylvaticum* | | | | | | | | | | |
| **Wood Horsetail** | | | | | | | | | | |
| **Wood Meadow-grass** *Poa nemoralis* | | | | | | | | | | |
| **Wood Melick** *Melica uniflora* | | | | | | | | | | |
| **Wood Millet** *Millium effusum* | | | | | | | | | | |
| **Wood-sage** | | | | | | | | | | |
| **Wood Sedge** *Carex sylvatica* | | | | | | | | | | |
| **Wood Sorrel** | | | | | | | | | | |
| **Wood Speedwell** | | | | | | | | | | |
| **Wood Spurge** | | | | | | | | | | |
| **Woodruff** | | | | | | | | | | |
| **Yellow Archangel** | | | | R | | | | | | |
| **Yellow Pimpernel** | | | | | | | | | | |

**NOTES**

**1 -** Gap < 20m counts as part of hedgerow

**2 -** Tree defined as stem diameter at least 20cm (1.3m high from ground) or two at least 15cm if multistemmed

**3 -** WOODY SPECIES
- Length <= 30m - count woody species
- Length 30 - 100m - use central 30m
- Length 100 - 200m - use a central 30m in each half - then divide by two
- Length > 200m - use a central 30m in each third - then divide by three

**4 -** WOODLAND SPECIES - From within one metre of outermost edges of hedge, in any direction

**DAFOR VALUES:**

| | |
|---|---|
| d | dominant |
| ld | locally dominant |
| a | abundant |
| la | locally abundant |
| f | frequent |
| lf | locally frequent |
| o | occasional |
| r | rare |

# HEDGEROW SURVEY DATA

| Date of Survey: June/July 2015 | Hedgerow Numbers | | | | | | | | | | | Hedgerow Numbers | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Qualifying as Important Hedgerow (red) OR Important if 1 extra feature found (yellow) | 7 | 8 | 8a | 9 | 10 | | | | | | Qualifying as Important Hedgerow (red) OR Important if 1 extra feature found (yellow) | 7 | 8 | 8a | 9 | 10 | | | | | |
| Feature / Species | | | | | | | | | | | Feature / Species | | | | | | | | | | |
| At least **30 years old** | Y | Y | Y | Y | Y | | | | | | **Woodland Species listed in Hedgerow Regulations criteria** (DAFOR scale) - See Note 4 | | | | | | | | | | |
| Adjacent to what type of land? (not garden) | | | | | | | | | | | **Barren Strawberry** | | | | | | | | | | |
| How **long?** At least **20m?** (Note 1) | Y | Y | Y | Y | Y | | | | | | **Bluebell** | | | | | | | | | | |
| OR < 20m? Meets other hedge BOTH ends | | | | | | | | | | | **Broad Buckler-fern** | | | | | | | | | | |
| **Hedgerow trees** If <= 50m then 1 tree | Y | Y | Y | Y | | | | | | | **Broad-leaved Helleborine** | | | | | | | | | | |
| Hedgerow trees If = 50-100m, 2 trees | | | | | | | | | | | **Bugle** | | | | | | | | | | |
| Hedgerow trees If > 100m, av. 1 in 50m | | | | Y | | | | | | | **Common Cow-wheat** | | | | | | | | | | |
| **Ditch** along at least half the length | | | | | | | | | | | **Common Dog-violet** | | | | | | | | | | |
| **Bank** along at least half of length | Y | Y | Y | Y | Y | | | | | | **Common Polypody** | | | | | | | | | | |
| **Wall** along at least half of length | | | | Y | Y | | | | | | **Dog's Mercury** | | | | | | | | | | |
| **Parallel hedge** within 15m of hedgerow | Y | Y | Y | Y | Y | | | | | | **Early Dog Violet** | | | | | | | | | | |
| **Adjacent public road**/track/bridleway/ftpath | Y | Y | Y | Y | Y | | | | | | **Early Purple-orchid** | | | | | | | | | | |
| **Connection** with (broadleaved) **Woodland** | Y | | | Y | | | | | | | **Enchanter's-nightsahde** | | | | | | | | | | |
| **Connection** with a **pond** | | | | | | | | | | | **Giant Fescue** | | | | | | | | | | |
| **Connection** to another **hedge** | Y | | | Y | Y | | | | | | **Greater Woodrush** | | | | | | | | | | |
| **Continuous** hedge or less than 10% **Gaps** | Y | Y | Y | Y | Y | | | | | | **Hairy Brome** | | | | | | | | | | |
| **Bluebell** present | | | | | | | | | | | **Hairy Woodrush** | | | | | | | | | | |
| **Badger** (S sett, F foraging, L latrine, R run) | | F | | | | | | | | | **Hard Fern** | | | | | | | | | | |
| Other **protected species** | | | | | | | | | | | **Hard Shield-fern** | | | | | | | | | | |
| Any **large old potential bat roost trees**? | | | | | | | | | | | **Heart's-tongue** | | | | | | | | | | |
| | | | | | | | | | | | **Heath Bedstraw** | | | | | | | | | | |
| | | | | | | | | | | | **Herb Paris** | | | | | | | | | | |
| **Woody Species listed in Hedgerow Regulations criteria** ( DAFOR scale) - See Note 3 | | | | | | | | | | | **Herb Robert** | | | | | | | | | | |
| **Alder** | | | | | | | | | | | **Lady Fern** | | | | | | | | | | |
| **Apple** | | | | | | | | | | | **Lords and Ladies** | | | | | | | | | | |
| **Ash** | R | O | | F | F | | | | | | **Male Fern** | | | | | | | | | | |
| **Aspen** | | | | | | | | | | | **Moschatel** | | | | | | | | | | |
| **Beech** | | | | | | | | | | | **Narrow Buckler-fern** | | | | | | | | | | |
| **Birch, Downy** | | | | | | | | | | | **Pignut** | | | | | | | | | | |
| **Birch, Silver** | | | R | | | | | | | | **Primrose** | | | | | | | | | | |
| **BLACK-POPLAR** | | | | | | | | | | | **Ramsons** | | | | | | | | | | |
| **Blackthorn** | D | O | D | O | R | | | | | | **Sanicle** | | | | | | | | | | |
| **Broom** | | | | | | | | | | | **Scaly Male-fern** | | | | | | | | | | |
| **Buckthorn** | | | | | | | | | | | **Soft Shield-fern** | | | | | | | | | | |
| **Cherry, Bird** | | | | | | | | | | | **Sweet Violet** | | | | | | | | | | |
| **Cherry, Wild** | | | | | | | | | | | **Toothwort** | | | | | | | | | | |
| **Dogwood** | | | | | | | | | | | **Tormentil** | | | | | | | | | | |
| **Elder** | | | | | | | | | | | **Wild Strawberry** | | | | | | | | | | |
| **elm spp.** | | | | | | | | | | | **Wood Anemone** | | | | | | | | | | |
| **Gooseberry** | | | | | | | | | | | **Wood Avens** | | | | | | | | | | |
| **Gorse, Common** | | | | | | | | | | | **Wood False-brome** *Brach.sylvaticum* | | | | | | | | | | |
| **Gorse, Western** | | | | | | | | | | | **Wood Horsetail** | | | | | | | | | | |
| **Guelder Rose** | | | | | | | | | | | **Wood Meadow-grass** *Poa nemoralis* | | | | | | | | | | |
| **Hawthorn** | | | | | O | | | | | | **Wood Melick** *Melica uniflora* | | | | | | | | | | |
| **Hazel** | O | O | | O | O | | | | | | **Wood Millet** *Millium effusum* | | | | | | | | | | |
| **Holly** | | | | | | | | | | | **Wood-sage** | | | | | | | | | | |
| **Hornbeam** | | | | | | | | | | | **Wood Sedge** *Carex sylvatica* | | | | | | | | | | |
| **LIME, LARGE-LEAVED** | | | | | | | | | | | **Wood Sorrel** | | | | | | | | | | |
| **LIME, SMALL-LEAVED** | | | | | | | | | | | **Wood Speedwell** | | | | | | | | | | |
| **Maple, Field** | | | | | | | | | | | **Wood Spurge** | | | | | | | | | | |
| **Mezerion** | | | | | | | | | | | **Woodruff** | | | | | | | | | | |
| **Oak, Pedunculate** | R | O | O | O | O | | | | | | **Yellow Archangel** | | | | | | | | | | |
| **Oak, Sessile** | | | | | | | | | | | **Yellow Pimpernel** | | | | | | | | | | |
| **Osier** | | | | | | | | | | | | | | | | | | | | | |
| **Poplar, (G Grey, W White)** | | | | | | | | | | | | | | | | | | | | | |
| **Privet, Wild** | | | | | | | | | | | | | | | | | | | | | |
| **rose spp.** | | | | | | | | | | | | | | | | | | | | | |
| **Rowan** | | | | | | | | | | | | | | | | | | | | | |
| **Sea-buckthorn** | | | | | | | | | | | | | | | | | | | | | |
| **SERVICE TREE, WILD** | | | | | | | | | | | | | | | | | | | | | |
| **Spindle** | | | | | | | | | | | | | | | | | | | | | |
| **Spurge-laurel** | | | | | | | | | | | | | | | | | | | | | |
| **Walnut** | | | | | | | | | | | | | | | | | | | | | |
| **Wayfaring-tree** | | | | | | | | | | | | | | | | | | | | | |
| **whitebeam spp.** | | | | | | | | | | | | | | | | | | | | | |
| **Willow, (C Crack, G Goat, W White)** | | R | | | | | | | | | | | | | | | | | | | |
| **Willow, Grey** | | | | | | | | | | | | | | | | | | | | | |
| **Yew** | | | | | | | | | | | | | | | | | | | | | |

**NOTES**

**1 -** Gap < 20m counts as part of hedgerow

**2 -** Tree defined as stem diameter at least 20cm (1.3m high from ground) or two at least 15cm if multistemmed

**3 -** WOODY SPECIES
- Length <= 30m - count woody species
- Length 30 - 100m - use central 30m
- Length 100 - 200m - use a central 30m in each half - then divide by two
- Length > 200m - use a central 30m in each third - then divide by three

**4 -** WOODLAND SPECIES - From within one metre of outermost edges of hedge, in any direction

**DAFOR VALUES:**

| | |
|---|---|
| d | dominant |
| ld | locally dominant |
| a | abundant |
| la | locally abundant |
| f | frequent |
| lf | locally frequent |
| o | occasional |
| r | rare |

# 9. PROTECTED and SIGNIFICANT FAUNA

(Rob Colley, Jacqueline Hartley, Barry Stewart & Richard Pryce)

## EUROPEAN PROTECTED SPECIES

### 9.1 Bats (Rob Colley)

#### 9.1.1 Bat survey objectives

Survey Zone 1 was examined in search of actual or potential bat roosts, in order to identify the possible requirement to procure a *European Protected Species Development Licence* (ref: *Habitat Regulations,* Appendix 1, paragraphs 3.4 – 3.7 and 4.5). Such a licence will be necessary to permit any *damage* or *disturbance* to a roost that might be occasioned by the landscape restoration project. This survey was extended to adjacent areas within Survey Zone 2 in order to identify any potential for incidental *disturbance.*

Bat activity surveys were undertaken within Survey Zones 1 and 2 and selected areas of the wider Garden estate in order to identify any landscape features which are used by bats or are have potential to be used by bats such as obligate flight lines, which the design team will need to consider when designing project working methods in order to comply with legislation and best practice[7].

Activity-survey data were examined in order to assess the foraging value to bats of different areas of the Garden estate.

#### 9.1.2 Bat survey methods

The various survey methods employed are as follows.

9.1.2.1 The site was searched during the daytime for potential bat-roost features in trees and built structures. Trees were examined from the ground in order to identify suitable features; built structures were directly examined for intra-masonry bat-access opportunities. All buildings at Waun Las and some at Pantwgan were also searched internally.

9.1.2.2 Over the dusk + one hour period during which emerging bats can be expected to leave their day roosts direct-observation surveys were made of four buildings, three bridges and four trees within, or close to Survey Zones 1 and 2. Survey visits are summarised at table 9.1.1, below.

[7] In compliance with the *Wildlife and Countryside Act* 1981 as amended, the *Natural Environment and Rural Communities Act* 2006 and UK and Local Biodiversity Action Plans.

## Table 9.1.1. Summary of roost emergence survey visits

*Abbreviations:*
*Ppip- Common pipistrelle; Ppyg- Soprano pipistrelle; u/d pip- unidentified pipistrelle; Pa- Long eared bat*

| ***Date*** | ***Site*** | ***Activity*** | ***Enviro. conditions*** | ***Results*** |
|---|---|---|---|---|
| 29/10/14 | Waun Las | farmhouse & outbuildings, internal/external | | |
| 27/05/15 | Pantwgan barn | emergence watch | 2050-2130<br>start temp: 13°C<br>100% cloud<br>fc3 sw | 2 u/d pip from top-of-range house-like building roof ridge |
| 10/06/15 | Waun Las | emergence watch | 2115-2230<br>start temp: 14°C<br>no cloud<br>no wind | x3 Ppyg, x1 u/d pip from house |
| 09/07/15 | Waun Las | emergence watch | 2120-2230<br>start temp: 13.5°C<br>10% cloud<br>no wind | x3 Ppyg, x2 Pa from house |
| | Stable block | emergence watch | | x209 Ppyg |
| | Llyn Canol outflow masonry | emergence watch | | No bats observed |
| 13/07/15 | Llyn Canol outflow masonry | emergence watch | 2120-2230<br>start temp: 16°C<br>100% cloud<br>no wind | No bats observed |
| | Llyn Uchaf outflow masonry | emergence watch | | No bats observed |
| 22/07/15 | Llyn Canol outflow masonry | emergence watch | 2120-2220<br>start temp: 13°C<br>5% cloud<br>no wind | No bats observed |
| 28/07/17 | Felin-gât bridge | emergence watch | 2110-2215<br>start temp: 14°C<br>100% cloud<br>no wind | No bats observed |
| 04/08/15 | Gwynon bridge | emergence watch | 2030-2115<br>start temp: 15°C<br>80% cloud<br>fc3 sw | No bats observed |
| 19/09/15 | Waun Las | emergence watch | 1920-2035<br>start temp: 13°C<br>5% cloud<br>no wind | x2 Ppyg, x5 u/d pip, x3 Pa |
| 23/09/15 | ash north lakeside | emergence watch | 1910-2010<br>start temp: 14°C<br>40% cloud<br>fc2 w | No bats observed |
| 01/10/15 | Stable block | emergence watch | 1845-1930<br>start temp: 12°C<br>no cloud<br>no wind | x48 Ppyg |
| 06/10/15 | x2 trees east lakeside | emergence watch | 1845-1930<br>start temp: 16°C<br>100% cloud<br>no wind | No bats observed |
| 12/10/15 | East Lodge | emergence watch | 1830-1930<br>start temp: 12°C<br>no cloud<br>fc2 ne | x2 Ppyg |

9.1.2.3 Night-time direct-observation transect surveys were made on nine dates within Survey Zones 1 and 2, generally following emergence-watches. Observers walked slowly along transects for c.60 minutes, with one-minute stationary-detection periods every five minutes.

Heterodyne, frequency-division and full-spectrum electronic detectors were used to aid bat detection and species identification during the emergence watches and transect surveys.

In order to sample overnight bat activity and in search of other species, frequency-division detector/recorder systems (AnabatExpress) were placed at seven locations within Survey Zone 1 as shown on Figure 9.1.1. for seven nights in late July and eight nights in late September. The same locations were used for both surveys. These units record all bat activity that is detected, dusk to dawn, over the whole period of each survey. Data were subsequently analysed in the lab.

Night-time field surveys were conducted on fourteen dates as follows:
27th May 2015,
10th June 2015,
9th July 2015, 13th July 2015, 22nd July 2015, 23rd July 2015, 28th July 2015,
4th August 2015,
19th September 2015, 23rd September 2015, 26th September 2015,
1st October 2015, 6th October 2015 and 12th October 2015.

9.1.2.4 Surveys were conducted by
Rob Colley: scientific/conservation bat licence 1999-, 62118:OTH:CSAB:2015;
Rob Taylor: scientific/conservation licence, 1995-.
John Galvin, GBG, 1989-;
Len Moran: named agent, 62118:OTH:CSAB:2015;
Jenny Colley, Glamorgan Bat Group, 2002-;

In addition to the data consultations listed at 2.1.1 (above), Steve Lucas, Bat Conservation Trust Wales, provided informal, historic, survey data from the Carmarthen Bat Group's visits to the Garden estate. Also some personal-data from the wider general area are referenced below.

### 9.1.3 Bat survey results: transect and direct observation data

Transect and direct observation data are summarized below and at Figure 9.1.1.

9.1.3.1 Overnight detector-recordings

In search of other species and to give an indication of differential site use by foraging bats, detector-recorder systems were placed for two periods at seven locations within Survey Zone 1 as shown on figure 9.1.1. The dates covered were 28th July 2015 to 4th August 2015 and 23rd September 2015 to 1st October 2015 and the locations as follows.

1 Ride through mature woodland on left bank of Gwynon valley
2 Clearing made during recent Cherry laurel control in scrub woodland with isolated mature trees on left bank of lake-outflow stream
3 Boundary of woodland and semi-improved grassland field at junction of east-west field boundary hedgeline
4 Under spreading mature oak at interface between woodland and unimproved field at west edge of Survey Zone 1

5 Open-floor woodland on left bank of incised Gwynon valley close to bridge;
6 Ride between hazel coppice and mature trees on lakeside
7 Boundary of woodland and semi-improved grassland field on eastern edge of Survey Zone 1 at junction of east-west field boundary hedgelines.

Field data were subsequently analysed and tabulated as "bat-positive" minutes recorded throughout each night.
*Raw data files can be made available for examination if required.*

With the exception of two single-pass Greater horseshoe bat detections, no species other than those encountered during the direct-observation surveys were detected.
Call sequences were almost entirely consistent with single animal foraging behaviour: there were no long, protracted or confused files which might indicate multi-animal activity.
Over the two recording periods, bat activity was detected and recorded during c.11% of the >52,680 minutes sunset – sunrise time that the Anabat units were "listening": 15% of summer minutes and 9% of autumn minutes were of detected bat calls. From comparison with other long-term monitored sites, this level of use is subjectively described as "low". There were no near-dusk or near-dawn data peaks which might indicate daytime roosting within Survey Zones 1 and 2.

During both summer and autumn, *Myotis* activity at the north of the site was largely during the first quarter of the night with all-night activity detected on only two summer nights (1-2 August at location 5 and 2-3 August at locations 1 and 6) and two autumn nights (28-29 September and 29-30 September a location 5). No activity-pattern was evident from the pipistrelle data collected.

NB In the absence of in-hand examination the identification of *Myotis* bats to species level is problematic. Referring to the analyses tabulated below, a conservative approach to sonogram interpretation is taken. Natterer's bat *Myotis nattereri* is definitively identified where data are unequivocal (consistently prolonged upper frequencies >100kHz). The majority of other call sequences at the northern/woodland locations 1, 2 and 5 are thought also to be this species, with *Myotis mystacinus, M. brandti* and *M. alcathoe* accounting for all others. Summer recordings at location 6 are believed to be *M. daubentonii*.

All-species bat-activity during both summer and autumn recording periods was concentrated at the longest established woodland in the north of the survey area along the Gwynon valley from Pantwgan to Pont Felin-gat. This was more pronounced during the autumn, with detectors at locations 1, 2 and 5 recording 83% of all-species bat activity, and 96% of all *Myotis* activity. Summer data were a little more evenly distributed. Field-edge locations (3 and 4) consistently recorded little bat activity on any date.

**Table 9.1.2**
**Number of positive activity minutes at July-August overnight Anabat locations**

| | ***Ppip*** | ***Ppyg*** | ***My*** | ***Mn*** | ***Nn*** | ***other*** | **total +ve minutes** |
|---|---|---|---|---|---|---|---|
| | # mins | # mins | # mins | # mins | # mins | # mins | |
| loc1 | 2 | 477 | 108 | 18 | 16 | 0 | **621** |
| loc2 | 14 | 480 | 62 | 12 | 3 | 0 | **571** |
| loc3 | 0 | 2 | 6 | 0 | 0 | 0 | **8** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| loc4 | 2 | 32 | 12 | 4 | 3 | 0 | **53** |
| loc5 | 12 | 214 | 132 | 5 | 13 | 1* | **377** |
| loc6 | 3 | 416 | 103 | 1 | 27 | 0 | **550** |
| loc7 | 27 | 418 | 42 | 14 | 17 | 3** | **521** |
| **total minutes per sp.** | **60** | **2039** | **465** | **54** | **79** | **4** | ***2701*** |

* Greater horseshoe bat, 23:42, 1st August
** Greater horseshoe bat, 03:36, 3rd August; Barbastelle bat, 03:50 & 21:59, 3rd August
Number of detection minutes at each location = c2,485 giving a total of c.17,400 minutes
*Ppip* Common pipistrelle; *Ppyg* Soprano pipistrelle; *My* Myotis species; *Mn* Natterer's bat; *Nn* Noctule; *Pa* Long eared bat*; other* other species.

**Table 9.1.3**
**Number of positive activity minutes at September overnight Anabat locations**

| | ***Ppip*** | ***Ppyg*** | ***My*** | ***Mn*** | ***Nn*** | ***Pa*** | **total +ve minutes** |
|---|---|---|---|---|---|---|---|
| | # mins | # mins | # mins | # mins | # mins | # mins | |
| loc1 | 0 | 275 | 144 | 61 | 8 | 0 | **488** |
| loc2 | 0 | 423 | 929 | 96 | 12 | 1 | **1461** |
| loc3 | 0 | 0 | 4 | 0 | 0 | 0 | **4** |
| loc4 | 3 | 8 | 8 | 0 | 0 | 0 | **19** |
| loc5 | 4 | 361 | 339 | 15 | 0 | 0 | **719** |
| loc6 | 1 | 111 | 39 | 0 | 13 | 0 | **164** |
| loc7 | 8 | 303 | 10 | 3 | 5 | 0 | **329** |
| **total minutes per sp.** | **16** | **1481** | **1473** | **175** | **38** | **1** | ***3184*** |

Number of detection minutes at each location = c5,040 giving a total of c.35,280 minutes
*Ppip* Common pipistrelle; *Ppyg* Soprano pipistrelle; *My* Myotis species; *Mn* Natterer's bat; *Nn* Noctule; *Pa* Long eared bat.

9.1.3.2 Summary of species recorded during the transect and direct observation survey

Roost emergence watch observations are summarized at Table 9.1.1.

Soprano pipistrelle *Pipistrellus pygmaeus*

The most widespread and abundant species recorded at the site with a long-established maternity colony roost in the Stable Block building, Middleton Hall. An early July emergence watch at this roost counted 209 animals leaving the roost, and 48 were still present at an early October emergence watch.

Early-season single-animal day roosting was seen at Waun Las farmhouse with two bats on the 27th May and three bats on 9th July. These were presumed to be males or non-breeding individuals.

Late-season single-animal day roosting was also seen at Waun Las farmhouse with eight or nine bats emerging on 19th September. These were presumed to be bats dispersed from the maternity colony.

Late season single-animal dispersal roosting was also recorded n early October at North East Lodge located just off site on the roadside to the west of Pont Felin-gât.

Following emergence from their roosts, animals appear to disperse quickly. Soprano pipistrelles were encountered at most "edge habitat" during all transect surveys. Whilst most regularly found at the lower Gwynon and over the lakes, individual foraging animals were typically well-spaced and there was no evidence of foraging hot-spots.

Common pipistrelle *Pipistrellus pipistrellus*
Individuals of this species were encountered during most survey visits but large numbers, which might indicate local maternity-colony roosting, were not seen. Encounters were at edge habitats particularly at or around the buildings and access roads to the west of Survey Zones 1 and 2. Overnight detections/recordings within Zone 1 were minimal, just 60 *P. pipistrellus detections* compared with 2039 *P. pygmaeus* during the summer session and 16 *P. pipistrellus detections* compared with cf.1481 *P. pygmaeus* during the autumn session.

A very early evening animal seen during the autumn emergence watch at the Stable Block, was thought likely to have emerged from the centre/west side of the building but this was not confirmed. An unidentified pipistrelle (insufficient data to differentiate *pipistrellus-pygmaeus*) that emerged from the west end of Waun Las farmhouse in July was thought to be *P. pipistrellus*.

*Myotis* bats
Differentiation of this group of species using audio detection alone is problematic and a conservative approach to species identification is taken. This is particularly the case for the analyses of call data used for the species summaries below.

Definitive species identifications are given where observers were confident of direct-observation heterodyne-detection and observed behaviour and where sonogram data unequivocally indicate Natterer's bat.

During the walked survey-transects observers encountered individual *Myotis* bats in all areas but with a clear and obvious concentration in the Gwynon valley woodland in the north of the site. 96% of *Myotis* overnight detections/recordings within Survey Zone 1 were observed at the three locations in the north of the site.

Natterer's bat *Myotis nattereri* During the direct-observation surveys, individual animals were detected

i) once at the lake outfall and at three points on the west edge of the Zone 1 woodland, and
ii) detected on all transects through the Gwynon valley.

The autumn overnight data show that 12% of *Myotis* recordings can be confidently identified as *M. nattereri* on the basis of call characteristics: this is almost certainly an underestimate of relative abundance of the species.

The timings of first-detections vary from 30-40 minutes to three hours after the "expected" emergence time suggesting that animals were taking time to travel to the site. On most dates, the easternmost of the Gwynon detectors recorded animals first, perhaps suggesting that the day roost is located to the east.

Whiskered bat *M. mystacinus* [8] During the direct-observation surveys, individual animals were encountered as follows.

i) on two dates at the lake outfall,
ii) on two dates at the Zone 1 western woodland-field edges,
iii) once at the eastern woodland-field boundary,
iv) once over the western "orchid field" and
v) on two dates at the lake outflow.

Many of the autumn overnight data are thought to be this species.

Daubenton's bat *M. daubentonii* During the direct-observation surveys, individual animals were encountered as follows.

i) in early July, two animals were seen foraging at the north end of the main lake.
ii) in mid-July, three animals were seen at the lake adjacent to the aqualab building,
iii) in early August and early October, individuals were seen/heard at the Gwynon valley/Pont Felin-gât.

The lake feeding bats were concentrated in areas free of surface/floating vegetation. This species was not subsequently refound at the lakes during spot-checks following each mid-August transect survey visit, when it was noted that all the lake surfaces were almost completely covered by floating vegetation leaving no clear areas free for bats to feed. The summer-autumn 4%-0·7% fall in *Myotis* positive-minute detections at the overnight detector-recorder location 6 (close to the Llyn Canol outflow), is similarly thought to suggest the "abandonment" of the lake as a feeding resource.

The failure to locate roosting at "likely" trees/structures during all survey visits and of attempts to identify travel-to-site movements, the erratic presence of only a few animals at the lakes, and the detections of individuals in the Gwynon valley in the north of the site suggest the possibility that this species is day-roosting off-site to the north.

Long eared bat *Plecotus* sp. (presumed to be Brown long eared *P. auritus*) During the direct-observation surveys, animals were encountered as follows.

i) Waun Las farmhouse was used by late summer and autumn roosting bats (see paragraph 9.1.5, below).
ii) in early-October a single animal was day roosting in the Ice House.
ii) in early-October two animals were day roosting in the bee viewing gallery at the western corner of the walled garden..

None of these sites was found to be hosting maternity colonies. It is possible that such a roost may be located in buildings to the west which remain unexamined as they fall outside the survey site. It should be noted that there is a large (30+ animals) maternity colony located at Lanfawr farmhouse, some 1·75km to the south.

Long eared bat was encountered only once during the walked transects and recorded only once on the autumn overnight recordings. This species is difficult to audio-detect and this lack of encounters almost certainly does not truly indicate the extent of site-use by this species. It can be assumed that the species is active across all of the site.

[8] No attempt to differentiate *Myotis mystacinus-brandti-alcathoe* is made without in-hand examination; Whiskered bat is used here to indicate this species group.

Noctule *Nyctalus noctula*
Surprisingly few Noctules were encountered. Overflying individuals were noted on several dates but overnight-recordings were few, discrete and of short duration, indicating passage over the site.

Barbastelle *Barbastella barbastellus*
A single detection during a walked transect on 22nd July at the western woodland – field-edge of Survey Zone 1 was thought to be this species. Two single-pass detections by overnight recorders at location 7 on the 3rd August at 03:50 and at 21:59 on the following evening were also thought to be this species but the brevity of the recordings reduces confidence.
This species has an exceptionally large foraging range and occasional passage through the site is quite possible. However, the absence of further direct-observation or overnight data detections indicate that the use being made of the site by this species is of little significance.

Greater horseshoe bat *Rhinolophus ferrumequinum*
Overnight recorder single-pass detections were made at location 5 (23:42, 1st August 2015) and location 7 (03:36, 3rd August 2015) indicate through-site travel. Individuals of this species range widely, with South Pembrokeshire animals tracked to the upper Cothi valley and Black Mountain winter-roost sites (pers.data). There are no opportunities for this species to roost in NBGW Survey Zones 1 or 2. In the absence of further direct-observation or overnight data, no more significant site-use by this species is suspected.

9.1.4 **Bat Survey Results: Potential tree roost sites**
Trees in Survey Zone 1 with potential to harbour roosting bats were examined from the ground with the aid of x8 binoculars and a 15-60 x 80 telescope, if required, in search of features including cracks, crevices, splits, deadwood, hollows, woodpecker holes and ivy plates which might be used by day-roosting bats. Trees with such features were subjectively/ adjectivally assigned to a category of "likelihood" of use, based upon the "scoring system" detailed at Table 9.1.4. Particular attention was directed towards trees located in areas of Survey Zone 1 where earthworks associated with the restoration of the lakes is likely to take place. Initial survey was carried out in June when trees were in full leaf which could impair the ability to visually detect potential roost features. Further survey was therefore undertaken from December 2015 to March 2016 after leaf fall had finished and when observations were more reliable.

**Table 9.1.4**
**Criteria to assess trees with potential to harbour bat-roosts**

| Tree assessment category | Felling/disturbance requirements |
|---|---|
| **1. Known or confirmed roost** | EPS Licence required |
| **2. High potential**<br>Tree has multiple features suitable for multi-animal roost-use | Pre works requirement for<br>Off ladder/rope direct examination<br>*and/or*<br>Dusk/dawn direct observation roost emergence/entry survey |
| **3. Moderate**<br>Fewer/less suitable features, *and/or* | Pre-works requirement for<br>Dusk/dawn direct observation bat |

| | |
|---|---|
| potential for individual roosting | activity survey |
| **4. Low**<br>No features visible from ground but size, age or obscuring ivy might conceal roost potential | During works requirement to<br>Stop work and seek advice if potential roost features found |
| **5. None**<br>No potential to host roosting bats | None |

Working to the boundaries delineated on old OS maps, no bat-roost potential was identified at trees within the perimeters of either the drained Llyn Mawr or the now-wooded Llyn Felin-gat. Trees colonising the site of Llyn Mawr are dominated by Grey Willow, are not more than about fifteen years old and have not developed any suitable roost features. The woodland colonising the Llyn Felin-gat is older but is also dominated by willow with Common Alder and Ash and, whilst having greater roost potential, none was found. If Llyn Gwynon is to be reinstated, similar additional survey of the old Alders which occupy the lake bed will also be required here.

Mature beech trees located along the crest of the dam at the northern end of the former lake, to the east of the breach, and trees on hill slopes above the footpaths extending south-west and east-southeast from Pont Felin-gat are sufficiently large to have developed roost potential but no appropriate features were identified from the ground. Furthermore, early evening transect-surveys targetting these areas, found no bat activity or movement to indicate that any trees were being used for roosting.

Four large, mature trees on the banks of the existing lakes have dead/broken/hollow timber judged to give a **high bat-roost potential**. Their locations are shown on Figure 9.1.1

i) One oak at the centre of the north-west bank of Llyn Canol,
ii) One ash near the north-east corner of Llyn Uchaf
iii) One ash and one oak at the eastern end of Llyn Uchaf.

In addition to their physical features, these trees were thought to be sufficiently close to the lakes for them to have potential for use by roosting Daubenton's bats. Each was watched at roost-emergence time on one date but no bat use was detected.

9.1.5 **Bat Survey Results: Potential roost sites in buildings and structures**

Several water-side masonry structures were identified as likely roost sites (particularly, for Daubenton's bat), although no potential roost opportunities (cracks, breaks, crevices) were found during daytime examinations of these structures.

Emergence watch surveys were made at

i) the bridge over the Afon Gwynon between Pont Felin-gat and Pantwgan farm,
ii) at the Pont Felin-gat bridge,
iii) at the outflow sluice at the north-east end of Llyn Canol (on two dates), and
iv) at the masonry sluice/spillway between Llyn Uchaf and Llyn Canol:

No bat emergence was detected at any of these locations.

The search was extended in an attempt to locate any faecal evidence of roosting Daubenton's bats. This comprised of the external examination of the exteriors of the Aqualab buildings on two dates. No evidence was found and no flight activity suggesting

such use was seen when four observers, spaced along the lake banks during the period covering from before dusk to dusk + one hour, sought to determine Daubenton's bat movement to and/or around the lakes.

The potential for winter/hibernation use of masonry features at newly exposed walls/culverts in the Pont Felin-gat area and along the Nant Gwynon and lake outflow stream was investigated by daytime, direct search in early December. No hibernating or torpid bats were found and neither were any potential winter-roost opportunities discovered.

In search of wider-area bat-use an external examination was made, on one date, of the exteriors of the buildings to the north and west of the Stable block, in search of faecal evidence of bat use. With the exception of the corner of the Stable block in which the pipistrelle roost is located, no such evidence was found.

In September, near-dusk spot-checks of other buildings to the west, found a single Long eared bat flying in the Ice House and two Long eared bats flying in the bee viewing gallery at the western end of the walled garden. These latter retreated into a roof cavity above a timber plate below the apex junction of converging rafters. Day-roosting at both of these locations was suspected but no faecal evidence that would indicate long-term use was seen.

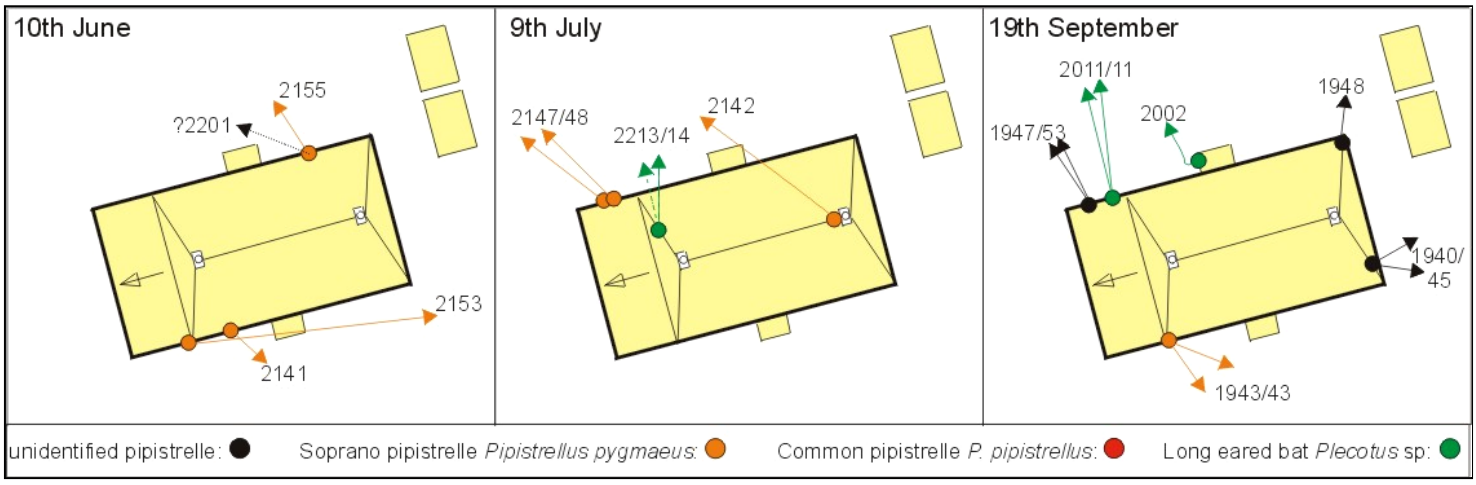
An emergence watch survey was focused on a barn on the north side of Pantwgan Farm to inform a Glastir application. No bat use of the barn was found but an incidental observation was made of two pipistrelles emerging from a roof at the south end of the range of buildings.

Long eared bats were proven to be roosting in the Waun Las farmhouse from faecal evidence recorded during an examination of the attics of the farm buildings in autumn 2014.

To determine the nature and extent of bat use, emergence-watches were made in June, July and September 2015.

The results of these surveys are as follows.

**Figure 9.1.2: Roost Emergence observations at Waun Las**



i) Pipistrelle bats were day-roosting on the date of each survey at the house walltops and at a west-end lean-to roof.
   - o In June, three Soprano pipistrelles, one Common pipistrelle and one unidentified pipistrelle were recorded.
   - o In July, three Soprano pipistrelles and one unidentified pipistrelle were recorded.
   - o In September, five Soprano pipistrelles, two Common pipistrelles and one unidentified pipistrelle were recorded.

   The early season bats are assumed to be males/non-breeders and the higher number in autumn is assumed to include animals dispersed from a maternity colony.

ii) Long eared bat use was not detected during the in-attic search in November 2014 but the small quantity of in-attic faeces indicated recent use by this species.
   - o No Long eared bats were seen or heard during the June 2015 emergence watch.
   - o During the July watch, one bat emerged from the east gable roof edge and briefly foraged in the garden on the north-side of the building.
   - o During the September watch, two bats emerged from an open door on the ground floor and a broken window..

9.1.6 **Bat Survey Results: fight lines and travel routes**

No roosting horseshoe bats (*Rhinolophus* spp.), which require linear landscape features as habitual travel lines, were found within the site and none have been recorded at the site in the past, therefore, no obligate-use flight line travel routes have been identified.

Long eared bats are shown by the survey to occur across the wider site and through-site movement is likely to be along hedgelines and treelines: this species is rarely encountered away from sheltering vegetation. As no multi-animal roosting within, or near to the site was identified during the survey, no assessment of the possible relative value of hedgerows within the wider site is possible but hedgeline and treeline habitat connectivity throughout the site should be addressed by the landscape restoration design team to ensure that potential flight lines remain intact and unbroken and, where appropriate, new connections made.

The observation of two Soprano pipistrelles travelling west-east, uphill, along the east-west aligned hedge/tree-line north of Waun Las (shown on figure 9.1.1) and the relatively large number of autumn overnight recordings of this species at a parallel hedgeline, across the field to the north, indicate pipistrelle travel use of these features. However, this species happily crosses and forages over open ground and its presence here is taken as typical generalist/opportunist en-route foraging behaviour rather than obligate-use flight line travel.

9.1.7 **Potential impact of the proposed landscape restoration works on bats**

It is proposed to demolish the Waun Las farm buildings which will result in the loss of roosts of two and possibly three bat species.

No other bat-roosts were identified during the survey that will be impacted by the project works.

No tree roosts have been identified within Survey Zones 1 and 2, including within the footprints of the lakes to be reinstated. Neither have any tree roosts been identified within the surrounding woodland but further examination will be required to identify any trees with roost-potential located close to proposed working areas. The identification of roosts in these

areas will ensure that any site works can be designed so as to prevent or, at least, minimize impact (eg deciding the lines of access routes).

Bat foraging activity, including the woodland-dwelling *Myotis* bats, is concentrated towards the north of the site within mature woodlands that will not be directly impacted by the restoration of Llyn Mawr but could be affected by the re-excavation of Llyn Felin-gat located south of Pont Felin-gat. However, the surveys have shown that the scrub woodland developing over the bed of Llyn Felin-gat is currently a comparatively unproductive foraging area.

Small numbers of Daubenton's bat were recorded as occasional foragers at and over the existing lakes and the Afon Gwynon. The creation of additional open-water habitat can be expected to increase foraging opportunity for this species.

Bat activity over the wider site is dominated by generalist/opportunist pipistrelles. These bats are essentially "edge habitat" foragers. The re-creation of Llyn Mawr and the Llyn Felin-gat will increase woodland edge habitat and result in additional over-water feeding potential.

No obligate flight-line following species were recorded at the site during the surveys.

### 9.1.8 **Identified constraints resulting from the presence of bats**

9.1.8.1 Waun Las

Waun Las farmhouse is an active "bat roost" within the meaning of relevant legislation: demolition or removal works or work which disturbs the structure and results in the removal or disturbance of the bat roosts in the building will be subject to the procurement of a *European Protected Species development licence* from Natural Resources Wales (NRW).

The granting of a licence will be conditional upon

i) agreed mitigation to ensure the provision of alternative like-for-like, or enhanced roost potential at or near the site, and

ii) an agreed works methodology designed to minimise any impact on the bats.

If planning consent is required, the Local Planning Authority will need to know, at application stage, what methodology/mitigation is being proposed. The applicant will need to propose an appropriate methodology and mitigation strategy that will have been agreed with NRW species protection staff, which will need to be attached to the planning application.

Although the building is not used by a maternity colony, two and possibly three, species of bat day roost there. Pipistrelle bats require "crevice" roost features. Long eared bats favour roost-sites which offer an in-roost flight-space such as an accessible attic. In order to provide these different roost environments compensatory roost opportunity would best be achieved by building a "bat house".

Such a building

i) should be located close to the existing roost;

ii) it should be within the Long eared bats' favoured woodland habitat, and

iii) it should have hedgerow "connectivity" to the wider area.

The compensatory roost facility should be in-place, alongside the existing farmhouse, in time for the spring-summer-autumn season in the year prior to the planned demolition of the existing buildings.

General considerations when procuring a disturbance licence

The licence application will need to specify a detailed mitigation methodology, with precise timings, dates and construction methods to be employed. A definitive final plan will be required which will be strictly adhered to.

All the survey work that is necessary to make application for an EPS Licence is completed and an appropriate Waun Las survey report, to inform a Licence application, will be produced when a decision is made about the future of the buildings.

Four options for a mitigation strategy are included below pending the decision as to the future use or removal of the farmstead buildings.

If either Options 1 or 2 as described below are implemented, it is recommended that the site ecologists meet NRW protected species staff on-site, in order to agree the proposed mitigation programme.

To facilitate the granting of a licence by NRW to remove the Waun Las buildings, the following programme is considered to be appropriate and achievable:

i) Spring 2016: project manager to agree with site ecologist the siting and design of a compensatory roost facility
ii) Spring/summer 2016: informal on-site consultation with NRW Species Protection Officer to discuss and agree the strategy leading to NBGW applying to NRW for the licence
iii) Autumn/winter 2016-17: construction of new roost facility
iv) Autumn/early winter 2017: demolition of Waun Las buildings closely supervised by the site ecologist acting within the terms of the licence.

The adoption of such a facility by a Long eared bat *multi-animal/maternity* colony is a likely incidental "conservation gain" for the restoration project.

At the time of writing it is likely that option 1 will be the course of action to be adopted and the recommendations at section 11.11.2 are based upon this assumption.

Option 1: Removal of Waun Las farmhouse and all associated outbuildings

In order to provide compensatory roost opportunity, an appropriately designed "new build" bat-house will be required at, or close to, the Waun Las site. Such a building will need to have hedgerow connectivity to the Long eared bats' favoured woodland habitat.

It is *recommended*, and is likely to be an NRW requirement, that such a compensatory roost facility is in-place and available to bats for a spring-summer-autumn season before any disturbance to the Waun Las farmhouse takes place.

The adoption of such a facility by a Long eared bat multi-animal/maternity colony is a likely incidental "conservation gain" for the restoration project.

To facilitate the granting of a licence by NRW to remove the Waun Las buildings, the following programme is considered to be appropriate and achievable:

i) Spring 2016: project manager to agree with site ecologist the siting and design of a compensatory roost facility
ii) Spring/summer 2016: informal on-site consultation with NRW Species Protection Officer to discuss and agree the strategy leading to NBGW applying to NRW for the licence

iii) Autumn/winter 2016-17: construction of new roost facility

iv) Autumn/early winter 2017: demolition of Waun Las buildings closely supervised by the site ecologist acting within the terms of the licence.

The adoption of such a facility by a Long eared bat *multi-animal/maternity* colony is a likely incidental "conservation gain" for the restoration project.

Option 2: Removal of Waun Las farmhouse but retention of associated outbuildings
This option will also require a NRW Licence.

It will also need to provide alternative, compensatory roost opportunity which would most readily be achieved by converting one of the taller barns to provide appropriate features. Such conversion would need to be completed before the demolition of the farmhouse following a similar the timeline as proposed at option 1.

Option 3: Conversion of Waun Las farmhouse to a different use
The conversion must ensure that bat access to the attic and walltops/roof is retained.

If planning consent from the Local Planning Authority is required to carry out the works and if the works are to be undertaken in spring-summer-autumn, a NRW licence will be required.

If planning consent is not required, depending on the nature and extent of the work, it might be possible to proceed without a licence provided the work is restricted to winter only and is carried out strictly following a method statement designed by the licenced bat ecologist. If works cannot be limited to winter months, they can only proceed following the issue of a NRW licence. Even if a licence is not sought, it would be prudent to consult with NRW.

Option 4: Retain Waun Las farmhouse and all outbuildings in their present state
No action to mitigate for bat presence required..

9.1.8.2 Other roosts

No other bat roosts have been found during the surveys but all potential roost features (including mature trees) will be further examined prior to any planned disturbance. Examinations will be undertaken following the identification of the areas which will be disturbed by site operations and, in particular, will include all old or large trees which may have potential to harbour roosting bats and which are located within these areas. The examination of these trees might only be achieved by climbing off-ropes, use of endoscopes, etc.

If it is necessary to disturb or remove any bat roosts identified during these planned examinations, their disturbance will also be subject to NRW licencing. This necessity may also apply to any potential roosts in trees which are to be retained along the edges of operational areas although it is anticipated that most of these trees will be protected by *Root Protection Areas* constructed and maintained to BS5837:2005 – *Trees in Relation to Construction* which should also substantially protect their branches and crowns from damage or disturbance and in turn protect any potential bat roost sites.

9.1.9 **Habitat connectivity**

The retention and maintenance of hedgeline and treeline habitat connectivity throughout the site should be addressed by the landscape restoration design team to ensure that potential flight lines remain intact and unbroken and, where appropriate, new connections made.

9.1.10 **Flood-lighting**

Both pipistrelle species are known to be very tolerant of artificial lighting and will actively visit illuminated areas to exploit insect prey attracted by light. Other species are less tolerant of or deterred by such lighting. Installation of temporary flood lighting during site operations or any form of permanent outside lighting should avoid direct illumination of potential roost entrances and be directed away from habitat having bat foraging or flight-line potential.

## 9.2 **Dormouse** (Jacqueline Hartley)

9.2.1 Previous surveys within the wider National Botanic Garden of Wales estate have recorded dormice around the northern, eastern and western peripheries of the site. However, although signs of dormouse presences have only been infrequently recorded, habitat that could have potential to support the species is also present within the site. Patches of scrub, woodland and hedgerows are located throughout Survey Zones 1 and 2, the majority of which connect together as well as being connected to the peripheral areas of the site, its vicinity and the wider countryside, where dormice are known to be present.

### 9.2.2 **Dormouse protection**

The Common or Hazel Dormouse is a *European Protected Species* protected under the *Habitats Regulations*. and is also protected by its inclusion on schedule 5 of the *Wildlife and Countryside Act 1981*. It is an offence to kill or disturb a Dormouse or to damage or destroy its nest site. It is also an offence to detrimentally effect the species' local distribution or abundance.

Dormouse is also a *Species of Principal Importance for Conservation of Biological Diversity* in Wales under section 42 of the Natural Environment and Rural Communities Act 2006 and also a *UK Biodiversity Action Plan Priority Species*.

### 9.2.3 **Dormouse Survey Methods**

9.2.3.1 Habitat Assessment

An assessment of the suitability of the habitats to support Dormice within Survey Zones 1 and 2 was undertaken through June and July 2015. The work included

- an assessment of the density of habitat,
- the range of available food sources,
- the availability of potential summer nest and hibernation nest sites, and
- an assessment of habitat connectivity with nearby suitable Dormouse habitat within the site and into the wider landscape.

The habitats suitable for dormice were then categorized into:

- Optimal Dormouse habitat - habitat that provides a range of food sources, summer nesting and hibernation sites which are thus able to support Dormice all year round,
- Suboptimal habitat - habitat that provides most but not all Dormouse requirements, and
- Poor habitat – habitat that provides one or two Dormouse requirements or Optimal or Suboptimal habitat that is not directly connected to other suitable habitat.

9.2.3.2 Dormouse Tube Survey

In early May 2015, two hundred Dormouse survey tubes were deployed in and through the woodland, scrub and hedgerows within Survey Zones 1 and 2. Figure 9.2 indicates the locations of the tubes. The tubes were checked for dormice or signs of dormice use once a month from May to November 2015.

9.2.3.3 Nut Search

A search for hazel nuts opened by Dormice was undertaken through November and December 2015. The searches were limited to where hazel bushes are located and had fruited sufficiently. The locations of these is indicated by black stars on figure 9.2. The area

of ground under and around each fruiting hazel bush was searched for at least twenty minutes or until no further nuts could be found.

### 9.2.4 Dormouse Survey Results

#### 9.2.4.1 Habitat assessment

The survey results indicate that the majority of the woodland, scrub and hedgerows throughout Survey Zones 1 and 2 provide either optimal or sub-optimal habitat for Dormice.

Table 9.2 lists the features of each woodland compartment that are favoured by Dormice.

Compartment numbers are those used by Matt Ridley in the NBGW Woodland Management Plan (Ridley, 2011).

**Table 9.2 Dormouse Habitat Assessment**

Key to cell colours in the table

| | |
|---|---|
| Pink cells | Dormouse confirmed to be present in these compartments during the 1997 survey |
| Yellow cells | Dormouse confirmed to be present in these compartments during the 2015 survey |

| Woodland compartment | Required Dormouse features present in woodland | Dormouse Habitat Assessment |
|---|---|---|
| 1a/1b Coed Pantwgan | Lowland mixed broad leaved woodland<br>Mixed age-range and species<br>Oak and Hazel present of particular value.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape south and east. | Optimal<br>Dormouse presence confirmed during 1997 survey. |
| 3c and scrub extending north.<br><br>Woodland south of Llyn Canol extending north along its eastern side | Lowland mixed broad leaved woodland<br>Mix of age range<br>Oak present of particular value.<br>Scrub extending north is mostly willow scrub of limited species diversity.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood and hedge banks providing potential hibernation sites.<br>Connected to the wider landscape north, east, south and west. | Sub-optimal |
| 5a/5b Coed Gwanwyn | Wet broad leaved woodland<br>Mixed age range and species<br>Oak present of particular value.<br>Compartment 5b has a greater amount of Alder and is less diverse.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape north, south and west. | Optimal |

| | | |
|---|---|---|
| 6a<br>Well Wood | Wet broad leaved woodland dominated by Alder and Ash.<br>Less diverse species range.<br>Bramble of particular value to Dormice is present and dense in places. Good food source and for summer nest sites.<br>Piles of leaves, tree stumps, piles of wood and hedge banks providing potential hibernation sites<br>Connected to tree line with some gaps to west | Sub-optimal |
| 8a/8b<br>Hangman's Wood | Lowland mixed broadleaved woodland<br>Mix of age range and species.<br>Oak and sweet chestnut present of particular value.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood providing potential hibernation sites.<br>Not connected. | Sub-optimal |
| 9a<br>Spinney at north-west corner of Cae Waun Las | Lowland mixed broad leaved woodland<br>Mix of age range<br>Oak and hazel present of particular value. Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood and hedge banks providing potential hibernation sites.<br>Connections to wider landscape north and west. | Optimal<br>Dormouse presence confirmed during 2015 survey. |
| 10a<br>Coed Felin-gat | Lowland mixed broad leaved woodland<br>Mixed age range<br>Less understorey and higher % of standards in places<br>Ash and Hazel present of particular value<br>Dense bramble in places providing summer nest locations<br>Piles of leaves, tree stumps, piles of wood, stone walls and hedge banks providing potential hibernation sites.<br>Connections to wider landscape north, south and west. | Sub-optimal<br>Dormouse presence confirmed during 1997 survey. |
| 10aNW (western extremity of 10a)<br>Coed Felin-gat | Lowland mixed broad leaved woodland, scrub and glade<br>Mix of age range<br>Ash, oak and hazel present of particular value.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood and hedge banks providing potential hibernation sites.<br>Connections to contiguous woodlands to north, east and south. | Optimal<br>Probable Dormouse presence confirmed by presence of fresh leaves in survey tube survey during 2015. |
| 10aW (south- | Lowland mixed broad leaved woodland<br>Mixed age range | Sub-optimal<br>Dormouse presence |

| | | |
|---|---|---|
| western extremity of 10a)<br><br>Coed Felin-gat | Locally sparse understorey<br>Ash, oak, Beech and Hazel present of particular value<br>Dense bramble in places providing summer nest locations<br>Piles of leaves, tree stumps, piles of wood, and hedge banks providing potential hibernation sites.<br>Connections to adjacent woodlands north and south. | confirmed during 2015 survey. |
| 10b<br>Coed Felin-gat | Lowland mixed broad leaved woodland<br>Mixed age range<br>Understorey shrubs present<br>Ash, oak, Hazel present of particular value<br>Occasional bramble<br>Piles of leaves, tree stumps, piles of wood, providing potential hibernation sites<br>Connects to north, east, south and west | Sub-optimal |
| 10c<br>Coed Felin-gat | Lowland mixed broad leaved woodland<br>Even aged younger patch of wood<br>Oak, Ash and Hazel present of particular value<br>Little bramble<br>Piles of leaves, stone walls and hedge banks providing potential hibernation sites.<br>Connections to wider countryside north, east, south and west | Sub-optimal |
| 10d<br>Coed Felin-gat | Lowland mixed broad leaved woodland<br>Even aged younger patch of wood<br>Ash and Hazel present of particular value<br>Younger trees/scrub dense in places for summer nests<br>Little bramble<br>Piles of leaves, stone walls and piles of wood providing potential hibernation sites.<br>Connections to the wider landscape north, east, south and west | Sub-optimal |
| 11aN – northern end.<br><br>Trawscoed Wood and north part of west side of Llyn Mawr | Lowland mixed broad leaved woodland<br>Mix age range and species<br>Oak and Hazel present of particular value.<br>Dense areas of scrub and bramble providing potential summer nest sites.<br>Piles of leaves, tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape north and west. | Optimal<br>Dormouse presence confirmed during 1997 and 2015 surveys. |
| 11aS – southern end.<br><br>South part of west side of Llyn Mawr | Lowland mixed broad leaved woodland<br>Mix age range and species with even aged re-growth in former lake edges dominated by willow.<br>Oak and Hazel present of particular value.<br>Very southern end cut in recent years, re-growing into dense scrub. | Sub-optimal |

| | | |
|---|---|---|
| | Dense areas of scrub and bramble providing potential summer nest sites.<br>Tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape north and west. | |
| 14a Woodland east of Holy Well Marsh | Wet broad leaved woodland dominated by Alder and Ash.<br>Less diverse species range.<br>Ash and bramble present of particular value<br>Bramble and scrub dense in places. Good food source and for summer nest sites.<br>Piles of leaves, tree stumps, piles of wood and hedge banks providing potential hibernation sites<br>Connected to the wider countryside south-west | Sub-optimal |
| 15b Spinney in E corner of Gatehouse Marsh | Lowland mixed broad leaved woodland<br>Mix age range and species<br>Oak, Ash and Hazel present of particular value.<br>Little bramble<br>Isolated. | Poor |
| 16a Spring Woods | Lowland mixed broad leaved woodland<br>Mix age range and species<br>Oak, Ash and Hazel present of particular value.<br>Little bramble and heavily managed ground vegetation<br>Isolated. | Poor |
| 16b Woodland plantings lining the north-western boundary of the formal Garden | Lowland mixed broad leaved woodland<br>Mix age range and species at southern end<br>Majority to the north planted recently of mixed broad leaves.<br>Oak, Ash and Hazel present of particular value.<br>Dense areas of bramble providing potential summer nest sites although extensive areas cut in autumn 2015.<br>Tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape north and south. | Sub-optimal<br>Dormouse presence confirmed during 2015 survey. |
| 17a Coed North Lodge | Lowland mixed broad leaved woodland<br>Mix age range and species.<br>Oak and Hazel present of particular value.<br>Dense areas of understorey and bramble providing potential summer nest sites.<br>Tree stumps, piles of wood providing potential hibernation sites.<br>Connected to wider landscape north, east, south and west. | Optimal<br>Dormouse presence confirmed during 2015 survey. |
| 17a(SW) Marshy grassland and scrub | Mix of marshy grassland and broad leaved scrub and plantation habitat.<br>Oak, Hazel and bramble present of particular value.<br>Dense areas of scrub and bramble providing | Optimal |

| | | |
|---|---|---|
| habitats immediately south west of 17a.<br><br>Coed North Lodge | potential summer nest sites<br>Grassland tussocks, plies of leaves and hedge banks providing potential hibernation sites<br>Connected to wider landscape to the north, and east | |
| Hedgerows H1 and H1a | Native hedge<br>Ash, Hazel and oak present of particular value<br>Some small gaps and hedge not dense limiting nesting sites<br>Hedge bank provides hibernation sites.<br>Connected to woodland east and west | Sub-optimal |
| Hedge H2 | Native hedge<br>Ash, Hazel and oak present of particular value<br>Bramble and dense scrub adjacent providing potential summer nesting areas<br>Hedge bank provides hibernation sites.<br>Connected to woodland east, south and west | Optimal |
| Hedge H3, H4 and H4a | Native hedge<br>Ash, Hazel and oak present of particular value<br>Managed creating a thick dense hedge providing potential summer nesting sites<br>Hedge bank provides hibernation sites.<br>Connected to woodland to south and hedgerow and woodland-belt to north | Optimal |
| Hedge H5 and H5a | Native hedge, unmanaged<br>Ash, Hazel and oak present of particular value<br>Adjacent thick scrub and bramble provides potential summer nest sites<br>Piles of leaves and adjacent tussock grassland provides hibernation sites.<br>Connected to woodland north. | Optimal |
| Hedge H6 and H6a | Native hedge<br>Hazel and oak present of particular value<br>Adjacent thick bramble and places where the hedge is managed and thicker provides potential summer nest sites<br>Piles of leaves and adjacent tussock grassland provides hibernation sites.<br>Connected to woodland north and south. | Optimal |
| Hedge H7 | Native hedge<br>Ash and oak present of particular value<br>Managed on road side creating thick dense growth provides potential summer nest sites<br>Hedge bank, and wood piles and leaves in adjacent wood provides hibernation sites.<br>Connected to woodland south and east, hedge west. | Optimal |

| | | |
|---|---|---|
| Hedge H8 and H8a | Native hedge<br>Ash and oak present of particular value<br>Managed on road side creating thick dense growth provides potential summer nest sites<br>Hedge bank, and wood piles and leaves in adjacent woodland panting provides hibernation sites.<br>Connected to woodland east. | Optimal |
| Hedge H9 | Native hedge<br>Ash and oak present of particular value<br>Unmanaged with limited summer nest sites<br>Hedge bank provides hibernation sites.<br>Connected to woodland west and hedge to the west | Sub-optimal |
| Hedge H10 | Ash, Hazel and oak present of particular value<br>Managed on road side creating thick dense growth provides potential summer nest sites<br>Hedge bank provides hibernation sites.<br>Connected to hedge to the west | Sub-optimal |

9.2.4.2 Dormouse Tube Survey

Two fresh green leaves which indicate the use of the tube by Dormice were recorded in a tube located in woodland north-west of Llyn Mawr (10aNW) (shown on Figure 9.2) on 19th November 2015.

No other signs of Dormice were seen in the survey tubes.

9.2.4.3 Nut search

Dormouse opened hazel nuts were found in April 2015 in the woodland adjacent to North Lodge (17a) and, in December 2015, in the woodland south-west of the Science Block (16b), in the woodland south of Waun Las Farm (9a) and two opened nuts in the woodland west of Llyn Mawr (10aW and 11aN). The locations of all finds are shown on Figure 9.2.

9.2.4.4 Other evidence

There was an unsubstantiated sighting of a Dormouse within the woodland in survey zone 1 on 29th October 2015. This was seen in the large wooded quarry between the breached dam and Pont Felin-gat (10c).

9.2.5 **Dormouse Assessment**

All of the woodland, scrub, hedges and bramble thickets assessed to provide optimal and sub-optimal Dormouse habitat have the potential to support Dormice and, despite the difficulty of detecting them, small numbers of animals are likely to be present.

The locations of the Dormouse signs found confirm that both optimal and sub-optimal areas support Dormice.

Dormice cannot be considered as absent from areas where their signs have not been detected. Many of these areas lack suitable fruiting Hazel to enable sufficient survey to be undertaken by searching for opened nuts. Dormice have a proven record of making little use of artificial nest-boxes and survey-tubes throughout the Garden estate: in the past six years of monitoring, only one Dormouse has been found in one box.

The majority of the suitable habitat areas are well connected by hedges, scrub and woodland. Dormice therefore have good opportunity to travel between all the optimal and

sub-optimal habitat and may either live within the connecting habitats or use them as dispersal routes.

Isolated blocks of woodland and scrub that are identified as optimal or sub-optimal, such as blocks 6a and 8a/8b, may also support Dormice. Recent research has shown that Dormice move between isolated blocks of woodland and may be present in them in some years but absent in others (Chanin and Gubert, 2012).

The areas assessed as providing poor habitat are unlikely to be used by Dormice as they are small and isolated. For example compartments 15b and 16b are isolated, heavily managed and/or planted with ornamental plants. The poor area near Pant-Wgan in the north-eastern part of the site (5bN), although primarily consisting of a grazed and gappy line of trees, does connect blocks of optimal and sub-optimal woodland and therefore may be used for dispersal.

### 9.2.6 Potential Impacts on Dormice

Any clearance of the woodland, scrub, hedgerows and associated bramble identified as optimal or sub-optimal within the site risks breaching the legal protection afforded to Dormice. Therefore any works planned in these areas will need to be discussed with Natural Resources Wales (NRW) protected species staff who are likely to advise that an appropriate licence is procured.

The protection afforded to Dormice may be breached in three ways:

- Dormice may be killed, disturbed and/or have their nests destroyed.
  As Dormice signs have been found in a number of locations throughout the site and the habitat assessment has identified that the majority of the woodland, scrub, hedgerows and bramble is likely to support Dormice, disturbance to or removal of these habitats may result in Dormice being killed, disturbed or their nests destroyed.
- Reduction of the local distribution and abundance of Dormice.
  Loss of woodland, scrub, hedgerows and bramble within the site will remove suitable Dormouse habitat, potentially isolate areas of habitat and reduce the connecting habitat links through the site. This will reduce their local distribution and abundance within the site and reduce habitat connectivity within the immediate area around the Garden estate.
- Increased disturbance and inappropriate management of habitats.
  The development will result in the potential increase for human disturbance both in terms of numbers of visitors and the in the construction of new pathways giving access to currently largely undisturbed areas. Habitats adjacent to and in the vicinity of pathways and ornamental planted areas are likely to degrade in the longer term unless the management plan specifically prescribes measures to prevent damage and appropriate control of increased human pressure. As Dormice are mainly active at night, management should also ensure that habitat is not subject to artificially lighting.

### 9.2.7 Recommendations for Dormouse Mitigation

As a condition of the NRW licence, mitigation will be required to limit the effects of any disturbance or habitat loss resulting from the landscape restoration scheme. Mitigation will be required, not only to alleviate immediate effects on Dormice, such as killing, nest destruction and habitat disturbance, but also long term effects including the provision for the

retention, enhancement and management of habitats to ensure the ability of the local Dormouse population to survive into the future.

The recommendations below provide an outline of mitigation and general principles that will need to be followed to procure the NRW licence and implement its requirements. A method statement will need to be agreed with NRW staff in support the licence application and will also include the production of a management plan for the mitigation areas.

Prevention of killing and disturbance of Dormice

Any disturbance to habitat which supports or which has potential to support Dormice will be undertaken either in late September/October or in November to February inclusive in order to limit the risk of killing and injuring Dormice.

Where vegetation is to be removed, full clearance works may be undertaken either in a single-stage procedure in late September/October or, alternatively, in a two stage procedure with surface vegetation removal between November and February followed by final stump and top-soil removal in May.

All disturbance to Dormouse habitat must be supervised by the ecologist named on the NRW licence.

All site personnel and operatives will be made aware that Dormice are present within the working area and of the measures they must take should any Dormice be discovered during the course of site operations. Such measures will include the immediate stopping of the work and the notification of NRW or the licensed ecologist.

Habitat loss and fragmentation

Habitat loss and fragmentation must be minimised by careful planning of site layout and operations to ensure that all suitable Dormouse habitat and potential habitat is avoided and retained. Retained habitat must be protected from disturbance during site operations using appropriate measures such as the construction and maintenance of barrier fencing and the diversion of any run-off away from protected areas.

NRW licences generally require that all suitable Dormouse habitat lost must be replaced with an equal or greater area of suitable habitat. The mitigation habitat will need to be planted and well established prior to commencement of any disturbance or removal of existing habitat. In general, this is taken to mean that planting and establishment must take place a minimum of two to three years prior to the start of clearance works.

There will also be a requirement that all areas of suitable Dormouse habitat retained must remain connected or be connected to other areas of suitable habitat. Existing connections through the site, in particular east to west, but also north to south, will also need to be maintained and, if breached, will need to be replaced by alternatives.

All opportunities should be taken to increase habitat connectivity through the site, for example, by establishing habitat features to join existing isolated woodlands, establishing a planned grazing regime in woodlands or by planting-up gaps in existing gappy hedgerows. Opportunities also exist to increase Dormouse potential in all areas of less than optimal habitat. These measures can be used to help provide mitigation in support of the NRW licence.

Any planting will be required to take into account the current ecology at each location to ensure any other protected and significant species and habitats and the biodiversity value of the site is not diminished.

## 9.3 **Otter** (Rob Colley)

### 9.3.1 **Otter survey objectives**

The field survey was designed to identify and describe Otter use of land within the area encompassed by the Regency Restoration Project. In order to identify any necessity for the procurement of a European Protected Species Development Licence (as required under the '*Habitat Regulations*'), Survey Zone 1 was examined in search for actual or potential Otter rest-sites. *damage* or *disturbance* or disturbance to an Otter rest-site can legally only be undertaken if licenced by Natural Resources Wales.

The survey was extended to adjacent areas (principally Survey Zone 2), to identify any potential for incidental *disturbance* to rest-sites and to identify any Otter-use features which the design-team will need to consider, as required under the Natural Environment and Rural Communities Act 2006 and by policies embraced by the UK & Local Biodiversity Action Plans.

A pre-survey assessment of the site suggested

i) from examination of the O.S. map: the possibility of through-site Otter travel between the Tywi (to north) and Gwendraeth fach (to south) catchments,

ii) from on-ground observation of site features: seasonally variable prey availability at the lakes, former lake and watercourses

and

iii) from on-ground observation of site features and consideration of previous-survey data: rest-site opportunity away from main rivers was thought likely to be seasonally variable in its attractiveness to Otters.

To address these objectives, including possible seasonal variations, the survey was extended over the ten months between June 2015 and March 2016 with additional observations of other observers included when available.

### 9.3.2 **Otter survey methods**

An in-stream survey of

i) the Afon Gwynon, from Pont Felin-gât to the road bridge at Pantwgan, and

ii) the Afon Gwynon tributary (also referred to as the Afon Gwynon West or 'Llyn Canol outflow stream'), from its confluence with the Afon Gwynon to the masonry cascade at the northern end of Llyn Canol

was carried-out in June 2015. This in-stream survey sought resting-sites (holts) and/or field-evidence of Otter presence/use, including spraint (characteristically scented faeces), footprints, pathways leading off-stream, and feeding remains.

The in-stream survey was repeated in December 2015 and in March 2016, when the (slight?) January-February peak in the birth of Otter cubs makes resting-sites away from main-rivers particularly important and when breeding amphibian aggregations cause shifts in Otter foraging patterns.

The initial in-stream survey also identified a sequence of sites along each watercourse at which spraint-deposition could be expected in the event of Otter presence: spraint is typically placed, as a chemo-communication, at prominent "signpost" positions. These sites were subsequently spot-checked for field-evidence at approximately monthly intervals in order to

detect seasonal or changing Otter use or presence. The sites listed below are shown on figure 9.3.1.

Potential spraint sites on the Afon Gwynon:

G1 Pantwgan under-road bridge, including upstream silt beach at left bank and (downstream) midstream boulders

G2 weir, retaining walls & sill; including shingle banks at upstream pool, mid-stream boulders at likely Otter pull-out downstream of masonry walls, and nearby pond

G3 under bridge: silt benches, midstream boulders

G4 cascade; upstream sill; downstream, natural rock sill and in-stream boulders

G5 footbridge & Llyn Mawr spillway: in-stream stones, silt banks

G6 confluence with Afon Gwynon tributary: banks and fallen tree over tributary

G7 Pont Felin-gât: under road bridge; left bank sill & in stream stones

Potential spraint sites on the Afon Gwynon tributary (Llyn Canol outflow stream):

L1 Llyn Canol outflow cascade: dam-top, lake banks and dam-foot at likely Otter pull-out site

L2 breach in dam of former lake

G6a confluence with Afon Gwynon: banks and fallen tree over tributary; silt benches, c20m upstream of tributary.

Of the data sources referred to at paragraph 2.1.1, particular contextual reference has been made to the February 1997 report to Anthony Hunt Assocs. Ltd entitled *Preliminary Otter and Otter Habitat Survey at Site Proposed for National Botanic Garden of Wales, Middleton Hall, Llanarthney, Carmarthenshire* (Liles & Midgeley).

### 9.3.3 **Otter survey results**

Field evidence

Subjective indications of spraint age are given in the observations that follow:

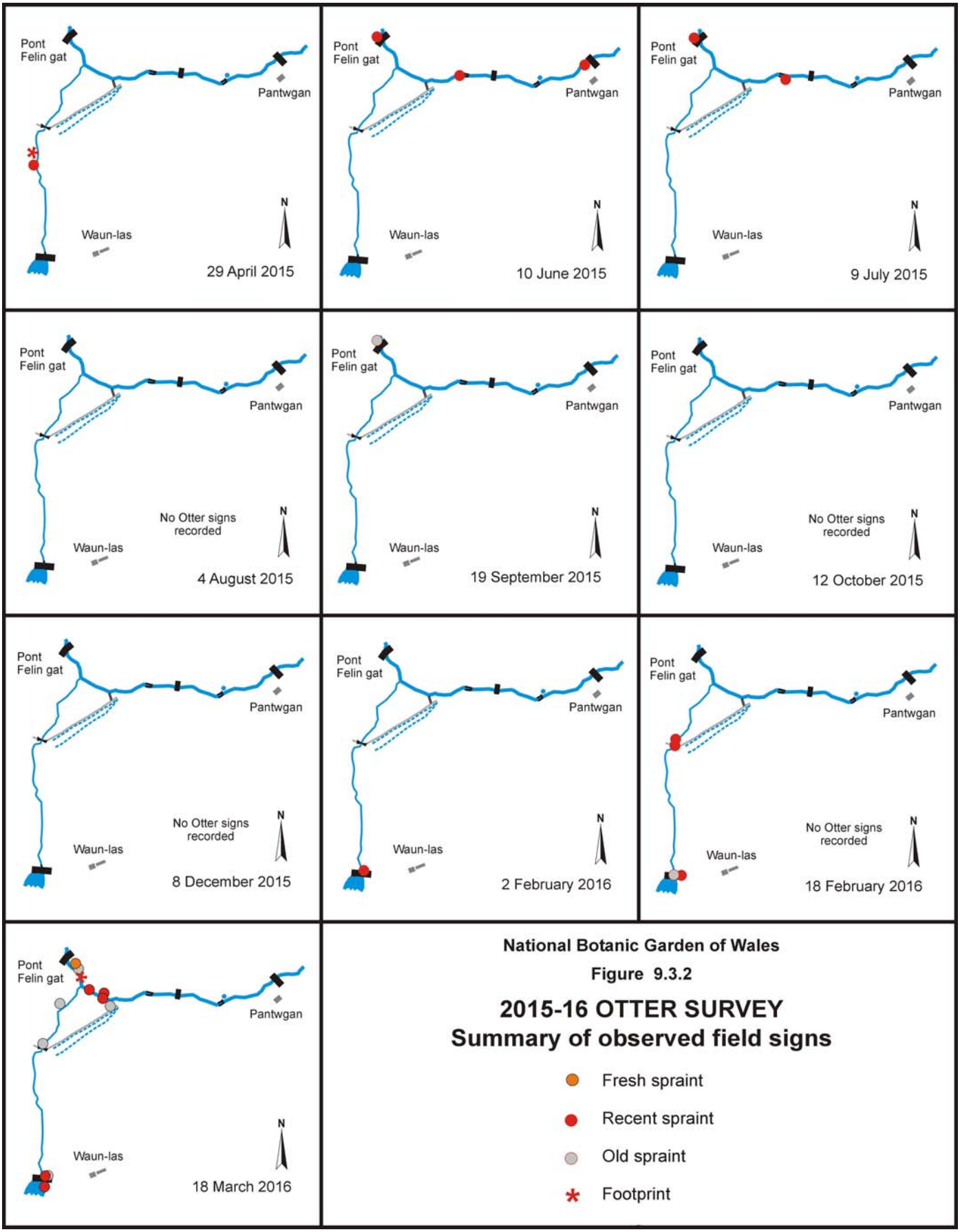
| | |
|---|---|
| Fresh | oily and heavily scented, thought to be deposited within previous 24 hrs; |
| Recent | still formed and scented, but not fresh, thought to be <2 weeks old; |
| Old | no scent, decomposed |

*29th April 2015*

Casual record made by Sam Bosanquet, Barry Stewart and Richard Pryce during the bryophyte and NVC vegetation survey:

An Otter spraint and scratch marks in the stream bank silt were recorded during the course of the surveys, located on the Afon Gwynon tributary at SN 52526 18488, about half way along, and towards the western side of the drained lake bed (L3 on figure 9.3.1; Phase 1 Survey Target Note TN014).

**Regency Landscape Restoration Project: Ecological Assessment**

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*10th June 2015*, in-stream survey of all on-site Gwynon and Llyn Canol-outflow:
Afon Gwynon:
Recent spraint was noted at the left bank Pont Felin-gât under-bridge (G7),
at an in-stream boulder below the Gwynon cascade (G4) and
at an in-stream boulder downstream of the Pantwgan bridge (G1).
No other field signs were seen.
The same-age and roughly equidistant spacing of the spraints was thought to be suggestive of a travelling animal.

Llyn Canol outflow/Llyn Mawr stream:
No Otter evidence was found.

*9th July 2015*, spot checks:
Afon Gwynon:
Recent spraint was noted at a midstream boulder downstream of the Pont Felin-gât bridge (G4) and
at an in-stream boulder below the Gwynon cascade (G7).
No other Otter evidence was found.

Llyn Canol outflow/Llyn Mawr stream:
No Otter evidence was found.

*4th August 2015*, spot checks:
No Otter evidence was found.

*19th September 2015*, spot checks:
Afon Gwynon:
One old spraint was found at Pont Felin-gât (G7).
No other evidence was found.

Llyn Canol outflow/Llyn Mawr stream:
No Otter evidence was found.

*12th October 2015*, spot checks:
No Otter evidence was found.

*8th December 2015*, in-stream survey of all on-site Gwynon and Llyn Canol-outflow:
No Otter evidence was found.
An anecdotal casual record of a “recent” sighting of an Otter at the banks of Llyn Canol was reported by Huw Jones (*pers.com*.).

*2nd February 2016*, spot checks:
Afon Gwynon:
No Otter evidence was found.

Llyn Canol outflow/Llyn Mawr stream:
A recent spraint was noted on the trackside, at the north-east end of the Llyn Canol dam wall (L1). A narrow and shallow drainage channel down the (north-east) embankment, directly below a field-drain outflow, was thought to be a “likely” Otter path/route from Llyn Canol to the bed of Llyn Mawr: this was followed down the bank but no confirmatory evidence of use was found, and the drain/path petered out at the foot of the bank. No corresponding path could be found on the Llyn Canol side of the dam-top track.

No other evidence was found.

*18th February 2016*, spot checks:
Afon Gwynon:

No Otter evidence was found.

Llyn Canol outflow/Llyn Mawr stream:

Two spraints were noted in the same location as was recorded on the Llyn Canol dam on 2nd February (L1). One of these was "old" and thought to be the spraint seen earlier in the month but a second, recent spraint was alongside. No other evidence was found on the side of the track.

Two recent spraints were noted on the masonry of the Llyn Mawr outflow culvert at the breached dam (L2).

*18th March 2016*, in-stream survey of all on-site Gwynon and Llyn Canol-outflow:
Afon Gwynon:

Fresh spraint was found on a right-bank rock shelf, immediately upstream of Pont Felin-gât (G7).

An old spraint and a footprint (large, thought to be a dog Otter) were found between here and the Llyn Canol outflow stream confluence (G6b).

Three recent spraints, on midstream boulders, were found between the confluence and the upstream footbridge (G5a).

One old/recent spraint was found in the lowest section of the Lyn Mawr spillway masonry (G5).

No Otter evidence was found upstream of here.

Llyn Canol outflow/Llyn Mawr stream:

A single recent spraint was found at the same Llyn Canol dam position (L1) alongside two old spraints (that were thought to be those noted in February). A recent spraint was also noted on the outflow-masonry wall at the Llyn Canol water's edge, with a light-use mammal path alongside the wall masonry to the track at the top of the dam.

Old spraint at the Llyn Mawr dam breach (L2) was thought to be that seen in February.

<u>On-site activity: summary of findings</u>:
The field-evidence reported above indicate low-level Otter activity within the Regency Landscape Restoration Project area.

Over the ten months of the survey, field-evidence of activity/presence was not consistent and was never intensive. Spraint evidence suggests little Otter use during the summer-autumn with an increase in use of the wider area during late winter/early spring. This suggestion is consistent with the expectation that Otter use of marginal foraging areas increases in late winter when fish prey-species' availability is depressed and when amphibian aggregations offer an alternative food source. The concentration of evidence in the Pont Felin-gat area suggests that site visitation is most likely to be by Otter(s) from the Tywi valley.

On the dates when field evidence was found across the wider-site (rather than in a restricted area) the wide spacing of spraint indicates a travelling animal: the 10th June 2015 findings suggest travel movement along the Gwynon whilst those of 18th February 2016 suggest Pont Felin-gat - Llyn Canol movement along the Gwynon Tributary. No spraint concentrations within a restricted area which would have indicated foraging/prolonged activity/presence were found during any of the survey visits.

The survey evidence indicate infrequent/occasional across site travel. No evidence of on-site foraging was found.

Resting sites

No actual or potential rest-sites were found during any of the survey visits. Whilst both watercourses have some areas of bankside vegetation suitable for daytime rest-site use by Otters, no evidence of such use was seen.

It should be noted that the wider area is much changed since the 1997 Liles & Midgeley survey: Llyn Mawr, around which many Otter signs were recorded in 1997, no longer has standing water and, clearly, is no longer an attractive foraging area for Otters. Furthermore, site management activities and increased leisure-use of woodland footpaths have resulted in a higher likelihood of daytime disturbance: the likelihood of Otter rest-site use at Llyn Mawr is judged to be much reduced (G. Liles, *pers. com*.).

Vegetation on the east bank of the former Llyn Mawr is now reduced to a narrow tree-line, with an open floor below occupying the strip between the former-lake bottom and the grazed fields to the immediate east: no evidence of Otter rest-site use of the oak tree root-plate cavities, as reported in 1997, was found and, in the absence of the lake, use of these features is considered unlikely. The oak and beech root-plate cavities on the western bank of the former Llyn Mawr where Otter use was also reported in 1997, could not be found, and it is presumed that the loss of the lake has seen these features fall into disuse. It should also noted that, during the 2015 survey period, the level of wider-area disturbance, eg Cherry-laurel removal, archaeological earthworks and, particularly, pedestrian/dog use of paths through the woodland to the west of the (former) lake is much greater than was seen and reported in 1997. These disturbances are thought likely to deter daytime Otter rest-site use here.

Well-used footpaths run close to or alongside the Afon Gwynon with evidence of dog activity along the river banks seen during all site visits. The woodland flanking the river is largely open floored with little opportunity for Otter rest-sites to be located in dense-scrub.

The swampy former lake bed is, in part, densely clothed with rush, Reed Canary-grass and/or Common Reed growing on a waterlogged substrate which precludes any possibility of the presence of underground rest-sites. The willow scrub that is developing over much of the lake bed does not offer suitable root-plate cavities for Otter use. There is some possibility of occasional or opportunistic rest-site use within well-developed vegetation tussocks but no evidence of such use was seen.

Otter through-site travel

Both the Afon Tywi, to the north/north west, and Afon Gwendraeth fach, to the south/south east, are main rivers which are known to support “healthy” populations of Otters and emigrating animals can be expected to move between these catchments. The Gwynon - Llyn Mawr - Llyn Canol - Llyn Uchaf watercourse connection, through NBGW, gives a likely travel route between these watersheds. The distribution of spraint evidence described above, is consistent with such use, as are occasional/opportunistic reports (from NBGW volunteers) of Otter spraint on the lake edge and feeder streams close to the NBGW entrance.

Otter road-deaths have been recorded on the A48 to the south of NBGW (eg February 2004; November 2006, *pers. data*). These in-winter dates are consistent with the slight increase in activity reported above, further supporting the suggestion of travel through NBGW.

9.3.4 **Assessment of the likely impact of the proposed landscape restoration project works**
No evidence of foraging activity was found in the Restoration Project area and no foraging opportunity will be lost to the proposed works. On the contrary, the re-creation of Llyn Mawr can be expected to increase the foraging-value of the area for Otters.

No Otter rest-sites were found during this survey. The loss of those sites described in 1997 is consistent with the minimal foraging opportunity in Survey Zone 1 following the drainage of Llyn Mawr in c.2000 and the increased daytime disturbance occasioned by current site-use.

The proposed works will not disturb, damage or destroy a rest-site.

Through-site travel by Otters can be expected to be largely nocturnal: the proposed works will have no impact on such use.

No Otter-related constraint to the restoration project is identified.

9.3.5 **Opportunity for conservation gain**:
The restoration of Llyn Mawr has obvious potential to increase the foraging value of the site for Otters but public use/disturbance is likely to be a constraining factor.

This constraint might be mitigated by landscape design: eg. the retention/creation of a secluded (east bank) corridor to the restored lake with the provision of artificial rest sites (eg log pile holts) within this secluded habitat might allow sufficient day-time rest-site security for Otters to regularly exploit any additional foraging opportunities. The project managers might consider the example of the National Trust's Bosherston Lakes site, where public access and daytime Otter rest-site use have been successfully integrated.

## NATIONALLY PROTECTED SPECIES

9.4 **Water Vole** (Rob Colley)
Currently the closest known Water Vole population to NBGW is located on the Llanelli Levels centered around the National Wetlands Centre, Penclacwydd. However, suitable habitat occurs in the Tywi valley and Carmarthen areas and therefore there may be the possibility of outlying populations closer.

No Water Voles or their signs have been recorded during the survey visits despite the lakes and some stretches of watercourse within the Garden estate providing suitable habitat. No Water Vole-related constraint to the proposed landscape restoration project has been identified.

## 9.5 **Badger** (Jacqueline Hartley & Richard Pryce)

### 9.5.1 Ecology and conservation-status

Badgers are opportunistic omnivores, taking a range of fruits, nuts and cereals. In Britain, earthworms are the single most important prey item. Varied habitats, with a range of natural and semi-natural features, support the greatest numbers of animals. Woodland is usually chosen for main setts and areas of improved grazing are important sources of earthworms.

Badgers live in social groups, comprising 2-25 animals (average 6). The group defends a territory of 10ha to 300ha (average 50ha, depending on habitat quality). Such territories are stable over time, and contain adequate food resources and underground shelters known as setts.

Setts comprise a series of tunnels and chambers in which badgers rest and breed. Woodland is favoured for sett sites and typically, they are dug on south facing slopes, in free-draining soils. Different types of sett can be recognised:

- the main sett is in continuous use (in some cases for several hundred years) and is used for breeding

- annexe setts are close to main setts (usually < 150m) and smaller. They are used infrequently as an alternative to the main sett (perhaps by individuals temporarily excluded because of breeding activity in the main sett)

- subsidiary and outlier setts are used sporadically, typically have one or two holes, and may be located anywhere in the territory.

The Badger and its underground sett are protected under various Acts of Parliament, most importantly the Protection of Badgers Act 1992. The Badger is also included on schedule 6 of the Bern Convention.

It is illegal to kill or injure any badger, or to intentionally or recklessly damage, destroy or obstruct access to a sett. Development work which will disturb a badger sett requires a licence to be obtained in advance from Natural Resources Wales (or in some instances from the Welsh Government). As a general rule, the use of machinery would not be permitted within 30m of an active sett (40m for pile driving, 10m for hand-tool operations) during the "close season" which extends from December to June inclusive.

### 9.5.2 Badger survey methods

The 2015-16 survey included searching for any evidence of Badger activity over the whole Garden estate with work being concentrated within Survey Zones 1 and 2. Such evidence includes setts (the underground breeding/resting burrow systems of badgers), latrines (dung pits, often used as territory-markers), paths (identified by footprints, hairs caught on barbed-wire fences) and feeding areas (identified by characteristically disturbed/uprooted ground). The search also included all areas within the generally accepted "disturbance distance" around the proposed works areas which, for mechanized plant, is taken to be 30m.

### 9.5.3 Badger survey results

The locations of setts and other Badger signs found during the 2015/16 as well as the 2012 surveys are shown on figure 9.5. Signs of Badger activity were found to be much more frequent in the northern half of the Garden estate. No setts and virtually no other signs were

found in the southern half of the estate which probably reflects to preponderance of wetter ground conditions over much of this area.

Two active, presumed main setts together with associated subsidiary and outlier setts were recorded, one on the wooded eastern bank (sett 12) and the other on the wooded western side (setts 8 and 11) of the drained Llyn Mawr lake bed.

A third presumed main sett was found within Survey Zone 1 on the woodland bank north of Nant Gwynon (sett 6)

Another main sett is located on the edge of Zone 2 (sett 7) adjacent to the Corporate entrance drive.

Additional setts, but not main setts, are located outside Survey Zones 1 and 2.

Other signs of badger activity were recorded scattered throughout the Survey Zones. In particular, foraging signs were seen within North Trawscoed and the Grow-the-Future fields during the Phase 1 habitat survey. A recently dug-out wasp's nest was found in the mown path-verge south of Llyn Uchaf on 11/10/15.

It should be noted that it is possible that additional setts may be located within the survey area that remain undetected because they could be concealed by thick undergrowth, bramble thickets, etc, which were impossible to access or observe closely during the fieldwork.

| Badger sett | Sett activity at the time of the survey | Assessment |
|---|---|---|
| **1** surveyed 13/5/15 and 14/1/16 | Sett with, on 13/5/15, one active entrance hole under fallen Elder bush and several other unused holes in vicinity to west with path and feeding signs on woodland floor. Judged to be inactive on 14/1/16 with a path to the entrance not having been used for some time. | Outlier Sett |
| **2** surveyed 14/1/16 | Single entrance sett<br>Little used Badger path to the entrance<br>Not active at the time of the survey | Outlier sett which may be used from time to time |
| **3** surveyed 14/1/16 | No sett was found in the area. | Sett is no longer present |
| **4** surveyed 14/1/16 | Two active entrances<br>1 inactive entrance<br>No bedding<br>Badger paths leading to the sett entrances and through this block of woodland out into the adjacent fields<br>3 additional holes too small to be used by badgers | Level of activity indicates a subsidiary sett |

| | | |
|---|---|---|
| **5** surveyed 14/1/16 | No holes large enough for badgers to use<br>No badger paths leading to them<br>Small holes, limited narrow fresh digging | No longer a badger sett<br>Currently used by rabbits |
| **6** surveyed 14/1/16 | Four active entrances<br>Bedding outside three of the entrances<br>Well worn paths to each and between entrances<br>Well warn paths to the sett<br>Latrine adjacent to the sett | Level of activity indicates main sett |
| **7** monitored through 2015 | Three continually active sett entrances<br>Occasional bedding outside one entrance<br>Well worn paths to each and between entrances<br>Well warn paths to sett | Level of activity indicates main sett |
| **8** surveyed 17/5/15 and 14/1/16 | Four active entrances with bedding outside two<br>Three inactive entrances<br>Well worn paths between and to the entrances | Level of activity indicates main sett linked to sett 11 |
| **9** surveyed 28/7/15 | One hole under root-plate of beech. Doubtfully active. | Possible outlier sett |
| **10** surveyed 2/4/12 | One active entrance located 1m inside woodland boundary fence under mature oak tree. Piles of bedding dragged out of sett on woodland floor in this area. Paths leading to entrance | Level of activity indicates outlier sett |
| **11** surveyed 20/9/12 | At least three active entrances and latrine under old oak tree at top of steep bank, with fresh grass dragged outside. Heavily used pathways connecting with sett 8 and to the south.. Most woodland-floor plant species eroded or disturbed by animal activity in vicinity. | Level of activity indicates main sett linked to sett 8 |
| **12** 2/4/12 | Active sett in dense bramble located about 5m into old hazel coppice woodland with willow. Number of entrances not determined due to difficult access into thicket. Much compacted soil and soil mounding around entrance/s. | Level of activity indicates Main sett or subsidiary sett |
| **13** 20/5/15 | One active entrance with fresh soil excavated from hole into new pile. | Level of activity indicates outlier sett |
| **14** 20/5/15 | Possible sett taken over by rabbits | No badger activity |
| **15** 8/3/16 | Possible large sett taken over by rabbits | No badger activity |

9.5.4 Badger survey assessment

Badger setts are located in zones 1 and 2, some of which are main setts, ie are the most important ones as these are where cubs are born and reared.

A number of subsidiary and outlier setts are also located within zones 1 and 2 and elsewhere within the wider Garden estate.

The survey results indicate that badgers also travel and forage extensively throughout the Garden estate.

9.5.5 Badger constraints

All badger setts are legally protected under the Protection of Badgers Act (PBA) against interference and disturbance, including specified works within generally accepted distances of the sett. This includes:

- destroying a sett
- damaging a sett or any part of a sett
- obstructing access to a sett or any entrance of a sett
- causing a dog to enter a sett, and
- disturbing a badger when it is occupying a sett.

In addition to activities at or directly over a sett, accepted guidelines offer guidance that "interference" includes

- the operation of heavy machinery within 30m of any sett entrance,
- the operation of light machinery within 20m of any sett entrance,
- hand digging/scrub clearance within 10m of any sett entrance.

9.5.6 Potential Impacts on Badgers

Works, including vegetation clearance within 30m of any of the setts identified as being active may disturb badgers, destroy setts and obstruct access.

Digging of trenches, holes etc. may trap badgers during site operations.

Disturbance to grassland and woodland areas will decrease the area available to Badgers for foraging during site work. It is anticipated that such disturbance will largely be reinstated following completion of the work and the amount of land available for foraging restored. Residual impacts due to loss of foraging area are therefore considered to be insignificant.

9.5.7 Badger Recommendations

To limit impacts to badgers and meet legal requirements the following will be necessary where badgers are likely to be disturbed or otherwise impacted.

- A 30m buffer zone around the each sett will be fenced off to protect badgers from disturbance during the works. Fencing will be to standard agricultural post and wire-netting specification BS1722-2 and will be maintained in serviceable condition for the whole duration of site operations.

- For works that are located within 30m of an active sett but do not require a disturbance licence, i.e. planned works that are not likely to cause disturbance, a method statement will be prepared and implemented detailing how works will be undertaken to ensure that Badgers will not be disturbed. The method statement will be agreed with Natural Resources Wales (NRW).
- If is not possible to complete the required works without disturbance to Badgers, an appropriate licence will need to be procured from NRW.
- If any existing main or subsidiary setts require closure and destruction, replacement artificial setts will need to be constructed, generally at least six months before the original setts are closed. Planned sett closure will necessitate a bait-marking survey to determine the extent of the territory occupied by animals of the social group residing in the affected setts. New artificial setts will need to be located within the territory of the affected social group and close to the sett(s) that will be closed.
- Bait marking surveys must be undertaken between February and April or in September.
- As a general rule, works that will result in disturbance to a badger sett and which are licenced by NRW, must be undertaken between July and November.
- During the construction phase, existing badger paths will not be blocked by fencing, stored materials or any other barrier to free passage of animals. Toxic materials, oils, etc will be safely stored in closed buildings or compounds which are maintained so as to be inaccessible to Badgers at all times.
- Trenches dug and left open overnight will include sections where the sides are not so steep as to prevent the escape of animals. or substantial wooden planks will be positioned and secured to provide a means of escape.
- New and replacement plantings will include species that provide replacement food sources for Badgers. Planting stock will be of locally native species of local origin and will include species that bear fruits such as Crab Apple, Hawthorn, Hazel, Rowan and Bramble. All nursery stock will comply with BS3936 Part 1:1992 and all subsequent amendments and all landscaping operations will comply with BS4428:1989 and all subsequent amendments

## 9.6 **Breeding Birds** (Barry Stewart)

### 9.6.1 Aims and objectives of the survey

- To establish the ornithological importance of the study area.
- To assess the potential impact on birds and their habitats resulting from the proposed works.
- To identify constraints which would mitigate for potential impacts on bird populations and their habitats resulting from the proposed works.

### 9.6.2 Breeding Bird Survey Methodology

Past ornithological data were procured from local ornithologists and the West Wales Biodiversity Information Centre nad past issues of the Carmarthenshire Bird Reports were consulted.

A Breeding Bird Survey was carried out in spring 2015. Field survey visits were undertaken between the end of April and beginning of June covering the whole of the Garden estate. Three visits were made to all parts of the site during morning periods, ensuring good spacing of visits to maximise the number of species detected. Routes selected enabled complete coverage of the site (adapted field by field method (Bibby *et al*, 1992)) with birds identified both visually (using x8 binoculars) and by vocalisations. During repeat visits, the direction each route walked was varied to minimise biases. The surveys were carried out by Barry Stewart.

The breeding bird survey records have been augmented with records made during the Phase 1 survey, bryophyte and invertebrate survey visits.

9.6.3 The following species were recorded within or on the boundaries of the NBGW estate. The annotation in the first column provides the breeding status of each species in 2015 and are as follows:

Co Confirmed breeding in 2015
Pr Probable breeding in 2015
Po Possible breeding in 2015
* pre 2015 records

| | **Common name** | **Scientific name** | **Code** |
|---|---|---|---|
| Co | Little Grebe | *Tachybaptus ruficollis* | LG |
| | Grey Heron | *Ardea cinerea* | H. |
| | Greylag Goose | *Anser anser* | GJ |
| | Canada Goose | *Branta canadensis* | CG |
| Co | Mallard | *Anas platyrhynchos* | MA |
| | Red Kite | *Milvus milvus* | KT |
| * | Goshawk | *Accipiter gentilis* | GI |
| Po | Sparrowhawk | *Accipiter nisus* | SH |
| Co | Buzzard | *Buteo buteo* | BZ |
| * | Hobby | *Falco subbuteo* | HY |
| * | Peregrine | *Falco peregrinus* | PE |
| Co | Pheasant | *Phasianus colchicus* | PH |
| Co | Moorhen | *Gallinula chloropus* | MH |
| Pr | Coot | *Fulica atra* | CO |

| | | | |
|---|---|---|---|
| | Lesser Black-backed Gull | *Larus fuscus* | LB |
| | Herring Gull | *Larus argentatus* | HG |
| * | Feral Pigeon | *Columba livia* | FP |
| Pr | Stock Dove | *Columba oenas* | SD |
| Co | Woodpigeon | *Columba palumbus* | WP |
| | Barn Owl | *Tyto alba* | BO |
| Po | Tawny Owl | *Strix aluco* | TO |
| Co | Swift | *Apus apus* | SI |
| * | Kingfisher | *Alcedo atthis* | KF |
| Po | Green Woodpecker | *Picus viridis* | G. |
| Pr | Great Spotted W'pecker | *Dendrocopos major* | GS |
| * | Skylark | *Alauda arvensis* | S. |
| | Sand Martin | *Riparia riparia* | SM |
| Co | Swallow | *Hirundo rustica* | SL |
| | House Martin | *Delichon urbica* | HM |
| Pr | Tree Pipit | *Anthus trivialis* | TP |
| Co | Meadow Pipit | *Anthus pratensis* | MP |
| Po | Grey Wagtail | *Motacilla cinerea* | GL |
| Po | Pied Wagtail | *Motacilla alba* | PW |
| Co | Dipper | *Cinclus cinclus* | DI |
| Co | Wren | *Troglodytes troglodytes* | WR |
| Co | Dunnock | *Prunella modularis* | D. |
| Co | Robin | *Erithacus rubecula* | R. |
| Po | Redstart | *Pheonicurus phoenicurus* | RT |
| Co | Blackbird | *Turdus merula* | B |
| Co | Song Thrush | *Turdus philomelos* | ST |
| Co | Mistle thrush | *Turdus vicivorus* | M |
| Po | Grasshopper Warbler | *Locustella naevia* | GH |
| Po | Sedge Warbler | *Acrocephalus scheonbaenus* | SW |
| Pr | Whitethroat | *Sylvia communis* | WH |
| Po | Garden Warbler | *Sylvia borin* | GW |
| Co | Blackcap | *Sylvia atricapilla* | BC |
| Co | Chiffchaff | *Phylloscopus collybita* | CC |
| Co | Willow Warbler | *Phylloscopus trochilus* | WW |
| Pr | Goldcrest | *Regulus regulus* | GC |
| Po | Spotted Flycatcher | *Muscicapa striata* | SF |
| Po | Pied Flycatcher | *Ficedula hypoleuca* | PF |
| Co | Long-tailed Tit | *Aegithalos caudatus* | LT |
| Pr | Marsh Tit | *Parus palustris* | MT |
| Pr | Willow Tit | *Parus montanus* | WT |
| Po | Coal Tit | *Parus ater* | CT |
| Co | Blue Tit | *Parus caeruleus* | BT |
| Co | Great Tit | *Parus major* | GT |
| Co | Nuthatch | *Sitta europaea* | NH |
| Pr | Treecreeper | *Certhia familiaris* | TC |
| Pr | Jay | *Garrulus glandarius* | J. |
| Po | Magpie | *Pica pica* | MG |
| Po | Jackdaw | *Corvus monedula* | JD |
| Pr | Crow | *Corvus corone* | C. |

| | | | |
|---|---|---|---|
| Co | Raven | *Corvus corax* | RN |
| Po | Starling | *Sturnus vulgaris* | SG |
| Co | House Sparrow | *Passer domesticus* | HS |
| Co | Chaffinch | *Fringilla coelebs* | CH |
| Pr | Greenfinch | *Carduelis chloris* | GR |
| Co | Goldfinch | *Carduelis carduelis* | GO |
| Pr | Linnet | *Carduelis cannabina* | LI |
| Co | Bullfinch | *Pyrrhula pyrrhula* | BF |
| Po | Reed Bunting | *Emberiza schoeniclus* | RB |

9.6.4. Bird species observed which are of conservation significance are as follows.

9.6.4.1 Species protected by their inclusion on *schedule 1 of the Wildlife and Countryside Act 1981*

Barn Owl: Fresh Barn Owl pellets and feathers were noted at Waun Las, though no evidence was found to indicate the species breeds at the site.

Kingfisher is an infrequent visitor to the site and whilst no breeding was identified in 2015, the site does provide suboptimal breeding opportunities for the species.

Red Kites are noted over the site with a degree of frequency and trees suitable for breeding are widespread. However, no evidence was obtained to indicate the species breeds on or adjacent to the Garden estate.

Goshawk has also been recorded in recent years and also could be a potential breeding species but better breeding opportunities are available elsewhere in the local area.

Little Ringed Plover: There is a 2005 record of Little Ringed Plover which is presumed to have been a passage bird. There is no suitable breeding habitat present within the Garden estate for this species.

The site does not provide nesting habitat for other Schedule 1 species found in the local area such as Peregrine *Falco peregrinus* and Crossbill *Loxia curvirostra* but it is possible these species could occasionally visit the site.

9.6.4.2 Section 42 *Species of Principal Importance for Conservation of Biological Diversity* in Wales (annotate 'a', below) and RSPB *Birds of Conservation Concern Red List* (annotated 'b') which were recorded during the 2015 survey are as follows.

- b Herring Gull (non-breeding)
- ab Tree Pipit (6 territories)
- b Skylark (former breeder)
- b Grey Wagtail (3 territories)
- ab Song Thrush (22 territories)
- a Mistle Thrush (confirmed breeder)
- a Dunnock (17 territories)
- ab Grasshopper Warbler (2 territories)
- ab Spotted Flycatcather (2 territories)
- a Pied Flycatcather (1 territory)
- ab Marsh Tit (6 territories)
- ab Willow Tit (2 territories)
- ab Starling (1 territory)
- ab House Sparrow (13 territories)
- ab Linnet (5 territories)
- a Bullfinch (5 territories)

a Reed Bunting (1 territory)

9.6.4.3 Additional species listed on the RSPB *Birds of Conservation Concern Amber List* recorded during the 2015 survey are as follows.

Grelag Goose (occasional non-breeder)
Mallard (confirmed breeder)
Shoveler (occasional winter visitor)
Red Kite (occasional visitor)
Lesser Black-backed Gull (occasional visitor)
Stock Dove (3+ territories)
Barn Owl (occasional visitor)
Swift (2+ breeding pairs)
Kingfisher (occasional visitor)
House Martin (frequent visitor)
Meadow Pipit (7 territories)
Redstart (1 possible breeder)
Willow Warbler (40 territories)
Pied Flycatcher (1 territory)

9.6.5 67 of the 72 species recorded at the Garden estate during the 2015 breeding season showed evidence of breeding. Of these, 20 territories of seven species of high/moderate conservation value were located within the area anticipated to be disturbed during the proposed site operations. Approximate numbers of concern species (ie not including species of local interest) are as follows:

Dipper (2 territories),
** Grey Wagtail (1 territory),
** Song Thrush (6 territories),
** Mistle Thrush (1 territory),
* Willow Warbler (3 territories),
** Marsh Tit (2 territories),
** Bullfinch (5 territories)

Key: ** 42 Species / BoCC Red List species
* BoCC Amber List species

It is anticipated that the majority of the secondary woodlands established on lake and pond beds will be removed when the water-bodies are reinstated. Disturbance to protected species that they support will require mitigation.

The change in habitat type will provide additional habitats for waterbirds, which will result in corresponding changes to the bird assemblage. The small waterbird population currently found on the existing lakes, which includes Moorhen, Coot, Little Grebe and Mallard, will extend to take advantage of the restored lakes.

An assessment of the likely impact of the Landscape Restoration project on these species is given at section 10.2.6:

9.6.6 Woodland, scrub and other dense vegetation supports a range of breeding bird species and, as all nests occupied or being built by breeding birds are protected by the Wildlife and Countryside Act 1981, it is recommended that all vegetation clearance work (including to facilitate site investigation) is undertaken outside the bird nesting season (March to August inclusive) or, if clearance in the breeding season is unavoidable, trees, scrub or dense vegetation must not be disturbed or removed unless, immediately prior to the commencement of such operations, it is judged by a qualified ornithologist, not to be supporting any nests.

## 9.7 **Non-Breeding Birds** (Barry Stewart)

9.7.1 Wintering and passage bird observations were largely collected as incidental observations during the course of other surveys, for instance during bryophyte and invertebrate recording, although some targeted effort was made to record water birds and owls. The occurrence of passage birds is highly unpredictable and the comparatively low level of recording over such a large site will mean the detection rate for less common species such as Pied Flycatcher, Tree Pipit and Garden Warbler will have been low, especially as the appearance of such species is often transient. Winter visitors, although highly mobile, are typically easier to detect as they generally frequent feeding areas for longer periods, increasing the likelihood of detection. The following species were recorded within or on the boundaries of the Garden estate outside of the bird breeding season. The annotation in the first column provides the status of each species in 2015.

P Passage migrant
W Winter visitor
R Resident at NBGW
R↑W Resident at NBGW, with significant increase in winter
R↑P Resident at NBGW, with significant increase on passage
P↑P Summer vistor at NBGW, with significant increases on spring & autumn passage
RN UK Resident that does not breed at NBGW,

| | **Common name** | **Scientific name** | **Code** |
|---|---|---|---|
| R | Little Grebe | *Tachybaptus ruficollis* | LG |
| RN | Cormorant | *Phalacrocorax carbo* | CA |
| RN | Grey Heron | *Ardea cinerea* | H. |
| RN | Greylag Goose | *Anser anser* | GJ |
| RN | Canada Goose | *Branta canadensis* | CG |
| RN | Gadwall | *Anas strepera* | GA |
| W | Teal | *Anas crecca* | T. |
| R | Mallard | *Anas platyrhynchos* | MA |
| W | Shoveler | *Anas clypeata* | SV |
| W | Tufted Duck | *Aythya fuligula* | TU |
| RN | Red Kite | *Milvus milvus* | KT |
| RN | Goshawk | *Accipiter gentilis* | GI |
| R | Sparrowhawk | *Accipiter nisus* | SH |
| R | Buzzard | *Buteo buteo* | BZ |
| RN | Peregrine | *Falco peregrinus* | PE |
| R | Pheasant | *Phasianus colchicus* | PH |
| W | Water Rail | *Rallus aquaticus* | WA |
| R | Moorhen | *Gallinula chloropus* | MH |
| R | Coot | *Fulica atra* | CO |
| W | Snipe | *Gallinago gallinago* | SN |
| W | Woodcock | *Scolopax rusticola* | WK |
| RN | Lesser Black-backed Gull | *Larus fuscus* | LB |
| RN | Herring Gull | *Larus argentatus* | HG |
| RN | Feral Pigeon | *Columba livia* | FP |
| R | Stock Dove | *Columba oenas* | SD |
| R↑W | Woodpigeon | *Columba palumbus* | WP |
| RN | Barn Owl | *Tyto alba* | BO |

| | | | |
|---|---|---|---|
| R | Tawny Owl | *Strix aluco* | TO |
| RN | Kingfisher | *Acedo atthis* | KF |
| R | Green Woodpecker | *Picus viridis* | G. |
| R | Great Spotted W'pecker | *Dendrocopos major* | GS |
| RN | Skylark | *Alauda arvensis* | S. |
| P | Sand Martin | *Riparia riparia* | SM |
| P | Swallow | *Hirundo rustica* | SL |
| P | House Martin | *Delichon urbica* | HM |
| P | Tree Pipit | *Anthus trivialis* | TP |
| R | Meadow Pipit | *Anthus pratensis* | MP |
| R | Grey Wagtail | *Motacilla cinerea* | GL |
| R | Pied Wagtail | *Motacilla alba* | PW |
| R | Dipper | *Cinclus cinclus* | DI |
| R | Wren | *Troglodytes troglodytes* | WR |
| R | Dunnock | *Prunella modularis* | D. |
| R | Robin | *Erithacus rubecula* | R. |
| P | Redstart | *Pheonicurus phoenicurus* | RT |
| RN | Stonechat | *Saxicola torquata* | SC |
| R↑W | Blackbird | *Turdus merula* | B |
| W | Fieldfare | *Turdus pilaris* | FF |
| R↑W | Song Thrush | *Turdus philomelos* | ST |
| W | Redwing | *Turdus iliacus* | RE |
| R | Mistle thrush | *Turdus vicivorus* | M |
| P | Sedge Warbler | *Acrocephalus scheonbaenus* | SW |
| P | Whitethroat | *Sylvia communis* | WH |
| P↑P | Blackcap | *Sylvia atricapilla* | BC |
| P↑P | Chiffchaff | *Phylloscopus collybita* | CC |
| P↑P | Willow Warbler | *Phylloscopus trochilus* | WW |
| R↑P | Goldcrest | *Regulus regulus* | GC |
| P | Spotted Flycatcher | *Muscicapa striata* | SF |
| R | Long-tailed Tit | *Aegithalos caudatus* | LT |
| R | Marsh Tit | *Parus palustris* | MT |
| R | Willow Tit | *Parus montanus* | WT |
| R | Coal Tit | *Parus ater* | CT |
| R | Blue Tit | *Parus caeruleus* | BT |
| R | Great Tit | *Parus major* | GT |
| R | Nuthatch | *Sitta europaea* | NH |
| R | Treecreeper | *Certhia familiaris* | TC |
| R | Jay | *Garrulus glandarius* | J. |
| R | Magpie | *Pica pica* | MG |
| R | Jackdaw | *Corvus monedula* | JD |
| R | Crow | *Corvus corone* | C. |
| R | Raven | *Corvus corax* | RN |
| R↑W | Starling | *Sturnus vulgaris* | SG |
| R | House Sparrow | *Passer domesticus* | HS |
| R↑W | Chaffinch | *Fringilla coelebs* | CH |
| R | Greenfinch | *Carduelis chloris* | GR |
| R | Goldfinch | *Carduelis carduelis* | GO |
| W | Siskin | *Carduelis spinus* | SK |

| | | | |
|---|---|---|---|
| R | Linnet | *Carduelis cannabina* | LI |
| W | Lesser Redpoll | *Carduelis cabaret* | LR |
| R | Bullfinch | *Pyrrhula pyrrhula* | BF |
| R | Reed Bunting | *Emberiza schoeniclus* | RB |

9.7.2. Bird species observed which are of conservation significance are as follows.

9.7.2.1 Species protected by their inclusion on schedule 1 of the *Wildlife and Countryside Act 1981*

Barn Owl, Kingfisher, Red Kite and Goshawk (see para. 9.6.3.1 for details). Fieldfare *Turdus pilaris* and Redwing *Turdus iliacus* are regular winter visitors.

9.7.2.2 Section 42 *Species of Principal Importance for Conservation of Biological Diversity* in Wales (annotate 'a', below) and RSPB *Birds of Conservation Concern Red List* (annotated 'b') which were recorded during the 2015 survey are as follows.

b Woodcock (winter visitor)
b Herring Gull (non-breeding)
ab Tree Pipit (occasional on passage)
b Grey Wagtail (resident)
ab Cuckoo (passage only)
b Fieldfare (winter visitor)
ab Song Thrush (resident)
b Redwing (winter visitor)
b Mistle Thrush (resident)
a Dunnock (resident)
ab Spotted Flycatcather (occasional on passage)
ab Marsh Tit (resident)
ab Willow Tit (resident)
ab Starling (increased numbers winter)
ab House Sparrow (resident)
ab Lesser Redpoll (winter visitor)
a Bullfinch (resident)
a Reed Bunting (resident)

9.7.2.3 Additional species listed on the RSPB *Birds of Conservation Concern Amber List*. Species recorded were as follows.

Grelag Goose (occasional non-breeder)
Gadwall (rare non-breeder)
Teal (occasional winter visitor)
Mallard (resident)
Shoveler (occasional winter visitor)
Snipe (winter visitor)
Lesser Black-backed Gull (occasional visitor)
Stock Dove (resident)
Barn Owl (resident)
Swift (passage)
Kingfisher (occasional visitor)
House Martin (passage)
Meadow Pipit (passage & winter)

Willow Warbler (passage)
Bullfinch (resident)

9.7.3 The available records indicate that since the development of the Botanic Garden, a total of 81 species have been noted within the estate during the non-breeding period but the site does not support significant numbers of any species nor does it support any regular winter aggregations.

The secondary woodlands established on the former lakes that it is proposed to reinstate, have no special winter and passage bird interest but nevertheless do provide a valuable resource for a large number of non-breeding birds, most occurring at low density. Species of high conservation concern likely to be affected include:

Woodcock (winter visitor),
Grey Wagtail (resident),
Fieldfare (winter visitor),
Song Thrush (resident),
Redwing (winter visitor),
Dunnock (resident),
Spotted Flycatcather (occasional on passage),
Marsh Tit (resident),
Willow Tit (resident),
Lesser Redpoll (winter visitor),
Bullfinch (resident)
Reed Bunting (resident)

An assessment of the likely impact of the Landscape Restoration project on these species is given at section 10.2.6:

## 9.8 **Reptiles** (Jacqueline Hartley)

Introduction

All potential reptile habitats within Survey Zones 1 and 2 were surveyed for the presence of reptiles by Jacqueline and Paul Hartley between May and July 2015. These habitats include areas of longer grass and vegetation that are not grazed or regularly cut which provide cover as well as open basking locations.

Context

Reptile species most likely to be present within the Survey Zones are Slow worm, Common lizard and Grass snake. All are listed on schedule 5 of the Wildlife and Countryside Act 1981 (as amended) which affords them protection against intentional killing or injuring and sale. They are also listed as *Species of Principal Importance for Conservation of Biological Diversity* in Wales under Section 42 of the Natural Environment and Rural Communities Act 2006.

Methods

The reptile survey was spread through May, June and July 2015 using artificial refugia comprising of squares of bituminized roofing felt and corrugated galvanized metal sheets. 150 refugia sheets were placed on 15th/16th May 2015 in habitats within the site that were assessed as most suitable to support reptiles. The locations of the refugia are shown on figure 9.8.

Following their deployment, the artificial refugia were left to 'bed in' for two weeks. They were then checked on seven occasions when the weather was dry with little or no wind and with an air temperature between 15.1°C and 22.9°C. Bright sunny days with no cloud cover were avoided.

In addition to the refugia survey, individual reptiles and their signs, such as sloughed skin, were sought throughout the site. Stones and other debris were also turned and replaced in search of animals.

Results

Low numbers of common lizard were recorded within areas 2, 2a and 3 of the reptile survey areas (figure 9.8.). The highest number of lizards recorded on any one visit was 3.

A single grass snake was recorded during the final check in area 3.

The full results are detailed at table 9.8.1.

Interpretation of results

This study concludes that the site provides habitat for low numbers of Common lizard and Grass snake.

Recommendations

During the implementation of the landscape restoration project the opportunity should be taken to provide appropriate terrestrial habitat enhancements, including subterranean hibernacula. Such action would improve the environment for reptiles and have the potential of increasing both numbers and species diversity.

## Table 9.8.1 Reptile Survey results including record of terrestrial-phase amphibians

| Date | Weather conditions including temperature and time of survey | Location | Reptiles recorded | Amphibians recorded |
|---|---|---|---|---|
| **Check 1** | | | | |
| 26 May 2015 | 80% cloud cover, wind speed 10mph north north west, air temperature – 15.1°C Survey started at 14.00 | 1 | | Common toad 2 juveniles |
| **Check 2** | | | | |
| 11 June 2015 | 65% cloud cover, wind speed 4mph north west, air temperature – 22.9°C Survey started at 14.30 | 1 | | Common toad 2 juvenile |
| | | 2a | Common lizard 1 adult | Common toad 4 juveniles |
| **Check 3** | | | | |
| 16 June 2015 | 95% cloud cover, wind speed 8mph north north easterly, air temperature - 17.1°C Survey started at 09.15 | 1 | | Common toad 3 juveniles |
| | | 2 | Common lizard 1 female | Common toad 3 juveniles |
| | | 2a | Common lizard 1 female, 1 male | Common toad 6 juveniles |
| **Check 4** | | | | |
| 02 July 2015 | 90% cloud cover, wind speed 5mph south west, air temperature – 17.5°C Survey start time 10.00 | 1 | | Common toad 1 juvenile |
| | | 2 | Common lizard 1 female | |
| | | 3 | Common lizard 1 adult | |
| **Check 5** | | | | |
| 16 July 2015 | 95% cloud cover, wind speed 8mph north north east air temperature – 22.1°C Survey started at 11.30 | 1 | | Common toad 3 juvenile |
| | | 4 | | Common toad 1 juvenile |
| **Additional record during Phase 1 Habitat Survey** | | | | |
| 21 July 2015 | Cloudy with brief sunny intervals. Fresh west to north-west wind, mild, remaining dry. | 1 | | Common toad 5 juveniles |
| **Check 6** | | | | |
| 18 August 2015 | 85% cloud cover, wind speed 8mph north north west, air temperature – 15.3°C Survey started at 09.30 | 1 | | Common toad 1 juvenile |
| | | 3 | | Common toad 1 juvenile |
| **Check 7** | | | | |
| 31 July 2015 | 50% cloud cover, wind speed 4mph southerly, air temperature – 18.4°C Survey started at 10.30 | 1 | | Common toad 3 juveniles |
| | | 2a | | Common toad 6 juveniles |
| | | 3 | Grass snake 1 adult | Common toad 1 juvenile |

## 9.9 **Amphibians** (Jacqueline Hartley)

Introduction

Amphibians require lakes, ponds, ditches or other water bodies in which to lay their eggs. Outside the breeding season and non-breeding animals during the spawning season, live a terrestrial life seeking shelter in shade and damp places and can be expected to occur at up to 1km away from their breeding sites. Within Survey Zones 1 and 2, potential terrestrial amphibian habitat includes areas of longer grass, woodland, scrub and hedge-bottoms.

Context

Amphibian species most likely to be present within the Survey Zones are Common toad, Common frog and Palmate newt. All are listed on schedule 5 of the Wildlife and Countryside Act 1981 (as amended) which affords them protection against intentional killing or injuring and sale. Common toad is also listed as *Species of Principal Importance for Conservation of Biological Diversity* in Wales under Section 42 of the Natural Environment and Rural Communities Act 2006.

Methods

During all 2015 survey visits, amphibians were sought and recorded. This included during the reptile survey undertaken during May, June and July using artificial refugia comprising of squares of bituminized roofing felt and corrugated galvanized iron (see section 9.9, above).

Results

Common toads were found throughout Survey Zones 1 and 2 and, in particular, many were attracted to the artificial reptile refugia located as shown on figure 9.9.1. Details of the locations and numbers recorded are at table 9.9.1.

One Common toad was also recorded in a dormouse tube in July, the location of which is indicated on figure 9.9. and other individuals were found during the Phase 1 habitat Survey, eg at TN15536 (north side of Waun Las Pond) on 11/8/15.

Common frogs were occasionally recorded in reptile survey area 3 (location shown on figure 9.9.) and immature individuals were noted during the Phase 1 Habitat Survey at TN15274 (north side of Llyn Canol, 30/5/15), TN15490 (west side of the drained Llyn Mawr, 28/7/15) and TN15566 (Bog Garden, 12/8/15).

A single Palmate Newt was found in the ice house during its inspection for roosting bats.

Interpretation of results

This study concludes that the site supports a good population of Common toad and smaller numbers of Common frog. Also small numbers of Palmate newts are present and, together with Common frog, may be breeding in the pond north of the gatehouse and other ponds eg the Dipping Ponds and in the Bog Garden..

Recommendations

During the implementation of the landscape restoration project the opportunity should be taken to provide appropriate breeding ponds and terrestrial habitat enhancements, including subterranean hibernacula. Such action would improve the environment for amphibians and have the potential of increasing numbers and species diversity.

## 9.10 **Invertebrates** (Barry Stewart)

### 9.10.1 Introduction

Eight non-marine invertebrates included on *Annex II* of the *EC Habitats & Species Directive* occur in Wales, none of which have been recorded at NBGW. The nearest area designated for protected invertebrates is the Caeau Mynydd Mawr SAC, which lies 2.5km to the south-east at its nearest point. Mynydd Mawr is notified for the Marsh Fritillary butterfly, which is an annex II European Protected Species and is also protected by its inclusion on schedule 5 of the *Wildlife and Countryside Act 1981* (as amended). The extent of suitable habitat, contained within more than 30 enclosures at Caeau Mynydd Mawr, suggests that this is one of the largest metapopulations in Wales.

Legal protection is afforded to a relatively small number of rare invertebrates which are listed under Schedule 5 of the *Wildlife and Countryside Act 1981* (as amended). Included are species of butterfly and moth, beetles, crickets, dragonflies, hemipteran bugs, spiders, crustaceans, molluscs and annelid worms. None of the listed species are known from the Garden estate and again only the Marsh Fritillary is found within the local area.

The list of *Species of Principal Importance for Conservation of Biological Diversity* in Wales under Section 42 of the *Natural Environment & Rural Communities Act 2006* includes a large number of invertebrate species that are less specialised than those protected under Schedule 5 of the *Wildlife and Countryside Act*. It is estimated that Welsh terrestrial and freshwater environments support more than 20,000 species of macro-invertebrates. One of the most represented groups on the list is the moths and butterflies (Lepidoptera) which includes 24 butterflies and 81 moths on the Section 42 list, with a further 71 moths listed as requiring urgent research.

### 9.10.2 Methods and sources of information

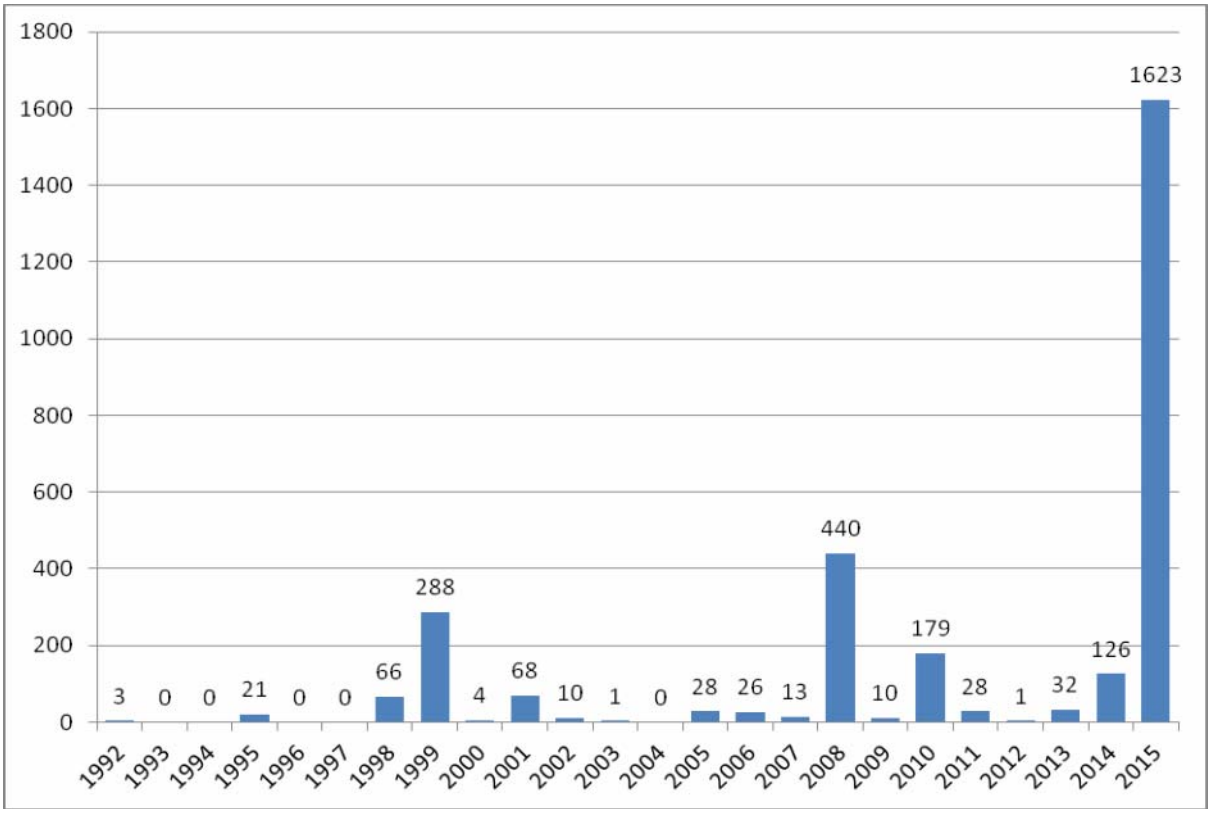
The records used in this report have been compiled over the period 1992 to 2015. A large number of records were collected by volunteers who, mostly undertook recording on an *ad hoc* basis, or focussing on a target group or species. Collectively a total of 37 different recorders have contributed 2969 records representing 13 discrete taxonomic groups from within the boundaries of the Garden estate, the desk study information being acquired from the West Wales Biological Information Centre (WWBIC) and also through consultation with conservation organisations and relevant individuals. The contributions of invertebate records collated for this report were produced by the following recorders:

| Recorder | Period | Records |
|---|---|---|
| Alastair Hotchkiss | 2008 | 285 |
| Anne Coker & Stephen Coker | 2008-2015 | 131 |
| Barry Stewart & Sandra Stewart | 2005-2015 | 1500 |
| Chris Manley | 2010 | 93 |
| Clare Flynn | 2014 | 50 |
| Clive Green | 2011 | 7 |
| Colin Russell | 2014 | 12 |

| | | |
|---|---|---|
| Dave Bannister | 2008-2014 | 27 |
| David Slade | 2001 | 66 |
| Ian McLean, Mike Pugh & Peter Chandler | 1995 | 21 |
| Ian Morgan | 1992 | 4 |
| Ian Tew | 2010 | 2010 |
| Isobelle Griffith | 2008 | 173 |
| Jan Crowden & Keith Crowden | 2015 | 1 |
| Janet Atkinson | 2010 | 5 |
| Jaqueline George | 2013 | 2 |
| Joanne Diamond | 2013 | 6 |
| John Langmaid | 2006 | 15 |
| Jon Baker | 2008 | 191 |
| L Williams | 1999 | 148 |
| Liz Howe & Mike Howe | 2000 | 4 |
| M. Raymond-Barr | 1999 | 95 |
| Marigold Oakley | 2015 | 141 |
| Mike Clark | 2003 | 1 |
| Peter Sturgess | 2014 | 4 |
| Peter Swire | 2001-2006 | 15 |
| Richard Becker | 2013 | 5 |
| Kath Pryce & Richard Pryce | 2005-2015 | 312 |
| Sam Bosanquet | 2008-2015 | 196 |
| Sarah Wall | 2014 | 3 |
| Steve Lucas | 1998-1999 | 106 |
| Tony Lewis | 2012 | 1 |

The period over which invertebrate recording has taken place extends from 1992 to 2015, figure 9.10.1 showing the most productive years for recording being 1999, 2008 and 2015. All records have been collated into a master spreadsheet, an electronic version of which, is provided as a supplement of the main report. A list of all species recorded is reproduced at appendix 15 and all invertebrate records at appendix 16.

**Figure 9.10.1. Annual totals of invertebrate records at NBGW**




Advice on targeted surveys was received from NRW and consideration was given to all species included on Section 42 list. Habitat details of the study area were already available prior to undertaking invertebrate sampling and a walkover was conducted to identify the habitat potential for key species and taxonomic groups. Invertebrate surveys were selected based on multiple criteria that included:

- Species of high conservation concern known to be present in the local area
- Speciose groups well represented in the principal habitats present within the study site
- Speciose groups where sampling techniques allow for a rapid accumulation of data
- Well studied groups where life history details are largely known and where there is a reasonable number of nationally rare/scrace and local species.
- Surveys of well known taxonomic groups to allow invertebrate assemblages to be assessed at local, regional and national levels
- Study of a number of readily identifiable and well known groups to provide good reference for non-specialists and to provide material for public interpretation

The Lepidoptera fulfil these criteria at all levels and were the invertebrate group to which most effort was focussed. However, other *ad hoc* sampling techniques were also employed to help provide baseline data for other groups. Those specifically targeted include dragonflies (Odonata), hoverflies (Diptera: Syrphidae), true bugs (Hemiptera) and bumblebees (Hymenoptera: Apinae). Samplng techniques included sweep-netting, beating, hand-searching, direct observation and mercury vapour light trapping.

Surveys were undertaken between May and October 2015 and coverage of the site during *ad hoc* sampling was extensive. Moth trapping locations were selected to provide data from representative habitats and to make use of available mains power supplies to extend the trap running times and to maximise use of the surveyors time.

9.10.3 Invertebrate Survey Results

The following totals of records and species are the combined results of all data gathered from the desktop data trawl, records held in the WWBIC database and results from the 2015 survey period:

| | Records | Species |
|---|---|---|
| Mollusca (slugs & snails) | 18 | 8 |
| Opiliones (harvestmen) | 7 | 6 |
| Araneae (spiders) | 9 | 3 |
| Odonata (dragonflies & damselflies) | 177 | 17 |
| Orthoptera (grasshoppers & crickets) | 9 | 5 |
| Ephemeroptera (mayflies) | 1 | 1 |
| Mecoptera (scorpion-flies) | 7 | 2 |
| Hemiptera (true bugs) | 49 | 28 |
| Trichoptera (caddisflies) | 30 | 14 |
| Lepidoptera (moths & butterflies) | 2570 | 513 |
| Diptera (true flies) | 257 | 94 |
| Coleoptera (beetles) | 78 | 42 |
| Hymenoptera (bees & wasps) | 115 | 24 |
| **Totals** | **3327** | **757** |

Only a limited number of invertebrate species are afforded legal protection in the UK; these are listed under Schedule 5 of the Wildlife and Countryside Act, 1981 (as amended). Of those that are afforded full protection none are known or suspected of occurring within the Garden estate. Those species listed on Section 9 (part 5) of the Act, which are protected from sale only, which might conceivably occur within the Garden estate include:

**White-letter Hairstreak *Stryrium w-album***: Suitable habitat occurs where there is elm (*Ulmus* spp.) in the canopy eg near Gorswen. Whilst searches for the species in 2015 were unsuccessful, the species is difficult to detect and requires patient and diligent searching, using binoculars to scan the canopy and locate trees, usually Ash, used by the butterfly. There are excellent resources online that will greatly assist with increasing the chances of locating the species e.g. http://www.hertsmiddx-butterflies.org.uk/w-album/w-album_tips.php

**Brown Hairstreak *Thecla betulae***: Suitable habitat occurs where there is lightly / unmanaged Blackthorn *Prunus spinosa* in hedgerows. The species has been

recorded as eggs in the band of scrub that separates North Trawscoed Meadow and Cae Blaen and it is likely it occurs at low desnity in other hedgerows around the site. Hedgerow management around the estate should be sympathetic to the requirements of the Brown Hairstreak, i.e. undertaking rotational hedge-cutting to ensure there is a succession of untrimmed Blackthorn hedge lengths around and radiating out from the Trawscoed Wood area. Butterfly Conservation have producd a very helpful information leaflet that provides clear guidance and advice for management practices to help maintain habitat in favourable condition for the Brown Hairstreak, which can be found here: http://butterfly-conservation.org/files/ari-0402m12-bc-brown-hairstreak-in-blackdown-hills-leaflet-final.pdf

Biodiversity Action Plans have been prepared to safeguard and help protect other key species of national and local significance. In Wales these are embraced by the Section 42 List of Species of Principal Importance but no species on this list have so far been recorded within the Garden estate, although White-letter Hairstreak (see above) might conceivably occur.

The Section 42 list also includes an additionally 71 common and widespread, but rapidly declining moths that have been included for research purposes only. Over 40 of these have either been recorded (bold in the list that follows) or are considered as likely to be found within the Garden estate:

**Grey Dagger** (*Acronicta psi*)
**Knot-grass** (*Acronicta rumicis*)
Flounced Chestnut (*Agrochola helvola*)
Beaded Chestnut (*Agrochola lychnidis*)
**Green Brindled Crescent** (*Allophyes oxyacanthae*)
**Ear Moth** (*Amphipoea oculea*)
Mouse Moth (*Amphipyra tragopoginis*)
**Dusky Brocade** (*Apamea remissa*)
**Garden Tiger** (*Arctia caja*)
Centre-barred Sallow (*Atethmia centrago*)
**Minor Shoulder-knot** (*Brachylomia viminalis*)
**Mottled Rustic** (*Caradrina morpheus*)
**Small Heath** (*Coenonympha pamphilus*)
**Small Square-spot** (*Diarsia rubi*)
**Small Phoenix** (*Ecliptopera silaceata*)
September Thorn (*Ennomos erosaria*)
Dusky Thorn (*Ennomos fuscantaria*)
August Thorn (*Ennomos quercinaria*)
Autumnal Rustic (*Eugnorisma glareosa*)
**Ghost Moth** (*Hepialus humuli*)
**The Rustic** (*Hoplodrina blanda*)
**Rosy Rustic** (*Hydraecia micacea*)
**Brindled Beauty** (*Lycia hirtaria*)
**Lackey** (*Malacosoma neustria*)
**Dot Moth** (*Melanchra persicariae*)
**Broom** (*Melanchra pisi*)
**Rosy Minor** (*Mesoligia literosa*)

**Shoulder-striped Wainscot** (*Mythimna comma*)
**Oblique Carpet** (*Orthonama vittata*)
**Powdered Quaker** (*Orthosia gracilis*)
**Large Wainscot** (*Rhizedra lutosa*)
**Shaded Broad-bar** (*Scotopteryx chenopodiata*)
**White Ermine** (*Spilosoma lubricipeda*)
**Buff Ermine** (*Spilosoma luteum*)
Hedge Rustic (*Tholera cespitis*)
**Feathered Gothic** (*Tholera decimalis*)
**Blood-vein** (*Timandra comae*)
**The Cinnabar** (*Tyria jacobaeae*)
**Oak Hook-tip** (*Watsonalla binaria*)
**The sallow** (*Xanthia icteritia*)
**Dark-barred Twin-spot Carpet** (*Xanthorhoe ferrugata*)

The following Red Data Book and Nationally Notable species have been recorded within the Garden estate:

Red Data Book

**a leaf beetle** *Hydrothassa hannoveriana* RDB3
**a longhorn beetle** *Stictoleptura rubra* RDBK
The larvae of *Stictoleptura rubra* develop in old dead wood and tree stumps, mainly in conifers. Dead wood is a highly prized resource for all longhorn beetles and ensuring there is a succession of different timbers, including standing dead wood, in a wide variety of situations should provide habitats to support a diverse saproxylic invertebrate community. Additional surveys on this group would be beneficial to help determine the significance of the dead wood community.
*Hydrothassa hannoveriana* is associated with Marsh-marigold *Caltha palustris* along with its congenors and identification is problematic. The lack of a voucher together with failure in relocating the species in 2015, despite targeted searches which yielded only the commoner *H. marginella*, suggests the species may have been misidentified. However, there are disjunct populations in southern England and it may reappear in future. To ensure that suitable habitat is provided, a patchwork of open fen with frequent Marsh Marigold should be maintained in marginal habitats around the lakes.

Nationally Scarce A

**a plant bug** *Adelphocoris seticornis*
**Scarce Burnished Brass** *Diachrysia chryson*
It seems likely that *Adelphocoris seticornis* has increased its range in recent years, but until a clearer understanding emerges of the extent of the expansion, the areas of tall fen and marshy grassland in which the species occurs at NBGW should be considered to be of regional importance for this species. Hemp Agrimony is the larval foodplant of the Scarce Burnished Brass and the species should be encouraged to become better established areas of tall fen and marginal habitats at various locations around the estate.

Nationally Scarce B

**a micro-moth** *Argolamprotes micella*
**a micro-moth** *Bohemannia quadrimaculella*
**a micro-moth** *Elachista alpinella*
**a micro-moth** *Elachista biatomella*
**a micro-moth** *Eudonia delunella*
**a micro-moth** *Phlyctaenia stachydalis*
Blomer's Rivulet *Discoloxia blomeri*
**Lead-coloured Pug** *Eupithecia plumbeolata*
**Valerian Pug** *Eupithecia valerianata*
**Waved Carpet** *Hydrelia sylvata*
**Devon Carpet** *Lampropteryx otregiata*
**Double Line** *Mythimna turca*
**a micro-moth** *Pammene populana*
**Plume Moth** *Platyptilia isodactylus*
White Letter Hairstreak *Stryrium w-album*

Nationally Scarce (unspecified)

**a hoverfly** *Rhingia rostrata* Ball & Morris (2014) indicate the species has rapidly expanded it range with 209 post-1980 hectads. It is said to abundant in the Sussex Weald, parts of South Wales and the West Midlands. There have also been recent records from the East Midlands.
**a hoverfly** *Brachypalpoides lentus*
**a hoverfly** *Sphaerophoria philanthus*
Both species are included in a list of species which are too widespread to qualify as Nationally Scarce, but which appear to be declining in the UK (Ball & Morris, 2014)

The following species have been recorded within the Garden estate and are listed as 'Local' at National or Regional levels:

Local Nationally

**Hairy Dragonfly** *Brachytron pratense*
**a true bug** *Aquarius najas*
**a true bug** *Macropsis prasina*
**Yellow-barred Brindle** *Acasis viretata*
**Strawberry Tortrix** *Acleris comariana*
**Alder Moth** *Acronicta alni*
**a micro-moth** *Agonopterix angelicella*
**Sallow Flat-body** *Agonopterix conterminella*
**a micro-moth** *Agriphila selasella*
**Double Lobed** *Apamea ophiogramma*
**Slender Brindle** *Apamea scolopacina*
**a micro-moth** *Apodia bifractella*
**Red-necked Footman** *Atolmis rubricollis*
**a micro-moth** *Bucculatrix nigricomella*
**a micro-moth** *Calamotropha paludella*
**Pearl-band Grass Veneer** *Catoptria margaritella*
**Brussels Lace** *Cleorodes lichenaria*

**Small Rufous** *Coenobia rufa*
**a micro-moth** *Coleophora paripennella*
**Coronet** *Craniophora ligustri*
**a micro-moth** *Cryptoblabes bistriga*
**Clay Triple-lines** *Cyclophora linearia*
**Small Elephant Hawk-moth** *Deilephila porcellus*
**a micro-moth** *Dichrorampha acuminatana*
**a micro-moth** *Digitivalva pulicariae*
**Marbled Brown** *Drymonia dodonaea*
**a micro-moth** *Ebulea crocealis*
**a micro-moth** *Ectoedemia intimella*
**Small Engrailed** *Ectropis crepuscularia*
**a micro-moth** *Eidophasia messingiella*
**Buff Footman** *Eilema depressa*
**Orange Footman** *Eilema sororcula*
**Dingy Shell** *Euchoeca nebulata*
**White-spotted Pug** *Eupithecia tripunctaria*
**Golden-rod Pug** *Eupithecia virgaureata*
**Alder Kitten** *Furcula bicuspis*
**a micro-moth** *Heliozela resplendella*
**Map-winged Swift** *Hepialus fusconebulosa*
**Gold Swift** *Hepialus hecta*
**Beautiful Snout** *Hypena crassalis*
**Silver-barred Clothes** *Infurcitinea argentimaculella*
**Double Kidney** *Ipimorpha retusa*
**Dog's Tooth** *Lacanobia suasa*
**Sharp-angled Peacock** *Macaria alternata*
**a micro-moth** *Micropterix tunbergella*
**Rosy Footman** *Miltochrista miniata*
**a micro-moth** *Mompha propinquella*
**a micro-moth** *Monochroa tenebrella*
**Southern Wainscot** *Mythimna straminea*
**a micro-moth** *Nematopogon metaxella*
**Least Black Arches** *Nola confusalis*
**Rufous Minor** *Oligia versicolor*
**a micro-moth** *Olindia schumacherana*
**a micro-moth** *Opsibotys fuscalis*
**Reed Smudge** *Orthotelia sparganella*
**Small yellow underwing** *Panemeria tenebrata*
**Beech Slender** *Parornix fagivora*
**a micro-moth** *Pempeliella dilutella*
**Grass Rivulet** *Perizoma albulata*
**a micro-moth** *Phtheochroa inopiana*
**Scorched Wing** *Plagodis dolabraria*
**Barred Umber** *Plagodis pulveraria*
**Frosted Green** *Polyploca ridens*
**a micro-moth** *Psychoides filicivora*
**Small Seraphim** *Pterapherapteryx sexalata*
**a micro-moth** *Ptocheuusa paupella*

**Pinion-streaked Snout** *Schrankia costaestrigalis*
**Cream Wave** *Scopula floslactata*
**a micro-moth** *Semioscopis steinkellneriana*
**a micro-moth** *Stigmella alnetella*
**a micro-moth** *Syncopacma taeniolella*
**Round-winged Muslin** *Thumatha senex*
**Barred Hook-tip** *Watsonalla cultraria*
**Triple-spotted Clay** *Xestia ditrapezium*
**Red Sword-grass** *Xylena vetusta*
**Willow Ermine** *Yponomeuta rorrella*
**Five-spot Burnet** *Zygaena trifolii*

9.10.3 Invertebrate Survey Conclusions

Using the criteria in table 10.1 (see next section), the value of the habitats for invertebrates within the Garden estate as a whole is considered as being of 'County' significance. The key elements that help support the rich diversity of invertebrates that the sampling has revealed, include habitat and structural diversity over a wide area, with vegetation diversity playing an important role. The low-intensity management, in particular, of the richest meadows, provide an important resource for many invertebrate species and the connectivity of grasslands and woodland facilitates their dispersal. There are no species of such high significance that they require any specialised management treatment especially as the existing management regime is generally symapatheic towards encouraging a diverse and productive invertebrate community.

Included at section 11.20 are some generalised recommendations for invertebrate habitat management and links to more detailed resources are provided as examples of good management practices for key habitats at the Garden:

## 9.11 Other species of significance

9.11.1 **Polecat, Hedgehog** and **Brown Hare** are Section 42 Species of Principal Importance and might be expected to occur on the Garden estate, at least occasionally[9].

Polecat is a nomadic species which was recorded near the Gatehouse at they Garden in 2014. However, it must be regarded as a very infrequent visitor and when it does visit the site, is unlikely to stay for any length of time. The landscape restoration project is unlikely to have a significant impact upon this species.

Brown Hare is generally confined in Carmarthenshire to relatively large open areas of mainly extensively managed farmland and marginal or unimproved land. The Garden estate offers suitable habitat for hares and animals have been seen in the area in the past. It is anticipated, however, that the landscape restoration project will have no significant impact upon the local hare population and, in the long term, as a result of the intention to restore and maintain a landscape of wider, open vistas, could provide more suitable habitat offering a potential gain for the species.

[9] Included under Section 42 of the Natural Environment and Rural Communities Act 2006 as *Species of Principal Importance for Conservation of Biological Diversity* in Wales which causes them to be a material consideration through the planning process.

Hedgehog is likely to frequent areas to be disturbed and individuals are likely to be displaced during site operations. However, in the long term, the project is unlikely to significantly affect this species.

9.11.2 No additional protected or significant species were identified within the Garden estate or its vicinity during the assessment and none are likely to be dependant upon the habitats which are present.

# 10. ECOLOGICAL ASSESSMENT

## 10.1. Assessment criteria

Impact significance has been assessed for each of the features using a three stage process: An assessment of ecological value; an assessment of the magnitude and extent of the likely impacts; and a determination of impact significance based on a combination of ecological value and magnitude/extent. This approach is based upon the CIEEM Guidelines (2006)

***Ecological Significance***

Each feature has been classified according to its ecological significance using the examples provided in Table 10.1.

**Table 10.1. Assessment of Ecological Significance**

| Value | Examples |
|---|---|
| **International** | • Internationally designated or proposed sites such as Ramsar Sites, Special Protection Areas, Biosphere Reserves and Special Areas of Conservation, or otherwise meeting criteria for international designation.<br>• Sites supporting populations of internationally important species. |
| **UK/National** | • Nationally designated sites such as Sites of Special Scientific Interest (SSSIs), or non-designated sites meeting SSSI selection criteria, National Nature Reserves (NNRs), Nature Conservancy Review (NCR) Grade 1 sites, viable areas of key habitats within the UK Biodiversity Action Plan.<br>• Sites supporting viable breeding populations of Protected and Red Data Book (RDB) species (excluding scarce species), or supplying critical elements of their habitat requirements. |
| **Regional** | • Sites containing viable areas of threatened habitats listed in a regional Biodiversity Action Plan, comfortably exceeding Site of Importance for Nature Conservation (SINC) criteria, but not meeting SSSI selection criteria.<br>• Sites supporting viable populations of Nationally Scarce species or those included in the Regional Biodiversity Action Plan on account of their rarity, or supplying critical elements of their habitat requirements. |
| **County** | • Sites meeting the criteria for a county or metropolitan area designation (such as SINC), which may include amenity and educational criteria in urban areas. Ancient semi-natural woodland. Designated Local Nature Reserves. Sites containing viable areas of any key habitat type identified in the Local Biodiversity Action Plan (LBAP).<br>• Sites supporting viable breeding populations of species known to be county/metropolitan rarities e.g. featuring in county 'red data book' or LBAP, or supplying critical elements of their habitat requirements. |

| | |
|---|---|
| **District** | • Undesignated sites, or features considered appreciably to enrich the habitat resource within the context of the Borough or District, or included in the Borough or District LBAP. Amenity and educational functions will be recognised in urban areas.<br>• Sites with viable breeding populations of species listed as rare in the District or Borough LBAP or supplying critical elements of their habitat requirements. |
| **Local** | • Undesignated sites, or features considered appreciably enriching the habitat resource within the context of the Parish or neighbourhood (e.g. a species-rich hedgerow). |
| **Not important** | • Low-grade and widespread habitats or feature not affected by proposals. |

***Magnitude and Extent of Impact***

The magnitude of each predicted impact has been assessed on a scale of High, Medium, Low, Minimal, Negligible and Potential Net Gain according to the criteria in Table 10.2.

**Table 10.2. Criteria for determining Magnitude and Extent of Impact**

| Magnitude | Criteria |
|---|---|
| **High** | Loss of about 50% or more of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of >50% of the site area. |
| **Medium** | Loss affecting 20-49% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 20-49% of the site area. |
| **Low** | Loss affecting 4-19% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 4-19% of the site area. |
| **Minimal** | Loss affecting up to 4% of the site area. Other effects (e.g. disturbance or damage arising from pollution) including indirect impacts having an adverse impact equivalent in nature conservation terms to a loss of 4% of the site area. |
| **No Impact** | No anticipated effects resulting from the implementation of the proposals. |
| **Potential Net Gain** | Mitigation will seek to increase the extent of existing habitats or replace lost habitats with larger areas of suitable habitats. Such areas will be established and, where significant species are to be displaced, in a state ready for colonisation prior to any proposed habitat disturbance. |

***Significance of Impact***

Table 10.3. illustrates how significance has been assigned to the impact, based on a combination of the value of the feature being assessed. This has been expressed on a five-point scale ranging from Severe to Negligible as shown below.

**Table 10.3. Criteria for determining Significance of Impact**

| Impact Magnitude and extent | Ecological Significance | | | | | | |
|---|---|---|---|---|---|---|---|
| | Inter-national | UK/ National | Regional | County | District | Local | Not important |
| **High** | Severe | Major | Major | Major | Moderate | Minor | Minor |
| **Medium** | Major | Major | Moderate | Moderate | Moderate | Minor | Negligible |
| **Low** | Moderate | Moderate | Minor | Minor | Minor | Negligible | Negligible |
| **Minimal** | Minor | Minor | Negligible | Negligible | Negligible | Negligible | Negligible |
| **No Impact** | Negligible | Negligible | No impact | No impact | No impact | No impact | No impact |
| **Potential net gain** | Potential net gain | Potential net gain | Potential net gain | Potential net gain | Potential net gain | Potential net gain | Potential net gain |

## 10.2. Impact Assessment of protected sites, significant habitats and significant species

### 10.2.1. Protected Sites

There are no statutory protected sites within the Garden estate although much is designated as a National Nature Reserve. Statutorily protected sites within the vicinity are included below.

Statutorily protected sites of European conservation significance which have been declared as Special Areas of Conservation under the Habitats Regulations are as follows:

- The **Afon Tywi/River Towy SAC** runs within about 2km to the north of the NBGW estate but none of the Tywi tributaries are included in the SAC designation. The Afon Gwynon and its tributaries which drain NBGW land flow directly into the Tywi. Otter is one of the qualifying reasons for the selection of this SAC and animals use, not only the Tywi, but also its tributaries, including, infrequently, the Gwynon and connected watercourses and riparian habitat within NBGW. The other qualifying reasons include the presence of a range of fish species including lampreys and shads, as well as Bullhead. Bullhead is certain to occur in the Gwynon and could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. However, any disturbance to this population is unlikely to adversely affect the Tywi population due to its isolation. Furthermore, the reinstatement of the lakes as planned will, in the

longer term, result in a substantial increase in the extent of suitable habitat available to this species.

All these species could be adversely affected by a deterioration in water quality should run-off or other potential pollution incidents not be contained during the restoration works.

Anticipated Significance of Impact during site operations:
**MINOR ADVERSE** (International ecological significance, Minimal magnitude)
Potential Significance of Impact during site operations should any pollution incident not be adequately contained:
**MINOR ADVERSE** (International ecological significance, Low magnitude)
Significance of Residual Impact:
**NEGLIGIBLE to SLIGHT POTENTIAL NET GAIN**
(International ecological significance, No Impact to slight potential net gain)

- The Afon Tywi flows into the **Carmarthen Bay and Estuaries SAC** which extends to Pibwrlwyd, just downstream of Carmarthen, some 11km west of the NBGW estate. Otter is also a qualifying reason for the selection of this SAC. There is a very small chance that any deterioration in water quality in the Tywi resulting from the site operations during the restoration project could also affect the waters of Carmarthen Bay.

  Anticipated Significance of Impact during site operations:
  **NEGLIGIBLE** (International ecological significance, No impact)
  Potential Significance of Impact during site operations should any pollution incident not be adequately contained:
  **MINOR ADVERSE** (International ecological significance, Minimal magnitude)
  Significance of Residual Impact:
  **NEGLIGIBLE** (International ecological significance, No Impact)

- The **Cernydd Carmel SAC** extends to within some 3.5km south-east of the NBGW estate. The Pentregwenlais Turloch is the primary reason for the selection of this SAC with wet and dry heath, active raised bog and Tilio-Acerion woodland as qualifying features. There is no hydrological connection between this SAC and the NBGW estate and no SAC features will be affected by the proposed NBGW landscape works.

  Significance of Impact during site operations:
  **NEGLIGIBLE** (International ecological significance, No impact)
  Significance of Residual Impact:
  **NEGLIGIBLE** (International ecological significance, No Impact)

- The **Caeau Mynydd Mawr SAC** extends to within some 7km south-east of the NBGW estate. The population of Marsh Fritillary butterfly is the primary reason for the selection of this site with *Molinia* meadows being a qualifying feature. No suitable habitat in a condition to support Marsh Fritillary currently occurs within the Garden estate and 'stepping-stones' of suitable habitat to provide habitat connectivity are also lacking. No primary or qualifying SAC features will be affected by the proposed NBGW landscape works.

  Significance of Impact during site operations:
  **NEGLIGIBLE** (International ecological significance, No impact)
  Significance of Residual Impact:
  **NEGLIGIBLE** (International ecological significance, No Impact)

No other statutory or non-statutory protected sites (including nature reserves or other sites of nature conservation interest) which might be adversely impacted by the proposed works occur within the survey site or its vicinity.

Statutorily protected sites of national conservation significance which have been declared as Sites of Special Scientific Interest (SSSI) under section 28(5)(b) of the Wildlife and Countryside Act 1981 located within about 5km of the NBGW estate are as follows. Sites are listed in order of increasing distance from the estate.

- **Wernbongham stream section and quarry SSSI** is notified for its important exposure of rocks straddling the Silurian – Devonian boundary critical in the interpretation of the change from marine to non-marine environments. It is located only some 125m from the north-western boundary of the NBGW estate.
- **Afon Tywi SSSI** includes the river channel and banks between Llandovery to below Carmarthen. Its closest point is located some 2km to the north of NBGW.
- **Cwm-yr Abbey stream section SSSI** is a geological site exposing rocks of Arenig age yielding an important trilobite fauna and is located 2km to the north-west of NBGW.
- **Coedydd-y-Garn SSSI** primarily comprises of woodland growing on Carboniferous Limestone and supports a wide range of characteristic flora and fauna. It is located some 2.5km to the south-southwest of NBGW.
- **Gweunydd a Choed Pen-ty (Pen-ty Pastures & Wood) SSSI** is of botanical and entomological importance and is located 3.25km to the west-southwest of NBGW.
- **Ynys Uchaf SSSI** is a mire occupying part of the Gwendraeth Fach flood-plain and is located 3.5km to the south-west of NBGW.
- **Allt-y-Gaer SSSI** was notified for its large heronry and is located some 4.1km to the north-east of NBGW.
- **Mynydd Llangyndeyrn SSSI** is an extensive area grassland, heath and rock outcrops on the Millstone grit ridge near Crwbin and is located some 4.1km to the south-west of NBGW.
- **Waun-fawr SSSI** is a small basin mire located some 4.1km to the south-west of NBGW.
- **Cernydd Carmel SSSI** includes a diverse range of habitats developed on Carboniferous Limestone and Millstone Grit including woodland, various types of grasslands, heaths and mires, as well as disused limestone quarries. It is located some 4.25km to the east-southeast of NBGW.
- **Caeau Rhyd-y-Gwiail SSSI** near Gorslas supports neutral and wet grassland vegetation, wet heath and scrub and is located some 4.5km to the south-east of NBGW.
- **Llyn Llech Owain SSSI** on the Millstone Grit ridge near Gorslas is an acid lake exhibiting upland features although situated at relatively low altitude, and located some 4.75km to the south-east of NBGW.

With the exception of the Afon Tywi which has been assessed under protected sites of European significance above, none of the SSSIs listed will be impacted by the proposed landscape restoration project.

Significance of Impact during site operations:

**NEGLIGIBLE** (UK/national ecological significance, No impact)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/national ecological significance, No Impact)

Nature Reserves and other sites of nature conservation interest

- **Waun Las National Nature Reserve** includes the majority of the land within the Garden estate and much of the landscape restoration works will take place within this area. An overall assessment of the impacts on the NNR must consider all the impacts on the constituent features for which it has been designated. Overall, whilst there is likely to be disruption to both habitats and some species during the restoration works, the resulting landscape will include restored and enhanced habitats suitable to support existing flora and fauna as well as potentially increasing species diversity and holding capacity.

  Significance of Impact during site operations:

  **MAJOR ADVERSE** (UK/national ecological significance, Medium magnitude)

  Significance of Residual Impact:

  **NEGLIGIBLE to POTENTIAL NET GAIN**

  (UK/national ecological significance, No Impact to potential net gain)

- **Carmel Woods National Nature Reserve** includes parts of Cernydd Carmel SAC and SSSI (see above) and is located some 4.25 km to the east-southeast of NBGW. This NNR will not be impacted by the proposed landscape restoration project.

  Significance of Impact during site operations:

  **NEGLIGIBLE** (UK/national ecological significance, No impact)

  Significance of Residual Impact:

  **NEGLIGIBLE** (UK/national ecological significance, No Impact)

Designated areas of Semi-Natural Ancient Woodland located within about 3km of the NBGW estate are as follows. Designated areas are listed in order of increasing distance from the estate. It should be noted that ancient woodland sites must extend to a minimum area of 2ha to qualify for designation but that many additional woodlands of ancient character and provenance but of lesser area may also be present within the area of search.

- Pont Felin-gât woodland, within NBGW, occupies much of the area north and north-east of the site of Llyn Mawr and extends north-westwards outside the Garden estate along the course of the Afon Gwynon for about 300m. It includes part of the former Llyn Felin-gât and Middle Pond so the woodland habiatt which has regrown since the silting-up of these waterbodies is likely to be disturbed whilst other parts may be thinned.
- Garreg Goch isaf wood adjoins the north-eastern boundary of NBGW (on the opposite side of the Allt Goch Lodge – Pantwgan road) and extends a further c.500m eastwards.
- Allt fawr is located some 1.1km to the north-east of NBGW.
- Allt Cae-blawd and Dan-yr-Allt wood is located some 1.25km to the north of NBGW.

- Allt Clos-glas wood is located some 1.25km to the east of NBGW beyond Garreg Goch isaf wood.
- Cwm-du wood is located some 1.25km to the north-west of NBGW.
- Cwmeiddon wood, Foelgastell, is located some 2km to the south-east of NBGW.
- Penybanc wood, Foelgastell, is located some 2km to the south-east of NBGW.
- Allt Rhyder-Wen is located some 2.1km to the east-northeast of NBGW.
- Wern-las – Capel Begewdin – Llawrcwrt woodlands are located some 2.3km to the south-southwest of NBGW.
- Banc-y-Mansel wood is located some 2.5km to the south-southeast of NBGW.
- Cwmisgwyn wood, Llanddarog, is located some 2.5km to the south-west of NBGW.
- Llethr Llestri wood, Cwmisfael, is located some 2.5km to the south-west of NBGW.
- Pen-y-banc-isaf wood, north of Y Polin, is located some 2.6km to the west-northwest of NBGW.
- Allt Pant-mawr is located some 2.9km to the east-northeast of NBGW.
- Kincoed wood, Abercothi, is located some 2.9km to the north-west of NBGW.
- Ty Picca wood, Cwmisfael, is located some 2.9km to the west-southwest of NBGW.

The impact of the proposed landscape restoration project upon Pont Felin-gât woodland will be limited to the removal of secondary growth in order to restore the waterbodies and some thinning to restore the parkland landscape.

Significance of Impact during site operations:

**MODERATE ADVERSE** (UK/national ecological significance, Low magnitude)

Significance of Residual Impact:

**MODERATE ADVERSE** (UK/national ecological significance, Low magnitude)

Impact of the proposed landscape restoration project on the other designated areas of ancient woodland.

Significance of Impact during site operations:

**NEGLIGIBLE** (UK/national ecological significance, No impact)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/national ecological significance, No Impact)

10.2.2. **County Wildlife Sites**

County Wildlife Sites (also known as Sites of Importance for Nature Conservation (SINCs) or Sites of Nature Conservation Importance (SNCIs)) have not been designated in Carmarthenshire. The county authority relies on the protection of habitats and species at a county level afforded by section 74 of the Countryside and Rights of Way Act 2000 as reviewed under section 40 of the Natural Environment and Rural Communities Act 2006 and listed under section 42 of that Act. Where these habitats are present in and around the assessment site, they have been assessed in the following paragraph.

10.2.3. **Habitats**

**Habitats of European Significance**

Habitats of European significance listed at Annex I of the *European Habitats Directive* which are present within the survey site include:

Old Oak woods with *Ilex* and *Blechnum* in the British Isles

Although extensively modified by replanting, many woodland and scrub-woodland areas within the Garden estate should be included in this category. However, the woodlands of the Gwynon valley and the tributary valley extending to Llyn Mawr bear little relationship to classic British oakwoods except in the composition of their ground flora. There are more typical examples of this annex 1 habitat located, for example, along the eastern periphery of the estate but these are unlikely to be affected by the proposed landscape restoration works. It is therefore judged that no woodland of this type which is sufficiently pristine or undisturbed to be of European significance will be affected by site operations.

Significance of Impact during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Significance of Residual Impact:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Molinia meadows on chalk and clay (Eu-Molinion)

Very few stands of this vegetation type (identified as M25 and M25c on the NVC map) are present in the Garden estate. Furthermore, they occur, only as very small fragmented areas and are generally in a poor and unmanaged or under-managed state which has resulted in a loss of their species diversity. None of these stands are within the area which is likely to be disturbed by works associated with the Regency landscape restoration project but, nevertheless, the project provides an opportunity to procure resources to restore these important grasslands to a favourable status.

Significance of Impact during site operations:

**NEGLIGIBLE** (International ecological significance, No Impact)

Significance of Residual Impact in the longer term if existing under-management continues, resulting in a prolonged further decline in habitat quality:

**MAJOR ADVERSE** (International ecological significance, Medium magnitude)

Significance of Residual Impact if resources are procured which allow for the introduction of positive conservation management to restore these grasslands:

**POTENTIAL NET GAIN** (International ecological significance, Potential net gain)

It is anticipated that no other habitats of European significance will be affected by the proposals.

**Habitats of UK/National Significance**

**Section 42 Habitats of Principal Importance[10] and UK Biodiversity Action Plan Priority Habitats**

*Habitats of Principal Importance for Conservation of Biological Diversity* in Wales and *UK Biodiversity Action Plan Priority Habitats* which occur within the Garden estate are as follows.

Wood pasture and parkland (included in Broadleaved, mixed and yew woodland)

Much of the open pastoral land with isolated trees and spinneys to the east and south of the formal Botanic Garden site is included in this category. It is anticipated that significant areas

[10] *Habitats of Principal Importance for Conservation of Biological Diversity* in Wales were identified at Section 74 of the Countryside and Rights of Way Act 2000 and reviewed under section 40 of the Natural Environment and Rural Communities Act 2006 and listed under section 42 of that Act. These habitats, by their listing under section 42, whilst not protected, are a material consideration through the planning process. There is generally a requirement to ensure their retention and future management or, if they cannot be retained, acceptable mitigation will need to be agreed and implemented.

may be disturbed by site operations but a meaningful assessment of impact cannot be made until details of the extent of land to be affected is known. However, after the completion of the project, land restoration and management, together with planting of additional parkland trees will mitigate any losses and is likely to result in a potential net gain in the medium to long term.

Possible significance of Impact during site operations:

**MAJOR - MODERATE ADVERSE**

(UK/National ecological significance, Medium - Low magnitude)

Significance of Residual Impact:

**NEGLIGIBLE to POTENTIAL NET GAIN**

(UK/National ecological significance, No impact to potential net gain)

Wet woodland (included in Broadleaved, mixed and yew woodland)

Within Survey Zone 1

Several areas of wet woodland are located within the area to be disturbed during proposed site operations. The most extensive of these are

1) the mature Alder-dominated stands along the tributary stream which fed Felin-gât Pond and some smaller similar stands along the Afon Gwynon,
2) the secondary Alder-willow dominated woodland which has become established on the bed of the drained Felin-gât Pond,
3) the mature Alder dominated woodland established on the silted bed of the former Llyn Gwynon, and
4) the younger, mainly willow-dominated scrub which is colonising the drained bed of Llyn Mawr.

The natural Alder stands an the banks of the Gwynon and its tributary are unlikely to be significantly impacted by proposed site works. The anticipated impact on these woodland stands is:

Significance of Impact during site operations:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/National ecological significance, No Impact)

It is anticipated that the majority of the secondary woodlands established on lake and pond beds will be removed when the water-bodies are reinstated and their loss will not be mitigated, although disturbance to protected and other significant species that they support will require mitigation. It must be borne in mind that these are secondary woodlands which have colonised a previous anthropogenic habitat and cannot therefore be considered as pristine and of as much value as, for instance, the natural woodlands along the river and stream banks. The anticipated impact on these secondary woodland stands is:

Significance of Impact during site operations:

**MAJOR ADVERSE** (UK/National ecological significance, High magnitude)

Significance of Residual Impact:

**MAJOR ADVERSE** (UK/National ecological significance, High magnitude)

Outside Survey Zone 1

The most extensive areas of wet woodland in this area are the Alder-willow woodlands located in the south-west of the Garden estate and shown on the NVC map. There are also willow plantations established in the past 10 – 15 years which could be included in this category. None of these areas are likely to be disturbed by the landscape restoration project.

Significance of Impact during site operations:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/National ecological significance, No Impact)

Lowland mixed deciduous woodland (included in Broadleaved, mixed and yew woodland)

Excluding the wet woodland assessed above, most of the remainder of the woodland within the Garden estate can be included in this category. Some areas may be affected by the proposed works but it is likely that the majority will remain undisturbed. It is anticipated that retained areas of this habitat disturbed during the project will naturally recover in the short to medium term.

Significance of Impact during site operations:

**MODERATE ADVERSE** (UK/National ecological significance, Low magnitude)

Significance of Residual Impact:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Hedgerows and boundary tree-lines (included in Boundary and linear features)

Only ten hedgerows within Survey Zones 1 and 2 satisfy the definition of hedgerow as stated in the Hedgerow Regulations 1997. However, for the purposes of the assessment of hedgerow habitats, boundary tree lines have been included. Several hedgerows and/or tree lines are likely to be removed or disturbed during the landscape restoration works. The following is a provisional assessment and will depend on the extent of disturbance. Hedgerows within and around the Garden estate support Dormice and their removal will therefore require the issue of a European Protected Species Disturbance Licence by NRW prior to any work commencing

Significance of Impact during site operations assuming that between 4% and 19% of hedgerows/treelines will be removed:

**MODERATE ADVERSE** (UK/National ecological significance, low magnitude)

Significance of Residual Impact assuming mitigation replaces lost habitat:

**MINOR ADVERSE** (UK/National ecological significance, minimal magnitude)

Arable field margins (included in Arable and horticultural)

Although small areas of 'arable' field margin vegetation were recorded during the Phase 1 habitat survey (eg TN15413), they are extremely small, mainly confined to the vicinity of field gateways and of very limited species composition when compared with good examples of this habitat type. These areas necessarily depend on soil disturbance and any temporary losses will be replaced in different locations each year depending upon which fields are ploughed and seeded. The quality of this habitat at NBGW does not qualify it to be of national, regional or county interest, nor even of local interest.

Potential significance of Impact during site operations:

**NEGLIGIBLE** (Not important ecological significance, Low magnitude)

Significance of Residual Impact:

**NO IMPACT** (Not important ecological significance, No Impact)

Lowland meadows (included in Neutral grassland)

Several large areas of lowland meadow grassland of high or moderate quality (NVC MG5 and NVC MG6 communities)occur within Survey Zone 2 but none in Zone 1. These include The Butterfly orchid meadow (North Trawscoed) and the undisturbed parts of the Grow the Future field. Other areas occur within the estate but outside these zones.

It is anticipated that all lowland meadow grassland of conservation interest will be retained and not disturbed as a result of proposed site operations. However, some areas have

deteriorated in the past due to insufficient grazing or other inappropriate management which should be addressed to maintain and restore affected areas to favourable conservation status in future.

Significance of Impact during site operations:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Significance of Residual Impact:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Significance of Residual Impact assuming that appropriate management maintains existing and restores damaged areas to favourable status:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential get gain)

Lowland dry acid grassland (included in Acid grassland)

Only very small areas of this grassland type (NVC U4) are present within the Garden estate and should be retained and protected from damage during site operations. It may be possible to enhance the favourability of the conservation status of these areas by improved conservation management in future.

Significance of Impact during site operations:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/National ecological significance, No Impact)

Significance of Residual Impact assuming that improved management enhances these areas to higher conservation status:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential get gain)

Purple moorgrass and rush pastures (included in Fen, marsh and swamp)

Only very small areas of Purple moorgrass vegetation (NVC M25) are present within the Garden estate and none occur within Survey Zones 1 or 2. These areas should be retained and protected from damage during site operations and taken into positive conservation management in the future. It may be possible to restore their conservation status by including them in the conservation management plan of the Regency Restoration Project.

Significance of Impact during site operations:

**MINOR ADVERSE** (UK/National ecological significance, minimal magnitude)

Significance of Residual Impact if habitat areas not taken into positive management:

**SEVERE ADVERSE** (UK/National ecological significance, high magnitude)

Significance of Residual Impact assuming that improved management enhances these areas to attain a higher conservation status:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential get gain)

Significant areas of rush pasture (principally NVC M23) occur within Survey Zone 2 (eg the Whorled Caraway meadows). All these areas should be retained and protected from damage during site operations and continue to be managed to promote and enhance their nature conservation status. It may be possible to enhance their conservation status further by including them in the conservation management plan of the Regency Restoration Project.

Significance of Impact during site operations assuming that between 4% and 19% will be disturbed:

**MODERATE ADVERSE** (UK/National ecological significance, low magnitude)

Significance of Residual Impact assuming that between 4% and 19% of the undisturbed resource is disturbed and reinstated but reinstatement is only successful in 25% of the area disturbed in the first 10 years:

**MODERATE ADVERSE** (UK/National ecological significance, low magnitude)

Significance of Residual Impact assuming that improved management enhances these areas to higher conservation status:

**NEGLIGIBLE SIGNIFICANCE to POTENTIAL NET GAIN**

(UK/National ecological significance, No impact to Potential net gain)

Reedbeds (included in Fen, marsh and swamp)

Tall-fen and tall-herb fen vegetation dominated by various species grows on the bed of the former Llyn Mawr in Survey Zone 1. NVC communities present include NVC S7, S9, S10, S12, S23, S26, S28. Smaller stands of this vegetation occur in Survey Zone 2, for instance in the former fish pond (Llyn Gwynon) and also elsewhere within the Garden estate.

The reinstatement of the lakes within Zones 1 and 2 will necessitate the removal of this type of vegetation. However, it should be possible to retain representative stands of the various tall-fen and tall-herb fen species in marginal zones along the new lake edges.

Significance of Impact during site operations within Zones 1 and 2:

**MAJOR ADVERSE** (UK/National ecological significance, High magnitude)

Significance of Residual Impact within Zones 1 and 2 provided marginal vegetation is established:

**MAJOR ADVERSE** (UK/National ecological significance, Medium magnitude)

It is assumed that vegetation of this type occurring outside zones 1 and 2 will not be disturbed by proposed site operations but in general, management needs to be enhanced to ensure that existing stands to not continue to deteriorate by, for example, the colonisation by scrub and wet woodland.

Significance of Impact during site operations outside Zones 1 and 2:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

Significance of Residual Impact outside Zones 1 and 2:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

Significance of Residual Impact outside Zones 1 and 2 assuming that improved management enhances these areas to maintain or increase their conservation status:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential get gain)

Rivers and streams

There is potential for silt-laden surface run-off and polluted discharges resulting from site operations to enter watercourses which connect with the European protected and internationally important Afon Tywi Special Area of Conservation (SAC) and the Carmarthen Bay and Estuaries SAC, although the risk of pollutant discharge significantly affecting the SACs is very low due to the low levels of possible discharge and the dilution effect both within the tributaries and the main river and estuary.

The presence of Otter is one of the qualifying reasons for the selection of these SACs and animals use the watercourses within the NBGW estate. Any degradation to habitats which support Otters, including watercourses and associated vegetation which has a detrimental impact on this species can also be regarded as causing damage to the SAC, although the habitats present are likely to contribute to the support of, at most, only two Otters (with their young) and therefore the significance of such an impact on the SAC would be very small.

Furthermore, Otter, as well as additional protected and concern species including Bullhead and other fish, could be adversely affected by a deterioration in water quality, should run-off or other potential pollution incidents not be contained during the restoration works.

Potential significance of Impact of site operations assuming between 4% and 19% disturbance to watercourses of ecological interest:

**MODERATE** (UK/National ecological significance, low magnitude)

Anticipated Significance of residual impact:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

Eutrophic standing waters

The existing lakes and other water bodies within the NBGW estate are located outside Survey Zones 1 and 2 and are unlikely to be adversely affected by the proposed landscape project. However, there may be a chance of impact to lake flora and fauna from silt-laden run-off should works extend outside these zones.

Potential significance of Impact of site operations:

**MINOR ADVERSE** (UK/National ecological significance, minimal magnitude)

Anticipated Significance of residual impact:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

**Local Biodiversity Action Plan Habitats**

Habitats additional to those included in the categories above for which Action Plans have been implemented in the Carmarthenshire Local Biodiversity Action Plan and which are present within the survey site include:

Veteran Trees

A particular feature of the Garden estate is the abundance of old and veteran parkland trees. It is assumed that a few such trees will need to be removed or disturbed during the landscape restoration works but less than 4% will be affected. It is planned to replace and augment existing parkland trees with new plantings in order to restore the Regency setting which, in the long term, will ensure that veteran trees continue to be a feature of the landscape.

Significance of Impact during site operations:

**NEGLIGIBLE** (County ecological significance, Minimal magnitude)

Significance of Residual Impact in the longer term:

**NO IMPACT to POTENTIAL NET GAIN**

(County ecological significance, No impact to potential net gain)

Ffridd and bracken slopes

Small areas of Bracken slope occur within the site but are considered to be of not important significance and are unlikely to be significantly disturbed by site operations.

Significance of Impact: **NO IMPACT** (Not important significance, No impact)

**Important Hedgerows**

Only ten hedgerows within Survey Zones 1 and 2 satisfy the definition of 'hedgerow' as stated in the *Hedgerow Regulations 1997*. Eight out of these ten were found to qualify as *Important Hedgerows* as defined in the *Regulations* and the remaining two would qualify with the addition of one extra qualifying feature. The following is a provisional assessment and will depend on the extent of disturbance resulting from the landscape restoration work. Hedgerows within and around the Garden estate support Dormice and their removal will therefore require the issue of a European Protected Species Disturbance Licence by NRW prior to any work commencing.

Significance of Impact during site operations assuming that between 4% and 19% of hedgerows/treelines will be removed:

**MODERATE ADVERSE** (UK/National ecological significance, low magnitude)

Significance of Residual Impact assuming mitigation replaces lost habitat:

**MINOR ADVERSE** (UK/National ecological significance, minimal magnitude)

**Non-designated Habitats**

Other habitats which could be affected by the proposed works include semi-improved neutral grassland, amenity grassland, improved grassland, tall-herb vegetation, walls, buildings, tracks, hardstandings, etc.

Areas of these habitats will be disturbed during site operations. It has been assumed that between 4% and 19% will be disturbed but will be reinstated on completion of the works.

Significance of Impact during site operations:

**NEGLIGIBLE** (Local ecological significance, Low magnitude)

Anticipated Significance of residual impact:

**NEGLIGIBLE** (Local ecological significance, Low magnitude)

10.2.4. **Plants and Vegetation**

Protected Plant Species

**Bluebell** is protected against sale by its inclusion on schedule 8 of the Wildlife and Countryside Act 1981 (as amended) and is present in the drier wooded areas. It is anticipated that these areas will not be significantly disturbed by site operations.

Anticipated significance of Impact during site operations:

**MINOR ADVERSE** (UK/national ecological significance, minimal magnitude)

Anticipated significance of residual impact:

**MINOR ADVERSE** (UK/national ecological significance, minimal magnitude)

Plants of International Significance

No plants included on Annex II of the Habitats Regulations occur within the survey site and none will be affected by the proposals.

Significance of Impact: **NEGLIGIBLE** (International ecological significance, No impact)

**Whorled Caraway** is a species included by the Countryside Council for Wales in category A of its list of Globally Threatened Plant Species. It is likely that some small stands of this species will be affected by the project but these are likely to amount to only a very low proportion of the total population in the site.

Anticipated significance of Impact during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Anticipated significance of residual impact:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

**Primrose** is included by the Countryside Council for Wales in category B of its list of Globally Threatened Plant Species and was recorded in woodland and along hedgerows during the present survey. A few plants may be affected during the project but these are likely to amount to only a very low proportion of the total population in the site. Any slight losses to the population in the sit are likely to be made good in the short to medium term by natural recruitment

Anticipated significance of Impact during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Anticipated significance of residual impact:

**NEGLIGIBLE** (International ecological significance, No impact)

NERC Section 42 and UK Biodiversity Action Plan Plant Species

No plants in these categories occur within the Garden estate and none will be affected by proposed site operations.

Significance of Impact: **NEGLIGIBLE** (National ecological significance, No impact)

NERC Section 42 and other designated Lichens and Lichen Communities

It is likely that trees supporting the lichen *Sticta sylvatica,* which is a component of the Section 42 Lobarian Lichen Community of Principal Importance, will be disturbed by the project and it is assumed that between 20% and 49% of these plants will be affected. Disturbance will be mitigated by translocating affected plants to suitable trees elsewhere within the garden estate.

Anticipated significance of Impact during site operations:

**MAJOR ADVERSE** UK/national ecological significance, Medium magnitude)

Significance of residual impact assuming translocation of 50% of plants is successful:

**MODERATE ADVERSE** (UK/national ecological significance, Low magnitude)

Local Biodiversity Action Plan Plant Species

No additional plant species which are subjects of Species Action Plans in the LBAP will be affected by the proposals.

Significance of Impact: **NO IMPACT** (County ecological significance, No impact)

Plant Species of County or Local Significance

Several species considered to be of County or Local significance may be subject to disturbance or losses during site operations. Species likely to be disturbed include

County significance: Green-leaved Willow (*Salix* x *rubra*), Smooth Brome (*Bromus racemosus*), *Juncus* x *kern-reichgeltii,* Hybrid Monkeyflower;

Local significance: Lesser Pond-sedge, Smooth-stalked sedge, Small-fruited Prickly-sedge, Bladder Sedge, Southern Marsh-orchid, the hybrid marsh-orchids *Dactylorhiza* x *transiens* and *Dactylorhiza* x *grandis,* Greater Butterfly-orchid, the hybrid willow *Salix* x *reichardtii,* Silky-leaved Osier and Great Burnet.

Where single plants of significance may be disturbed, efforts will be made to ensure their well-being, either by establishing an exclusion zone around them or by translocating them to suitable safe locations.

Anticipated significance of Impact during site operations assuming that between 4% and 19% of the populations of each species within the Garden estate will be impacted:

**MINOR ADVERSE** (County, district or local ecological significance, Low magnitude)

Anticipated significance of residual impact assuming mitigation measures are successful:

**NEGLIGIBLE** (County, district or local ecological significance, Minimal magnitude)

### 10.2.5. **European Protected Fauna**

**Bats**

Bats and their places of rest/shelter (ie roosts) are fully protected and a licence obtained from Natural Resources Wales is required to permit any damage, destruction or disturbance of a roost whether in a man-made structure, a tree or elsewhere. The bat assessment has identified bat roosts in several buildings and bats are very likely to roost in some of the older trees. The assessment assumes that no buildings will be disturbed except Waun Las farmhouse, which will be demolished and a new, purpose-built 'bat house' is provided as a replacement roost.

Significance of impact of the licenced demolition of all Waun Las farmstead buildings during site operations, assuming that all licence conditions are implemented and that a replacement roost site is provided:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Anticipated significance of residual impact of the loss of Waun Las and provision of replacement roost site following the completion of site operations:

**NEGLIGIBLE to POTENTIAL NET GAIN**

(International ecological significance, No impact to Potential net gain)

No bat roosts in trees have been found within Survey Zones 1 and 2 during the survey. It is anticipated, therefore, that roost-use of woodland and parkland trees is negligible but if any tree with potential to harbour roosting bats is to be lopped, felled or otherwise disturbed advice will be sought from the bat ecologist who will carry out survey procedures appropriate to the situation. If required a disturbance licence will be procured from NRW to permit disturbance to any roost.

Significance of impact of the licenced removal of trees which have been shown to harbour rosin bats:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Anticipated significance of residual impact of the loss of such trees:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Insects associated with mature trees, hedges and scrub within the site provide a food source for bats and losses resulting from the scheme should be mitigated.

Bats habitually travel along habitat corridors and landscape features eg well established tree-belts, so losses of such features need also to be assessed in the context of bat-use and if traditionally-used flight-features are to be removed, mitigation should be implemented.

Both pipistrelle species are known to be very tolerant of artificial lighting and will actively visit outside lighting to exploit insect prey attracted by light. Other species are less tolerant of, or deterred by such lighting. Installation of flood lighting during site operations should avoid direct illumination of roost entrances.

Anticipated significance of impact of loss of bat foraging and flight-line features during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Anticipated significance of impact of loss of bat foraging and flight-line features following re-establishment of affected habitat after completion of site operations:

**NEGLIGIBLE** (International ecological significance, No impact)

Potential Significance of Impact of loss of foraging habitat during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Potential Significance of residual impact following re-establishment of affected habitat:

**NEGLIGIBLE** (International ecological significance, No impact)

Both pipistrelle species are known to be very tolerant of artificial lighting and will actively visit outside lighting to exploit insect prey attracted by light. Other species are less tolerant of, or deterred by such lighting. Installation of flood lighting during site operations should avoid direct illumination of roost entrances.

Potential Significance of Impact of properly controlled flood lighting on bats during site operations:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Potential Significance of residual impact of properly controlled flood lighting on bats:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

If a roost were to be disturbed and no remedial action taken, this would have resulted in a breach of the protection legislation and the possibility of a consequent conviction.

Attention is drawn to the best practice protocol for mitigating the effects on bats where trees are felled or lopped, which is reproduced at appendix 8.

**Dormouse**

Dormice are European Protected Species and their places of rest/shelter are also protected under schedule 5 of the Wildlife and Countryside Act 1981. A licence issued by Natural Resources Wales is required to permit any damage, destruction or disturbance to a Dormouse nest or occupied habitat.

The presence of Dormice has been recorded in woodland, scrub and bramble habitats within Survey Zones 1 and 2 and it is therefore assumed that all such suitable habitat is occupied by the animal. The proposed Regency Landscape Restoration work will impact on Dormouse habitat.

The impact assessment has assumed that between 4% and 19% of all Dormouse habitat within the Garden estate will be disturbed during site operations but that the area disturbed will be mitigated by the replacement of at least an equivalent area; this will, in any case, be a requirement of the NRW disturbance licence and replacement habitat will need to be in mature condition ready for occupation by Dormice prior to the disturbance of any existing habitat. The opportunity for Dormouse habitat holding capacity to be increased over and above its present potential by provision of additional native-species plantings of a variety of shrubs such as Hazel, Hawthorn, Blackthorn, oak and Honeysuckle, and by allowing the re-establishment of Bramble to compensate for losses, could result in a beneficial impact.

Anticipated significance of Impact during site operations:

**MINOR ADVERSE** UK/national ecological significance, Minimal magnitude)

Significance of residual impact:

**NEGLIGIBLE to POTENTIAL NET GAIN**

(UK/national ecological significance, No impact to Potential net gain)

**Otter**

The restoration of Llyn Mawr has an obvious potential to increase the foraging value of the site for Otters but public use/disturbance is likely to be a constraining factor. This constraint might be mitigated by landscape design: eg the retention/creation of a secluded (east bank) corridor to the restored lake with the provision of artificial rest sites (eg. log pile holts) within this secluded habitat, might allow sufficient day-time rest-site security for Otters to regularly exploit any additional foraging opportunities. The project managers might consider the example of the National Trust's Bosherston Lakes site, where public access and daytime Otter rest-site use have been successfully integrated.

Potential Significance of Impact during site operations:

**MINIMAL** (International ecological significance, No Impact)

Potential Significance of Residual Impact if public and dogs are not excluded from secure lake-side habitat:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Potential Significance of Residual Impact:

**POTENTIAL NET GAIN** (International ecological significance, Potential net gain).

**Bullhead**

Bullhead is certain to occur in the Afon Gwynon below Pont Felin-gât and Bullhead could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. However, the reinstatement of the lakes as planned will, in the longer term, result in a potential increase in the extent of suitable habitat available to this species.

Bullhead could be adversely affected by a deterioration in water quality should run-off or other potential pollution incidents not be contained during the restoration works.

Significance of Impact on the Bullhead population during site operations assuming all discharge consents are achieved and no pollution of watercourses occurs:

**MINOR ADVERSE** (International ecological significance, Minimal magnitude)

Significance of Impact on the Bullhead population during site operations arising from an accidental pollution incident:

**MODERATE ADVERSE** (International ecological significance, Low magnitude)

Significance on the Bullhead population of Residual Impact:

**POTENTIAL NET GAIN** (International ecological significance, Potential net gain)

**Marsh Fritillary**

The Marsh Fritillary butterfly is a European Protected Species and is also protected by its inclusion on schedule 5 of the Wildlife and Countryside Act 1981. The nearest past records to NBGW of Marsh Fritillary appear to be about 4km away to the south-east, 4km to the west, 6.5km to the east and 8km to the north-east. Whilst there is suitable habitat for the butterfly in the intervening area, there is very little habitat currently in optimum or even sub-optimum condition within the BGW estate. It is therefore anticipated that the landscape restoration project will have no detrimental effect on the local butterfly population. However, management of those small areas of habitat which are present within the Garden estate should seek to restore them to optimum condition to support the species.

Significance of Impact during site operations:

**MINIMAL** (International ecological significance, No Impact)

Potential Significance of Residual Impact in the absence of remedial management:

**MINIMAL** (International ecological significance, No Impact)

Potential Significance of Residual Impact:

**POTENTIAL NET GAIN** (International ecological significance, Potential net gain).

10.2.6. **UK/Nationally Protected Fauna**

**Badger**

Several active Badger setts are located within the Garden estate, indicating several social groups, and it is anticipated that the landscape restoration works could have an adverse effect on them. In particular, setts located around the banks of the former Llyn Mawr (setts 1, 8, 9, 10, 11 and 12) will be directly affected whilst there is potential for other setts to be affected by site investigation or archaeological works. Disturbance or closure of setts will can only be legally achieved under licence from NRW. The licence will require the implementation of agreed mitigation designed to minimise any impacts on the animals resulting from the proposed works.

Significance of Impact during site operations assuming that all agreed mitigation is implemented and licence conditions met:

**MINOR ADVERSE** (UK/national ecological significance, Minimal magnitude)

Potential Significance of Residual Impact:

**NEGLIGIBLE** (UK/national ecological significance, No impact)

Attention is drawn to the best practice protocol designed to minimise impact to Badgers during development works, which is reproduced at appendix 9.

**Birds**

Breeding Birds

67 of the 72 species recorded at the Garden estate during the 2015 breeding season showed evidence of breeding. Of these, 20 territories of seven species of high/moderate conservation value were located within the area anticipated to be disturbed during the proposed site operations. Approximate numbers of concern species (ie not including species of local interest) are as follows:

Dipper (2 territories),
** Grey Wagtail (1 territory),
** Song Thrush (6 territories),
** Mistle Thrush (1 territory),
* Willow Warbler (3 territories),
** Marsh Tit (2 territories),
** Bullfinch (5 territories)

Key: ** 42 Species / BoCC Red List species
* BoCC Amber List species

The anticipated impact on the breeding bird assemblage is assessed as:

Significance of Impact during site operations:

**MINOR ADVERSE** (District ecological significance, Low magnitude)

It is anticipated that the majority of the secondary woodlands established on lake and pond beds will be removed when the water-bodies are reinstated. Disturbance to protected species that they support will require mitigation.

The change in habitat type will provide additional habitats for waterbirds, which will result in corresponding changes to the bird assemblage. The small waterbird population currently found on the existing lakes, which includes Moorhen, Coot, Little Grebe and Mallard, will extend to take advantage of the restored lakes.

Significance of Residual Impact:

**NEGLIGIBLE** (District ecological significance, Minimal magnitude)

Non-breeding Birds

The available records indicate that since the development of the Botanic Garden, a total of 81 species have been noted within the estate during the non-breeding period. The site does not support significant numbers of any species nor does it support any regular winter aggregations. The secondary woodlands established on the former lakes that it is proposed to reinstate, have no special winter and passage bird interest but nevertheless do provide a valuable resource for a large number of non-breeding birds, most occurring at low density. Species of high conservation concern likely to be affected include:

Woodcock (winter visitor),
Grey Wagtail (resident),
Fieldfare (winter visitor),
Song Thrush (resident),
Redwing (winter visitor),
Dunnock (resident),
Spotted Flycatcather (occasional on passage),
Marsh Tit (resident),
Willow Tit (resident),
Lesser Redpoll (winter visitor),
Bullfinch (resident)
Reed Bunting (resident)

The anticipated impact on the non-breeding bird assemblage is assessed as:

Significance of Impact during site operations:

**MINOR ADVERSE** (District ecological significance, Low magnitude)

Significance of Residual Impact:

**NEGLIGIBLE** (District ecological significance, Minimal magnitude)

**Reptiles**

Common Lizard and Grass-snake are the only reptile species recorded during the surveys and habitat which supports these species is present within proposed working areas. All reptile species are protected against "deliberate killing", which is interpreted to include habitat destruction whilst animals are present. An appropriately implemented mitigation scheme may need to

i) provide exclusion fencing around the working areas and,
ii) undertake the physical translocation of animals from the working area.

However, as reptile numbers are small, it may be sufficient to rely upon a finger-tip search as working areas are cleared of vegetation to ensure that animals are captured and transported to safety.

Potential significance of impact to local reptile populations assuming that a finger-tip search of all potential reptile habitat is undertaken as vegetation is disturbed:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Potential significance of residual Impact following successful translocation:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

During the implementation of the landscape restoration project the opportunity should be taken to provide appropriate habitat enhancements, including subterranean hibernacula. Such action would improve the environment for reptiles and have the potential of increasing both numbers and species diversity.

Potential significance of residual Impact following habitat enhancements:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential net gain)

**Amphibians**

Significant numbers of Common Toads are present within Survey Zones 1 and 2 and these, together with a smaller number of Common Frogs and possibly Palmate Newts are likely to be present within proposed working areas. Similar mitigation to that proposed for reptiles (above) is likely to be needed to avoid the "deliberate killing" of any animals.

It may be sufficient to rely upon a finger-tip search as working areas are cleared of vegetation to ensure that animals are captured and transported to safety but given the large

numbers of Common Toads, it may be unsafe to rely on this technique and a systematic capture operation using artificial refugia sheets would be preferable although much more expensive.

Potential significance of impact to local amphibian populations in the absence of a formal translocation process:

**MAJOR ADVERSE** (UK/National ecological significance, Medium magnitude)

Potential significance of impact to local amphibian populations assuming a systematic capture operation using artificial refugia sheets is undertaken:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Potential significance of residual Impact following successful translocation:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

During the implementation of the landscape restoration project the opportunity should be taken to provide appropriate breeding and terrestrial habitat enhancements, including subterranean hibernacula. Such action would improve the environment for amphibians and have the potential of increasing both numbers and species diversity.

Potential significance of residual Impact following habitat enhancements:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential net gain)

**Other UK/Nationally Protected Fauna**

No habitat suitable for other UK/Nationally Protected Fauna such as Water Vole is likely to be affected by the scheme.

Significance of Impact: **NEGLIGIBLE** (UK/National ecological significance, No impact)

10.2.7 **Section 42 Species of Principal Importance and UK BAP Priority Species**

**Fish**

Eel and Bullhead are certain to occur in the Afon Gwynon below Pont Felin-gât and Bullhead could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. It is unlikely that eels currently migrate over land around this obstruction but the restoration project gives the opportunity to provide a suitable feature to allow individuals to avoid this barrier. Furthermore, the reinstatement of the lakes as planned will, in the longer term, result in a potential increase in the extent of suitable habitat available to these species.

Both these species could be adversely affected by a deterioration in water quality should run-off or other potential pollution incidents not be contained during the restoration works.

Bullhead has been assessed under European Protected Species above.

Significance of Impact to Eel during site operations assuming all discharge consents are achieved and no pollution of watercourses occurs:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Significance of Impact to Eel during site operations arising from an accidental pollution incident:

**MODERATE ADVERSE** (UK/National ecological significance, Low magnitude)

Significance to Eel of Residual Impact:

**POTENTIAL NET GAIN** (UK/National ecological significance, Potential net gain)

**Hedgehog**

Hedgehog is likely to be present within the assessment site but temporary habitat disturbances resulting from the project are unlikely to significantly impact upon this species.

Significance of Impact during site operations:

**MINOR ADVERSE** (UK/National ecological significance, Minimal magnitude)

Significance of Residual Impact:

**NEGLIGIBLE** (UK/National ecological significance, No impact)

**Invertebrates**

Applying the criteria set out at table 10.1, the overall value of the habitats for invertebrates within the Garden estate as a whole is considered as being of 'County' significance. The key elements that help support the rich diversity of invertebrates include habitat and structural diversity over a wide area, with the diversity of vegetation playing an important role. The implementation of a whole-estate Habitat Management Plan will facilitate the maintenance of the present diversity of habitats which, in turn, will maintain invertebrate populations.

Anticipated impact on the invertebrate assemblage during site operations

**MINOR ADVERSE** (County ecological significance, Low magnitude)

It is anticipated that the majority of the secondary woodlands established on the lake beds will be removed when the water-bodies are reinstated. The change in habitat type will reduce the area of marginal and arboreal habitats and replacement habitats will result in their replacement by a largely aquatic invertebrate community. However, the overall diversity of invertebrate assemblages within the Garden estate is likely to remain similar to that at present, although the numbers of individuals of each species is likely to change, depending upon their habitat preferences.

Significance of Residual Impact:

**NEGLIGIBLE** (County ecological significance, Minimal magnitude)

# 11 ECOLOGICAL RECOMMENDATIONS and OPPORTUNITIES

## 11.1 Further Survey

A Badger bait-marking survey was commenced in March 2016 to determine the nature and extent of Badger territories in the vicinity of Llyn Mawr.

It is recommended that prior to the commencement of site operations, the following additional surveys or checks are undertaken.

- Surveys for the presence of protected and other material species, in particular bats, Dormouse, Badger, reptiles and amphibians, must be undertaken immediately prior to the removal or disturbance of all areas of woodland, scrub and rank vegetation.
- Once the detailed extent of any tree works is known, trees with potential for harbouring roosting bats must be subject to a pre-construction survey using an appropriate approved method. If any bat roosts are found, their removal or disturbance will be subject to the successful procurement of a disturbance licence from NRW.
- It is assumed that all suitable habitat within the Garden estate is occupied by Dormice. It is recommended that a survey is undertaken to determine how best to mitigate Dormouse disturbance and where to site replacement habitat.
- If it is necessary to commence the clearance of dense or woody vegetation in the bird breeding season (generally taken to be March to August inclusive), a check to ensure that no active nests will be disturbed must be undertaken by an experienced ornithologist. If active nests are found, work must be delayed until the birds have successfully completed their nesting activity.

## 11.2 Ecological Constraints Plan

A plan showing constraints to the landscape restoration project resulting from the presence of existing and potential ecological features has been prepared and is presented at figure 11.1. Various levels of constraint have been shown based upon the degree of protection or other significance of each feature. Observations or signs of protected and other significant species have been shown where it is considered they may present a constraint, or in their absence, an interpretation has been made as to the magnitude of the constraint, based upon the ecologists team's experience and judgement.

### Habitats and Vegetation

## 11.3 Grassland

The areas of grassland shown in cross hatched red on figure 11.1 should, as far as possible, be left undisturbed and their management continued to maintain and enhance their existing ecological value.

The areas of grassland shown in cross hatched orange on figure 11.1 are, at present, of lesser ecological significance than the cross hatched red areas but, by the application of appropriate management resources, are capable of being returned to a condition which would elevate their current value to that of the cross hatched red areas.

As far as possible, therefore, no cross hatched red or cross hatched orange areas should be disturbed during the landscape works except to enhance their conservation status by appropriate management.

*Neutral Grasslands*

The NVC MG5 grasslands in Trawscoed North Meadow (compartment 30), Cae Tegeirianau (compartment 13) and the Grow the Future field, should continue to be subject to traditional 'haymeadow' management (ie a late summer cut with removal of arisings, followed by aftermath grazing, removing stock when ground conditions become too wet to avoid excessive poaching or the foraging is exhausted).

In addition to the NVC MG6b grassland in Cae Tegeirianau (compartment 13) already targetted for grassland restoration, the better quality stands, particularly in Cae Banc (compartment 12), Cae Allt Goch (compartment 16) and compartment 17, would also be suitable to concentrate on grassland restoration as they are closest to unimproved NVC MG5 swards. Several areas within the Woods of the World site would also be suitable but would need to be taken into appropriate management soon, before their vegetation becomes even more rank and regresses further.

*Meadow Thistle Grassland Community*

The 2015 survey found that since the previous survey in 2007-11, the rare Meadow Thistle NVC M24 marshy grassland community has been lost as a result of the cessation of grazing which has subsequently resulted in its overwhelming by Purple Moor-grass in Snipe Marsh and by colonisation of Lesser Pond-sedge in Morfa Du. This, together with possible soil nutrient-enrichment are the most likely reasons for the loss of the Meadow Thistle fen-meadow community. Bosanquet noted that there had been recent management carried out in late 2007 in Morfa Du with the removal of willow to reinstate the marshy grassland in these fields. He commented that this should have been followed-up in April 2008 by raking and removal of Purple Moor-grass litter which may have saved the Meadow Thistle community from disappearing.

It might be possible, however, to restore this vegetation with appropriate but intensive management, strictly controlled by a member of the farm staff with experience in such conservation restoration practices. If included in an overall Garden Estate Management Plan, funding for this and other urgent conservation management may be more accessible.

*Purple Moor-grass dominated Grassland*

The small extant areas of Purple Moor-grass dominated grassland in Morfa Du and Snipe Marsh should be brought into an intensive restoration management regime which will include removal of encroaching willow, Alder and bramble followed-up by the removal of the build-up of grass-leaf-litter by raking and removal of the arisings. Where the Purple Moor-grass has developed into tall tussocks, consideration should be given to their removal to restore an even ground surface to facilitate the growth of a more diverse sward. This is likely to require either a tractor-mounted flail (with arisings being raked-up and removed) or, if ground conditions preclude the use of a tractor, the removal of individual tussocks using a chain-saw as close to the original ground level as possible.

*Meadowsweet dominated marshland*

Bosanquet expressed concern over the very extensive area of Meadowsweet-dominated mire community, as this vegetation often indicates nutrient-enrichment and it appeared to him that ditches diverting some enriched water may be the only things preventing the loss of the last remaining Purple Moor-grass stands. The 2015 survey found the extent of the Meadowsweet stands to be broadly similar to that recorded in 2007-11 but most continue to be ungrazed or insufficiently grazed which has resulted in the increasing coarseness of the vegetation, principally of Meadowsweet, rushes and Purple Moor-grass.

Management is particularly urgently needed in Snipe Marsh (compartment 28) and Morfa Du (compartment 26b) where initial mechanical clearance of rank vegetation including dense rush "thatch" and tussocky Purple Moor-grass would need to precede the re-introduction of hardy-cattle grazing. A similar management approach is also needed in Holy Well Marsh, the northern part of North Trawscoed Meadow, and the formerly open grassland area of Coed North Lodge in order to restore the grassland vegetation to favourable status.

### 11.4 Woodland and scrub-woodland

All woodland and scrub areas are assumed to support Dormice. Woodlands and scrub also provide habitat for other protected species including bats, birds and, mainly in riparian zones, Otter.

Woodland and scrub areas which are in optimal and sub-optimal condition to support Dormice are highlighted in red and orange respectively on figure 11.1. These, together with other woodland and scrub stands should all be considered capable of supporting protected and other significant species. As such, each area which is likely to be disturbed during site operations should be assessed individually prior to the commencement of works and appropriate mitigation proposed. In the case of protected species such as Dormouse, Otter, bats and Badger, this is likely to include habitat management and enhancements, as well as the creation of replacement habitat areas, which would need to have been implemented and matured prior to the issue of any licences required for the disturbance of the species involved. These actions should be addressed in the preparation of a Conservation Management Plan which includes the whole Garden estate.

The north-west facing slope of Cae Banc, over the past fifteen years, has been subject to the progressive removal of, what was previously, a substantial area of gorse scrub which would have provided valuable faunal habitat, including for several protected and significant species. This habitat is now almost absent from within the Garden estate and consideration should be given to allowing gorse to recolonise this slope. Gorse stands could be cut on a five-year rotation to ensure that it remains in a suitable condition and does not become over mature.

All woodland and scrub areas to be retained but which are located within areas of site operations, must be protected from damage by the establishment of root protection areas to British Standard BS5837.

### 11.5 Swamp and other open wetlands

The areas of swamp shown in diagonal hatched red on figure 11.1 (Morfa Du, Gatehouse Marsh and Holy Well Marsh) should, as far as possible, be left undisturbed and conservation management introduced or intensified to restore their past ecological value which is currently deteriorating. None of these areas should be disturbed except to promote their conservation management.

The areas of swamp shown in diagonal hatched orange on figure 11.1 (the bed of Llyn Mawr) are also of high ecological significance but will be removed when Llyn Mawr is reinstated. However, the management plan should ensure that representative examples from each of the existing swamp communities are included in vegetation stands to be established in suitable locations around the margins of the reinstated lake..

The extant areas of Lesser Pond-sedge swamp are a valuable ecological asset in a county context which should be retained and managed to prevent the continuing threat of scrubbing-over and to enhance their existing diversity. However, Bosanquet points out that

the density and homogeneity of this vegetation at Morfa Du make it an undesirable part of the floristic make-up at the Waun Las NNR because it has colonised and replaced the more valuable and more-rare Meadow Thistle community. Management should therefore, in addition, seek to restore the Meadow Thistle vegetation.

11.6 **Lakes**

Greater Duckweed should be treated as an alien invasive species at this site. If it continues to be so dominant a species on the lakes, its removal should be treated as a priority as it is potentially detrimental to aquatic fauna and flora due to excessive shading preventing light from reaching below the water surface.

11.7 **Water quality**

Site operations, of necessity, will require working in or close to existing watercourses. These watercourses connect directly to the Afon Tywi Special Area of Conservation which in turn is connected to the Carmarthen Bay and Estuaries SAC that includes the Burry Inlet Ramsar Site and the Burry Inlet and Loughor Estuary Site of Special Scientific Interest. The boundary of the latter coincides with the Burry Inlet Special Protection Area (SPA).

There is potential for silt-laden surface run-off and polluted discharges resulting from site operations to enter the watercourses which might affect water quality in these European protected and internationally important sites, although the risk of pollutant discharge significantly affecting the SACs is very low due to the low levels of possible discharge and the dilution effect both within the tributaries and the main river and estuary.

The presence of Otter is one of the qualifying reasons for the selection of the SACs and animals use the watercourses within the NBGW estate. Any degradation to habitats which support Otters, including watercourses and associated vegetation which has a detrimental impact on this species can also be regarded as causing damage to the SAC, although the habitats present are likely to contribute to the support of, at most, only two Otters (with their young) and therefore the significance of such an impact on the SAC would be very small.

Furthermore, Otter as well as additional protected and concern species including Bullhead and other fish, could be adversely affected by a deterioration in water quality should run-off or other potential pollution incidents not be contained during the restoration works.

Strict control must be exercised to prevent degradation of water quality in the watercourses and to limit the extent of disturbance to vegetation and other features of potential wildlife interest.

11.8 **Vascular Plants**

Where there is potential for plants of significance to be disturbed, efforts will be made to ensure their well-being, either by establishing an exclusion zone around them or by translocating them to suitable safe locations.

11.9 **Lichens**

Although there are some well-lit parkland oaks at the site, many mature oaks are excessively shaded due to scrub and ivy growth. It would be an advantage to remove some of the scrub around mature oaks but retain some degree of shelter. Certain other trees could be rescued from being swallowed up by woodland (figure 6.10. shows an example). The woodlands at the site are mostly very shady and some have abundant ivy and brambles. Intermittent or light grazing of some of the woodlands would help to maintain

more open conditions. When clearing the margins of the silted lake, large stumps and logs should be retained and whenever possible kept in light shade. All dead wood is potentially valuable, especially that of oak.

The lichen flora of the woodland beside the Afon Gwynon would benefit from the woodland being allowed to mature. However, some opening-up of the canopy to create glades would be of potential value. This is not urgent, as there are no or few light-demanding notable species currently present apart from *Sticta sylvatica* but some tree felling in connection with restoration of the regency features is clearly not a problem. However, at least one tree supporting *Sticta* has been felled recently, so indiscriminant felling should not be encouraged. The valley of the Afon Gwynon is the most natural area of the site, and it is suggested that non-native species should be controlled here. At the time of the survey, non-native *Cornus* under-scrub beside the Gwynon was creating a dense thicket, detrimental both to lichens and ground flora (see figure 6.11). Some of this has subsequently been removed but this operation should be continued until all is removed, and no further alien species should be introduced.

Broad lichen management recommendations for the site can be summarised as:

1. Allow well-lit conditions around mature oaks. Scrub and ivy should be removed.
2. If possible grazing should be allowed around the trees, either by removing fences or allowing some grazing in woodland. However, avoid removing all shelter near to trees, especially if they already have notable species..
3. Maintain some areas of wet willow woodland around Llyn Mawr if possible.
4. Retain dead wood *in situ*, in light shade.
5. Create or maintain glades in dense woodland.
6. Remove invasive non-native species along the valley of the Afon Gwynon.

11.10 **Fungi**

Whilst a great deal of further research is needed to determine the status of mycological interest at the Garden, it is evident that the estate supports a wide diversity of species in numerous different habitats. Existing areas of interest shown on figure 7.1. should therefore be managed with this interest in mind and, in particular, consideration should be given to their avoidance during the implementation of the Regency Landscape Restoration project.

## European Protected Species

11.11 **Bats**

11.11.1 Tree and woodland roosts

No bat roosts in trees have been found within Survey Zones 1 and 2 during the survey. It is anticipated, therefore, that roost-use of woodland and parkland trees is negligible but if any tree with potential to harbour roosting bats is to be lopped, felled or otherwise disturbed advice must be sought from the bat ecologist who will carry out survey procedures appropriate to the situation. If required a disturbance licence will be procured from NRW to permit disturbance to any roost. This necessity may well apply to any potential roosts in trees which are to be retained along the edges of operational areas although it is anticipated that most of these trees will be protected by *Root Protection Areas* constructed and maintained to BS5837:2005 – *Trees in Relation to Construction* which should also

substantially protect their branches and crowns from damage or disturbance and, in turn, protect any potential bat roost sites.

Attention is also drawn to the best practice protocol for mitigating the effects on bats where trees are felled or lopped, which is reproduced at appendix 8.

11.11.2 Waun Las

The removal of the bat roosts located within the farm buildings will be subject to the procurement of a *European Protected Species Development Licence* from Natural Resources Wales (NRW). The Waun Las farmhouse is an active bat roost within the meaning of relevant legislation.

The granting of a licence will be conditional upon

iii) agreed "mitigation", to ensure the provision of alternative (like-for-like, or enhanced) roost potential at or near the site, and

iv) an agreed "works methodology" designed to minimise any impact on the bats.

If planning consent is required, the Local Planning Authority will need to know, at application stage, what methodology/mitigation is being proposed. The applicant will need to propose an appropriate methodology and mitigation strategy, agreed with NRW species protection staff, which will need to be attached to the planning application.

Although the building is not used by a maternity colony, two and possibly three, species of bat day roost there. Pipistrelle bats require “crevice” roost features. Long eared bats favour roost-sites which offer an in-roost flight-space such as an accessible attic. In order to provide these different roost environments compensatory roost opportunity would best be achieved by building a “bat house”.

It is planned that such a building

i) will be located close to the hedgeline immediately east of the existing buildings;

ii) this will ensure that it is within the Long eared bats’ favoured woodland habitat, and

iii) will ensure it has hedgerow “connectivity” to the wider area.

The compensatory roost facility will be in-place, alongside the existing farmhouse, in time for the spring-summer-autumn season in the year prior to the planned demolition of the existing buildings.

To facilitate the granting of a licence by NRW to remove the Waun Las buildings, the following programme is considered to be appropriate and achievable:

| **Possible Timeline for Bat management works** | |
|---|---|
| Spring/summer 2016 | Assuming Waun Las is to be demolished, project manager to agree with site ecologist the siting and design of a compensatory roost facility |
| Summer 2016 | Informal on-site consultation with NRW Species Protection Officer to discuss and agree the mitigation strategy leading to NBGW applying to NRW for the licence |
| Summer 2016 | Agreement on location and design of new roost facility to include NRW requirements |
| Autumn/early winter 2016-17 | Construction of new roost facility |

| | |
|---|---|
| Summer 2017 | Monitor new roost facility |
| June - July 2017 | Apply for licence to demolish Waun Las |
| Autumn/early winter 2017/18 | Demolish Waun Las |
| Spring/Summer 2018 | Monitor new roost facility |
| Spring/Summer 2019 | Monitor new roost facility |

The adoption of such a facility by a Long eared bat *multi-animal/maternity* colony is a likely incidental "conservation gain" for the restoration project.

11.11.3 Habitat connectivity

The retention and maintenance of hedgeline and treeline habitat connectivity throughout the site should be addressed by the design team in consultation with the site ecologist to ensure that potential flight lines remain intact and unbroken and, where appropriate, new connections made.

11.11.4 Flood-lighting

Both pipistrelle species are known to be very tolerant of artificial lighting and will actively visit illuminated areas to exploit insect prey attracted by light. Other species are less tolerant of or deterred by such lighting. Installation of temporary flood lighting during site operations or any form of permanent outside lighting should avoid direct illumination of potential roost entrances and be directed away from habitat having bat foraging or flight-line potential.

11.11.5 Bat habitat reinstatement

Following the completion of site operations, disturbed areas and habitat losses should be made good by appropriate native-species tree plantings of local provenance. Consideration should also be given to the provision of appropriately-located bat boxes if recommended by the site ecologist.

11.12 **Dormice**

The recommendations below provide an outline of mitigation and general principles that will need to be followed to procure the NRW licence and implement its requirements.

Wherever feasible, disturbance or removal of habitat that could support dormice should be avoided. Where this is possible, it will negate the requirement for further Dormouse survey and any potential licensing requirements in those areas. As the detailed design emerges, the potential effect on Dormice must be assessed and action taken to minimize any adverse impacts.

As a condition of the NRW licence, mitigation will be required to limit the effects of any disturbance or habitat loss resulting from the landscape restoration scheme. Mitigation will be required, not only to alleviate immediate effects on Dormice, such as killing, nest destruction and habitat disturbance, but also long term effects including the provision for the retention, enhancement and management of habitats to ensure the ability of the local Dormouse population to survive into the future.

Prevention of killing and disturbance of Dormice

Any disturbance to habitat which supports or which has potential to support Dormice will be undertaken either in late September/October or in November to February inclusive in order to limit the risk of killing and injuring Dormice.

Where vegetation is to be removed, full clearance works may be undertaken either in a single-stage procedure in late September/October or, alternatively, in a two stage procedure with surface vegetation removal between November and February followed by final stump and top-soil removal in May.

All disturbance to Dormouse habitat must be supervised by the ecologist named on the NRW licence.

All site personnel and operatives will be made aware that Dormice are present within the working area and of the measures they must take should any Dormice be discovered during the course of site operations. Such measures will include the immediate stopping of the work and the notification of NRW or the licensed ecologist.

Habitat loss and fragmentation

Habitat loss and fragmentation must be minimised by careful planning of site layout and operations to ensure that all suitable Dormouse habitat and potential habitat is avoided and retained. Retained habitat must be protected from disturbance during site operations using appropriate measures such as the construction and maintenance of barrier fencing and the diversion of any run-off away from protected areas.

NRW licences generally require that all suitable Dormouse habitat lost must be replaced with an equal or greater area of suitable habitat. The mitigation habitat will need to be planted and well established prior to commencement of any disturbance or removal of existing habitat. In general, this is taken to mean that planting and establishment must take place a minimum of two to three years prior to the start of clearance works. Compensatory habitat should include the establishment of appropriate native-species plantings of local provenance of a variety of shrubs such as Hazel, Hawthorn, Blackthorn, oak and Honeysuckle and also allow the natural re-colonisation of species such as Bramble and Gorse.

There will also be a requirement that all areas of suitable Dormouse habitat retained must remain connected or be connected to other areas of suitable habitat. Existing connections through the site, in particular east to west, but also north to south, will also need to be maintained and, if breached, will need to be replaced by alternatives.

All opportunities should be taken to increase habitat connectivity through the site, for example, by establishing habitat features to join existing isolated woodlands, establishing a planned grazing regime in woodlands or by planting-up gaps in existing gappy hedgerows. Opportunities also exist to increase Dormouse potential in all areas of less than optimal habitat. These measures can be used to help provide mitigation in support of the NRW licence.

Any planting will be required to take into account the current ecology at each location to ensure any other protected and significant species and habitats and the biodiversity value of the site is not diminished.

Dormouse Management Plan

**To facilitate the granting of a licence, it is strongly recommended that a Dormouse Management Plan is drafted that includes all areas of the Garden estate in order that all suitable habitat is maintained and enhanced and that new habitat planted in compensation for losses incurred during the landscape restoration scheme can be located throughout the Garden estate and not limited to the Regency Landscape Project area**.

A method statement will need to be agreed with NRW staff in support the licence application which will also include the production of a management plan for the mitigation areas.

DRAFT heads for such a plan are printed below.

## National Botanic Garden of Wales

## Dormouse Habitat Management Plan to cover the whole Garden estate

## DRAFT headings

This Habitat Management Plan will apply to the whole Garden estate leasehold area. Its requirements include:

- The locations of all suitable habitats;
- A description of the habitats in each area and its condition to support dormice;
- A description of what the habitat should be like;
- A description of the management required to reach the desired condition;
- A description of the management required to maintain it after it has reached the required condition; and,
- A regime or repeat surveys to monitor the dormouse populations and the habitat.

### Optimal Habitat for Dormouse

The majority of the habitats suitable for dormice will be managed with the aim of providing optimal habitat for dormice. Optimal dormouse habitat is considered to have the following attributes.

**Diversity of plant species**

A wide range of tree and shrub species will be provided to help provide food for dormice throughout the year. They eat nuts, seeds, fruit, nectar, pollen and insects. They will also eat buds and young leaves but cannot digest large amounts of mature leaves.

Plants considered to be of particular value to dormice are:

- Hazel
- Oak
- Honeysuckle
- Bramble
- Hawthorn
- Blackthorn
- Sycamore
- Ash

**Age of trees and shrubs**

Trees and shrubs bear fruit and nuts once they are a certain age. This includes trimming of and cutting of shrubs after which they will take a minimum of 2 years, and 5 to 7 for hazel, to fruit again. Mature trees and shrubs old enough to bear fruit will therefore be encouraged.

**Physical Structure**

Dormice appear to prefer dense leafy habitats such as woodland, scrub and hedgerows with plenty of horizontal pathways. These are formed by interconnecting branches and climbers through the trees e.g. honeysuckle, bramble and native rose species. Bramble is of particular value and they often build their nests within it during the summer.

Winter or hibernation nest sites are usually on the ground under leaf litter, pieces of wood, large branches, in hollows around tree roots and in thick grass tussocks.

**Connectivity**

It is thought that dormice prefer to travel between areas via aerial linkages and avoid time on the ground. Areas of habitat suitable for dormice will therefore be linked to one another via trees, scrub, hedgerows and bramble.

## Good Practice Management for Dormice

**Woodland and scrub**

Periodic removal, coppicing or killing of trees to limit the density of the canopy layer and maintain a well lit understorey.

Areas of tree removal and coppicing will be limited to small groups/areas at intervals throughout the Garden estate. The locations of these will be informed following the survey to describe the habitat areas.

Evergreens such as rhododendron or cherry laurel should be removed. They provide little, if any, value to dormice and they smother other shrubs.

Where rides and paths are created or present, locations where the canopy meets across the paths will be provided at least every 70m or so.

Domestic stock will be excluded from woodlands that are to be managed for dormice.

**Hedgerows**

Except where safety or access requires more frequent trimming, hedgerows will be trimmed every 3 years or less frequently.

Height of trimmed hedges will be no less than 3m.

One third of hedges within the Garden estate will be left to grow for 7 to 10 years before being trimmed.

Hedgerows will be cut on a rotational basis. A maximum of 30% should be cut in any one year.

Where possible, hedges should be cut on one side one year and the other a year or two later.

Ideally, flails should not be used to cut hedges.

Where hedges have become gappy or lack dense branches at their base they will be coppiced or layed.

New hedges will include at least five native species of local provenance. The best species include Hawthorn and Hazel.

The Dormouse Conservation Handbook decision flow chart to enhance woodland for dormice reproduced below indicates when woodland management is required.

**Any management of habitat that is suitable to support dormice within the Garden estate will require a licence as dormice are a European Protected Species.**

| **Possible Timeline for Dormouse management works** | |
|---|---|
| During 2016 | Assess impacts on dormice, loss of habitat (in particular area to be affected), design mitigation strategy in consultation with NRW species licensing team. |
| During 2016 | In conjunction with the above, develop a Gardens wide strategy/management plan for dormice. To include identification of where licences are required and what type to enable woodland, scrub and bramble management works, mitigation and compensation management planting for the regency scheme. |
| Winter 2016/2017 and winter 2017/2018 | Plant dormouse compensation areas |
| May - August 2017 | Secure licence for enabling and main construction works |
| Sept- Nov 2017 or Nov 17 - Feb 18 first stage, May 2018 second stage | Veg clearance enabling followed by main clearance operation |
| Through the licensing period 2017-2018, possibly until completion of the monitoring | Highly likely to require to be audited |
| From winter 2016/2018 | Monitoring new dormouse compensation planting and replace failures |
| From 2018, for a minimum of 5 years | Monitor dormouse populations |

11.13 **Otter**

The restoration of Llyn Mawr has an obvious potential to increase the foraging value of the site for Otters but public use/disturbance is likely to be a constraining factor. This constraint might be mitigated by landscape design: eg. the retention/creation of a secluded (east bank) corridor to the restored lake with the provision of artificial rest sites (eg. log pile holts) within this secluded habitat, might allow sufficient day-time rest-site security for Otters to regularly exploit any additional foraging opportunities. The project managers might consider the example of the National Trust's Bosherston Lakes site, where public access and daytime Otter rest-site use have been successfully integrated.

11.14 **Fish**

Both Bullhead and Eel are certain to occur in the Afon Gwynon and Bullhead could well be present upstream of the Pont Felin-gât in-channel rock and masonry impediments. Bullhead is a qualifying feature of the Afon Tywi SAC and both are section 42 *Species of Principal Importance.* Site works are unlikely to result in significant disturbance to these species but the reinstatement of the lakes as planned will, in the longer term, result in a substantial increase in the extent of suitable habitat available to them. Furthermore, to ensure that eels can access the Afon Gwynon upstream of Pont Felin-gât, it is proposed that a suitably designed eel-pass will be constructed in consultation with NRW fisheries staff.

11.15 **Marsh Fritillary**

There is virtually no habitat currently in optimal or even sub-optimal condition to support the Marsh Fritillary butterfly within the NBGW estate, and suitable habitat for the butterfly which has the potential to act as 'stepping stones' in the area between it and known populations, for instance in the Cross Hands area, is also scarce. The landscape restoration project will have no detrimental effect on the local butterfly population but might provide an opportunity to manage those small areas of habitat which are present within the Garden estate to restore them to optimum condition to support the species.

**Nationally Protected Species**

11.16 **Badger**

To limit impacts to badgers and meet legal requirements the following will be necessary where badgers are likely to be disturbed or otherwise impacted.

- A 30m buffer zone around the each sett will be fenced off to protect badgers from disturbance during the works. Fencing will be to standard agricultural post and wire-netting specification BS1722-2 and will be maintained in serviceable condition for the whole duration of site operations.
- For works that are located within 30m of an active sett but do not require a disturbance licence, i.e. planned works that are not likely to cause disturbance, a method statement will be prepared and implemented detailing how works will be undertaken to ensure that Badgers will not be disturbed. The method statement will be agreed with Natural Resources Wales (NRW).

- If is not possible to complete the required works without disturbance to Badgers, an appropriate licence will need to be procured from NRW.
- If any existing main or subsidiary setts require closure and destruction, replacement artificial setts will need to be constructed, generally at least six months before the original setts are closed. Planned sett closure will necessitate a bait-marking survey to determine the extent of the territory occupied by animals of the social group residing in the affected setts. New artificial setts will need to be located within the territory of the affected social group and close to the sett(s) that will be closed.
- Bait marking surveys must be undertaken between February and April or in September.
- As a general rule, works that will result in disturbance to a badger sett and which are licenced by NRW, must be undertaken between July and November.
- During the construction phase, existing badger paths will not be blocked by fencing, stored materials or any other barrier to free passage of animals. Toxic materials, oils, etc will be safely stored in closed buildings or compounds which are maintained so as to be inaccessible to Badgers at all times.
- Trenches dug and left open overnight will include sections where the sides are not so steep as to prevent the escape of animals. or substantial wooden planks will be positioned and secured to provide a means of escape.
- New and replacement plantings will include species that provide replacement food sources for Badgers. Planting stock will be of locally native species of local origin and will include species that bear fruits such as Crab Apple, Hawthorn, Hazel, Rowan and Bramble. All nursery stock will comply with BS3936 Part 1:1992 and all subsequent amendments and all landscaping operations will comply with BS4428:1989 and all subsequent amendments
- A DRAFT timeline for Badger works is printed below.

| **Possible Timeline for Badger management works** | |
|---|---|
| Sept 15 - June 17 | Assess impacts on existing setts, any closures required |
| Feb - April 2016 | Undertake bait marking survey to determine territory extent of setts at risk of flooding |
| July-Aug 2017 | Initiate vaccination if available |
| Sept - Nov 17 | Obtain licence |
| December 2017 | Construct new setts if required |
| Sett closure July - Oct 18 | Close and destroy setts if required |
| Mar-June 18 | Repeat vaccination, if available |
| Feb-April 2019 | Monitor affected badger setts and newly constructed setts |

11.17 **Reptiles and Amphibians**

Further amphibian and reptile surveys are recommended at paragraph 11.1. All reptile species are protected against "deliberate killing", which is interpreted by relevant statutory bodies to include habitat destruction whilst animals are present. Should reptile presence be found at or adjacent to any extensive areas where habitats will be removed it is likely that it will be necessary to carry out translocation of animals to areas where they would remain safe. In areas where disturbance is less intensive (eg access routes) it is likely that the implementation of a working method statement would be sufficient to avoid "deliberate killing". A possible timeline of reptile mamagement work is printed below.

| **Possible Timeline for reptile and amphibian management works** | |
|---|---|
| April - June 2018 | Translocate reptiles and enhance receptor areas |
| July - Oct 18; Mar - Sep 19 | Main construction works |

During the implementation of the landscape restoration project the opportunity should be taken to provide appropriate amphibian breeding ponds and terrestrial habitat enhancements, including subterranean hibernacula. Such action would improve the environment for reptiles and amphibians and have the potential of increasing numbers and species diversity.

11.18 **Nesting Birds**

Many habitats within and adjacent to the NBGW estate provide nesting sites, cover and feeding opportunities for birds. It is likely that a number of nest sites will be lost as a result of the scheme but it is recommended that as much potential nesting habitat as possible is retained and protected, during site operations.

The surveys determined that Barn Owl regularly roosts in Waun Las farmhouse but no evidence of nesting was seen. The provision of an appropriately sited nest box would encourage birds to breed.

Removal of trees, shrubs and other dense vegetation is best undertaken between September and February inclusive to ensure that disturbance to nesting birds is kept to a minimum. If vegetation clearance must be undertaken in the breeding season, as all nests occupied or being built by breeding birds are protected by the Wildlife and Countryside Act 1981, trees, scrub, dense vegetation or other potential nesting habitat must not be disturbed or removed unless, immediately prior to the commencement of such operations, it is judged by a qualified ornithologist, not to be supporting any nests. Wherever possible, all such vegetation should be retained to maximise the available habitat for birds and other fauna. Due regard should also be paid to the accepted protocol for the felling or lopping of potential bat-roost trees (see appendix 8).

**Species of Principal Importance**

11.19 **Hedgehog**

Initial disturbance to features which might be concealing Hedgehogs, such as hedge-banks, should be undertaken with great care to avoid possible killing or injury to individual animals. Such work would be best done in September or October. Initial work should only be

undertaken using hand tools following an inspection to ensure no animals are present. Site operatives should ensure that, if any Hedgehogs are encountered, they are translocated to safety away from the working area or allowed to seek refuge in areas which will not be further disturbed.

## Other Species

11.20 **Invertebrates**

In addition to the European Protected Marsh Fritillary, recommendations for which are given at paragraph 11.8, the **Hairy Dragonfly**, a nationally notable species, has been recorded at NBGW in the past. Precautions must be taken to ensure that habitat quality of the existing water-bodies is maintained and no effluent or silty run-off enters waters which might cause the water quality to deteriorate and impact this species.

Hedgerow management around the estate should be sympathetic to the requirements of the **Brown Hairstreak**, i.e. undertaking rotational hedge-cutting to ensure there is a succession of untrimmed Blackthorn hedge lengths around and radiating out from the Trawscoed Wood area. Butterfly Conservation have producd a very helpful information leaflet that provides clear guidance and advice for management practices to help maintain habitat in favourable condition for the Brown Hairstreak, which can be found here: http://butterfly-conservation.org/files/ari-0402m12-bc-brown-hairstreak-in-blackdown-hills-leaflet-final.pdf

Old dead wood and tree stumps, both of broad-leaf and conifers is a highly prized resource for longhorn beetles, other invertebrates and other taxonomic groups. Ensuring there is a succession of different timbers, including standing dead wood, in a wide variety of situations should provide habitats to support a diverse saproxylic biotal community. Additional surveys would be beneficial to help determine the significance of the dead wood community.

To ensure that suitable habitat is provided for the Red Data Book *Hydrothassa hannoveriana*, a patchwork of open fen with frequent Marsh Marigold should be maintained in marginal habitats around the lakes. Furthermore, the areas of tall fen and marshy grassland in which Scarce Burnished Brass occurs should be considered to be of regional importance for this species. Hemp Agrimony is the larval foodplant and should be encouraged to become better established areas of tall fen and marginal habitats at various locations around the estate.
Detailed guidance for manageing habitats for invertebrates is provided by Buglife at https://www.buglife.org.uk/advice-and-publications/managing-priority-habitats-invertebrates

Included below are some generalised recommendations for invertebrate habitat management and links to more detailed resources are provided as examples of good management practices for key habitats at the Garden:

Lowland wood, pastures and parklands
https://www.buglife.org.uk/advice-and-publications/advice-on-managing-bap-habitats/lowland-wood-pastures-and-parklands

- Ensure continuity of dead wood habitat
- Avoid over-zealous tidying
- Encourage the growth of a variety of fungi
- Consider creating new deadwood niches
- Maintain a mixture of native tree species

- Manage grazing carefully
- Retain wet areas

Lowland Meadows
https://www.buglife.org.uk/advice-and-publications/advice-on-managing-bap-habitats/lowland-meadows

- Continue traditional practices
- Maintain structural diversity
- Allow plants to flower and set seed
- Minimise fertilizer inputs
- Prevent scrub encroachment
- Maintain hydrology

Ancient and/or species-rich hedgerows
https://www.buglife.org.uk/advice-and-publications/advice-on-managing-bap-habitats/ancient-and-species-rich-hedgerows

- Maintain structural diversity
- Adopt rotational management
- Maintain diversity at hedge bottoms
- Retain standard trees
- Retain dead wood
- Maintain headlands and margins
- Maintain ditches
- Avoid spraying of chemicals

Fens and marshy grassland
https://www.buglife.org.uk/advice-and-publications/advice-on-managing-bap-habitats/fens

- Maintain structural diversity of vegetation
- Manage water courses sympathetically
- Prevent scrub encroachment
- Retain areas of wet woodland
- Maintain water levels and water quality
- Avoid overgrazing
- Retain a deep litter layer in some areas of the site

Dead Wood
https://www.buglife.org.uk/sites/default/files/Deadwood.pdf

- Leave naturally occurring deadwood *in situ*
- Aim for natural average deadwood density
- Aim for natural rate of input of new deadwood
- Create new standing dead wood
- Create new fallen dead wood
- Create new rot holes & crevices
- Create new logpiles
- Encourage veteran trees
- Aim for natural age structure
- Aim for natural species diversity

11.21 **Geological research opportunities**

The earthworks associated with the Regency landscape restoration project may provide the opportunity for the development of fresh rock exposures which could offer the chance for geological research. In particular the Silurian – Devonian boundary exposed in the Wernbongham stream section and quarry SSSI extends into the Garden estate and existing exposures in old quarries within the Pont Felin-gât area could be enhanced to provide research opportunities.

11.22 **Alien invasive plant species**

Several alien invasive plant species were recorded during the 2015 surveys. These include:

Terrestrial species:

Indian (Himalayan) Balsam (*Impatiens glandulifera*)
Cherry Laurel (*Prunus laurocerasus*)
An alien dogwood (*Cornus* sp.)

Aquatic species:

Nuttall's Waterweed (*Elodea nuttallii*)
Canadian Waterweed (*Elodea canadensis*)
Curly waterweed (*Lagarosiphon major*)
Least Duckweed (*Lemna minuta*)
Great Duckweed (*Spirodela polyrhiza*)

No Japanese Knotweed (*Fallopia japonica*) was recorded but it is possible that a few plants could occur especially, for example, along the wooded roadside boundaries of the Garden estate. In particular, small plants with just a few stems may not have been noticed during the surveys. It is therefore recommended that a repeat survey is undertaken in areas specific to sites where earth works are to be undertaken which might disturb plants. No site work should be commenced before a detailed check for knotweed has been completed.

Indian (Himalayan) Balsam was recorded near the Llyn Gwynon dam. This has potential to spread downstream and substantially alter the herbaceous woodland floor along the riparian corridor. A particular effort should be commenced to ensure that this insidious alien does not become further established by using accepted control methods: remove all seedlings as they appear or, if too large, cut all plants before June to ensure they do not have a chance to set and disperse seed [it should be noted that ripe seed 'explodes' from the seed capsules on the plant distributing them over a wide area]. All cuttings must be disposed of in such a way that cut plants bearing unripe seed are not left to dry allowing seed to ripen and disperse from the cut plants.

Carpets of Great Duckweed have become a problem on the lakes over the past couple of years. In the absence of reducing nutrient input to the water, probably the most effective way of dealing with this problem is to mechanically collect the vegetative carpet from the water surface using a specially equipped boat. Arisings should be left on the lake banks for a few days to allow aquatic fauna to migrate back to the water before the vegetative material is removed and composted.

Particular care should be taken not to spread propagules of any alien invasive species during site operations, whether within the site or by exporting to, or importing from other sites, including on vehicle wheels, tracks, etc. The control and eradication of different

invasive species involves the implementation of different approved methods and sufficient time should be allowed to ensure that successful treatment is accomplished.

11.23 **Ecological Management Plan and Future Monitoring**

In addition to the specific species management plans and the Environmental Management System recommended at paragraph 11.25, below, an Ecological Management Plan should be drawn-up and implemented to cover all ecological aspects of the site during site operations and to ensure that they are appropriately maintained after the completion of the work. The Ecological Management Plan should, where the Regency Restoration works might have wider impact, include the whole Garden estate. This is, in particular, necessary to ensure mitigation of habitat losses for protected species such as Dormouse, bats and Badger.

Future management of the whole estate should include all staff, whether Garden staff, horticultural workers or agricultural and farm workers and must bear due regard to the wellbeing of individual species as well as whole habitats, also including the consideration of the importance of vegetation in supporting faunal populations. For instance, excessive and over-frequent cutting of hedgerows should be avoided and areas that support wetland and grassland plants that are dependent upon the maintenance of open swards need to be managed by grazing or regular cutting and removing the arisings.

Maintenance of the wildlife interests of the whole Garden estate will be greatly facilitated by the drafting and implementation of an estate-wide Ecological Management Plan.

The success of the Ecological Management Plan will further depend upon future regular monitoring of the effects of management practices and flexibility must be incorporated within the plan to permit its easy amendment to alter management prescriptions as required.

11.24 **General Recommendations**

All works should be carried out bearing due regard to the requirements of ecological features of significance and appropriate features should be designed into the scheme on its completion to provide foraging and roosting, nesting and refuge sites.

Works must only be carried out during the appropriate seasons, in order to comply with current legislation and best practice (see also appendix 8 re felling and lopping of trees with potential bat roost interest).

Arisings from tree and scrub-cutting should be used to construct habitat piles in areas least likely to be disturbed in future and where existing habitats will not be damaged, to provide additional faunal habitat and cover. Their locations should be decided in association with a qualified ecologist.

Following the completion of site operations, disturbed land should only be reinstated with new plantings of species appropriate to preserve the character of the local landscape and of locally native species of local origin. In order to ensure that all planting is compatible with the local gene pool of the area, all woody plant species should be compliant with the recommendations made in Forest Practice Note No. 8, entitled '*Using Local Seed Sources for Planting Native Trees and Shrubs*', produced by the Forestry Commission (1999).

Existing vegetation and new plantings should not be over-managed and species such as ivy, bramble and gorse should be allowed to grow, as these also provide good food sources and cover for nesting birds.

11.25 **Implementation and Supervision**

Careful planning and supervision of contractors should seek to ensure that disturbance to existing habitats and species is kept to an absolute minimum. Future site maintenance should also bear due regard to the well-being of all habitats, flora and fauna.

There should be input from a qualified ecologist at all stages of the project. All recommendations must be translated into appropriate clauses in works contracts and be specified in appropriate method statements. Where appropriate, a qualified ecologist should approve documents and plans.

A qualified ecologist should, where appropriate, be present at pre-works meetings and at site progress meetings, in order to ensure that the appointed personnel are familiar with site conditions and ecological requirements and that such requirements are being satisfactorily implemented.

Site works should be supervised by an appropriately qualified member of staff performing the duties of an Ecological Clerk of Works to ensure that the ecological requirements of the works progress to completion satisfactorily.

All site personnel should be made familiar with the ecological requirements of the site at induction courses and tool-box talks, particularly as regards protected species and wildlife legislation.

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