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Appendix 8.2 – Terrestrial Invertebrate Survey Report

APFP Regulation 5(2)(a)

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Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

The A47/A11 Thickthorn Junction Development Consent Order 202[x]

ENVIRONMENTAL STATEMENT APPENDICES
Appendix 8.2 – Terrestrial Invertebrate Survey Report

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A47/A11 THICKTHORN JUNCTION

Terrestrial Invertebrate Survey Report

[redacted] FRES

On behalf of [redacted] for [redacted]

SEPTEMBER 2020

Left - *Omophron limbatum*; Right *Cerceris quinquefasciata.* Two of the Nationally Rare species recorded during this survey.

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Executive summary

[redacted] was commissioned by [redacted] in response to proposed works at the A47/A11 Thickthorn Junction to the southwest of Norwich (the site). This report details the terrestrial invertebrate surveys. This survey same sampled the same areas as the 2017 survey.

The proposed area includes woodland, old/ancient oaks scattered trees, semi-improved grassland, improved grassland, arable, tall ruderal, waterbodies, watercourses and hedgerows. A full terrestrial invertebrate survey was conducted in 2020 with a range of sampling techniques used during four visits in May, June, July and August.

502 species were recorded during the surveys, including **27 species of conservation concern**. The following Nationally Rare species were recorded: the beetles *Omophron limbatum*, *Quedius dilatatus* and *Aulonothroscus brevicollis*; the solitary wasps *Cerceris quinquefasciata* (BAP S41 species) and *Hedychrum niemelai* and the tachinid fly *Cistogaster globosa*. *C. quinquefasciata*.

Several of the species of conservation concern are associated with the dead/decaying wood. The most valuable habitats in the survey area are the old and veteran oaks and Area A. Significant oak trees and old hedgerows are found in D1, D2 and D3. An oak tree in D3 (TG 17978 05132) is very likely of county/national significance because of its great age and veteran features. This one tree will support a huge assemblage of specialist animals.

The proposed road scheme could enhance the area for terrestrial invertebrates if it is planned and executed in a sympathetic manner with the appropriate mitigation. The creation of habitat corridors alongside the route linking existing habitats and created habitats further from the route will benefit terrestrial invertebrates in what is currently a largely sterile agricultural landscape. Creating a mosaic of habitats (species rich grassland, bare ground, scrub, woodland and waterbodies) alongside both sides of the route and creating valuable habitat that will improve connectivity through the landscape.

The monitoring of protected habitats, created habitats and mitigation measures after the development is recommended.

1 Introduction

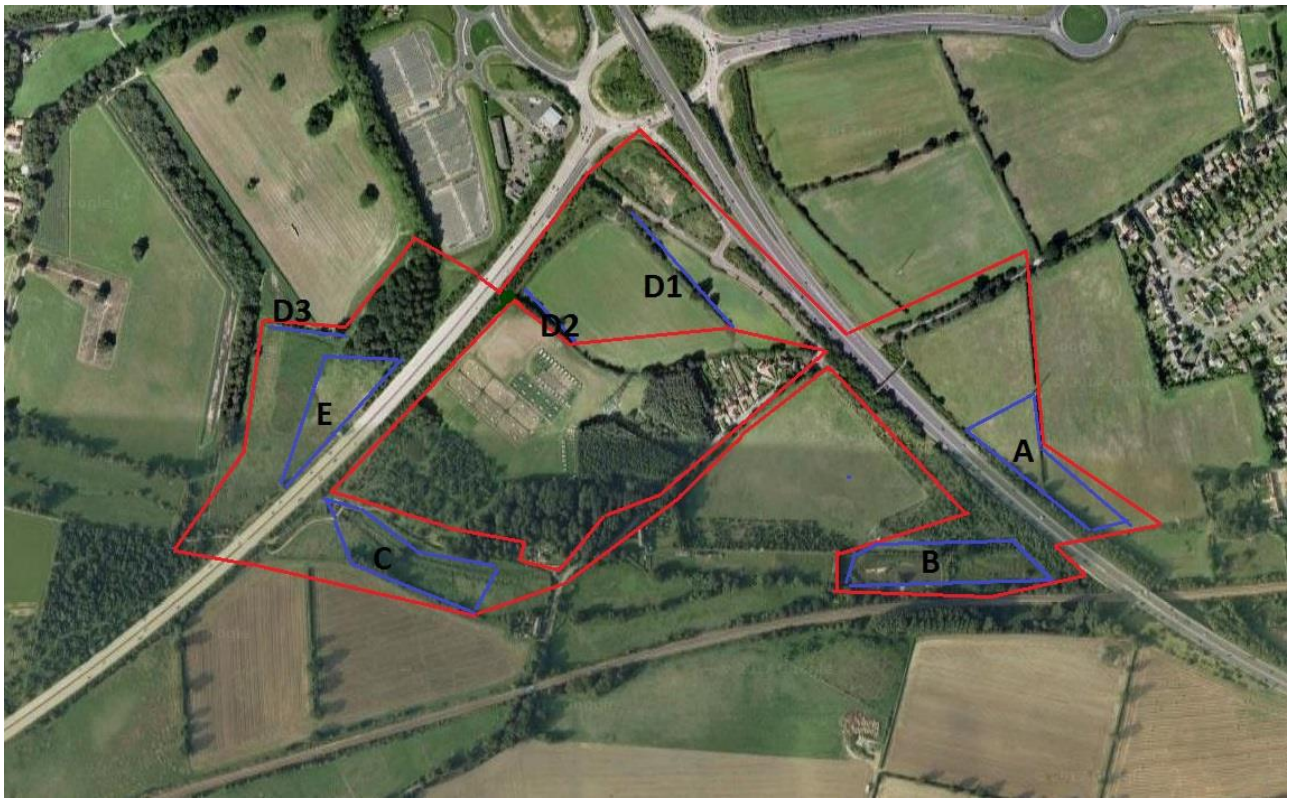
1.1 Overview

This survey was commissioned by [redacted] in response to proposed works at the A47/A11 Thickthorn Junction to the southwest of Norwich (the site). The scope of the survey is to identify terrestrial invertebrate species present on the site, with the emphasis being on insects. The results of the survey are used to evaluate the quality of the site and to offer recommendations for mitigation that focus on damage limitation, and on creating habitat and preserving associated insect assemblages. This report summarises the results of four site visits between May and August 2020. A survey was conducted on the site in 2017.

1.2 Site location and setting

The site is centred on TG1834205256 and consists of arable farmland, field margins, grassland, ancient hedgerows, mature and veteran trees and pond edge. Figure one shows the site and the survey areas. For the purposes of comparison, the survey areas are the same as those investigated by [redacted] in 2017 ([redacted], 2017).

Figure 1: Site location plan and survey areas (taken from [redacted], 2017)



1.3 Aims and objectives

1.3.1 Aim

The aim of the survey was to sample the terrestrial invertebrate fauna of the site and make recommendations for mitigation in view of the proposed road scheme.

1.3.2 Objectives

- To review previous survey reports of the site;
- To conduct a terrestrial invertebrate survey of the area;
- To produce a report including findings, an evaluation of key habitat and species assemblages and an appraisal of the potential conservation value of the site's habitats for invertebrates;
- To provide recommendations for mitigation, further surveys and monitoring.

2 Methodology

2.1 Desk study

Prior to conducting fieldwork, the previous survey report was reviewed.

2.2 Field survey

2.2.1 Timing

The accurately reflect the invertebrate diversity of the sites, four surveys were conducted during the summer of 2020:

- 14th May
- 23rd June
- 27th July
- 19th August

Target notes were made to reference both features of value as invertebrate habitat and general habitat as an aide-memoire. A photographic record was also made of key features recorded during the survey, these providing resolution to target note data.

2.2.2 Sampling

During each visit, the following sampling protocol was employed in each of the discrete survey areas:

- 1 x 10 minutes transects with a sweep net where vegetation is vigorously swept;
- 1 x 2 min suction samples with vacuum sampler;

- 20 mins of beating scrub and taller vegetation with a beating tray;
- Vane traps for the sampling of saproxylic invertebrates – only deployed on old/veteran trees;
- Direct searching and spot sampling.

Sweep sampling allows the capture of terrestrial invertebrates in the sward and dense vegetation, including very mobile species. The vacuum sampler allows the capture of ground-dwelling species, including leaf-litter and tussock dwelling invertebrates. Vane traps are a very effective means of sampling of saproxylic invertebrates, especially beetles. The animals fly into the transparent vanes and drop into the preservative-filled container. These can be left in situ for the duration of a survey and emptied once a month.

The methodology broadly follows methods outlined in NERR005 (Drake *et al*., 2007), a manual produced by Natural England, which sets out standard approaches to invertebrate survey and analytical techniques for the purposes of conservation evaluation.

2.2.3 Limitations

Every effort was made to record habitat features of potential conservation value for invertebrates at a suitable resolution to inform a robust scoping study. However, the recognition of key habitat features with potential to support important invertebrate species or species assemblages is based on knowledge and experience. It cannot be guaranteed that habitats considered to have high conservation potential would be confirmed as such if surveyed in detail, or conversely, some habitat features supporting uncommon species or species assemblages may have been overlooked during the survey.

In addition, access limitations reduced the potential to survey in sites the optimal weather conditions so some species and groups may have been missed by this.

3 Results

3.1 Desk study

The previous survey conducted in 2017 by [redacted] comprised seven visits between 13th April and 25th August. The report of this survey was reviewed.

3.1.1 Species

The 2017 recorded 598 species. Four species of category Nationally Rare (Red Data Book) status were recorded; the ground beetle *Omophron limbatum*, the rove beetles *Cypha seminulum* and *Tachinus flavolimbatus* and the Five banded Weevil wasp *Cerceris quinquefasciata*. The latter species is also a BAP Priority Species, covered under Section 41 of the NERC Act (2006). The only other NERC Section 41 species observed was the Cinnabar moth *Tyria jacobaeae*. This is only of BAP Priority (Research Only)

status and therefore of no importance for conservation of the site. Eighteen Nationally Scarce were also recorded.

3.2 Field survey

3.2.1 Survey areas

The areas covered during the survey are shown as A to E in Figure 1. These areas were the same as those sampled during the 2017 survey. The following is taken from Lane 2017.

Area A

A large block of grassland and disturbed ground east of the A47 comprising heavily rabbit grazed short turf, with ragwort *Senecio jacobaea* , mullein *Verbascum* sp , St John's wort *Hypericum* sp. and weld *Reseda lutea* and much exposed substrate. The grassland extends further south towards horse grazed paddocks (just south of red site outline) where it becomes relatively less close cropped but equally species rich botanically. An area of marginal wet mud (flooded in spring and early summer) is present along the north edge of the easternmost pool, grading into a gravelly area with prostrate vegetation.

Area B

Fishing pools and scrambling track with earth banks. Pools of particular interest for emergents. Towards the north western corner of the western pool is a small eroding earth bank. An area of marginal wet mud (flooded in spring and early summer) is present along the north edge of the easternmost pool, grading into a gravelly area with prostrate vegetation.

Area C

Stream meandering through pasture/improved grassland and bordered by shallow wet mud margins with quantity of watercress *Rorippa* and other marginals. Some stands of emergents also present. At the south edge of the pasture is a hedge line with hawthorn *Crataegus* and oaks *Quercus*, none of great age. The hedge at the northern boundary is more interesting with several old oaks with decay features.

Areas D1, D2 and D3

Three hedge lines at the edge of arable fields containing mature/ancient oaks *Quercus*. The hedges also contain hawthorn *Crateagus monogyna* and elder *Sambucus nigra*. In D3 is perhaps the most significant oak in the entire site, a hollowed veteran tree of great age. There are also significant trees in D1 and D2. These significant trees all have potential for deadwood invertebrates and were sampled with vane traps.

Area E

A large block of grassland gently sloping south eastwards down towards the A11 dual carriageway. Mainly rough grassland with docks *Rumex* and thistle *Cirsium* etc. Much of the area in the south section has been planted up with trees. Much rabbit activity is evident with scrapes, diggings and areas of short turf particularly along the eastern perimeter of this compartment.

3.2.2 Invertebrate species recorded in 2020

502 invertebrate species were recorded (see Appendix for full list). Of these, 27 had some degree of conservation status. The most notable of these are listed in Table 1. The ground beetle *Omophron limbatum* and the five-banded digger wasp were recorded in the 2017 survey and in the same locations. The rove beetle *Quedius dilatatus* and the throscid beetle *Aulonothroscus brevicollis* were both found in vane traps positioned on large oak trees. The former is thought to be increasing its range and the latter is more frequently encountered as vane traps are increasingly used; therefore, the conservation status of both of these needs to be reviewed.

Table 1: Most notable species recorded during the 2020 survey.

Scientific name	Common name	Conservation status	Areas/habitat
Omophron limbatum	A Ground Beetle	Nationally Rare	B
Quedius dilatatus	A Rove Beetle	Nationally Rare (RDB1)	C, D3
Aulonothroscus brevicollis	A Throscid Beetle	Nationally Rare (RDB1)	D3, E
Cerceris quinquefasciata	Five-banded Weevil Wasp	BAP, S41 Species (RDB3)	A
Hedychrum niemelai	A Cuckoo Wasp	Nationally Rare (RDB3)	A
Cistogaster globosa	A Tachinid Fly	Nationally Rare (RDB1)	A

Carabid beetle *Omophron limbatum*. This distinctive beetle was first reliably recorded in Great Britain as recently as 1969 and thought to be a recent coloniser or re-coloniser. It is currently known from East Anglia, East Sussex and East Kent. Previously only recorded from discrete populations, but thought to be expanding its range or just being better recorded, certainly in Norfolk where it has been found at a good number of additional sites in recent years. At Thickthorn there is a small population in the sandy eroding bank of the westernmost fishing pool in Area A at TG18720486.

Hornet rove beetle *Quedius dilatatus*. This large rove beetle is associated with hornets – both the larvae and adults live in the debris that accumulates under the nest in tree cavities. The adults are also to be found on sap runs where they predate other insects. It appears to be expanding its range, tracking the range expansion of hornets. Individuals were found in vane traps in Area C and D3.

Throscid beetle *Aulonothroscus brevicollis.* This small beetle is associated with dead/decaying wood, but little else is known of its ecology. In recent years it has been more widely recorded as vane traps are

increasingly used to sample this habitat. Two individuals were found – one in the vane trap in D3 and via sweeping in Area E (very close to the ancient oak in D3).

Five banded weevil wasp *Cerceris quinquefasciata*. This medium-sized solitary wasp is a predator of weevils and makes its nest in areas of bare or sparsely vegetated ground. It is a BAP Priority species and is listed in Section 41 of the NERC (Natural Environment and Rural Communities) Act 2006. This Act requires relevant authorities to have regard for conservation and biodiversity when carrying out their functions. Two individuals of this wasp were found in pan traps in Area 2.

Cuckoo wasp *Hedychrum niemelai*. This beautiful wasp is a cuckoo of Cerceris rybyensis and perhaps *Cerceris quinquefasciata*. It lays its eggs in the nests of its hosts and the larva feed on the host egg and provisions in the nest. It is thought to be expanding its range. Several individuals were found in Area.

Tachinid fly *Cistogaster globosa.* This fly was allocated RDB1 status by Shirt (1987) and Falk (1991). The most recent review (Falk & Pont in preparation) has provisionally accorded the species RDB2 status. It is known from a few localities in Southern England and is a distinctive species unlikely to be overlooked and probably genuinely rare. The species parasitises heteropteran bugs, in Europe the shieldbug *Aelia* (Pentatomidae), mostly *A. acuminata* (Belshaw 1993), the only species of the genus found in Britain. The egg is laid on the dorsal surface of the host's abdomen and the larva leaves the host to pupate in the ground. The fly appears to favour dry grassland where the host is predominately found. A single individual was found in Area A.

3.2.3 Pantheon analysis

The species lists obtained for the site were analysed with Pantheon. Pantheon is an online resource for recording and analysis of invertebrate assemblages developed jointly by the CEH and Natural England became available. The resource includes a modified version of ISIS which was formerly available in spreadsheet form and then as trial versions. However, these versions were used extensively both for common standards monitoring of entomological features of SSSIs and for EcIA purposes.

The Species Quality Indices (SQIs) reflect the proportion of rarities attributed to an assemblage and scores of around 100 generally indicate assemblages comprised of a high proportion of common species. In broad terms, scores of around 140 indicate the presence of assemblages of some conservation value. However, it is important to note that Species Quality Indices (SQIs) calculated from less than 15 species may not be reliable.

Table 2: Habitats & Resources – Broad Biotopes

Broad biotope	No. of species	% representation	SQI	Species with conservation status	Conservation status
open habitats	291	7	110	12	NS|[RDB 3]|Nb|Section 41 Priority Species|[Nb]|Section 41 Priority Species - research

					only|NS|NS|Nb|Nb|[RDB 3]|Section 41 Priority Species|[RDB 3]
tree-associated	137	4	147	10	Nb|NS|Nb|RDB 1|NS|RDB 3|Notable|NS|NS|Notable
wetland	39	1	131	1	NR

Table 3: Habitats and Resources – Habitats

Broad biotope	Habitat	No. of species	% representation	SQI	Species with conservation status	Conservation status
open habitats	tall sward & scrub	209	8	101	2	[Nb]|Section 41 Priority Species - research only
open habitats	short sward & bare ground	71	5	134	9	Section 41 Priority Species|[RDB 3]|NS|Nb|Nb|NS|Nb|[RDB 3]|Section 41 Priority Species|NS
tree-associated	arboreal	62	5	105	1	NS
tree-associated	decaying wood	60	5	203	9	Notable|Nb|NS|Nb|RDB 1|RDB 3|Notable|NS|NS
wetland	marshland	21	3	125		
tree-associated	shaded woodland floor	19	2	100		
wetland	peatland	12	1	100		
wetland	running water	11	1	164	1	NR
wetland	lake	3	2	100		
wetland	wet woodland	2	<1	100		
tree-associated	wet woodland	2	<1	100		
open habitats	upland	1	<1	100		

Table 4: Habitats and Resources – Specific Assemblage Types

Broad biotope	Habitat	SAT	No. of species	% representation	SQI	Species with conservation status	Conservation status	Code	Reported condition
tree-associated	decaying wood	bark & sapwood decay	36	7	175	4	Nb|Nb|Notable|NS	A212	Favourable

open habitats		scrub edge	19	8	116			F001	Favourable
open habitats	short sward & bare ground	open short sward	15	8	120	1	Nb	F112	Favourable
open habitats	short sward & bare ground	bare sand & chalk	13	3	215	5	Section 41 Priority Species|Nb|NS|Nb|NS|[RDB 3]	F111	Unfavourable (13 of 19 species)
tree-associated	decaying wood	heartwood decay	11	6	409	5	NS|RDB 3|Notable|RDB 1|NS	A211	Favourable
open habitats		rich flower resource	9	4	100			F002	Unfavourable (9 of 15 species)
open habitats		scrub-heath & moorland	4	1	100	1	[RDB 3]	F003	Unfavourable (4 of 9 species)
tree-associated	decaying wood	fungal fruiting bodies	3	3	100			A213	Unfavourable (3 of 7 species)
wetland	peatland	reed-fen & pools	2	2	100			W314	Unfavourable (2 of 11 species)
tree-associated	decaying wood	epiphyte fauna	1	5	100			A215	Unfavourable (1 of 3 species)
wetland	running water	riparian sand	1	2	800	1	NR	W122	Unfavourable (1 of 5 species)

4 Discussion

4.1 Discussion of results

The previous survey ([redacted], 2017) reported 22 species of conservation concern from the site, four of which are considered to be Nationally Rare.

On a landscape (broad biotope) level, the Pantheon analysis attributed 291, 137 and 39 species to 'open habitats', 'tree-associated' and wetland', respectively (Table 2). Proportionately, the 'Open habitats' and 'tree associated' classifications support 7% and 4%, respectively, of the national pool of species attributed in the Pantheon database. These findings would be expected in consideration of sampling effort being concentrated largely on open habitats with abundant trees.

On the Pantheon 'habitat' level tier, there were six assemblages attributed with a sufficient number of species recognised in ISIS to be considered robust, i.e. >15 species (Table 3). 209 species were attributed

to the ‘tall sward and scrub’ assemblage, which basically includes species associated with taller grassland, scrub and scrub edge habitats. 71, 62, 60, 21 and 19 were attributed to ‘short sward and bare ground’, ‘arboreal’, ‘decaying wood’, ‘marshland’, ‘shaded woodland floor’, respectively.

The ‘decaying wood’ habitat supports a fauna of some conservation value as the SQI (species quality index) score is 203. If compared with the threshold score set in ISIS for an assemblage to be considered in ‘Favourable Condition’ (FC), i.e. equivalent to an assemblage of National importance, a score of 203, which is significantly higher than the threshold target of 160.

In conservation assessment Specific Assemblage Types (SATs) are generally regarded as the most valuable metrics for assessing site quality (Table 4). This is because SATs are made up of species with a high degree of habitat specialisation. Such species tend to be both uncommon and representative of sites supporting habitat of quality in terms of conservation value. However, SATs often require targeted sampling of specific habitat features and are not always well represented in broad-brushstroke surveys designed to gain an overall, or baseline assessment of a site’s value.

From the Pantheon output the SAT with the highest SQI and a number of species high enough to provide a reliable result was ‘bark and sapwood decay’ (SQI 175). The SQI for ‘heartwood decay’ was 409, but the number of species in this SAT was 11, which is slightly short of the threshold of 15. This limits the reliability of the result. Likewise, the SQI for ‘bare sand and chalk’ was 215, but the number of species in this SAT was 13.

In terms of total area, much of the site is of limited value to terrestrial invertebrates because of the large areas of agricultural land. In terms of invertebrate conservation, the most interesting habitats across the site are veteran trees with decay features, botanically rich grassland with a short sward and an abundance of bare ground.

5 Mitigation recommendations and further work

5.1 Introduction

This section of this report outlines the mitigation proposed to protect the most valuable habitats for terrestrial invertebrates and enhancing the overall area, so it supports a greater diversity of these animals. This section does not constitute a full outline of the mitigation on the site, this will be provided and will be evolved during detailed design. Throughout determining the mitigation to be implemented, the mitigation hierarchy of avoid, mitigate, compensate, enhance is followed.

5.2 Design mitigation

5.2.1 Avoidance of impacts to invertebrate populations (design)

In line with the mitigation hierarchy, the first step of the proposed mitigation for impacts to invertebrate populations will be avoidance. Within the development, all the most valuable habitats should be retained and buffered. Specifically, these are all the old/ancient trees and the grassland in Area A.

Table 5: Summary of habitats – value to invertebrates, impact of development and appropriate mitigation

Survey Area	Value to invertebrates	Recommendation	Mitigation
A	Moderate/High Botanically rich grassland with bare ground. *Cerceris quinquefasciata, Hedychrum niemelai* and *Cistogaster globosa* all recorded here	Retain and protect	Protect from development work and negative impacts of new road. e.g. light pollution, air and water pollution. Create similar habitats
B	Moderate Fishing pools, associated edges and scramble tracks. *Omophron limbatum* recorded here	Retain what is practical	Create of similar habitats
C	Low/Moderate Improved pasture, ditch/stream and old oaks in hedgerow. *Quedius dilatatus* recorded here	Retain oaks	Create buffers around oaks and plant with native nectar sources
D1, D2, D3	High Hedgerows with old/veteran oaks. *Quedius dilatatus* and *Aulonothroscus brevicollis* recorded here	Retain, protect and enhance	Protect from development work and negative impacts of new road. e.g. light pollution, air and water pollution
E	Low/Moderate Grassland with planted trees	Retain what is practical. Retain and protect veteran oak	Create buffers around oaks and plant with native nectar sources

5.2.2 Habitat design mitigation

The main negative impacts of the road would be as follows:

- The loss of valuable existing habitats
- Damage to existing habitats
- A barrier to dispersal for many terrestrial invertebrates
- Light pollution
- Air pollution
- Water pollution

Each of these and the appropriate mitigation is discussed below.

5.2.2.1 Habitat loss mitigation

Much of the proposed route is across agricultural land, which has very little value for terrestrial invertebrates. Some areas of more valuable habitat will be lost, but, on the whole, this can be compensated for by the creation of new habitats. The entire length of the proposed new road could be designed with nature in mind to create a ribbon of valuable habitat through the landscape. With sufficiently wide margins, embankments and SUDs the road could offer a mosaic of habitats from woodland, scrub, florally diverse grassland, bare ground and waterbodies. Indeed, if designed and executed correctly this would be considerably better for nature than the agricultural landscape through which it passes.

South facing embankments lend themselves to the creation of species rich grassland and scrub with areas of bare ground. The Weymouth Relief Road (WRR) in Dorset is a perfect example of how a road scheme if planned and executed correctly can transform an otherwise sterile agricultural landscape into a haven for wildlife. Butterflies are useful bioindicators and in this respect the WRR has had a huge positive impact. When the WRR was opened in 2011, only two species of butterfly were recorded, but by 2018 this number had jumped to 30.

Some of the learnings from the WRR project can be applied here. It is crucial that the retained habitats are enhanced and better connected so that animals can more easily move through the landscape. An interesting design mitigation to offset any losses of habitat along the proposed route would be the creation of habitat to better connect more valuable resources, especially old/veteran trees.

The degree to which linear transportation infrastructure verges constitute a habitat and/or a corridor for insects in temperate landscapes is presently unclear (Villemay *et al.* 2018). There is currently limited evidence on how wide the margin/verge should be or what the plant species/habitat composition should be (Villemay *et al.* 2018).

The loss of any old hedgerows or old/veteran trees is difficult/impossible to mitigate for. These habitats support a rich community of dead-wood associated terrestrial invertebrates that have very specific habitat

requirements. Simply cutting existing trees and leaving the timber in a buffered area will only provide habitat for a small proportion of these species. Providing dead wood in a range of situations, e.g. on the ground and standing dead will support a greater range of species, but efforts must be made to offer a continuity of dead-wood resources in the greater landscape, planting nectar sources and facilitating the dispersal of species by improving habitat connectivity. Any old/veteran trees must be protected and buffered.

Nectar sources are especially important for many dead-wood insects when they emerge as adults. Native shrubs and trees should be planted to offer a better and more complete sequence of nectar sources. Cherry plum, goat willow, blackthorn and hawthorn will provide nectar from February until late May. This sequence can be further enhanced with further willows, wild cherry, apple, pear, wayfaring tree, field maple, dogwood, etc. This sequence of nectar sources would also benefit a huge range of other species and should be employed throughout the development.

5.2.2.2 Damage to retained habitats mitigation

Buffers must be established around the retained high value habitats. This is especially important for old/veteran trees as they are among the most valuable habitats in the area. The same also applies for Area A, but it is still not clear exactly how far the proposed route will be from this habitat. It is important that these habitats are buffered from disturbance during the development to prevent contamination of the air and groundwater.

5.2.2.3 Barrier to dispersal mitigation

Roads negatively affect the abundance and diversity of insects because it is a physical barrier to movement. Some groups of insects are strong fliers, but mortality of these will be high when they are crossing the road (Muñoz *et al.* 2015). Many other terrestrial invertebrates have very poor dispersal ability and roads are sufficiently wide to act as barriers to flying insects (Andersson *et al.* 2017).

I have demonstrated in my research that the populations of some species can be isolated from one another by seemingly insignificant barriers, such as small areas of unsuitable habitat (Piper and Compton 2003). In this regard, a road without wildlife corridors could completely prevent the movement of some species through the landscape.

Connecting retained habitats and created habitats will benefit all fauna and flora in the area. A margin of mosaic habitat either side of the road that connects to retained and created habitats would prevent the road becoming a barrier to dispersal.

5.2.2.4 Light pollution mitigation

Light pollution during the works and from the lights on the completed road will have an impact on the populations of terrestrial invertebrates. It has been shown in many studies that artificial light at night (ALAN) has a negative impact on insects (Grubisic *et al* 2018). ALAN can increase overall environmental pressure

on insect populations, and this is particularly important in agroecosystems where insect communities provide important ecosystem services (such as natural pest control, pollination, conservation of soil structure and fertility and nutrient cycling), and are already under considerable environmental pressure (Grubisic *et al* 2018).

Valuable, retained habitats are sufficiently close to the proposed route for light pollution to be an important consideration. Nocturnal species in these habitats will be drawn to the artificial lighting used during the development and the lights illuminating the finished road.

To mitigate the impact of light pollution it is recommended that lighting be used sparingly and only where necessary during the development and on the completed road. Where artificial lighting is crucial units should be used that illuminate specific areas without producing lots of 'waste' light. Lighting units should also use wavelengths of light that are less attractive to nocturnal insects. White/bluish wavelengths are much more attractive to nocturnal insects than orange wavelengths.

5.2.2.5 Air pollution mitigation

The traffic travelling along the proposed route will lead to an increase local air pollution, but it is unclear how this compares to the current agricultural pollution of the area. The deposition of nitrogen (in the form of nitrous oxide) from motor vehicles, especially near busy roads, means that fossil fuels are also a major contributor to soil nitrogen levels (NERC 2005). Direct effects may occur in the immediate vicinity of major roads and in urban areas, caused by high NOx emissions from vehicles. NOx may lead to ground flora changes related to eutrophication (APIS 2019).

In the habitats that have been studied in any detail this eutrophication can lead to grasses becoming dominant at the expense of overall species diversity (Baxter and Farmer 1994). Broadly, lower plant diversity will result in lower diversity of terrestrial invertebrates.

Near a major road, these changes to the vegetation can be detected up to 200m from the carriageway (Angold 1997). Near smaller roads the effect is less far reaching and there is a positive correlation between traffic density and the width of the zone that is seen to be affected (Angold 1997). The build of vehicle-borne nitrogen in roadside habitats is likely to cumulative, so that the impact of a road on roadside wildlife will increase with time (Bobbink et al. 1990).

The switch to electric vehicles will reduce the amount of nitrogen entering road-side habitats, but it will be several decades before these account for the majority of vehicles on our roads. Buffer zones to minimise the input of pollution from vehicle exhausts are recommended. These could consist of a margin of trees and tall shrubs nearest to the road with grassland and scrub communities further away from the road.

5.2.2.6 Water pollution mitigation

The surface run-off from the new road will carry a range of pollutants. All measures must be used to prevent this surface water entering existing water bodies, especially those in high value habitats.. The creation of SUDs in appropriate places along the route will allow for the collection of this run-off.

5.3 Additional mitigation

In addition to the design mitigation above, during detailed design and construction of the development, it is likely that additional actions may be required to safeguard the current invertebrate populations. These actions may include:

- Clear demarcation of areas that are to be retained with minimal disturbance to the buffers. Many species of invertebrate overwinter as eggs, larvae or adults in the soil, leaf-litter, under bark, etc. so it is imperative that these habitats are not disturbed in the buffers surrounding the more important retained habitats;
- Any large pieces of dead wood to be retained and buffered.
- Large, clear boundaries around the retained areas to protect from machinery, excavations and general disturbance;
- Habitat creation and management plans to be evolved with the detailed design and phasing of the development (i.e. outlining the habitats within the development parcels) to create and enhance habitats;
- Habitat manipulation to displace invertebrates into retained habitats adjacent to habitats to be removed;
- It is imperative that the long-term management of the habitats (both retained and created) be agreed before the development. In addition, the management should be for communities -specifically the saproxylic and short sward/bare ground assemblages - rather than for single species.
- The planting of native nectar sources to provide a blossom sequence that will benefit many terrestrial invertebrate species. Cherry plum, goat willow, blackthorn and hawthorn will provide nectar from February until late May. This sequence can be further enhanced with further willows, wild cherry, apple, pear, wayfaring tree, field maple, dogwood, etc.
- The creation of species grassland, scrub and bare ground habitats.

6 Conclusions

A full terrestrial invertebrate survey was conducted in 2020 with a range of sampling techniques used during visits in May, June, July and August.

502 species were recorded during the surveys, including **27 species of conservation concern**. The most notable species recorded during the surveys were the beetles *Omophron limbatum*, *Quedius dilatatus* and *Aulonothroscus brevicollis*; the solitary wasps *Cerceris quinquefasciata* and *Hedychrum niemelai* and the tachinid fly *Cistogaster globose.*

Several of the species of conservation concern are associated with the dead/decaying wood. The most valuable habitats in the survey area are the old and veteran oaks and Area A. Significant oak trees and old hedgerows are found in D1, D2 and D3. An oak tree in D3 (TG 17978 05132) is very likely of county/national

significance because of its great age and veteran features. This one tree will support a huge assemblage of specialist animals.

The proposed road scheme could enhance the area for terrestrial invertebrates if it is planned and executed in a way that sympathetic to nature conservation. The creation of habitat corridors alongside the route linking existing habitats and created habitats further from the route will benefit terrestrial invertebrates in what is currently a largely sterile agricultural landscape. Creating a mosaic of habitats alongside both sides of the route, creating valuable habitat between retained and protected areas will improve connectivity through the landscape.

The monitoring of protected and created habitats after the development is recommended.

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APPENDIX A: SPECIES LIST FOR THIS SURVEY

Status Key: Nb= Notable B; NS= Nationally Scarce; NR= Nationally Rare; N= Notable; NA= Not assessed; RDB3= Red Data Book 3; RDB1= Red Data Book 1; S41= Section 41 priority species; S41-R= Section 41 priority species – research only

Species	Common Name	Survey Area	Status
Coleoptera - Beetles			
Agonum muelleri	A Ground Beetle	A	
Agonum viduum	A Ground Beetle	B, E	
Amara aenea	A Ground Beetle	E	
Amara convexior	A Ground Beetle	A	
Amara ovata	A Ground Beetle	E	
Amara plebeja	A Ground Beetle	A, D3	
Amara tibialis	A Ground Beetle	E	
Anchomenus dorsalis	A Ground Beetle	C	
Asaphidion stierlini	A Ground Beetle	C	
Badister bullatus	A Ground Beetle	E	
Bembidion lampros	A Ground Beetle	A, D2, E	
Bembidion lunulatum	A Ground Beetle	B, C	
Bembidion properans	A Ground Beetle	B, C, E	
Bembidion quadrimaculatum	A Ground Beetle	A, D2	
Calathus fuscipes	A Ground Beetle	B, E	
Calathus melanocephalus	A Ground Beetle	A	
Demetrias atricapillus	A Ground Beetle	E	
Dromius quadrimaculatus	A Ground Beetle	C	
Harpalus rufipes	A Ground Beetle	C, D1	
Loricera pilicornis	A Ground Beetle	C, E	
Nebria brevicollis	A Ground Beetle	C, E	
Notiophilus substriatus	A Ground Beetle	A	
Omophron limbatum	A Ground Beetle	B	NR
Paradromius linearis	A Ground Beetle	A, E	

Paranchus albipes	A Ground Beetle	C	
Pterostichus madidus	A Ground Beetle	All Areas	
Pterostichus melanarius	A Ground Beetle	All Areas	
Pterostichus strenuus	A Ground Beetle	C	
Syntomus foveatus	A Ground Beetle	A	
Trechus obtusus	A Ground Beetle	A, B	
Anotylus nitidulus	A Rove Beetle	C	
Anotylus sculpturatus	A Rove Beetle	A	
Bisnius fimetarius	A Rove Beetle	C	
Cypha longicornis	A Rove Beetle	C	
Drusilla canaliculata	A Rove Beetle	A, E	
Gabrius breviventer	A Rove Beetle	C, D1	
Lesteva longoelytrata	A Rove Beetle	D2, D3	
Metopsia clypeata	A Rove Beetle	C, E	
Oxytelus laqueatus	A Rove Beetle	D3	
Paederus riparius	A Rove Beetle	E	
Philonthus carbonarius	A Rove Beetle	E	
Philonthus cognatus	A Rove Beetle	E	
Philonthus sanguinolentus	A Rove Beetle	A, E	
Quedius semiobscurus	A Rove Beetle	E	
Sepedophilus nigripennis	A Rove Beetle	E	
Stenus cicindeloides	A Rove Beetle	C	
Stenus clavicornis	A Rove Beetle	C	
Stenus flavipes	A Rove Beetle	B, C	
Stenus fulvicornis	A Rove Beetle	C	
Stenus impressus	A Rove Beetle	C, E	
Stenus ossium	A Rove Beetle	E	
Stenus nitidiusculus	A Rove Beetle	A, E	
Stenus providus	A Rove Beetle	B	
Tachinus rufipes	A Rove Beetle	C	

Tachinus subterraneus	A Rove Beetle	D3	
Tachyporus atriceps	A Rove Beetle	C	
Tachyporus chrysomelinus	A Rove Beetle	E	
Tachyporus dispar	A Rove Beetle	C, E	
Tachyporus hypnorum	A Rove Beetle	A, C, E	
Tachyporus nitidulus	A Rove Beetle	A	
Velleius dilatatus	A Rove Beetle	C	RDB1
Xantholinus linearis	A Rove Beetle	A	
Apion frumentarium	An Apionid Weevil	E	
Betulapion simile	An Apionid Weevil	E	
Ceratapion gibbirostre	An Apionid Weevil	A, C	
Ceratapion onopordi	An Apionid Weevil	C	
Eutrichapion vorax	An Apionid Weevil	E	
Oxystoma craccae	An Apionid Weevil	A, C	
Perapion hydrolapathi	An Apionid Weevil	A	
Perapion marchicum	An Apionid Weevil	A	
Protapion apricans	An Apionid Weevil	A	
Protapion assimile	An Apionid Weevil	A	
Protapion fulvipes	An Apionid Weevil	A	
Protapion nigritarse	An Apionid Weevil	A	
Taeniapion urticarium	An Apionid Weevil	C	
Anthonomus pomorum	A Weevil	B, C	
Anthonomus rubi	A Weevil	A	
Archarius salicivorus	A Weevil	A	
Ceutorhynchus obstrictus	A Weevil	E	
Ceutorhynchus pallidactylus	A Weevil	All Areas	
Ceutorhynchus picitarsis	A Weevil	E	
Ceutorhynchus typhae	A Weevil	E	
Cionus alauda	A Weevil	B	
Cionus hortulanus	A Weevil	B	

Coelositona cambricus	A Weevil	A, E	
Curculio glandium	A Weevil	A, C, D1, D2	
Curculio venosus	A Weevil	D1, D3	
Dorytomus dejeani	A Weevil	A, D1, D2	
Dorytomus rufatus	A Weevil	A	
Dorytomus taeniatus	A Weevil	A, D1, D2	
Euophryum confine	A Weevil	C, E, D1	
Glocianus distinctus	A Weevil	A	
Hadroplontus litura	A Weevil	A	
Hypera pollux	A Weevil	B, C	
Mogulones asperifoliarum	A Weevil	E	
Nedyus quadrimaculatus	A Weevil	C, E	
Orchestes pilosus	A Weevil	E	
Otiorhynchus singularis	A Weevil	E	
Philopedon plagiatum	A Weevil	A	
Phyllobius argentatus	A Weevil	C, E	
Phyllobius maculicornis	A Weevil	A	
Phyllobius pomaceus	A Weevil	A	
Phyllobius pyri	A Weevil	A, C, E	
Phyllobius roboretanus	A Weevil	E	
Phyllobius virideaeris	A Weevil	A, C, E	
Polydrusus cervinus	A Weevil	A, C, E	
Poophagus sisymbrii	A Weevil	C	
Rhamphus pulicarius	A Weevil	C, E	
Rhinusa antirrhini	A Weevil	A	
Romualdius angustisetulus	A Weevil	A	
Sitona hispidulus	A Weevil	A	
Sitona lineatus	A Weevil	A, C, E	
Stenocarus ruficornis	A Weevil	A	Nb
Strophosoma melanogrammum	A Weevil	E	

Trachyphloeus scabriculus	A Weevil	D3	
Tychius junceus	A Weevil	C	
Tychius picirostris	A Weevil	A	
Tatianaerhynchites aequatus	Apple Fruit Weevil	D2, D3	
Hylesinus toranio	A Bark Beetle	A, C	
Scolytus intricatus	A Bark Beetle	C	
Xyleborinus saxesenii	A Bark Beetle	C, E, D3	
Bruchidius varius	A Seed Beetle	A	
Bruchus rufimanus	A Seed Beetle	E	
Altica lythri	A Flea Beetle	C	
Altica palustris	A Flea Beetle	C	
Chaetocnema hortensis	A Flea Beetle	A	
Crepidodera aurata	A Flea Beetle	A	
Crepidodera aurea	A Flea Beetle	A, E	
Longitarsus dorsalis	A Flea Beetle	C	
Longitarsus flavicornis	A Flea Beetle	A, E	
Longitarsus luridus	A Flea Beetle	E	
Neocrepidodera ferruginea	A Flea Beetle	C	
Neocrepidodera transversa	A Flea Beetle	C	
Phyllotreta atra	A Flea Beetle	B, C	
Phyllotreta nigripes	A Flea Beetle	C	
Phyllotreta tetrastigma	A Flea Beetle	A	
Phyllotreta undulata	A Flea Beetle	C	
Psylliodes affinis	A Flea Beetle	A, B, C	
Psylliodes chrysocephala	Cabbage Stem Flea Beetle	All Areas	
Sphaeroderma testaceum	A Flea Beetle	A, C	
Cassida rubiginosa	A Tortoise Beetle	C	
Cassida vibex	A Tortoise Beetle	C	
Chrysolina hyperici	A Leaf Beetle	A	
Cryptocephalus moraei	A Leaf Beetle	A	

Donacia marginata	A Reed Beetle	B	
Donacia vulgaris	A Reed Beetle	B	
Galerucella nymphaeae	Water-lily Leaf Beetle	B	
Galerucella sagittariae	A Leaf Beetle	C	
Gastrophysa polygoni	A Leaf Beetle	A, E	
Lochmaea crataegi	A Leaf Beetle	D1, D2, D3	
Oulema melanopus	A Leaf Beetle	C, E	
Phaedon cochleariae	A Leaf Beetle	C	
Pseudovadonia livida	A Longhorn Beetle	A	
Rutpela maculata	A Longhorn Beetle	A, D1, D2	
Aphodius granarius	A Dung Beetle	A	
Aphodius haemorrhoidalis	A Dung Beetle	C	
Aphodius sticticus	A Dung Beetle	C, E	
Melolontha melolontha	Cockchafer	C	
Phyllopertha horticola	A Chafer	C, E	
Serica brunnea	Brown Chafer	C	
Thanasimus formicarius	A Chequered Beetle	C	
Olibrus aeneus	A Shining Flower Beetle	A	
Olibrus corticalis	A Shining Flower Beetle	E	
Olibrus liquidus	A Shining Flower Beetle	A	
Olibrus pygmaeus	A Shining Flower Beetle	A	Nb
Sericoderus brevicornis	A Hooded Beetle	C	
Brachypterus glaber	A Short-winged Flower Beetle	C	
Cryptarcha strigata	A Sap Beetle	C, E	Nb
Cryptarcha undata	A Sap Beetle	E	Nb
Epuraea biguttata	A Sap Beetle	A, C, E	
Glischrochilus hortensis	A Sap Beetle	E, C	
Meligethes aeneus	A Pollen Beetle	All Areas	
Soronia grisea	A Sap Beetle	C, E	
Notolaemus unifasciatus	A Flat Beetle	C	NA

Adalia decempunctata	10-spot Ladybird	D1	
Calvia quattuordecimguttata	Cream-spot Ladybird	C	
Coccinella septempunctata	7-spot Ladybird	C	
Exochomus quadripustulatus	Pine Ladybird	A, C, D1, D2, E	
Hippodamia variegata	Adonis Ladybird	A	[Nb]
Propylea quattuordecimpunctata	14-spot Ladybird	A	
Psyllobora vigintiduopunctata	22-spot Ladybird	C, E	
Rhyzobius litura	A Ladybird	A, C, E	
Scymnus auritus	A Ladybird	B, C	
Subcoccinella vigintiquattuorpunctata	24-spot Ladybird	E	
Tytthaspis sedecimpunctata	16-spot Ladybird	A, E	
Grammoptera ruficornis	A Longhorn Beetle	C, E	
Rutpela maculata	A Longhorn Beetle	D3	
Tetrops praeustus	A Longhorn Beetle	D1, D2, A	
Oedemera lurida	A False Blister Beetle	A, C, E	
Oedemera nobilis	A False Blister Beetle	A, C, E	
Malachius bipustulatus	A Flower Beetle	All Areas	
Euglenes oculatus	An Ant-Like Beetle	C, D3, D1	NS
Dasytes aeratus	A Soft-winged Flower Beetle	All Areas	
Dasytes plumbeus	A Soft-winged Flower Beetle	C, D1, D2	NS
Notoxus monoceros	An Ant-like Flower Beetle	A, C, D1, D2	
Pyrochroa serraticornis	Common Cardinal Beetle	D1, D3	
Cantharis cryptica	A Soldier Beetle	C, D1, D2	
Cantharis decipiens	A Soldier Beetle	D1 and D2	
Cantharis flavilabris	A Soldier Beetle	C	
Cantharis lateralis	A Soldier Beetle	D2, E	
Cantharis livida	A Soldier Beetle	A, C	
Cantharis nigricans	A Soldier Beetle	D1	
Cantharis pallida	A Soldier Beetle	C	
Cantharis pellucida	A Soldier Beetle	C	

Cantharis rustica	A Soldier Beetle	A, C	
Malthinus balteatus	A Soldier Beetle	C	
Malthinus flaveolus	A Soldier Beetle	C, D1, D2	
Malthinus seriepunctatus	A Soldier Beetle	E	
Rhagonycha fulva	A Soldier Beetle	C	
Rhagonycha lignosa	A Soldier Beetle	A, C, E	
Rhagonycha limbata	A Soldier Beetle	E	
Rhagonycha lutea	A Soldier Beetle	E	NS
Byturus tomentosus	A Raspberry Beetle	D1, D2, E	
Pseudocistela ceramboides	A Darkling Beetle	C, D1	NS
Adrastus pallens	A Click Beetle	D1, D3	
Agriotes acuminatus	A Click Beetle	A, E	
Agriotes pallidulus	A Click Beetle	A, D1	
Agriotes sputator	A Click Beetle	A	
Athous haemorrhoidalis	A Click Beetle	A, C, D1, D2, E	
Dalopius marginatus	A Click Beetle	C, E	
Hemicrepidius hirtus	A Click Beetle	E	
Kibunea minuta	A Click Beetle	C, D1, D2	
Melanotus castanipes	A Click Beetle	C, E, D1	
Aulonothroscus brevicollis	A Throscid Beetle	E, D3	RDB3
Lampyris noctiluca	Glow-worm	A	
Anobium fulvicorne	A Wood-borer Beetle	C, E	
Anobium inexspectatum	A Wood-borer Beetle	C, D1	
Anobium punctatum	A Wood-borer Beetle	C, D3	
Dorcatoma chrysomelina	A Wood-borer Beetle	E	
Hedobia imperialis	A Wood-borer Beetle	C	
Ochina ptinoides	A Wood-borer Beetle	C, E	
Ptilinus pectinicornis	A Wood-borer Beetle	D1	
Xestobium rufovillosum	Deathwatch Beetle	E	
Cis bilamellatus	A Tree-fungus Beetle	D3	

Cis pygmaeus	A Tree-fungus Beetle	D3	
Mycetophagus piceus	A Hairy Fungus Beetle	E	
Triplax russica	A Pleasing Fungus Beetle	C, D3	
Rhizophagus bipustulatus	A Root-eating Beetle	C, E	
Anaspis fasciata	A False Flower Beetle	E	
Anaspis frontalis	A False Flower Beetle	D2	
Anaspis maculata	A False Flower Beetle	All Areas	
Anaspis regimbarti	A False Flower Beetle	C	
Mordellistena variegata	A Tumbling Flower Beetle	D1	NS
Cryptophagus labilis	A Silken Fungus Beetle	E	N
Atomaria atricapilla	A Silken Fungus Beetle	C	
Atomaria fuscata	A Silken Fungus Beetle	C	
Atomaria linearis	A Silken Fungus Beetle	C	
Cartodere bifasciata	A Minute Brown Scavenger Beetle	C	
Corticaria elongata	A Minute Brown Scavenger Beetle	C	
Corticarina minuta	A Minute Brown Scavenger Beetle	A, E	
Cortinicara gibbosa	A Minute Brown Scavenger Beetle	A, C	
Enicmus brevicornis	A Minute Brown Scavenger Beetle	C, D1	N
Enicmus transversus	A Minute Brown Scavenger Beetle	C	
Agathidium varians	A Round Fungus Beetle	D3	
Megasternum concinnum	A Water Scavenger Beetle	C	
Cerylon ferrugineum	A Minute Bark Beetle	C	
Salpingus planirostris	A Narrow Bark Beetle	C, E	
Salpingus ruficollis	A Narrow Bark Beetle	C	
Anthrenus fuscus	A Larder Beetle	C, D3	
Ctesias serra	Cobweb Beetle	C, E, D1	
Hymenoptera – Wasps, Ants, Bees and Sawflies			
Andrena barbilabris	A Mining Bee	D2	
Andrena bicolor	A Mining Bee	D2	
Andrena haemorrhoa	A Mining Bee	C	

Andrena minutula	A Mining Bee	E	
Andrena subopaca	A Mining Bee	C, D2	
Andrena wilkella	A Mining Bee	D2	
Bombus terrestris	Buff-tailed Bumblebee	C	
Hylaeus communis	A Yellow-faced Bee	E	
Megachile ligniseca	A Leafcutter Bee	C	
Sphecodes ephippius	A Blood Bee	D2	
Cerceris quinquefasciata	A Solitary Wasp	A	[RDB3], BAP, S41
Crossocerus annulipes	A Solitary Wasp	C	
Lindenius albilabris	A Solitary Wasp	A	
Mellinus arvensis	A Solitary Wasp	C	
Oxybelus uniglumis	A Solitary Wasp	A, D2	
Symmorphus gracilis	A Solitary Wasp	C	
Hedychrum niemelai	A Jewel Wasp	A	[RDB3]
Vespa crabro	European Hornet	C, D3	
Vespula vulgaris	Common Wasp	C	
Rhogogaster viridis	A Sawfly	A	
Tenthredo temula	A Sawfly	E	
Formica fusca	An Ant	A	
Lasius fuliginosus	An Ant	D1	
Lasius niger	Black Garden Ant	A, E	
Myrmica ruginodis	An Ant	C, E	
Myrmica scabrinodis	An Ant	A, E	
Diptera - Flies			
Episyrphus balteatus	Marmalade Hoverfly	All Areas	
Cheilosia albitarsis	A Hoverfly	A, C	
Cheilosia illustrata	A Hoverfly	C	
Chrysogaster solstitialis	A Hoverfly	A	
Eristalis intricarius	A Hoverfly	All Areas	
Eupeodes corollae	A Hoverfly	C	

Melanogaster hirtella	A Hoverfly	B, C	
Melanostoma mellinum	A Hoverfly	E	
Pipizella viduata	A Hoverfly	D1	
Platycheirus albimanus	A Hoverfly	D1, D2	
Riponnensia splendens	A Hoverfly	A	
Sphaerophoria scripta	A Hoverfly	All Areas	
Syritta pipiens	A Hoverfly	A, C, D1	
Syrphus ribesii	A Hoverfly	C	
Volucella pellucens	A Hoverfly	D1, D2, D3	
Xylota segnis	A Hoverfly	C	
Thereva nobilitata	A Stiletto Fly	A	
Choerades marginatus	A Robberfly	C	
Dioctria atricapilla	A Robberfly	E	
Dioctria baumhaueri	A Robberfly	C, E	
Leptogaster cylindrica	A Robberfly	A, C, E	
Machimus atricapillus	A Robberfly	C	
Neoitamus cyanurus	A Robberfly	C	
Chrysopilus asiliformis	A Snipefly	C, D1	
Rhagio scolopaceus	A Snipefly	C	
Sicus ferrugineus	A Conopid Fly	A	
Dilophus femoratus	A St. Mark's Fly	E	
Cistogaster globosa	A Tachinid Fly	A	[RDB1]
Tachina fera	A Tachinid Fly	C	
Chrysotus neglectus	A Long-legged Fly	B, C	
Dolichopus longicornis	A Long-legged Fly	B	
Hercostomus nigripennis	A Long-legged Fly	C	
Limonia phragmitidis	A Limoniid Cranefly	C	
Sylvicola cinctus	A Wood Gnat	C	
Sylvicola fenestralis	A Wood Gnat	C	
Nemopoda nitidula	An Ensign Fly	E	

Minettia fasciata	A Lauxaniid Fly	A, C	
Sapromyza quadripunctata	A Lauxaniid Fly	A, E	
Geomyza tripunctata	An Opomyzid Fly	A	
Opomyza florum	An Opomyzid Fly	C	
Opomyza germinationis	An Opomyzid Fly	E	
Opomyza petrei	An Opomyzid Fly	C	
Thaumatomyia notata	A Grass Fly	C	
Beris chalybata	A Soldierfly	C	
Beris vallata	A Soldierfly	C	
Chorisops nagatomii	A Soldierfly	A	
Chorisops tibialis	A Soldierfly	C, D3	
Pachygaster atra	A Soldierfly	C, E, D3	
Oxyna parietina	A Fruit Fly	E	
Terellia tussilaginis	A Fruit Fly	C	
Urophora stylata	A Fruit Fly	E	
Loxocera ichneumonea	A Rust Fly	C	
Suillia variegata	A Heleomyzid Fly	C	
Coremacera marginata	A Snail-killing Fly	C, E	
Limnia unguicornis	A Snail-killing Fly	E	
Lepidoptera – Butterflies and Moths			
Aglais urticae	Small Tortoiseshell Butterfly	All Areas	
Celastrina argiolus	Holly Blue Butterfly	C	
Inachis io	Peacock Butterfly	All Areas	
Maniola jurtina	Meadow Brown Butterfly	A, C, E	
Pararge aegeria	Speckled Wood Butterfly	C	
Pieris brassicae	Large White	All Areas	
Pieris rapae	Small White	All Areas	
Polyommatus icarus	Common Blue Butterfly	A, E	
Pyronia tithonus	Gatekeeper Butterfly	A, E	
Thymelicus sylvestris	Small Skipper Butterfly	A	

Tyria jacobaeae	Cinnabar Moth	A, E	S41-R
Vanessa atalanta	Red Admiral Butterfly	All Areas	
Synanthedon vespiformis	Yellow-legged Clearwing	D3	NS
Mecoptera - Scorpionflies			
Panorpa germanica	A Scorpionfly	B, C, E	
Neuroptera – Lacewings et al.			
Wesmaelius subnebulosus	A Lacewing	C	
Megaloptera – Alderflies et al.			
Sialis lutaria	Alderfly	B	
Orthoptera – Grasshoppers, Crickets et al.			
Chorthippus brunneus	Common Field Grasshopper	All Areas	
Chorthippus parallelus	Meadow Grasshopper	All Areas	
Tetrix undulata	Common Groundhopper	C, E	
Leptophyes punctatissima	Speckled Bush Cricket	C, D2, D3	
Meconema thalassinum	Oak Bush Cricket	C, D3	
Pholidoptera griseoaptera	Dark Bush Cricket	C, E	
Conocephalus dorsalis	Short-winged conehead	A, E	
Psocoptera - Barklice			
Graphopsocus cruciatus	A Barklouse	C, E	
Hemiptera – True Bugs			
Asiraca clavicornis	A Planthopper	A	Nb
Criomorphus albomarginatus	A Planthopper	C	
Javesella pellucida	A Planthopper	A	
Stenocranus minutus	A Planthopper	C	
Agallia ribauti	A Leafhopper	A	
Allygus mixtus	A Leafhopper	C, D3, D1	
Anoscopus serratulae	A Leafhopper	C	
Aphrodes makarovi	A Leafhopper	A, E	
Balclutha punctata	A Leafhopper	A	
Euscelis incisus	A Leafhopper	A, E	

Graphocraerus ventralis	A Leafhopper	E	
Iassus lanio	A Leafhopper	C	
Megophthalmus scanicus	A Leafhopper	A, E	
Mocydiopsis attenuata	A Leafhopper	A	
Psammotettix confinis	A Leafhopper	C	
Cixius nervosus	A Lacehopper	C	
Neophilaenus lineatus	A Froghopper	A	
Philaenus spumarius	Common Froghopper	C	
Acanthosoma haemorrhoidale	Hawthorn Shieldbug	D1	
Aelia acuminata	Bishop's Mitre Shieldbug	A, E	
Dolycoris baccarum	Hairy Shieldbug	A	
Eurydema oleracea	Brassica Shieldbug	A, E	
Legnotus limbosus	Bordered Shieldbug	E	
Podops inuncta	Turtle Shieldbug	A, E	
Sehirus luctuosus	Forget-me-not Shieldbug	E	
Arenocoris falleni	Fallen's Leatherbug	A	NS
Coreus marginatus	Dock Bug	E	
Coriomeris denticulatus	Denticulate Leatherbug	A	
Syromastus rhombeus	Rhombic Leatherbug	A	
Amblytylus nasutus	A Plant Bug	E	
Atractotomus mali	A Plant Bug	A, C, D1, D2	
Campyloneura virgula	A Plant Bug	C, D1, D2, E	
Capsus ater	A Plant Bug	C	
Closterotomus norwegicus	A Plant Bug	C, E	
Cyllecoris histrionius	A Plant Bug	D1, D2	
Dicyphus globulifer	A Plant Bug	A	
Deraeocoris flavilinea	A Plant Bug	D1	
Deraeocoris lutescens	A Plant Bug	C, E	
Dryophilocoris flavoquadrimaculatus	A Plant Bug	D1	
Halticus luteicollis	A Plant Bug	C	

Harpocera thoracica	A Plant Bug	All Areas	
Heterotoma planicornis	A Plant Bug	C	
Leptopterna dolabrata	A Plant Bug	C, E	
Lygus rugulipennis	A Plant Bug	A, C, E	
Lygus pratensis	A Plant Bug	A, C, E	[RDB3]
Miris striatus	A Plant Bug	A, C	
Notostira elongata	A Plant Bug	C, E	
Orthotylus marginalis	A Plant Bug	D1, D2	
Phylus palliceps	A Plant Bug	C, D1, D2	
Phytocoris varipes	A Plant Bug	A	
Pithanus maerkelii	A Plant Bug	C	
Plagiognathus arbustorum	A Plant Bug	C, E	
Plagiognathus chrysanthemi	A Plant Bug	A	
Psallus mollis	A Plant Bug	D1	
Psallus perrisi	A Plant Bug	C, D2	
Psallus salicis	A Plant Bug	E	
Psallus variabilis	A Plant Bug	C	
Psallus varians	A Plant Bug	C, D1, D2	
Psallus wagneri	A Plant Bug	C, D1	
Rhabdomiris striatellus	A Plant Bug	D2, E	
Stenotus binotatus	A Plant Bug	E	
Trigonotylus caelestialum	A Plant Bug	A	
Drymus ryei	A Ground Bug	E	
Drymus sylvaticus	A Ground Bug	E	
Graptopeltus lynceus	A Ground Bug	E	Nb
Ischnodemus sabuleti	A Ground Bug	E	
Kleidocerys resedae	Birch Catkin Bug	E	
Nysius ericae	A Ground Bug	A	
Nysius senecionis	A Ground Bug	A	
Peritrechus geniculatus	A Ground Bug	A, E	

Scolopostethus affinis	A Ground Bug	E	
Stygnocoris sabulosus	A Ground Bug	A, E	
Myrmus miriformis	A Rhopalid Bug	A	
Rhopalus parumpunctatus	A Rhopalid Bug	A	NS
Rhopalus subrufus	A Rhopalid Bug	E	
Stictopleurus abutilon	A Rhopalid Bug	A	
Himacerus apterus	Tree Damsel Bug	E	
Himacerus major	A Damsel Bug	E	
Himacerus mirmicoides	Ant Damsel Bug	A, E	
Nabis ferus	A Damsel Bug	E	
Nabis rugosus	A Damsel Bug	E	
Anthocoris nemoralis	A Flower Bug	A	
Anthocoris nemorum	A Flower Bug	E	
Kalama tricornis	A Lacebug	A	
Physatocheila dumetorum	A Lacebug	D1, D2, C	
Tingis cardui	A Lacebug	E	
Dermaptera - Earwigs			
Forficula auricularia	Common Earwig	All Areas	
Odonata – Dragonflies and Damselflies			
Aeshna grandis	Brown Hawker	B, C, E	
Aeshna mixta	Migrant Hawker	B, C	
Anax imperator	Emperor Dragonfly	B	
Libellula depressa	Broad-bodied Chaser	B	
Sympetrum striolatum	Common Darter	B	
Calopteryx splendens	Banded Demoiselle	C	
Coenagrion puella	Azure Damselfly	B, C	
Erythromma najas	Red-eyed Damselfly	B	
Ischnura elegans	Blue tailed Damselfly	B	
Isopoda – Woodlice et al.			
Armadillidium vulgare	Common Pill Woodlouse	E	

Oniscus asellus	Common Shiny Woodlouse	E	
Philoscia muscorum	Common Striped Woodlouse	E	
Porcellio scaber	Common Rough Woodlouse	E	
Gastropoda - Snails			
Ashfordia granulata	A Hairy Snail	E	
Araneae - Spiders			
Agelena labyrinthica	A funnelweb spider	All	
Araniella cucurbitina	Cucumber Spider	All	
Clubiona comta	A Sac Spider	D2	
Clubiona corticalis	A Sac Spider	A	
Clubiona lutescens	A Sac Spider	D3	
Cheiracanthum erraticum	A Sac Spider	B, C	
Zelotes latreillei	A ground spider	A	
Dictyna arundinacea	A Mesh-web Spider	A	
Anelosimus vittatus	A Comb-footed Spider	A, D2, E	
Enoplognatha ovata	Candy-striped Spider	All	
Paidiscura pallens	A Comb-footed Spider	C, D2	
Theridion mystaceum	A Comb-footed Spider	All	
Araneus diadematа	An orb web spider	All	
Araneus marmoreus	An orb web spider	All	
Gibbaranea gibbosa	An Orb-web Spider	E	
Larinioides cornutus	An Orb-web Spider	E	
Metellina segmentata	An Orb-web Spider	A	
Nuctenea umbratica	An Orb-web Spider	C, D1, D2	
Tetragnatha montana	A Large-jawed Orb-weaver	A, E	
Metellina mengei	A Large-jawed Orb-weaver	C, E	
Pardosa agrestis	A Wolf Spider	C	NS
Pardosa pullata	A Wolf Spider	C	
Alopecosa pulverulenta	A Wolf Spider	E	
Misumena vatia	A Crab Spider	A, C, E	

Ozyptila sanctuarius	A Crab Spider	A	
Philodromus aureolus	A Crab Spider	E, D1, D2	
Philodromus cespitum	A Crab Spider	A	
Xysticus cristatus	A Crab Spider	A, C	
Euophrys frontalis	A Jumping Spider	All	
Heliophanus flavipes	A Jumping Spider	A, C, E	
Talavera aequipes	A Jumping Spider	A	
Drassyllus pusillus	A Ground Spider	A	
Theridion mystaceum	A Comb-footed Spider	E	
Theridion varians	A Comb-footed Spider	A	
Pisaura mirabilis	Nursery-web Spider	All	
Tibellus oblongus	A Grass Spider	A, E	
Opiliones - Harvestmen			
Nemastoma bimaculatum	A Harvestman	C	
Paroligolophus agrestis	A Harvestman	A	

APPENDIX B: Photographs

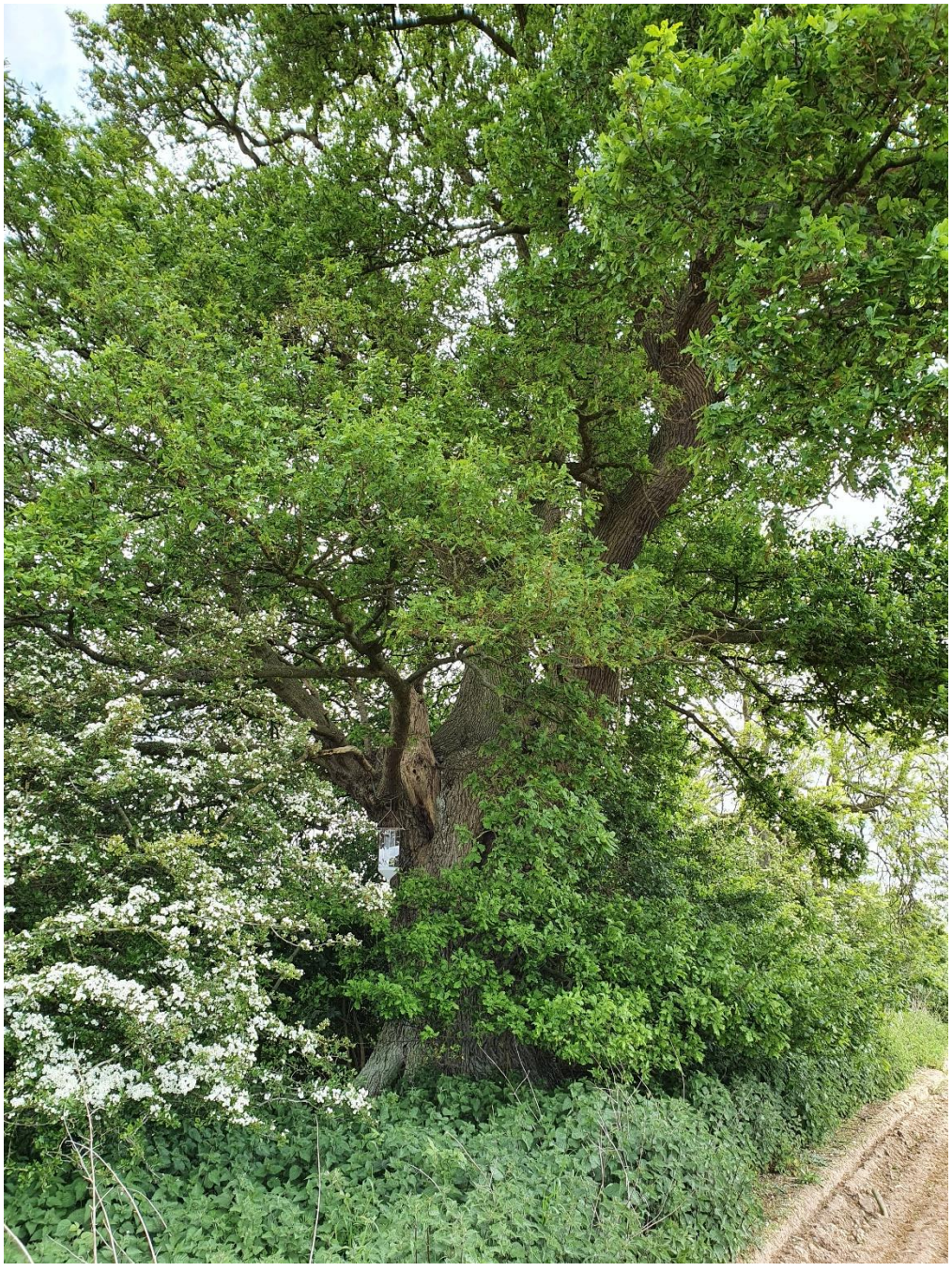
Area A. Botanically diverse grassland with short sward and bare ground.

Area B. Fishing ponds, their margins and scramble tracks.

Area C. Improved pasture and old hedgerow with large oaks

Area C. Old oak in hedgerow with vane trap in situ.

Area D1. Hedge and arable field.



Area D1. Ancient oak with vane trap.

Area D2. Hedge and bank. Bare ground obscured by bracken after May.

Area D2. Veteran oak with abundant decay features. The vane trap on this tree was vandalised.

Area D3. Hedge and veteran oak – the most significant in the entire survey area.

Area E. Grassland with planted trees.

Omophron limbatum. A Nationally Rare carabid beetle found in the edges of the fishing pools in Area B.

Cerceris quinquefasciata. The Nationally Rare five-banded weevil wasp, which is also a BAP, S41 species. This species was found in Area A.