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An Analysis of Wetland Habitat Restoration and Biodiversity

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MASTERS BY RESEARCH THESIS

An Analysis of Wetland Habitat Restoration and Biodiversity

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Declaration

I hereby declare that this thesis is the results of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards

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Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw'r thesis hwn, ac eithrio lle nodir ynwahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid ywsylwedd y gwaith hwn wedi cael ei dderbyn o'r blaen ar gyfer unrhyw radd, ac nid yw'n cael eigyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan yBrifysgol, am gymwysterau deuol cymeradwy

Contents

Abstract

Habitat restoration is the improvement of habitats to a near natural state. Biodiversity is the variety of habitats, organisms and/or genetic variation within and ecosystem. The restoration of habitats has long been seen as an effective method for restoring, improving, and maintaining biodiversity to the extent that it is often used as a measure of success of habitat restoration schemes. Wetland habitats provide multiple ecosystem services benefiting humans, nature, and the environment and are often labelled biodiversity hotspots. They are also proven to deliver ecosystem services such as flood prevention and carbon sequestration more successfully than habitats such as woodlands. However, the extent at which biodiversity is studied before and after restorative actions have taken place is often unclear within the literature considering it is used as a measure for success. Specific taxa are often chosen as measure of success, for example, birds but the effects on all organisms within a habitat or ecosystem is relatively unknown. Throughout this study we reviewed the use of biodiversity data used in "successful" wetland restoration projects. We then undertook a biodiversity comparison study two wet meadow habitats one post restorative actions and one pre-restorative actions using floral and aquatic macroinvertebrate biodiversity as indices to measure whether restoration does increase biodiversity of these taxa. This was due to lack of available date from pre-restoration of the restored wet meadow. We found the restored wet meadow habitat had a great floristic biodiversity however the habitat chosen as pre-restoration had a greater macroinvertebrate biodiversity. We then undertook a baseline study on an area which is in the design phase for a habitat restoration scheme. By doing this we collected biodiversity data across all available taxa an measured its current biodiversity. This provides a foundation for future research post restoration of this site to study the effects of the scheme have had on the biodiversity of the site, which species have newly colonised, which species have been lost and changes in population size. By conducting these studies, we can start to look at whether it is worth costing into schemes large studies such as this to truly measure success and impact on biodiversity. We aim to better improve the future understanding of the impacts that habitat restorative actions may have on biodiversity and how best to use it as an indices to measure success noting that biodiversity is more complex than simply a specific taxa increasing in species richness.

Thesis Introduction

The primary motivations of habitat restoration are to increase the area of a given habitat and to improve the quality of a pre-existing habitat specifically where extensive habitat fragmentation and degradation have taken place (Miller, Hobbs 2007). Restoration of degraded habitats is now internationally recognised as a means of enhancing and improving biodiversity, species richness and ecosystem services (Peh, Balmford et al. 2014). Globally wetland habitats are arguably the most productive habitats accounting for approximately 40% of global ecosystem services, providing economic, social, cultural, and recreation resources as well as protection areas from erosion, flooding and storms, regulating atmospheric gasses, improving water quality and protecting and sustaining often vulnerable biota (Clarkson, Ausseil et al. 2013). Despite the importance of these habitats, between 50-90% of wetland habitats have been lost in Europe alone often leading to a decline in value of these habitats (Rispoli, Hambler 1999). The UK alone has seen an 80% decline in wetland habitats (Rispoli, Hambler 1999). With wet meadows particularly threatened due to drainage for agricultural use (Williams, 1993). The term wet meadow is difficult to define due to the similarity that this habitat has with other wet grasslands including but not limited to lowland fen meadows and marsh grasslands. However, some key defining features of wet meadows include extended periods of flooding often in the winter followed by short periods of inundation, flora include a variety of species including *Caltha palustris, Filipendula ulmaria, Valeriana* species, *Crepis paludosa, Dacylorhiza* species, *Eupatorium cannabinum, Juncus* species and *Carex* species. Historically in England there was approximately 1,200,000 ha of wet grasslands, including wet meadows, with around 220,000 ha remaining (Prach 2008). Wet meadows are important for their high diversity of plants which in turn provide a vital habitat for various species of invertebrates, birds, and mammals. The maintenance, protection and improvement of biodiversity is a central tenet of conservation partly due to the influence biodiversity has on ecosystem functions across terrestrial, freshwater, and marine systems (Hughes, et al., 2017). Biodiversity-ecosystem function relationships have a clear relevance for the design of habitat restoration efforts, however the degree in which biodiversity is incorporated into habitat restoration practice is unclear (Hughes, et al., 2017). MacArthur and MacArthur (1961) developed the habitat-heterogeneity hypothesis. They proposed that increasing the number of different habitats can lead to an increase in species diversity (MacArthur & MacArthur, 1961). Success of habitat restoration projects has long been linked with the specific goals and aims of restorative action (Kentula, 2000) whether that is to improve the habitat for specific species, flood mitigation or carbon sequestration. However due to the long-time scales and costs of restoration projects, measuring success can often be difficult and expensive due to the size of the projects and the time it would takes to conduct studies to compare the desired research objectives before and after restorative action.

Chapter 1: Wetland Habitat Restoration in the UK: A Review

Introduction

Increasing the amount of habitat present in any given area is often a primary motivation for undertaking restorative actions, particularly where extensive ecosystem fragmentation and modification have taken place (Miller & Hobbs, 2007). The restoration of degraded land is internationally recognised as a means of enhancing biodiversity and ecosystem services (Peh et al. 2014). Wetlands are arguable the world's most productive and possibly valuable ecosystems, accounting for approximately 40% of global ecosystem services (Clarkson, et al., 2013) as well as providing a range of economic, social, cultural and environmental benefits (Clarkson, et al., 2013). These services include cultural, educational, and recreational resources, protecting shorelines from erosion, water quality supply, maintenance and flood mitigation, regulation of atmospheric gasses including carbon sequestration and sustaining unique and often vulnerable biota (Clarkson, et al., 2013). According to the WWT wetlands account for 3% of land coverage and are home to 10% of all species within the UK (WWT, 2021). The UK has seen an 80% decline in wetlands within the last millennium (Rispoli & Hambler, 1999) with up to a quarter of the UK once thought to be wetlands. Anthropogenic activity such as drainage to create arable land and peat cutting have largely been to blame for the direct loss of wetlands within the UK (Williams, 1993). The maintenance, protection and improvement of biodiversity is a central tenet of conservation partly due to the influence biodiversity has on ecosystem functions across terrestrial, freshwater and marine systems (Hughes, et al., 2017). Biodiversity-ecosystem function relationships have a clear relevance for the design of habitat restoration efforts, however the degree in which biodiversity is incorporated into habitat restoration practice is unclear (Hughes, et al., 2017). MacArthur and MacArthur (1961) developed the habitat-heterogeneity hypothesis. They proposed that increasing the number of different habitats can lead to an increase in species diversity (MacArthur & MacArthur, 1961). Success of habitat restoration projects has long been linked with the specific goals and aims of restorative action (Kentula, 2000) whether that is to improve the habitat for specific species, flood mitigation or carbon sequestration. However due to the long-time scales and costs of restoration projects, measuring success can often be difficult and expensive due to the size of the projects and the time it would takes to conduct studies to compare the desired research objectives before and after restorative action. A global meta-analysis, including 70 studies conducted across 14 countries was conducted to understand whether restoration enhances biodiversity and ecosystem services. They concluded that although it was context dependant restorative actions did increase overall ecosystem services supply and enhance biodiversity in restored wetlands 43% and 19% retrospectively, when compared to degraded land. However, when compared to "natural" wetlands, the ecosystem supply was not as high in restored wetlands (13% lower in restored wetlands). Restoring degraded wetlands enhanced biodiversity by 19% and did not significantly differ from that in natural wetlands. Meli et al identified several context factors that significantly affected the biodiversity and ecosystem recovery in restored wetlands, including ecosystem type, main cause of degradation, restoration action taken, and experimental design used to assess the restoration. They concluded that context needs to be considered when evaluating the effects of wetland restoration (Meli, et al., 2014). The following chapter looks at four case studies where wetland habitat restoration has taken place and that have declared success through increased biodiversity. The following chapter outlines what the aims of the case studies were, the restorative actions undertaken, and how success has been measured. These four case studies were chosen due to the lack of available information regarding UK wetland restoration and how it increases biodiversity. This chapter aims to review the available literature which has informed the research outlined in chapters 2 and 3.

Table .1. Principal ecosystem services (ES) supplied by wetlands (Meli, et al., 2014)**.**

ES Type	Individual ES	Description
	Biogeochemical cycling	Maintenance of natural exchange or flux of material and energy between living and non-living components of biosphere, thereby supporting climatic and biological dynamics.
Supporting	Biotic interactions	Pollination of wild species or crops; seed dispersal; preservation and maintenance of trophic chains.
	Habitat (terrestrial)	Habitat for resident and transient terrestrial populations (refugia/nursery).
	Habitat (aquatic)	Habitat for resident and transient aquatic populations (refugia/nursery).
	Plant food/raw material	The proportion of gross primary production that can be extracted as food or raw materials.
Provisioning	Animal food/raw material	The proportion of secondary production that can be extracted as food or raw materials
	Water supply	Filtering, retention and storage of fresh water for human use (domestic, industrial, agriculture).
	Climate regulation	Regulation of the chemical composition of the atmosphere, global temperature, and other biologically mediated climatic processes at global and regional levels.
	Hydrological dynamics	Regulation of natural hydrological flows, role of land cover in regulating runoff and river discharge, and infiltration; groundwater recharge.
Regulating	Water quality	Retention and removal or breakdown of xenic nutrients and compounds; water purification.
	Regulation of extreme events	Capacity and integrity of ecosystem response to environmental fluctuation such as floods or storms, or to other extreme events.
	Regulation of soil fertility and erosion	Soil maintenance and formation, for both natural ecosystems and crops; sediment retention and prevention of erosion; shoreline stabilization; accumulation of organic matter.
	Regulation of invasive species, pests, and diseases	Regulation of invasive species populations; trophic-dynamic regulations of pest populations.
	Cultural	Contribution by ecosystems to experiences that benefit human population directly or indirectly.
Cultural	Recreation	Provision of opportunities for recreational activities.

Case Studies

Four wetland restoration case studies were chosen for the restorative actions undertaken, the wetland habitat types, the varying overall aims for each project and measures of success. Wigan flashes aimed to restore reedbed habitats with reedbed specific avian fauna and specific target species being the measure of success. Wicken Fen aimed to restore degraded and arable land into fen wetland habitat using gained ecosystem services as the measure of success. Woodland Education Centre wetland restoration scheme aimed to create multiple wetland habitats and remove invasive species. Changes to floral composition and biodiversity was used to measure success of habitat creation over a 10-year period. West Sedgemoor RSPB Reserve aimed to restore previously drained peat and moorland by flooding land and managing water levels. This project used wading bird species presence and species richness as a measure for success.

Wigan Flashes – reedbed restoration

The Wigan flashes reedbed habitat restoration project aimed to increase and improve habitat for a range of target species with the main priority given to the European Bittern (*Botaurus stellaris)* due to its reed bed habitat preferences for hunting and nesting and conservation value (Tyler, et al., 1998) and sightings within the local area. Four other Reedbed birds were also used as target species albeit with less priority, these were Reed bunting, reed warbler, sedge warbler and water rail where annual data was collected on the number of singing males to monitor the abundance of the 4 target species listed throughout the restorative process. In total ten bird species including the five target species were listed as likely to benefit from restorative actions. Water voles were also identified as a species likely to benefit due to its conservation value (Carter & Bright, 2003) as well as 5 other non-avian vertebrate species likely to benefit. Data was collected for avian fauna likely to benefit from restorative action, data included species-specific requirements for nesting and for feeding. For the six non-avian fauna classified as likely to benefit, data was collected on habitat requirements and requirements for feeding. The presence, absence and population data were not presented in the paper to measure success or failure of the restorative actions through the changes in population dynamics, presence or absence of species (Champion & Ashton, 2010).

Map.1. Map of the British Isles (United Kingdom and Ireland) showing the location of the four UK wetland habitat restoration project case studies reviewed. Wigan Flashes, Greater Manchester (NW England), Wicken Fen, East Anglia (SE England), West Sedgemoor RSPB Reserve, Somerset (SW England) and Offwell Woodland and Wildlife Trust Woodland Education Centre, Devon (SW England) (Google, 2021)

Wicken Fen – Costs and Benefits of wetland ecological restoration

Major drainage in the 17th and 19th centuries of the fenland basin in East Anglia left only four areas of original undrained fen wetland, covering 7.12km², 0.18% of the original 3850 km² floodplain wetland (Peh, et al., 2014) one of these, Wicken Fen NNR, still includes undrained alkaline peats, up to four metres in depth and supports semi-natural, biodiverse alkaline fen habitats supporting over 8000 species, many of which are rare fen specialist invertebrates (Peh, et al., 2014) Launched in 1999 by the National Trust, The Wicken Fen restoration project aimed to turn a small wetland relic of what was once vast fenlands in East Anglia into a functioning wetland to conserve biodiversity and to maintain water table levels well above the reclaimed and drained surrounding farmland. Peh et al analysed the benefits and costs of ecological restoration at Wicken fen in Cambridgeshire. They recognized that restoration of degraded land was an important part of enhancing both biodiversity and ecosystem services, but more information was needed about the costs and benefits (Peh, et al., 2014). The results from Peh et al 2014 showed that more people benefited from the Restored wetland through the creation of jobs and nature-based recreation than people would benefit from arable land (Landowners / Farmers and those they employ). The main ecosystem services that have been gained at Wicken Fen as a result of restoration are enhanced nature-based recreation, reduced GHG emissions, increased flood protection and increased grazing by domestic stock. The main service lost after restoration is arable production.

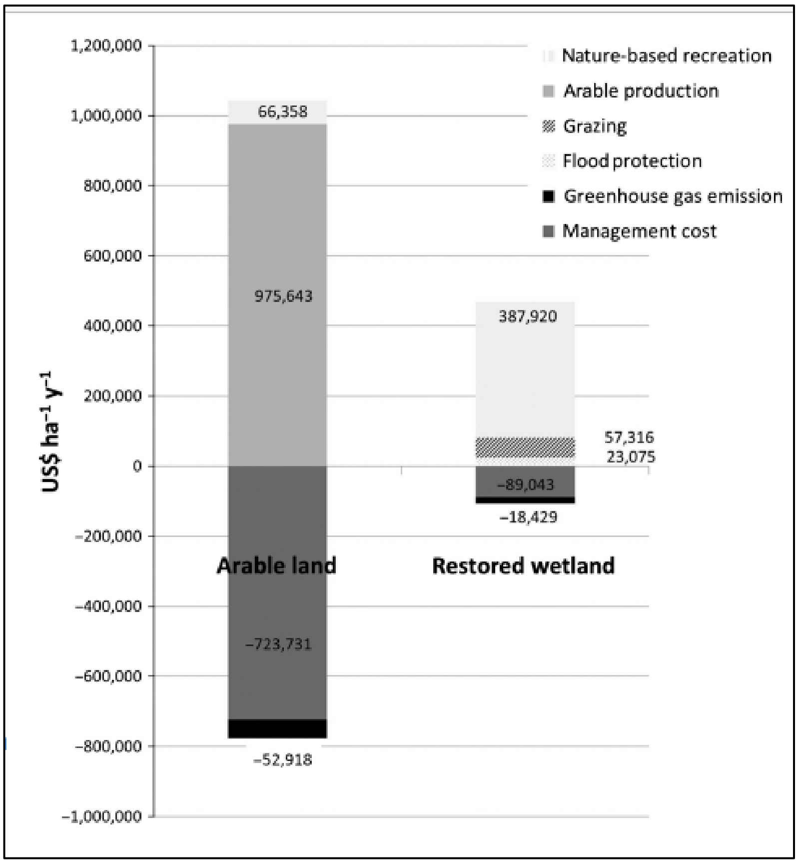

Fig .1. A comparison of the ecosystem service values and management costs in 2011 (in US$ for 479ha y-1) of restored wetland and of the same land if returned to arable agriculture (Peh, et al., 2014).

Woodland Education Centre, Devon - The Wetlands Restoration Project

Between 1988 and 1991 the Woodland Education Centre on the outskirts of Offwell, Devon, began work on the Wetland Restoration project which aimed to remove the invasive Rhododendron and to restore several freshwater aquatic habitats including ponds, lakes, wetlands, and marshes to support a wide range of plants and animals as the site is used primarily for environmental education (Woodland Education Centre, 2000). Floral surveying was conducted at the four new habitats in the summer of 1991 following the removal of Rhododendron in 1990 and completion of the project (Woodland Education Centre, 2000). In the year 2000 an in-depth ecological survey and report was published to review the ecological changes that have taken place in the 10 years since the project's completion (Corker, 2000). Surveys were predominantly botanical as the aims and goals was to clear away Rhododendron to allow the growth of new vegetation and to remove and invasive species.

<u>West Sedgemoor RSPB Reserve, Somerset</u>

The 560-ha RSPB reserve forms a proportion of a larger 35,000-ha former wetland complex of Somerset levels and Moors, which is recognised for its wildlife and landscape interest. Drainage of the agricultural ly fertile, peat rich soils continued up to the early 1980s resulting in the destruction of the wetland habitats causing drier conditions unsuitable for breeding and wintering birds. Between 1977 and 1987 there was a 70% decline in breeding snipe and a 55% decline in breeding Lapwing. Water-level management was proposed to re-create the suitable conditions for breeding waders and wintering waterfowl. This was achieved through the creation of a series of hydrological management blocks surrounded my embankments. This has allowed the implementation of a range of water management regimes; this includes maintaining shallow flood water in the winter to benefit feeding wintering birds. In the spring the water levels are lowered to provide areas of shallow flooding and damp soil to benefit nesting breeding (Benstead, 2000).

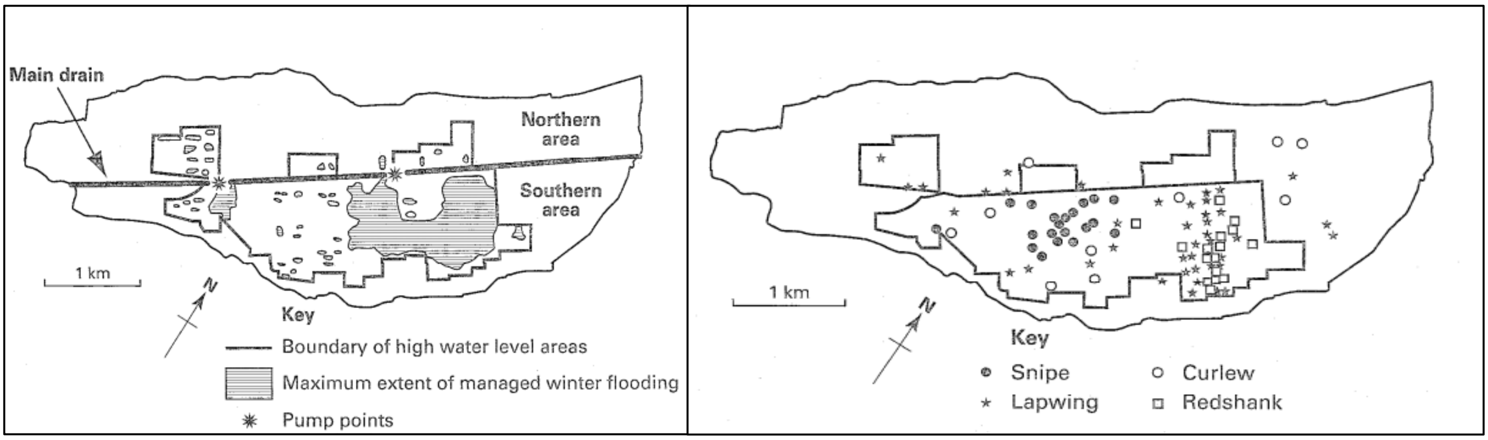

Figure 2. Left- Creation of bounded high water level areas to allow water levels on reserves to be maintained at a higher level than on surrounding intensively managed farmland (West Sedgemoor, Somerset, UK) (Benstead, 2000)**. Right - Distribution of breeding waders, with the highest concentration found within the hydrologically managed areas** (Benstead, 2000)**.**

In other areas of the Somerset levels and Moors, populations of wintering waterfowl and breeding waders have declined, however wader density has increased on the hydrologically managed areas of the reserve from 48 pairs in 1987 to approximately 125 pairs in 2000, of which 90% of these bred on the raised water level areas which form approximately 20% of the site (Benstead, 2000).

Before the implementation of the hydrological management, flooding was unreliable and often short in duration due to the flood water being rapidly pumped away. The reinstatement of winter flood drastically increased the number of over wintering birds (figure 4) to above 50,000 individuals. (Benstead, 2000)

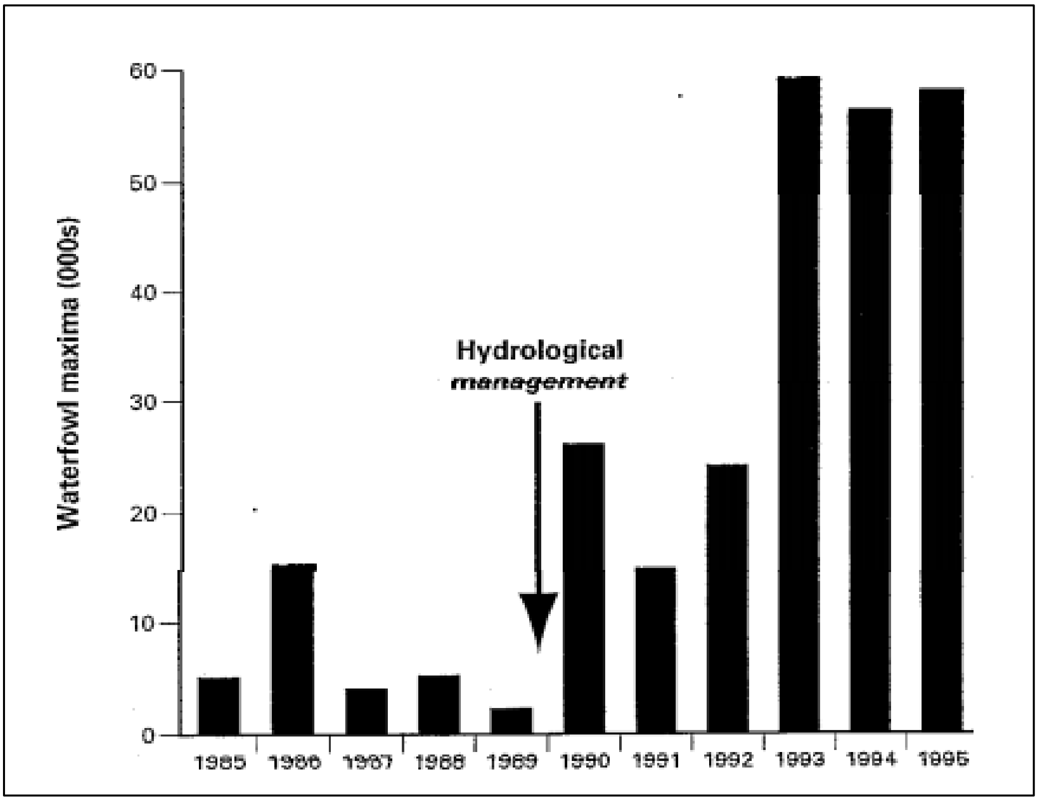

Figure 4. number of overwintering waterfowl prior to and after the implementation of hydrological management. (Benstead, 2000)

<u>Discussion</u>

Restoration, or the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed, has the potential to reverse habitat degradation, increase biodiversity, and deliver important ecosystem services (Hughes, et al., 2017). The five wetland restoration case studies reviewed, show varying aims and goals in which success of the restorative actions undertaken are measured or can be measured. This is typical of UK habitat restoration where the success of restorative action is based upon the achievement of specific aims and goals of said project (Meli, et al., 2014) improvement of habitat for the Eurasian Bittern and other target wetland bird species (Champion & Ashton, 2010) (Benstead, 2000) and the removal of Rhododendron to increase plant biodiversity (Corker, 2000). Peh et al 2014 costs and benefits analysis of the different ecosystem services takes a modelling approach due to the difficulties and variables when comparing an area of restoration with an area of arable land of equal size. That said the model shows just how beneficial restorative action is economically and socially, although it does not produce as much economically, there is also less of a financial loss when compared to the financial loss of arable land used for agriculture (Peh, et al., 2014). There is no denial in the importance of wetland restoration to increase ecosystem services and enhance biodiversity, although as there is no general measure of success that incorporates the changes in ecosystem services and biodiversity, evaluating restorative actions is difficult and often context dependant (Meli, et al., 2014). Restorative actions increase the success of which ecosystems carry out ecosystem services including the preservation of biodiversity however it is not always possible to restore ecosystem services back to Natural levels (Meli, et al., 2014). Success is often a very subjective term to use and means different things to different people in different situations, Measuring success is difficult due to a lack of specificity of what the goals of restorative actions are (Kentula, 2000). In the context of the UK restorative actions historically and continue to be measured of the success of a specific goal however the inclusion of biodiversity and ecosystem services albeit more of headache is not impossible when assessing the success of restorative actions, especially regarding an ecosystem / habitat that has so many benefits. This should also be considered for project design when considering what the primary goals/ aims of the restorative action are and what potential secondary aims and goal can be to further improve the evidence to support the restoration of degraded wetlands. The literature on the subject of UK wetland habitat restoration is intermittent with project specifics often lacking such as the data used to analyse success and a fixed criterion to know when "Success" has been reached. In the context of the West Sedgemoor RSPB Reserve, Somerset, Success of habitat restoration and management through the means of hydrological management, was measured using the number of over wintering birds and nesting waterfowl, as the habitat was to a more natural state than it had been previously **(figure 4)** Measuring success based on increases in waterfowl populations at a site shows it is successful for that specific taxon, which is the specific goal of that project. However, the impact was not measured on other taxa such as macro-invertebrates or fish.

Conclusion

To conclude, A full meta-analysis of all UK wetland habitat restoration projects would be needed to create a more thorough and in-depth review of wetland habitat restoration within the UK, what drives it, its cost and benefits and the criteria set to measure the success or failure of the restorative actions used and management plans implemented to create, restore, or maintain UK wetland habitats. Through the case studies reviewed it has become apparent that there is a gap within scientific literature and experimentation to provide statistical evidence on how successful the restorative actions have been with the success often being based around specific goals e.g., to increase the habitat, to increase specific species populations. However, this does not necessarily provide evidence for the restoration of wetland habitats or contribute to creating best practice when restoring wetland habitats. It is evident that further scientific research is needed to analyse the various impacts that wetland habitat restorations have on biodiversity, soil chemistry, water quality, hydrology, and other ecosystem services such as leisure and education. This will provide the knowledge to create better action plans that are more beneficial to both the environment, the organisms that inhabit it and the people who wish to enjoy it whilst also removing the stigmas that wetland habitat have of being smelly, mosquito filled areas of little life.

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Chapter 2: A comparative study of two wet meadow sites at different stages of restoration / rewilding in Cheshire, England

1.0. Introduction

Between 50% to 90% of wetland ecosystems have been lost in Europe alone (Rispoli, Hambler 1999), often accompanied by a decline in the value of these ecosystems. The term Wet meadow habitat is difficult to define due to their similarity to both grassland habitats such as lowland fen meadows and wetland habitats such as marshes due to the species that in habit. However, some key defining features of wet meadows include extended periods of flooding often in the winter followed by short periods of inundation, flora include a variety of species including *Caltha palustris, Filipendula ulmaria, Valeriana* species, *Crepis paludosa, Dacylorhiza* species, *Eupatorium cannabinum, Juncus* species and *Carex* species. Wet meadow habitats are may also be defined as floodplain meadows. Wet meadow habitats, across Europe have seen a huge decline in area and quality (Prach 2008). Historically in England there was approximately 1,200,000 ha of wet grasslands, including wet meadows, with around 220,000 ha remaining (Prach 2008). Wet meadows are important for their high diversity of plants which in turn provide a vital habitat for various species of invertebrates, birds, and mammals. The restoration of degraded land has been recognised international as a way of enhancing biodiversity and of increasing the ecosystem services which they provide (Peh, Balmford et al. 2014). Often the primary motivation for undertaking restorative action is to increase the amount of habitat present. This is particularly important where extensive habitat fragmentation and modification have taken place (Clarkson, Ausseil et al. 2013) such is the case with wet meadow habitats throughout the United Kingdom. Wetland ecologists often agree that hydrology and fertility are the two most important controls of vegetation diversity. However, the composition of wetlands is influenced by a number of additional factors, of which mowing is one of the most traditional disturbance, especially in European wetlands and wet meadows of which many had been cut for hay or managed for cattle for hundreds of years (Kołos, Banaszuk 2013).

This study investigates the habitat restoration actions, where by a habitat or ecosystem is restored through the improvement of pre-existing habitat or the creation of new habitats for the specific purpose of providing habitat, either for the individual species of for the entire suite of species likely to be found in and area (Miller, Hobbs 2007) and rewilding actions, which in its most simple form means to make wild again by return land to a wilder, more natural state (Jørgensen 2015) of a wet meadow habitat have been successful in altering the species composition, diversity and water quality when compared to a marsh grassland where plans have been proposed to restore / create a wet meadow habitat to provide and area for continuous scientific research, education, preserve and increase biodiversity and mitigate flooding. We hypothesise that a wet meadow which has undergone habitat restoration/ rewilding would be more biologically diverse and species rich when measuring aquatic macro-invertebrate diversity and floristic diversity with an emphasis on wet meadow specific plant species.

1.1 Site Background

Habitat restorative actions and previous management, Chester Zoo Nature Reserve Wet meadow

Information on previous restorative actions undertaken at the Chester Zoo Nature Reserve wet meadow habitat was acquired through interviews of staff directly involved in the nature reserve. The Chester Zoo wet meadow habitat is an area of approximately 2.74 ha located in in the northeast area of the Chester Zoo nature reserve 53°13'54.4"N 2°53'16.5"W. The Chester Zoo Nature Reserve underwent extensive habitat improvement and restoration through the removal of topsoil, the creation of ponds, the altering of water ways and the introduction of native species to allow quick colonisation of the cleared areas. Although most of these habitat restorative actions occurred in areas separate to the area of interest (Figure 1). The area of interest was however sporadically grazed and mowed over the past 4 years starting in 2017 and has predominantly been left to rewild.

Proposed habitat restorative actions, Chester Wetland Centre

The proposed Chester Wetland Centre (CWC) is an area of unmanaged marsh grassland and semi-improved neutral grassland, covering an area of 5.24h in the Northwest of the Countess of Chester Country Park, 53°12'55.2"N 2°54'28.4"W, on land owned by the Land Trust. Is it situated between the Shropshire Union Canal and Finchett's Gutter, a man-made gutter for historic agricultural uses. The main aims and objectives of the CWC are to create a wet meadow habitat which will provide a range of ecosystem services including but not limited to, improving water quality, education and continuous scientific research, flood mitigation, carbon sequestration and increasing and preserving biodiversity. The current proposal intends to edit the water course through the site to reduce the speed of the flow and amount of water flowing through Finchetts Gutter during times of heavy rainfall, increasing the saturation of the site. Furthermore, the proposal looks to create a treatment reedbed further upstream to naturally treat the water with the aim of reducing the nutrient content of the water feeding the site. The proposal also looks toward management methods such grazing and mowing to manage the vegetation of the site.

2.0 Methodology

Two sites in Cheshire, England were chosen for their ecological similarity and ecological and anthropogenic pressures. The first, Chester Zoo Nature Reserve (CZNR) wet meadow habitat, indicated by the red polygon on the map shown in **Figure 1,** had previously undergone restorative actions and a management plan to maintain it. The second site, Chester Wetland Centre (CWC), indicated on the map in Figure **1** by the blue polygon, was a seasonally flooded marsh grassland used as a flood storage reserve with the proposal to create a wet meadow habitat. A Phase 1 Habitat Survey **(Figure 2)** was conducted at the CWC site to evaluate its suitability and similarity for the purpose of this study. The area was made up of two habitats a marsh grassland indicated by purple stripes over an orange shading and a semi-improved neutral grassland indicated by orange shading with "SI" over the top.

Figure 1: Locations and area polygons of the two study; Wet meadow habitat at the Chester Zoo Nature Reserve represented by the polygon in the northeast section of the map and the marsh grassland habitat at the proposed Chester Wetland Centre, represented by the polygon in the southwest area of the map and their relation to one another.

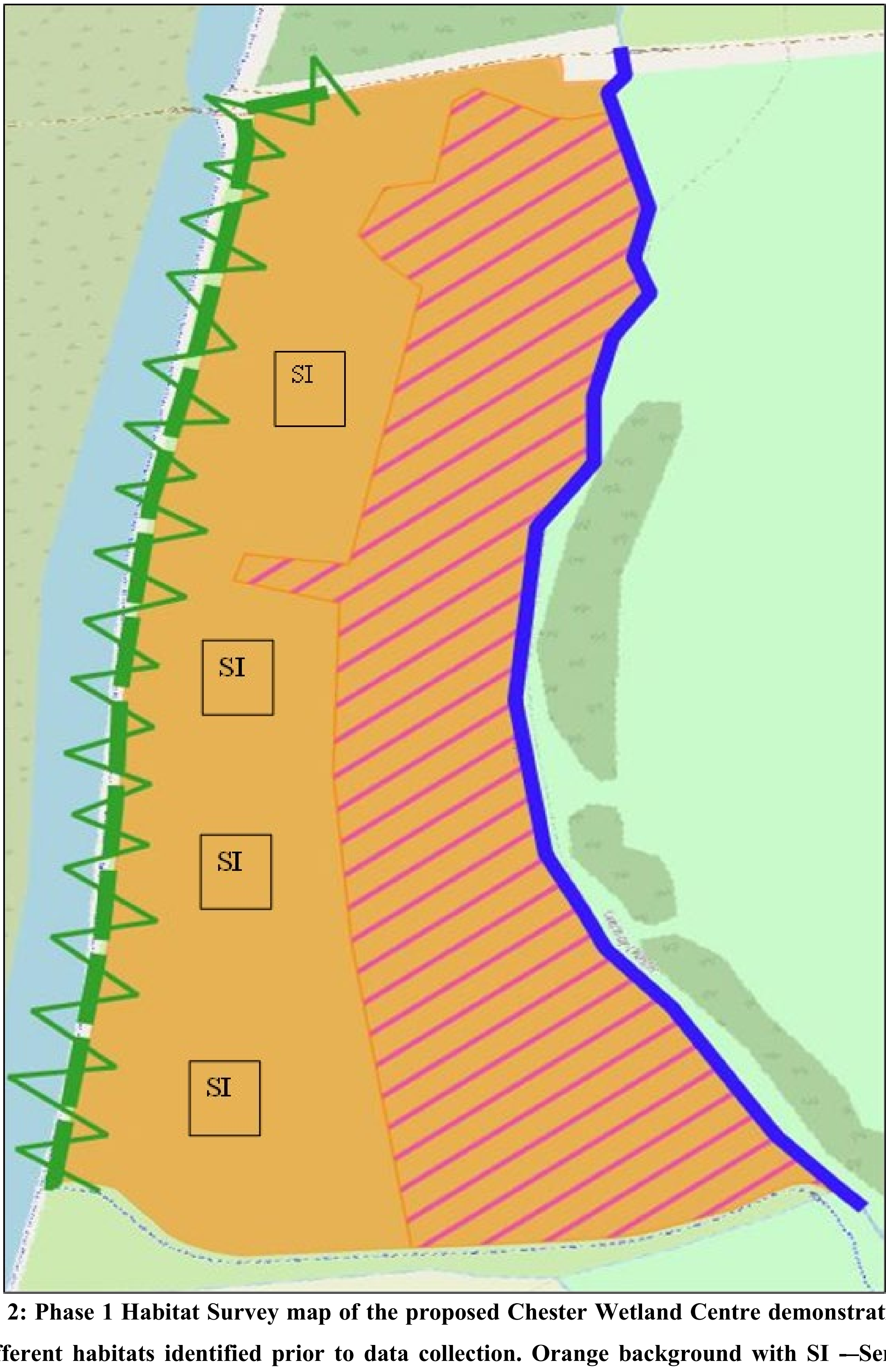

Figure 2: Phase 1 Habitat Survey map of the proposed Chester Wetland Centre demonstrating the different habitats identified prior to data collection. Orange background with SI –Semi-improved neutral grassland, orange background with purple lines – marsh grassland, Bold dark blue line – eutrophic running water and broken green line with green zig zag- defunct, native species rich hedgerow. (See appendix A for full Phase 1 Habitat Survey)

2.1 Habitat Quality

A complete wet meadow plant species list was created, see appendix, to identify those species classed as wet meadow specialist plant species. This was created by searching through various British / UK plant guides. All species which had wet meadow habitats under the habitat section of the species description were included. The UK Habitat survey and Phase 1 habitat survey data sheets were also analysed; however, the term "wet meadow" is not used, and the list of plants given for similar habitats is limited to only the most abundant species in that habitat. This list is not extensive as there is little literature distinguishing wet meadows, wet grasslands, damp meadows, damp pastures, and floodplain meadows all of which may be used interchangeably with one another. Only species which contained wet meadow in their habitat descriptions were included. Other species could also have been included within this list as they are able to inhabit a range of habitats so more research with the inclusion of visits to other wet meadow habitats would be needed to create a more accurate list of wet meadow plant species.

2.2 Floristic Biodiversity and Benthic Macro-invertebrate Biodiversity

Data was collected on the floristic biodiversity throughout British Summer months, June to August, during times of fair weather to increase the success of species identification as most plants were in flower and the ease of surveying as the two sites were saturated but not flooded unlike the rest of year. At each site 9 transects, 40 metres long and 20 metres apart were laid out perpendicular to the gutter, at the Chester wetland centre site the transects started at the gutter, at the Chester Zoo nature reserve the transects spanned 20 metres either side of the gutter due to the positioning of the gutter and the shape of the survey area **(Figure 3)**. One by one metre quadrats were placed every other metre on alternating sides of the transects. For each quadrat the plant species present were identified in the field using Collins Wildflower Guide 2nd edition and the National Plant Monitoring Scheme Species Identification Guide. Once identified the number of each species within the quadrats were counted. Poales (Grasses and Sedges) were estimated by counting the number of clumps / tufts where individual plants could not be distinguished from one another. A Species discovery curve **(Figure 3)** was used to estimate when to stop surveying. After nine transects had been conducted, the number of new species being recorded had dropped and the species discovery curve **(Figure 2)** had begun to plateau. Surveying could have continued with more transects to record more species however new species would only have been represented by a few individuals thus not impacting the quality of the data.

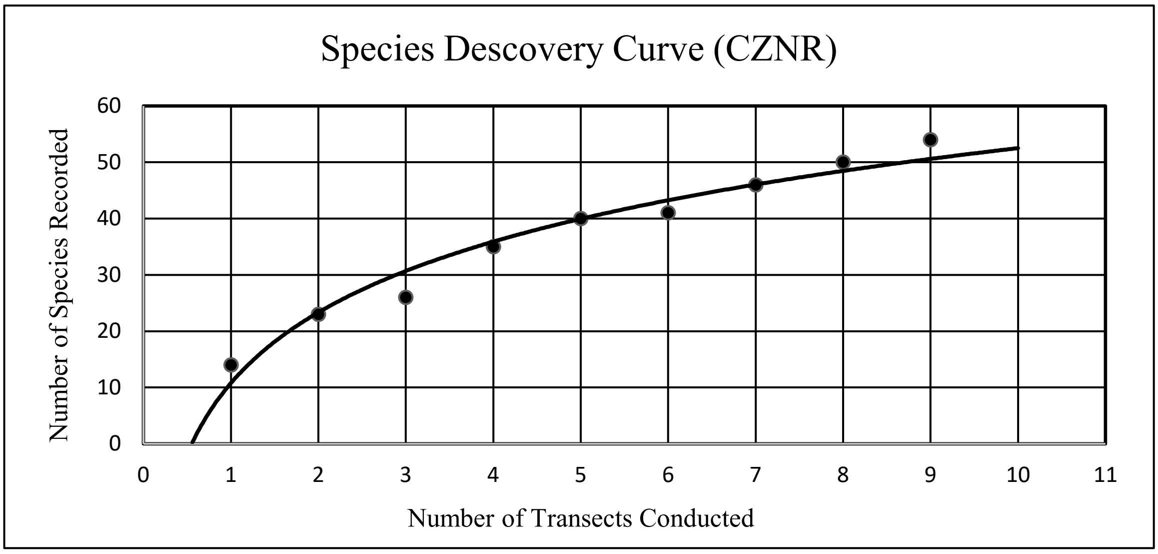

Figure 2: Floristic Species discovery curve of the Chester Zoo Nature Reserve wet meadow habitat

Figure 3: examples of the belted transect line (black line with black squares) and the kick net sampling (black circles) methods used at the proposed Chester Wetland Centre marsh grassland (top) and the Chester Zoo Nature Reserve wet meadow (bottom). Images are not to scale.

Benthic macro-invertebrate data was collected during British Summertime, June, in 2021. Four locations equally spaced out along a stretch of gutter which ran through the two sites of interest were surveyed for 30 seconds six times, totalling three minutes of surveying for each of the four locations **(Figure 3)** A 30cm by 30cm long handled net was passed through a 2X2m area of water in a figure of eight movement at different depths to optimise the amount of data collected. Specimens were sorted in the field into different tubs based on their taxonomic families and where possible identified to a species level. High resolution macro photographs and electronic microscope photographs were taken to identify species away from the field reducing the need to remove specimens from the sites as this would have void permissions. Data was collected on the number of each species present for calculating the biodiversity indices and the organisms' taxonomic families for calculating the Biological Members Working Party (BMWP) Scores and Average Score Per Taxa (ASTP) to be used as an indication to the level of pollution in the two stretches of Finchetts gutter which feed the two sites of interest (Mandaville 2002, Advances in Water Pollution Control. 1990, Hawkes 1998).

3.0 Data Analysis and Statistical Considerations

Simpsons Diversity Index (D)

The analysis methods used for this study were chosen due to their popularity within the scientific literature with the Shannon-Weiner diversity index and the Simpsons diversity index often being used together. The similarity coefficients were chosen as they provide two pieces of similarity information, the first, Sorensen's coefficient, provides a numerical value between 0 and 1 looking at the overlap of species in two sites. The second similarity coefficient used, Jaccard's provides a percentage value for the % of species in common.

Floristic diversity and benthic aquatic macro-invertebrate diversity were calculated using Simpson's diversity index (D)

$$\mathrm{D} = 1 - \frac{\Sigma n(n-1)}{N(N-1)}$$

Where N is the total number of organisms and n is the total number of each species present. This index places more weight on common/ dominant species and little weight on rare species with only one or two individuals present in the data. Results of the Simpsons diversity indices range between 0 (complete homogeneity or no diversity) and 1 (complete heterogeneity or complete diversity)(Mandaville 2002, Izsák, Papp 2000).

Shannon-Weiner Biodiversity Index (H)

Floristic diversity and benthic aquatic macro-invertebrate diversity were calculated using the Shannon-Weiner Index (H).

$$H = -\sum_{i=1}^{s} \left(\frac{n_i}{N}\right) \log_2 \left(\frac{n_i}{N}\right)$$

Where S is the total number of species in the sample, N the total number of individuals in each sample and n the total number of individuals of each species. A value of 0 would imply complete homogeneity or no species diversity. A larger value indicates greater diversity. This measure takes into consideration rarer species (Species represented by 1 or a few individuals in the overall data set) (Jhingran, Ahmad et al. 1989).

Hutchinson t-test

The Hutchinson t-test was used to analyse statistical significance of the Shannon Diversity Index with a p value =>0.05 accepted for statistical significance (Hutcheson 1970). The Hutcheson t-test was developed as a method to compare the diversity of two community samples using the Shannon diversity index (Hutcheson 1970)..

$$t \frac{H_a - H_b}{\sqrt{S^2 H_a + S^2 H b}}$$

In the formula H represents the Shannon diversity index for each of the two samples (subscripted a and b). The bottom of the formula refers to the variance of each of the samples.

Community Similarity: Sorenson's and Jaccard community similarity coefficient

Sorenson's Coefficient was used to measure the floristic community similarity between the CZNR wet meadow and CWC marsh grassland. Where C is the Number of species two communities have in common and S1 being the number of species found at Site 1 and S2 the number of species found at site 2. Results are between 1 and 0 with 1 being a complete overlap or similarity in species found at each site and 0 being no similarity whatsoever (Sala, Oesterheld et al. 1986, Goodall 1978).

$$\boldsymbol{Cc = \frac{2C}{S1 + S2}}$$

Jaccard community similarity coefficient was used to measure the floristic similarity of the CZNR wet meadow and the CWC marsh grassland. Where X is the number of species recorded at CZNR and Y is the number of species recorded at CWC. The number of species in common at the two sites was divided by the total number of species found at both sites. The figure generated from Jaccard community similarity coefficient was multiplied by 100 as this gave it a % of species in common between the two sites (McKinney 2004, Real 1999).

$$\boldsymbol{J = \frac{|X \cap Y|}{|X \cup Y|}}$$

Water Pollution

The BMWP score and ASTP was used to gain an immediate in field evaluation of the pollution levels of the water feeding the two sites (Hawkes 1998) using benthic macro-invertebrates as indicators of levels of water pollution. Each taxonomic family is scored between 1 and 10 depending on their tolerance to pollutants, 1 being the most tolerable to pollutants and 10 having no to little tolerance to pollutants. The sum of each family's tolerance score equals the BMWP Score for that section of waterway. The higher the score the less polluted the water (**Table 1**).

Table 1: Interpretation of the Biological Members Working Party (BMWP) scores, description of scores and interpretation of scores.

BMWP Score	Water Quality Category	Interpretation
0-10	**Very Poor**	**Heavily Polluted**
11-40	**Poor**	**Polluted / Impacted**
41-70	**Moderate**	**Moderately Polluted / Impacted**
71-100	**Good**	**Clean / Slightly Impacted**
>100	**Very Good**	**Unpolluted/ Unimpacted**

The Average Score Per Taxa (ASTP) was calculated by dividing the BMWP Score by the number of scoring taxonomic families (Mandaville 2002).

4.0 Results

4.1 Floristic diversity and community similarity

The results of the Sorenson's Coefficient and Jaccard Coefficient represented in table 2 show that there is a mid to low floristic community similarity in the two study sites.

Table 2: Result of the Sorenson's Coefficient (CC) and Jaccard similarity coefficient (J) of floristic community similarity of the Chester Zoo (CZ) wet meadow and Chester Wetland Centre (CWC) marsh grassland.

Number of species at the CWC	Number of species at CZ	Total number of species at both sites	Number Species in Common	CC	J	Interpretation
44	54	78	20	0.41	25.64%	Low

The result of the Sorenson's coefficient shows that there is a mid to low community similarity CC=0.41, a figure of 0.5 would indicate that half the surveyed species at the two study sites are the same, a figure of 0.0 would indicate no community similarity and a figure of 1.0 would indicate complete community similarity. The results of Jaccard community similarity coefficient, J= 25.64%, indicates that there is a low % of floristic species in common at the two study sites as 0% would indicate no community similarity and 100% would indicate complete community similarity. The Jaccard coefficient arguable provides more information than Sorenson's coefficient, whether this is due to sample size would have to be further investigated. The two sites had a total of 20 species in common. With the CZ wet meadow being more species rich with 54 plant species recorded compared to 44 species recorded at the CWC marsh grassland.

The results represented below in table 3 show that there is no difference in the diversity of the two sites of interest when using the Simpson's Index, **D=0.91**. Although both sites have relatively high levels of floristic diversity with a figure closer to 1 indicating complete heterogeneity.

Table 3: Results of the Simpson's (D) and Shannon's (H) Diversity Index for floristic biodiversity at the Chester Zoo wet meadow and proposed Chester Wetland Centre marsh grassland.

Location	**Simpson's Diversity Index (D)**	**Shannon's Diversity Index (H)**
Chester Zoo Wet Meadow	0.91	2.90
Proposed Chester Wetland Centre Marsh Grassland	0.91	2.81

The Shannon's index was used as it considers rarer species unlike the Simpson's Index which excludes species represented by only one or a small number of individuals. The Simpson's Index gives more weight to dominant or more common species. The result of the Shannon Index shows that the Chester Zoo wet meadow habitat is more diverse, H=2.90, than the proposed Chester Wetland Centre marsh grassland habitat, H=2.81, albeit by only by 0.09.

Table 4: Comparison of the proportion (%) of and richness of wet meadow specialist species found at the Chester Zoo Nature Reserve (CZNR) and Chester Wetland Centre (CWC) between the months of June and August 2021.

Location	**Floristic species richness**	**No. of wet meadow specialist species**	**% Of wet meadow specialist plant species within the population**	**% Of overall sampled population that are wet meadow specialist species**
CZ wet meadows	**54**	**6**	**11.11%**	**14.47%**
CWC marsh grassland	**44**	**3**	**6.82%**	**4.17%**

A total of 54 for different plant species were identified at the CZNR wet meadow habitat. With **11.11%** (6 species) of species found at the site being identified as wet meadow specialist species. These 6 species make up **14.47%** of the total sample population at the CZNR wet meadow. 44 plant species were identified at the CWC with **6.82%** (3 species) identified as wet meadow specialist species. These 3 species make up **4.17%** of the sampled population at the CWC. The CZNR wet meadow habitat supports more wet meadow specialist species than the CWC with the wet meadow specialist species making up a higher percentage of the overall sampled population.

A Hutcheson t-test was conducted to analyse if there was a statistical significance between the two Shannon Diversity index (H) results.

Table 5: Results of the Hutcheson t-test (t) for significance (p), where df is the degrees of freedom and crit is the critical value. E1 refers to the Chester Zoo wet meadow habitat and E2 refers to the proposed Chester Wetland Centre current marsh grassland habitat.

Site:	E1	E2
Total	3783	2782
Richness	54	44
H	2.90	2.81
S^2_H	0.000353	0.000466
t	2.963822	
df	6043	
Crit	1.960357	
p	0.00305	
CI	0.037594	0.043194

The results of the Hutchinson t-test show a significant difference in biodiversity using the Shannon diversity index where the p value is >0.05. There is a significant difference in biodiversity p=0.003 with the Chester Zoo Nature reserve wet meadow habitat having a significantly greater biodiversity than the proposed Chester Wetland Centre current marsh grassland.

4.2 Benthic macro-invertebrate Biodiversity and water quality indicators

4.2.a Benthic macro-invertebrate biodiversity

The results from the two diversity indices used, Simpsons Diversity index and Shannon's Diversity Index, show that the proposed Chester Wetland Centre has a greater diversity of benthic invertebrates **D=0.88, H=2.13** than the Chester Zoo Nature Reserve, **D=0.83, H=1.95.** the Shannon index gives more weight to species richness and considers species represented by one or a few individuals meaning that the data is influenced by all species present and not just the most abundant species.

Table 6: Results of the Simpsons (D) and Shannon's Diversity (H) Index for Benthic Invertebrate biodiversity of the two sections of Finchetts Gutter which flow through the Chester Zoo Nature Reserve wet meadow habitat and proposed Chester Wetland Centre marsh grassland habitat.

Location	Simpson’s Diversity Index (D)	Shannon’s Diversity Index (H)
Chester Zoo Wet meadow	0.83	1.95
Proposed Chester Wetland Centre Marsh Grassland	0.88	2.13

4.2.b. BMWP and ASTP indices for benthic invertebrate as indicators water pollution levels

The values represented in **table 7** from the calculation of the BMWP Scores and ASTP values shows that both sites are moderately polluted with BMWP scores of **47** (CWC marsh grassland) and **53** (CZNR wet meadow) and ASTP values of **4.7** (CWC) and **5.3** (CZNR). The section of Finchetts Gutter at the CWC is more polluted than the section found at the CZNR wet meadow although both sections of the gutter surveyed show moderate levels of pollution.

Table 7: A comparison of Biological Members Working Party (BMWP) scores, Average Score per Taxa (ASPT) values of the benthic macro-invertebrate families found in the Chester wetland centre (CWC) and Chester Zoo Nature Reserve (CZNR) sections of Finchetts Gutter and interpretation of figures.

CWC Gutter		**CZ Gutter**	
Family	**BMWP Score**	**Family**	**BMWP Score**
Sphaeriidae	3	Asellidae	3
Sialidae	4	Coenagrionidae	6
Erpobdellidae	3	Corixidae	5
Physidae	3	Dytiscidae	5
Limnephilidae	7	Hydrophilidae	5
Calopterygidae	8	Libellulidae	8
Coenagrionidae	6	Lymnaeidae	6
Asellidae	3	Lymnephilidae	7
Acroloxidae	6	Naucoridae	5
Baetidae	4	Planorbidea	3
Total BMWP Score	**47**	**Total BMWP Score**	**53**
No. of scoring taxa	**10**	**No. of scoring taxa**	**10**
ASTP	**4.7**	**ASTP**	**5.3**
Level of pollution	**Moderate**	**Level of pollution**	**Moderate**

4. Discussion

Success of habitat restoration varies from project to project depending on the overall aims and planned outcomes of the restorative outcomes used. An area that has already undergone habitat restorative actions, the CZNR wet meadow was compared to an area where wet meadow restorative actions were planned but had yet to be undertaken. Differences in Floristic Biodiversity, community similarity, presence of wet meadow specific plant species, benthic macro-invertebrate biodiversity and water quality were all analysed to measure whether a restored habitat was more biologically diverse. Linking back to our hypothesis that a wet meadow habitat which has undergone habitat restoration/ rewilding would be more biologically diverse and species rich when measuring aquatic macro-invertebrate diversity and floristic diversity with an emphasis on wet meadow specific plant species compared to that of a marsh grassland habitat where restorative actions have been proposed to restore/ create a wet meadow habitat. The two habitats chosen for this study were ecologically similar, both were wetland habitats and faced similar ecological pressures both past and present. The restored wet meadow habitat at the CZNR was more species rich, **N=54,** than the marsh grassland at the CWC, **N=44**.

We cannot say that the restorative actions and habitat management methods at the CZ wet meadow habitat have been successful in creating a more biodiverse and species rich habitat as no data was present for this site from before restorative actions and management methods were used. However, from the data collected and analysed we can say that the CZ wet meadow habitat is more species rich and biologically diverse than the CWC marsh grassland with the assumption that restoration and management actions have played a part in this. Species richness is often the measure used to evaluate the success of habitat restoration projects (Ruiz-Jaen, Mitchell Aide 2005), presuming that more species present, equals a "better" habitat. Species diversity is one of the three mayor ecosystem attributes used to assess restoration success: (1) Diversity, (2) Vegetation Structure, and (3) ecological process(Ruiz-Jaen, Mitchell Aide 2005).

To further understand the effects of habitat restoration on biodiversity, Shannon and Simpson diversity indices were used to measure the floristic biodiversity and benthic macro-invertebrate biodiversity of the two study sites. When comparing the floristic biodiversity, the results of the Shannon diversity index showed that the restored wet meadow habitat at the CZNR was more diverse, **H=2.90**, compared to the CWC, **H=2.81.** There was a significant difference in biodiversity between the two sites **p=0.003** which supports our hypothesis that a restored wet meadow habitat has greater biodiversity. When comparing the results of the Simpsons index there was no difference in floristic biodiversity, **CZNR D=0.91**, **CWC D=0.91** respectively. Vegetation structure was also tested although simplified to community similarity and the presence of wet meadow specialist species. We defined wet meadow specialist plant species as plants which are described as prominently growing or found in wet meadows using the Collins Wildflower Guide 2nd edition. The Sorenson's and Jaccard community similarity coefficients were used to measure the similarity of floristic species at the two sites. Both sites had 20 species in common. Although there was a relatively low community similarity between these two sites, **CC=0.41** and **J=20.41**%, where a value of **C=1.0** and **J=100%** showing complete community similarity (Mandaville 2002, Goodall 1978, McKinney 2004, Real 1999, Sala, Oesterheld et al. 1986). To further test the vegetation structure of the wet meadow habitat compared to the marsh grassland habitat the number of wet meadow specialist plant species were counted and the percentage of wet meadow plant species richness was calculated as well as the proportion of wet meadow plant species in the overall sampled population **(Table 3)**. The CZNR meadow habitat had 6 species identified as wet meadow specialist species compared to the 3 species identified at the CWC. Wet meadow specialist plant species made up **11.11%** of the overall floristic species richness of the CZNR wet meadow habitat compared to **6.82%** of the CWC species richness. There was approximately a **10%** difference in the proportion of wet meadow specialist plant species that make up the overall sampled population. At the CZNR wet meadow habitat, **14.47%** of the overall sampled population is made up of specialist wet meadow plant species compared to **4.17%** of wet meadow specialist plant species that make up the overall sampled population of the CWC. A greater richness and proportion of wet meadow specialist plant species indicates that the restorative actions and habitat management methods have (1) created a wet meadow habitat and (2) provided a suitable habitat in which wet meadow specialist plant species can grow and colonise. However, the site at the Chester Zoo nature reserve has a relatively low proportion of wet meadow specialist plant species, it may not be in the best condition due to the low number of wet meadow specialist plant species present and how little they make up of the overall floristic community, this could be due to several different stressors including management or lack of management. There was no available data for any management process that may have occurred at the CWC marsh grassland and non-had occurred over the 11 months that surveying had been undertaken at the site. The grassland habitat that joins to the marsh grassland **(Figure 2 Phase 1 Habitat Survey Map)** showed visible evidence of mowing at some point in time, although to what extent and for how long was not known and no evidence of mowing was visible in the marsh grassland habitat. Grassland management through grazing or mowing is known to alter the composition of vegetation with intermediate levels of disturbance assumed to increase floristic species richness and reduce the dominance of more competitive species (Steffan-Dewenter, Leschke 2003) this is further confirmed by the CZNR wet meadow habitat being more species rich, biologically diverse and with a greater species richness and density of wet meadow specialist plant species recorded albeit by only a small amount, where we know grazing or mowing methods have taken place to maintain the habitat albeit sporadically. Whether a more continuous practice of mowing or grazing practice rather than a more sporadic practice yielded an even greater difference in species richness or diversity for this site is not known. However, previous studies have found grazing management practices have changed the floristic species composition (Smith, Rushton 1994) and have increased the floristic biodiversity (Dostálek, Frantík 2008).

Across most European countries, biodiversity in grassland habitats is endangered by two opposite trends: Intensification of practices such as those within the agricultural industry and abandonment, where restoration practices are not followed up by continuous management and maintenance. Both have led to a reduction in plant species number (Plantureux, Peeters et al. 2005). Further methods of restoration have found a combination of diaspore transfer, the movement of hay / cuttings from a species rich or more diverse habitat to an area undergoing restorative action, topsoil removal and re-wetting have been successful in restoring wet meadow habitats with topsoil removal accelerating nutrient impoverishment and creating more favourable conditions for seedling recruitment (RW.ERROR - Unable to find reference:doc:619395488f08a97cd1884c38). Alterations to streams including plugging, the creation of ponds and the altering and/ or creation of channels has been closely linked with increasing the height of the water table and re-wetting areas of meadow and increasing the habitat suitability and improving the composition and cover of riparian vegetation (Hammersmark, Dobrowski et al. 2010). However, the majority of studies that have assessed the restorative methods used for wet meadow habitat restoration have come out of the Netherlands with UK based wet meadow habitat restorations being poorly documented within the scientific. Continuous management of restored wet meadow habitats through grazing and mowing as previously discussed is key to restoring and protecting the biodiversity. This is often agreed as the most effective method of management of semi-natural non-forest plant communities (Kołos, Banaszuk 2013).

Benthic macro-invertebrates were used as an indicator to the levels of pollution in the water courses running through the two sites as the water feeding a wetland has an impact on the plant species found throughout the habitat as wetland plant species have adapted to inhabit nutrient poor soils(Scholz 2016). The Biological Members Working Party (BMWP) Score and Average Score per taxon (ASPT) use benthic macro-invertebrates as an indicator to the level of pollution in a water course by giving each taxonomic family a numerical value based on their tolerance to pollutants (see appendix)(Hawkes 1998). The results of the BMWP score and ASPT **(Table 6)** show that both sections of Finchetts gutter were moderately polluted however the section of Finchetts gutter flowing through the CWC was more polluted than the section which runs through part of the CZNR (CWC **BMWP= 47**, CZNR **BMWP=53)**. The ASPT uses the sum of all families scored divided by the number of scoring taxonomic families (Hawkes 1998). On average the CZNR section of Finchetts gutter has a higher average tolerance score **ASPT=5.3** than that of the section of Finchetts gutter running through the CWC, **ASTP=4.7**. The diversity of benthic macro-invertebrates present at the two sites was analysed using the Shannon diversity index and the Simpson's diversity index (Jhingran, Ahmad et al. 1989). The section of gutter running through the CZNR wet meadow had little difference in benthic macro-invertebrate diversity than the section flowing through the CWC marsh grassland when using Simpson's index **D=0.83** and **D=0.88** respectively. The section running through CWC marsh grassland is slightly more diverse. When using the Shannon index which includes rarer species the diversity of benthic macro-invertebrates is greater in the section of Finchetts gutter flowing through the CWC marsh-grassland habitat, **H=2.13** when compared to that of the section flowing through CZNR wet meadow **H=1.95 (Table 5).** The level of pollutants in Finchetts gutter at the two sites of interest does not appear to impact the diversity of benthic-macro invertebrates as the section of Finchetts gutter flowing through the CWC marsh grassland is slightly more polluted but more biologically diverse than that of the section flowing through the CZNR wet meadow. Although not included in this study the level of vegetation cover of the sampled areas of the two sections of Finchetts gutter surveyed was noted and is included in the appendix. The section which runs through the CZNR wet meadow habitat had approximately >80% of vegetation within the sections sampled. This potentially impacted the results as the section of Finchetts gutter at the CZNR was hard to survey due to the large amounts of vegetation which gave the benthic macro-invertebrates more areas to take cover or vegetation to cling on to.

6.0 Conclusions

The results of this study clearly show a significance in biodiversity between a restored wet meadow habitat at the Chester Zoo Nature Reserve and a marsh grassland habitat where habitat restoration has been proposed to create a wet meadow habitat at the proposed Chester Wetland Centre. With the aforementioned, also showing a difference in species richness. From the results outlined and discussed in this paper we can say that habitat restoration has been successful in creating a more biologically diverse and species rich habitat define whether the habitat restoration / rewilding attempts have been successful in the creation of a wet meadow habitat. The two sections of Finchetts Gutter surveyed show a minimal difference in organic pollutants with both sections of Finchetts Gutter having moderate levels of organic pollutants having a knock on effect on the surrounding habitats in creating nutrient rich/ fertile habitats, where wetland habitats ideally are nutrient poor which is why one of the main aims of the proposed Chester Wetland Centre is to create a treatment wetland to remove pollutants from the water entering the section identified for the creation of a wet meadow habitat. This study proved a good baseline for the project and the need to improve the quality of the water entering the study site. The section of Finchetts Gutter at the Chester Wetland Centre had a lower BMWP score and ASPT than the section running through the Chester Zoo wet meadow. However, this did not impact biodiversity and instead did the inverse with the Chester Wetland Centre section of Finchetts Gutter having a great diversity of benthic macro-invertebrates than the section flowing through the Chester Zoo wet meadow habitat.

Further study is needed to explore the effects that other restorative actions and combinations of restorative methods have had on biodiversity within wet meadow habitat restorations however this is often difficult due to the extended time periods and funding often needed to undertake these types of studies and the lack of available data pre restorative actions and post restorative actions to analyse the success have habitat restoration and rewilding projects.

For the purposes of this study, to recommend management and restorative techniques based on the findings outlined and discussed throughout this paper, we support first and foremost the improvement of water quality through the creation of a treatment reedbed as already proposed, we also further recommend the "re-wiggling" of the water course to slow the movement of water and to provide a better habitat for aquatic vegetation to grow thus encouraging and providing suitable habitat for aquatic macro-invertebrates. We also recommend the introduction of mowing and dispore transfer to gradually reduce the nutrient levels in the marsh grassland and to allow less competitive species to grow, with dispore transfer from other wet meadow site introducing more desired plant species. To further manage this site in the future we recommend the introduction of grazing cattle as mowing would be limited if the desired effects of creating a more saturated habitat are achieved.

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8.0 Appendices

UK Wet Meadow plant list

Family	Common Name	Scientific Name
Fabaceae	Greater Birdsfoot Trefoil	*Lotus pedunculatus*
Ranunculaceae	Marsh Marigold	*Caltha palustris*
Caryophyllacaea	Ragged Robin	*Silene flos-cuculi*
Equisetaceae	Great Horsetail	*Equisetum telmateia*
	Water Horsetail	*Equisetum fluviatile*
	Marsh Horsetail	*Equisetum palustre*
Marsileaceae	Clover Fern	*Marsilea quadrifolia*
	Monk's-Hood	*Aconitum napellus*
Ranunculaceae	Common Meadow-rue	*Thalictrum flavum*
	water Chickweed	*Myosoton aquaticum*
Polygonaceae	Common Bistort	*Persicaria bisorta*
	Tasteless Water Pepper	*Persicaria mitis*
	Northern Dock	*Rumex longifolius*
	Clustered Dock	*Rumex conglomeratus*
Hypericaceae	Square Stalked St. John's Wort	*Hypericum tetrapterum*
Brassicaceae	Cuckoo flower/ Lady's Smock	*Cardemine pratensis*
Parnassiacaea	Grass-of-parnassus	*Parnassia palustris*
Rosaceae	Meadowsweet	*Filipendula ulmaria*
	Water Avens	*Geum rivale*
	Great Burnet	*Sanguisorba officinalis*
	Smooth Lady's-mantle	*Alchemilla glabra*
Hydrocotylaceae	Marsh Pennywort	*Hydrocotyle vulgaris*
Apiaceae	Tubular Water-dropwort	*Oenanthe fistulosa*
	Parseley Water-dropwort	*Oenanthe lachenalii*
	Wild Angelica	*Angelica sylvestris*
Lamiaceae	Skullcap	*Scutellaria galericulata*
	Water Mint	*Mentha aquatica*
Veronicaceae	Brooklime	*Veronica beccabunga*
	Blue Water-speedwell	*Veronica anagallis-aquatica*
	Pink Water-speedwell	*Veronica catenata*
	Marsh Speedwell	*Veronica scutellata*
Orobanchaceae	Marsh Lousewort / Red-rattle	*Pedicularis palustris*
Caprifoliaceae	Marsh Valerian	*Valerian dioica*
Globulariaceae	Devils-bit Scabious	*Succisa pratensis*
Asteraceae	Meadow Thistle	*Cirsium dissectum*
	Marsh Hawk's beard	*Crepis paludosa*
	Common Fleabane	*Pulicaria dysenterica*
	Sneezewort	*Achillea ptarmica*
	Marsh Fleawort	*Senecio congestus*
	Marsh Ragwort	*Senecio aquaticus*
	Butterbur	*Petasites hybridus*

	Trifid Bur-marigold	*Bidens tripartita*
Juncaginaceae	Marsh Arrow Grass	*Triglochin pallustris*
Junaceae	Round-fruited Rush	*Juncus Compressus*
	Blunt-flowered Rush	*Juncus subnodulosus*
	Hard Rush	*Juncus inflexus*
	Soft Rush	*Juncus Effusus*
Cyperaceae	Common Spike-rush	*Eleocharis palustris*
	False Fox Sedge	*Carex otrubae*
	True Fox Sedge	*Carex vulpina*
	Brown Sedge	*Carex disticha*
	Bladder Sedge	*Carex vesicaria*
	Distant Sedge	*Carex distans*
	Downy-fruited Sedge	*Carex filiformis*
	Common Sedge	*Carex nigra*
	Flea Sedge	*Carex pulicaris*
Poaceae	Meadow Fescue	*Schedonorus (=Festuca) pratensis*
	Floating Sweet Grass	*Glyceria fluitans*
	Meadow Foxtail	*Alopecurus pratensis*
	Orange Foxtail	*Alopecurus aequalis*
	Timothy	*Phleum pratense*
	Smooth Brome	*Bromus racemosus*
Nartheciaceae	Meadow Saffron	*Colchicum autumnale*
Alliaceae	Summer Snowflake	*Leucojum aestivum*
Orchidaceae	Early March-orchid	*Dactylorhiza incarnata*
	Southern Marsh-rochid	*Dactylorhiza praetermissa*
	Nothern Marsh-orchid	*Dactylorhiza purpurella*

Chapter 3: Species and Biodiversity Analysis of the Proposed Chester Wetland Centre

Contents

1.0 Introduction

Wetland habitats, as a whole, are valuable habitats due to how biologically diverse, they are and the numerous ecosystem services they provide to humans (Meli, Rey Benayas et al. 2014). Up to a quarter of the British Isles is thought to have once been some sort of wetland habitat of which 80% has now been lost leaving the remaining wetland habitats in a degraded state (Rispoli, Hambler 1999) and left existing as biogeographical "islands". In recent years there has been greater call for the improvement of habitat restorative techniques often with a focus on improving or increasing biodiversity (Miller, Hobbs 2007, Peh, Balmford et al. 2014, Ruiz-Jaen, Mitchell Aide 2005). Maintaining biodiversity has been a central tenant of conservation, with biodiversity influencing ecosystem function. Biodiversity-Ecosystem function relationships have a clear relevance to the design and success of habitat restoration projects (Hughes, Grabowski et al. 2018). However, studies often have limited data of the biodiversity of sites pre-restoration and often focus on specific taxa or target species with comparisons done with sites that are similar to pre or post restorative actions and not the site its self. (Gørtz 1998, Kail, Brabec et al. 2015, Klimkowska, Van Diggelen et al. 2007, Meli, Rey Benayas et al. 2014, Moroń, Szentgyörgyi et al. 2008, Sengl, Magnes et al. 2017). We understand that we do not live in an idyllic world where financial and time constraints do not impact the ability of scientific study or the delivery of conservation projects. however, this study outlines the availability of data and ecological information collected for a site pre-restoration with the aim that this will be used to further improve the research of this specific habitat restoration projects, whilst also making recommendations for the techniques used based on the scientific knowledge.

1.1. Statement of Aims

Proposal to Create a Wet Meadow habitat at the proposed Chester Wetland Centre and Disclaimer.

The Chester Wetland Centre is a multi-organisational project which aims to create and restore wetland habitats along the catchment of Finchetts Gutter. Plans have been proposed for the creation of a reedbed habitat further upstream to improve the quality of water entering the various restored habitats (Mandi, Houhoum et al. 1996) , the improved management of a wet woodland habitat and the creation of a wet meadow habitat (at the site of study). The overall aims of this large project are to mitigate flooding, improve water quality, increase, and improve wetland habitats for carbon sequestration, improve biodiversity within and around the project site and to create and area for environmental education and continuous research. Information on the specific plans proposed for this project is limited with in this study as, at the time of writing, the plans had not been made publicly. This study takes into consideration the overall aims and goals of the Chester Wetland Centre project, however, makes its own recommendations based on the findings of this study, separate to the ecological information collected by Binnies, the consultancy firm which created the proposed plan, our hope is that the information collected throughout this study will aid in the execution of this plan with the recommendations we've made.

1.2. Phase 1 Habitat Survey

A Phase 1 Habitat Survey was conducted prior to data collection to identify what habitats were present at the proposed Chester Wetland Centre study site. The Phase 1 Habitat Survey identified two grassland habitats, a semi-improved neutral grassland indicated in Figure 1 by a block orange background with the letter code SI over laying it and a marsh grassland represented by a block orange background with purple lines overlaying it. A eutrophic running water habitat (indicated by the dark blue line) and a native, species rich hedgerow indicated by presented in **Figure 1**. During the Study Phase 1 Habitat Surveys and reports were gradually being phased out and replaced with UK Hab Surveys. We continued to use the Phase 1 Habitat Survey as this is recognised throughout the UK and has been used for a long period of time within ecological reports. Whereas the UK Hab survey is relatively new. the full Phase 1 Habitat survey and report is included in Appendix A.

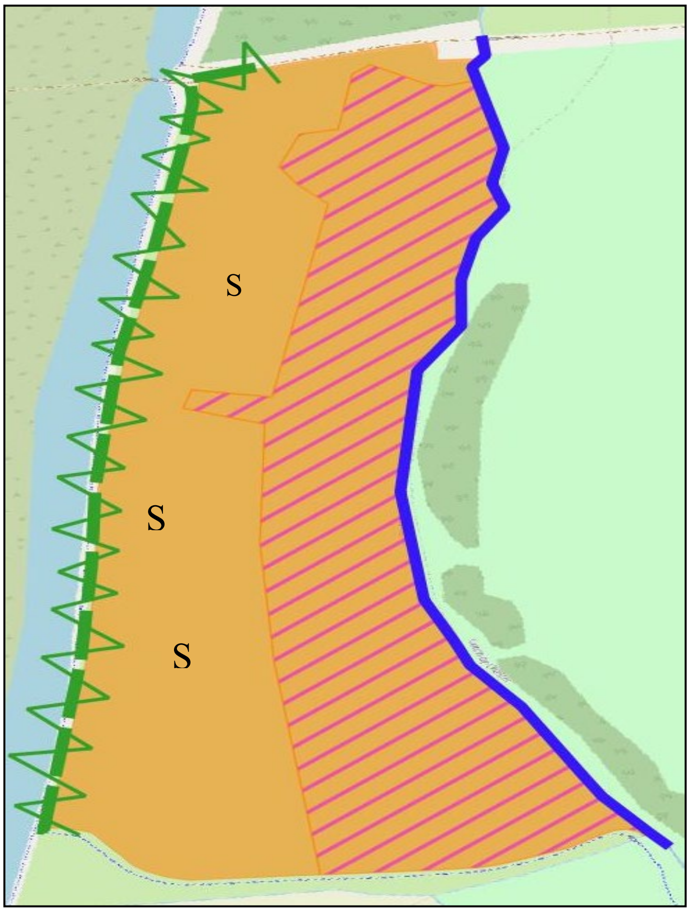

Figure 1: A Phase 1 Habitat Survey Map of the proposed Chester Wetland Centre. Where a dashed green line with a green zigzag over lay indicates a native species rich defunct hedgerow, the dark blue line indicates eutrophic running water, the orange block with SI overlay indicates a semi improved neutral grassland and the orange block with purple lines indicates a marsh grassland.

2.0 Methods

A combination of data collection methods outlined and escribed below in Table 1 were utilised to collect the maximum available ecological data at the proposed Chester Wetland Centre over a period of 11 months spanning all four seasons starting in October 2020 and ending in August 2021. Data was collected between 06:00 and 21:00 GMT. There was primary focus on species present and richness to gain an understanding of how diverse the site was prior to restorative actions beginning.

Data was collected on the number of individuals seen, the habitat/s they were present in, date and time of day, the sex and life stage where possible, and any extra information including morphological differences within species and behavioural observations including but not limited to nesting, breeding, foraging/ hunting, feeding to understand how species use the study site.

Recorded species were cross referenced with the UK Biodiversity Action Plan to further identify any species which may require more protection thus inhibiting or increasing the progress of the proposed habitat restorative actions. Recorded specie's UK conservation status were also noted where possible to identify species that are more under threat or require greater conservation, again potentially inhibiting or increasing the progress of the proposed habitat restorative actions.

Table 1: Methods used for collecting ecological data at the proposed Chester Wetland Centre over a period of 11 months covering all four seasons.

Data collection method	**Description**	**Specific taxa**
Quadrats including fixed and random	10 fixed 2x2metre quadrats were placed throughout the site, 5 in the marsh grassland habitat and 5 in the semi-improved neutral grassland. All quadrats were scattered and at various distances away from the water course and the two habitats. Over 100 50X50cm quadrats were placed/ thrown at random. For both types of quadrats used the different species found were identified and counted. For grasses and sedges, the number of clumps / tufts were counted where individual plants could not be (Sutherland 2006).	Terrestrial invertebrates, plants, amphibians, mammals
Refugia	5 Black, corrugated, sheets of rubber 50x50cm were placed scattered throughout the semi-improved grassland habitat. No refugia were placed in the marsh grassland as it was prone to flooding. All species found beneath or on top of the refugia were identified and counted these were checked once a week over the course of five months (Sutherland 2006).	Reptiles, amphibians, terrestrial invertebrates
Transects (including pollard walks and sweep netting)	Transects were conducted both parallel to and perpendicular to the gutter and hedgerow. For terrestrial invertebrates the number of individuals within a 2m radius were identified and counted. For birds a 20m radius was used. For plants each plant touching the transect was identified, 1X1metre quadrats ere also placed every other metre on alternating sides of the transect to create a belted transect. The same method for quadrats was used. Where a sweep net was used, the net was passed through the vegetation for two metres. The contents were then removed, identified, and counted for each two-metre section of the line transect. **Invalid source specified.Invalid source specified.**	Terrestrial invertebrates, birds, plants, amphibians, mammals,
Fixed Radius Point sampling	Each position was sampled for 10 seconds recording the number of individuals of each species seen. For birds a 50m radius was used where all individuals with in the 50m radius during the 10 seconds were counted. For mammals a 20m radius was used and for terrestrial invertebrates a 2m radius was used. A 10 second timer was used to avoid recounting the same individuals (Sutherland 2006, Bibby, Burgess et al. 2000, Buckland, Marsden et al. 2008).	Terrestrial invertebrates, birds, mammals
Kick Net	A 30X30cm net was passed through the water in a figure of eight movement for 30 seconds, 6 times at eight locations 20m apart along the stretch of gutter running through the research	Aquatic invertebrates, fish, amphibians.

	site. Each location was sampled for a total of 3 minutes(Zeybek, Kalyoncu et al. 2014, Ojija, Laizer 2016, Brua, Culp et al. 2011). This was predominantly used to collect data for the water quality analysis however the data was used to gain a general understanding of the species present and how they use the habitat.	
Evidence of species (tracks, latrines, pellets, nests)	The evidence left behind by species was used for presence fo a species without physically seeing it. Faeces, tracks, nests, latrines. burrows and other forms of evidence were collected, photographed, and analysed to decipher which species they were from. This was useful in understanding the presence of species that were harder to survey due to their times of activity or where specific licenses and agreements were needed to survey and had not been obtained.	Birds, mammals, terrestrial invertebrates (E.g., galls)
Citizen Science Applications, iNaturalist	A project was created on iNaturalist with a polygon that encompassed the proposed Chester Wetland Centre. All wildlife recording made on the platform were included into the data once they had been verified and approved and the species confirmed or corrected. This allowed any member of the public to make observations of wildlife observed at the proposed Chester Wetland Centre and to contribute to ongoing scientific research. Whilst also aiding the researcher with providing more data no matter how big or small the contribution **Invalid source specified.**.	All taxa

2.1 Water Quality Analysis using Biological Members Working Party (BMWP) Scores and Average Score per Taxon (ASPT).

The section of Finchetts gutter which flows through the proposed Chester Wetland Centre was surveyed for the presence of benthic macro-invertebrate. The surveyed stretch of water was sampled every 20 metres with a D shaped net passed through the water at different depths for 30 seconds 6 times, twice for each depth, bed, middle and surface(Brua, Culp et al. 2011, Ojija, Laizer 2016, Zeybek, Kalyoncu et al. 2014). Surveying took place during late spring in the month of May. Organisms were identified to a taxonomic family level in the field and where needed a small electronic microscope was used. Families and their tolerance to organic pollution to analyse the water quality using the Biological Members Working Part Score (BMWP Score) and Average Score per Taxa (ASPT) **Invalid source specified.**. The BMWP gives a score to each taxonomic family based on their tolerance to organic pollution. A greater score and the presence of less tolerable benthic macro-invertebrate families indicated a higher quality of water and less presence of organic pollutants (A. Hawkes 1998). The ASPT is the BMWP score divided by the number of scoring families (Armitage, Moss et al. 1983). The surveyed stretch of water was sampled every 20 metres with a D shaped net passed through the water at different depths for 30 seconds 6 times, twice for each depth, bed, middle and surface. Surveying took place during late spring in the month of May.

Table 2: Interpretation of the Biological Members Working Party (BMWP) Scores, category, and interpretation of results Invalid source specified..

BMWP Score	Category	Interpretation
0-10	Very Poor	Heavily Polluted
11-40	Poor	Polluted/ Impacted
41-70	Moderate	Moderately Impacted
71-100	Good	Clean/ Slightly Impacted
>100	Very Good	Unpolluted/ Unimpacted

2.2 Biodiversity Analysis

Shannon-Weiner Biodiversity Index (H)

The biodiversity of the two main habitat types, Semi-improve neutral grassland and marsh grassland, was calculated using the Shannon-Weiner Index (H).

$$H = -\sum_{i=1}^{s} \left(\frac{n_i}{N}\right) \log_2 \left(\frac{n_i}{N}\right)$$

Where S is the total number of species in the sample, N the total number of individuals in each sample and n the total number of individuals of each species. The result of the Shannon-Weiner indices is the inverse of Simpson's Diversity indices. A value of 0 would imply complete homogeneity or no species diversity. A larger value indicates greater diversity. This measure takes into consideration rarer species (Species represented by 1 or a few individuals in the overall data set) **Invalid source specified.**

3.0 Results

3.1 Water Quality Analysis

An analysis of Finchetts gutter was conducted using macro-aquatic invertebrates as biological indicators of organic pollution with the method for this practice outlined in Table 1 of the methods section. To analyse the quality of the water in Finchetts Gutter, the Biological Members Working Party (BMWP) Index and Average Score per Taxa (ASPT) were used.

Table 3: Results of the water quality analysis of Finchett's Gutter which runs through the proposed Chester Wetland Centre using the Biological Members Working Party (BMWP) Score and Average Score Per Taxa (ASPT) using benthic macro-invertebrates as indicators to water quality from their tolerance to organic pollutants.

Family	Species	BMWP Score
Acroloxidae	Lake Limpet	6
Asellidae	Two-spotted Water-slater	3
Baetidae	Mayflies	4
Calopterygidae	Jewel-winged Damselflies	8
Coenagrionidae	Narrow winged Damselflies	6
Erpobdellidae	Leeches	3
Gammaridae	Amphipod (Shrimp)	6
Limnephilidae	Northern Caddisfly	7
Physidae	Acute Bladder Snails	3
Sialidae	Alderflies	4
Sphaeriidae	Pea Mussel	3
Hydrosychidea	Net Spinning caddisfly	5
	BMWP	**58**
	ASPT	**4.83**
	Shannon-Weiner Diversity Index (H)	**2.13**

The Biological Members Working Party (BMWP) Score gives benthic macro-invertebrate families a numerical value depending on their tolerance to organic pollutants with 10 being the highest score meaning they have little tolerance to organic pollutants and 1 meaning they have a high tolerance to organic pollutants present. The BMWP Score for the section of Finchett's Gutter which runs through the proposed Chester Wetland Centre was 58 which is interpretated as moderately polluted which can be interpreted as having a moderate impact on the species found within the water course. the ASPT score provides and average score across all benthic macro-invertebrate families present, on average the benthic-macro invertebrate families recorded have and ASPT=4.83 this shows on average the tolerance to organic pollutants from the species found is quite high with those species able to live in more polluted waters. A higher ASPT value would suggest 1) the water is less polluted and 2) the tolerance to organic pollutants of the species found is lower and therefore possibly more at risk of population decline/ local extinction due to increased amounts of organic pollutants. The BMWP score and ASPT value provide a foundation for potential changes to be made to improve the water quality which supplies the proposed Chester Wetland Centre thus improving habitat quality. The Shannon-Wiener diversity index was used to evaluate the diversity of macro-invertebrate families with in Finchetts Gutter, results of the diversity index were promising, H=2.13, where 12 aquatic macro-invertebrate families were present within Finchetts Gutter. A value of H=0 would indicate complete homogeneity or no diversity. The higher the H value the greater the diversity.

3.2 Biodiversity and Species Analysis

Biodiversity comparison of the two main habitat types at the proposed Chester Wetland Centre

The results of the Shannon Diversity index indicated in the table below show a clear difference in how biodiverse each of the two habitats tested are. All available taxa that were identified in the two habitats were included in the analysis to get a clear understanding of the overall biodiversity of the habitats rather than just using a specific taxon.

Table 4: Results of the Shannon-Wiener diversity index of the two largest habitat types, semi-improved neutral grassland (B2.2), and marsh grassland (B5), of the proposed Chester Wetland Centre prior to restorative actions.

Habitat Type	Shannon-Wiener Diversity Index (H)
Semi-improved Neutral Grassland (B2.2)	3.80
Marsh Grassland (B5)	3.28
Entire study site including the 4-habitat typed present	3.85

All taxa recorded and identified from the data collection methods outlined in table 1 were included with in the Shannon diversity index to gain a full understanding of how biologically diverse the two habitats were in comparison to one another as well as the overall biodiversity of the study site. The semi-improved neutral grassland (B2.2) is a more biologically diverse habitat, H=3.80, compared to the marsh grassland (B5), H=3.28. The marsh grassland habitat is the main area of focus at the study site for where habitat restorative actions have been proposed for the creation of a wet meadow habitat. A lower biodiversity value for this habitat supports a potential need for habitat restoration to be undertaken as wetland habitats are often classed as very biodiverse habitats often referred to as biodiversity hotspots. However, with the semi-improved neutral grassland having a higher biodiversity value care needs to be taken to prevent loss of biodiversity and loss of habitat, and for further improvements and management techniques to be undertaken. The overall biodiversity of the site includes all species recorded throughout the study from all four habitats identified in the Phase 1 Habitat survey and report (appendix 1). From the Shannon diversity calculation, the overall site biodiversity, H=3.85, is relatively low when we compare this to the biodiversity of the two largest habitats identified at the site (table 3). This figure alone provides little information regarding the species present and the species-habitat functions and relationships. This figure however can be used in future studies of this site to compare how the overall site biodiversity changes over time post restorative actions and using different management techniques to maintain the site and habitats within it.

Species Analysis

To make the large amount of data collected for this study easier to understand and analyse each taxonomic class was given a colour code, shown in the figure below, this made is easier to see how each taxonomic class contributed to the overall species richness of the project site See Appendix B for an example of the way data was stored.

Throughout the 11-month data collection period 283 different species were identified at the proposed Chester Wetland Centre. These comprised of seventeen different taxonomic classes, 65 different taxonomic orders and 211 different taxonomic families.

Represented in Figure 2 below, Insects, Class Insecta, was the most species rich taxonomic class making up 38.6% of overall species richness of the proposed Chester Wetland Centre with 110 species out of 285 species recorded in total. The other five most represented taxonomic classes present at the proposed Chester Wetland Centre were Magnoliopsida (flowering plants), 75 species making up 26.32% of species richness, Aves (birds), 29 species making up 10.18% of overall species richness, Arachnids (Spiders, mites and harvestmen) 19 species making up 6.67% of overall species richness, Liliopsida (Grasses, rushes and sedges) 17 species making up 5.96% of overall species and Gastropods (Slugs and snails) 11 species making up 3.86% of overall species richness. A total of 17 different taxonomic classes were identified at the proposed Chester Wetland Centre, less represented taxonomic classes which were represented by only a few species include Bivalves (mussels and clams), Actinopterygii (ray-finned fish), Amphibia (frogs, toads, and newts), Lecanoromycetes (Lichens), Entognatha (springtails. dipluran and proturan), Malacostraca (woodlice and shrimps), Diplopoda (millipedes and centipedes), Bryopsida (mosses), Agaricomycetes (fungi), Mammalia (mammals), Clitellata (worms and leeches) these taxa each make up >2% of overall species richness.

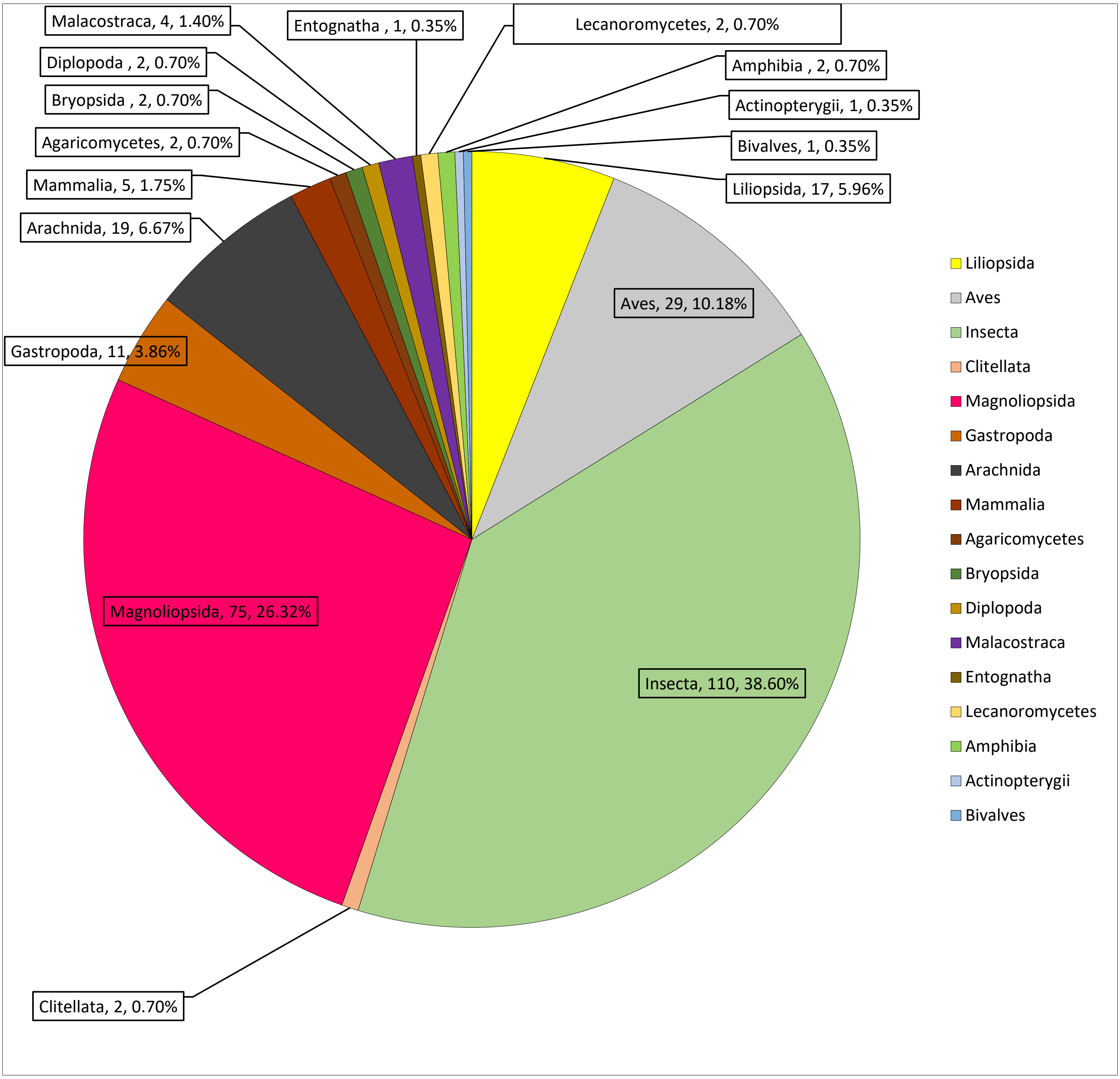

Figure 2: The number of different species per taxonomic class and the proportion they make up of the overall species richness of the proposed Chester Wetland Centre site across all four habitat types identified after and 11-month period of surveying throughout all four seasons.

This is not to say that these taxonomic classes are limited to or only represented by a few species as some species would have missed during the data collection period due to the size of the site, inaccessibility to areas of the site during different times of year due to seasonal flooding in winter and denser vegetation during summer, difficulty in identification and a lack of resources including powerful microscopes, the primary use of in field identification to avoid euthanising specimens for identification, lack of experience identifying more cryptic taxa and the natural history of species including subterranean or aquatic lifestyles, nocturnal activity, etc. The total number of individuals recorded during the data collection period was 7,486 specimens across all taxa. Due to the data collection methods used, plants (Magnoliopsida and Liliopsida) were the most represented of taxa in the data base. An overview of the data set can be view in appendix 2.

A Review of Species Present at the Proposed Chester Wetland Centre Study Site

Species of importance were categorised as those covered by the UK Biodiversity Action Plan and Section 41: Species of Principal Importance in England, Natural Environment and Rural Communities (NERC) Act 2006 **Invalid source specified.**.

Five species were identified as being UK Biodiversity Action Plan (BAP) priority species **Invalid source specified.**. The five species identified as UK BAP species were Common Toad (*Bufo bufo*), White Ermine Moth (*Spilosoma lubricipeda*), Common Bullfinch (*Pyrrhula pyrrhula subsp. pileate*), Song Thrush (*Turdus philomelos*) and Reed Bunting (*Emberiza schoeniclus*).

All 5 species previously included in the UK BAP were also included in Section 41: Species of principle importance in England with the inclusion of one more species identified at the Chester Wetland Centre, Dunnock (*Prunella modularis subsp. occidentalis).*

Birds

Of the numerous taxa that were included in the data set, one such taxa, Aves (Birds) are often used to look at the quality of habitat and are often used as a target class to analyse success or failure of habitat restoration sites. Within this taxa, 29 species were identified and recorded at the study site, with some identified as year-round residence and others migrating to the study site. The avian residence of the proposed Chester Wetland Centre inhabits a range of habitats outlined in the table below and fit into different conservation categories, providing support for the importance of research and projects such as this.

Table 5: The 29 species of bird present at the proposed Chester Wetland Centre with their UK conservation status using the RSPB traffic light system of Green, Amber, and Red depending on the species conservation priority **Invalid source specified.** their residency at the site, whether they are nesting and their preferred habitat types.

Common Name	Scientific Name	UK Conservation Status	Residency	Nesting	Preferred habitat/s
Carrion Crow	*Corvus corone*	Green	Year round	N	All kinds of open areas inc. farmland, upland moors, and suburbs.
Common Buzzard	*Buteo buteo*	Green	Year round	N	Wooded farmland, hills, moors, near crags and forests.

Common Kestrel	*Falco tinnunculus*	Amber	Year round	N	Cities to remote mountains; common around woodlands, heaths, and farmland
Common Pheasant	*Phasianus colchicus*	Green / Introduced (Naturalised)	Year round	N	Found widely in varied habitats, very mixed countryside, in arable fields, woods, reedbeds, heaths and moorland edges.
Common Snipe	*Gallinago gallinago*	Green	Wintering	N	Wet marshes and boggy heaths, freshwater marshes with shallow water and soft mud.
Dunnock	*Prunella modularis*	Amber	Year round	N	Heaths and moors with low dense scrub, exposed coastal areas, higher forest, bushy garden, ornamental flower beds, and parks
Eurasian Black Bird	*Turdus merula*	Green	Year round	Y	Woods, gardens, parks, farmland with tall hedges, woodlands with rotting leaf litter on the ground.
Eurasian Blue Tit	*Cyanistes caeruleus*	Green	Year round	N	Woods of all kinds, parks, gardens, and bushy places.
Common Bullfinch	*Pyrrhula pyrrhula subsp. pileata*	Amber	Year round	N	Woodland, farmland with hedges, thickets, parks, gardens with thick shrubs.
Eurasian Coot	*Fulica atra*	Green	Year round	N	Lakes, flooded pits with marginal vegetation or overhanging branches.
Eurasian Jay	*Garrulus glandarius*	Green	Year round	N	Parks with extensive lawns, various woodlands, and large gardens.
Eurasian Magpie	*Pica pica*	Green	Year round	Y	Farmland with hedges, edges of woodlands, towns, and parks.

Eurasian Moorhen	*Gallinula chloropus*	Green	Year round	N	Ditches, rivers, ponds, lakes, and reservoirs of all kinds.
Eurasian Wren	*Troglodytes troglodytes*	Green	Year round	Y	Anywhere from open clifftops and heaths to broadleaved and coniferous woodland, parks, gardens, and hedges.
European Robin	*Erithacus rubecula*	Green	Year round	Y	All kinds of forest especially more open woodland, as well as bushy heaths, in gardens with hedges, and shrubberies and in town parks.
European Stonechat	*Saxicola rubicola*	Green	Year round	Y	Open places with gorse, heather, and bushes, on heaths or above coastal cliffs, and dunes.
Gold Finch	*Carduelis carduelis*	Green	Year round	N	Likes weedy places with tall, seed-bearing flowers such as thistles and teasles; also, alders and larch.
Great Tit	*Parus major*	Green	Year round	N	Mixed woodlands, parks, and gardens.
Long-Tailed Tit	*Aegithalos caudata*	Green	Year round	N	Mixed or deciduous woods with bushy undergrowth, scrub, and tall old hedgerows.
Mallard	*Anas platyrhynchos*	Amber	Year round	N	Towns, to remote moorland, near almost any type of water.
Pied Wagtail	*Motacilla alba*	Green	Year round	N	Varied habitats often near water and in built up areas.
Reed Bunting	*Emberiza schoeniclus*	Amber	Year round	N	Wet places with reeds, sedges, rushes, willow thickets, and the fringes of lakes and rivers, also drier heathy slopes and heathland bogs.

Sedge Warbler	*Acrocephalus schoenobaenus*	Green	Year round	N	In reeds from narrow ditches to extensive reedbeds, and associated wetland vegetation, such as sedge and reedmace, more rarely in nettles, willowherb, and other rank growth.
Song Thrush	*Turdus philomelos*	Red	Year round	Y	Broad-leaved woodland, parks, farmland with trees and hedges gardens, parks with lawns and shrubberies.
Swallow	*Hirundo rustica*	Green	Migrant	N	Often near water, feeding over grassy or cultivated river valleys, open space, or rich farmland with hedgerows.
Teal	*Anas crecca*	Amber	Year round	N	Fresh water marshes and wet moors and heaths, including high moorland pools.
White Throat	*Sylvia communis*	Green	Migrant	N	In bushy, dry, and heathy places with low, thorny scrub, dense herbs, such as nettles, hedges, thickets.
Wood Pigeon	*Columba palumbus*	Green	Year round	N	Woodland and parkland with trees, town parks, and big gardens.
Grey Heron	*Ardea cinerea*	Amber	Year round	N	Both freshwater and slat water habitats, from salt marsh to rocky coasts to floods and fishponds.

One species of bird recorded; Song Thrush (Turdus philomelos) was identified as being categorised as red according to the RSPB. This is the most critical group with species on this list requiring urgent conservation action and priority. 7 of the 29 species of birds recorded at the proposed Chester Wetland Centre were identified as being part of the Amber List. The other 21 species of bird recorded at the Chester Wetland Centre were identified as being on the Green List, this is the least critical of the groups and is made up of species which regularly occur within the UK and do not meet any of the above criteria **Invalid source specified.**. Of the 29 species of bird recorded at the CWC 25 species were observed residing all year round. The three species which were not deemed as resident due to not residing at the site all year round were the Common Snipe (Gallinago gallinago), this species was observed at the site between late November to late January. Swallow (*Hirundo rustica*) this species was seen only once during a visit to the sight in late September with approximately 20 individuals flying around the sight, presumed to be feeding. The occurrence at the site at the time of year they were recorded coincides with when this species begins its yearly migration away for the UK (Ormerod 1991). The third species classed as migrator was the Whitethroat (*Sylvia communis*), this species was observed on a few occasions between June and July. One owl pellet was found during the data collection period, although this could not be attributed to a specific species, however it does inform us that the site is used by at least one species of owl. Of the 29 species of bird recorded, 8 species were identified as wetland species: Common Snipe, Eurasian Coot, Eurasian Moorhen, Mallard, Reed Bunting, Sedge Warbler, Teal, and Grey Heron. Other species listed in Table 5 are also able to inhabit wetland habitats or use them for feeding. Five species of bird were identified as nesting (Y) at the proposed Chester Wetland Centre, where N, meant no nest were identified for that species although does not mean that they are not nesting it just means during the data collection period no nests were identified. All nest were found within the defunct, native species rich hedgerow habitat.

Herpetofauna

Two species of Amphibian were identified at the CWC, predominantly located in the marsh grassland habitat, these species were the Common Toad (*Bufo bufo*) and the Common Frog (*Rana temporaria*). All individuals identified were adults with no evidence of breeding or spawning, potentially due to not having the correct habitat requirements to breed or spawn as both species require ponds to spawn (Laurila, Kujasalo 1999, Reading, Clarke 1983). No species of reptile were recorded as being present at the site during the data collection period.

Mammals

Five species of mammal were recorded at the CWC site, these included Red Fox (*Vulpes vulpes*), Field Vole (*Mictrotus agrestis*), Common Shrew (*Sorex Araneus*), European Mole (*Talpa europaea*) and European Rabbit (*Oryctolagus cuniculus*). All species recorded are native and categorised as Least Concern (LC) on the IUCN red list. The European Mole undergoes population management at the request of the Environment Agency to prevent damage to the flood prevention bund.

Arachnids

19 species of arachnid were recorded, including 16 species of spider (Aranea), 1 species of mite (Trombidiformes) and 2 species of what are commonly known as harvestmen / daddy long legs (Opiliones). Of the 16 species of spider recorded 15 were identified as common, locally common, or widespread. 1 species of spider identified as *Alopecosa barbipes* was identified as a rare species of spider. 6 of the 16 species recorded were identified as preferring wetland or damp habitats,

Flora

92 species of plant were recorded across the four habitat types present at the proposed Chester Wetland Centre. 84 species of plant were identified to a species level, 35 species were identified as preferring wetland habitats this included 3 species identified as wet meadow specific species. 34 species of plant were identified as preferring fertile/ nutrient rich habitats, this included 4 species of plants preferring fertile / nutrient rich wetland habitats. 4009 individual plants were recorded over the 11-month data collection period across all four seasons. Wetland plants (1012 individuals recorded) accounted for 25.24% of species recorded. Plants preferring fertile/ nutrient rich soils (1138 individual) accounted for 28.39% of the recorded plant population. Plants which preferred wetland / damp nutrient rich/ fertile habitats accounted for 34.27% of the overall recorded plant population. In total 62.66% of the overall recorded plant population prefer nutrient rich/ fertile habitats in which to grow. The remain 37.34% of recorded plant species were identified as being able to inhabit a variety of habitats with varying soil types.

Insects

110 species of insect, across 11 different orders, were recorded at the Chester Wetland Centre over the 11-month data collection period. Of these 110 species, 20 species were identified as specifically inhabiting wetland habitats with many more species recorded favouring a variety of habitats including wetlands. Three families (Coenagrionidae, Libellulidae, Calopterygidae) from the Class Odonata, Dragonflies and Damselflies, were recorded at the study site, this included 1 species of Dragonfly, Four-spotted Chaser (*Libellula quadrimaculata*) and one species of Damselfly (*Ischnura elegans*) which were recorded as adults. Those recorded from the family Coenagrionidae (Narrow-winged Damselflies) could not be identified to a genus or species level as they were recorded in their larval stage. Species recorded from the Family Calopterygidae were further identified as being part of the Calopteryx Genus (Jewel-wing Damselflies), like those identified as part of the Calopterygidae Family, further identification was not possible due to these species being recorded in their larval stage.

Data collected for the BMWP Scoring of Finchett's gutter (Table 6) identified six insect families in their larval stages within the water course, these were Baetidae (Mayflies), Calopterygidae (Jewel-winged Damselflies), Coenagrionidae (Narrow winged Damselflies), Limnephilidae (Northern Caddisfly), Sialidae (Alderflies), Hydrosychidea (Net Spinning caddisfly).

21 species of Lepidoptera (Butterflies and Moths) were recorded at the study site. This included 18 species in their adult form and 4 species in their larval form although 2 species could not be correctly identified at a species level.

Seven species of Bee were recorded at the study site, including one species of bee that was observed as nesting, Tawny Mining Bee (Andrena fulva), the other 6 species were all identified from their drones and were recorded whilst foraging.

From 110 species of insect recorded, 22 species were identified as preferring wetland, wet grassland, damp, or boggy habitats.

Eristalis tenax was identified as preferring habitats fed by water polluted with organic materials further indicating that the marsh grassland habitat is nutrient rich. Although insects were the most species rich of the taxonomic families as previously discussed, they only accounted for 4.7% of the overall recorded population. This is not to say there is a low number of insects, albeit a possibility, it more so shows the methods used for this study had a biased towards plant communities and populations.

Parasites

Four parasites were identified and recorded at the study site: Oak marble gall wasp (*Andricus kollari*), Oak artichoke gall wasp (*Andricus fecundator*), Velvet mite (Family Trombidiidae**)** and Probiscis less Leech (*Erpobdella*).

The larvae of the Oak marble gall wasp (*Andricus kollari*) and the Oak artichoke gall wasp (*Andricus fecundator*) live in galls in sessile and common oak trees. The galls form once the female wasp deposits and egg at the base of a leaf stem.

Velvet Mite, Family Trombidiidae, although not all of the adults of most of the species of this taxonomic family are parasitic, many of the first instars are parasites of invertebrates.

Probiscis less Leech (*Erpobdella*), although not all species of this genus are parasites many are parasites of aquatic invertebrates, fish, and waterfowl.

4.0 Discussion

Biodiversity

A total of 282 species were identified at the Chester Wetland Centre including yearlong residents and migratory/ temporary residents. The 11-month data collection period created an extensive list of the species present with data including the time of year they were recorded, the number of each species recorded, the habitats they were recorded in, conservation status, specific legislation they are protected by/ included in and where possible the sex, age, and extra behavioural notes to identify how each species was using the site e.g., nesting, breeding, hunting/foraging (See Appendix C). This extensive list was used to provide a bigger picture approach to understand the needs of the species recorded and to make habitat restorative recommendations to improve the habitat for specific taxa and species thus we hypothesis will increase biodiversity.

In this study we compared the two largest habitats present at the proposed Chester Wetland Centre, they were both very close in regards to proximity and were both grassland habitats however they differed from one another as one was a marsh grassland that flooded in the winter whilst the other was a semi-improved neutral grassland that was situation on slightly higher ground, thus being (a) a reason for the two types of habitats present and (b) and a difference in the level of moisture retained in the soil. A total of 1951 individual specimens were recorded in habitat B2.2 (semi-improved neutral grassland habitat) whereas 5145 individual specimens were recorded in habitat B5 (marsh grassland habitat), despite the higher number of individual specimens recorded in habitat B5, habitat B2.2 had a higher biodiversity value, H=3.80 compared to habitat B5, H=3.28. The marsh grassland also acts as a flood water storage zone for Finchetts Gutter, a eutrophic, canalised stream which feeds the study site, causing a nutrient rich habitat. This is further indicated by the presence of large numbers of Common Nettle (*Urtica dioica*) which is found on fertile or enriched soil types **Invalid source specified.**. 234 Common Nettle plants were recorded in the semi-improved neutral grassland compared to 513 Common Nettle plants recorded in the marsh grassland **(Table 5**) suggesting a more nutrient rich / fertile soil and habitat and a potential causation for lack of wetland specific plants which preferring nutrient poor soils (Bedford, Walbridge et al. 1999). This is further supported by 528 specimens of Great willowherb (*Epilobium hirsutum*) plants recorded in habitat B5 compared to 59 Great willowherb (*Epilobium hirsutum)* specimens recorded in habitat B2.2. Great Willowherb (*Epilobium hirsutum)* grow on predominantly wet, fertile soils **Invalid source specified.**. The presence of large numbers of this plant species further indicates to the marsh grassland being a nutrient rich habitat. Habitat B2.2 was predominantly on higher ground; this is possibly the causation for the numbers of nutrient rich preferring plants being lower. 139 different species across multiple taxa were recorded from habitat B5 compared to 188 different species recorded in habitat B2.2 making the semi-improved neutral grassland a more species rich and biodiverse habitat. Other species indicating less favourable soil conditions included Large Bindweed (Calystegia silvatica) which can often be found inhabiting waste ground and is an introduced species **Invalid source specified.**,Orange Balsam (*Impatiens capensis)* and the highly invasive Himalayan / Indian Balsam (*Impatiens glandulifera).* Both these species of *Impatiens* grow in wet nutrient rich habitats **Invalid source specified.** and were absent in the semi-improved neutral grassland habitat. They are also invasive/ non-native species to the UK. Approximately 20 species of pollinating insect including 6 species of Bees including the Tawny Mining Bee (*Andrena fulva)* which had been identified as having approximately one nest at the study site, were present during data collection. The site is attractive to pollinating insects due to the large number of flowering plants, 49 species, found throughout across the four habitat types present over the 11-month data period collection period. Using data collected from the four habitat types present at the proposed Chester Wetland Centre, the overall biodiversity of the site was H=3.85. On its own this figure provides us with little information without comparing it to other H values, a lower H value does tell us that there is a low level of biodiversity, and a high H value tells us that there is high biodiversity at the study site. However, the overall biodiversity of the site was calculated to provide information for future research and to set an example for what can be achieved when we analyse all species present and their populations.

The semi-improved neutral grassland had undergone some historic management, with evidence suggesting limited or sporadic mowing whereas the marsh grassland habitat had not undergone any known management or improvements and there was no indication towards it. An old concrete trough was present at the site which indicates at some point a farmer had used the area to graze cattle although this had not occurred for more than a minimum of 10 years after interviewing residents and those involved within the park where the research site is now situated. Water quality analysis (Table 6) and the large presence and dominance of plant species preferring nutrient rich habitats, outlined in the discussion indicate the presence of large amounts of organic pollutants causing a nutrient rich and more monoculture habitat, causing potential explanation for a lower level of biodiversity.

Flora

Four habitat types were identified during the Phase 1 Habitat Survey conducted prior to data collection, these included a defunct, native species rich hedgerow, a eutrophic canalized stream, a semi-improved neutral grassland, and a marsh grassland (fig 1). One of the long-term goals of the proposed Chester Wetland Centre Project is to create a wet meadow habitat with improved biodiversity. From the results outlined above and from the preliminary Phase 1 Habitat survey, the flora present at the survey site is synonymous with nutrient rich/ fertile soils with many of the wetland floral species preferring marsh habitats. As previously discussed, the marsh grassland has a lower biodiversity value, H=3.28 (this included all available taxa within this habitat) when compared to the semi-improved neutral grassland H=3.80. In this section we discuss previous studies on how best to develop the marsh grassland into a wet meadow habitat with a focus on techniques to increase/ improve biodiversity. A combination of restorative techniques to tackle the issues outlined throughout this study are needed to improve habitat suitability for species thus improving the biodiversity of the site. The restoration of Finchetts gutter, a channelized agricultural stream, by "re-wiggling"/ modification of the channel through the site to improve water retention in the study area would be beneficial to the floral species at the site as this method of stream restoration increases the depth of the water table and improves the suitability of habitat for wet meadow species with the assumption that this will also increase wet meadow floristic biodiversity (Hammersmark, Dobrowski et al. 2010). Re-wetting, (increasing water table depth) has for many years been the main form of wet meadow restoration (Grootjans, Verbeek 2002) although the success of this restorative action in improving species richness has not been significant enough to declare if this method is successful. With the literature cited in this article rarely looking into other ecological stressors such was water quality. As previously discussed there was a large number of nutrient rich soil preferring plants present at the study site which in relation to the water quality analysis discussed later on in this study, the creation of treatment reedbeds further upstream would reduce the amount of organic pollutants being fed into the study site (Mandi, Houhoum et al. 1996) thus reducing the nutrient levels as this is considered to be essential for the successful restoration of wet meadow habitats (Klimkowska, Van Diggelen et al. 2007). Other projects and methods of wet meadow restoration have used topsoil removal, with the removal of 20cm of soil considered most effective. This reduces the nutrient levels in the soil more rapidly than mowing or through the creation of a treatment reed bed (Klimkowska, Van Diggelen et al. 2007). The removal of nutrient rich soil, tall vegetation and the seed bank of competitive weed species results in better establishment of lower competitive target species (Klimkowska, Van Diggelen et al. 2007, Verhagen, Klooker et al. 2001). The use of dispore transfer, the spreading of hay and seeds from another site has been observed to be effective when combined with other methods such as topsoil removal (Klimkowska, Van Diggelen et al. 2007) however the success is also dependant on the site where the hay material has been collected from as it may differ from the number of viable seeds and the types of plants species present at the site where the hay material is retrieved from (Klimkowska, Van Diggelen et al. 2007). However, mowing as a tool for wet meadow restoration and management has been successful in increasing biodiversity and species richness in a short space of time. The results of A. Kołos, & P. Banaszuk 16-year study found that mowing once a year increase species richness and diversity in a relatively short space of time (Kołos, Banaszuk 2013).

During the data collection period 29 species of bird were recorded at the proposed Chester wetland centre, this included one species that was categorised as red, four species categorised as amber and the remaining species all categorised as green according to the RSPB's conservation categories **Invalid source specified.**. As previously discussed above, four species of bird are included in section 41: Species or Principal Importance of the Natural Environment and Rural Communities (NERC) Act 2006 **Invalid source specified.**. All nests of species identified as nesting were found within the defunct, native species rich hedgerow. There is a correlation between the size (width and height) of a hedgerow and the number of tree species found within the hedgerow and an increase in bird species richness (Hinsley, Bellamy 2000). However, the continued management and restoration of the defunct, native species rich hedgerow is needed to achieve the goal of increasing species richness and biodiversity. Management and restoration actions include but are not limited to the following, which have been successful in previous studies in achieving the desired goals of increased species richness and biodiversity; (Hinsley, Bellamy 2000) (i) More Habitat, an increase in habitat size especially an increase of hedgerow width to a preferable size of 2m allows coverage and protection for birds using the hedgerow for protection, nesting, and foraging. Where possible combining the hedgerow habitat with other surrounding habitats has been seen to increase bird species richness and biodiversity (Hinsley, Bellamy 2000, Barr, Britt et al. 1995). (ii) Hedgerow structural types, having a variation in heights and the number of trees dispersed withing the hedgerow to encourage certain types of birds depending on their habitat preferences (Barr, Britt et al. 1995, Hinsley, Bellamy 2000)(iii) Hedgerow trimming, timing hedgerows in rotation so that not all the hedgerows are cut each year. This management metho combined with (ii) provides a range of hedgerow type and size within a given locality. Timing of cutting should be left until late winter to avoid removing supplies of fruit and seed before the winter. Avoid cutting of hedgerows during the breeding season approximately March to August in the UK. Avoidance of overuse of a flail cutter and the removal of too much material during trimming (Hinsley, Bellamy 2000, Barr, Britt et al. 1995). (iv) Maintenance of good vegetive coverage in the hedge bottom and improved vegetive species richness and biodiversity to attract more insect for insectivorous birds and the preventing of over mowing/ grazing this area of the hedgerow habitat (Hinsley, Bellamy 2000, Barr, Britt et al. 1995). (v) Hedgerow restoration and the creation of new hedgerows should have a primary consideration for the bird species liable to be present in the location concerned. In cases where gappy hedges might be best converted to rows of bushes interspersed with grass/flowers/seedy weeds and sometimes a grass bank with grass, flowers and seed sources might be better than woody hedgerow plants (Hinsley, Bellamy 2000, Barr, Britt et al. 1995).

Insects

Insects were the most species rich of the recorded taxonomic families despite being less represented in the database of species found at the proposed Chester Wetland Centre. Insects are important as they are often used an indicator for habitat health especially plants thus making them an important factor in evaluating success regarding restoration (Mortimer, Hollier et al. 1998). Of the 108 species of insect identified, 7 species were bees. Bees play an important role in maintaining plant species diversity. Restored wet meadow habitats have a higher diversity of bee species than less intensively managed grasslands (Moroń, Szentgyörgyi et al. 2008). Alongside the 7 species of bee. 6 species of hoverfly and drone fly, Syrphidae, were also identified with these species also performing an important role in pollination (Baumann, Keune et al. 2021). Increase in pollination success positively correlates with bee and hoverfly diversity and available habitat size (Baumann, Keune et al. 2021). Restoration/ creation of the wet meadow habitat would not only increase the habitat size but also increase the diversity and species richness of bee and hoverfly species, thus increasing the pollination success, colonisation, species diversity, and species richness of plant species post restorative actions.

Insects are also a valuable food source to various other species including birds, mammals, amphibians, fish, and other invertebrates such as arachnids. Restoring habitats with a focus on increasing insect diversity will provide a valuable resource for a variety of other species.

The presence of *Eristalis tenax* further indicates that the marsh grassland is nutrient rich as this species prefers wet habitats heavily polluted by organic materials (Aguilera, Cid et al. 1999). Further indications to how nutrient rich the marsh grassland habitats are outlined below in the water quality analysis using aquatic macro-invertebrates and their tolerances to organic pollutants in water bodies.

Water Quality Analysis

Water quality was analysed using the Biological Members Working Party (BMWP) index and Average Score per taxa (ASPT) use aquatic macro-invertebrates as an indication of fresh water habitat quality by evaluating the tolerance of aquatic macro-invertebrate families to organic pollutants using a numerical value as these are a key part in the recycling and decomposition of organic materials and are a major food source to many birds and fish (Zeybek, Kalyoncu et al. 2014, A. Hawkes 1998). The section of Finchetts Gutter surveyed for the water quality assessment had a BMWP score of 58 categorising the stream as questionable which is interpretated as moderately polluted **Invalid source specified.**(Ojija, Laizer 2016). A Shannon-Weiner diversity index was also used to assess the diversity of macro-invertebrate families within Finchetts Gutter. 12 families were present within Finchetts Gutter at the time of surveying producing a diversity value H=2.13 where H=0 indicates complete homogeneity or no diversity **Invalid source specified.**. The diversity indices alone provide little information however for the purpose of the study and future research of the proposed Chester Wetland Centre habitat restoration project, provides a basis to evaluate the improvement or deterioration of Finchetts Gutter post restorative actions. Previous studies have used the Shannon-Weiner diversity index to support the BMWP index and ASPT values when crating a wider analysis of the condition of freshwater habitats such as streams and rivers (Abdullahi 2018). The Average Score per Taxa for the surveyed section of Finchetts Gutter was ASPT=4.83. On average the taxa recorded in Finchetts gutter have a relatively high tolerance to organic pollutants with species having a BMWP score between 4 and 5, the closer the BMWP score is to 10 the lower the tolerance to organic pollutants thus indicating a more polluted habitat as species with a lower tolerance score (7,8,9,10) would not be able to inhabit this habitat therefore increasing the need to improve the quality of the habitat by reducing the organic pollutants to encourage less tolerable species (Ojija, Laizer 2016, Zeybek, Kalyoncu et al. 2014, A. Hawkes 1998). Increased aquatic macro-invertebrate biodiversity through restoration of a waterbody is a hotly debated subject with evidence proving and disproving the hypothesis that restoring waterbodies increases/ improves aquatic macro-invertebrates where some restorative actions have no impact on aquatic macro-invertebrate biodiversity, for example gravel introduction. Analysis of success of stream restoration has been difficult as few studies contain pre-restoration data on biodiversity, with many studies using a reference site that most resembles the pre restored streams being studied (Palmer, Menninger et al. 2010). For this reason, making restoration and management recommendations is difficult with scientific evidence that both proves and disproves that habitat restoration successfully increasing aquatic macro-invertebrates. Restoration techniques can include but are not limited to introduction of gravel, introduction of large wood, boulders, and "re-wiggling" to reduce canalisation. However, the restorative actions need to also address the water quality and the sources of pollutants further upstream. The creation of a treatment reedbed further upstream could reduce organic pollutants through naturally filtering the water passing through the reedbed. With a larger reedbeds and reedbeds with a longer water retention time having more success in reducing the amount of nutrients exiting the bed than in smaller reedbeds (Mandi, Houhoum et al. 1996).

Species of interest with habitat recommendations to increase biodiversity.

This section outlines some of the species of interest which may benefit from the proposed Chester Wetland Project and whether further research and precautions are needed to prevent loss of habitat and populations for these species.

UK Biodiversity Legislation of Importance with reference to specific species

The Biodiversity Action Plan is an internationally recognised programme addressing threatened species and habitats, designed to protect and restore biological systems, this was the outcome from the 19992 Convention on Biological Diversity (CBD). The UK BAP was published in 1994 with a review of habitats and species published in 2007 with the issues addressed in Rio de Janeiro at the CBD having an end date in 2012 **Invalid source specified.**. In 2012 the UK BAP was replaced by the UK Post-2010 Biodiversity Framework with a revised version published in 2018-2020 **Invalid source specified.**. The UK BAP list of priority species and habitats does however remain and important source of reference. The UK BAP priority species list was replaced by Section 41: Species of Principal Importance in England, Natural Environment and Rural Communities (NERC) Act 2006 **Invalid source specified.**.

Five species that are residents of the Chester Wetland Centre were identified as being on the UK BAP list, these included Common Toad (*Bufo bufo*), White Ermine Moth (*Spilosoma lubricipeda*), Common Bullfinch (*Pyrrhula pyrrhula subsp. pileate*), Song Thrush (*Turdus philomelos*) and Reed Bunting (*Emberiza schoeniclus*). Species were included in BAP as they faced immediate effects and required immediate actions to reduce or mitigate population loss. *Bufo bufo, Pyrrhula pyhrrula subsp. Pilatea, Turdus philomelos* and *Emberiza schoeniclus* were included in BAP as they fit into the criteria of other. Species within this criteria were included because (i) Their geographic range is very restricted AND there is evidence of species decline (BRIG, Biodiversity Reporting and Information Group 2007), (ii) There is a substantial threat to a food plant or to a highly specialised habitat, if it is impossible to predict the resulting rate of decline in the species (BRIG, Biodiversity Reporting and Information Group 2007), (iii) There is pressure from disease, if it is impossible to predict the resulting rate of decline reproductive failure, if it is impossible to predict the resulting rate of decline (BRIG, Biodiversity Reporting and Information Group 2007), (iv) For a species on the existing priority list, factors that caused the original decline are still operating or the species population has not recovered to a point where it is likely to be viable in the long term (BRIG, Biodiversity Reporting and Information Group 2007), (v) The species is declining (but does not qualify under Criterion 3, marked decline in the UK, and is a good 'indicator' species for a declining taxonomic group, a threatened habitat type or a pressing conservation issue. *Pyrrhula pyhrrula subsp. pilatea* and *Turdus philomelos* were included in the BAP as this species requires an international responsibility and there has been a moderate decline in the UK, where 25% of this species international population is found in the UK or there has been a 25% decline of the UK population of these species in the UK (BRIG, Biodiversity Reporting and Information Group 2007). *Spilosoma lubricipeda* was included as there has been a marked decline in the UK population of at least 50%.

In the updated list from Section 41 Species of Principle Importance all five species preciously identified at the proposed Chester Wetland Centre as being included in the UK BAP Priority Species List were also included in Section 41 Species of Principle Importance with the inclusion of one more specie, Dunnock (*Prunella modularis subsp. occidentalis)* ***Invalid source specified.***.

The actions outlined in the UK BAP to conserve and improve biodiversity were later updated and implemented into the Natural Environment and Rural Communities (NERC) Act 2006. This legislation focuses on seven sections to conserve biodiversity and the species outlined in Section 41, with relevant species of the proposed Chester Wetland Centre included in the corresponding section **Invalid source specified.**. The six species identified at the proposed Chester Wetland Centre fall into three of the seven sections to conserve biodiversity; Regional and local government: (Dunnock (*Prunella modularis),* Song Thrush (*Turdus philomelos)*, Common Toad (*Bufo bufo*), White Ermine (*Spilosoma lubricipeda*)), This sector includes the work undertaken by local and regional government in all its forms, such as forward/spatial planning at regional, sub-regional and local level. It includes coastal management planning, transport and minerals planning and strategic planning for economic development and climate change. It also covers the services provided by local and regional government such as sports and recreation provision and education, and the management of the associated estate, including open spaces, landscaping and built infrastructure itself. It also includes all the estate managed by social housing providers. Agriculture: (Reed Bunting (*Emberiza schoeniclus*), Song Thrush (*Turdus philomelos*), Common Toad (*Bufo bufo*)), This sector is aimed at agricultural land managers and those that influence the management of farmland such as food producers and retailers, National Trust, National Parks, AONBs, Local and Regional Government and Regional Development Agencies. Freshwater: (Reed Bunting (*Emberiza schoeniclus*), Common Toad (*Bufo bufo*)), This sector is aimed at managers of the freshwater environment including the Environment Agency, British Waterways, the Broads Authority, water companies, Internal Drainage Boards, fisheries, and navigation managers. the four remaining sections are; Land use planning, Forestry, Upland, and Marine however there were no species identified under section 41 as being of concern to theses remaining four section.

Recommendations for habitat restorative strategies

This section further discusses and recommends strategies previously mentioned in the above to restore/ recreate the habitats identified at the Chester Wetland Centre study site and the goals of the overall Chester Wetland Centre Project. During the Writing of this study the feasibility report and environmental action plan were published by Binnies one of the partners and contractor for this project which contains some recommendations for restorative strategies to be used, which are also discussed in this section. The recommendations outlined below are based on a "prefect scenario" where financial constraints don't exist.

Recommended Wet Meadow Restorative actions.

The area intended to be recreated into a wet meadow habitat is a mixture of marsh grassland and semi-improved neutral grassland (refer to Figure 1 and section x in the appendix), this provides a good foundation to create a wet meadow habitat on already saturated soil. Previous wet meadow habitat restorations have used re-wetting as a strategy to raise the water table however this technique alone has little evidence of improving habitat quality and increasing biodiversity, however the opposite may occur with re-wetting increasing levels of nitrogen and phosphorus (Grootjans, Verbeek 2002, Grootjans, Bakker et al. 2002). High levels of phosphorus and nitrogen have been linked with a decline in species richness and loss of endangered plants (Wassen, Venterink et al. 2005). Re-wetting at the proposed Chester Wetland Centre study site can be achieve through the removal of the bund that separates the marsh grassland habitat and the Finchetts Gutter, which would allow the wet meadow to flood more easily from the overflow of Finchetts Gutter during times of heavy rainfall. Rewetting the site through modification of the Finchetts Gutter by re-channelling it through the study site will also increase the area of habitat re-wetted and thus increasing the size of the restored wet meadow habitat. Re-channelling and re-wetting are some of the strategies already included in the feasibility study report.

Alongside the rewetting of the study site, we also recommend a combined technique of topsoil removal sod transplantation and dispore transfer to restore the current grassland habitats into a wet meadow and to further manage the desired habitat should it be successful. To achieve the desired goal of a nutrient poor, wet meadow we recommend a topsoil removal depth of 30-50cm. Topsoil removal at a depth of 50cm has a seen a greater immediate reduction in nutrient levels then a top soil removal depth of 30cm (Hölzel, Otte 2003). Topsoil removal of 15-20cm, removes most the more recent seedbank of competitive species, however common, competitive species have a greater chance of re-invading (Klimkowska, Van Diggelen et al. 2007, Verhagen, Klooker et al. 2001) , where as a removal depth of 50cm completely removes the recent seed bank, lowers the overall habitat closer to the water table increasing areas of prolonged standing water, creating the anoxic conditions that prevent less desirable plant species from colonising (Klimkowska, Van Diggelen et al. 2007). Combining this with sod transplantation, whereby the topsoil of a depth of 30cm is removed from a doner site such as an already established restored wet meadow or a wet meadow in a near natural state. The sod is then placed at the site where restoration is being undertaken. This restorative technique has been shown to have the most success in forming plant communities most similar to the doner site (an already establish or near natural wet meadow, the desired goal) (Sengl, Magnes et al. 2017). Dispore transfer is the process in which the seedbank, vegetation containing seeds of wet meadow species seeds, from a wet meadow site to the restoration site. Combining topsoil removal with dispore transfer increases the number of target species including rare/ endangered species albeit only by a small amount (Donath, Bissels et al. 2007) with the quality of the host site having a significant impact on the types and number of species transferred (Klimkowska, Van Diggelen et al. 2007). Klimkowska et al's and Sengl et al's studies of various restoration techniques found that a combination of the four strategies outlined in this section were most successful in increasing plant diversity and successfully restoring wet grassland habitats e.g., salt marshes and wet meadows, projects with long-term management post restorative actions were more successful (Klimkowska, Van Diggelen et al. 2007, Sengl, Magnes et al. 2017). We recommend identifying a site with similarities to the desired habitat being created to collect material for dispore transfer. The wet meadow habitat at the Chester Zoo nature reserve has some of the target species to create a wet meadow habitat and is located close to the proposed Chester Wetland Centre, however due to a lack of management at this site and low numbers of target species (Martin-Parsons 2022) this site would not be suitable for dispore transfer. R Schmiede et al found a large number of target species had established by the third year after topsoil removal and dispore transfer this included 28 species of red list plants with over 100 species being identified post restoration (Schmiede, Otte et al. 2012).

Recommended Hedgerow Restorative Actions

We recommend the following hedgerow restorative actions to increase the number of bird species, improve habitat for nesting birds and restore the hedgerow habitat.

Increasing the available habitat, where possible including increasing the size of the hedgerow habitat to a width of approximately 2m as this has been successful in increasing coverage and protection for birds when foraging and nesting, combining the increased size of the hedgerow and improving the habitat around it increases the species richness and biodiversity with in the hedgerow (Barr, Britt et al. 1995, Hinsley, Bellamy 2000). Furthermore, we recommend varying the hight at different sections of the hedgerow to encourage a variety of life which we hope will inhabit it (Hinsley, Bellamy 2000, Barr, Britt et al. 1995). The continuous maintenance of the hedgerow will have an impact on the species found within this habitat, we recommend trimming the hedgerow to different widths and heights will provide variability in the habitat that should be sufficient in meeting the needs of the species that we are encouraging, predominantly wetland bird species including reed bunting. We recommend trimming the hedgerow in late winter to avoid removing resources such as fruits and seeds for overwintering and yearlong resident birds and to encourage more invertebrates such as insects which are also a valuable resource. Furthermore, this prevents cutting the hedgerow during the bird breeding seasons

(March to August) reducing disturbances to nests and fledglings. Avoidance of the use or overuse of a flail cutter and the removal of too much material during trimming should be considered when managing and maintaining this habitat (Hinsley, Bellamy 2000, Barr, Britt et al. 1995).

Recommended Stream Restorative Actions

For the eutrophic stream habitat, we recommend channel modification through re-meandering and channel widening to reduce the flow of water moving through this waterbody and to increase the holding time that the water is in the wider study site to provide areas for fish and amphibians to spawn. Although this strategy doesn't have a huge impact in increasing fish and macro-invertebrate biodiversity (Kail, Brabec et al. 2015, Gørtz 1998). However re-meandering the stream alongside other restorative actions outlined in Kail et al's meta-analysis of stream restoration has found that the following restorative actions increased fish and macro-invertebrate biodiversity, river margin enhancement through the removal of bunds and the management of margin vegetation, the placement of large wood and boulder in the stream and the creation of rifles were all found to have a positive impact on fish and macro-invertebrate biodiversity (Kail, Brabec et al. 2015). Therefore, we recommend these actions during the habitat restoration process. The Restorative actions conducted need to also address the water quality and the sources of pollutants further upstream. With stream restoration projects that had arable land in their catchment having lower species richness and biodiversity (Kail, Brabec et al. 2015) in regards to fish and macro-invertebrates The creation of a treatment reedbed further upstream would reduce organic pollutants from entering the study site through naturally filtering the water passing through the reedbed. Larger reedbeds and reedbeds with a longer water retention time having more success in reducing the amount of nutrients exiting the bed than in smaller reedbeds (Mandi, Houhoum et al. 1996). Furthermore restoration of streams has positively impacted the floral biodiversity and presence of desired or target species through the restoration of the water table depth that these plants need (Hammersmark, Dobrowski et al. 2010).

5.0 Conclusion

Throughout the period of this study, we have been able to create a comprehensive list of the flora and fauna that inhabits the proposed Chester Wetland Centre study. This has allowed us to investigate the natural history of each species and to understand the intrinsic relationships that they have with each other, and the habitats found at the study site. Using the scientific knowledge available from the literature referenced throughout this study and our own findings, we are able to recommend habitat restorative actions and strategies that will best benefit as many of the species found there and to increase the overall biodiversity of the site by increasing and improving the available habitat and resources, creating new habitats and reducing species competition through the removal of invasive and weedy / "less-desirable" species. This study has further analysed the biodiversity of two habitats already present to provide a foundation for the continuous research on the effects of habitat restoration on biodiversity and to provide evidence and support for the proposed Chester Wetland Centre project and other projects like this. The marsh grassland habitat, which is the main area proposed for wet meadow restoration was less biodiverse when compared to the semi-improved neutral grassland habitat that neighbours it. Providing more evidence to create/ restore this area into a wet meadow habitat. The recommendations made throughout this paper are based on an ideal world scenario excluding time and financial constraints. However, we can conclude from the case studies referenced, that should a combination of some of the proposed restorative actions and strategies be utilised then the overall biodiversity of this site will increase.

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Thesis Conclusion

This thesis as analysed and described the use of biodiversity as a measure for the success wetland habitat restoration, reviewing the use of biodiversity data as a tool, available literature from previous case studies outlined in Chapter 1. Further comparing the effect that wetland habitat restoration has on site pre and post restorative actions in Chapter 2. And finally, analysing the use of large biodiversity data sets in a current wetland restoration project, the Chester Wetland Centre, the information it can provide to support projects such as the proposed Chester Wetland Centre and the recommendations made to support high biodiversity and improve biodiversity from previous tried and tested methods in Chapter 3. We conclude that biodiversity is often used as a measure for success in wetland habitat restoration projects but that this is often limited to a few taxa or target species instead of using all available taxa at a site, potentially due to the large amount of work needed to collect a large data set. Furthermore, success is often based of comparative studies between sperate sites, which we have conducted one ourselves, however, studies rarely use data from pre-restoration and post-restoration of a study site when measuring success. This is outlined in Chapter 2: A comparative study of two wet meadow sites at different stages of restoration / rewilding in Cheshire, England. Where two sites at different stages of wet meadow habitat restoration was conducted. It supported the hypothesis that habitat restorative actions increase biodiversity however there was no available data for the established wet meadow site to compare how biodiversity and species composition changes with habitat restoration. For this purpose, a full analysis of habitat, species and biodiversity was conducted in Chapter 3, using all available taxa. We outline the amount of data and information for a site prior to habitat restorative action with the understanding that this research will be used further along the line of the restoration project to analyse how biodiversity and species composition changes and is affected throughout the habitat restoration of the proposed Chester Wetland Centre Project. Biodiversity loss and gain is currently, at the time of writing this thesis a hot topic in the overall global climate crisis. The aim of this thesis was to outline how biodiversity data could be used more effectively to assist the planning of habitat restoration projects when time is taken to collect as much available data as possible.

7.0 Appendix

Appendix A: The phase 1 Habitat Survey and report conducted prior to the undertaking of research for the purpose of this study, to identify the types of and extent of habitats at the study site.

Phase 1 Habitat Survey and Report of the Proposed Chester Wetland Centre

Contents

Executive Summary

This report is based on the finding of the phase 1 habitat survey conducted at the proposed Chester Wetland Centre at the Countess of Chester Country Park conducted by Alfie Martin-Parsons under the supervision of Dr Christian Dunn for the purpose of his MscRes project and for those involved in the project for the purpose of their undergraduate and combined degrees.

A small area owned by the land trust is the proposed location of the Chester Wetland Centre subject to planning permission. This report aims to identify potential ecological constraints to the proposal and for the purposes of scientific research to be conducted at the site.

The project site comprises of open grassland and marsh grassland with some evidence of human disturbance. It is located toward the Northwest of the Countess of Chester County Park, running parallel to the Shropshire Union canal. The habitat within the application site is of significant wildlife value as it provides potentially suitable habitat for habitat reconstruction and to house protected species.

This report recommends a number of measures for the purpose of this report, its value to training students and limit the impact on the wildlife already present. These include the maintenance of the grassland and the hedgerow already present at the site and the conservation of some of the trees located throughout the site.

1 Introduction

1.1.1 Alfie Martin-Parsons conducted a Phase 1 habitat survey to identify the types of and extense of habitats present, prior to conducting his master's in research study. The area of land where the Phase 1 Habitat Survey was conducted was a section of the Countess of Chester Country Park owned by the land trust which is bordered by the Shropshire Union canal and the rest of the Countess of Chester Country Park, this land is herein referred to as the project site.

1.1.2 The project site is located towards in the Northwest of Bach in the borough of Chester and comprises of approximately 4 ha of land, at Grid Reference SJ 39428 68987.

1.1.3 The aim of this study was to provide a description of the existing habitat types, to determine the existence and location of any ecologically valuable areas of this site for the purpose of soil quality, water quality and biodiversity research to be conducted at the site. No survey was conducted to identify the potential presence of protected fauna species.

1.1.4 The project site is the proposed location of the Chester Wetland Centre which aims to be an area of natural preservation, leisure, education, scientific research, and physical and mental wellbeing. This site will accommodate a wetland including reedbeds, a wet meadow, improved paths and viewing platforms and environmental interpretation.

2 Methodology

2.1 Desk Study

2.1.1 The purpose of the desk study was to compile data from different map and global imagery sources such as Ordnance survey, iNaturalist, Google maps and Google earth to look at the presence or absence of habitat types and species already recorded at the site and which may not be detectable at the time of surveying.

2.2 Phase 1 Habitat Survey

2.2.1 A Phase 1 habitat survey was undertaken with reference to the Handbook for Phase 1 Habitat Survey **Invalid source specified.** to establish the presence and distribution of habitat types within the project site.

2.2.2 A walk-over field survey of the entire site was carried out on the 5th, 6th, and 8th of October 2020 in rainy and clear conditions. The timing of the survey was outside of the optimal season for grassland habitat survey (April- September), however due to the habitat types on the project site, it was possible to identify the dominant plant species needed to classify the different habitat types by the vegetation types present and presented in the standard Phase 1 habitat survey format with habitat descriptions and a habitat map (Figure 2) with Target Notes (TN), listed in Appendix A. The timing of the survey is not considered to be a significant constraint to the survey findings.

Protected Species

2.2.3 No specific protected species survey was carried out however all species observed and identified at the project site were cross reference with the Gov.Uk website page for UK protected species **Invalid source specified.** and the British Trust for Ornithology website **Invalid source specified.**. Findings are exhibited in **Table 1**. Due to the time of year and day the survey has limitations on the presence of certain species such as bats, amphibians, spring/summer flying insects and breeding birds. However, information from the local authorities is needed to find out if any of the tree species have Tree preservation Orders (TPOs) on them.

Invasive species

2.2.4 During the identification process of species observed at the project site all species were thoroughly researched to identify if any were non-native/ invasive. No invasive species were identified at the project site.

3 Baseline Conditions

3.1 Habitat Descriptions

3.1.1 The Phase 1 habitat survey map is shown in Figure 1. The habitat descriptions below should be read in conjunction with the survey map and TNs in Appendix A. An indicative plant species list is provided in Appendix B.

General Description

3.1.2 The project site, located on the outskirts of the Countess of Chester Country Park and is Bordered by the Shropshire Union canal, comprises of semi-improved neutral grassland and marsh grassland bordered by eutrophic flowing water and a species-poor hedgerow mixed with trees and is generally of high ecological value. Outside the project site boundary are habitats of low ecological value including open tussocky grassland habitat on historical illegal landfill and parkland.

Semi-improve Neutral Grassland

3.1.2 Chester Wetland Centre supports Tussocky, neutral grassland habitat. The grassland habitat is present on the Western side of the Project Site with an area approximately 27,227.62 m^2. Dominant grass species recorded during this Autumn survey are False-oat Grass (*Arrenatherum elatius)* and Cock's-foot (*Dactylis Glomerata*). The grass land is Semi-improved with some evidence of un-improved grassland however it is not managed extensively. Other dominant species observed include Creeping Thistle (*Cirsium arvense*), Hogweed (*Heracleum sphondylium*), Creeping Buttercup (*Ranunculus repens*), Common Nettle (*Urtica dioica*) and Ragwort (*Jacobaea vulgaris).* During the survey various species of invertebrate and birds were observed foraging

Marsh Grassland

3.1.3 The marsh grassland has an area of approximately 23,741.91 m^2 and is bordered by Finchetts Gutter, a small stream. The Weir System located in the Northeast of the Project site is controlled by the Environment Agency (EA) for flood mitigation purposes although this does not prevent the marsh grassland from flooding suggesting a higher water table in this habitat. There is little clear distinct boarder between the marsh grassland and the neutral semi-improved grassland due to the nature of marsh grassland being flooded through the Autumn and Winter months and relatively dry through the Spring and Summer Months however the presence of Soft Rush (*Juncus effusus*), Hard Rush (*Juncus inflexus*), Sharp-flowered Rush (*Juncus acutiflorus*), and other species such as Meadow Sweet (*Filipendula ulmaria*), Marsh Woundwort (*Stachys plustris*), and Common Comfrey (*Symphytum officinale*) are indicative of Marsh Grassland habitat where these species are absent in the semi-improved neutral grassland. Bird Species including Snipe (*Gallinago gallinago*) and Mallards (Anas platyrhynchos) were observed in the marsh grassland providing further support for the classification of this habitat.

Scattered trees

3.1.4 Scattered trees are present throughout the marsh grassland habitat and comprise of two species, Grey Willow (*Salix cinerea*) and Sessile Oak (*Quercus petraea*) with the majority being immature trees or naturally occurring saplings. Bird species including Long-tailed Tits (Aegithalos caudatus) and Great Tits were observed using these trees to move across the Project site from the hedgerow to the tree line on the opposite side of Finchetts Gutter.

Native, Species Rich, Defunct Hedgerow

3.1.6 The Hedgerow that boarder the Project Site to the Western side is classed as defunct due to the large gaps withing the hedgerow. The hedgerow is dominated by Hawthorn (*Crataegus monogyna*) however is interspersed with trees including Wyche Elm (*Ulmus glabra*), Small Elm (*Ulmus mino*), Sycamore (*Acer pseudoplatanus*) and Elder (*Sambucus nigra*), as well as Blackthorn (*Prunus spinosa*), the hedgerow is also interspersed with Bramble (*Rubus fruticosus*), Sweet-brier (*Rosa rubiginosa*) and Common Ivy (*Hedera helix*). Other species found below the Hedgerow included Greater Plantain (*Plantago major*), Common Nettle (*Urtica dioica*) and Common Ragwort (*Jacobaea vulgaris*).

Running Open Water

3.1.7 Due to the time of year and rainfall prior to and during the survey, aquatic vegetation was not able to be surveyed due to the swollen state of Finchetts Gutter and difficulties accessing the water way to flooding of the marsh grassland. No Algal blooms were visible, and no water samples taken to classify the water as either eutrophic, mesotrophic or oligotrophic.

3.2 Consideration of species

Birds

3.2.1 At its current state the Project Site's only suitable habitat for nesting birds is the Hedgerow. The tussocky grassland is potentially suitable for ground nesting birds however regular dog walkers passing through may be an indication as to why no old/ disused nests were identified in the semi-improved grassland habitat. Two male Pheasants (*Phasianus colchicus*) were observed at the site on the 5th however were absent on the 6th and 8th suggesting they are not permanent residents.

3.2.2 The Project site contains suitable over winter habitat in the form of the flooded marsh grassland. This is indicated by the presence of Snipe () and Mallards () observed on all three days the survey took place.

Table 1: Bird Species Recorded at the Project Site during the Phase 1 habitat survey (October 2020)

Common name	Scientific Name	Observation Type	Habitat Type	Protected Species (England)
Snipe	*Gallinago gallinago*	Visual	B5	N
Eurasian Magpie	*Pica pica*	Visual	B2.2	N
Carrion Crow	*Corvus corone*	Visual	B2.2	N
Reed Bunting	*Emberiza schoeniclus*	Visual	B2.2 / B5	N
Mallard	*Anas platyrhynchos*	Visual	B5	N
Eurasian Jay	*Garrulus glandarius*	Visual	J2.3	N
Great Tit	*Parus major*	Visual	B2.2 / B5	N
Cetti's Warbler	*Cettia cetti*	Sound	J2.3	Y
Long-tailed Tit	*Aegithalos caudata*	Visual	B2.2 / B5	N
European Stonechat	*Saxicola rubicola*	Visual	B2.2/ B5	N
Eurasian Wren	*Troglodytes troglodytes*	Visual	J2.3	N
Common Pheasant	*Phasianus colchicus*	Visual	B2.2	N

3.2.3 These are anecdotal records only and does not constitute a bird survey. Alphanumeric codes have been used for habitat types see Appendix C. Protected species categorised as Y (Yes) and N (No) **Invalid source specified.**.

Amphibians

3.2.4 The Project site provides suitable terrestrial habitats for amphibians due to the tussocks of grass providing shelter although no amphibians were observed.

3.2.5 The Aquatic habitat present provides suitable habitat for breeding and tadpole growth should the marsh grassland remain permanently flooded however the running water is too fast flowing and polluted in its current state.

Reptiles

3.2.6 The combination of tall grassland and freshwater habitats is suitable for grass snakes (*Natrix natrix)* although none were present at the time of survey.

Mammals

3.2.7 No specific mammal surveying was conducted however evidence of European moles (*Talpa europaea*) and European rabbit (*Oryctolagus cuniculus*) was recorded in the semi-improved grassland habitat. The habitat types at the project site are suitable for a range of small mammals with Eurasian Otters (*Lutra lutra*) recorded along the Shropshire Union Canal however are absent from the Project site. The habitat types are unsuitable for larger mammals including Badgers (*Meles meles*) and Deer spp.

Invertebrates

3.2.8 The project site provides suitable habitat for a large array of invertebrates including those that have aquatic life stages or that hibernate. A range of flowering and fruiting plants provides suitable food sources.

Invasive Species

3.2.9 No invasive species were recorded at the project site at the time the Phase 1 Habitat Survey was conducted however this does not mean that invasive species were not present at the site.

4 Discussion and Recommendations

4.1 Overview of Scientific Use

4.1.1 The project site will have regular surveying over the next 12 months for the purposes of postgraduate and undergraduate research looking at the flora and fauna biodiversity of the project site. Permanent quadrat squares will be placed for surveying purposes. Small holes may be dug into the project site for the purposes of taking soil samples, installing pitfalls traps and surveying subterrestrial invertebrates. The project site will be regularly walked away from the present paths for surveying purposes. All scientific surveying work will aim to have little damaging impact on the habitats and the flora and fauna found within them.

4.2 Further Survey Recommendations

4.2.1 More specific surveying will be needed to detect the presence or absence of protected species. These will be possible to identify throughout the biodiversity research conducted at the project site.

4.3 Recommendations for Habitat Retention, Protection and Re-Instatement

Scattered Trees

4.3.1 The Larger trees found at the project site provide a steppingstone for small birds moving between the hedgerow and the tree line on the opposite side of Finchetts gutter. These slightly larger trees should be maintained as they provide habitat and protection for small nesting birds as well as various species of insect.

Marsh Grassland

4.3.2 I recommend a scheme to increase the water retention in the marsh grassland to improve this habitat as it may provide ideal habitat for various species of wading bird as well as provide suitable breeding water for amphibians and small freshwater fish as well as insects with aquatic life stages.

Semi-improved Neutral Grassland

4.3.3 Strimming or grazing is recommended for this habitat to allow for growth of more meadow flowers, creating suitable habitat for a range of insects and other invertebrates which will in turn attract more small mammals, reptiles, amphibians, and birds.

Running, Open Water

4.3.4 recommendations for discovering the sources of pollution for this water way and a scheme to treat the water will greatly increase the health of the marsh grassland and the water way itself and provide suitable habitat for freshwater fish, amphibians, aquatic or wading birds and invertebrates, aquatic invertebrates and invertebrates which have aquatic life stages.

Native, Species Rich, Defunct Hedgerow

4.3.5 Recommendations on the preservation of this habitat as this is where the Cetti's Warbler (*Cettia cetti*) sound observation was recorded. This habitat provides perfect habitat for Passeriformes as well as small mammals including mice, shrews, and hedgehogs. Maintenance on this habitat should be minimal and undertaken after the breeding season. The Trees Within the hedgerow provide cover and viewpoints for birds of prey and other birds spp.

Paths and Fencing

4.3.6 Recommendations on improved paths through the project site to reduce the potential damage and erosion to the grassland habitats present at the Project Site. Improved paths will also increase accessibility of this site for visitors with mobility issues as the current grass path can get cut up and muddy in the autumn and winter month. Fences to also prevent the public from accessing areas of potential danger (Grassland Marsh) and to provide protection of ground dwelling birds from dogs, walkers, cyclists etc.

Permanent Quadrats

4.3.7 Suggestions of the positioning of permanent quadrats see Figure 2.

5 Conclusion

5.1.1 The Project site comprises of open semi-neutral grassland and marsh grassland with trees scattered throughout the Project Site, bordered by a stretch of running open water on the eastern side and a native, species rich, defunct hedgerow with trees. The project site provides suitable habitat for a range of species including the potential for protected species.

5.1.2 This report recommends several measures for the protection, maintenance, and improvement of the Project Site for the proposed Chester Wetland Centre alongside recommendations for the purposes of research and habitat improvement and re-instatement. This includes the placement of permanent quadrats, improving the marsh grassland into a permanent wetland, improving, and treating the water flowing through Finchetts gutter which feeds the marsh grassland, and the preservation of some of the trees located throughout the site and the improvement of the hedgerow which boarders the project site and provides refuge for a multitude of species.

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Figure 1: Phase 1 Habitat Survey Map

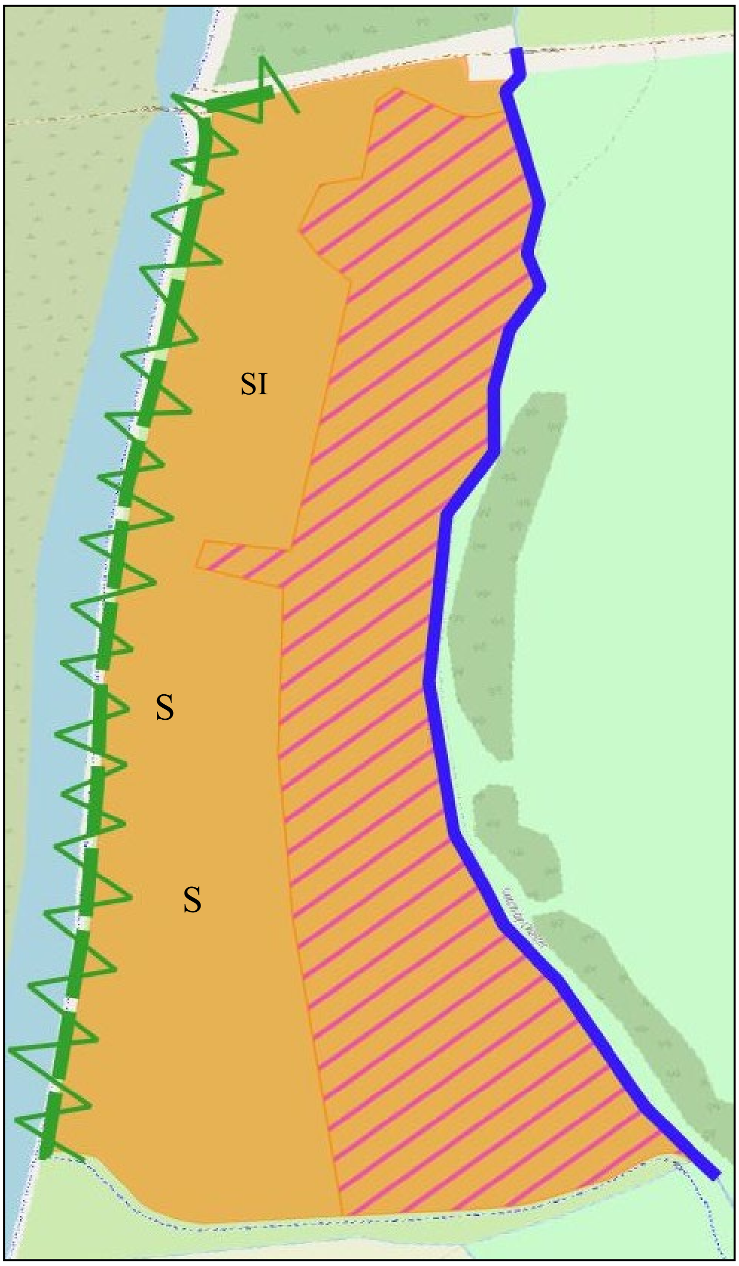

Figure 1 shows the size and positioning of the Different habitats present at the Project site at the proposed Chester Wetland Centre with reference to the Phase 1 Habitat Survey Handbook **Invalid source specified.**

Figure 2 Permanent Quadrats

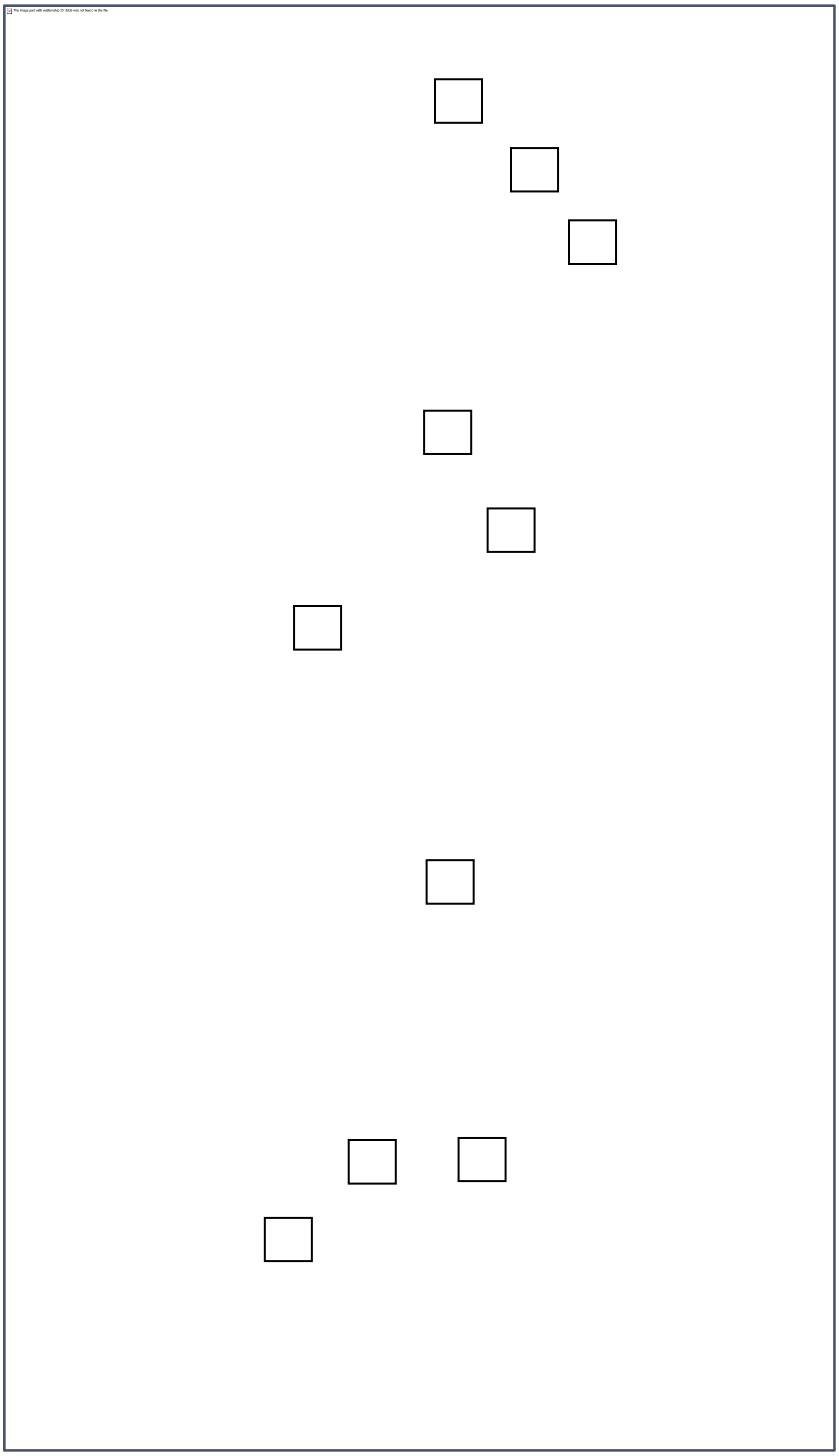

Figure 2 shows recommendations for the positions of permanent quadrats indicated by black squares. The black squares are not to scale and are enlarged to clearly show the quadrat positions on the map. Permanent quadrat positions are based on the finding in the Phase 1 habitat survey, see **Figure 1**, and are present in or near all habitats surveyed at the Project Site.

Appendix A: Target Notes

These TNs relate to Figure 1: Phase 1 habitat survey map.

Target note 1: large open space predominantly Tussocky grass species *Deschampsia cespitosa mixed* with *Holcus lanatus* with some meadow plants, areas of predominantly Thistles, nettles, and brambles.

Target note 2: Large open space, flooded, predominantly Juncus sp. Some marsh herbs, small copse of Sessile Oak. Lone standing Grey Willow.

Target note 3: Hedgerow, predominantly Hawthorn, defunct in areas, variety of tree species throughout. Other vegetation predominantly nettles, brambles and Rose.

Target note 4: Stretch of open water, brown colours, fast flowing and banks burst. No visible vegetation in/ on the water. Flooding marsh grassland.

Appendix B: Indicative Plant List

Scientific name	Common Name
Complex Rubus fruticosus	European Bramble Complex
Argentina anserina	Common Silverweed
Heracleum sphondylium	Hogweed
Plantago major	Greater Plantain
Juncus effusus	Soft Rush
Salix cinerea	Grey Willow
Trifolium repens	White Clover
Stachys plustris	Marsh Woundwort
Anthriscus sylvestris	Cow Parsley
Ranunculus repens	Creeping Buttercup
Leucanthemum vulgare	Oxeye Daisy
Achillea millefolium	Yarrow
Epilobium hirsutum	Great Willowherb
Veronica chamaedrys	Germander Speedwell
Scrophularia nodosa	Common Figwort
Sonchus asper	Prickly Sow thistle
Filipendula ulmaria	Meadowsweet
Symphytum officinale	Common Comfrey
Jacobaea vulgaris	Ragwort
Arrenatherum elatius	False Oatgrass

Dactylis Glomerata	Cock's-foot
Urtica dioica	Common Nettle
Cirsium arvense	Creeping Thistle
Quercus petraea	Sessile Oak
Lathyrus pratensis	Meadow Vetchling
Aegopodium podagraria	Ground-elder
Calystegia silvatica	Large bindweed
Ulex europaeus	Gorse
Rumex obtusifolius	Broad-leaved Dock
Carex limosa	Bog-sedge
Chamaenerion angustifolium	Rosebay Willowherb
Crataegus monogyna	Common Hawthorn
Ulmus minor	Small-leaved Elm
Prunus spinosa	Blackthorn
Rosa rubiginosa	Sweet brier
Acer pseudoplatanus	Sycamore
Sambucus nigra	Elder
Ulmus glabra	Wych Elm
Hedera helix	Common Ivy
Deschampsia cespitosa	Tufted Hair Grass
Juncus acutiflorus	Sharp-Flowered Rush
Juncus inflexus	Hard Rush

Appendix B

Table A: a record of the types of species found at the proposed Chester Wetland Centre, colour coded based on their taxonomic class (see Figure 2), the number of each species recorded and the Shannon diversity index formulas for calculating biodiversity.

Class	Order	Family	*Genus*	*Scientific name*	Common Name	UK Conservation Status	N	pi	l1npil	(pi) ln pi
Actinopterygii	Cypriniformes	Cyprinidae	----------	--------	Minnos / Carp	--------	1	0.000133	-8.92638	-0.00119
Agaricomycetes	Agaricales	Galeropsidaceae	*Panaeolus*	*Panaeolus foenisecii*	Brown Mottlegill	Common	1	0.000133	-8.92638	-0.00119
Agaricomycetes	Agaricales	Bolbitiaceae	*Bolbitius*	*Bolbitius titubans*	Yellow Field Cap	Common	1	0.000133	-8.92638	-0.00119
Amphibia	Anura	Ranidae	*Rana*	*Rana temporaria*	Common Frog	Common	5	0.000664	-7.31695	-0.00486
Amphibia	Anura	Bufonidae	*Bufo*	*Bufo bufo*	Common Toad	Common	3	0.000399	-7.82777	-0.00312
Arachnida	Araneae	Lycosidae	*Alopecosa*	*Alopecosa barbipes*	Alopecosa barbipes	Rare	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Araneidae	*Araneus*	----------	Angulate and Round-shouldered Orb weavers	-------	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Theridiidae	*Enoplognatha*	*Enoplognatha ovata*	Common Candy-striped Spider	Common	6	0.000797	-7.13463	-0.00569

Arachnida	Araneae	Tetragnathidae	*Tetragnatha*	*Tetragnatha extensa*	Common Stretch Spider	Common	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Araneidae	*Araneus*	*Araneus diadematus*	European Garden Spider	Common	10	0.001328	-6.6238	-0.0088
Arachnida	Araneae	Pisauridae	*Pisaura*	*Pisaura mirabilis*	European Nursery Web Spider	Common	8	0.001063	-6.84694	-0.00728
Arachnida	Araneae	Araneidae	*Araneus*	*Araneus quadratus*	Four-Spot Orb weaver	Common / declining	54	0.007173	-4.9374	-0.03542
Arachnida	Araneae	Philodromidae	*Philodromus*	*Philodromus dispar*	House Crab Spider	Common	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Linyphiidae	----------	----------	Linyphiidae	------	5	0.000664	-7.31695	-0.00486
Arachnida	Araneae	Dictynidae	*Dictyna*	----------	Mesh Weavers	----------	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Philodromidae	*Tibellus*	*Tibellus oblongus*	Oblong Running Spider	locally common	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Tetragnathidae	*Pachygnatha*	*Pachygnatha clercki*	Pachygnatha clercki	Widespread	1	0.000133	-8.92638	-0.00119
Arachnida	Araneae	Theridiidae	*Theridion*	*Theridion pictum*	Painted Cobweb Weaver	locally common	2	0.000266	-8.23324	-0.00219
Arachnida	Araneae	Theridiidae	*Steatoda*	----------	*Steatoda*		1	0.000133	-8.92638	-0.00119

Arachnida	Araneae	Lycosidae	*Paradosa*	----------	Thin Legged Wolf Spiders		12	0.001594	-6.44148	-0.01027
Arachnida	Araneae	Cheiracanthiidae	*Cheiracanthium*	*Cheiracanthium mildei*	Yellow Sac spider		4	0.000531	-7.54009	-0.00401
Arachnida	Opiliones	Sclerosomatidae	*Leibunum*	*Leibunum blackwalli*	Leibunum blackwalli	common	1	0.000133	-8.92638	-0.00119
Arachnida	Opiliones	Phalangioidea	*Oligolophus*	*Oligolophus tridens*	Oligolophus tridens	Common	1	0.000133	-8.92638	-0.00119
Arachnida	Trombidiformes	Trombidiidae	----------	----------	True Velvet Mites		4	0.000531	-7.54009	-0.00401
Aves	Accipitriformes	Accipitridae	*Buteo*	*Buteo buteo*	Common Buzzard	Green	5	0.000664	-7.31695	-0.00486
Aves	Anseriformes	Anitdae	*Anas*	*Anas platyrhynchos*	Mallard	Amber	5	0.000664	-7.31695	-0.00486
Aves	Anseriformes	Anitdae	*Anas*	*Anas crecca*	Teal	Amber	2	0.000266	-8.23324	-0.00219
Aves	Charadriiformes	Scolopacidae	*Gallinago*	*Gallinago gallinago*	Common Snipe	Green	2	0.000266	-8.23324	-0.00219
Aves	Columbiformes	Columbidae	*Columba*	*Columba palumbus*	Wood Pigeon	Green	2	0.000266	-8.23324	-0.00219
Aves	Falconiformes	Falconidae	*Flaco*	*Falco tinnunculus*	Common Kestrel	Amber	1	0.000133	-8.92638	-0.00119

Aves	Galliformes	Phasianidae	*Phasianus*	*Phasianus colchicus*	Common Pheasant	introduced (Naturalised)	2	0.000 266	- 8.233 24	- 0.002 19
Aves	Gruiformes	Rallidae	*Fulica*	*Fulica atra*	Eurasian Coot	Green	1	0.000 133	- 8.926 38	- 0.001 19
Aves	Gruiformes	Rallidae	*Gallinula*	*Gallinula chloropus*	Eurasian Moorhen	Green	1	0.000 133	- 8.926 38	- 0.001 19
Aves	Passeriform es	Corvidae	*Corvus*	*Corvus corone*	Carrion Crow	Green	2	0.000 266	- 8.233 24	- 0.002 19
Aves	Passeriform es	Prunellidae	*Prunella*	*Prunella modularis*	Dunnock	Amber	1	0.000 133	- 8.926 38	- 0.001 19
Aves	Passeriform es	Turdidae	*Turdus*	*Turdus merula*	Eurasian Black Bird	Green	5	0.000 664	- 7.316 95	- 0.004 86
Aves	Passeriform es	Paridea	*Cyanistes*	*Cyanistes caeruleus*	Eurasian Blue Tit	Green	1	0.000 133	- 8.926 38	- 0.001 19
Aves	Passeriform es	Fringillidae	*Pyrrhula*	*Pyrrhula pyrrhula subsp. Pileata*	Eurasian Bullfinch	Amber	7	0.000 93	- 6.980 47	- 0.006 49
Aves	Passeriform es	Corvidae	*Garrulus*	*Garrulus glandarius*	Eurasian Jay	Green	2	0.000 266	- 8.233 24	- 0.002 19
Aves	Passeriform es	Corvidae	*Pica*	*Pica pica*	Eurasian Magpie	Green	3	0.000 399	- 7.827 77	- 0.003 12
Aves	Passeriform es	Troglodytid ae	*Troglodyte s*	*Troglodytes troglodytes*	Eurasian Wren	Green	1	0.000 133	- 8.926 38	- 0.001 19

Aves	Passeriformes	Muscicapidae	*Erithacus*	*Erithacus rubecula*	European Robin	Green	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Muscicapidae	*Saxicola*	*Saxicola rubicola*	European StoneChat	Green	5	0.000664	-7.31695	-0.00486
Aves	Passeriformes	Paridea	*Parus*	*Parus major*	Great Tit	Green	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Aegithalidae	*Aegithalos*	*Aegithalos caudata*	Long-Tailed Tit	Green	6	0.000797	-7.13463	-0.00569
Aves	Passeriformes	Motacillidae	*Motacila*	*Motacilla alba*	Pied Wagtail	Green	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Emberizidae	*Emberiza*	*Emberiza schoeniclus*	Reed Bunting	Amber	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Acrocephalidae	*Acrocephalus*	*Acrocephalus schoenobaenus*	Sedge Warbler	Green	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Turdidae	*Turdus*	*Turdus philomelos*	Song Thrush	Red	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Hirundinidae	*Hirundo*	*Hirundo rustica*	Swallow	Green	20	0.002657	-5.93065	-0.01576
Aves	Passeriformes	Sylviidae	*Sylvia*	*Sylvia communis*	White Throat	Green	1	0.000133	-8.92638	-0.00119
Aves	Passeriformes	Fringillidae	Carduelis	*Carduelis carduelis*	Gold Finch	Green	2	0.000266	-8.23324	-0.00219

Aves	Pelecaniformes	Ardeidae	*Ardea*	*Ardea cinerea*	Grey Heron	Amber	1	0.000133	-8.92638	-0.00119
Bivalves	Sphaeriida	Sphaeriidae	*Pisidium*	*Pisidium*	Pea Mussels		4	0.000531	-7.54009	-0.00401
Bryopsida	Hypnales	Brachytheciaceae	*Kindbergia*	*Kindbergia praelonga*	Common Feather-moss	Common	10	0.001328	-6.6238	-0.0088
Bryopsida	Hypnales	Brachytheciaceae	*Brachythecium*	*Brachythecium rutabulum*	Rough-stalked Feather Moss	Very Common	51	0.006775	-4.99456	-0.03384
Clitellata	Haplotaxida	Lumbricidae	*Lumbricus*	*Lumbricus terrestris*	Common Earthworm	Common	16	0.002125	-6.1538	-0.01308
Clitellata	Arhynchobdellida	Erpobdellidae	*Erpobdella*	*Erpobdella*	Leech		2	0.000266	-8.23324	-0.00219
Diplopoda	Julida	Julidae	*Cylindroiulus*	*Cylindroiulus caeruleocinctus*	Cylindroiulus caeruleocinctus		4	0.000531	-7.54009	-0.00401
Diplopoda	Polydesmida	Polydesmidae	*polydesmus*	*Polydesmus*	Polydesmus (Flat backed millipedes)		12	0.001594	-6.44148	-0.01027
Entognatha	Entomobryomorpha	Tomoceridae	*Pogonognathellus*		Elongate Springtales		1	0.000133	-8.92638	-0.00119
Gastropoda	Hygrophila	Physidae	*Physa*	*Physa acuta*	Acute Bladder Snail	common (introduced)	16	0.002125	-6.1538	-0.01308
Gastropoda	Hygrophila	Acroloxidae	*Acroloxus*	*Acroloxus lacustris*	Lake Limpet	common	1	0.000133	-8.92638	-0.00119

Gastropoda	Stylommatophora	Arionidae	*Arion*	*Arion ater agg*	Black Slug	Common	2	0.000266	-8.23324	-0.00219
Gastropoda	Stylommatophora	Arionidae	*Arion*	*Arion cirsumscriptus*	Brown-banded Arion	Common	8	0.001063	-6.84694	-0.00728
Gastropoda	Stylommatophora	Helicidae	*Cepaea*	*Cepaea nemoralis*	Brown-lipped Snail	Common	3	0.000399	-7.82777	-0.00312
Gastropoda	Stylommatophora	Succineidea	*Succinea*	*Succinea putris*	Common European Ambersnail	Common	13	0.001727	-6.36144	-0.01099
Gastropoda	Stylommatophora	Arionidae	*Arion*	*Arion subfuscus*	Dusky Slug	Common	2	0.000266	-8.23324	-0.00219
Gastropoda	Stylommatophora	Hygromiidae	*Monacha*	*Monacha cantiana*	Kentish Snail	Threatened	22	0.002922	-5.83534	-0.01705
Gastropoda	Stylommatophora	Agriolimacidae	*Deroceras*	*Deroceras reticulatum*	Milky Slug	Common	4	0.000531	-7.54009	-0.00401
Gastropoda	Stylommatophora	Agriolimacidae	*Deroceras*	*Deroceras*	Smooth Land Slugs	----------	1	0.000133	-8.92638	-0.00119
Gastropoda	Stylommatophora	Helicidae	*Cepaea*	*Cepaea hortensis*	White-lipped Snail	Common	8	0.001063	-6.84694	-0.00728
Insecta	Coleoptera	Coccinellidae	*Propylea*	*Propylea quatuordecimpunctata*	14-Spot Ladybird	Common	1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Coccinellidae	*Subcoccinella*	*Subcoccinella vigintiquatuorpunctata*	24-Spot Ladybird	widespread	4	0.000531	-7.54009	-0.00401

Insecta	Coleoptera	Coccinellidae	*Coccinella*	*Coccinella septempunctata*	7-spot Ladybird	Common	10	0.001328	-6.6238	-0.0088
Insecta	Coleoptera	Brentidae	*Apion*	*Apion frumentarium*	Apion frumentarium	Common	1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Cantharidae	*Cantharis*	*Cantharis rufa*	Cantharis rufa	widespread and abundant	3	0.000399	-7.82777	-0.00312
Insecta	Coleoptera	Elateridae	*Agriotes*	*Agriotes*	Click Beetle		6	0.000797	-7.13463	-0.00569
Insecta	Coleoptera	Nitidulidae	*Brassicogethes*	*Brassicogethes aeneus*	Common Pollen Beetle	very common	4	0.000531	-7.54009	-0.00401
Insecta	Coleoptera	Curculionidae	----------	Curculionidae	Curculionidae (True Weevils)		1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Chrysomelidae	*Gastrophysa*	*Gastrophysa viridula*	Green Dock Beetle	Common	2	0.000266	-8.23324	-0.00219
Insecta	Coleoptera	Curculionidae	*Barypeithes*	*Barypeithes pellucidus*	Hairy Spider weevil		1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Coccinellinidae	*Harmonia*	*Harmonia axyridis*	Harlequin Lady Beetle	introduced Naturalised	1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Curculionidae	*Phyllobius*	small green nettle weevle	Phyllobius roboretanus	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Coleoptera	Cantharidae	*Rhagonycha*	*Rhagonycha nigriventris*	Rhagonycha nigriventris	widespread and abundant	1	0.000133	-8.92638	-0.00119

Insecta	Coleoptera	Cantharidae	----------	Cantharidae	Soldier Beetles (Larvae)	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Chrysomelidae	*Cassida*	*Cassida rubiginosa*	Thistle Tortoise Beetle	Common	1	0.000133	-8.92638	-0.00119
Insecta	Coleoptera	Chrysomelidae	*Pyrrhalta*	*Pyrrhalta viburni*	Viburnum Leaf Beetle	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Cheilosia*	*Cheilosia*	Blacklets		1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Calliphoridae	----------	Calliphoridae	Blow flies		1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Calliphoridae	*Lucilia*	*Lucilia caesar*	Caesar Greenbottle Fly	Common	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Eristalis*	*Eristalis tenax*	Common Drone Fly	Very Common	3	0.000399	-7.82777	-0.00312
Insecta	Diptera	Sarcophagidae	*Sarcophaga*	*Sarcophaga*	Common Flesh Flies		1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Asilidae	*Dioctria*	Dioctria Rufipes	Common red-legged robber fly	widespread and locally common	7	0.00093	-6.98047	-0.00649
Insecta	Diptera	Tipuloidea	----------	Tipuloidea	Cranefly Sp		1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Culicidae	----------	Culicidae	Culcidae (Mosquitos)		1	0.000133	-8.92638	-0.00119

Insecta	Diptera	Empididae	*Empis*	*Empis*	Dance Flies		7	0.00093	-6.98047	-0.00649
Insecta	Diptera	Sciaridae	----------	Sciaridae	Dark Winged Fungus Gnats		2	0.000266	-8.23324	-0.00219
Insecta	Diptera	Bibionidae	*Dilopus*	*Dilopus*	Dilophus (Fly)		8	0.001063	-6.84694	-0.00728
Insecta	Diptera	Tipulidae	*Tipula*	*Tipula paludosa*	European Cranefly	common	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Eristalis*	*Eristalis arbustorum*	European Drone Fly	common	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Muscidae	Neomyia	Neomiya	False green bottle	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Opomyzidae	*Goemyza*	*Goemyza*	Goemyza		5	0.000664	-7.31695	-0.00486
Insecta	Diptera	Calliphoridae	*Lucilia*	*Lucilia*	Green Bottle Flies		3	0.000399	-7.82777	-0.00312
Insecta	Diptera	Empididae	*Empis*	*Empis tessellata*	Hanging Fly	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Bibionidae	*Bibio*	*Bibio marci*	Hawthorn Fly	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Diptera	Syrphidae	----------	Syrphidae	Hover Fly Sp (Black)	widespread and abundant	1	0.000133	-8.92638	-0.00119

Insecta	Diptera	Phoridae	----------	Phoridae	Humpbacked Flies	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	Lejogaster	Lejogaster	Lejogaster	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Bibionidae	*Bibio*	*Bibio*	March Fly Sp	widespread and abundant	2	0.000266	-8.23324	-0.00219
Insecta	Diptera	Sciomyzidae	*Tetanocera*	*Tetanocera*	Marsh and Snail Killing Flies	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Diptera	Psychodidae	----------	Psychodidae	Moth Flies	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Orthinerva*	*Riponnensia Splendens*	Muck Suckers	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Chironomidae	*Circoptus*	*Circoptus*	Non-biting Midges	widespread and abundant	2	0.000266	-8.23324	-0.00219
Insecta	Diptera	Syrphidae	*Eristalis*	*Eristalis nemorum*	Orange Spined Hover Fly	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Anasimyia*	*Anasimyia contracta*	Rat-tail Maggot Flies	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Sciomyzidae	*Coremacera*	*Coremacera marginata*	Seive Winged Snail Killer	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Ephydridae	*Hydrellia*	*Hydrellia*	Shore Flies	widespread and abundant	1	0.000133	-8.92638	-0.00119

Insecta	Diptera	Lonchopteridae	*Lonchoptera*	*Lonchoptera*	Spear Winged Flies	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Syrphidae	*Helophilus*	*Helophilus pendulus*	Sun Fly	widespread and abundant	3	0.000399	-7.82777	-0.00312
Insecta	Diptera	Syrphidae	*Syritta*	*Syritta pipiens*	Thick Legged Hoverfly	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Diptera	Scathophagidae	*Scathophaga*	*Scathophaga stercoraria*	Yellow Dung Fly	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Diptera	Syrphidae	*Myathropa*	*Myathropa florea*	Yellow Haired Sun fly	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Ephemeroptera	----------	----------	Ephemeroptera	Mayflies	widespread and abundant	6	0.000797	-7.13463	-0.00569
Insecta	Hemiptera	Aphididae	----------	Aphididae	Aphid Sp		13	0.001727	-6.36144	-0.01099
Insecta	Hemiptera	Pentatomidae	*Polomena*	*Palomena prasina*	Green Shield Bug	Common	1	0.000133	-8.92638	-0.00119
Insecta	Hemiptera	Cercopoidea	----------	Cercopoidea	Common Frog Hopper	widespread and abundant	2	0.000266	-8.23324	-0.00219
Insecta	Hemiptera	Rhyparochromidae	*Scolopostethus*	*Scolopostethus*	Dirt-coloured seed bugs		9	0.001196	-6.72916	-0.00804
Insecta	Hemiptera	Blissidae	*Ischnodemus*	*Ischnodemus sabuleti*	European Chinchbug	Widespread (England)	3	0.000399	-7.82777	-0.00312

Insecta	Hemiptera	Gerridae	----------	Gerrini	Gerrini		3	0.000399	-7.82777	-0.00312
Insecta	Hemiptera	Miridae	*Leptopterna*	*Leptopterna dolabrata*	Meadow Plant Bug	widespread and abundant	6	0.000797	-7.13463	-0.00569
Insecta	Hemiptera	Aphrophoridae	*Philaenus*	*Philaenus spumarius*	Meadow Spittle Bug	widespread and abundant	3	0.000399	-7.82777	-0.00312
Insecta	Hemiptera	Miridae	*Notostira*	*Notostira elongata*	Notostira elongata	Common	2	0.000266	-8.23324	-0.00219
Insecta	Hemiptera	Cercopidae	*Cercopis*	*Cercopis vulnerata*	Red and Black Frog Hopper	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Hemiptera	Miridae	*Deraeocoris*	*Deraeocoris ruber*	Red-spotted plant bug	common	1	0.000133	-8.92638	-0.00119
Insecta	Hemiptera	Delaphacidae	*Stenocranus*	Stenocranus major	Stenocranus major (Plant Hopper)	Locally common	1	0.000133	-8.92638	-0.00119
Insecta	Hemiptera	Triozidae	*Trioza*	*Trioza*	Trioza	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera				Alder Spittle Bug		3	0.000399	-7.82777	-0.00312
Insecta	Hymenoptera	Andrenidae	*Andrena*	*Andrena cineraria*	Ashy Mining Bee	widespread	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Apidae	*Bombus*	*Bombus terrestris audax*	Buff-tailed Bumble Bee	widespread and abundant	4	0.000531	-7.54009	-0.00401

Insecta	Hymenoptera	Apidae	*Bombus*	*Bombus pascuorum*	Common Carder Bee	Common	31	0.004118	-5.4924	-0.02262
Insecta	Hymenoptera	Vespidae	*Vespula*	*Vespula vulgaris*	Common Wasp	common	9	0.001196	-6.72916	-0.00804
Insecta	Hymenoptera	Vespidae	*Vespula*	*Vespula germanica*	German Wasp	Common	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Formicidae	*Mymirca*	*Mymirca*	Myrmicine Ants	widespread and abundant	12	0.001594	-6.44148	-0.01027
Insecta	Hymenoptera	Cynipidae	*Andricus*	*Andricus fecundator*	Oak Artichoke Gall Wasp	Common	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Cynipidae	*Andricus*	*Andricus kollari*	Oak Mable Gall wasp	Common	16	0.002125	-6.1538	-0.01308
Insecta	Hymenoptera	Apidae	*Bombus*	*Bombus lapidarius*	Red Tailed Bumble Bee	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Halictidae	*Lsioglossum*	*Lasioglossum fratellum*	Smooth-Faced Furrow Bee	Widespread	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Apidae	*Andrena*	*Andrena fulva*	Tawny Mining bee	widespread and abundant	10	0.001328	-6.6238	-0.0088
Insecta	Hymenoptera	Tenthredinoidea	----------	Tenthredinoidea	Typical Sawflies	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Hymenoptera	Apidae	*Apis*	*Apis mellifera*	Western Honeybee	widespread and abundant	2	0.000266	-8.23324	-0.00219

Insecta	Hymenoptera	Apidae	*Bombus*	*Bombus lucorum*	White-tailed Bumble Bee	widespread and abundant	3	0.000399	-7.82777	-0.00312
Insecta	Lepidoptera	Nymphalidae	----------	Nymphalidae	Brush Footed Butterfly Larvae		5	0.000664	-7.31695	-0.00486
Insecta	Lepidoptera	Lycaenidae	*Polyommatus*	*Polyommatus icarus*	Common Blue	widespread	1	0.000133	-8.92638	-0.00119
Insecta	Lepidoptera	Tortricidae	*Syricoris*	*Syricoris lacunana*	Common Marble	Very common	3	0.000399	-7.82777	-0.00312
Insecta	Lepidoptera	Choreutidea	*Anthophila*	*Anthophila fabriciana*	Common Nettle-tap	Common	1	0.000133	-8.92638	-0.00119
Insecta	Lepidoptera	Noctuidae	----------	Noctuidae	Cutworms & Dart Moths		9	0.001196	-6.72916	-0.00804
Insecta	Lepidoptera	Lasiocampoidea	*Euthrix*	*Euthrix potatoria*	Drinker Moth	Common	2	0.000266	-8.23324	-0.00219
Insecta	Lepidoptera	Nymphalidae	*Polygonia*	*Polygonia c-album*	European Comma	Common	2	0.000266	-8.23324	-0.00219
Insecta	Lepidoptera	Nymphalidae	*Pyronia*	*Pyronia tithonus*	Gate Keeper	Common	2	0.000266	-8.23324	-0.00219
Insecta	Lepidoptera	Pieridae	*Pieris*	*Pieris napi*	Green-Veined White	widespread and abundant	3	0.000399	-7.82777	-0.00312
Insecta	Lepidoptera	Gelechiidae	Helcystogramma	Helcystogramma	Helcystogramma (Micro Moth)	widespread and abundant	1	0.000133	-8.92638	-0.00119

Insecta	Lepidoptera	Hesperiidae	*Ochlodes*	*Ochlodes sylvanus*	Large Skipper	widespread and abundant	2	0.000266	-8.23324	-0.00219
Insecta	Lepidoptera	Noctuidae	*Noctua*	*Noctua pronuba*	Large Yellow underwing	Common	3	0.000399	-7.82777	-0.00312
Insecta	Lepidoptera	Tortricidae	*Pammene*	*Pammene*	Leaf Roller Moths	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Lepidoptera	Pieridae	*Anthocaris*	*Anthocharis cardamines*	Orange Tip Butterfly	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Lepidoptera	Geometridae	*Archiearis*	*Archiearis parthenias*	Orange Underwing	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Lepidoptera	Crambidae	*Udea*	*Udea lutealis*	Pale Straw Pearl	Very Common	1	0.000133	-8.92638	-0.00119
Insecta	Lepidoptera	Nymphalidae	*Aglais*	*Aglais io*	Peacock Butterfly	widespread and abundant	4	0.000531	-7.54009	-0.00401
Insecta	Lepidoptera	Nymphalidae	*Vaness*	*Vanessa atalanta*	Red Admiral	widespread and abundant	2	0.000266	-8.23324	-0.00219
Insecta	Lepidoptera	Nymphalidae	*Aglais*	*Aglais urticae*	Small Tortoise Shell	widespread and abundant	6	0.000797	-7.13463	-0.00569
Insecta	Lepidoptera	Pieridae	*Pieris*	*Pieris rapae*	Small White	widespread and abundant	6	0.000797	-7.13463	-0.00569
Insecta	Lepidoptera	Eribidae	*Spilosoma*	*Spilosoma lubricipeda*	White Ermine	Common	1	0.000133	-8.92638	-0.00119

Insecta	Mecaoptera	Panorpidae	*Panorpa*	*Panorpa communis*	Common European Scorpion Fly	Common	2	0.000266	-8.23324	-0.00219
Insecta	Megaloptera	Sialidae	*Sialis*	*Sialis*	Sialis (Alderflies)	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Odonata	Coenagrionidae	*Ischnura*	*Ischnura elegans*	Blue tailed Damselfly	very common	3	0.000399	-7.82777	-0.00312
Insecta	Odonata	Libellulidae	*Libellula*	*Libellula quadrimaculata*	Four Spotted Chaser	widespread	1	0.000133	-8.92638	-0.00119
Insecta	Odonata	Calopterygidae	*Calopteryx*	*Calopteryx*	Jewelwings	widespread and abundant	11	0.001461	-6.52849	-0.00954
Insecta	Odonata	Coenagrionidae	----------	Coenagrionidae	Narrow-winged Damselflies	widespread and abundant	19	0.002524	-5.98195	-0.0151
Insecta	Orthoptera	Tetrigidae	*Tetrix*	*Tetrix subulata*	Slender Ground Hopper	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	*Hydropsyche*	Net-spinning caddisfly	widespread and abundant	1	0.000133	-8.92638	-0.00119
Insecta	Trichoptera	Limnephilidae	*Limnephilinae*	*Limnephilinae*	Northern Caddisfly	widespread and abundant	6	0.000797	-7.13463	-0.00569
Lecanoromycetes	Caliciales	Physciaceae	*Physcia*	----------	Rosette lychens		1	0.000133	-8.92638	-0.00119
Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria	*Xanthoria parietina*	Golden Shield Lichen		1	0.000133	-8.92638	-0.00119

Liliopsida	Alismatales	Potamogetonaceae	*Potamogerton*	*Potamogeton obtusifolis*	Bluntleaf Pondweed		9	0.001196	-6.72916	-0.00804
Liliopsida	Paoles	Juncaceae	*Juncus*	*Juncus effusus*	Soft Rush	Common	379	0.050345	-2.98885	-0.15047
Liliopsida	Poales	Cyperaceae	*Carex*	*Carex limosa*	Bog Sedge		2	0.000266	-8.23324	-0.00219
Liliopsida	Poales	Poaceae	*Dactylis*	*Dactylis Glomerata*	Cock's-foot	Ubiquitous	93	0.012354	-4.39379	-0.05428
Liliopsida	Poales	Poaceae	Agrostis	Agrostis capillaris	Common Bent Grass		5	0.000664	-7.31695	-0.00486
Liliopsida	Poales	Poaceae	*Arrhenatherum*	*Arrenatherum elatius*	False Oat-grass	Common	36	0.004782	-5.34287	-0.02555
Liliopsida	Poales	Cyperaceae	*Carex*	Carex hirta	Hairy Sedge		33	0.004384	-5.42988	-0.0238
Liliopsida	Poales	Juncaceae	*Juncus*	Juncus inflexus	Hard Rush		30	0.003985	-5.52519	-0.02202
Liliopsida	Poales	Poaceae	*Alopecurus*	*Alopecurus geniculatus*	Marsh Foxtail	Frequent	101	0.013417	-4.31126	-0.05784
Liliopsida	Poales	Poaceae	*Alopecurus*	Alopecurus pratensis	Meadow Foxtail		32	0.004251	-5.46065	-0.02321
Liliopsida	Poales	Poaceae	*Phalaris*	Phalaris arundinacea	Reed Canary Grass		309	0.041047	-3.19304	-0.13106

Liliopsida	Poales	Poaceae	*Glyceria*	Glyceria maxima	Reed Meadow Grass		623	0.082758	-2.49184	-0.20622
Liliopsida	Poales	Cyperaceae			Sedge Sp		9	0.001196	-6.72916	-0.00804
Liliopsida	Poales	Juncaceae	*Juncus*	Juncus acutiflorus	Sharp-Flowered Rush		72	0.009564	-4.64972	-0.04447
Liliopsida	Poales	Poaceae	*Phyleum*	*Phleum pratense*	Timothy Grass		1	0.000133	-8.92638	-0.00119
Liliopsida	Poales	Poaceae	*Deschampsia*	Deschampsia cespitosa	Tufted Hair Grass		41	0.005446	-5.21281	-0.02839
Liliopsida	Poales	Poaceae	*Holcus*	*Holcus lanatus*	Yorkshire Fog		231	0.030685	-3.48397	-0.10691
Magnoliopsida	Apiales	Araliaceae	*Hedera*	*Hedera hibernicum*	Common Ivy	Common	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Apiales	Apiaceae	*Anthriscus*	*Anthriscus sylvestris*	Cow Parsley	Common	58	0.007705	-4.86594	-0.03749
Magnoliopsida	Apiales	Apiaceae	*Aegopodium*	*Aegopodium podagraria*	Ground-elder	Common	12	0.001594	-6.44148	-0.01027
Magnoliopsida	Apiales	Apiaceae	*Heracleum*	*Heracleum sphondylium*	Hogweed	Common	22	0.002922	-5.83534	-0.01705
Magnoliopsida	Apiales	Apiaceae	*Angelica*	*Angelica sylvestris*	Wild Angelica		47	0.006243	-5.07624	-0.03169

Magnoliopsida	Asterales	Asteraceae	*Taraxacum*	*Taraxacum officinale*	Common Dandilion		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Asterales	Asteraceae	*Artemisia*	*Artemisia vulgaris*	Common Mugwort		4	0.000531	-7.54009	-0.00401
Magnoliopsida	Asterales	Asteraceae	*Jacobaea*	*Senecio jacobaea*	Common Ragwort	Common	4	0.000531	-7.54009	-0.00401
Magnoliopsida	Asterales	Asteraceae	*Glebionis*	*Glebionis segetum*	Corn Marigold		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Asterales	Asteraceae	*Cirsium*	*Cirsium arvense*	Creeping Thistle	Ubiquitous	289	0.03839	-3.25996	-0.12515
Magnoliopsida	Asterales	Asteraceae	*Leucanthemum*	*Leucanthemum vulgare*	Oxeye Daisy	Common	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Asterales	Asteraceae	*Sonchus*	*Sonchus asper*	Prickly Sowthistle		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Asterales	Asteraceae	*Sonchus*	*Sonchus oleraceus*	smooth swothistle		2	0.000266	-8.23324	-0.00219
Magnoliopsida	Asterales	Asteraceae	*Achillea*	*Achillea millefolium*	Yarrow	Common	1	0.000133	8.926385	0.001186
Magnoliopsida	Boraginales	Boraginoideae	*Symphytum*	*Symphytum officinale*	Common Comfrey	Locally common	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Boraginales	Boraginaceae	*Myosotis*	*Myosotis laxa*	tufted Foget Me Not		14	0.00186	-6.28733	-0.01169
Magnoliopsida	Brassicales	Brassicaceae	*Cardemine*	*Cardamine pratensis*	Cuckoo Flower		39	0.005181	-5.26282	-0.02726

Magnoliopsida	Brassicales	Brassicaceae	*Rorippa*	*Rorippa palustris*	Marsh Yellow Cress		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Brassicales	Brassicaceae	*Nasturtium*	*Nasturtium officinale*	Watercress		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Brassicales	Brassicaceae	*Cardemine*	*Cardamine flexuosa*	Wavy Bitter Cress	Common	40	0.005313	-5.23751	-0.02783
Magnoliopsida	Caryophyllales	Polygonaceae	*Persicaria*	Persicaria amphibia	Amphibious Bistort		143	0.018996	-3.96354	-0.07529
Magnoliopsida	Caryophyllales	Polygonaceae	*Rumex*	*Rumex obtusifolius*	Broad-leaved Dock	Abundant	15	0.001993	-6.21833	-0.01239
Magnoliopsida	Caryophyllales	Caryophyllaceae	Stellaria		Chickweed Sp		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Caryophyllales	Polygonaceae	*Rumex*	*Rumex conglomeratus*	Clustered Dock		25	0.003321	-5.70751	-0.01895
Magnoliopsida	Caryophyllales	Polygonaceae	*Rumex*	*Rumex acetosa*	Common Sorrel		218	0.028959	-3.54189	-0.10257
Magnoliopsida	Caryophyllales	Polygonaceae	*Rumex*	*Rumex crispus*	Curled Dock		114	0.015143	-4.19019	-0.06345
Magnoliopsida	Caryophyllales	Polygonaceae	*Rumex*		Dock Sp		17	0.002258	-6.09317	-0.01376
Magnoliopsida	Caryophyllales	Caryophyllaceae	*Cerastium*	*Cerastium fontanum*	Mouse-Ear Chickweed		6	0.000797	-7.13463	-0.00569

Magnoliopsida	Caryophyllales	Amaranthaceae	*Atriplex*	*Atriplex prostrata*	Spear-Leaved Orache		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Caryophyllales	Polygonaceae	*Persicaria*	*Persicaria hydropiper*	Water Pepper		330	0.043836	-3.12729	-0.13709
Magnoliopsida	Dipsacales	Viburnaceae	*Sambucus*	*Sambucus nigra*	Elder		4	0.000531	-7.54009	-0.00401
Magnoliopsida	Ericales	Balsaminaceae	*Impatiens*	*Impatiens glandulifera*	Himilayan Balsam	Introduced	68	0.009033	-4.70688	-0.04252
Magnoliopsida	Ericales	Balsaminaceae	*Impatiens*	*Impatiens capensis*	Orange Balsam	Introduced	171	0.022715	-3.78472	-0.08597
Magnoliopsida	Fabales	Fabaceae	*Ulex*	*Ulex europaeus*	Gorse		3	0.000399	-7.82777	-0.00312
Magnoliopsida	Fabales	Fabaceae	*Lotus*	*Lotus pedunculatus*	Greater Bird's foot trefoil		65	0.008634	-4.752	-0.04103
Magnoliopsida	Fabales	Fabaceae	*Vicia*	*Vicia hirsuta*	Hairy Tare		5	0.000664	-7.31695	-0.00486
Magnoliopsida	Fabales	Fabaceae	*Lathyrus*	*Lathyrus pratensis*	Meadow Vetchling		5	0.000664	-7.31695	-0.00486
Magnoliopsida	Fabales	Fabaceae	*Trifolum*	*Trifolium repens*	White Clover		2	0.000266	8.233238	0.002187
Magnoliopsida	Fagales	Fagaceae	*Quercus*	*Quercus robor*	Penduncaulate Oak		19	0.002524	-5.98195	-0.0151
Magnoliopsida	Gentianales	Rubiaceae	*Galium aparine*	Galium aparine	Cleavers		31	0.004118	-5.4924	-0.02262

Magnoliopsida	Gentianales	Rubiaceae	*Galium*	*Galium palustre*	Common Marsh-Bedstraw	Throughout	60	0.00797	-4.83204	-0.03851
Magnoliopsida	Gentianales	Rubiaceae	*Galium*	*Galium uliginosum*	Fen Bedstraw	Less Common	5	0.000664	-7.31695	-0.00486
Magnoliopsida	Gentianales	Rubiaceae	----------	----------	Madder Family		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Geraniales	Geraniaceae	*Geranium*	*Geraium dissectum*	Cut-leaved Crane's-bill	Common	2	0.000266	-8.23324	-0.00219
Magnoliopsida	Geraniales	Geraniaceae		***Geranium lucidum***	Shining crane's bill	Widespread	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Lamiales	Scrophulariaceae	*Scrophularia*	*Scrophularia nodosa*	Common Figwort	Common	5	0.000664	-7.31695	-0.00486
Magnoliopsida	Lamiales	Lamiaceae	*Galeopsis*	*Galeopsis tetrahit*	Common Hempnettle		530	0.070404	-2.65351	-0.18682
Magnoliopsida	Lamiales	Plantaginaceae	*Veronica*	*Veronica chamaedrys*	Germander Speedwell	Common	75	0.009963	-4.6089	-0.04592
Magnoliopsida	Lamiales	Plantaginaceae	*Plantago*	*Plantago major*	Greater Plantain	Ubiquitous	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Lamiales	Lamiaceae	*Lycopus*	*Lycopus europaeus*	Gypsywort		391	0.051939	-2.95768	-0.15362
Magnoliopsida	Lamiales	Lamiaceae	*Stachys*	*Stachys plustris*	Marsh Woundwort	Common	1	0.000133	-8.92638	-0.00119

Magnoliopsida	Lamiales	Plantaginaceae	*Plantago*	*Plantago lanceolata*	Ribwort Plantain		3	0.000399	-7.82777	-0.00312
Magnoliopsida	Lamiales	Lamiaceae	*Mentha*	*Mentha aquatica*	Water Mint		127	0.01687	-4.0822	-0.06887
Magnoliopsida	Malpighiales	Salicaceae	*Salix*	*Salix cinerea*	Grey Willow	Common	12	0.001594	-6.44148	-0.01027
Magnoliopsida	Myrtales	Onagraceae	*Epilobium*	*Epilobium hirsutum*	Great Willowherb	Common	587	0.077976	-2.55136	-0.19894
Magnoliopsida	Myrtales	Onagraceae	*Epilobium*	*Epilobium palustre*	Marsh Willow Herb	Frequent	33	0.004384	-5.42988	-0.0238
Magnoliopsida	Myrtales	Lythraceae	*Lythrum*	*Lythrum salicaria*	Purple Loosetrife		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Myrtales	Onagraceae	*Chamaenerion*	*Chamerion angustifolium*	Rosebay Willowherb	Common	1	0.000133	-8.92638	-0.00119
Magnoliopsida	Myrtales	Onagraceae	*Epilobium*		Willow Herb Sp		63	0.008369	-4.78325	-0.04003
Magnoliopsida	Ranunculales	Ranunculaceae	*Ranunculus*	*Ranunculus repens*	Creeping Buttercup	Common	67	0.0089	-4.72169	-0.04202
Magnoliopsida	Ranunculales	Ranunculaceae	*Ficaria*	*Ficaria verna*	Lesser Celandine	Common	14	0.00186	-6.28733	-0.01169
Magnoliopsida	Rosales	Rosaceae	*Malus*	*Malus pumila*	Apple		1	0.000133	-8.92638	-0.00119

Magnoliopsida	Rosales	Rosaceae	*Prunus*	*Prunus spinosa*	Blackthorn		3	0.000399	-7.82777	-0.00312
Magnoliopsida	Rosales	Rosaceae	*Crataegus*	*Crataegus monogyna*	Common Hawthorn	Common	12	0.001594	-6.44148	-0.01027
Magnoliopsida	Rosales	Urticaceae	*Urtica*	*Urtica dioica*	Common Nettle	Common	747	0.09923	-2.31032	-0.22925
Magnoliopsida	Rosales	Rosaceae	*Potentilla*	*Potentilla anserina*	Common Silverweed	Common	170	0.022582	-3.79059	-0.0856
Magnoliopsida	Rosales	Rosaceae	*Potentilla*	*Potentilla reptans*	Creeping Cinquefoil		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Rosales	Rosaceae	Rosa	*Complex Rosa canina*	Dog Rose		2	0.000266	-8.23324	-0.00219
Magnoliopsida	Rosales	Rosaceae	*Rubus*	*Complex Rubus fruticosus*	European Bramble Complex	Common	13	0.001727	-6.36144	-0.01099
Magnoliopsida	Rosales	Rosaceae	*Filipendula*	*Filipendula ulmaria*	Meadowsweet	Common	22	0.002922	-5.83534	-0.01705
Magnoliopsida	Rosales	Rosaceae	*Rosa*	----------	Rose Sp		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Rosales	Ulmaceae	*Ulmus*	*Ulmus minor*	Small-leaved Elm		1	0.000133	-8.92638	-0.00119
Magnoliopsida	Rosales	Ulmaceae	*Ulmus*	*Ulmus glabra*	Wych Elm		1	0.000133	-8.92638	-0.00119

Magnoliopsida	Sapindales	Sapindaceae	*Acer*	*Acer pseudoplatanus*	Sycamore	Introduced (Naturalised)	2	0.000266	-8.23324	-0.00219
Magnoliopsida	Solanales	Convolvulaceae	*Calystegia*	*Calystegia silvatica*	Large bindweed	Introduced (Invasive)	82	0.010893	-4.51967	-0.04923
Malacostraca	Amphipoda	Gammaridae	*Gammarus*	----------	Shrimp		6	0.000797	-7.13463	-0.00569
Malacostraca	Isopoda	Oniscidae	*Onsicus*	*Oniscus asellus*	Common Shiny Woodlouse		16	0.002125	-6.1538	-0.01308
Malacostraca	Isopoda	Philosciidae	*Philoscia*	*Philoscia muscorum*	Common Striped Woodlouse		3	0.000399	-7.82777	-0.00312
Malacostraca	Isopoda	Asellidae	*Asellus*	*Asellus aquaticus*	Two-Spotted Water Slater		6	0.000797	-7.13463	-0.00569
Mammalia	Carnivora	Canidae	*Vulpes*	*Vulpes Vulpes*	Red Fox	LC	1	0.000133	-8.92638	-0.00119
Mammalia	Eulipotyphla	Soricidae	*Sorex*	*Sorex araneus*	Common Shrew		1	0.000133	-8.92638	-0.00119
Mammalia	Eulipotyphla	Talpidae	*Talpa*	*Talpa europaea*	European Mole	LC	3	0.000399	-7.82777	-0.00312
Mammalia	Lagomorpha	Leporidae	*Oryctolagus*	*Oryctolagus cuniculus*	European Rabbit	introduced (Naturalised)	2	0.000266	-8.23324	-0.00219
Mammalia	Rodentia	Cricetidae	Myodes	*Mictrotus agrestis*	Field Vole	LC	3	0.000399	-7.82777	-0.00312
							7631			-3.85

Appendix C

Table B: An example of the data collected throughout this study using the Methods outlined in Table 1 of this study.

Taxanomic Class	Taxanomic Order	Common Name	*Scientific Name*	n	Date	Habitat	GPS	What 3 Words	Survey Type	Quadrat	Quadrat	Soil prefernce	Weather	Start	End Temp	Time of day	Life Stage	Sex	Notes
Agaricomycetes	Order Agaricales	Brown Mottlegill	*Panaeolus foenisecii*	1	18/05/2020	B 2.2			Random	N/A	N/A								
Clitellata	Haplotaxida	Common Earthworm	*Lumbricus terrestris*	1	29/09/2020	B 2.2	53.212839, -2.909203	///habit.march.pushed	N/A	N/A	N/A					Mid Afternoon			
Magnoliopsida	Asterales	Smooth Sow thistle	Sonchus oleraceus	1	29/09/2020	B 2.2	53.216667, -2.906944	///foil.humans.lame	N/A	N/A	N/A	wetland							
Aves	Galliformes	Common Pheasant	*Phasianus colchicus*	2	02/10/2020	B 2.2	53.21292, -2.908364	///spared.spring.brand	N/A	N/A	N/A						Adult		
Aves	Passeriformes	European StoneChat	*Saxicola rubicola*	1	03/10/2020	B 5	53.213345, -2.908266	///impact.rather.items	N/A	N/A	N/A						Adult		
Aves	Anseriformes	Mallard	*Anas platyrhynchos*	1	05/10/2020	G 2.1	N/A	N/A	N/A	N/A	N/A								Yellow Form
Aves	Falconiformes	Common Kestrel	*Falco tinnunculus*	1	05/10/2020	B 2.2	N/A	N/A	N/A	N/A	N/A							Male	
Aves	Passeriformes	Eurasian Magpie	*Pica pica*	1	05/10/2020	B 2.2	53.214282, -2.908206	///frame.model.lifted	N/A	N/A	N/A				3°C	Midday	Adult		

Aves	Passeriformes	Eurasian Wren	*Troglodytes troglodytes*	1	05/10/2020	B2.2	53.214302, -2.908223	///think.necks.ports	N/A	N/A	N/A				6°C				
Aves	Passeriformes	European Stonechat	*Saxicola rubicola*	1	05/10/2020	B5	N/A	N/A	N/A	N/A	N/A				11°C		Adult		
Aves	Passeriformes	Reed Bunting	*Emberiza schoeniclus*	1	05/10/2020	B5	53.214583, -2.90792	///stem.fallen.scared	N/A	N/A	N/A				9°C	Mid Morning			
Aves	Pelecaniformes	Grey Heron	*Ardea cinerea*	1	05/10/2020	G2.1	N/A	N/A	N/A	N/A	N/A				11°C				
Gastropoda	Stylommatophora	Black Slug	*Arion ater*	1	05/10/2020	B2.2	53.214834, -2.908165	///frog.stores.over	N/A	N/A	N/A								
Gastropoda	Stylommatophora	Common European Amber Snail	*Succinea putris*	1	05/10/2020	B2.2	53.215, -2.908056	///gates.scan.stones	N/A	N/A	N/A								
Gastropoda	Stylommatophora	Kentish Snail	*Monacha cantiana*	1	05/10/2020	J2.3.1	53.216667, -2.907222	///means.window.boil	N/A	N/A	N/A								
Gastropoda	Stylommatophora	White Lipped Snail	*Cepaea hortensis*	1	05/10/2020	J2.3.1	53.215703, -2.907225	///taxi.gloves.powder	N/A	N/A	N/A								
Gastropoda	Stylommatophora	White Lipped Snail	*Cepaea hortensis*	1	05/10/2020	B2.2	53.212778, -2.909167	///daring.dips.linked	N/A	N/A	N/A								
Liliopsida	Poales	Cock's-foot	*Dactylis Glomerata*	2	05/10/2020	B2.2	53.213056, -2.909167	///fingernails.gently.brave	N/A	N/A	N/A	fertile							
Liliopsida	Poales	False Oat-grass	*Arrenatherum elatius*	1	05/10/2020	B2.2			N/A	N/A	N/A	varied							

Liliopsida	Poales	Soft Rush	*Juncus effusus*	1	05/10/2020	B5			N/A	N/A	N/A	wetland							
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	05/10/2020	B2.2	53.213889, -2.908889	///frame.thick.ground	N/A	N/A	N/A	meadow							
Magnoliopsida	Fagales	Penduncul ate Oak	*Quercus robor*	1	05/10/2020	B5	53.215742, -2.907235	///cooks.ship.calms	N/A	N/A	N/A	varied				Late Morning			
Magnoliopsida	Fagales	Penduncul ate Oak	*Quercus robor*	1	05/10/2020	B2.2	53.21666, -2.906944	///humid.dark.poetic	N/A	N/A	N/A	varied				Midday			
Magnoliopsida	Lamiales	Ribwort Plantain	*Plantago lanceolata*	1	05/10/2020	B2.2	53.216667, -2.906944	///foil.humans.lame	N/A	N/A	N/A	fertile			4 °C				
Magnoliopsida	Geraniales	Shining crane's bill	***Geranium lucidum***	1	05/10/2020	B2.2	53.214444, -2.908333	///hunter.helps.dine	N/A	N/A	N/A	fertile							
Magnoliopsida	Boraginales	tufted Forget me not	*Myosotis laxa*	1	05/10/2020	B2.2	53.216667, -2.906944	///foil.humans.lame	N/A	N/A	N/A	meadow							
Magnoliopsida	Boraginales	tufted Forget me not	*Myosotis laxa*	2	05/10/2020	B5	53.213333, -2.908333	///money.exams.glory	N/A	N/A	N/A	fertile							
Magnoliopsida	Boraginales	tufted Forget me not	*Myosotis laxa*	3	05/10/2020	B2.2	53.213056, -2.908333	///hooks.tells.range	N/A	N/A	N/A	varied							
Magnoliopsida	Brassicales	water cress	*Rorippa palustris*	1	05/10/2020	B2.2	53.215, -2.908333	///hoping.panel.wink	N/A	N/A	N/A	fertile							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	1	05/10/2020	B2.2	53.213889, -2.908889	///frame.thick.ground	N/A	N/A	N/A	wetland							

Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	25	05/10/2020	B2.2	53.2125, -2.908333	///volume.matter.flips	N/A	N/A	N/A	fertile and wetland							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	6	05/10/2020	B2.2	53.213333, -2.908889	///roof.golf.farmer	N/A	N/A	N/A	wetland			3°C				
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	1	05/10/2020	B5	53.215278, -2.907778	///pillow.brain.arch	N/A	N/A	N/A	fertile and wetland			4°C				
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	2	05/10/2020	B2.2	53.215, -2.908056	///gates.scan.stones	N/A	N/A	N/A	fertile			4°C				
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	05/10/2020	B2.2	53.216657, -2.907927	///trace.poetic.puts	N/A	N/A	N/A	fertile			11°C				
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	05/10/2020	B5	53.214639, -2.908039	///motor.fetch.novel	N/A	N/A	N/A	wetland							
Magnoliopsida	Lamiales	Gypsywort	*Lycopus europaeus*	1	05/10/2020	B2.2	53.21539, -2.908082	///cracks.glitz.tides	N/A	N/A	N/A	wetland			8°C				
Magnoliopsida	Myrtales	Rosebay Willowherb	*Chamaenerion angustifolium*	1	05/10/2020	B2.2	53.212778, -2.909167	///daring.dips.linked	N/A	N/A	N/A	fertile				Late Morning			
Magnoliopsida	Rosales	Small-leaved Elm	*Ulmus minor*	1	05/10/2020	B2.2	53.212778, -2.909167	///daring.dips.linked	N/A	N/A	N/A	fertile							
Aves	Gruiformes	Eurasian Moorhen	*Gallinula chloropus*	1	06/10/2020	G2.1	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Great Tit	*Parus major*	1	06/10/2020	B2.2	N/A	N/A	N/A	N/A	N/A				11				

															°C				
Gastropoda	Stylommatophora	Western Dusky Slug	*Arion fuscus*	1	06/10/2020	B5	53.216389, -2.906944	///lively.cases.origin	N/A	N/A	N/A				6°C				
Insecta	Coleoptera	Cantharis rufa	*Cantharis rufa*	1	06/10/2020	B2.2	53.213889, -2.908889	///frame.thick.ground	N/A	N/A	N/A								Nesting
Liliopsida	Poales	Cock's-foot	*Dactylis Glomerata*	1	06/10/2020	B5			N/A	N/A	N/A	wetland							
Magnoliopsida	Fagales	Penduncculate Oak	*Quercus robor*	1	06/10/2020	B2.2	53.216389, -2.9075	///fuel.event.affair	N/A	N/A	N/A	varied				Late Morning			
Magnoliopsida	Asterales	Smooth Sow thistle	Sonchus oleraceus	1	06/10/2020	B2.2	53.216667, -2.906944	///foil.humans.lame	N/A	N/A	N/A	fertile							
Magnoliopsida	Sapindales	Sycamore	*Acer pseudoplatanus*	1	06/10/2020	B2.2	53.216389, -2.9075	///fuel.event.affair	N/A	N/A	N/A	meadow							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	9	06/10/2020	B2.2	53.214722, -2.908611	///homes.fake.jumps	N/A	N/A	N/A	fertile							
Magnoliopsida	Myrtales	Willow Herb Sp	Epilobium	3	06/10/2020	B5	53.216282, -2.906956	///equal.under.flying	N/A	N/A	N/A	fertile							
Arachnida	Araneae	European Garden Spider	*Araneus diadematus*	1	08/10/2020	B2.2	53.216667, -2.907778	///nerve.pots.grows	N/A	N/A	N/A							Male	
Arachnida	Araneae	European Nursery Web Spider	*Pisaura mirabilis*	1	08/10/2020	B2.2	53.214302, -2.908223	///think.necks.ports	N/A	N/A	N/A				4°C				
Aves	Passeriformes	European Robin	*Erithacus rubecula*	1	08/10/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A								

Insecta	Coleoptera	7-spot Ladybird	*Coccinella septempunctata*	1	08/10/2020	B2.2	53.216111, -2.908056	///piper.nasal.brass	N/A	N/A	N/A				3°C				
Insecta	Hymenoptera	Aphididae	Aphididae	1	08/10/2020	B2.2	53.214465, -2.908281	///shower.calms.groups	N/A	N/A	N/A				3°C				
Insecta	Hymenoptera	Aphididae	Aphididae	4	08/10/2020	B5	53.21430, -2.90822	///think.necks.ports	N/A	N/A	N/A								
Insecta	Odonata	Blue-Tailed Damselfly	*Ischnura elegans*	1	08/10/2020	B2.2	53.213889, -2.908889	///frame.thick.ground	N/A	N/A	N/A								
Insecta	Coleoptera	Cantharis rufa	*Cantharis rufa*	1	08/10/2020	B5	53.21430, -2.90822	///think.necks.ports	N/A	N/A	N/A								
Insecta	Coleoptera	Click Beetle	*Agriotes*	1	08/10/2020	B2.2	53.215833, -2.908333	///posed.left.dogs	N/A	N/A	N/A								
Insecta	Coleoptera	Click Beetle	*Agriotes*	1	08/10/2020	B2.2	53.215833, -2.908333	///posed.left.dogs	N/A	N/A	N/A								
Magnoliopsida	Fagales	Pendunculate Oak	*Quercus robor*	1	08/10/2020	B2.2	53.214401, -2.90874	///privately.scarf.paper	N/A	N/A	N/A	varied	B2.2.						
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	5	08/10/2020	B2.2	53.215278, -2.908333	///proud.aware.mirror	N/A	N/A	N/A	hedge							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	22	08/10/2020	B2.2	53.215278, -2.908333	///proud.aware.mirror	N/A	N/A	N/A	hedge			3°C				
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	2	08/10/2020	B2.2	53.215295, -2.908475	///zips.likely.vest	N/A	N/A	N/A	hedge							

Magnoliopsida	Ericales	Himilayan Balsam	Impatiens glandulifera	1	12/10/2020	B2.2	53.214174, -2.908806	///castle.thing.sounds	N/A	N/A	N/A	hedge			8°C				
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	12/10/2020	B2.2	53.213039, -2.909187	///judge.packet.even	N/A	N/A	N/A	hedge			11°C				
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	12/10/2020	J2.3.1	53.216667, -2.908056	///drag.bars.wizard	N/A	N/A	N/A	hedge							
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	12/10/2020	J2.3.1	53.213741, -2.9091	///proven.union.forget	N/A	N/A	N/A	hedge				Late afternoon			
Magnoliopsida	Sapindales	Sycamore	*Acer pseudoplatanus*	1	12/10/2020	J2.3.1	53.216667,-2.908056	///drag.bars.wizard	N/A	N/A	N/A	fertile			11°C				
Bryopsida	Hypnales	Common Feather-moss	*Kindbergia praelonga*	10	19/10/2020	B5	53.215556, -2.907222	///forms.frame.eaten	N/A	N/A	N/A								
Aves	Passeriformes	Carrion Crow	*Corvus corone*	1	20/10/2020	B2.2	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Dunnock	*Prunella modularis*	1	20/10/2020	J2.3.1	53.216818, -2.908037	///snail.ended.rested	N/A	N/A	N/A								
Aves	Passeriformes	Eurasian Black Bird	*Turdus merula*	1	20/10/2020	B2.2	53.216676, -2.907814	///laptop.dizzy.summer	N/A	N/A	N/A					Midday	Adult		
Aves	Passeriformes	Eurasian Jay	*Garrulus glandarius*	1	20/10/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A				7°C				
Insecta	Coleoptera	Click Beetle	*Agriotes*	1	20/10/2020	B2.2	53.216667, -2.906944	///foil.humans.lame	N/A	N/A	N/A								

Mammalia	Eulipotyphla	European Mole	*Talpa europaea*	1	20/10/2020	B2.2	53.213611, -2.908889	///loose.hurls.launch	N/A	N/A	N/A								
Aves	Passeriformes	Eurasian Bullfinch	*Pyrrhula pyrrhula*	7	23/10/2020	J2.3.1	53.21489, -2.908692	///calms.sands.driven	N/A	N/A	N/A					Early Afternoon	Adult		
Aves	Passeriformes	European Stonechat	*Saxicola rubicola*	1	23/10/2020	B2.2	53.215002, -2.908647	///round.such.beams	N/A	N/A	N/A					Mid Afternoon	Adult		
Aves	Passeriformes	European Stonechat	*Saxicola rubicola*	1	23/10/2020	B2.2	53.215046, -2.908625	///create.oath.vocal	N/A	N/A	N/A					Mid Afternoon	Adult		
Arachnida	Araneae	Common Stretch Spider	*Tetragnatha extensa*	1	26/10/2020	B2.2	53.21362, -2.909141	///vibe.found.skills	N/A	N/A	N/A								
Magnoliopsida	Rosales	Rosa spp	*Rosa*	1	26/10/2020	B2.2	53.214444, -2.908889	///global.shot.clash	N/A	N/A	N/A	fertile			3 ° C				
Magnoliopsida	Boraginales	tufted Forget me not	*Myosotis laxa*	1	26/10/2020	B5	53.215278, -2.9075	///dish.firms.remedy	N/A	N/A	N/A	wetland							
Aves	Passeriformes	Eurasian Black Bird	*Turdus merula*	5	02/11/2020	J2.3.1	53.21588, -2.908375	///rests.risky.trend	N/A	N/A	N/A					Midday	Adult		
Aves	Passeriformes	European Robin	*Erithacus rubecula*	1	02/11/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Long-tailed Tit	*Aegithalos caudata*	6	02/11/2020	B2.2	53.214302, -2.908223	///think.necks.ports	N/A	N/A	N/A					Mid Morning			
Arachnida	Araneae	European Nursery Web Spider	*Pisaura mirabilis*	1	05/11/2020	B2.2	53.215043, -2.908502	///roof.curiosity.saying	N/A	N/A	N/A								

Arachnida	Araneae	*Steatoda*	*Steatoda*	1	05/11/2020	B2.2	53.213056, -2.908333	///hooks.tells.range	N/A	N/A	N/A				11°C				
Arachnida	Opiliones	Oligolophus tridens	*Oligolophus tridens*	1	05/11/2020	B2.2	53.214167, -2.908611	///acting.flat.agents	N/A	N/A	N/A								
Aves	Galliformes	Common Pheasant	*Phasianus colchicus*	2	05/11/2020	B2.2	N/A	N/A	N/A	N/A	N/A							Male	Feaces
Aves	Passeriformes	Dunnock	*Prunella modularis*	1	05/11/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Eurasian Blue Tit	*Cyanistes caeruleus*	1	05/11/2020	B5	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Eurasian Magpie	*Pica pica*	1	05/11/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A				6°C		Adult		
Aves	Passeriformes	Eurasian Magpie	*Pica pica*	1	05/11/2020	B2.2	N/A	N/A	N/A	N/A	N/A						Adult		
Aves	Passeriformes	Great tit	*Parus major*	2	05/11/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A				11°C				
Aves	Passeriformes	Long-tailed Tit	*Aegithalos caudata*	2	05/11/2020	B5	N/A	N/A	N/A	N/A	N/A								
Insecta	Diptera	Aschizan Flies		1	05/11/2020	B2.2	53.215278, -2.908611	///venue.entertainer.worry	N/A	N/A	N/A					Midday		Female	
Magnoliopsida		Spear Leaved Orache		1	05/11/2020	B5	53.213611, -2.908333	///lakes.stump.push	N/A	N/A	N/A	fertile							

Mammalia	Lagomorpha	European Rabbit	*Oryctolagus cuniculus*	1	05/11/2020	B2.2	53.215079, -2.908361	///slide.chain.boots	N/A	N/A	N/A				11°C				
Insecta	Diptera	Culcidae (Mosquitos)		1	06/11/2020	B2.2	53.21493, -2.90873	///spared.option.hints	N/A	N/A	N/A								
Liliopsida	Poales	Bog-sedge	*Carex limosa*	1	06/11/2020	G2.1	53.21506, -2.907422	///tour.brings.swear	N/A	N/A	N/A	fertile and wetland							
Insecta	Diptera	Alderflies	*Sialis*	1	09/11/2020	B5	53.21472, -2.90778	///teeth.coins.rash	N/A	N/A	N/A								
Liliopsida	Poales	Marsh Foxtail	*Alopecurus geniculatus*	1	09/11/2020	B5			N/A	N/A	N/A	wetland							
Magnoliopsida	Rosales	Common Nettle	*Urtica dioica*	11	09/11/2020	B5	53.212778, -2.907222	///craft.pool.rated	N/A	N/A	N/A	fertile							
Magnoliopsida	Lamiales	Water Mint	Mentha aquatica	23	09/11/2020	B5	53.214499, -2.907856	///wisely.foam.online	N/A	N/A	N/A	wetland							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	16	09/11/2020	B2.2	53.214167, -2.908611	///acting.flat.agents	N/A	N/A	N/A	meadow							
Magnoliopsida	Lamiales	Water Pepper	Persicaria hydropiper	10	09/11/2020	B5	53.213333, -2.9075	///worth.coach.causes	N/A	N/A	N/A	wetland							
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	1	09/11/2020	B5	53.215278, -2.9075	///dish.firms.remedy	N/A	N/A	N/A	wetland							
Bryopsida	Hypnales	Rough-stalked Feather Moss	*Brachythecium rutabulum*	8	10/11/2020	B5	53.216389, -2.907222	///forms.frame.eaten	N/A	N/A	N/A								

Insecta	Hymenoptera	Aphididae	Aphididae	4	10/11/2020	B2.2	53.21583, -2.90778	///hogs.mental.caves	N/A	N/A	N/A								
Insecta	Odonata	Blue-Tailed Damselfly	*Ischnura elegans*	1	10/11/2020	B2.2	53.216111, -2.907778	///movies.vast.soon	N/A	N/A	N/A				4 °C				
Magnoliopsida	Rosales	Common Nettle	*Urtica dioica*	9	10/11/2020	B5	53.213272, -2.907483	///reform.pays.keen	N/A	N/A	N/A	wetland							
Agaricomycetes	Order Agaricales	Yellow Field Cap	*Bolbitius titubans*	1	12/11/2020	B2.2	53.215278,-2.908611	///venue.entertainer.worry	Random	N/A	N/A								
Aves	Charadriiformes	Common Snipe	*Gallinago gallinago*	1	12/11/2020	B5	N/A	N/A	N/A	N/A	N/A								
Aves	Passeriformes	Long-Tailed Tit	*Aegithalos caudata*	1	12/11/2020	J2.3.1	N/A	N/A	N/A	N/A	N/A								
Insecta	Coleoptera	Common Pollen Beetle	*Brassicogethes aeneus*	1	12/11/2020	B2.2	53.21500, -2.90861	///round.such.beams	N/A	N/A	N/A								
Magnoliopsida	Boraginales	tufted Forget me not	*Myosotis laxa*	1	12/11/2020	B5	53.213421, -2.908282	///free.open.slips	N/A	N/A	N/A	fertile			11 °C				
Arachnida	Araneae	Painted Cobweb Weaver	*Theridion pictum*	1	24/11/2020	B2.2	53.216667, -2.907778	///nerve.pots.grows	N/A	N/A	N/A								
Aves	Passeriformes	Eurasian Blue Tit	*Cyanistes caeruleus*	1	24/11/2020	B2.2	N/A	N/A	N/A	N/A	N/A								
Bryopsida	Hypnales	Rough-stalked Feather Moss	*Brachythecium rutabulum*	4	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Qu	2	1 m^2		Clear / wet						

									adrat										
Gastropoda	Stylommatophora	Chocolate Arion	*Arion rufus*	1	24/11/2020	J2.3.1	53.214535, -2.908332	///knots.slimy.media	N/A	N/A	N/A				8°C				
Gastropoda	Stylommatophora	Milk Slug	*Deroceras reticulatum*	1	24/11/2020	B2.2	53.216025, -2.907805	///Gender.Cakes.Rival	Fixed Quadrat	3	1 m^2		Clear / wet		3°C				
Liliopsida	Poales	Cock's-foot	*Dactylis Glomerata*	1	24/11/2020	B5	53.213372, -2.907725	///roses.first.amuse	Fixed Quadrat	10	1 m^2	fertile and wetland	Clear / wet						
Liliopsida	Poales	Cock's-foot	*Dactylis Glomerata*	6	24/11/2020	B2.2	53.213453, -2.908595	///paying.beard.logs	Fixed Quadrat	8	1 m^2	fertile	Clear / wet						
Liliopsida	Poales	Marsh Foxtail	*Alopecurus geniculatus*	42	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	wetland	Clear / wet						
Liliopsida	Poales	Marsh Foxtail	*Alopecurus geniculatus*	26	24/11/2020	B5	53.215524, -2.907175	///encounter.snail.couple	Fixed Quadrat	6	1 m^2	wetland	Clear / wet						
Liliopsida	Poales	Soft Rush	*Juncus effusus*	13	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	wetland	Clear / wet						

Liliopsida	Poales	Soft Rush	*Juncus effusus*	15	24/11/2020	B5	53.215677, -2.907667	///Hill.Decay.Rider	Fixed Quadrat	5	$1 m^2$	wetland	Clear / wet						
Liliopsida	Poales	Soft Rush	*Juncus effusus*	11	24/11/2020	B5	53.2134611, -2.9082532	///spring.boats.pass	Fixed Quadrat	9	$1 m^2$	wetland	Clear / wet						
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	24/11/2020	B2.2	53.216025, -2.907805	///Gender.Cakes.Rival	Fixed Quadrat	3	$1 m^2$	varied	Clear / wet						
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	24/11/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$1 m^2$	varied	Clear / wet						
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	24/11/2020	B5	53.213372, -2.907725	///roses.first.amuse	Fixed Quadrat	10	$1 m^2$	varied	Clear / wet						
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	$1 m^2$	varied	Clear / wet						
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	11	24/11/2020	B2.2	53.2150002, -2.9085147	///vivid.detail.email	Fixed Quadrat	7	$1 m^2$	varied	Clear / wet						

Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	12	24/11/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	4	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	3	24/11/2020	B2.2	53.2150002, -2.9085147	///vivid.detail.email	Fixed Quadrat	7	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	9	24/11/2020	B2.2	53.213453, -2.908595	///paying.beard.logs	Fixed Quadrat	8	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	24	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	4	24/11/2020	B5	53.215677, -2.907667	///Hill.Decay.Rider	Fixed Quadrat	5	1 m^2	fertile	Clear / wet						
Magnoliopsida	Rosales	Common Nettle	*Urtica dioica*	17	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	wetland	Clear / wet						

Magnoliopsida	Asterales	Common Ragwort	*Senecio jacobaea*	1	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	$1m^2$	fertile	Clear / wet						
Magnoliopsida	Asterales	Common Ragwort	*Senecio jacobaea*	1	24/11/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$1m^2$	fertile	Clear / wet						
Magnoliopsida	Asterales	Common Ragwort	*Senecio jacobaea*	1	24/11/2020	B2.2	53.213453, -2.908595	///paying.beard.logs	Fixed Quadrat	8	$1m^2$	fertile	Clear / wet						
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	3	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	$1m^2$	meadow	Clear / wet		4 °C				
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	24/11/2020	B5	53.213398, -2.907649	///poet.stud.jukebox	N/A	N/A	N/A	wetland				Midday			
Magnoliopsida	Caryophyllales	Curled Dock	*Rumex crispus*	1	24/11/2020	B5	53.2134611, -2.9082532	///spring.boats.pass	Fixed Quadrat	9	$1m^2$	fertile	Clear / wet						
Magnoliopsida	Caryophyllales	Curled Dock	*Rumex crispus*	1	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	$1m^2$	varied	Clear / wet						

Magnoliopsida	Caryophyllales	Curled Dock	*Rumex crispus*	4	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	meadow	Clear / wet						
Magnoliopsida	Ericales	Orange Balsam	Impatiens capensis	1	24/11/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	1 m^2	fertile	Clear / wet						
Magnoliopsida	Ericales	Orange Balsam	Impatiens capensis	2	24/11/2020	B2.2	53.2150002, -2.9085147	///vivid.detail.email	Fixed Quadrat	7	1 m^2	fertile	Clear / wet		8 °C				
Magnoliopsida	Lamiales	Common Figwort	*Scrophularia nodosa*	2	24/11/2020	B2.2	53.213453, -2.908595	///paying.beard.logs	Fixed Quadrat	8	1 m^2	varied	Clear / wet			Midday			
Magnoliopsida	Asterales	Common Ragwort	*Senecio jacobaea*	1	24/11/2020	B5	53.215677, -2.907667	///Hill.Decay.Rider	Fixed Quadrat	5	1 m^2	fertile	Clear / wet						
Magnoliopsida	Lamiales	Germander Speedwell	*Veronica chamaedrys*	1	24/11/2020	B5	53.21642238, -2.9072400	///Intelligible.Splash.Trim	Fixed Quadrat	2	1 m^2	fertile and wetland	Clear / wet						
Magnoliopsida	Lamiales	Gypsywort	*Lycopus europaeus*	1	24/11/2020	B2.2	53.2166539, -2.907784	///Linen.Visual.Juror	Fixed Quadrat	1	1 m^2	wetland	Clear / wet						

Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	2	24/11/2020	B2.2	53.2150002, -2.9085147	///vivid.detail.email	Fixed Quadrat	7	$1m^2$	fertile and wetland	Clear / wet						
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	1	24/11/2020	B2.2	53.213453, -2.908595	///paying.beard.logs	Fixed Quadrat	8	$1m^2$	fertile and wetland	Clear / wet						
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	1	24/11/2020	B5	53.215677, -2.907667	///Hill.Decay.Rider	Fixed Quadrat	5	$1m^2$	fertile and wetland	Clear / wet						
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	1	24/11/2020	B5	53.215524, -2.907175	///encounter.snail.couple	Fixed Quadrat	6	$1m^2$	fertile and wetland	Clear / wet						
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	1	24/11/2020	B5	53.2134611, -2.9082532	///spring.boats.pass	Fixed Quadrat	9	$1m^2$	fertile and wetland	Clear / wet						
Mammalia	Lagomorpha	European Rabbit	*Oryctolagus cuniculus*	1	24/11/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$1m^2$		Clear / wet		11°C				
Clitellata	Haplotaxida	Common Earthworm	*Lumbricus terrestris*	4	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2m^2$		Cloudy	4°C		Midday			

Diplopoda	Polydesmida	Polydesmus sp	*Polydesmus*	5	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C		Midday			
Gastropoda	Stylommatophora	Brown-banded Arion	*Arion circumscriptus*	5	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C		Midday	Juvenile		
Gastropoda	Stylommatophora	Brown-Lipped Snail	*Cepaea nemoralis*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C	18 °C	Midday	Adult		
Gastropoda	Stylommatophora	Chocolate Arion	*Arion rufus*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C	18 °C	Midday	Neonate		
Gastropoda	Stylommatophora	White Lipped Snail	*Cepaea hortensis*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C		Midday	Adult		
Insecta	Hymenoptera	Aphididae	Aphididae	3	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C		Midday	Larva		
Insecta	Coleoptera	Click Beetle	*Agriotes*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	$2 m^2$		Cloudy	4 °C		Midday	Larva		

Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	varied	Cloudy	4°C		Midday			
Magnoliopsida	Lamiales	Common Hemp-Nettle	Galeopsis tetrahit	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	fertile	Cloudy	4°C		Midday			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	meadow	Cloudy	4°C	4°C	Midday			
Magnoliopsida	Caryophyllales	Curled Dock	*Rumex crispus*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	varied	Cloudy	4°C		Midday			
Magnoliopsida	Rosales	Common Silverweed	*Potentilla anserina*	1	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	fertile	Cloudy	4°C		Midday			
Magnoliopsida	Lamiales	Gypsywort	*Lycopus europaeus*	14	27/11/2020	B2.2	53.2166539, -2.907784	///linen.visual.juror	Fixed Quadrat	1	2m²	wetland	Cloudy	4°C		Midday			
Mammalia	Rodentia	Bank Vole	*Myodes glareolus*	1	27/11/2020	B5	53.212993, -2.908041	///flood.photos.game	N/A	N/A	N/A				11°C				

Insecta	Coleoptera	Cantharis rufa	*Cantharis rufa*	1	04/12/2020	B2.2	53.215833, -2.908056	///tooth.trunk.hurls	N/A	N/A	N/A		Cloud and light rain	4°C		Morning	Gall		
Insecta	Diptera	*Ceasar green bottle fly*	*Lucilia caesar*	1	04/12/2020	B5	53.215630, -2.907626	///exams.items.areas	N/A	N/A	N/A		Cloud and light rain	4°C		Morning	Gall		
Insecta	Diptera	Circopotus (Mosquito)		1	04/12/2020	B2.2	53.216074, -2.907550	///crib.hangs.scouts	N/A	N/A	N/A		Cloud and light rain	4°C		Morning	Galls		
Insecta	Diptera	Circopotus (Mosquito)		1	04/12/2020	B2.2	53.215820, -2.097737	///yard.scar.coach	N/A	N/A	N/A		Cloud and light rain	4°C		Morning	Gall		
Magnoliopsida	Apiales	Cow Parsley	*Anthriscus sylvestris*	7	04/12/2020	J2.3.1	53.213633, -2.909123	///vibe.found.skills	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Apiales	Cow Parsley	*Anthriscus sylvestris*	4	04/12/2020	J2.3.1	53.213667, -2.909124	///dollar.wins.trendy	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Apiales	Cow Parsley	*Anthriscus sylvestris*	1	04/12/2020	B2.2	53.216223, -2.907527	///slim.honest.comical	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B2.2	53.216665, -2.907076	///bricks.sock.goat	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.2166621, -2.9070348	///sentences.bugs.dairy	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.2166240, -2.9070231	///cares.salad.race	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B5	53.2164967, -2.9070992	///stores.zones.forgot	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	6°C	Morning			

Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	7	04/12/2020	B5	53.2163788, -2.9069822	///woven.relate.acting	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	9°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	4	04/12/2020	B5	53.2162855, -2.9071381	///hints.knots.making	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	9°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	4	04/12/2020	B5	53.2164391, -2.9073506	///item.leader.alien	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	9°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	22	04/12/2020	B5	53.215987, -2.907306	///spicy.teach.itself	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	9°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B5	53.215630, -2.907626	///exams.items.areas	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	9°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.2166378, -2.9069912	///brush.jets.potato	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	8°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	3	04/12/2020	B2.2	53.2164955, -2.9075836	///chairs.trucks.belly	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	8°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	12	04/12/2020	B2.2	53.2161937, -2.9076135	///bubble.hood.jokes	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	8°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	3	04/12/2020	B2.2	53.216257, -2.907688	///stored.milk.riders	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	8°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B2.2	53.216380, -2.907510	///fuel.event.affair	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	11°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	3	04/12/2020	B2.2	53.216167, -2.907358	///author.trash.armed	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	11°C	Morning			

Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.216074, -2.907550	///crib.hangs.scouts	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	11°C	Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B2.2	53.216039, -2.907705	///envy.outfit.brief	N/A	N/A	N/A	fertile	Cloud and light rain	4°C	11°C	Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.215870, -2.907625	///spicy.making.tested	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning			
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	5	04/12/2020	B2.2	53.215820, -2.907737	///yard.scar.coach	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	2	04/12/2020	B2.2	53.215728, -2.907732	///item.props.doll	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	4	04/12/2020	B2.2	53.215658, -2.907799	///oven.call.lock	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning	Sapling		
Magnoliopsida	Asterales	Creeping Thistle	*Cirsium arvense*	1	04/12/2020	B2.2	53.215575, -2.907794	///burst.able.relay	N/A	N/A	N/A	fertile	Cloud and light rain	4°C		Morning	Sapling		
Magnoliopsida	Rosales	European Bramble Complex	*Complex Rubus fruticosus*	5	04/12/2020	B2.2	53.215046, -2.908068	///themes.work.bucks	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Rosales	European Bramble Complex	*Complex Rubus fruticosus*	1	04/12/2020	B2.2	53.215032, -2.908410	///grit.call.legend	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Rosales	European Bramble Complex	*Complex Rubus fruticosus*	2	04/12/2020	B2.2	53.214886, -2.908473	///heads.almost.renew	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Gentianales	Fen Bedstraw	*Galium uliginosum*	5	04/12/2020	B2.2	53.214841, -2.908619	///quench.jacket.spell	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			

Magnoliopsida	Lamiales	Germander Speedwell	*Veronica chamaedrys*	27	04/12/2020	B5	53.214320, -2.907992	///slam.puzzle.create	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Lamiales	Germander Speedwell	*Veronica chamaedrys*	47	04/12/2020	B5	53.213713, -2.908161	///icons.ankle.boat	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Fabales	Hairy Tare	Vicia hirsuta	1	04/12/2020	J2.3.1	53.213067, -2.909315	///taking.worker.riches	N/A	N/A	N/A	hedge	Cloud and light rain	4°C		Morning			
Magnoliopsida	Ericales	Orange Balsam	Impatiens capensis	3	04/12/2020	B5	53.2162961, -2.9071810	///catch.couches.pipes	N/A	N/A	N/A		Cloud and light rain	4°C		Morning			
Magnoliopsida	Ericales	Orange Balsam	Impatiens capensis	2	04/12/2020	J2.3.1	53.213203, -2.909283	///text.tone.bugs	N/A	N/A	N/A	hedge	Cloud and light rain	4°C		Morning			
Magnoliopsida	Apiales	Wild Angelica	Angelica sylvestris	2	04/12/2020	B5	53.216273, -2.907202	///frogs.silver.point	N/A	N/A	N/A	hedge			11°C				
Magnoliopsida	Rosales	European Bramble Complex	*Complex Rubus fruticosus*	1	04/12/2020	B2.2	53.214847, -2.908509	///wink.grace.bikes	N/A	N/A	N/A	wetland	Cloud and light rain	4°C		Morning			
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	1	04/12/2020	J2.3.1	53.213583, -2.909131	///stage.fuzzy.alone	N/A	N/A	N/A	hedge	Cloud and light rain	4°C	9°C	Morning			
Magnoliopsida	Apiales	Hogweed	*Heracleum sphondylium*	6	04/12/2020	B2.2	53.215112, -2.908475	///late.maple.tent	N/A	N/A	N/A	hedge	Cloud and light rain	4°C	7°C	Morning			
Arachnida	Araneae	Common Candy-Striped Spider	*Enoplognatha ovata*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	2m²		Complete cloud cover	3°C		Morning			

Arachnida	Araneae	European Nursery Web Spider	*Pisaura mirabilis*	3	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Aves	Passeriformes	European Robin	*Erithacus rubecula*	1	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$2 m^2$		Complete cloud cover	3 °C		Morning			
Bryopsida	Hypnales	Rough-stalked Feather Moss	*Brachythecium rutabulum*	6	07/12/2020	B5	53.2164238, -2.9072400	///intelligible.splash.trim	Fixed Quadrat	2	$2 m^2$		Complete cloud cover	3 °C		Morning			
Bryopsida	Hypnales	Rough-stalked Feather Moss	*Brachythecium rutabulum*	12	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Clitellata	Haplotaxida	Common Earthworm	*Lumbricus terrestris*	2	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$2 m^2$		Complete cloud cover	3 °C		Morning			
Clitellata	Haplotaxida	Common Earthworm	*Lumbricus terrestris*	5	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Diplopoda	Julida	Cylindroiulus caeruleocinctus	*Cylindroiulus caeruleocinctus*	2	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			

Diplopoda	Polydesmida	Polydesmus sp	*Polydesmus*	3	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	2 m^2		Complete cloud cover	3 °C		Morning			
Diplopoda	Polydesmida	Polydesmus sp	*Polydesmus*	1	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	2 m^2		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	Brown-banded Arion	*Arion circumscriptus*	1	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	2 m^2		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	Brown-Lipped Snail	*Cepaea nemoralis*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	2 m^2		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	Kentish Snail	*Monacha cantiana*	2	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	2 m^2		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	Kentish Snail	*Monacha cantiana*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	2 m^2		Complete cloud cover	3 °C	7 °C	Morning			
Gastropoda	Stylommatophora	Milk Slug	*Deroceras reticulatum*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	2 m^2		Complete cloud cover	3 °C	8 °C	Morning			

Gastropoda	Stylommatophora	Milk Slug	*Deroceras reticulatum*	1	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$2 m^2$		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	White Lipped Snail	*Cepaea hortensis*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Gastropoda	Stylommatophora	White Lipped Snail	*Cepaea hortensis*	2	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$2 m^2$		Complete cloud cover	3 °C		Morning			
Insecta	Coleoptera	Click Beetle	*Agriotes*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Insecta	Hymenoptera	Common Carder Bee	*Bombus pascuorum*	29	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2 m^2$		Complete cloud cover	3 °C		Morning			
Liliopsida	Poales	Cock's-foot	*Dactylis Glomerata*	2	07/12/2020	B5	53.2164238, -2.9072400	///intelligible.splash.trim	Fixed Quadrat	2	$2 m^2$	wetland	Complete cloud cover	3 °C		Morning			
Liliopsida	Poales	Soft Rush	*Juncus effusus*	21	07/12/2020	B5	53.2164238, -2.9072400	///intelligible.splash.trim	Fixed Quadrat	2	$2 m^2$	wetland	Complete cloud cover	3 °C		Morning			

Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	07/12/2020	B5	53.216025, -2.907805	///gender.cakes.rival	Fixed Quadrat	3	$2m^2$	varied	Complete cloud cover	3°C	6°C	Morning			
Liliopsida	Poales	Yorkshire Fog	*Holacus lanatus*	1	07/12/2020	B2.2	53.2157653, -2.9082773	///diner.slate.voices	Fixed Quadrat	4	$2m^2$	varied	Complete cloud cover	3°C	-1°C	Morning			

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