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Planning Act 2008

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ENVIRONMENTAL STATEMENT APPENDICES
Appendix 8.7 Terrestrial Invertebrate Report

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A47 BLOFIELD TO NORTH BURLINGHAM

Terrestrial Invertebrate Survey Report

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On behalf of Abrehart Ecology for SWECO

SEPTEMBER 2020

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Executive summary

Abrehart Ecology was commissioned by SWECO UK Limited to undertake a terrestrial invertebrate survey of land identified as falling within the preferred route option of the A47 Corridor Improvement Plan that extends from its junction with the A1 (Wansford) in the west to Great Yarmouth in the east. This report details the terrestrial invertebrate surveys of a section of the route between Blofield and North Burlingham, near Norwich, Norfolk. This survey same sampled the same areas as the 2017 and 2018 surveys.

The survey area is predominantly arable. Between the arable field are botanically poor margins, recent plantations, mature hedgerows and old oak trees with decay features. 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.

369 species were recorded during the surveys, including **14 species with a National Conservation Status**. The most notable species recorded during the surveys was the beetle *Quedius dilatatus*, which is considered to be Nationally Rare, although this status needs updating to reflect a recent range expansion. Other insects of note include *Abdera biflexuosa, Dorcatoma flavicornis* and *Diaperis boleti.* These species and most of the others with a National Conservation Status are associated with old and veteran trees, typically oak, with decay features.

The most valuable habitats in the survey area are the old oak trees as they support a huge assemblage of specialist animals that depend on centuries of habitat continuity in the same area. The dispersal of these species is often poor, so improving habitat connectivity is important.

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, hedgerows, woodland, deadwood and waterbodies) alongside both sides of the route will improve connectivity through the landscape.

Mitigating for the loss of old trees is practically impossible, so where feasible, significant trees, mostly oaks, should be retained and protected during the development work.

1 Introduction

1.1 Overview

Abrehart Ecology was commissioned by SWECO UK Limited to undertake a terrestrial invertebrate survey of land identified as falling within the preferred route option of the A47 Corridor Improvement Plan that extends from its junction with the A1 (Wansford) in the west to Great Yarmouth in the east. This report refers to the approximate 2.6 km sector located between the villages of Blofield and North Burlingham that lie between 10 and 13 km east of Norwich, Norfolk. The proposed route ('the site') mostly forms an off-line section to the south of the existing A47 and passes through predominantly arable fields bounded by species-poor intact hedgerows with trees.

1.2 Site location and setting

The study site is a linear corridor representing the proposed preferred route of a new section of the A47, a major trunk road connecting Peterborough (and thus the A1) with the ports of Great Yarmouth and Lowestoft. The preferred route will be an off-line dual carriageway, departing the existing carriageway just east of Blofield (TG 345 099) and re-joining it, immediately east of North Burlingham (TG 373 099), approximately 10 km east of Norwich within a rural area of Norfolk.

1.3 Previous surveys

Two previous surveys have been conducted on the site. Amey commissioned a survey in 2017 that reported 170 species, 14 of which have a conservation status. A survey in 2018 by Richard Wilson Ecology Limited on behalf of SWECO reported 441 species, ten of which have a conservation status.

1.4 Aims and objectives

1.4.1 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.

1.4.2 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
- 22nd 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;
- 5 x 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. Pitfall traps were installed, but were disturbed by wild animals.

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. Access requirements made it difficult to visit the site proactively when the weather dictated good conditions for sampling terrestrial invertebrates. Two of the visits had to be made in poor weather. This would have had an impact on the total number of species recorded during the surveys.

3 Results

3.1 Desk study

The Amey survey conducted in 2017 involved monthly visits between June and October. The 2018 surveys by Richard Wilson Ecology Limited involved four visits between April and June 2018.

3.1.1 Species

The 2017 survey recorded 170 species, 14 of which have a conservation status; however, the methodology and data in this survey have various shortcomings, so the notable species recorded during this survey must be treated with caution.

The 2018 survey recorded 441 species, of which ten have a conservation status. A further three species recorded during this survey retain a formal nature conservation status due to no updated Species Status Reviews for their groups but are no longer considered Nationally Scarce. The ten notable species were the millipede *Brachychaeteuma bradeae*, the beetles *Ilyobates propinquus, Dermestes murinus, Dorcatoma flavicornis, Aderus populneus, Rhinocyllus conicus, Dorytomus ictor, Curculio villosus* and *Kissophagus vicinus.*

3.2 Field survey

3.2.1 Survey area

The following details on the survey area are taken from the 2018 survey (Wilson, 2018).

"The site is predominantly arable land on fine, silty loam. Most of the arable fields are divided by intact species-poor (mostly hawthorn (*Crataegus* sp.) hedgerows, individual trees (within-field and within-hedgerow) and occasional linear blocks of deciduous plantation woodland. A few of the hedgerows are more species-rich and also support mature and veteran trees including poplars (*Populus* sp.), pines (*Pinus* sp.) and pollarded oaks (*Quercus* sp.). One of the east-west hedgerows, centred on TG 367 097 contains a number of mature and veteran oaks which have varying amounts of dead wood habitat including heartwood decay.

Limited headlands and field margins are present across the majority of the study site but are wider where these are adjacent to the plantation woodlands. The two significant plantations, which are orientated north-south, are aligned with the western side of North Burlingham village and separated by arable fields. Both are plantations with a variety of native broad-leaved species including oak (*Quercus* sp.), elm (*Ulmus* sp.), ash (*Fraxinus excelsior*), silver birch (*Betula pendula*), wild cherry (*Prunus avium*), hazel (*Corylus avellana*) and hawthorn (*Crataegus monogyna*). Associated with these plantations are wider coarse-grassland strips which are species-poor, dominated by tall, tussock forming species such as false oat-grass (*Arrhenatherum elatius*) and cock's-foot (*Dactylis glomerata*), with nectar resources largely restricted to taller species such as hogweed (*Heracleum sphondylium*). Arable headlands and field margins are present across the majority of the study site but are wider where these are adjacent to the plantation woodlands. There is a single pond within the study site alongside a hedge and almost completely enclosed by bramble thicket.

The study site is situated within the North East Norfolk and Flegg National Character Area (NCA) which is characterised by a generally flat, low lying landscape with limited topographic variation. The fertile soils inland have resulted in long-standing productive arable farming and this is reflected in the dominance agriculture has on the landscape. Semi-natural habitat considered to be of high nature conservation value such as international or nationally designated sites account for less than 1 % of the NCA's total area. Habitats of Principle Importance (HoPI), including ancient woodland, similarly account for a tiny proportion of the NCA (Natural England, 2014). The study site's setting reflects this general character of the NCA; the nearest statutory sites lie between 2.5 km to the south-west (Yare Broads and Marshes SSSI), and 2.9 km to the east (Decoy Carr, Acle SSSI), neither of which are functionally connected to the study site. Furthermore, there is a lack of semi-natural habitat identified as HoPI and likewise, no ancient woodland, within 2 km of the proposed route."

3.2.2 Invertebrate species recorded in 2020

369 invertebrate species were recorded (see Appendix for full list). Of these, 14 have a national conservation status (Table 1). The Nationally Rare rove beetle *Quedius dilatatus* was once a great rarity but is thought to be increasing its range in response to the spread of its host, the hornet *Vespa crabro*. Some of the other

scarce saproxylic insects recorded during this survey are more frequently encountered today as vane traps are increasingly used; therefore, the conservation status of these might also need to be reviewed.

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

Scientific name	Common name	Conservation status	Areas/habitat
Omalium rugatum	A Rove Beetle	Nationally Scarce	Fungi on trees
Quedius dilatatus	A Rove Beetle	Nationally Rare (RDB1). Requires updating in light of range expansion	Hornet nests and sap runs on old trees
Curculio villosus	A Nut Weevil	Nationally Scarce	Oak trees, where it develops as inquiline in the 'oak-apple' galls induced by the cynipid wasp *Biorhiza pallida*
Dorytomus ictor	A Weevil	Nationally Scarce	Adults on poplars. The larvae probably develop in the catkins
Rhinocyllus conicus	A Weevil	Nationally Scarce. Requires updating in light of range expansion	Adults and larvae associated with thistles
Kissophagus vicinus (=hederae)	A Bark Beetle	Nationally Scarce	Develops in decaying ivy *Hedera* stems on trees
Scolytus mali	A Bark Beetle	Nationally Scarce	Larva in galleries in sapwood just under bark, where it feeds on living timber; mainly pear, *Pyrus*, cherry *Prunus*, elm *Ulmus* and hawthorn *Crataegus*, also other fruit trees
Abdera biflexuosa	A False Darkling Beetle	Nationally Scarce	Develops in decaying branchwood of oak Quercus, and to a lesser extent other broad-leaved trees.

			Generally found on lower dead branches which have been shaded out by the tree's own canopy
Enicmus brevicornis	A Minute Brown Scavenger Beetle	Nationally Scarce. Requires updating in light of range expansion	Associated with mouldy bark of beech *Fagus*, birch *Betula*, ash *Fraxinus* and sycamore *Acer pseudoplatanus*
Rhagonycha lutea	A Soldier Beetle	Nationally Scarce	Ecology poorly known
Dorcatoma flavicornis	A Spiderweb Beetle	Nationally Scarce	Develops in the interior of boughs and trunks of oak which are red-rotten, due to activity of the fungus *Laetiporus sulphureus*; has also been found in a red-rotted ash Fraxinus stump
Diaperis boleti	A Darkling Beetle	Nationally Scarce – recently updated to reflect range expansion	Adults and larvae on birch polypore *Piptoporus betulinus*
Cryptarcha undata	A Sap Beetle	Nationally Scarce	Associated with freshly exposed and fermenting sap on oak
Sesia apiformis	Hornet Clearwing Moth	Nationally Scarce	Larva tunnels between bark and wood in lower trunk and roots of poplars *Populus* sp.

NB: Ecological information for the saproxylic species taken from Alexander 2002

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	197	5	105	3	Section 41 Priority Species|Section 41 Priority Species - research only|[Nb]
tree-associated	104	3	159	12	Nb|RDB 1|Notable|Nb|NS|Nb|NS|Nb|NS|Notable|Nb|NS
wetland	23	<1	136	1	Notable
shaded woodland floor	1	33	100		

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	171	6	104	1	Section 41 Priority Species - research only
tree-associated	arboreal	44	3	120	3	Nb|Nb|NS
tree-associated	decaying wood	42	4	213	8	NS|Nb|Notable|RDB 1|NS|Nb|Nb|NS
tree-associated	shaded woodland floor	21	2	127	1	Notable
open habitats	short sward & bare ground	20	2	116	2	Section 41 Priority Species|[Nb]
wetland	marshland	12	1	140		
wetland	peatland	9	<1	100		
wetland	running water	5	<1	100		
tree-associated	wet woodland	2	<1	100		

wetland	wet woodland	1	<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	26	5	184	5	Nb|Nb|NS|Nb|Notable	A212	Favourable
open habitats		scrub edge	10	4	100			F001	Unfavourable (10 of 11 species)
open habitats		rich flower resource	7	3	100			F002	Unfavourable (7 of 15 species)
tree-associated	decaying wood	heartwood decay	5	3	520	2	NS|RDB 1	A211	Unfavourable (5 of 6 species)
tree-associated	decaying wood	fungal fruiting bodies	2	2	250	1	NS	A213	Unfavourable (2 of 7 species)
open habitats		scrub-heath & moorland	2	<1	100			F003	Unfavourable (2 of 9 species)
open habitats	short sward & bare ground	bare sand & chalk	2	<1	250	1	[Nb]	F111	Unfavourable (2 of 19 species)
open habitats	short sward & bare ground	open short sward	1	<1	100			F112	Unfavourable (1 of 13 species)

4 Discussion

4.1 Discussion of results

The previous survey (WIlson, 2010) reported 10 species of conservation concern from the site and a further three species where the conservation status is in need of review. This survey recorded 14 species with a conservation status, but at least two of these need to be reviewed in light of recent range expansions.

On a landscape (broad biotope) level, the Pantheon analysis attributed 197, 104 and 23 species to 'open habitats', 'tree-associated' and wetland', respectively (Table 2). Proportionately, the 'Open habitats' and 'tree associated' classifications support 5% and 3%, 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 five assemblages attributed with a sufficient number of species recognised in ISIS to be considered robust, i.e. >15 species (Table 3). 171 species were attributed to the 'tall sward and scrub' assemblage, which basically includes species associated with taller grassland, scrub and scrub edge habitats. 44, 42, 21 and 20 species were attributed to the 'arboreal', 'decaying wood', 'shaded woodland floor' and 'short sward and bare ground', respectively.

The 'decaying wood' habitat supports a fauna of some conservation value as the SQI (species quality index) score is 213. 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 213, 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 184). The SQI for 'heartwood decay' was 520, but the number of species in this SAT was 5, which is much less than the threshold of 15. This limits the reliability of the result. Likewise, the SQI for 'fungal fruiting bodies' and 'bare sand and chalk' was 250, but the number of species in each of these SATs was only 2.

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 old trees with decay features.

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 oak trees with decay features.

Where possible, these should be protected and buffered from development. Native nectar sources should be planted along the development to increase habitat connectivity.

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 saproxylic 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 the most valuable habitats in the area. 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/trees 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-rich 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.

369 species were recorded during the surveys, including **14 species with a National Conservation Status**. The most notable species recorded during the surveys was the beetle *Quedius dilatatus*, which is considered to be Nationally Rare, although this status needs updating to reflect a recent range expansion. Other insects of note include *Abdera biflexuosa* and *Dorcatoma flavicornis.* These species and most of the others with a National conservation status are associated with old and veteran trees, typically oak, with decay features.

While more species were recorded in the 2018 survey (440 vs 369), a larger number of species with a conservation status were recorded during this survey (14 vs 10). The most valuable habitats in the survey area – old oak with decay features – were more intensively sampled during this survey via the use of vane traps.

The most valuable habitats in the survey area are the old oak trees as they support a huge assemblage of specialist animals that depend on centuries of habitat continuity in the same area. The dispersal of these species is often poor, so improving habitat connectivity is important.

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.

7 References

Alexander KNA. 2002. The invertebrates of living and decaying timber in Britain & Ireland: A provisional annotated checklist (ENRR467).

Andersson P et al. 2017. Roads may act as barriers to flying insects: species composition of bees and wasps differs on two sides of a large highway. *Nature Conservation* 18:47.

APIS. 2019. Air Pollution Information System. Nitrogen Oxides: Grasslands. http://www.apis.ac.uk/nitrogen-oxides-grasslands. Accessed Oct 2019.

Baxter D & Farmer AM. 1994 The control of *Brachypodium pinnatum* in chalk grasslands: influence of management and nutrients English Nature Research Report 100.

Bobbink R, Heil G & Raesen M. 1990. Atmospheric Deposition and Canopy Exchange in Heathland Ecosystems. Elinkwijk BV, Utrecht.

Drake CM *et al.* 2007. Surveying terrestrial and freshwater invertebrates for conservation evaluation. *Natural England Research Report* NERR005.

Grubisic M *et al*. 2018. Insect declines and agroecosystems: does light pollution matter? *Annals of Applied Biology*; DOI: 10.1111/aab.12440.

Lane S. 2017. Invertebrate Survey Report. A47 Thickthorn Junction Improvements. Prepared by Steve Lane for AECOM Environment and Ground Engineering, UK & Ireland.

Muñoz PT, *et al.* 2015. Effects of roads on insects: A review. *Biodiversity and Conservation*. 2015, 24, 659–682.

NERC. 2005 Global nitrogen enrichment (GANE): reports and key findings. www.nerc.ac.uk/research/programmes/gane/results.asp. Accessed October 2019.

Piper RW & Compton SG. 2003. *Cryptocephalus* sub-populations. Geographically close but genetically far. *Diversity and Distributions*;9:29-42.

Villemay A *et al.* 2018. Can linear transportation infrastructure verges constitute a habitat and/or a corridor for insects in temperate landscapes? A systematic review. *Environmental Evidence*;7:5.

Wilson R. 2018. Terrestrial Invertebrate Survey, Land off the A47 Blofield to North Burlingham, Norfolk. For Sweco UK, Ltd.

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	Status
Amischa decipiens	A Rove Beetle	
Amischa nigrofusca	A Rove Beetle	
Anotylus nitidulus	A Rove Beetle	
Anotylus rugosus	A Rove Beetle	
Anotylus sculpturatus	A Rove Beetle	
Anotylus tetracarinatus	A Rove Beetle	
Bisnius fimetarius	A Rove Beetle	
Callicerus obscurus	A Rove Beetle	
Carpelimus corticinus	A Rove Beetle	
Cypha longicornis	A Rove Beetle	
Dinaraea angustula	A Rove Beetle	
Drusilla canaliculata	A Rove Beetle	
Gyrohypnus angustatus	A Rove Beetle	
Habrocerus capillaricornis	A Rove Beetle	
Homalota plana	A Rove Beetle	
Ilyobates propinquus	A Rove Beetle	
Ischnosoma splendidum	A Rove Beetle	
Lesteva longoelytrata	A Rove Beetle	
Omalium caesum	A Rove Beetle	
Omalium rugatum*	A Rove Beetle	N
Othius subuliformis	A Rove Beetle	

Oxypoda haemorrhoa	A Rove Beetle	
Pella limbata	A Rove Beetle	
Philonthus carbonarius	A Rove Beetle	
Philonthus cognatus	A Rove Beetle	
Philonthus varians	A Rove Beetle	
Plataraea brunnea	A Rove Beetle	
Proteinus ovalis	A Rove Beetle	
Quedius dilatatus**	A Rove Beetle	RDB1
Quedius cruentus	A Rove Beetle	
Rugilus erichsonii	A Rove Beetle	
Sepedophilus immaculatus	A Rove Beetle	
Sepedophilus nigripennis	A Rove Beetle	
Stenus impressus	A Rove Beetle	
Stenus ossium	A Rove Beetle	
Tachinus marginellus	A Rove Beetle	
Tachyporus atriceps	A Rove Beetle	
Tachyporus hypnorum	A Rove Beetle	
Tachyporus nitidulus	A Rove Beetle	
Tachyporus tersus	A Rove Beetle	
Xantholinus longiventris	A Rove Beetle	
Paromalus flavicornis	A Clown Beetle	
Saprinus semistriatus	A Clown Beetle	
Choleva angustata	A Round Fungus Beetle	
Phosphuga atrata	A Carrion Beetle	
Thanatophilus rugosus	A Carrion Beetle	
Amara aenea	A Ground Beetle	

Amara communis	A Ground Beetle	
Amara plebeja	A Ground Beetle	
Anchomenus dorsalis	A Ground Beetle	
Badister bullatus	A Ground Beetle	
Bembidion illigeri	A Ground Beetle	
Bembidion lunulatum	A Ground Beetle	
Bembidion quadrimaculatum	A Ground Beetle	
Bembidion tetracolum	A Ground Beetle	
Bradycellus harpalinus	A Ground Beetle	
Calathus fuscipes	A Ground Beetle	
Calathus melanocephalus	A Ground Beetle	
Curtonotus aulicus	A Ground Beetle	
Demetrias atricapillus	A Ground Beetle	
Dromius quadrimaculatus	A Ground Beetle	
Harpalus rufipes	A Ground Beetle	
Leistus ferrugineus	A Ground Beetle	
Leistus spinibarbis	A Ground Beetle	
Loricera pilicornis	A Ground Beetle	
Microlestes minutulus	A Ground Beetle	
Notiophilus biguttatus	A Ground Beetle	
Notiophilus palustris	A Ground Beetle	
Ophonus rufibarbis	A Ground Beetle	
Paradromius linearis	A Ground Beetle	
Poecilus versicolor	A Ground Beetle	
Pterostichus madidus	A Ground Beetle	
Pterostichus melanarius	A Ground Beetle	

Pterostichus strenuus	A Ground Beetle	
Trechus quadristriatus	A Ground Beetle	
Aphodius fimetarius	A Dung Beetle	
Aphodius prodromus	A Dung Beetle	
Melolontha melolontha	Cockchafer	
Cytilus sericeus	A Pill Beetle	
Clytus arietis	Wasp Beetle	
Grammoptera ruficornis	A Longhorn Beetle	
Leiopus nebulosus	A Longhorn Beetle	
Aphthona euphorbiae	A Flea Beetle	
Bruchus rufimanus	A Seed Beetle	
Bruchus rufipes	A Seed Beetle	
Cassida rubiginosa	Thistle Tortoise Beetle	
Chaetocnema concinna	A Flea Beetle	
Chaetocnema hortensis	A Flea Beetle	
Chrysolina staphylaea	A Leaf Beetle	
Crepidodera aurata	A Flea Beetle	
Crepidodera aurea	A Flea Beetle	
Crepidodera fulvicornis	A Flea Beetle	
Gastrophysa polygoni	A Leaf Beetle	
Lochmaea crataegi	Hawthorn Leaf Beetle	
Longitarsus melanocephalus	A Flea Beetle	
Longitarsus parvulus	A Flea Beetle	
Oulema melanopus	Cereal Leaf Beetle	
Phaedon tumidulus	A Leaf Beetle	
Phyllotreta atra	A Flea Beetle	

Phyllotreta ochripes	A Flea Beetle	
Psylliodes chrysocephala	A Flea Beetle	
Apion frumentarium	An Apionid Weevil	
Protapion assimile	An Apionid Weevil	
Protapion fulvipes	An Apionid Weevil	
Anthonomus pomorum	A Weevil	
Ceutorhynchus pallidactylus	A Weevil	
Curculio glandium	A Weevil	
Curculio villosus*	A Weevil	Nb
Dorytomus dejeani	A Weevil	
Dorytomus ictor	A Weevil	NS
Dorytomus longimanus	A Weevil	
Dorytomus tortrix	A Weevil	
Euophryum confine	A Weevil	
Hypera nigrirostris	A Weevil	
Hypera postica	A Weevil	
Leiosoma deflexum	A Weevil	
Mecinus pyraster	A Weevil	
Nedyus quadrimaculatus	A Weevil	
Orchestes pilosus	A Weevil	
Pachyrhinus lethierryi	A Weevil	
Phyllobius pomaceus	A Weevil	
Phyllobius pyri	A Weevil	
Phyllobius roboretanus	A Weevil	
Polydrusus cervinus	A Weevil	
Rhinoncus pericarpius	A Weevil	

Rhinocyllus conicus	A Weevil	NS
Sciaphilus asperatus	A Weevil	
Sitona lepidus	A Weevil	
Sitona lineatus	A Weevil	
Dryocoetes villosus	A Bark Beetle	
Kissophagus vicinus (=hederae)***	A Bark Beetle	Nb
Scolytus intricatus	A Bark Beetle	
Scolytus mali*	A Bark Beetle	Nb
Xyleborinus saxesenii	A Bark Beetle	
Sericoderus brevicornis	A Hooded Beetle	
Adalia decempunctata	10-spot Ladybird	
Coccidula rufa	A Ladybird	
Coccinella septempunctata	7-spot Ladybird	
Harmonia axyridis	Harlequin Ladybird	
Propylea quattuordecimpunctata	14-Spot Ladybird	
Psyllobora vigintiduopunctata	22-Spot Ladybird	
Rhyzobius litura	A Ladybird	
Subcoccinella vigintiquattuorpunctata	24-Spot Ladybird	
Tytthaspis sedecimpunctata	16-Spot Ladybird	
Cis pygmaeus	A Tree-fungus Beetle	
Choleva angustata	A Fungus Beetle	
Nemadus colonoides	A Fungus Beetle	
Salpingus planirostris	A Narrow Bark Beetle	
Abdera biflexuosa**	A False Darkling Beetle	NS
Anaspis regimbarti	A False Flower Beetle	

Omonadus formicarius	An Ant-like Beetle	
Byturus tomentosus	Raspberry Beetle	
Anaspis frontalis	A Scraptiid Beetle	
Anaspis maculata	A Scraptiid Beetle	
Cartodere bifasciata	A Minute Brown Scavenger Beetle	
Corticaria impressa	A Minute Brown Scavenger Beetle	
Cortinicara gibbosa	A Minute Brown Scavenger Beetle	
Enicmus brevicornis*/**	A Minute Brown Scavenger Beetle	N
Enicmus transversus	A Minute Brown Scavenger Beetle	
Atomaria fuscata	A Silken Fungus Beetle	
Atomaria linearis	A Silken Fungus Beetle	
Atomaria testacea	A Silken Fungus Beetle	
Cantharis cryptica	A Soldier Beetle	
Cantharis decipiens	A Soldier Beetle	
Cantharis livida	A Soldier Beetle	
Cantharis nigricans	A Soldier Beetle	
Cantharis rustica	A Soldier Beetle	
Oedemera lurida	A False Blister Beetle	
Oedemera nobilis	Swollen-thighed Beetle	
Anobium fulvicorne	A Wood-boring Beetle	
Rhagonycha limbata	A Soldier Beetle	
Rhagonycha lutea*	A Soldier Beetle	NS
Malthinus seriepunctatus	A Soldier Beetle	

Anobium inexspectatum	A Wood-boring Beetle	
Anthrenus verbasci	A Dermestid Beetle	
Ctesias serra	Cobweb Beetle	
Dorcatoma flavicornis**	A Spiderweb Beetle	NS
Ochina ptinoides	A Spiderweb Beetle	
Ptilinus pectinicornis	A Wood-boring Beetle	
Xestobium rufovillosum	Deathwatch Beetle	
Diaperis boleti**	A Darkling Beetle	NS
Lagria hirta	A Darkling Beetle	
Anthrenus fuscus	A Carpet Beetle	
Ctesias serra	Cobweb Beetle	
Cryptarcha undata**	A Sap Beetle	Nb
Epuraea aestiva	A Sap Beetle	
Glischrochilus hortensis	A Sap Beetle	
Meligethes aeneus	A Pollen Beetle	
Meligethes ruficornis	A Pollen Beetle	
Brachypterus urticae	Neetle Pollen Beetle	
Olibrus aeneus	A Phalacrid beetle	
Dasytes aeratus	A Soft-winged Flower Beetle	
Malachius bipustulatus	Malachite Beetle	
Mordellochroa abdominalis	A Tumbling Flower Beetle	
Agriotes acuminatus	A Click Beetle	
Agriotes sputator	A Click Beetle	
Athous haemorrhoidalis	A Click Beetle	
Hemicrepidius hirtus	A Click Beetle	
Kibunea minuta	A Click Beetle	

Melanotus castanipes	A Click Beetle	
Melanotus villosus	A Click Beetle	
Cheilosia albitarsis	A Hoverfly	
Cheilosia illustrata	A Hoverfly	
Chrysogaster solstitialis	A Hoverfly	
Episyrphus balteatus	A Hoverfly	
Eristalis intricarius	A Hoverfly	
Eupeodes corollae	A Hoverfly	
Melanogaster hirtella	A Hoverfly	
Pipizella viduata	A Hoverfly	
Platycheirus albimanus	A Hoverfly	
Sphaerophoria scripta	A Hoverfly	
Syritta pipiens	A Hoverfly	
Syrphus ribesii	A Hoverfly	
Volucella pellucens	A Hoverfly	
Xylota segnis	A Hoverfly	
Chrysopilus asiliformis	A Snipefly	
Beris chalybata	A Soldierfly	
Beris vallata	A Soldierfly	
Chorisops nagatomii	A Soldierfly	
Chorisops tibialis	A Soldierfly	
Microchrysa polita	A Soldierfly	
Pachygaster atra	A Soldierfly	
Dioctria baumhaueri	A Robberfly	
Empis tessellata	A Dance Fly	
Empis trigramma	A Dance Fly	

Rhamphomyia sulcata	A Dance Fly	
Elachiptera brevipennis	A Chloropid Fly	
Phytomyza ilicis	A Leaf-Mining Fly	
Dolichopus trivialis	A Long-legged Fly	
Botanophila fugax	An Anthomyiid Fly	
Delia florilega	An Anthomyiid Fly	
Delia platura	An Anthomyiid Fly	
Sylvicola fenestralis	A Wood Gnat	
Rhamphomyia sulcata	A Daggerfly	
Bibio hortulanus	A March Fly	
Bibio marci	A March Fly	
Nephrotoma quadrifaria	A Cranefly	
Minettia fasciata	A Lauxaniid Fly	
Sapromyza quadripunctata	A Lauxaniid Fly	
Geomyza tripunctata	An Opomyzid Fly	
Opomyza germinationis	An Opomyzid Fly	
Thaumatomyia notata	A Grass Fly	
Coremacera marginata	A Snail-killing Fly	
Limnia unguicornis	A Snail-killing Fly	
Suillia variegata	A Heleomyzid Fly	
Oxyna parietina	A Fruit Fly	
Terellia tussilaginis	A Fruit Fly	
Vespa crabro	European Hornet	
Vespula vulgaris	Common Wasp	
Ectemnius cephalotes	A Solitary Wasp	
Passaloecus gracilis	A Solitary Wasp	

Pemphredon lugubris	A Solitary Wasp	
Andrena dorsata	A Solitary Bee	
Andrena haemorrhoa	A Solitary Bee	
Andrena minutula	A Solitary Bee	
Apis mellifera	HoneyBee	
Bombus terrestris	Buff-tailed Bumblebee	
Bombus lapidarius	Large Red-tailed Bumblebee	
Bombus pascuorum	Common Carder Bee	
Hylaeus communis	A Yellow-faced Bee	
Lasius niger	An Ant	
Myrmica rubra	An Ant	
Pachyprotasis rapae	A Sawfly	
Aglais urticae	Small Tortoiseshell Butterfly	
Celastrina argiolus	Holly Blue Butterfly	
Inachis io	Peacock Butterfly	
Maniola jurtina	Meadow Brown Butterfly	
Pararge aegeria	Speckled Wood Butterfly	
Pieris brassicae	Large White	
Pieris rapae	Small White	
Sesia apiformis	Hornet Clearwing Moth	NS
Tyria jacobaeae	Cinnabar Moth	
Vanessa atalanta	Red Admiral Butterfly	
Cercopis vulnerata	A Froghopper	
Allygus mixtus	A Leafhopper	
Eupteryx florida	A Leafhopper	
Euscelis incisus	A Leafhopper	

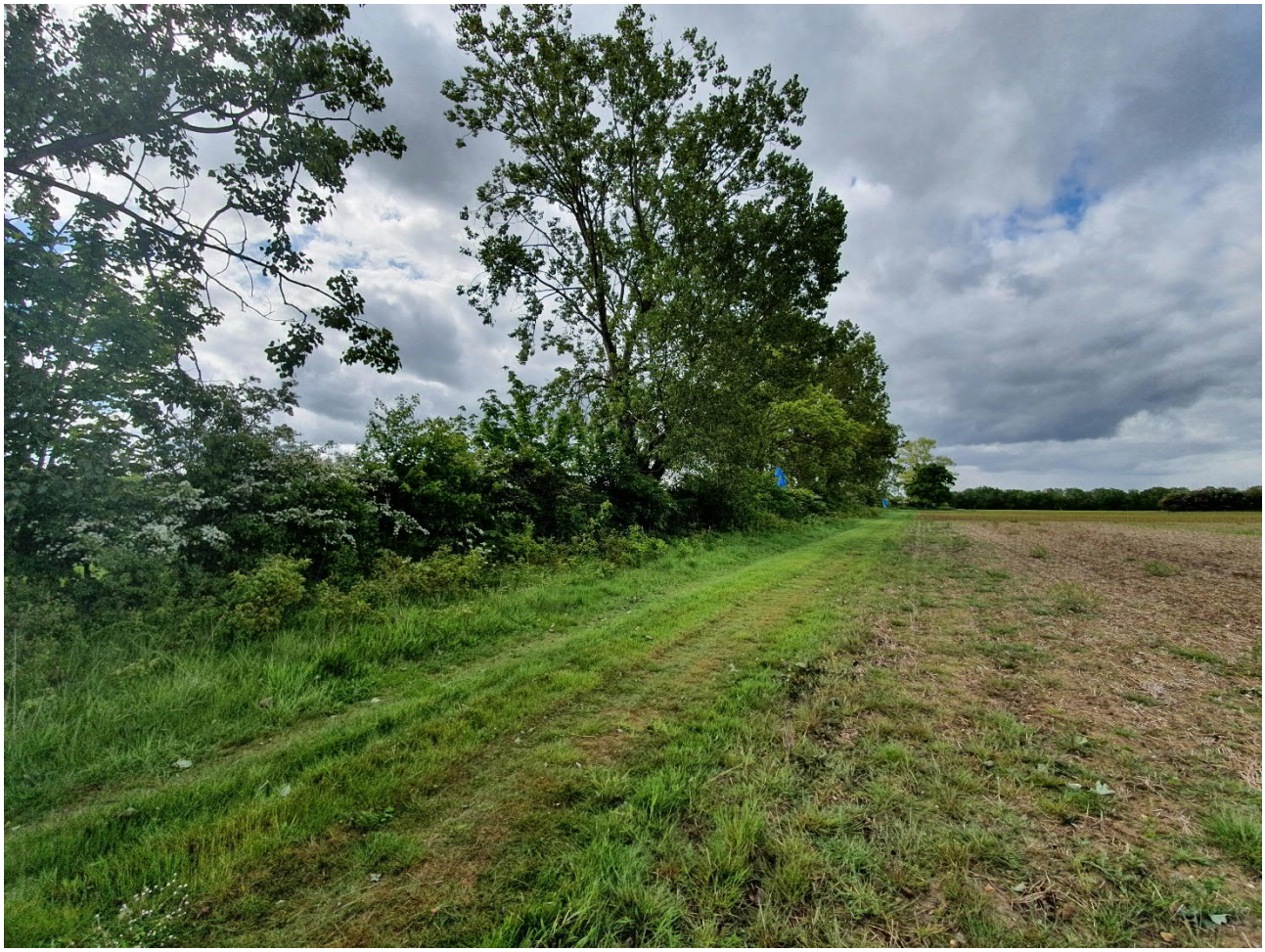
Metidiocerus rutilans	A Leafhopper	
Tachycixius pilosus	A Lacehopper	
Stenocranus minutus	A Planthopper	
Coreus marginatus	Dock Bug	
Coriomeris denticulatus	Denticulate Leatherbug	
Acanthosoma haemorrhoidale	Hawthorn Shieldbug	
Pentatoma rufipes	Red-legged Shieldbug	
Sehirus luctuosus	Forget-me-not Shieldbug	
Eysarcoris venustissimus	Woundwort Shieldbug	
Tritomegas bicolor	Pied Shieldbug	
Anthocoris nemoralis	A Flower Bug	
Anthocoris nemorum	A Flower Bug	
Tingis ampliata	A Lace Bug	
Atractotomus mali	A Plant Bug	
Campyloneura virgula	A Plant Bug	
Capsus ater	A Plant Bug	
Closterotomus norwegicus	A Plant Bug	
Cyllecoris histrionius	A Plant Bug	
Deraeocoris lutescens	A Plant Bug	
Dicyphus globulifer	A Plant Bug	
Dryophilocoris flavoquadrimaculatus	A Plant Bug	
Harpocera thoracica	A Plant Bug	
Heterotoma planicornis	A Plant Bug	
Leptopterna dolabrata	A Plant Bug	
Lygus rugulipennis	A Plant Bug	

Miris striatus	A Plant Bug	
Notostira elongata	A Plant Bug	
Phylus palliceps	A Plant Bug	
Phytocoris varipes	A Plant Bug	
Pithanus maerkelii	A Plant Bug	
Plagiognathus arbustorum	A Plant Bug	
Psallus perrisi	A Plant Bug	
Psallus varians	A Plant Bug	
Psallus wagneri	A Plant Bug	
Rhabdomiris striatellus	A Plant Bug	
Stenotus binotatus	A Plant Bug	
Trigonotylus caelestialum	A Plant Bug	
Piesma maculatum	A Beet Bug	
Himacerus mirmicoides	A Damsel Bug	
Nabis ferus	A Damsel Bug	
Nabis rugosus	A Damsel Bug	
Kleidocerys resedae	Birch Catkin Bug	
Nysius senecionis	A Ground Bug	
Peritrechus geniculatus	A Ground Bug	
Stygnocoris sabulosus	A Ground Bug	
Myrmus miriformis	A Rhopalid Bug	
Stictopleurus abutilon	A Rhopalid Bug	
Chorthippus brunneus	Common Field Grasshopper	
Chorthippus parallelus	Meadow Grasshopper	
Leptophyes punctatissima	Speckled Bush Cricket	
Meconema thalassinum	Oak Bush Cricket	

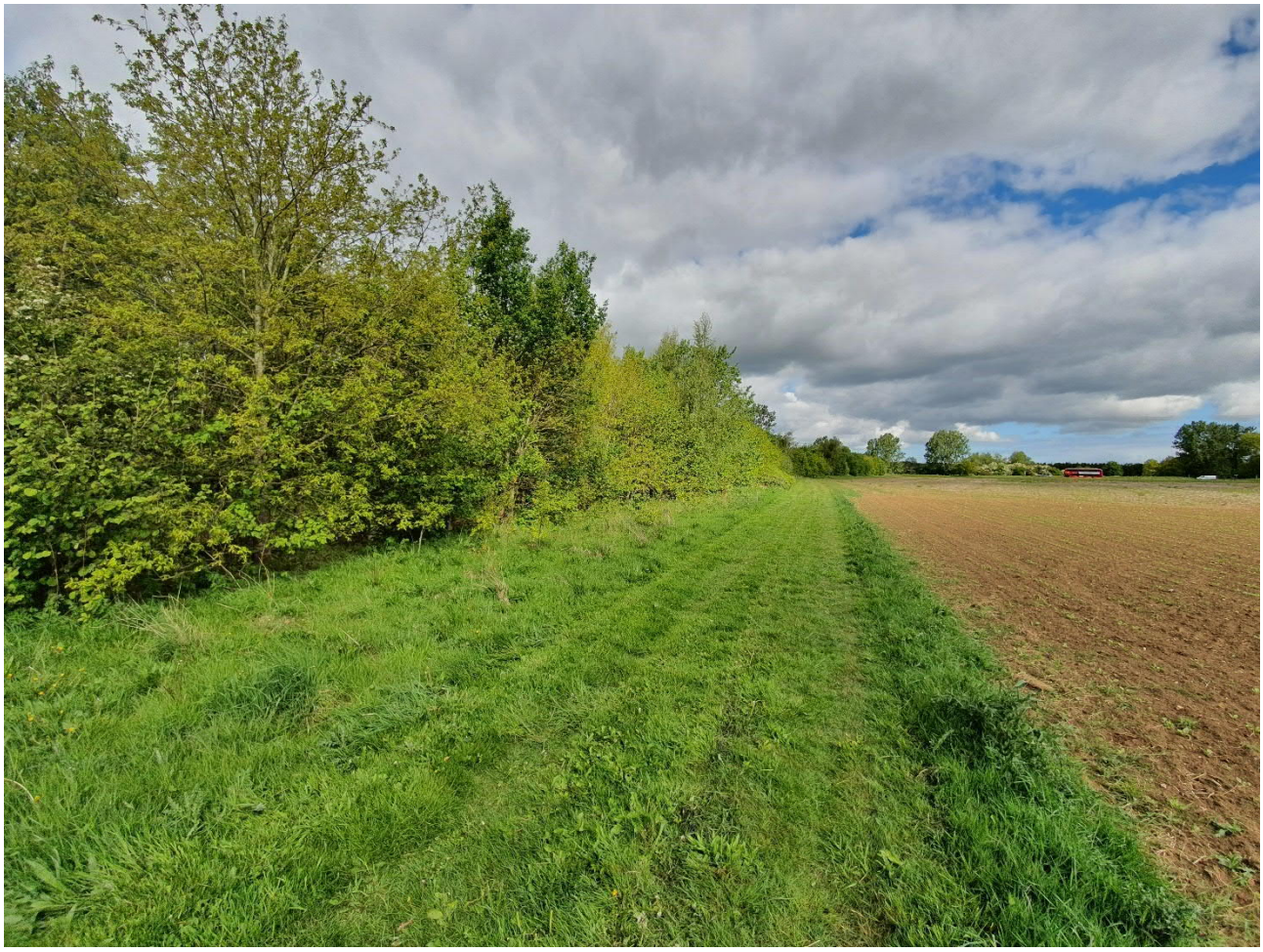
Tetrix subulata	Slender Ground Hopper	
Forficula auricularia	An Earwig	
Aeshna grandis	Brown Hawker	
Anax imperator	Emperor Dragonfly	
Libellula depressa	Broad-bodied Chaser	
Sympetrum striolatum	Common Darter	
Coenagrion puella	Azure Damselfly	
Agelena labyrinthica	A funnelweb spider	
Araniella cucurbitina	Cucumber Spider	
Clubiona comta	A Sac Spider	
Clubiona lutescens	A Sac Spider	
Cheiracanthium erraticum	A Sac Spider	
Dictyna arundinacea	A Mesh-web Spider	
Anelosimus vittatus	A Comb-footed Spider	
Enoplognatha ovata	Candy-striped Spider	
Paidiscura pallens	A Comb-footed Spider	
Theridion mystaceum	A Comb-footed Spider	
Araneus diadematа	An orb web spider	
Araneus marmoreus	An orb web spider	
Gibbaranea gibbosa	An Orb-web Spider	
Nuctenea umbratica	An Orb-web Spider	
Tetragnatha montana	A Large-jawed Orb-weaver	
Pardosa pullata	A Wolf Spider	
Alopecosa pulverulenta	A Wolf Spider	
Misumena vatia	A Crab Spider	
Ozyptila trux	A Crab Spider	

Xysticus cristatus	A Crab Spider	
Philodromus aureolus	A Running Crab Spider	
Heliophanus flavipes	A Jumping Spider	
Theridion mystaceum	A Comb-footed Spider	
Theridion varians	A Comb-footed Spider	
Pisaura mirabilis	Nursery-web Spider	
Tibellus oblongus	A Grass Spider	
Paroligolophus agrestis	A Harvestman	
Glomeris marginata	Pill Millipede	
Tachypodoiulus niger	White-legged Snake Millipede	
Polydesmus angustus	Common Flat-backed Millipede	
Polydesmus denticulatus	A Flat-backed Millipede	
Brachydesmus superus	A Millipede	
Discus rotundatus	Rounded Snail	
Cepaea nemoralis	Brown-lipped Snail	
Cepaea hortensis	White-lipped Snail	
Cornu aspersum	Common Garden Snail	

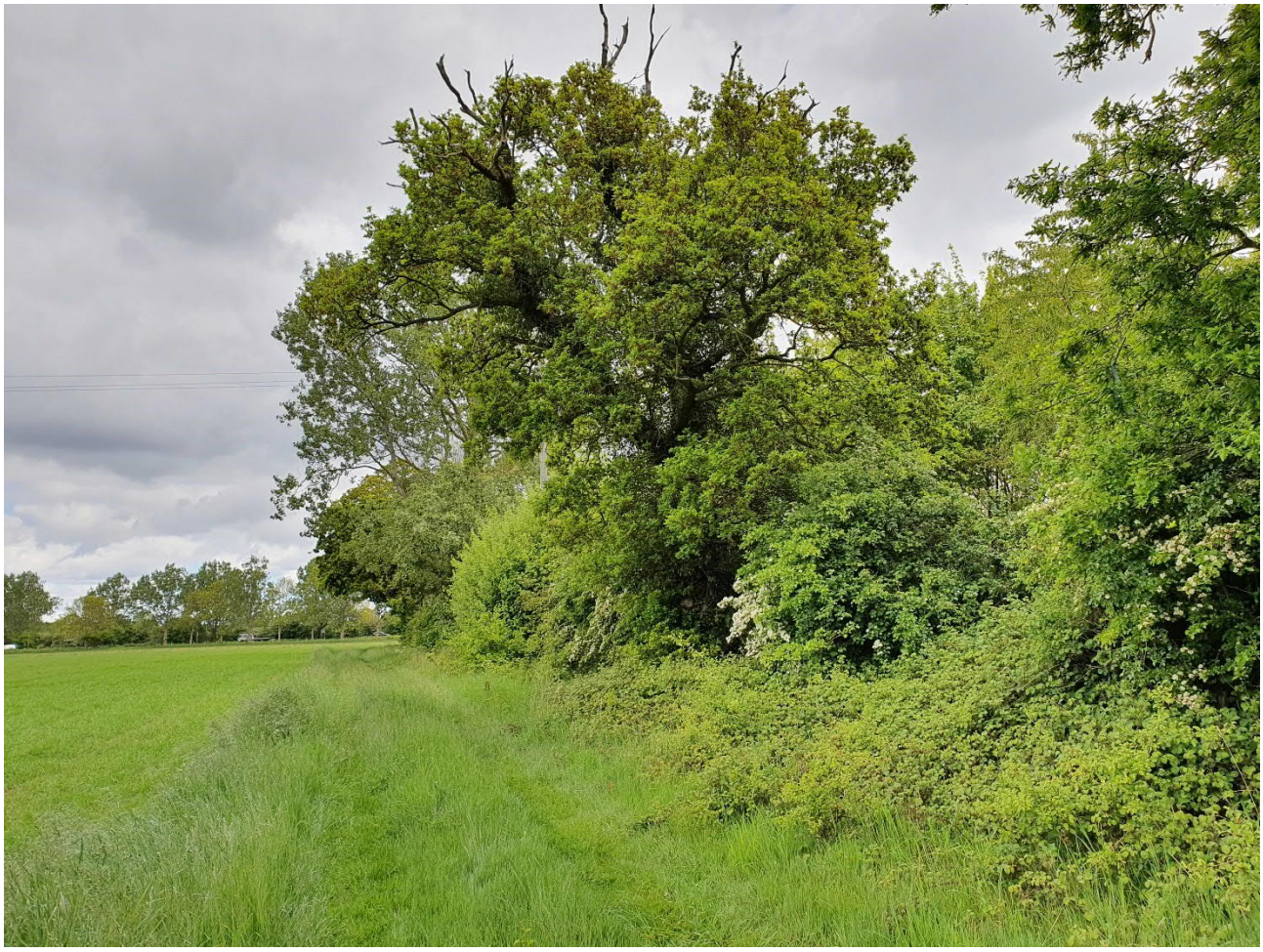
APPENDIX B: Photographs



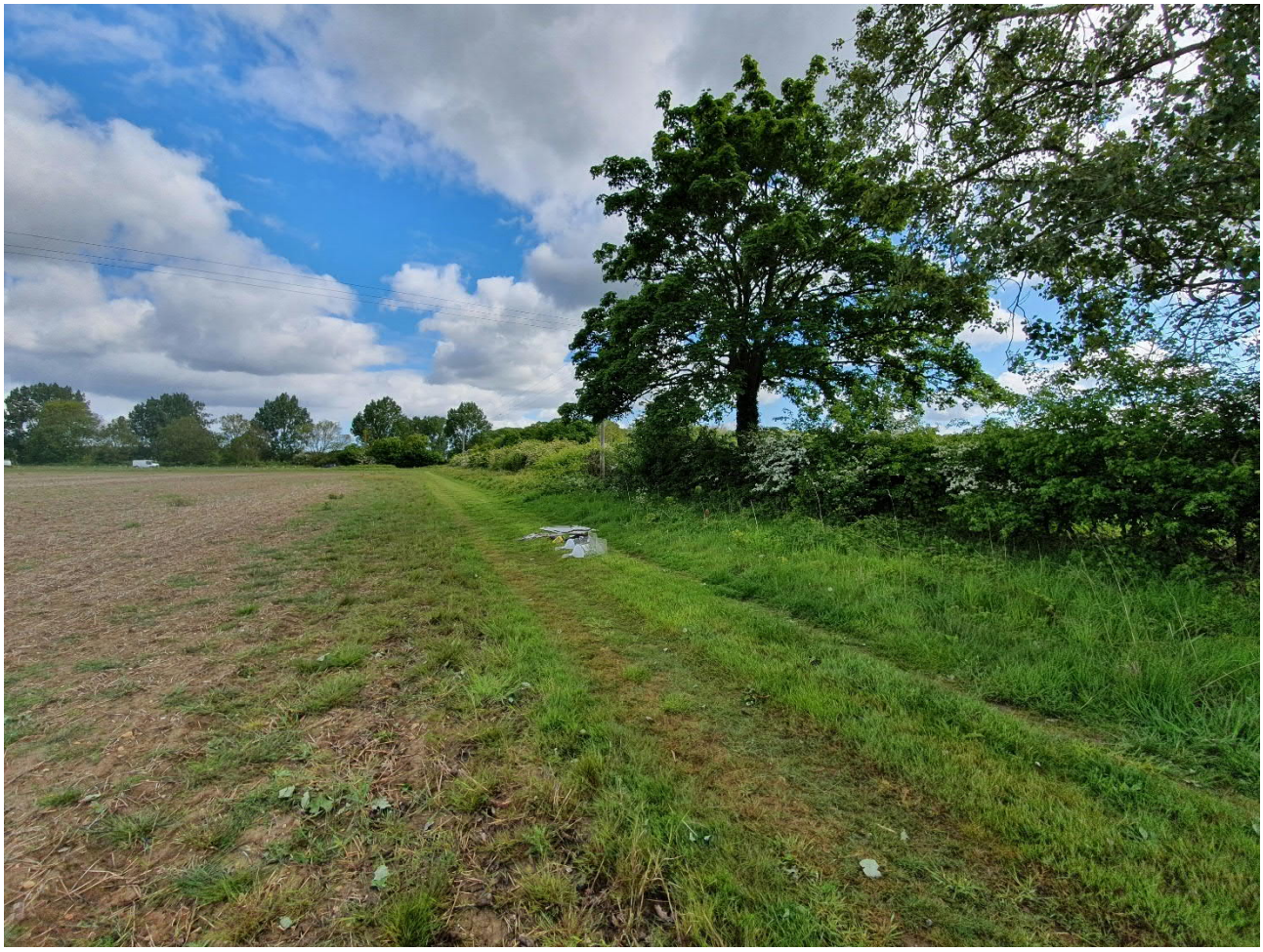
Arable field, margin and hedgerow – typical habitat throughout the survey area



Arable field, broad, botanically poor margin and recent planted wood (~20 years).



Arable field, broad botanically poor margin and planted wood (~20 years). One of several old oaks that has the beginnings of veteranisation – stag-head decay in the canopy and decay in the trunk. Vane traps were installed on four trees like this throughout the site.



Wide field margins throughout the site, but botanically poor.

Old oak in hedgerow with vane trap in situ.

Area D1. Hedge and arable field.