GREAT DIXTER

Invertebrate Survey 2016/2017

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LOTTERY FUNDED

Bombylius major

Scaeva pyrastri

Pholidoptera griseoaptera

Platyrhinus resinosus

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Polygonia c-album

Corizus hyoscyami

Orgyia antiqua

Anax imperator

Hypositticus pubescens

Cauchas rufimitrella

Osmia bicornis

Ectemnius continuus

Contents

Volucella pellucens

Summary

An invertebrate survey of the Great Dixter Estate, Northiam, East Sussex was undertaken between August 2016 and September 2017, part funded by the Heritage Lottery Fund, as a contribution to the Great Dixter Biodiversity Audit.

Over 1890 records of 676 species were recorded throughout the estate. Of the 676 species recorded 274 (40%) were pollinators. In the formal gardens 60% of all species recorded were pollinators.

Recent research has shown a decline in pollinators within the British countryside. This will have a dramatic effect on agriculture and conservation if this decline is not halted. The loss of flower-rich meadow, hedgerows and woodland edge, the use of pesticides and other changes in agriculture are the main causes. Great Dixter Estate is without doubt an outstanding example of the role horticulture and traditional meadow, orchard & coppice management can play in pollinator conservation.

Over 150 species of aculeate (bees, wasps & ants) were recorded. In total 90 species of bee, including 12 bumblebee species were found. Also 63 species of hoverfly were recorded as well as 112 spider species, and a beetle new to Sussex.

12 nationally rare and 47 nationally scarce species were recorded, including two nationally endangered species of mining bee, the **white-bellied mining bee** (*Andrena gravida*) and the **oak mining bee** (*Andrena ferox*).

A rich and diverse pollen and nectar resource was present within the gardens, meadows, woodland edge & coppice coups. A diverse array of invertebrate nesting and breeding habitat was also present including log piles, stumps, wooden posts, ground nesting space and sandstone walls all contributing to the number and diversity of pollinators present.

Despite the rich invertebrate fauna recorded during the survey there is still potential to improve the site for invertebrate conservation and this work needs to be studied with ongoing invertebrate monitoring to ensure its success.

1. Introduction

Great Dixter House & Gardens is a world renowned public garden known for its horticultural excellence, especially for its creative and colourful naturalistic mixed planting. The Great Dixter Estate lies within East Sussex, UK, near the Kent border. The Estate includes the famous formal gardens, the 15th century Great Dixter House, an old orchard, areas of semi-natural flower-rich meadows, sheep pasture and deciduous ancient coppiced woodland. Three ponds are present within the gardens as well as some temporary standing freshwater in Weights Wood and other areas throughout the Estate.

The Estate sits within the High Weald Area of Outstanding Natural Beauty and as such is influenced by the complex underlying geology of mainly Early Cretaceous sands and clays that make up the Wealden Group. This produces a mix of some quite dry sandy soils and wetter areas of heavy clay soils.

Until recently little was known about the gardens invertebrate fauna, except for macro moths, butterflies, spiders and bumblebees. Moth trapping surveys have been carried out over a number of years by Jim Winter and the late Tony Harman. Tony Russell-Smith has been leading a number of spider surveys by British Arachnological Society members in recent years. Bumblebee transects have been undertaken recently by Nikki Gammans, Catherine Haydock & Sarah Seymour, and butterfly transects carried out by Claire Williamson and Graham Tippen within the gardens and Weights Wood. The occasional recording days by invited entomologists have also been organised but no formal professional invertebrate survey had been undertaken of the site until now.

An all taxa biodiversity audit is currently being undertaken, funded by a Heritage Lottery Fund (HLF) grant, and this survey is a contribution to the project. The original survey was started in August 2016 and the core field surveys completed by September 2017, so a full year of recording was undertaken but focussed mainly between March 2017 and September 2017. A pitfall trapping survey was undertaken by the author, Tony Russell-Smith and Norman Heal of a number of the survey areas within the gardens during March-October 2016. This pitfall data has been combined with the walkover surveys and published in this document.

Bombylius major

2. Survey Methodology

The survey was predominantly designed as a series of walkover surveys using beating, sweeping and direct observation within defined survey areas during a timed 1 hour field survey once a month between March-September. This allows a level of comparability if the survey is repeated in the future, although due to the complexity of factors that influence invertebrate populations there are many layers of uncertainty present when using this data for accurate comparison between survey areas and/or changes over time.

The main objective of this methodology is to sample the dominant habitat resources within each survey area and describe the invertebrate assemblages present within each resource. This provides a concise snapshot of the dominant invertebrate assemblages within the site and will efficiently identify the key invertebrate groups that characterise the habitats present and provide a focus for continued monitoring and management. This methodology has been used effectively for over twenty years on a number of invertebrate survey projects by the author and as part of a team of invertebrate specialists including Mike Edwards, Peter Hodge, Graham Collins and Graeme Lyons (Edwards, M. 2006).

One of the key weaknesses of this methodology is that it does not effectively sample detritivore and detritivore predator assemblages present in plant litter, moss, humus and very short prostrate ground layer vegetation. This can be rectified somewhat by incorporating vacuum sampling, sieving and/or pitfall trapping into the survey. Pitfall trapping also having the advantage of sampling nocturnally active invertebrates. Also sampling of freshwater habitat using pond nets or kick nets needs to be incorporated if the site has standing or running freshwater habitat present.

The combination of the pitfall data from 2016 and the walkover & pond surveys during 2016-2017 provided a more complete picture of all key habitat resources present within the survey sites.

Weather has a considerable influence on the data produced from walkover surveys so field surveys were only carried out within a very narrow range of weather conditions. Survey dates were chosen only when the cloud cover was 50% light cloud coverage or less, the wind speed was 8-12 mph or less, and there was zero precipitation. The temperature during the March and April surveys needed to be 10℃ or greater, and during May - September the temperature required being 15℃ or greater. Only during one survey date, 22nd June 2017, did the weather became unsuitable for survey while on site and had to be abandoned.

2.1. Survey Areas

Ten survey areas were chosen to survey. The survey areas were defined via natural boundaries, habitat and management. The survey areas chosen were considerably unique in terms of size and habitat type. As specified above the objective was not to compare survey areas but to describe the habitat resources and invertebrate assemblages within each survey area. A brief description of each survey area, site centroid grid reference and survey methods used is given below.

2.1.1. Formal Gardens (FG)

Long Border

Grid Reference: **TQ 81973 25124**

Survey methods used: **Walkover survey, aquatic sampling.**

This is the largest of the survey areas and consists of the formal ornamental gardens, Great Dixter House & buildings, nursery and car parks. This survey area contains the greatest diversity of habitat resources including cultivated mixed beds, standing freshwater, log piles, sandstone walls, semi-natural meadow, ornamental scrub, trees & hedges as well as buildings and man made structures. The survey time was doubled to two hours per survey for this area due to the larger size of the survey area as well as extra time spent talking to interested visitors to the gardens.

2.1.2. Orchard (OR)

Orchard

Grid Reference: **TQ 81967 25050**

Survey methods used: **Walkover survey.**

The Orchard consists of an area of neutral semi-natural flower rich meadow with mature pear *(Pyrus)*, apple (*Malus*) and cherry (*Prunus*) fruit trees. The top edge of the Orchard survey area is bordered by an old sandstone wall (TQ 81949 25105), which is crumbling in places and is heavily vegetated with naturalised plants, including Mexican fleabane (*Erigeron karvinskianus*), which provides a valuable pollen and nectar resource. Adjacent to the wall, and included in the survey area, is Upper Moat (TQ 81940 25106), once an area of standing freshwater which is now filled in. This area produces a dense display of dandelions in early spring which is especially valuable to early spring mining bees.

2.1.3. Horse Pond & Quarry (HP)

Grid Reference: **TQ 82039 25138**

Survey methods used: **Aquatic sampling.**

The Horse Pond is the largest body of standing freshwater within the gardens. This semi-natural pond has a large display of *Gunnera tinctoria* on one side and a sizeable area of the open water is decorated by water-lilies. Adjacent to the pond is an old quarry where marshy vegetation has developed.

Horse Pond

2.1.4. Prairie (PR)

Grid Reference: **TQ 82084 25100**

Survey methods used: **Walkover survey, pitfall traps.**

The Prairie is an area of slightly acidic semi-natural meadow, the central zone being quite marshy due to a seepage and drain. This meadow has a distinctly different nature to the other meadows present within the Orchard, New Meadow and Plant Fair Field, growing quite tall with grasses in late summer and autumn. The meadow has an excellent mixed woodland edge on its border (TQ 82075 25120), containing oaks (*Quercus robur*), pine (*Pinus sylvestris*) and gorse (*Ulex europaeus*). The meadow is accessed from the gardens and Horse Pond via a damaged and compacted path (TQ 82027 25120), which is the best area of open bare ground for nesting aculeates within the gardens.

Prairie

2.1.5. New Meadow (NM)

Grid Reference: **TQ 81906 24972**

Survey methods used: **Walkover survey, pitfall traps.**

The New Meadow is a recently created area of flower rich neutral meadow bordered on one side by woodland edge and the other by a fence and hedge. The sward stays quite short in spring providing space for ground nesting mining bees. The bottom end of the meadow is more nutrient rich and humid with a sheltered corner (TQ 81862 24936) of sprawling bramble (*Rubus fruticosus*).

New Meadow

2.1.6. Plant Fair Field (PF)

Plant Fair Field

Grid Reference: **TQ 81862 25024**

Survey methods used: **Walkover survey, pitfall traps.**

Plant Fair Field is a legume rich area of meadow and is the best structured grassland of all the meadows. The stall posts used for the Great Dixter Plant Fairs, as well as two log piles, provides an excellent dead wood nesting resource. The north facing woodland edge (TQ 81846 25004) is exceptional providing a humid but warm & partially sunlit, sheltered edge which during June and July produces a wide dense display of hogweed flowers (*Heracleum sphondylium*) amongst the stall posts. The top edge of the meadow (TQ 81882 25043) appears to be the most drought affected area of grassland within all the meadows and contains yellow meadow ant (*Lasius flavus)* nests providing lots of ground nesting space and one of the best areas of ragwort (*Senecio jacobaea*) and other yellow Asteraceae within the meadows.

2.1.7. Bottom Field (BF)

Bottom Field

Grid Reference: **TQ 81760 24910**

Survey methods used: **Walkover survey, pitfall traps.**

This large sheep pasture consists of quite a species poor mesotrophic grassland with large patches of white clover (*Trifolium repens*) and creeping thistle (*Cirsium arvense*). The lower third of the pasture is more species rich with patches of bird's-foot trefoil (*Lotus corniculatus*), red clover (*Trifolium pratense*) and tufted vetch (*Vicia cracca*). At the top border of the survey area is a large bank of sand spoil (TQ 81816 24985), deposited during the production of the main car park surface. Unfortunately the bank is shaded by a dense area of creeping thistle, nettle and dock, otherwise this south facing bank could be an excellent resource for ground nesting invertebrates. The lower border of the pasture is a sheltered area of woodland edge (TQ 81678 24863) containing sallow, oak, field maple, hazel, ash and sprawling bramble.

2.1.8. Farm (FA)

Farm Pond

Grid Reference: **TQ 81989 25323**

Survey methods used: **Walkover survey (part year).**

The farm survey area consists of a small area of legume rich meadow, part of which is being used for management experiments. A bee hotel and log pile (TQ 81983 25319) is also present as well

some small cultivated mixed borders and the farm and educational buildings. Also present is a heavily silted and shaded pond (TQ 81986 25270) adjacent to a small area of grassland which has twig piles and large wooden posts present, providing some excellent dead wood and stem nesting resource.

2.1.9. Weights Wood (WW)

Grid Reference: **TQ 82331 25760**

Survey methods used: **Walkover survey (part year), pitfall traps.**

Weights Wood is an area of ancient deciduous coppice woodland. The two areas of recently worked coppice were the main focus for survey. The main gate and entrance (TQ 82555 25760) to the wood also contains an interesting area of scrubby sheltered edge.

Weights Wood Coppice

2.1.10. Four Acre Shaw (4A)

Grid Reference: **TQ 81776 24775**

Survey methods used: **Pitfall traps.**

This small thin area of ancient deciduous coppice woodland was only surveyed as part of the pitfall trapping survey. The coppice is quite old and heavily shaded with little ground flora and open sunlit clearings. The shaw edge was surveyed as part of the Bottom Field, New Meadow and Plant Fair Field survey areas.

Upper Moat & sandstone wall

2.2. Taxa Surveyed

The majority of the major invertebrate groups were recorded during the survey. A summary of each of the key invertebrate groups surveyed is outlined below.

2.2.1. Hymenoptera

Eucera longicornis

This is the second most speciose group of insects within the UK with over 6700 species recorded. It is a taxonomically complex, and now considered to be the most globally speciose group of insects, characterised by the presence of two pairs of membranous wings with relatively reduced venation, which are held together in many species by a row of hooks on the hind wings. A number of species groups though have reduced or absent wings, the most well known being the worker caste of ants.

The order is split into two divisions, the Symphyta (sawflies), which are predominantly phytophagous (plant-eating) wasps that do not have 'waisted' abdomens and have caterpillar like larvae with true legs and 6+ pairs of prolegs.

The larger division is the Apocrita, which includes bees, solitary wasps, social wasps and ants as well as the parasitoid wasps, gall wasps and smaller families of micro-hymenoptera. These insects are characterised by their 'waisted' gasters. The true abdomen of the Apocrita also incorporates the last segment of the thorax. This is why the 'thorax' of Apocrita is referred to as the mesosoma and the 'abdomen' as the metasoma or gaster. The larvae of Apocrita are more maggot like with no obvious legs. (Goulet, H. & Huber, J.T. 1993)

The parasitoid wasps are one of the most ecologically important groups of insects due to their role in influencing populations of predominantly holometabolous insects. Predators and especially parasitoids balance phytophagous insect populations fine tuning the solar/plant/insect engine that powers energy flow within most of the planet's terrestrial ecosystems. (Quike, D.L.J. 2015)

A further subdivision of the Apocrita is the Aculeate Hymenoptera. This subdivision includes the familiar bees, wasps and ants. Aculeates have an ovipositor that has been adapted into a sting for predatory or defensive use rather than for depositing or injecting eggs as in the parasitoid wasps. The aculeates include some of the most important groups of pollinator insects. Bees have completely abandoned the predator strategies of their wasp ancestry and specialise in harvesting pollen as a protein rich food store for their larvae. Bees therefore move large quantities of pollen within a pollen and nectar resource providing a key role in pollinating herbaceous plants, crops, flowering scrub and fruit trees.

Hymenoptera are predominantly surveyed by sweeping of vegetation with a net, direct observation, and collection of specimens in flight, on flowers or at nest sites. Ichneumonids, other parasitoid wasps and gall wasps require rearing from hosts or galls or the use of light traps and Malaise traps, which are particularly effective at catching parasitoid Hymenoptera.

			
Bumblebees	*Mining Bees*	*Leafcutter Bees*	*Nomad Bees*
			
Social Wasps	*Digger Wasps*	*Spider Hunting Wasps*	*Potter Wasps*
			
Jewel Wasps	*Ichneumonid Wasps*	*Sawflies*	*Ants*

2.2.2. Coleoptera

Platystomos albinus

Beetles are one of the most speciose and diverse group of insects on the planet. Their diversity is centred on the tropics and subtropics where beetle diversity can be staggering. Nearly 400,000 species have been described and the current estimate for the possible number of beetles on the planet is between 1-2 million species.

Beetles are characterised by the hardened forewings called elytra, although some species such as the soldier beetles have soft elytra or reduced elytra such as the rove beetles. The most speciose group of beetles are the weevils which are predominately plant eating and have an elongated rostrum (the section of the head between the eyes and the mouthparts). Many weevils are highly specialised and adapted to their particular food plants physical and chemical defences, so many weevils are restricted by the distribution of their food plant or food plant group.

In Britain there are over 4000 beetle species recorded. Coleoptera is a very diverse group of insects with many phytophagous and predatory species, as well as species groups that occupy almost any habitat resource such as water beetles, dung beetles, saproxylic (dead wood & fungi feeding) beetles, species that live in ants nests & bird nests and even parasitic species. Some families of beetles are also important pollinators such as long-horn beetles, pollen beetles and some soldier beetles. Ladybirds are also well known for their control of aphids, being welcome in gardens, although some phytophagous beetles such as leaf beetles are serious pests of crops and garden plants.

Beetles are recorded mainly by beating of scrub and low branches of trees, or the sweeping of vegetation with a net. Ground beetles and other ground dwelling species can be effectively recorded with the use of pitfall traps or by vacuum sampling. Aquatic beetles require the use of a pond net for standing freshwater or a kick net in running water.

Weevils

Leaf Beetles

Long-horn Beetles

Cardinal Beetles

2.2.3. Diptera

Choerades marginatus

The two-winged flies are the most speciose group of insects in Britain with about 7000 recorded. A few families of two-winged flies are important pollinators such as the well known hoverflies, soldierflies and tachinids. Many hoverflies have predatory larvae that feed on aphids and other small Hemiptera so are another group important in the control of crop and garden pests.

The two-winged flies are characterised by only having one pair of membranous wings. The hind wings of Diptera are greatly reduced and modified to form halteres, predominantly used for balance during flight. They are quite a diverse group utilising many food sources such as dung, dead & decaying animal matter, nectar, pollen and fungi. Some groups such as mosquitos and horse-flies are hematophages, feeding on blood, and some are parasitoids of lepidoptera and hymenoptera larvae such as Tachinidae species. There are also some true parasitic species such as bot-flies and louse-flies. (A true parasite feeds off a living host usually doing little harm to the host. Parasitoids kill their hosts either immediately when they hatch, called idiobiont parasitoids, or allow the host to feed for a while to grow and then kill the host, these are kionobiont parasitoids.)

Diptera are predominantly surveyed by sweeping of vegetation with a net, direct observation & collection of specimens on flowers or other habitat resources. Leaf-miners require rearing from mines collected in the field and parasitoids need rearing from hosts. As with other orders of insect light trapping can also be effective.

Hoverflies

Horseflies

Robberflies

Soldierflies

2.2.4. Lepidoptera

Vanessa atalanta

Butterflies and moths are another very speciose group of insects with nearly 60 species of butterfly and over 2500 species of moth recorded in Britain. They are characterised by the two pairs of scale covered wings. The exception being the clearwings which have reduced scales exposing areas of clear membranous wing, and the females of some moth species have greatly reduced or absent wings.

The wings of most moth species are held together in flight by a long bristle on the hind wing, called the frenulum, which attaches to a row of hooks on the forewings. Butterflies do not have these structures and their wings are loosely held together by overlapping the fore and hindwings.

Lepidoptera are almost exclusively phytophagous, and all parts of a plant are exploited. Some species have root feeding larvae, other species eat the stems or leaves and some species feed on seed heads. Some families of micro moths are leaf miners while others feed on lichens. Some moth species are saproxylic, usually feeding under bark. Amongst the exceptions to this phytophagous strategy are species that feed on the keratin within the hairs of dead animals and would be considered scavengers.

Butterflies are mainly surveyed either by direct observation in the field, or from recording larvae by beating and sweeping. Moths are recorded predominately through the use of light traps or from recording larvae by beating and sweeping. Micro moths can also be effectively surveyed by sweeping and beating and leaf-miners reared from collected mines.

Butterflies

Moths

2.2.5. Hemiptera

Palomena prasina

Hemiptera are the fifth largest insect order in Britain with nearly 2000 species described. The order is divided into three main divisions or suborders, the Hemiptera:Heteroptera, the Hemiptera:Auchenorrhyncha, and the Hemiptera:Sternorrhyncha.

The Heteroptera include shield bugs, mirid bugs, squash bugs, assassin bugs and the water bugs. These insects are characterised by the hardened basal section of the forewing, called the corium and embolium, and the membranous outer section of the forewing. The piercing needle shaped mouthparts are also a characteristic feature of Hemiptera. This enables phytophagous species to feed on plant sap and predatory species to feed on their prey. A small number of species are also hematophages feeding on blood, such as the bedbugs (*Cimex* spp.).

The Auchenorrhyncha include the leafhoppers, planthoppers and froghoppers. These insects are predominantly phytophagous sometimes feeding on a narrow range of food plants or specialised on one food plant species, which can aid in identification.

The Sternorrhyncha include the aphids, psyllids and scale insects. This suborder includes many pests of garden plants, but are also a key prey resource for many predatory Hymenoptera, Diptera, Coleoptera and Neuroptera.

This order is mainly collected through sweeping and beating of vegetation, but many species are also nocturnally active coming to light traps.

Squashbugs

Rhophalid Bugs

Shieldbugs

Mirid Bugs

2.2.6. Odonata

Aeshna cyanea

The dragonflies and damselflies are a readily identifiable order of large aquatic insects. This is a small order of insects with about 57 species recorded from Britain, but it is a very well studied group due to the ease of observation and identification in the field. These insects are all predatory both in the aquatic larval stage and the adult stage.

Dragonflies and damselflies are easily recorded in the field either hunting over water bodies, amongst woodland edge or resting on tall vegetation. Larvae can also be found and identified by aquatic insect sampling with a pond net.

Dragonflies

Damselflies

2.2.7. Orthoptera

Leptophyes punctatissima

This is a small but distinctive order with about 28 breeding species of grasshoppers, bush-crickets, groundhoppers and crickets in Britain as well as a number of other introduced and vagrant species. This order is characterised by the long thin forewing with dense venation (some species have greatly reduced wings) and the use of territorial stridulation (song), except for the groundhoppers which do not stridulate. Grasshoppers use stridulating pegs on their hind-legs to sing, whereas crickets and bush-crickets use the roughened patches on the base of their forewings to stridulate.

Orthoptera can be found by sweeping and beating but the best way to record many of these insects is through their song which can be distinctive for each species.

Grasshoppers

Bush-crickets

Groundhoppers

2.2.8. Araneae

Araneus quadratus

Spiders are a relatively large order with over 650 British species, many of which are within the family Linyphiidae (money spiders). The head and thorax of a spider are fused to form the cephalothorax and 1-4 pairs of spinnerets are present at, or near, the tip of the abdomen. Spiders use silk in many different ways, to create prey traps, to form protective retreats and to create egg sacs. Reproduction is carried out using secondary sexual organs, palpal organs (adapted from mouthpart appendages) are used by the male to inseminate the female through the epigyne, a hardened highly specialised structure under the female abdomen. These structures are highly specific and microscopic examination of the palps and epigyne is required to identify most spider species. All spiders are predatory and either hunt through web traps, ambush or actively hunt by sight or use the very fine sensitive hairs (trichobothria) on their legs to detect airborne vibrations caused by their prey. (Foelix, R.F. 2011)

Spiders are best recorded by beating, sweeping, grubbing and pitfall trapping.

Jumping Spiders

Crab Spiders

Wolf Spiders

Orbweavers

2.2.9. Smaller Orders

A number of smaller invertebrate groups were also recorded including **Acari** (mites), **Opiliones** (harvestmen), **Dermaptera** (earwigs), **Neuroptera** (lacewings), **Mecoptera** (scorpion-flies), **Chilopoda** (centipedes), **Diplopoda** (millipedes), and **Isopoda** (woodlice).

3. Results

Over 1890 records of 676 species were recorded during the survey. A breakdown of the species records is outlined in table 1. In total 5 UKBAP species, 12 nationally rare and 47 nationally scarce species were recorded, as well as three newly colonised species.

3.1. Breakdown of records and species with conservation designations

It must be noted that the invertebrate fauna of the British Isles has gone through a considerably dynamic period over the last 20-30 years with many new species being found in the UK for the first time (e.g. tree bumblebee *Bombus hypnorum*), previously scarce and restricted species expanding greatly in distribution and abundance (e.g. Roesel's bush-cricket *Metrioptera roeselii*), and highly specialised species expanding habitat range, food plant and prey choice (e.g. box bug *Gonocerus acuteangulatus*). Also some common species have shifted distribution becoming more common in the North and less frequent in the South (e.g. Norwegian wasp *Dolichovespula norwegica*), and some once widespread species have become scarce and restricted including species that have become confined to a few coastal regions (e.g. long-horned bee *Eucera longicornis* & potter flower bee *Anthophora retusa*).

Many of the conservation designations for invertebrates have not been updated for many years. The main revisions for many invertebrate groups occurred in 1987 and 1991 and conservation designations are long overdue for revision although a number of invertebrate groups are currently in the process of revision.

The list below outlines the conservation designations used in the report.

Conservation Designations

- **UKBAP** - A species listed as a priority for conservation in the UK Biodiversity Action Plan. These are species that are endemic to the UK, significantly restricted to the UK and the Northern European Atlantic Biogeographical Region, UK supports internationally important populations of the species and/or species that have shown a serious and rapid decline over the last few decades.
- **RDB1/RedList GB Pre94 - Endangered** - Nationally endangered species that are greatly restricted to a very small number of sites. These are species at most risk of becoming extinct in the UK.
- **RDB2/RedList GB Pre94 - Vulnerable** - Nationally vulnerable species that are also greatly restricted in the UK to a very small number of sites but not at immediate risk of extinction.

- **RDB3/RedList GB Pre94 - Rare** - Nationally rare species that are restricted to usually less than sixteen 10km UK grid squares.
- **RDBK/RedList GB Pre94 - Insufficiently known** - Greatly restricted species but not enough information is available to place into one of the above RDB categories.
- **Nationally Scarce/Nationally Scarce A/Nationally Scarce B** - Previously referred to as Notable A and Notable B these designations are given to species that have been recorded within 16-30 10km grid squares (Notable A/Nationally Scarce A) or 31-100 10km grid squares (Notable B/Nationally Scarce B).

The following breakdown of species records should therefore be viewed in the context that many of these species need conservation designation revision. The habitat resource assemblages section highlights the species and species assemblages that should be considered of conservation priority within the Great Dixter Estate as well as some species that are common but characteristic of the invertebrate fauna of each habitat resource.

List of survey areas with area code:

FG - Formal Gardens
OR - Orchard
HP - Horse Pond & Quarry
PR - Prairie
NM - New Meadow
PF - Plant Fair Field
BF - Bottom Field
FA - Farm
WW - Weights Wood
4A - Four Acre Shaw

Table 1. Number of species recorded for each survey area.

	All Areas	FG	OR	HP	PR	NM	PF	BF	FA	WW	4A
All Species	**676**	**271**	106	45	162	145	**240**	137	43	121	36
Aculeates (Bees, Wasps & Ants)	**154** (22.8 %)	**91**	42	7	37	27	**65**	29	14	18	2
Coleoptera (Beetles)	**139** (20.6 %)	26	2	3	18	**43**	37	16	2	**41**	15
Araneae (Spiders)	**112** (16.6 %)	24	3	8	**37**	22	**31**	16		28	10
Diptera (Two-winged Flies)	**90** (13.3 %)	**51**	26	6	16	15	**44**	17	7	8	1
Lepidoptera (Moths & Butterflies)	**70** (10.4 %)	**31**	14	4	25	14	**28**	23	11	11	1
Hemiptera (True Bugs)	**44** (6.5%)	**20**	8	1	15	7	9	**20**	2	3	
Odonata (Dragonflies & Damselflies)	**15**	**11**	2	**11**	2	3	5	6	1	2	
Parasitoid Wasps & Micro Hymenoptera	**12**	5	2		4	1	3	1			
Orthoptera (Grasshoppers & Crickets)	**10**	7	6		5	3	8	6	1	2	
Hymenoptera: Symphyta (Saw-flies)	**6**	2		1		1	2				
Diplopoda (Millipedes)	**5**					3	2			3	3

	All Areas	FG	OR	HP	PR	NM	PF	BF	FA	WW	4A
Isopoda (Woodlice)	**5**	1		1		3	3	1	1	2	2
Mollusca (Slugs & Snails)	**4**	1								3	
Opiliones (Harvestmen)	**3**				2			1			1
Other	**7**	1	1	3	1	3	3	1		1	1

Table 2. Species with conservation designations.

	All Areas	FG	OR	HP	PR	NM	PF	BF	FA	WW	4A
All Species (not including UKBAP)	**59**	**27**	**19**	1	7	4	**22**	8	3	7	3
UKBAP	**5**	2	2		1			1		1	
RDB1	**3**	1	1					1			
RDB2	**1**	1					1				
RDB3	**4**	2	1				2				
RDBK	**4**	3	2				4				
Nationally Scarce	**47**	**20**	**15**	1	7	4	**15**	7	3	7	3
% of total species	**8.7%**	**10%**	**17.9%**	2.2%	4.3%	2.8%	**9.2%**	5.8%	7%	5.8%	8.3%

Table 1 clearly shows that the main gardens and the Plant Fair Field were the richest areas for invertebrates within the Estate. As the main gardens constitute the largest survey area and contains the greatest diversity of habitat resources this is understandable. It was a considerable surprise though to

record such a large number of species from the Plant Fair Field which was one of the smaller survey areas and at first glance one of the most unremarkable areas botanically.

Hymenoptera was the most speciose invertebrate group recorded during the survey, although further study and monitoring using different techniques such as Malaise traps, vacuum sampling and light traps will probably raise the number of Coleoptera, Diptera and Lepidoptera much closer to the Hymenoptera species count for the site. The key pollinator groups, Hymenoptera, Diptera and Lepidoptera were also best represented in both the formal gardens and Plant Fair Field. The number of spiders recorded was also quite high especially within the Plant Fair Field and the Prairie due to the more variable structure of these grasslands. Coleoptera was best represented in the New Meadow and Weights Wood mainly due to the success of the pitfall trapping in these two survey areas producing a good diversity of ground beetles.

The overall percentage of species with conservation designations was 8.7%. Three areas, the formal gardens, the Orchard and the Plant Fair Field, produced species lists that had a higher percentage of species with conservation designations. It is interesting that although the species list for the Orchard was relatively low it contained a very high number of species with conservation designations (17.9%).

Overall aculeates were not only the most speciose group but also contained the highest percentage of species with conservation designations (20.8%).

3.2. Habitat Resource Assemblages

Psenulus pallipes on thatch roof

An excellent diversity and distribution of habitat resources were identified during the survey. The most speciose habitat resources were the pollen and nectar resources present in the garden, meadows and woodland edge. Key members of the invertebrate assemblages recorded during the survey are outlined within each habitat resource section below. These species are not necessarily just the rare and scarce species recorded but also common and local species that are characteristic components of the habitat resource described.

Even though this is a breakdown and description of each habitat resource it is important to consider the connections and interactions of invertebrate assemblages between habitat resources.

A good example of this is the little potter wasp ***Microdynerus exilis***. This species nests in beetle burrows within dead wood.

This first requires a population of a common Anobiidae beetle species such as ***Ptilinus pectinicornis*** to create a series of larval burrows within an ash or oak branch in a woodland area such as Weights Wood or Four Acre Shaw. These fallen or cut branches then need to be moved to create a log pile, in a warm unshaded area, within the gardens, meadows or coppice clearing.

The adult wasps hunt for weevil larvae amongst herbaceous vegetation within the gardens and meadows to store in its burrow as food for its developing larvae. The wasp also collects and transports wet sand and mud to close up each cell within its burrow, possibly from marshy ground or pond edges.

The wasp also forages for nectar amongst the nectar & pollen resources within the gardens to maintain enough energy and live long enough to complete its lifecycle.

Associated species such as the cleptoparasitic jewel wasp ***Chrysis gracillima***, for which ***Microdynerus exilis*** is considered a host, and predators of the wasps are also affected by this complex interaction between species, physical parameters, energy flows and human influence within the Great Dixter Estate and the surrounding landscape.

Table 3. Number of species associated with habitat resources.

	All Areas	FG	OR	HP	PR	NM	PF	BF	FA	WW	4A
All Species	**676**	**271**	**106**	**45**	**162**	**145**	**240**	**137**	**43**	**121**	**36**
Nectar/Pollen	*274*	167	74	17	67	50	123	59	27	32	2
	40.5%	61.6%	69.8%	37.8%	41.4%	34.5%	51.3%	43.1%	62.8%	26.4%	5.6%
Herbaceous Vegetation	*259*	86	40	14	77	77	101	76	16	39	9
	38.3%	31.7%	37.7%	31.1%	47.5%	53.1%	42.1%	55.5%	37.2%	32.2%	25.0%
Litter/Moss/Humus	*144*	18	10	12	22	44	49	11	4	58	27
	21.3%	6.6%	9.4%	26.7%	13.6%	30.3%	20.4%	8.0%	9.3%	47.9%	75.0%
Dead Wood/Posts	*87*	63	10	2	5	6	40	11	10	4	1
	12.9%	*23.2%*	*9.4%*	*4.4%*	*3.1%*	*4.1%*	*16.7%*	*8.0%*	*23.3%*	*3.3%*	*2.8%*
Stems/Thatch	*26*	16	5	2	3	4	15	2	1	0	0
	3.8%	*5.9%*	*4.7%*	*4.4%*	*1.9%*	*2.8%*	*6.3%*	*1.5%*	*2.3%*	*0.0%*	*0.0%*
Scrub/Trees	*138*	48	22	9	48	17	39	37	4	17	4
	20.4%	*17.7%*	*20.8%*	*20.0%*	*29.6%*	*11.7%*	*16.3%*	*27.0%*	*9.3%*	*14.0%*	*11.1%*
Bare Ground	*103*	36	25	4	27	33	33	18	4	30	5
	15.2%	*13.3%*	*23.6%*	*8.9%*	*16.7%*	*22.8%*	*13.8%*	*13.1%*	*9.3%*	*24.8%*	*13.9%*

3.2.1. Pollen & Nectar Resources

The pollen and nectar resources within Great Dixter are diverse and rich and species associated with this resource were very well represented with 90 species of bee, 63 hoverfly species, and an overall tally of 274 pollinators recorded. A number of important semi-natural and cultivated pollen and nectar resources were present within the site. The following section outlines these resources with key members of associated invertebrate assemblages described.

Long Border

Peacock Garden

New Meadow

Plant Fair Field

As Table 3 shows the formal gardens and Plant Fair Field maintained the highest number of pollinators. The gardens support a rich diversity of pollen & nectar resources while the Plant Fair Field supported a large assemblage of pollinators associated with hogweed flowers and deadwood nesting habitat. New Meadow unfortunately had a relatively low number of pollinators despite being one of the most botanically diverse areas, this was probably due to the presence of an artificial bee hive in the meadow containing a colony of honey bee (*Apis mellifera ligustica)* that aggressively defended pollen resources within the New Meadow and the adjacent areas of the Orchard meadow and throughout the gardens. This is discussed in more detail later in the report.

3.2.1.1. Early spring flowering scrub and trees.

The main areas of spring flowering scrub and trees were present within the Orchard and Front Meadow area with many mature apple (*Malus*), pear (*Pyrus*), and cherry (*Prunus*) trees present. Some sallow (*Salix*) is also present within the Cat Garden, around Horse Pond, around the edge of the Bottom Field and within Weights Wood. The Orchard and Front Meadow were particularly interesting with a surrounding meadow consisting of dense dandelions (*Taraxacum spp.*) and crocuses (*Crocus spp.*). The crocus flowers proving to be a favoured resource for emerging bumblebee queens.

Orchard Fruit Trees

Andrena gravida Imhoff, 1832

white-bellied mining bee

Status: UKBAP, RDB1-Nationally Endangered

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Orchard

Dates Recorded:

1 female - 13/03/2017

1 female - 08/04/2017

This species is extremely rare in Britain with very few records from a small number of sites. Most records are centred around the Kent/Sussex border with most records from orchards, cemeteries and other sites with a good abundance of spring flowering fruit trees. On the Continent the species is an important pollinator of fruit trees. At Great Dixter it was only found in the Orchard and both females found on dandelions.

Andrena cineraria (Linnaeus, 1758)

ashy mining bee

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Orchard

This stunning bee is another species that commonly uses spring flowering trees and scrub to forage. It is quite a large, distinctive black and white mining bee which is quite common and widespread in Britain but appears to be quite local in Sussex. A single female was collected from dandelion.

Andrena cineraria

Andrena clarkella (Kirby, 1802)

Clarke's mining bee

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Weights Wood

This very early spring species collects pollen exclusively from sallow flowers. This species is just one of a group of mining bees that specialise on sallow pollen in early spring. At Great Dixter this

species was only found within Weights Wood which has the best abundance of sallow within the estate.

Nomada leucophthalma (Kirby,1802)

early nomad bee

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded: Weights Wood, New Meadow

This nomad bee is a cleptoparasite of *Andrena clarkella* and is commonly found around *Andrena clarkella* nest sites and can be found visiting sallow and dandelion flowers for nectar. The species was found in Weights Wood around a possible *Andrena clarkella* nesting bank and in New Meadow.

Criorhina ranunculi (Panzer,1804)

a bumblebee mimic hoverfly

Class: INSECTA

Order: DIPTERA

Family: SYRPHIDAE

Survey Areas Recorded: Front Meadow

This hoverfly is a large early spring bumblebee mimic that breeds in rotting stumps and forages mainly on fruit trees and flowering scrub. The species was found only once on *Pyrus* blossom within the Front Meadow.

Bombylius major Linnaeus,1758

common bee-fly

Class: INSECTA

Order: DIPTERA

Family: BOMBYLIIDAE

Recorded on many dates throughout the Estate.

Bombylius major

This is usually one of the most abundant and distinctive insects of early spring either foraging on sallow blossom and other early spring flowering trees and scrub, or hunting for mining bee burrows at ground level. The species was particularly abundant in early spring during the survey. The species is an inquiline predator on mining bee larvae and can be seen searching for mining bee burrows along woodland rides and bare ground. This fly was particularly abundant along the rides and clearings within Weights Wood in spring 2017.

3.2.1.2. Late spring flowering scrub and trees.

Peacock Garden

Hawthorn, oak, field maple and flowering scrub species within the gardens, such as *Aralia*, *Rosa*, and *Malus hupehensis*, are important pollen and nectar resources within Great Dixter providing a prolonged season of scrub flowering resource during the main spring season for mining bees. The hedges throughout the site provide the best areas of hawthorn including a particularly productive hedge near the entrance to the gardens. The woodland edge around the Prairie and the Bottom Field provide the best areas of oak and field maple.

Andrena ferox Smith,1847

oak mining bee

Status: UKBAP, RDB1-Nationally Endangered

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Woodland edge around Bottom Field

Dates Recorded:

1 female - 26/05/2017

The oak mining bee is unusual in that it is monolectic (collects pollen from one plant species) on oak pollen and as such females are best found foraging on oak flowers. Males are best found nectaring on field maple and hawthorn flowers. The species is extremely rare, but probably under recorded, and found in only a small number of sites. The High Weald and the New Forest being strongholds for the species in Britain. A single female was found on oak flowers on the edge of the Bottom Field. The underground nest sites for this fossorial (underground nesting) species are difficult to find and nest burrow entrances are communally used by females.

Andrena chrysosceles (Kirby,1802)

hawthorn mining bee

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Recorded on many dates throughout the Estate.

This mining bee is one a number of common species that forage on hawthorn flowers. Within Great Dixter this species, along with *Andrena scotica*, were the most abundant mining bee species

found on hawthorn. Nest sites for this species were found amongst the coppice coups and ride edges within Weights Wood and around the edge of New Meadow.

Bombus hypnorum (Linnaeus,1758)

tree bumblebee

Bombus hypnorum

Status: New colonist

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded:

Recorded on many dates throughout the Estate.

Late spring flowering scrub is particularly important for bumblebees, as this time of year many bumblebee species will have nests up and running. The *Malus hupehensis* around the car park was attractive to many bumblebee workers with up to seven species seen foraging on the dense flowers at any one time. In total 12 species of bumblebee were recorded during the survey throughout Great Dixter.

The newly colonised bumblebee *Bombus hypnorum* bred within Great Dixter during 2017 in a nest made amongst the car park hay pile, and many workers could be seen foraging on the adjacent *Malus hupehensis* flowers. Despite being the newest addition to Britain's bumblebee fauna it is fast becoming one of Britain's most successful species especially in suburban areas as the species can utilise bird boxes in gardens and other man made nest locations, as well as natural cavities in trees. It is very distinctive being the only British bumblebee with a ginger thorax, black gaster and white 'tail'.

Malus hupehensis

3.2.1.3. Legume & labiate rich grassland.

New Meadow

Plants within the Fabaceae and Lamiaceae families are of particular importance for many species of bee and the loss of legume and labiate rich grassland is considered to be one of the main reasons for the decline in many bumblebee and solitary bee species. The damp, neutral soils of the High Weald are especially conducive to the creation of legume rich meadow and grassland. The High Weald was once within the restricted historical range of the scarce long-horned bee *Eucera nigrescens*, which is now considered extinct. *E.nigrescens* and the more widespread species *Eucera longicornis* forage amongst legume rich grassland collecting pollen from many Fabaceae species. Due to changes in agriculture the nitrogen fixing utility of legumes as part of meadow and grassland ley between crop rotations is now rarely used and as such the extent and continuity of this type of grassland and meadow has been lost from much of the High Weald landscape. Legume rich grassland is present mainly within Plant Fair Field, Orchard, Prairie, and pockets of meadow within the gardens, such as the Topiary Lawn.

Eucera longicornis (Linnaeus,1758)

long-horned bee

Eucera longicornis

Status: UKBAP, Nationally Scarce A
Class: INSECTA
Order: HYMENOPTERA
Family: APIDAE
Survey Areas Recorded: Weights Wood, Prairie
Dates Recorded:
1 male - 17/05/2016 - WW
1 female - 07/07/2017 - PR

This large and distinctive bee, especially the male with its very long antennae, has greatly declined in Britain. Once widespread in the South-East, the species has significantly reduced in distribution, now found mainly on coastal grasslands and soft rock cliffs. A very small number of inland populations still exist. A male was recorded on the edge of Weights Wood in 2016 and a female on meadow vetchling (*Lathyrus pratensis*) in the Prairie. The female specimen was checked and confirmed as *E.longicornis* and not *E.nigrescens*. It is important that all specimens of this species within Great Dixter are retained and checked for specimens of *E.nigrescens* as the site has the potential to retain small populations of both *E.longicornis* and *E.nigrescens*. Clay banks in open woodland rides have been recorded as *Eucera* nest

sites, and due to the presence of a patrolling male in Weights Wood, it important to try and locate possible nest sites for the species within the Great Dixter Estate.

Bombus ruderatus (Fabricius,1775)

large garden bumblebee

Status: UKBAP, Nationally Scarce B

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded: Formal Gardens

This large bumblebee is one of a number of *Bombus* species that have greatly declined in Britain. The species has been shown to do well on legume rich swards as a pollen source although workers will obtain pollen from a wide range of plants especially deep tubed flowers such as foxglove (*Digitalis purpurea*), comfrey (*Symphytum officinale*) and honeysuckle (*Lonicera periclymenum*). Within the gardens the species was observed foraging from large flowered labiates, foxgloves and red clover (*Trifolium pratense*).

Bombus ruderarius (Müller,1776)

red-shanked bumblebee

Status: UKBAP

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded: Formal Gardens, Orchard

This bumblebee is considered to have suffered a catastrophic decline in Britain. The species collects pollen mainly from plants within the Fabaceae and Lamiaceae families and requires large areas of flower rich meadow. Only two workers were found, one in the Orchard on bird's-foot trefoil (*Lotus corniculatus*) and one in the gardens, presumably nectaring from *Cotoneaster*.

Andrena labialis (Kirby, 1802)

large meadow mining bee

Class: INSECTA

Order: HYMENOPTERA

Family: ANDRENIDAE

Survey Areas Recorded: Orchard, New Meadow, Bottom Field, Farm

This mining bee is quite local in Southern Britain. The species is one of the largest mining bees in Britain and the males are particularly distinctive due to the extensive yellow markings on the face. The species collects pollen from early flowering legumes and as such requires legume rich grasslands and sparsely vegetated areas for its underground nests. The species was found within the Orchard, New Meadow, Bottom Field and at the Farm.

Melitta leporina (Panzer,1799)

clover blunt-horn bee

Class: INSECTA

Order: HYMENOPTERA

Family: MELLITIDAE

Survey Areas Recorded: Formal Gardens, Bottom Field, Plant Fair Field, Prairie

Another local species found mainly in Southern Britain. This species collects pollen predominately from clovers, even white clover (*Trifolium repens*), so can be found on some quite species poor mesotrophic (moderately nutrient rich) pasture. The species was found within the long border, mainly males nectaring in groups on composites and flowering shrubs, and within the Bottom Field on white clover, but the main areas of abundance were within the Prairie and Plant Fair Field on red clover (*Trifolium pratense*).

Nomada flavopicta (Kirby,1802)

blunt-horn nomad bee

Status: Nationally Scarce B

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded: Prairie

This species of bee is cleptoparasitic (steals larval food stores by laying eggs in host burrows) on *Melitta* species and requires good populations of *Melitta* bees. The species was found within the Prairie very close to where there were good numbers of foraging *Melitta leporina*.

3.2.1.4. Cultivated garden planting & umbellifers.

High Garden

The naturalistic and diverse mixed displays within the gardens create an outstanding richness and diversity of pollen & nectar resources within Great Dixter. The gardens themselves produced the biggest list of pollinators during the survey. This is not only due to the pollen & nectar resource present within the gardens but also the diversity, continuity and proximity of nesting habitat within the gardens and surrounding meadows. This is explained in detail later in the report. Of particular note are the many labiates, umbellifers and composites used within the planting displays. The Long Border itself probably being one of the best examples of how to create a great diversity and richness of pollen & nectar resources in a cultivated intensively managed garden. As well as a number of the species listed above the gardens produced records of many other scarce pollinators.

The use of umbellifers within the gardens, of both native and Mediterranean species, has the advantageous effect of providing a long protracted season of umbellifer pollen and nectar for insect pollinators. The large flat inflorescences of small flowers are attractive and accessible to many insect species, and the tall stems provide a support for web building spiders and dead umbellifer stems provide nesting space for aculeates. As well as in the gardens the sheltered woodland edge within Plant Fair Field produced a spectacular abundance of hogweed flowers during mid summer. The assemblage of pollinators in this small area was the most speciose within the site.

Lasioglossum laevigatum

Andrena labiata Fabricius, 1781

red-girdled mining bee

Andrena labiata

Status: Nationally Scarce A
Class: INSECTA
Order: HYMENOPTERA
Family: ANDRENIDAE
Survey Areas Recorded:
Formal Gardens, New Meadow, Plant Fair Field.

These small to medium sized mining bees are quite distinctive due to the red colouration of much of the gaster. They do look very similar to the blood bees *Sphecodes* spp. but these are cleptoparasitic species so do not collect pollen on the hind legs as *Andrena labiata* does.

During early spring this species was observed collecting pollen from forget-me-nots (*Myosotis* spp.) within the gardens. The use of underplanting garden displays with forget-me-nots clearly benefitting the species early in the season. Later in spring the species switched to collecting lesser stitchwort (*Stellaria graminea*) pollen on the edge of Plant Fair Field, and the species was also recorded on speedwell within New Meadow. A nest of this species was located on the eroded south-facing side of a yellow meadow ant (*Lasius flavus*) nest within Plant Fair Field. The elevated bare ground created by these yellow meadow ant nests may be an important nesting resource for this species.

Andrena nitidiuscula Schenck,1853

carrot mining bee

Status: RDB3 - Nationally Rare
Class: INSECTA
Order: HYMENOPTERA
Family: ANDRENIDAE
Survey Areas Recorded: Formal Gardens

The carrot mining bee specialises on collecting umbellifer pollen and coastal populations of this species are associated with wild carrot (*Daucus carota*). At Great Dixter the bee was found on *Angelica* sp. umbels within the High Garden. This is another fossorial species found nesting singly or in small aggregations in exposed clay soil.

Anthophora quadrimaculata (Panzer,1798)

four-banded flower bee

Status: Nationally Scarce B

Class: INSECTA

Order: HYMENOPTERA

Family: APIDAE

Survey Areas Recorded: Formal Gardens

This was probably the most expected nationally scarce bee to turn up at Great Dixter. This species is well known from gardens due to its liking for cultivated labiates and use of crumbling sandstone walls for nesting, although it is quite restricted and localised in distribution. The species was recorded within the gardens exclusively on cultivated *Salvia sp.* flowers. The distinctive striped males were seen patrolling clumps of *Salvia sp.*, presumably looking for females.

Chelostoma campanularum (Kirby,1802)

small scissor bee

Class: INSECTA

Order: HYMENOPTERA

Family: MEGACHILIDAE

Survey Areas Recorded: Formal Gardens

This tiny bee, one of Britain's smallest species, collects pollen from cultivated and native species of *Campanula*. It will also visit other plant species for nectar. Nest sites include vacant beetle burrows in dead wood and wooden posts, as well as bee hotels and thatch roofs.

Male Chelostoma campanularum

The bee was quite common around the main gardens and was seen in numbers around *Campanula* and *Geranium* flowers. Nest sites included the wooden posts around the barn log pile and in the new thatch that was being installed adjacent to the log pile.

Hylaeus pictipes Nylander,1852

little yellow-face bee

Status: Nationally Scarce A

Class: INSECTA

Order: HYMENOPTERA

Family: COLLETIDAE

Survey Areas Recorded: Formal Gardens, Farm

Another of Britain's smallest bees. This species is quite scarce and restricted to South-East England. This is a stem nesting species using dead bramble twigs and other small hollow stems. Females will also use old beetle burrows in dead wood.

This bee was quite common nesting around the barn log pile and around the bee hotel at the farm. Males of the species were also seen in numbers around umbellifer umbels and other plant species in the nursery.

Myolepta dubia (Fabricius, 1805)

a hoverfly

Status: Nationally Scarce

Class: INSECTA

Order: DIPTERA

Family: SYRPHIDAE

Survey Areas Recorded: Plant Fair Field

This scarce black and orange hoverfly is found mainly around woodland in Southern England. This species breeds in rot holes in tree species such as beech and oak.

One male and one female were found on hogweed along the woodland edge in the Plant Fair Field.

Criorhina berberina (Fabricius, 1805)

a bumblebee mimic hoverfly

Class: INSECTA

Order: DIPTERA

Family: SYRPHIDAE

Survey Areas Recorded: Plant Fair Field

A large stunning bumblebee mimic hoverfly that occurs in two colour forms, one with a brown thorax and white tail and an all brown form. The species nests in rotten wood and rotting tree roots.

The species was found on hogweed within the Plant Fair Field amongst a large assemblage of hoverfly species.

3.2.1.5. Ivy

By late autumn there are few pollen and nectar resources active. Ivy (*Hedera helix*) plays an important role in providing an abundant pollen and nectar resource during this time. The small inconspicuous flowers are readily accessible to many pollinators and a patch of ivy in late September/ October can be visited by a dense and diverse assemblage of insects foraging for nectar and/or pollen.

Colletes hederae Schmidt & Westrich,1993

ivy bee

Colletes hederae

Status: New Colonist

Class: INSECTA

Order: HYMENOPTERA

Family: COLLETIDAE

Survey Areas Recorded: Formal Gardens

The ivy bee was first found in Britain in 2001. The first Sussex site was Castle Rocks, Hastings a few years later where very large nesting aggregations were present in sandy banks at the base of the rocks. In recent years the species has spread with rapid pace throughout Southern Britain and is now a common autumn insect in many counties. The species is quite large and has distinctive orange hair bands on the gaster.

The bee is monolectic (collects pollen from a single plant species) on ivy pollen, and the species times its emergence in late autumn to coincide with the flowering of ivy.

The species was found on ivy within the main gardens and the nursery. There was an overlap in the emergence of *Colletes daviesanus* and *Colletes hederae*, and late male *C. daviesanus* were found feeding on ivy nectar amongst early emerging male and female *C.hederae*. Female *C. daviesanus* collect pollen from Asteraceae, mainly *Matricaria* species within the gardens.

Vespa crabro Linnaeus,1758

European hornet

Class: INSECTA
Order: HYMENOPTERA
Family: VESPIDAE
Survey Areas Recorded:
Recorded from many sites throughout the gardens.

Vespa crabro

It was only a few years ago when this species was very scarce in Sussex. In recent years the species is starting to becoming widespread and common in the South-East. Hornets are predatory on other social wasps, honeybees, butterflies, moths and two-winged flies. Queens emerge in late March or April and workers can be seen hunting throughout the year until November.

In 2016 a large nest was present in the hay pile in Plant Fair Field and workers were seen regularly chewing wood in the log pile and the external timbers of Great Dixter House for nest material. In 2017 a nest was present in the old apple stump behind the house where new queens were observed emerging.

The only observed flower visits for nectar within the gardens were of workers on ivy. Good numbers of hornet workers could be observed around large patches of ivy in the High Garden and the nursery.

Vespa crabro on ivy

3.2.2. Nesting & Breeding Resources

As well as providing a rich pollen & nectar resource it also essential to provide nesting and breeding resources to maintain an abundant and diverse assemblage of pollinators. At Great Dixter the amount of nesting and breeding resources are as diverse and abundant as the pollen & nectar resources and contributed greatly to the pollinator assemblage recorded. Species associated with the dead wood and stem nesting resource were especially well represented.

Wooden Posts

Log Piles

Thatch Roof

Stumps

3.2.2.1. Dead wood, posts, stems and thatch.

Apple Stump Aculeate Nest Site

Much of the dead wood nesting resource comes from quite young cut timber and the posts that are made from this timber on site. This creates a good continuity of log piles and posts on site.

Bramble, rose, and umbellifer stems are also important resources for stem nesting aculeates and this is well represented around the estate amongst hedgerows, bramble thickets, woodland edge and the abundant umbellifers within the gardens. Also the thatch roof next to the barn log pile acts like a giant bee hotel, especially the new thatch that was installed during 2017. This proved highly attractive to large numbers of aculeates.

The species accounts below highlight the rich aerial nesting aculeate assemblage that was recorded within Great Dixter. The species chosen are just a sample of the many species present but highlight the fascinating and complex life histories of this important assemblage.

Microdynerus exilis (Herrich-Schäffer,1839)

little potter wasp

Status: Nationally Scarce B

Class: INSECTA

Order: HYMENOPTERA

Family: VESPIDAE

Survey Areas Recorded: Orchard

As highlighted above this scarce and restricted potter wasp is a very interesting species. It is a small thin black wasp with two creamy white thin stripes. The small size enables it to utilise quite small thin nest spaces such as beetle burrows in dead wood and posts as well as other narrow nest cavities. This species hunts for weevil larvae and as with many wasps plays a very important role in balancing phytophagous pests in gardens. And like many wasps also acts as a pollinator. The females task of nest creation and hunting for larval food stores requires a great deal of energy requiring regular foraging for nectar. This species was recorded from the Upper Moat area.

Chrysis gracillima (Förster,1853)

a jewel wasp

Status: RDB2 - Nationally Vulnerable

Class: INSECTA

Order: HYMENOPTERA

Family: CHRYSIDIDAE

Survey Areas Recorded: Formal Gardens, Plant Fair Field

This small thin jewel wasp is considered to be cleptoparasitic on *Microdynerus exilis (Archer, M.E. 2014)*, and was once extremely rare. The species has been increasing in recent years indicating the species has switched to a wider range of possible hosts and as such may not be restricted to a specialist host as once thought. This wasp was much more common than *Microdynerus exilis* at Great Dixter indicating that other more common wood nesting hosts were being used by the species. It was found a number of times on log piles in the gardens and on posts in the Plant Fair Field.

Heriades truncorum (Linnaeus,1758)

large-headed resin bee

Status: RDBK - Insufficiently Known
Class: INSECTA
Order: HYMENOPTERA
Family: MEGACHILIDAE
Survey Areas Recorded:
Formal Gardens, Plant Fair Field, Orchard, Formal Gardens

Heriades truncorum

This once very rare and restricted species has increased greatly in distribution over the last twenty years. The species collects pollen from ragworts and other yellow-flowered Asteraceae. Due to its liking for nesting in holes in wooden posts the species is becoming quite frequent in gardens and sub-urban areas.

Within Great Dixter females were commonly seen collecting pollen from Mexican fleabane (*Erigeron karvinskianus*) growing on the walls around the gardens and especially at Upper Moat. Nest sites were found in wooden posts around the barn log pile, within the wooden posts in Plant Fair Field and in a stump in the Orchard.

Stelis breviuscula (Nylander,1848)

little dark bee

Status: RDBK - Insufficiently Known
Class: INSECTA
Order: HYMENOPTERA
Family: MEGACHILIDAE
Survey Areas Recorded:
Formal Gardens, Plant Fair Field, Formal Gardens

Stelis breviuscula

This bee is cleptoparasitic on its host *Heriades truncorum* above. As such was once very rare and restricted by the presence of its host. In recent years the species has spread widely with its host *Heriades truncorum* and has become frequent in South-East England.

The species was found at *Heriades truncorum* nest sites in the Formal Gardens and Plant Fair Field.

Hoplitis claviventris (Thomson,1872)

welted mason bee

Class: INSECTA

Order: HYMENOPTERA

Family: MEGACHILIDAE

Survey Areas Recorded: Plant Fair Field

This bee is a stem nester, nesting in bramble and rose stems. It has also been recorded nesting in ragwort (*Senecio jacobaea*) stems. The species has been recorded collecting pollen from birds-foot trefoil (*Lotus corniculatus*) but probably uses a wide range of plants. The species is locally distributed in Southern Britain, recorded from a range of habitats were its nesting requirements are met.

The species was recorded around the bramble (*Rubus fruticosus*) and dog rose (*Rosa canina*) thicket at the top border of Plant Fair Field.

Stelis ornatula (Klug,1807)

spotted dark bee

Status: RDB3 - Nationally Rare

Class: INSECTA

Order: HYMENOPTERA

Family: MEGACHILIDAE

Survey Areas Recorded: Plant Fair Field

This bee is cleptoparastic on *Hoplitis claviventris* but is much rarer than its host with only a small number of sites in Southern Britain recorded.

The species was recorded around the same bramble and dog rose thicket in Plant Fair Field were its host was found.

Chelostoma florisomne (Linnaeus,1758)

large scissor bee

Class: INSECTA

Order: HYMENOPTERA

Family: MEGACHILIDAE

Survey Areas Recorded: Plant Fair Field

The larger of the two scissor bee species is more widely distributed in Britain but less frequent. The species collects buttercup (*Ranunculus sp.*) pollen especially from buttercups growing on the edge

between meadow and woodland. The species nests in old beetle burrows in dead wood and wooden posts, and has also been recorded nesting in thatch.

Specimens were only found in Plant Fair Field either at nest sites in the wooden posts or from buttercup flowers along the woodland edge.

Monosapyga clavicornis (Linnaeus,1758)

yellow-spotted sapyga wasp

Status: Nationally Scarce B
Class: INSECTA
Order: HYMENOPTERA
Family: SAPYGIDAE
Survey Areas Recorded: Plant Fair Field

This distinctive wasp is cleptoparasitic on *Chelostoma florisomne* and *Osmia* species. It is widely distributed in areas were its hosts occur but is uncommon.

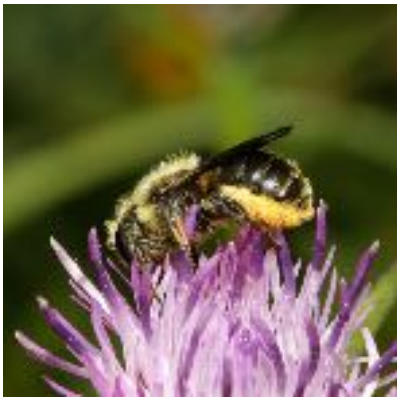
A single female was found on one of the wooden posts where *Chelostoma florisomne* were nesting.

Osmia leaiana (Kirby,1802)

orange-vented mason bee

Class: INSECTA
Order: HYMENOPTERA
Family: MEGACHILIDAE
Survey Areas Recorded: Formal Gardens, Orchard, Farm

Widely distributed throughout England and Wales. Commonly found in gardens where it nests in dead wood, posts and walls. Also nests in cavities in cliff faces. The species visits many plant species for nectar but collects pollen mainly from yellow-flowered Asteraceae.



Osmia leaiana

The species was found in good numbers within the gardens, Upper Moat and in the bee hotel at the Farm along with *Osmia caerulescens,* a less frequent mason bee.

Chrysura radians (Harris,1776)

a jewel wasp

Status: Nationally Scarce A
Class: INSECTA
Order: HYMENOPTERA
Family: CHRYSIDIDAE
Survey Areas Recorded: Formal Gardens

Chrysura radians

This once very scarce jewel wasp has increased in distribution and frequency in recent years. It is cleptoparasitic on *Osmia* species such as *Osmia leaiana*.

The species was one of the most frequently found jewel wasps at Great Dixter around the barn log pile and posts especially where *Osmia leaiana* was nesting.

Platyrhinus resinosus (Scopoli, 1763)

cramp-ball fungus weevil

Status: Nationally Scarce B
Class: INSECTA
Order: COLEOPTERA
Family: ANTHRIBIDAE
Survey Areas Recorded: Formal Gardens, Plant Fair Field

Platyrhinus resinosus

Locally distributed in Southern Britain and frequently found around log piles. The larvae feed within cramp-ball fungus *Daldinia concentrica* (also called King Alfred's cakes) which grows mainly on dead ash trees.

Adults were found on the log piles in the Formal Gardens and within Plant Fair Field. An adult was also swept from vegetation in the Plant Fair Field.

Platystomos albinus (Linnaeus, 1758)

scarce fungus weevil

Status: Nationally Scarce B
Class: INSECTA
Order: COLEOPTERA
Family: ANTHRIBIDAE
Survey Areas Recorded: Formal Gardens

This striking beetle is less frequently found and much more scarce than the similar *Platyrhinus resinosus*. The larvae feed on dead wood and the adults can be found amongst log piles and fallen dead wood in woodland. This species has much longer antennae than *Platyrhinus,* especially in the males, and have white markings at the end of the antennae.

Two females were found amongst the barn log pile.

Platystomos albinus

Dasycera oliviella (Fabricius, 1794)

a micro-moth

Status: Nationally Scarce A

Class: INSECTA

Order: LEPIDOPTERA

Family: OECOPHORIDAE

Survey Areas Recorded: Formal Gardens

This striking micro-moth is very scarce and very locally found in Southern Britain. This is a saproxylic species, the larvae feeding on dead and decaying trees. It is usually associated with good quality ancient woodland.

A single adult was collected from around the barn log pile, flying in warm sunshine. The similar but much more common *Esperia sulphurella* was abundant around the log piles within the gardens as well as another saproxylic Oecophorinae species, *Batia lunaris*.

3.2.2.2. Bare ground, walls & exposed rock.

Bare ground and wall nesting aculeates were also very well represented within the gardens, but not to the same extent as dead wood nesters. The best area of bare ground was the damaged path leading to Horse Pond and the Prairie where a number of digger wasp species could be observed. Other bare ground resource existed in droughted areas of the meadows and along the edges of paths where mining bee nests could be observed.

The sandstone walls within the gardens supported good numbers of nesting aculeates especially the south-facing crumbling sandstone wall along the edge of Upper Moat.

Sphecodes scabricollis Wesmael,1835

rough-backed blood-bee

Sphecodes sp.

Status: RDB3 - Nationally Rare
Class: INSECTA
Order: HYMENOPTERA
Family: HALICTIDAE
Survey Areas Recorded: Formal Gardens, Plant Fair Field

A very local and rare bee with very few records for Sussex. The species is cleptoparasitic on *Lasioglossum zonulum*, which nest in open ground exposed to the sun. The bull-headed furrow bee, *Lasioglossum zonulum*, was one of the more numerous furrow bees found within the gardens.

The species was found and confirmed by Mike Edwards during the survey in the Plant Fair Field and within the gardens. A male was also found by the author on fleabane (*Pulicaria dysenterica*) within the nursery. This was one of the most significant finds of the survey.

Sphecodes species are very similar in general appearance and difficult to identify requiring microscopic examination. The above photo is of an unidentified male blood-bee showing the knobbly antennae characteristic of the males of this genus of bees.

Lasioglossum morio (Fabricius,1793)

common green furrow bee

Lasioglossum morio

Class: INSECTA
Order: HYMENOPTERA
Family: HALICTIDAE
Survey Areas Recorded: Formal Gardens, Orchard

A common and widespread bee especially in Southern Britain. This small metallic green bee nests in cavities in cliff faces and walls. It can occur in large aggregations.

This was the most common wall nesting bee within the gardens, especially within the Upper Moat sandstone wall. Two specimens of the brighter *Lasioglossum smeathmanellum* were also collected from the Upper Moat wall but *L.morio* was clearly the more abundant species.

Sphecodes niger von Hagens,1874

dark blood-bee

Status: RDB3 - Nationally Rare

Class: INSECTA

Order: HYMENOPTERA

Family: HALICTIDAE

Survey Areas Recorded: Orchard

This is an increasing species but still mainly a Southern bee. The males of this *Sphecodes* species are distinctive amongst *Sphecodes* being all black, without red markings, but can be mistaken for a small *Lasioglossum* species. The species is cleptoparasitic on *Lasioglossum morio*.

The species was found around the Upper Moat wall near the *L.morio* nesting aggregation.

Auplopus carbonarius (Scopoli,1763)

a spider-hunting wasp

Status: Nationally Scarce B

Class: INSECTA

Order: HYMENOPTERA

Family: POMPILIDAE

Survey Areas Recorded: Orchard

A scarce and local species found mainly in Southern Britain. This is an unusual spider-hunting wasp as it builds cells to its nest with clay and water, and provisions each cell with a spider that it sometimes flies to the nest. The nests are built within many types of cavity including dead wood, walls, snail shells, empty bee nests and under stones.

A couple of females were found during the survey actively hunting on the Upper Moat wall. The species has also been recorded in the past from the Plant Fair Field. A female, possibly of this species, was also seen hunting on the barn log pile although the similar all black spider-hunting wasp *Anoplius nigerrimus* was the most common Pompilid found amongst the gardens log piles.

Agenioideus cinctellus (Spinola, 1808)

a spider-hunting wasp

Class: INSECTA

Order: HYMENOPTERA

Family: POMPILIDAE

Survey Areas Recorded: Orchard

A small spider-hunting wasp that is frequently found in Southern Britain. The wasp preys on small Salticidae (jumping spiders) species and uses natural cavities and empty aculeate burrows to create its nest.

The species was found on the Upper Moat wall, presumably hunting the *Salticus scenicus* and *Sitticus pubescens* present on the wall.

Lasioglossum malachurum (Kirby, 1802)

sharp-collared furrow bee

Status: Nationally Scarce B
Class: INSECTA
Order: HYMENOPTERA
Family: HALICTIDAE
Survey Areas Recorded: Orchard

This was previously a scarce bee found mainly on soft rock cliff sites. The species has increased dramatically over the last twenty years and can be common and abundant in Southern Britain. Large aggregations can be found in well worn compacted paths and even car parks. A wide range of flowers are visited for pollen and nectar.

One of a number of ground nesting furrow bees recorded from Great Dixter. In total fourteen species of *Lasioglossum* were recorded during the survey.

Cerceris rybyensis (Linnaeus,1771)

ornate-tailed digger wasp

Class: INSECTA
Order: HYMENOPTERA
Family: CRABRONIDAE
Survey Areas Recorded:
Formal Gardens, Prairie, Plant Fair Field

Cerceris rybyensis

Quite a common wasp in Southern Britain found nesting in sandy soils, especially bare exposed ground such as paths and sand banks. The species is predatory on small bees especially *Lasioglossum* species. A nesting aggregation of this species can be very busy with females coming and going to hunt, and the smaller males swarming around nest sites waiting for females.

The species was found nesting in the path leading to the Prairie along with *Astata boops*, *Lindenius albilabris*, *Lindenius panzeri* and *Lasioglossum malachurum*. *L.malachurum* and *L.puncticolle* seemed

to be the main prey for *Cerceris rybyensis* females here. The species was also found visiting flowers in the Prairie, Plant Fair Field and Formal Gardens for nectar.

Astata boops (Schrank,1781)

a digger wasp

Class: INSECTA

Order: HYMENOPTERA

Family: CRABRONIDAE

Survey Areas Recorded: Formal Gardens, Prairie

Astata boops with prey

This species of digger wasp has quite a restricted range in Southern Britain. It's habitat is also usually restricted to sandy heathland, soft rock cliffs and dunes, although can occur in other habitats. The relatively large black and red females prey on shield bug nymphs and can sometimes be seen dragging quite large nymphs into their underground nests.

The species was found both at nest sites along the Prairie path and at flowers in the gardens.

Hedychridium roseum (Rossi,1790)

a jewel wasp

Class: INSECTA

Order: HYMENOPTERA

Family: CHRYSIDIDAE

Survey Areas Recorded: Prairie

This species of jewel wasp is a cleptoparasite, or parasitoid, of *Astata boops* and is found wherever its host nests. The restricted range of both these species indicates they may deserve a conservation designation.

One female was found on the Prairie path hunting for its hosts nests.

Sitticus pubescens (Fabricius, 1775)

a jumping spider

Class: ARACHNIDAE

Order: ARANEAE

Family: SALTICIDAE

Survey Areas Recorded: Formal Gardens, Orchard

This is a widespread jumping spider that is associated with human habitation (synanthropic). It can be found on walls, fence posts, rocks in gardens and log piles. It can also be found away from human habitation at the base of large pines on heathland.

The species was found hunting on the barn log pile and on the Upper Moat wall.

3.2.3. Herbaceous vegetation, woody vegetation, trees and scrub.

These resources are the key resources for phytophagous (plant-eating) invertebrates and their associated parasitoids and predators. Butterflies & moths, beetles and true bugs are the main phytophagous invertebrate groups, the larvae of which provide a resource for Hymenoptera parasitoids, spiders and predatory beetles. Many phytophagous species specialise on a food-plant species or group of species, so the more botanically rich a site is the more diverse the invertebrate fauna will be. Great Dixter is rich in a diversity of food-plants both within the gardens and the surrounding meadows and woodland. Native species are the most important food-plants for an invertebrate fauna, but as with the pollen & nectar resource non native plants can provide an additional resource of herbaceous and scrub species sometimes enabling new species of insect to colonise Britain.

3.2.3.1. Herbaceous vegetation.

The herbaceous vegetation was the second most speciose resource within Great Dixter with 259 species, 38% of all species recorded. Plant Fair Field had the highest number of species associated with herbaceous vegetation, the Formal Gardens had the second highest list with the Prairie, New Meadow and the Bottom Field close behind (see Table 3, p23).

Chrysolina coerulans (Scriba, 1791)
blue mint beetle

Status: New Colonist
Class: INSECTA
Order: COLEOPTERA
Family: CHRYSOMELIDAE
Survey Areas Recorded: Formal Gardens

Chrysolina coerulans

This colourful metallic blue beetle was first recorded in Britain in 2011 not far from Great Dixter over the border in Kent. The records of the beetle at Great Dixter during 2017 were the first verified records for Sussex, although it appears the species has been present in the gardens for many years, unknown to the entomologist community. This species is considered a serious pest of cultivated mint by the RHS, although at Great Dixter it is not a problem causing little damage to plants despite being quite easy to

find. The naturalistic planting at Great Dixter could prevent the rapid spread of phytophagous pest species such as *Chrysolina coerulans*, compared to the damaging effect this beetle has on commercially grown mint and garden mint collections on the continent.

Larinus planus (Fabricius, 1793)
thistle bud weevil

Status: Nationally Scarce B
Class: INSECTA
Order: COLEOPTERA
Family: CURCULIONIDAE
Survey Areas Recorded: Formal Gardens

This relatively large weevil used to be very scarce in Sussex but in recent years has become frequently found in the Hastings/Pett Level/Rye Harbour coastal area on creeping thistle (*Cirsium arvense*). Its presence at Great Dixter would indicate the species has spread inland from the coast.

Metrioptera roeselii (Hagenbach, 1822)
Roesel's bush-cricket

Class: INSECTA
Order: ORTHOPTERA
Family: TETTIGONIIDAE
Survey Areas Recorded:
Common throughout the gardens and meadows.

Metrioptera roeselii

This bush-cricket was once very restricted in distribution in the UK and restricted to saltmarsh, estuarine and dune habitat. In the last 10-20 years the species has expanded greatly in distribution, abundance and habitat choice. The species can now be found in many types of tall vegetation either wet or dry. The species feeds on grasses, grass seeds and small insects and females lay eggs in grass stems using their blade-like ovipositor. The male song is a loud piercing 'electrical' buzz which lasts for long periods during warm weather, although some people are unable to hear the sound.

This was one of the most abundant and widely distributed insects within the gardens and meadows of Great Dixter occurring in seven of the survey areas.

Paratalanta hyalinalis (Hübner, 1796)

translucent pearl

Status: Nationally Scarce B

Class: INSECTA

Order: LEPIDOPTERA

Family: CRAMBIDAE

Survey Areas Recorded: Orchard

This is an uncommon and locally distributed moth in Southern Britain. The larvae feed on black knapweed (*Centaurea nigra*) and great mullein (*Verbascum thapsus*).

The species was found in the Orchard meadow with a small number of specimens swept from black knapweed and seen flying around black knapweed stems.

3.2.3.2. Seed-heads & capitulum.

The number of species associated with seed-heads and the capitulum of plants was very low despite the extent of meadow present. An assemblage of insects including the Tephritidae (picture-wing fruit flies) and a number of micro-moth species feed within seed-heads, many requiring the seed-heads to overwinter to complete their life cycle. Only 14 species associated with seed-heads were recorded, three of which were gorse seed feeders, so the number of meadow seed-head feeding species was extremely low. This indicates that the continuity of overwintering grassland and meadow is deficient within the site. It is the continuity of this resource rather than the extent of the resource that is important. As long as there is always an area of uncut meadow and grassland somewhere within the site adult insects are very good at finding potential habitat. A rotation of areas left uncut during winter will increase the continuity of this resource. This is explained in greater detail later in the report.

3.2.3.3. Trees & scrub.

Over 20% of all species recorded were associated with trees and scrub. This resource occurs mainly within Weights Wood and Four Acre Shaw, although it is woodland edge especially the ecotone between woodland, scrub and meadow that is the most speciose for invertebrates. South-facing woodland with a good transition between woodland and meadow can be the most diverse in invertebrates, but sheltered, humid, north-facing woodland edge can also be rich in invertebrates. This resource is especially important for Coleoptera, Hemiptera, Lepidoptera and Araneae.

Anatis ocellata (Linnaeus, 1758)

eyed ladybird

Class: INSECTA

Order: COLEOPTERA

Family: COCCINELLIDAE

Survey Areas Recorded: Formal Gardens

This is the largest ladybird to be found in the UK and occurs on pine trees where it preys on pine aphids. It is quite widespread but restricted to areas where pine trees grow.

The row of pine trees in the Formal Gardens car park produced an excellent diversity of ladybird species including *Anatis ocellata*.

Gonocerus acuteangulatus (Goeze, 1778)

box bug

Status: RDB1-Nationally Endangered

Class: INSECTA

Order: HEMIPTERA

Family: COREIDAE

Survey Areas Recorded: Formal Gardens

Once a very rare and endangered bug that only occurred at Box Hill, Surrey on box. The species has spread in recent years by switching to a range of scrub and tree food-plants including yew, hawthorn and plum.

One specimen was found in the nursery on *Euphorbia*.

Tetragnatha pinicola L.Koch, 1870

a long-jawed spider

Status: Nationally Scarce B

Class: ARACHNIDAE

Order: ARANEAE

Family: TETRAGNATHIDAE

Survey Areas Recorded: Weights Wood

This small long-jawed spider is found widely but locally within South-East England. It is usually found on the lower branches of trees, scrub and tall vegetation along woodland rides and clearings, including regenerating coppice.

The species was found in Weights Wood at the entrance gate on scrubby vegetation.

Nigma puella (Simon, 1870)

a cribellate spider

Status: Nationally Scarce B

Class: ARACHNIDAE

Order: ARANEAE

Family: DICTYNIDAE

Survey Areas Recorded: Prairie, Plant Fair Field

A small green and red cribellate spider that is very local and restricted to Southern Britain. The spider occurs on scrub and the lower branches of trees on woodland edge and in gardens.

The species was found on gorse (*Ulex europaeus*) in the Prairie and on hawthorn (*Crataegus monogyna*) hedge bordering Plant Fair Field.

Grapholita lobarzewskii (Nowicki, 1860)

Kent fruit piercer

Status: Nationally Scarce A

Class: INSECTA

Order: LEPIDOPTERA

Family: TORTRICIDAE

Survey Areas Recorded: Orchard

A very scarce species that was once restricted to small number of Kent sites. The species larvae feed on the fruits of apple, plum and cherry in orchards.

An adult was found on the lower branch of an apple tree in the Orchard.

3.2.3.4. Bark & Sap Runs

It is not only the branches and leaves of trees that provide a resource for invertebrates. A number of invertebrates live their entire lives on the bark of trees. Damaged bark and the activities of saproxylic insect larvae can produce sap runs that are also an important resource for many species either as a source of sugar and nutrients or as a larval breeding resource. Standing dead wood left by dead, dying or snapped branches is also an important dead wood resource that some saproxylic species require rather than fallen dead wood. In ancient trees the trunk itself starts to rot leaving just a thin living exterior around the side of the tree. This internal rot is a very important resource for invertebrates and ancient trees have some level of protection from felling due to the scarce invertebrate assemblage they support.

Marpissa muscosa (Clerck, 1757)

a jumping spider

Status: Nationally Scarce B

Class: ARACHNIDAE

Order: ARANEAE

Family: SALTICIDAE

Survey Areas Recorded: Weights Wood, Plant Fair Field

Marpissa muscosa

Britains largest jumping spider is quite local and restricted to South-East England usually found on the bark of large trees. In recent years the species has spread and can be found on fence posts and even wooden sheds in gardens.

At Great Dixter the species was found at Weights Wood and on the wooden posts in Plant Fair Field.

Lasius brunneus (Latreille, 1798)

tree ant

Status: Nationally Scarce A

Class: INSECTA

Order: HYMENOPTERA

Family: FORMICIDAE

Survey Areas Recorded: Orchard

This ant is locally distributed within Central and Southern England. It is very similar to the common black garden ant (*Lasius niger)* but has very different behaviour. The nests are built in trees usually under the bark, in the roots or in the boughs of the tree. The workers will hunt within the tree much of the time hidden under the bark or occasionally seen running up and down deep crevices in the bark. The workers 'farm' populations of aphids living on the tree, but will also eat small insects.

One worker was found on a large tree in the Orchard but further searches for the species proved fruitless. A large cherry adjacent to the Lower Moat showed signs of a possible *Lasius brunneus* nest with a lot of frass visible under a dead branch and adjacent to a sap run. The Orchard trees require further monitoring to locate nests of this species.

Volucella inflata (Fabricius, 1794)

a hoverfly

Status: Nationally Scarce

Class: INSECTA

Order: DIPTERA

Family: SYRPHIDAE

Survey Areas Recorded: Orchard, Weights Wood

Volucella inflata

This large colourful hoverfly is locally distributed in Southern Britain. It is associated with deciduous trees affected with sap runs and tunnels made by the goat moth *Cossus cossus*, although as the goat moth is much rarer than *Volucella inflata* the hoverfly is obviously not restricted by the present of goat moths. The hoverfly oviposits into sap runs were the larvae feed.

The species was recorded in Weights Wood at a sap run in a large oak and also found on vegetation near the sap run in the large cherry in the Orchard adjacent to Lower Moat.

It is interesting to note that all five British species of *Volucella* were recorded at Great Dixter including a record of three species together nectaring on one patch of ivy. Three species of *Volucella* breed in wasp nests (*V.pellucens, V.zonaria, V.inanis*), one in bumblebee & wasp nests (*V.bombylans*) and *Volucella inflata* in sap runs and insect burrows in dead wood. It was an exceptional year for *Volucella* especially the social wasp nest breeding species highlighting the excellent year it proved to be for social wasps during 2017 with seven species recorded.

Volucella zonaria

Volucella pellucens

Volucella bombylans

Volucella inanis

3.2.4. Detritivore & Scavenger Resources

3.2.4.1. Litter, moss, humus, stones.

The litter/moss/humus resource is utilised by detritivores and detritivore predators. Ecologically this is a very important assemblage of invertebrates in combination with fungi in breaking down dead plant and animal matter into water soluble nutrients enabling plants to grow and complete nutrient and energy cycles.

This was the third most speciose resource with 144 species recorded. Most records of detritivores and detritivore predators came from the pitfall trap survey as this is the most effective way of sampling this resource. Many detritivores are nocturnal feeders being active during the humid conditions at night. Many detritivores and predators will spend the daytime in high humidity conditions under stones, damp shaded logs, and in deep litter.

3.2.4.2. Dead Animal Matter/Faeces

The least pleasant of invertebrate resources but without scavengers and coprovores the flow of nutrients and energy from dead animal matter would not be possible. These resources can support a very interesting invertebrate community. This was not a particularly rich invertebrate resource within Great Dixter. The presence of mixed grazing stock including cattle that have not been treated with antibiotics usually supports the best scavenger and coprovore assemblage.

Nicrophorus vestigator Herschel, 1807

a burying beetle

Status: Nationally Scarce A

Class: INSECTA

Order: COLEOPTERA

Family: SILPHIDAE

Survey Areas Recorded: Weights Wood

A scarce and locally distributed burying beetle, sometimes called sexton beetles. These black and orange striped beetles bury birds and small mammals as a larval food source. The adults emerge in late spring and again in late summer.

This species was recorded from the pitfall traps in Weights Wood.

Rhingia rostrata (Linnaeus, 1758)

grey-backed snout hoverfly

Status: Nationally Scarce

Class: INSECTA

Order: DIPTERA

Family: SYRPHIDAE

Survey Areas Recorded: Weights Wood, Formal Gardens, New Meadow

This once highly restricted species has undergone a rapid range expansion over the last few years, but is still quite localised in distribution. It is very similar to the more common *Rhingia campestris* and only separated accurately by the lack of black markings along the edge of the abdominal tergites (plates on the top of the abdomen), and by the entirely orange tibia. Whereas *Rhingia campestris* breeds within cattle dung *R.rostrata* is believed to breed in badger dung or maybe deer dung, which is why it is apparently restricted to woodland habitat. (Stubbs, A.E. & Falk, S.J. 2002)

3.2.6. Standing freshwater.

The standing freshwater resource utilised by invertebrates with aquatic stages is provided by four ponds. Horse Pond which is the largest area of open standing fresh water with submerged vegetation and emergent vegetation. The small pond in the Sunk Garden is another area of unshaded freshwater with some submerged vegetation. The Lower Moat between the Orchard and Plant Fair Field is a heavily silted and shaded area of freshwater with little submerged or emergent vegetation. There is also a small pond adjacent to the farm that is also heavily silted and shaded but does have some submerged vegetation and emergent vegetation beside the pond dipping platform.

The aquatic fauna was quite poor, although the Horse Pond was difficult to sample adequately and needs further survey work. Improved management of the freshwater resource is discussed in more detail later in the report.

Erythromma viridulum (Charpentier, 1840)

small red-eyed damselfly

Class: INSECTA

Order: ODONATA

Family: COENAGRIONIDAE

Survey Areas Recorded: Formal Gardens, Horse Pond

A relatively recent colonist of Britain with the first records of the species in 1999. The species spread rapidly and is now common in the South-East. Similar to the larger and more widespread red-eyed damselfly (*Erythromma najas*) and occupies similar standing freshwater habitat. Both species seem to require floating vegetation such as water-lilies.

Erythromma viridulum

At Great Dixter this species was present on the pond in the Sunk Garden and on Horse Pond, whereas the red-eyed damselfly was only present on Horse Pond. Its presence in the Sunk Garden seemed to be due to patrolling males investigating new habitat looking for females. Mating and egg-laying was only observed on the Horse Pond.

Platycnemis pennipes (Pallas, 1771)
white-legged damselfly

Class: INSECTA
Order: ODONATA
Family: PLATYCNEMIDIDAE
Survey Areas Recorded: Bottom Field, Plant Fair Field

An uncommon and local species of Southern Britain. The species breeds on slow flowing freshwater such as wooded streams and canals. The pale blue males are very distinctive due to the expanded white legs that are used in breeding display.

Platycnemis pennipes

The species was found hunting amongst woodland edge around the Bottom Field and Plant Fair Field. The species probably breeds outside of Great Dixter in suitable habitat not found within the gardens.

4. Conclusions

Overall the site is clearly of local and county importance for its invertebrates and is possibly of regional importance for its aculeate assemblage associated with High Weald meadow, orchard and woodland. The site has the potential for producing a very large list of bees, possibly approaching 120+ with further survey work.

The species tally of 676 is very good for essentially a year's worth of single surveyor walkover surveys and a small amount of pitfall trapping. To put this in context a similar survey using the same methodology at another, much larger, High Weald location, Hastings Country Park Nature Reserve, by four surveyors (including the author) produced a list of 750+ species. The actual number of invertebrates present at Great Dixter will number into the thousands but this will take many years of survey and monitoring work using different survey methods to produce. Beetles, flies, moths and parasitoid wasps should make up the bulk of the invertebrate diversity at the the site. Passive trapping

using Malaise traps, pan traps and more pitfall & light trapping will produce a great deal of new data on the invertebrate fauna of Great Dixter.

Sometimes within the nature conservation community the role gardens play in biodiversity conservation is forgotten or dismissed, and the term 'gardening' is used as derogatory term for intensive habitat management. Great Dixter, which is a very intensively managed garden, is without doubt a shining example of how much horticulture can play in invertebrate conservation. The influence of a popular and acclaimed public garden such as Great Dixter will also play an important role in shaping the way public green spaces, public gardens and private gardens are managed for biodiversity conservation. There is clearly great potential at Great Dixter for interpretation of biodiversity within a horticultural setting, and greater publicity for the commitment to conservation shown by the management of the gardens. The biodiversity blog should be incorporated into the main website and given greater prominence, also allowing visitors, volunteers and staff to add their own wildlife sightings.

The meadow creation around the gardens, especially with the purchase of new land, presents a great opportunity for a new High Weald meadow project, in partnership with Buglife, Natural England and the High Weald Partnership, centred around Great DIxter and the Northiam area.

There is still a great deal that can be done to improve meadow and woodland management within and around the gardens to continue the excellent work that has been carried out over the years by Christopher Lloyd and Fergus Garrett following their commitment to bringing nature into the gardens.

The following section below outlines some possible management recommendations for each of the survey areas and the overall management of the site.

4.1. Management Recommendations

4.1.1. Formal Gardens & Orchard

The main priority for the Formal Gardens should always be its planting and garden design, so little needs to be changed within the main gardens at Great Dixter. The policy of restricted pesticide use should be maintained except for the periodic control of serious pests.

The only serious insect pest found within the gardens was the waterlily leaf beetle (*Galerucella nymphaeae*), which is causing serious damage of waterlilies within Horse Pond and the Sunk Garden pond. The use of pesticides to control this pest would be ill advised due to the effect this would have on other aquatic invertebrates and subsequently on available prey for the great crested newt (*Triturus cristatus*) population within the gardens.

Provision of a continuity of nesting resources should be maintained throughout the gardens including the maintenance of log piles, and the use of local cut timber to make posts and fences within the gardens. Any opportunity to create green roofs on man-made structures should be carried out, and efforts to provide nest space in wooden posts through drilling of small burrow holes should be encouraged. If crumbling walls are to be repaired or re-pointed no more than two-thirds of the wall section should be repaired at any time to ensure a continuity of nesting resource.

Overall the diverse availability of pollen and nectar resources within the formal gardens and orchard should be maintained, limiting the use of double-flowered plants that block insect access to nectar.

The hay pile in the Orchard should be removed and replaced with a permanent log pile. A wide fire break should be created around the log pile using stone or compacted hardcore, then lay a mixed surface of crushed sandstone and sand from the pasture sand bank, framed by cut timber. Widely spaced posts can be installed around the log pile to ensure logs do not fall out and embossed with images of bees and long-horned beetles by an artist as subtle interpretation of the log piles purpose.

Currently most of the meadow areas within the gardens and Orchard flower at the same time and finish flowering at the same time. To increase the flowering period of semi-natural meadow at least half of the meadow areas should be cut in early summer and the rest cut in late summer/early autumn. A rotational cutting plan could be implemented trying a spring cut in some areas, early summer cuts, late summer cuts and some areas left to overwinter. To keep the meadow areas looking neat for visitors the edges of paths could be cut at the same time as areas selected for an early summer cut. This would greatly lengthen the meadow flowering period, provide ground nesting space for mining bees, improve the structure of the meadows for spiders and provide much needed overwintering seedheads and capitulum.

4.1.2. Horse Pond & Prairie

The Horse Pond is heavily silted and work to improve the pond should be focussed on de-silting the pond, but no more than than two-thirds of the pond should be de-silted at any one time. The eastern end of the pond should be a priority for de-silting as well as re-shaping the eastern end to provide a shallow basin in which submerged and emergent vegetation can develop providing an improved provision of wetland habitat resources which are scarce within the gardens. The silt, humus and soil extracted in this operation can be used within the gardens.

Any work to decrease nutrient levels within the Prairie should be undertaken. An over-wintering seed-head resource can best be provided in the Prairie. A rotational cutting and grazing regime can be planned to ensure a third of the Prairie is overwintered uncut, a third cut in spring and a third cut/grazed in late summer/autumn. A wide buffer along the woodland edge can be left longer, being cut

once in every two years. As always cut arisings should be removed and placed in one of the gardens habitat piles.

4.1.3. New Meadow

The main priority should be to remove the artificial honey bee hive within the New Meadow. It was very evident throughout the survey that the *Apis mellifera ligustica* colony was a detriment to pollinator conservation rather than a benefit. The reasons this subspecies is ideal for commercial pollination are also the reasons they are so bad for conservation. This subspecies has very high flower constancy, once a pollen resource is chosen and communicated throughout the hive that pollen resource is protected with competitive aggression. The small foraging range this subspecies maintains and its efficiency at exploiting and protecting that resource was clearly evident during the survey. The hive utilised three key pollen resources throughout the gardens and aggressively protected these resources even from honey bees from other local hives. In early spring the Orchard fruit trees were a key pollen resource for the hive. In late spring cotoneaster within the gardens was protected with such aggression that only male bumblebees and large *Eristalis* hoverflies were tolerated. In late summer/autumn black knapweed (*Centaurea nigra*) was territorially protected from most other pollinators, especially black knapweed within the New Meadow and the adjacent part of the Orchard.

The efficiency of black knapweed pollination by the hive may even be a factor that is favouring black knapweed growth within the New Meadow and the lower end of the Orchard allowing this plant to dominate in these two areas. Black knapweed is so dominant in the sward by late summer it almost has the appearance of a commercial crop in these areas lowering the potential for botanical diversity.

4.1.4. Plant Fair Field

This small survey area, which was not initially to be included in the survey, proved to be exceptional and without doubt the most speciose in terms of species/area within the Estate. It works so well as an example of man-made aculeate habitat creation that it would probably be foolish to suggest any changes. The legume rich meadow, wooden posts, hogweed rich woodland edge, log piles and bramble thickets provide a perfect storm of habitat resources to support a rich aculeate and hoverfly assemblage. Dense hogweed litter can be a problem over time enriching the soil favouring rough grasses, nettles and allowing bramble to spread into the meadow so any effort to remove hogweed litter during the meadow cut would be useful. Ground nesting habitat could be created along the top edge of the meadow by creating sand banks with some of the sand bank spoil in the adjacent sheep pasture. Sand nesting digger wasps such as *Oxybeles uniglumi*s and *Crabro peltarius* were clearly using the hogweed to forage and log piles to hunt so creation of small south-facing sand banks along the top border of the meadow would only be beneficial.

Disturbance during the popular plant fairs in spring and autumn is actually beneficial creating a variable structure to the meadow vegetation. So there is no need to protect any area within the meadow from disturbance during the plant fairs.

4.1.5 Bottom Field & Four Acre Shaw

Any project to improve the botanical diversity of the pasture would be beneficial but it is highly recommended to create meadow or lightly grazed pasture that is rich in legumes, labiates and yellow composites. There is great potential both here and with the purchase of the pasture connecting the gardens to Weights Wood to create a large area of legume and labiate rich grassland that will benefit many of the UKBAP bees present at Great Dixter.

The sand bank at the top of the pasture has potential for creating habitat for ground nesting invertebrates. A number of possible projects include using the sand to create banks within the south-facing grassland. This could affect the ability to improve and manage the field so the bank is probably best left in situ and cleared of vegetation to create an open south-facing bank of sand for ground nesting aculeates. In addition to this some of the sand could be used to create sand banks within Plant Fair Field, especially along the top edge of the meadow.

The woodland edge around the pasture, which is the boundary with Four Acre Shaw, could be improved by allowing a scrubby edge to develop out into the pasture, although this will diminish the amount of grassland available. Alternatively scallops could be cut into the shaw and cut on rotation to maintain an improved edge.

4.1.6. Weights Wood

A coppice rotation needs to be maintained to produce a continuity of coppice at different stages of succession. Recently cut coppice is of particular importance for invertebrates providing cut timber, open sunlit ground and a flush of ground flora.

Ride maintenance needs to continue to widen rides and improve vegetation structure and ecotone along the ride edges. Sunlit clay banks along the edges of rides are of particular importance for early spring mining bees, especially species that forage on sallow blossom and other early spring flowering scrub and trees.

It is important to check the sallow within the wood for purple emperor (*Apatura iris*) larvae and abundance of early spring foraging bees before any clearance of sallow, and aspen, takes place.

Twig jams and fallen timber within streams, seepages and temporary ponds should be left in situ and not removed as these are very important breeding sites for scarce woodland Diptera. It is usually

best to leave ponds to silt up naturally within woodland and dig new ponds if suitable areas within the woodland floor are available.

4.2. Further Survey Work

Due to the importance of the site for invertebrates continued work should be carried out focussed around the monitoring of pollinators and further survey work on Coleoptera, Diptera and Lepidoptera.

A five year project of monitoring work should be established using pan traps, malaise traps, light traps and further walkover surveys to monitor invertebrate diversity. Also monitoring work should focus on many of the UKBAP, rare and scarce species described in this report.

5. Acknowledgements

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Appendices

1. Great Dixter Invertebrate Survey Report Data & Species List

2. Great Dixter Invertebrate Survey Records Update 2018

3. Great Dixter Invertebrate Survey October 2018 Update