Report for Cannock Chase AONB Partnership

An invertebrate species audit for Cannock Chase AONB

Saving the small things that run the planet

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Cannock Chase
Area of Outstanding Natural Beauty

Contents

1. Executive Summary

Buglife was commissioned by the Cannock Chase AONB Partnership to carry out a desk based invertebrate audit of the Cannock Chase AONB. The AONB Partnership, through the Land Management and Biodiversity Task and Finish Group, wishes to better understand what invertebrate species are present across the AONB, their distribution and conservation status, and how they are faring, in order to inform any protection and conservation measures.

Data was sourced from all recognised potential sources, including Staffordshire Ecological Record, county recorders, local entomologists, statutory bodies and relevant conservation partners. This yielded 27,566 fine-scale post-1995 records of 2,655 invertebrate species - which formed the central invertebrate audit dataset. Hotspot mapping was undertaken to identify core areas within the Cannock Chase AONB for invertebrates, with 10 hotspots identified and confirmed by consultation with local experts. Species of conservation concern were also mapped, considering all species with an acknowledged status including species listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006, Endangered or Vulnerable in modern status reviews, or Red Data Book, Nationally Scarce and Notable. This produced records of 226 species of conservation concern, with lists produced for each of the identified invertebrate hotspots. The Pantheon database tool was also used to identify habitat and resource associations which are represented by the overall 25 year dataset. The report confirmed that some species are over-represented within the AONB-wide dataset as a result of popularity, ease of identification or as a result of sustained effort to survey for specific high profile species, with the 20 most frequently recorded species accounting for 14% of all post 1995 records.

Records of the 226 species of conservation concern were collated, including 58 Section 41 Priority Species, although 46 of these species were noted as widespread but declining 'research only' Lepidoptera species. Three species were recorded with a modern threat status of Vulnerable or higher, and a further five have been assessed as Near Threatened. This indicates an overall invertebrate fauna of significance and the distribution of these records was used to identify a series of hotspots for invertebrates across Cannock Chase. These 10 invertebrate hotspots contain a large proportion of the records for species of conservation concern.

The audit confirmed that the Cannock Chase AONB supports an important assemblage of invertebrates, with records in the last 25 years of species that correlate with the habitats and features listed in the Cannock Chase Site of Special Scientific Interest citation and Special Area of Conservation's conservation objectives. The combined invertebrate assemblages for Cannock Chase include high levels of representation for habitats and resources associated with the heathland areas, woodland habitats and decaying wood features, as well as diverse standing and running water wetland habitats.

The Lepidoptera are disproportionately well represented in the overall data relative to the number of species supported. Targeted surveys of groups with fewer current records per species, such as the Araneae, Coleoptera, Diptera and Hemiptera could yield valuable additional data. Invertebrate recording correlates strongly with the protected area networks as well as the Priority Habitat network, particularly with the areas of open acid grassland and lowland heath. However, in reviewing areas that may be poorly recorded, referred to as "not spots", it appears that many of the areas of lower record density are areas lacking semi-natural habitats, likely dominated by intensive forestry and agriculture that are of less value for invertebrates overall.

An analysis of species not recorded since 1995 revealed 791 species lacking a modern record, including 137 species of conservation concern, many of which could likely be re-found with targeted survey effort. Future survey work and flagship species are proposed which would make significant improvements to the knowledge of invertebrates in the Chase and better inform future management priorities.

2. Introduction

The Cannock Chase Area of Outstanding Natural Beauty (AONB) was designated in 1958, to protect its considerable character and natural heritage. The Cannock Chase AONB area is well known to be of significant value for wildlife, with much of the area designated as Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) or Local Wildlife Site (LWS), including much of the Chase's network of heathland, grassland, parkland and wood pasture, woodland and river valley habitats (Figure 1).

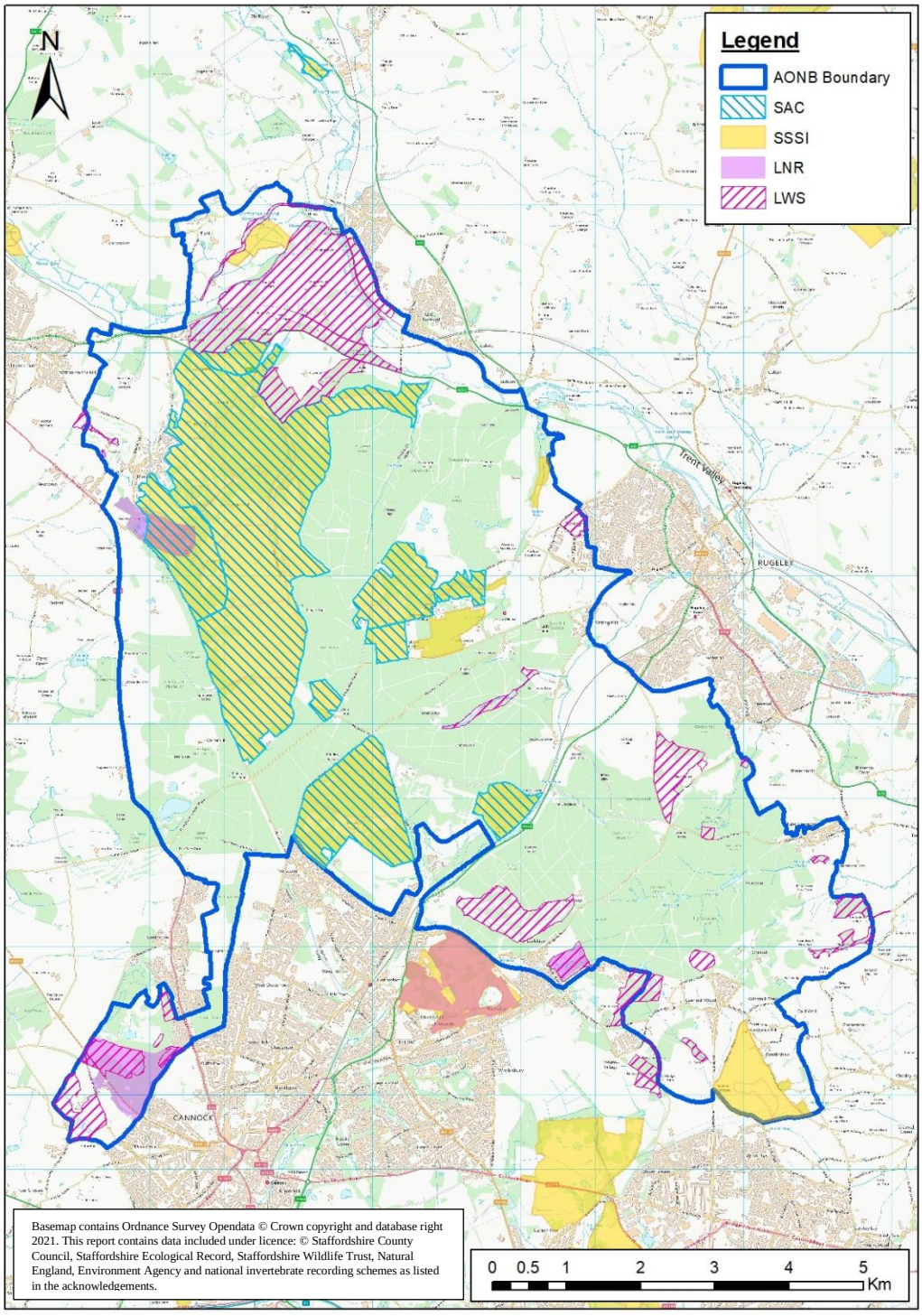

Figure 1 *Map of Cannock Chase AONB and the location of SAC, SSSI, LNR and LWS units.*

The Chase has been subject to invertebrate survey and assessment over many years, thanks to the dedication and effort of the entomological community and organisations involved with managing and maintaining the area's habitats and landscape. This rich history of survey has revealed that the Chase supports an outstanding range of invertebrates, which includes charismatic scarce species such as Welsh clearwing (*Synanthedon scoliaeformis*), Small pearl-bordered fritillary (*Boloria selene*), Bog bush-cricket (*Metrioptera brachyptera*) and assemblages of rare and scarce Coleoptera (beetles) and Hymenoptera (ants, bees and wasps) associated with specific habitat features such as dead wood and bare ground in heathland sites. Elements of this diverse interest are highlighted in the Cannock Chase SSSI citations, including the rich woodland moth fauna, heathland and mire Lepidopteran assemblages, and the beetles of wetlands and mature trees and deadwood habitats. However, the invertebrate interest of the Chase is wider than these limited notified features, and the Cannock Chase SAC citation also details the importance of early successional habitats across the dry heathland, and the assemblages of valley mire/wet heath habitats.

Much of the data produced from decades of ongoing survey and conservation effort is dispersed and held with different organisations and recorders. The Cannock Chase AONB partnership wishes to better understand the diverse invertebrate species present across the AONB, including their distribution and conservation status to ensure they are protected and well served by conservation measures.

The aim of this project is to carry out a comprehensive audit of Cannock Chase AONB's invertebrates and invertebrate groups that will:

- Draw together the known resources of relevant invertebrate information on Cannock Chase AONB.
- Help increase the knowledge base of invertebrates and invertebrate groups, including important invertebrate assemblages as well as species of conservation concern and local biodiversity interest.
- Identify gaps in knowledge.
- Assist with strategically targeted funding for future invertebrate conservation work on the Cannock Chase AONB, including improving the status of declining invertebrates/invertebrate groups.

The objectives of this project are to:

1) Search and collate existing invertebrate records to create a knowledge base of the invertebrates found on Cannock Chase AONB based upon the taxon groups and date ranges detailed below.
2) Identify and map the distribution of all invertebrates of conservation concern (defined as protected by UK law, S41, Red Data Book, Nationally Scarce or similar authoritative listing and local biodiversity interest) in order to understand the importance of Cannock Chase AONB for invertebrates, that have been recorded within the past 25 years.
3) Collate all records for the following orders or sub-groups from Cannock Chase AONB since 1st January 2010: Coleoptera (terrestrial and aquatic beetles); Diptera (flies); Araneae (spiders); Hemiptera (true bugs); Aculeate Hymenoptera (bees, wasps, and ants); Lepidoptera (butterflies and moths); Odonata (damselflies and dragonflies); Orthoptera and allied insects (grasshoppers, crickets, earwigs, and cockroaches); Trichoptera (caddisflies); Ephemeroptera (mayflies); and Plecoptera (stoneflies).
4) Using Pantheon analysis software or equivalent interpret the above data to give indications of which specific invertebrate assemblages are or might be important for Cannock Chase AONB.
5) Identify and map any sites/areas/habitat types of particular importance for invertebrates in order to inform future conservation strategies
6) Highlight and interpret key findings in order to inform our understanding of the value of Cannock Chase AONB for invertebrates
7) Identify any gaps in our knowledge that emerge from the data to inform future survey and monitoring strategies.
8) Flag up any conservation issues or priorities that can assist with future invertebrate conservation work on the AONB.

Detailed recommendations for future management for invertebrates and invertebrate groups are separate from this exercise.

3. Methodology

3.1 Study area

The study area was defined as the boundary of the Cannock Chase AONB. However, for some specified elements of the analysis a 500m buffer was applied.

3.2 Data collation

Invertebrate data is often held by a number of organisations, recording schemes and individuals. To capture this dispersed data, a significant data collation exercise was necessary to ensure that the final audit takes as full account of the invertebrate fauna as possible. Data requests were made by Buglife for the species groups identified in the report objectives. No date range was specified, despite the report focusing on data post 1995 to allow an additional analysis of species which have not been recorded in the last 25 years. It was also decided that where species groups not identified by the project specification could easily be sourced and mapped, that they would be included within the study to maximise its coverage of invertebrate species groups and provide a higher quality resource.

An initial data request was made to Staffordshire Ecological Record (SER), the Local Environmental Record Centre for the Cannock Chase AONB area. Requests for additional data were made to the Staffordshire Invertebrate Group, local entomologists, county recorders, statutory bodies and relevant conservation partners, working closely with the Cannock Chase AONB to ensure that all potential sources of data were identified. A significant volume of data was also mobilised for use in the audit and future use by the local ecological community by digitising data from scanned reports. Buglife was also able to use data from a number of national invertebrate recording schemes with which it has longstanding relationships, with data explicitly sourced for their use in this exercise. Those recorders and schemes which provided data are outlined in the Acknowledgements.

Records were entered into a single analysis database, labelled with the source of record, verification status and conservation status appended. Most records fell within the 100m resolution range and could be easily incorporated into the dataset. For records with only 1km resolution (centroid of monad), records were included where at least 50% of the monad fell within the AONB boundary. Fine-scale records were considered to be those with a 1km or lower resolution and were used throughout later analysis. More general records with a 10km resolution which could be confirmed as being within the Chase from record information were incorporated in the dataset but only used for some elements of the analysis where spatial attributes were not needed.

3.2.2 Conservation status review

Due to the wide range of species groups, expertise required and differing states of knowledge, status reviews for invertebrates vary significantly in their age. Over time, methods for reviewing statuses have also changed, leading to a number of potential statuses being used across entomology. It was agreed that all modern status reviews would supersede older reviews, but that where old reviews are the only available standard status that these would be used. There are also instances where national statuses disagree with those at the European or global level- in these instances the national status was used in preference, but a note made of any international statuses.

The modern status review system uses a two-pronged approach that separates rarity from threat. Threat status is determined using internationally recognised post-2001 IUCN criteria: Extinct; Regionally Extinct; Critically Endangered; Critically Endangered (Possibly Extinct); Endangered; Vulnerable; Near Threatened; Data Deficient; Least Concern; Not Assessed; and Not Evaluated. Rarity is calculated as either Nationally Rare for a species only recorded from between 1-15 British hectads (10km x 10km square) or Nationally Scarce for species recorded from 16-100 hectads - both within a given time period and where there is confidence that extensive recording wouldn't record them in further hectads.

The old status reviews evaluate species using different criteria, and include: RDB 1 – Endangered; RDB 2 – Vulnerable; RDB 3 – Rare; RDB K - Insufficiently Known; RDB I – Indeterminate; Na - Notable A; Nb - Notable B; Notable - Notable or Nationally Scarce; Unknown; Not reviewed; New to Britain; and Not native.

In addition to these formal status reviews, Species of Principal Importance have been identified by Natural England under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006. These species were identified by expert ecologists based on their national declines and high level of threat or where the UK holds a significant proportion of the world's total population.

The list of species of conservation concern for this audit was agreed to include any species identified as a Species of Principal Importance under Section 41 of the NERC Act; with a status of Endangered, Vulnerable, Near Threatened or Nationally Rare in a recent status review; Red Data Book listed, or identified as Nationally Scarce or Notable in historic status reviews; or as Near Threatened or higher in a European or Global red listing (albeit with the GB status prioritised).

3.2.3 Consultation

Invertebrate recording can be vulnerable to misidentification as a result of the difficulty in identifying key species, despite often thorough verification routes for many datasets. Species are also subject to being split, merged or downgraded to subspecies status as our knowledge of their taxonomy improves.

It was therefore decided in consultation with the Cannock Chase AONB that records of species considered dubious or unlikely by local entomological experts and county recorders would be removed from the dataset. A list of all species identified as species of conservation concern and with a post 1995 record was circulated among county recorders and local entomologists to identify any species which might have a material impact on mapping priority areas for invertebrates. This led to the removal of 11 Lepidopteran species on the recommendation of the county moth recorder who considered the records to be unverified, in addition to the removal of records for Heath tiger beetle (*Cicindela sylvatica*) and the Tormentil tubetail hoverfly (*Sphaerophoria potentillae*) following confirmation by the original recorders.

3.3 Limitations of data and analysis

The UK has some of the world's best invertebrate data, thanks to the long-term effort of entomologists. However, any analysis of data is only as good as the dataset inputted. Invertebrate recording can be heavily skewed towards sites which are known to already be of value for species of conservation concern, motivating entomologists and recorders to visit them more often and submit yet more records. The effect of this is to magnify the importance of some sites that are renowned for their value. In addition, site access and permissions often dictate the distribution of records, with clusters of records around sites with public access, along public rights of way, along woodland rides and even visitor infrastructure such as car parks.

Invertebrate recording is highly skilled and some groups may be poorly represented in data sets due to the degree of specialism needed to identify them. Conversely, the presence of specialists for lesser recorded invertebrate groups in an area can also lead to hotspots for individual species groups, that result in an unusual peak in local recording relative to the national landscape.

All of the above can have a significant impact on any hotspot analysis and the relative value of different sites for invertebrates.

It must also be noted that any survey or record itself represents just a picture in time and a record from 25 years ago should not be considered to suggest a continued presence. As such this audit assessed the invertebrate fauna that has been recorded across the Cannock Chase AONB over the last 25 years and cannot be used to fully assess the quality of habitats in their current state or necessarily the success of current management techniques.

3.4 Hotspot analysis methodology

Hotspot analysis is a spatial analysis and mapping technique that identifies clusters of data, in this case clusters of invertebrate records in the same local area. Areas with a greater number of invertebrate records appear warmer, standing out against the background of areas with fewer records. The resultant hotspot maps help to visualise where the statistical hotspots for invertebrate records are.

Hotspot mapping of recording effort across the Cannock Chase AONB used the entire dataset of post 1995 records collated as part of the invertebrate audit. This was done using both Kernel density and Point Density statistical analysis tools in ArcGIS. The results were nearly identical, and with Kernel density usually viewed as a more accurate measure, this method was used.

Contour hotspot maps were also produced to help refine the boundaries of key hotspots in the Chase (Section 4.4). The lines of contours delineate areas of equal record density- with the area between contours representing the same averaged density of records, or bands of record density. As with topographical contour maps, the centre of the perceived peaks represent the highest density of records. Sites were then delineated using accepted known boundaries such as SSSI management units, the LWS series or buffering from a central feature such as the centre line of river valleys.

It was considered essential to also map out records for the Chase's most scarce and threatened invertebrates specifically, to ensure that the hotspots identified by the Kernel density analysis overlap with their distribution. It is not possible to repeat this hotspot exercise with just the records of species of conservation concern, however, due to the smaller size of the dataset, which is below the required statistical threshold.

3.5 Pantheon analysis

Pantheon is a database tool developed by Natural England and the Centre for Ecology & Hydrology, which analyses invertebrate datasets and can help to identify site quality for habitat features, associations and key ecological resources. It currently provides the supporting information for over 13,000 invertebrate species, for those species and families where their ecology is sufficiently understood, based on expert input. Among its outputs, Pantheon identifies habitat associations and specific requirements for individual species, tied to structural habitats (e.g. sparse vegetation) or environmental factors (e.g. fast flowing water). Pantheon is then able to compare individual site lists against a national list of associations with each habitat or resource to show the number of species associated with them and the proportion of the national fauna represented. It must be noted that there do remain significant gaps in the Pantheon dataset, but the current database is based on a significant proportion of UK species for which we understand their ecology, meaning that it is a valuable tool in identifying assemblages of significance.

Habitat and resources associations were analysed for the entire Cannock Chase AONB invertebrate audit dataset to assess the overall key habitats for invertebrates. However, to provide additional information on the key sites identified through hotspot mapping and mapping of species of conservation concern, the data was also clipped to the areas identified as hotspots for invertebrates and analysed.

4. Results

4.1 Records summary

Following the extensive data collation and sorting exercise, a total of 27,566 fine-scale invertebrate records formed the central audit dataset, representing a total of 2,666 invertebrate species (Figure 2). This consisted of 19,815 from the SER dataset, 5,092 records sourced from entomologists and additional national recording scheme data and sourced from entomologists, and 2,659 records digitised from PDF reports and previously unavailable for spatial mapping. A further 160 general records are for confirmed species within the Cannock Chase AONB but were insufficiently fine-scale for most elements of the audit's analysis.

All data has been provided to the Cannock Chase AONB for their use. Data mobilised from scanned reports which had the appropriate permissions has also been shared with SER for its future use in assisting in invertebrate conservation.

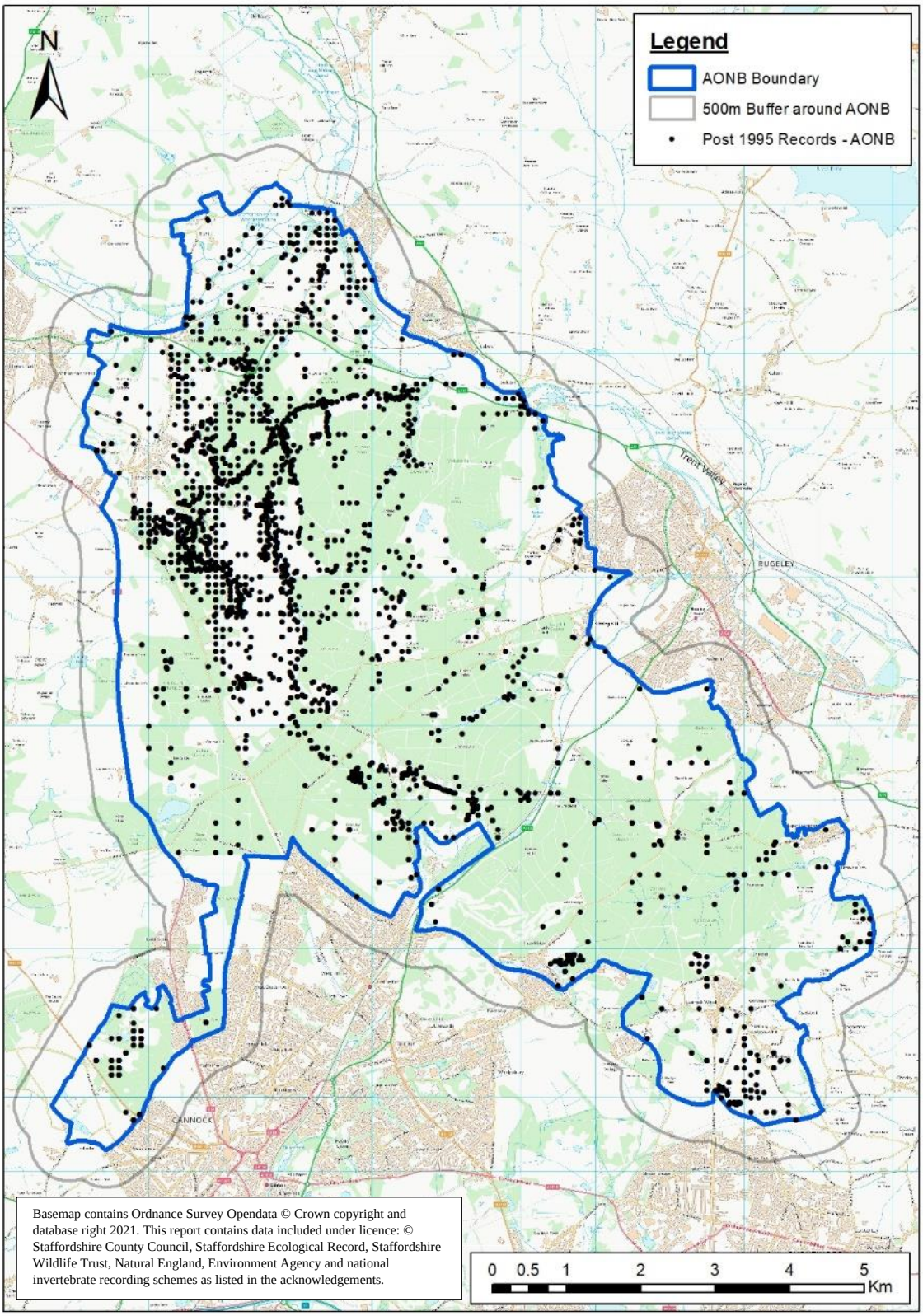

Figure 2 *Map of all post 1995 invertebrate records within the Cannock Chase AONB that form the invertebrate audit dataset. Dots may represent multiple stacked records.*

4.2 Cannock Chase invertebrate records hotspot mapping

Hotspot mapping analysis involved mapping the distribution of all invertebrate species with post 1995 fine-scale records, regardless of status. This effectively identifies the areas of highest recording effort, rather than being indicative of relative value for rare or scarce invertebrates and recording effort (Figure 3). Contour mapping was used to aid the delineation of key sites as discussed in the methodology (Figure 4).

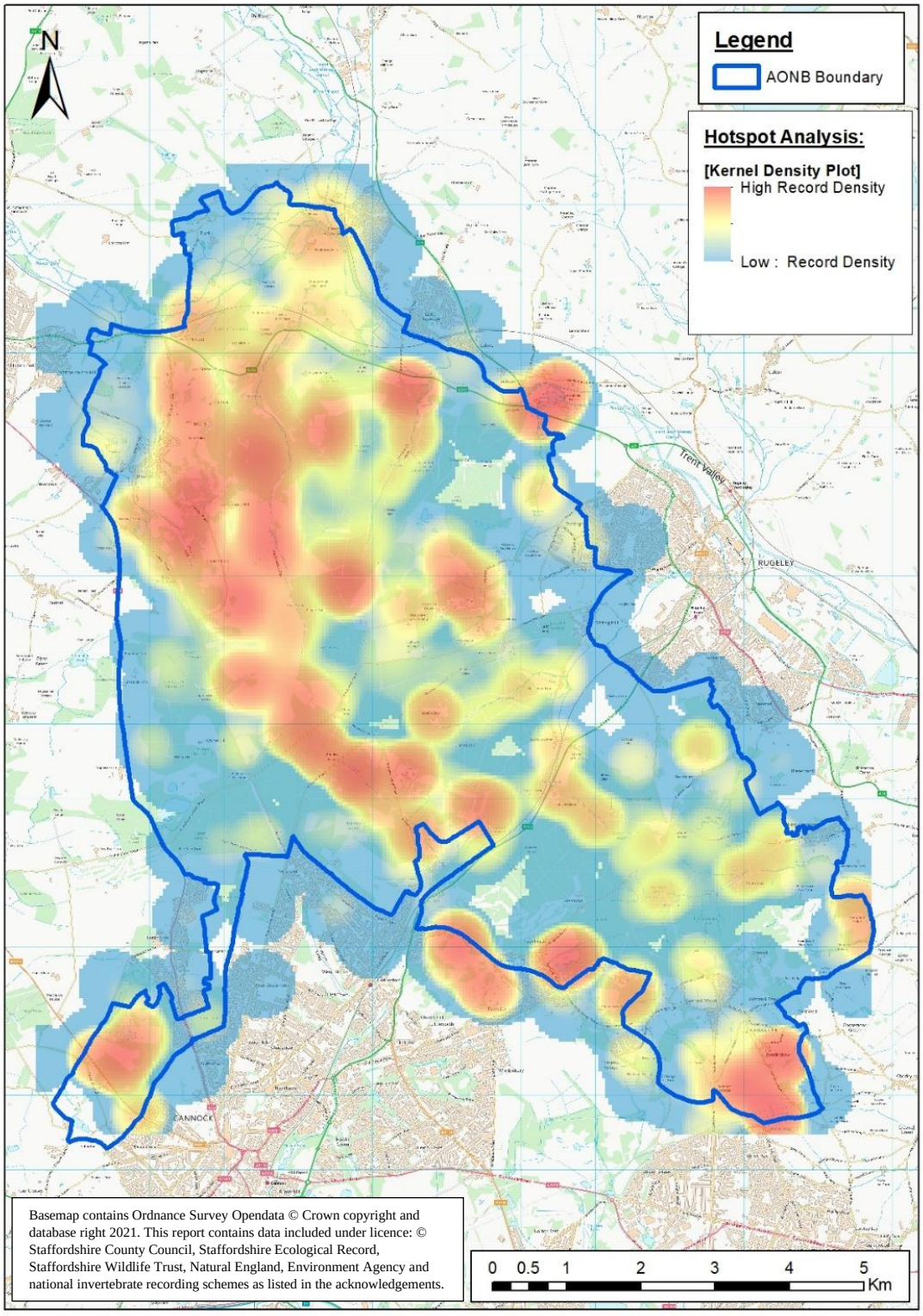

Figure 3 *Hotspot map of all species records within Cannock Chase. Blue areas indicate the fewest number of records with areas of the densest recording shown in red*

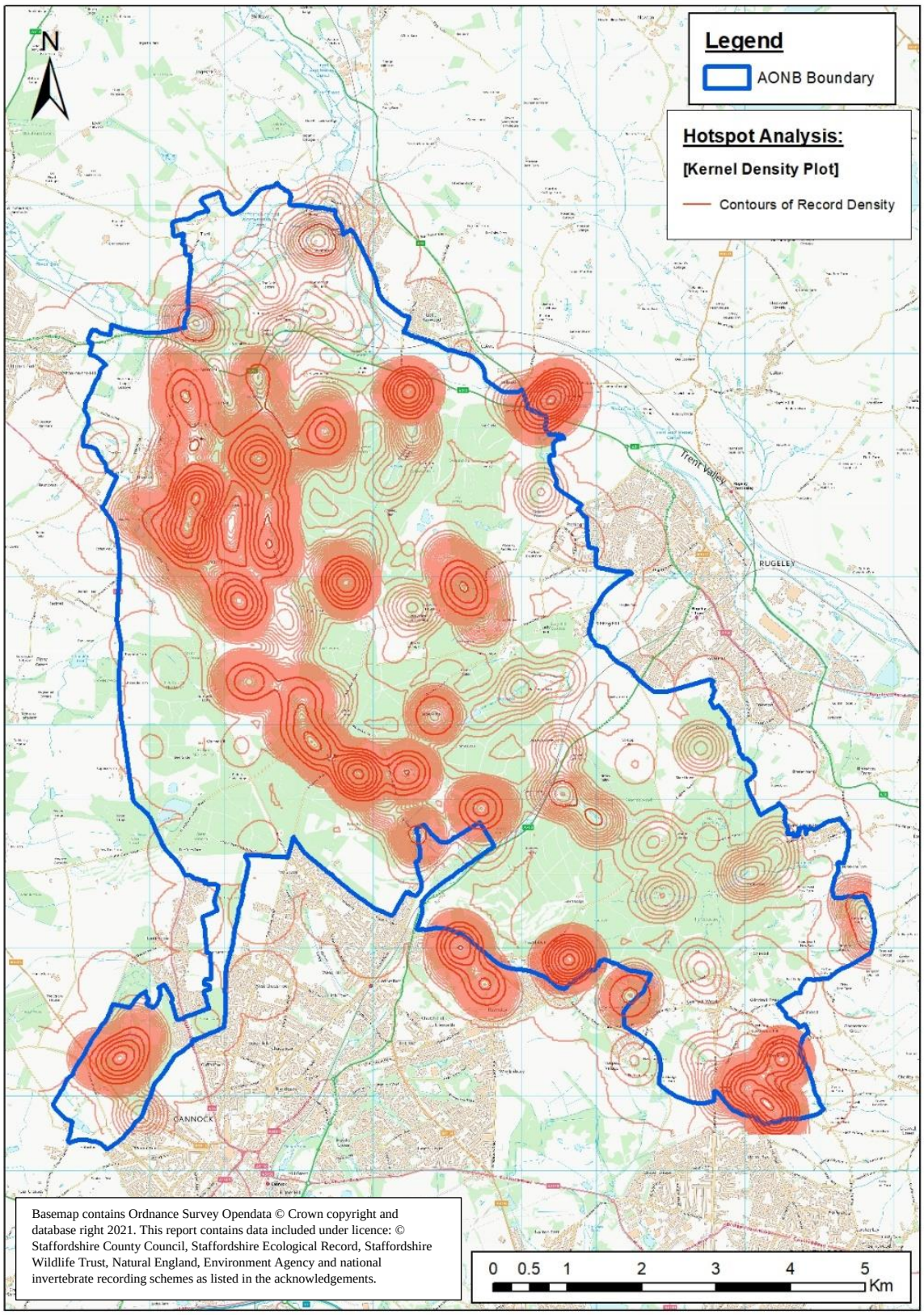

Figure 4 *Contour hotspot map of all species records within Cannock Chase, showing areas of higher density of records*

4.3 Species of conservation concern and selection of key sites

Data collation identified records for 226 species with a recognised conservation status, with a list of species provided in Appendix 1. This is a significantly smaller dataset than the entire invertebrate audit dataset for the Chase, preventing a true hotspot analysis from being completed. However, a map was produced showing records of all species of conservation concern (Figure 5). Individual maps for each species identified as either a full Section 41 species (e.g. not research only), or with a Vulnerable or higher GB threat status have been provided as an annex to this report.

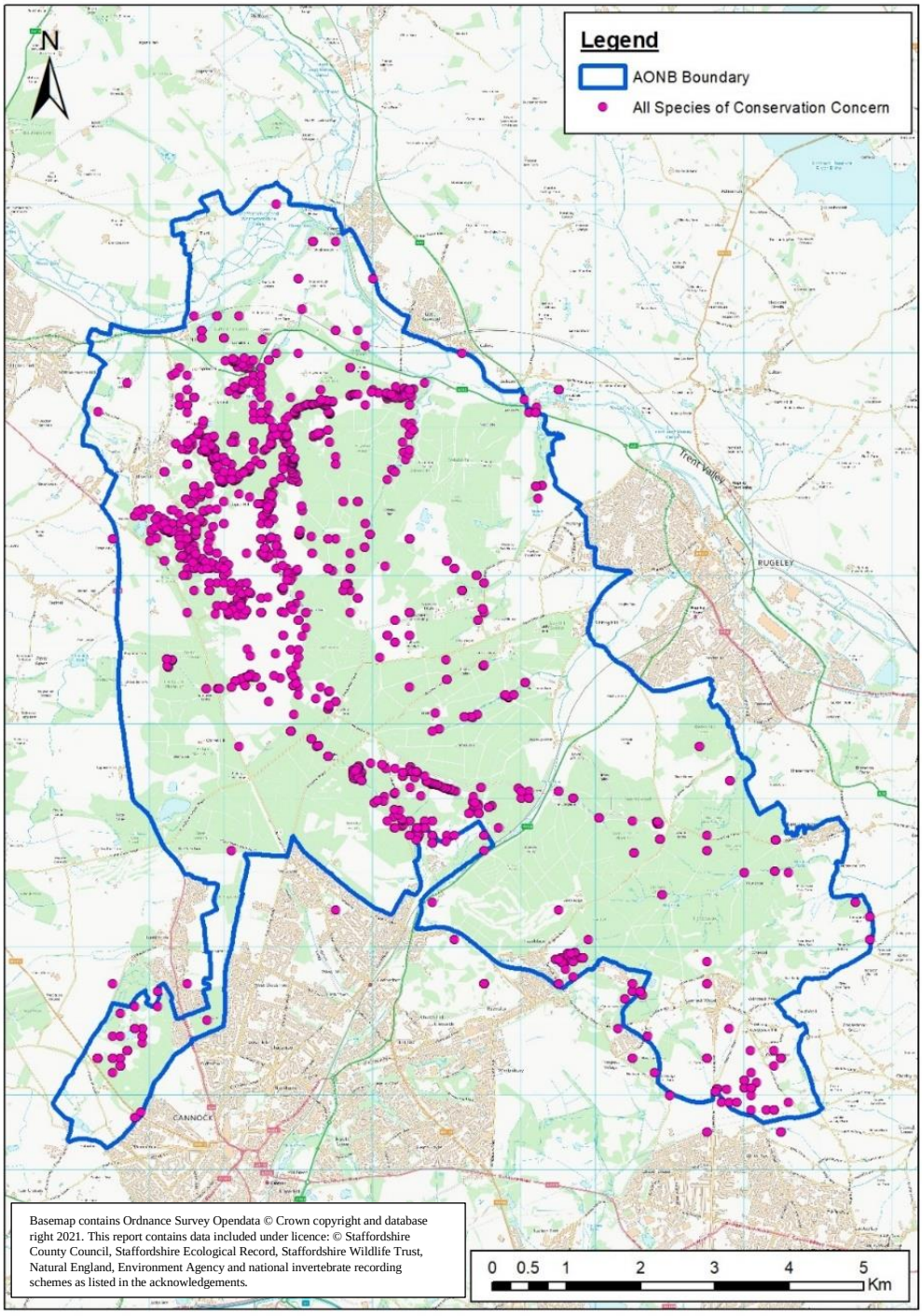

Figure 5 *Map of all post 1995 invertebrate records with a conservation status within the Cannock Chase AONB that from the invertebrate audit dataset. Dots may represent multiple stacked records.*

Invertebrate statuses are subject to change as and when new status reviews are undertaken, as discussed in the methodology. It can often be useful to specifically map records of species which have undergone a modern status review and identified as having a threat status. The audit revealed that the Chase has post 1995 records of three species with a modern threat status of Vulnerable or higher in national status reviews, as shown in Table 1, with their distribution shown in Figure 6. A further five species have been assessed as Near Threatened.

Common name	Scientific name	Order	GB Threat status
a Dolichopodid fly	*Dolichopus lineatocornis*	Diptera	Vulnerable
Dingy skipper	*Erynnis tages*	Lepidoptera	Vulnerable
White-letter hairstreak	*Satyrium w-album*	Lepidoptera	Endangered

Table 1 *List of invertebrate species with post 1995 records in the Cannock Chase AONB and a GB threat status of Vulnerable or higher*

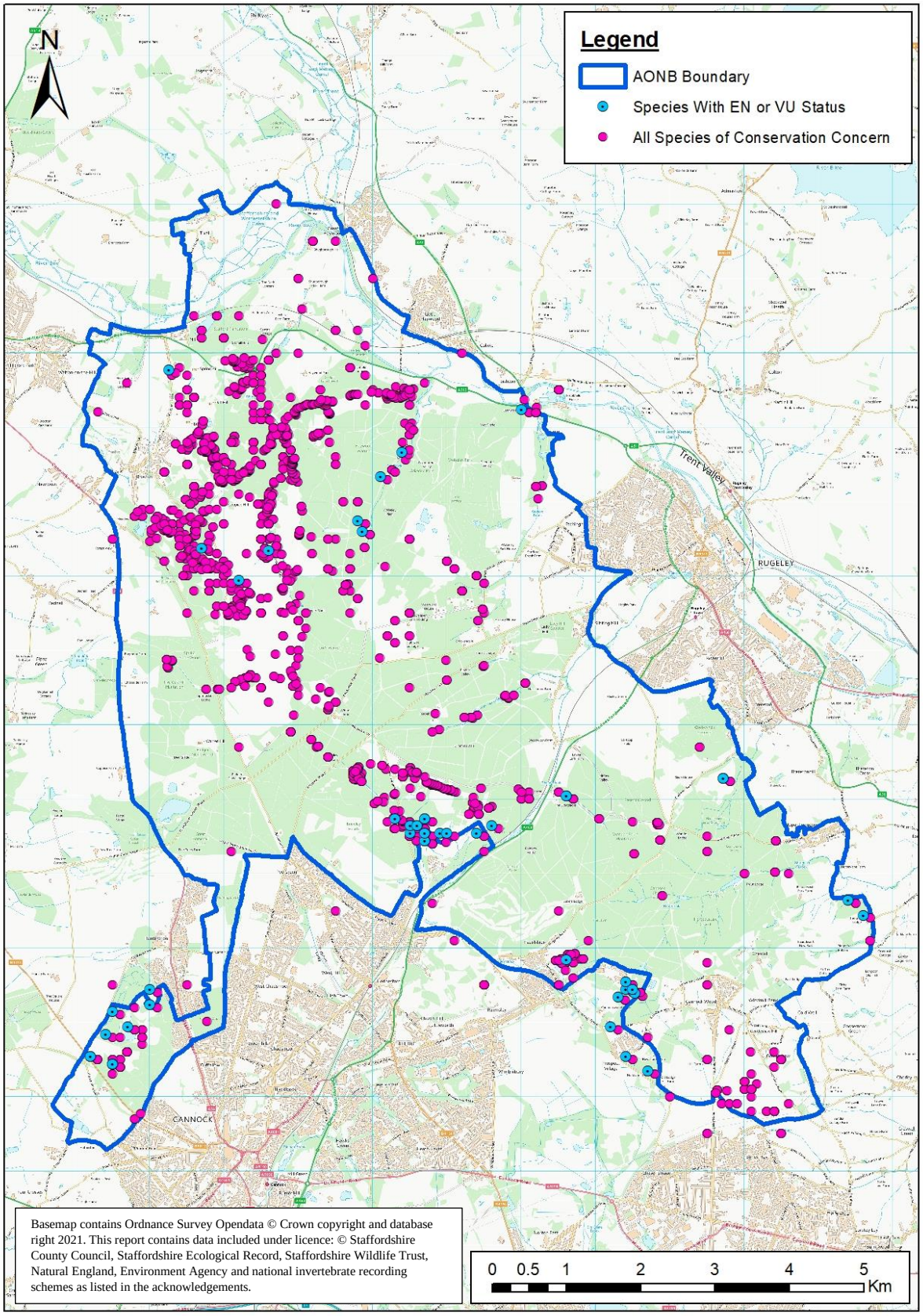

Figure 6 *Map of all post 1995 invertebrate records with a conservation status within the Cannock Chase AONB that from the invertebrate audit dataset, highlighting those listed as Endangered or Vulnerable in modern status reviews. Dots may represent multiple stacked records.*

The Cannock Chase AONB has a particular responsibility for Species of Principal Importance under Section 41 of the NERC Act. A total of 57 species were identified- listed in Appendix 1. 46 of these species are the 'research only' Lepidoptera species which are regarded as being widespread but declining. Of the 11 'true' Section 41 species, seven are Lepidoptera, one Coleoptera, one Hymenoptera, one crayfish and one freshwater mollusc. The combined distribution of Section 41 species is shown in Figure 7.

The crayfish records are for White-clawed crayfish (*Austropotamobius pallipes*) and the mollusc for the Depressed river mussel (*Psuedanodonta complanata*), both of which are included in this report - but must be considered cautiously. White-clawed crayfish used to be a common freshwater species but it has suffered from steep national declines as a result of the spread of invasive, non-native crayfish species such as the American signal crayfish (*Pacifastacus leniusculus*), which spread a disease known as crayfish plague, as well as habitat degradation and pollution. Once established, invasive crayfish species can slowly come to dominate waterways and are very difficult to eradicate. As a result, White-clawed crayfish data must be considered carefully as this sensitive species is vulnerable to local extinction events in very short periods of time. This audit considers species presence in the last 25 years, however, for White-clawed crayfish a much shorter window is required and individual records do not provide a great deal of information. A specific assessment of the relative number of modern White-clawed crayfish records alongside those of invasive species is needed to identify the most secure and significant sites for this species, based on the input of local experts in the species. There is also often a need for the location of important White-clawed crayfish sites to be kept confidential. Although not mapped as part of this exercise, Nick Mott from Staffordshire Wildlife Trust (2021, *pers. comm*.) has indicated that four strongholds for White-clawed crayfish remain in the Chase: Rising Brook from Furnace Coppice to Rugeley flood Alleviation Scheme; Stony Brook; Fallow Stream; and Shropshire Brook

The Depressed river mussel records are all located on or adjacent to the Trent or Trent and Mersey Canal, parts of which run through the AONB. However, although it has been identified as a Vulnerable species at the European level, it remains of Least Concern in the UK, albeit Nationally Scarce. It is difficult to get accurate data for Depressed river mussel as only a few rivers have accurate full or near-full catchment surveys (Willing, M. 2018 *pers. comm.*). Many rivers with confirmed records have only spot records, which cannot be used to assume presence elsewhere, with time-consuming and rigorous survey required. As a result, the species has been included in the mapping exercise, but hotspot mapping has not tried to consider this species as its distribution is largely unknown.

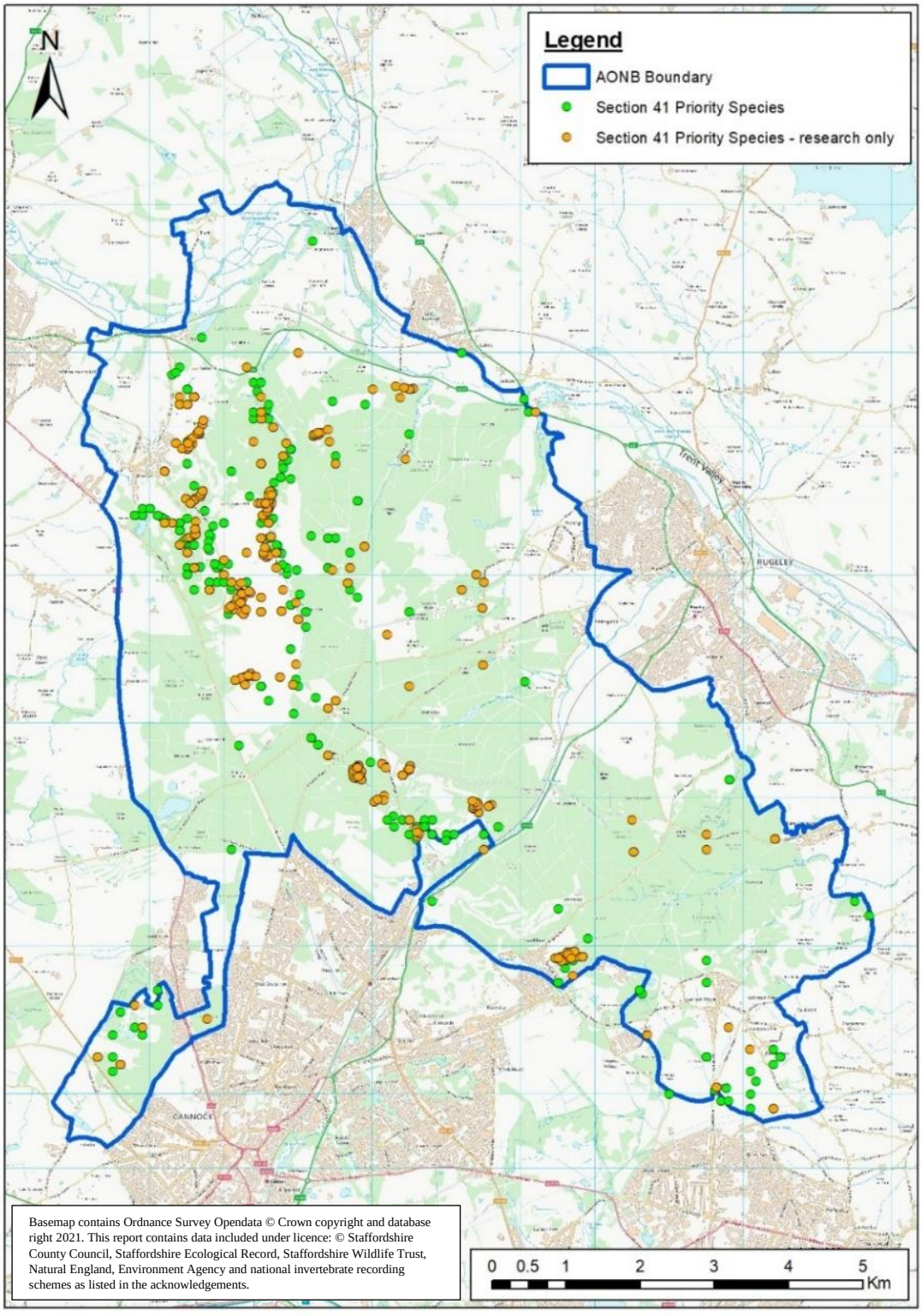

Figure 7 *Map of all post 1995 Section 41 Priority Species from the invertebrate audit dataset. Dots may represent multiple stacked records.*

It is notable that the Chase contains records of a number of species which have a threat status at the European or global level. Of the six species listed in Table 2. two are currently Section 41 Priority Species, but none have a modern national threat status. It is notable that the UK mollusc status review has been undertaken and confirmed that all three of these species are currently of Least Concern in the UK. The Hymenoptera review has yet to be finalised following repeated delays and should be reviewed on its release. The White-clawed

crayfish remains a species of high conservation concern, given it is Endangered at the global level and continues to suffer from local extinction events across the UK.

Group	Taxon name	International status	Section 41	GB Threat	GB Rarity
Hymenoptera	*Bombus muscorum*	VU (European)	Section 41 Priority Species		
Decapoda	*Austropotamobius pallipes*	EN (Global)	Section 41 Priority Species		
Veneroida	*Sphaerium rivicola*	VU (Global)			
Unionoida	*Anodonta cygnea*	NT (European)			
Hymenoptera	*Formica rufa*	NT (Global)			
Unionoida	*Pseudanodonta complanata*	VU (Global), NT (European)			

Table 2 *Invertebrate species with an international status and post 1995 records in Cannock Chase AONB.*

4.4 Selection of Hotspots for invertebrates

Key sites or hotspots for invertebrates across Cannock Chase were identified, using the contour hotspot maps to manually identify the areas with the greatest density of records. However, the maps of records of species of conservation concern were also used, to ensure that the most rare and scarce species were also included in hotspots. This is essential to ensure that the increased recording effort of more common and visible species does not dominate the records of species more in need of targeted conservation effort. It must also be noted that the static maps of records of species of conservation concern should be treated with some caution, as many individual dots represent multiple stacked records for the same grid reference.

With all of the key clusters of records and notably of species of conservation concern identified, site boundaries were then defined, ideally using known identifiable boundaries such as SSSI units, the LWS series, landholdings, or by buffering river corridors as appropriate.

A list of draft key sites was then shared with local entomologists and experts, to ensure that all of the sites considered locally as the most significant for invertebrates had been selected as a result of the data analysis. A total of 13 sites were identified as representing hotspots for records of species of conservation concern, 11 entirely within the AONB boundary, one straddling the boundary, and one site immediately adjacent to the boundary (Figures 8 & 9). Following consultation it was agreed that three of these sites (including the two outside/partially outside of the AONB) are more likely to be the result of being popular and readily accessible sites or sites which have been the focus of recording effort and are not necessarily of raised quality for invertebrates. This leaves a total of 10 sites which represent true key sites for invertebrates: Brindley Heath, Brocton Coppice, Furnace Coppice, Gentleshaw Common, Milford Quarry, Old Acre Valley & Gravel Pits, Old Brook, Sherbrook Valley, Shoal Hill, and the Shugborough Estate.

The maps of species of conservation concern also show clusters along many of the major public rights of way that cross the AONB. After examination, it was considered that the clusters of records along these rights of way are not indicative of raised habitat value, with the majority of records being readily identifiable and mobile Lepidoptera.

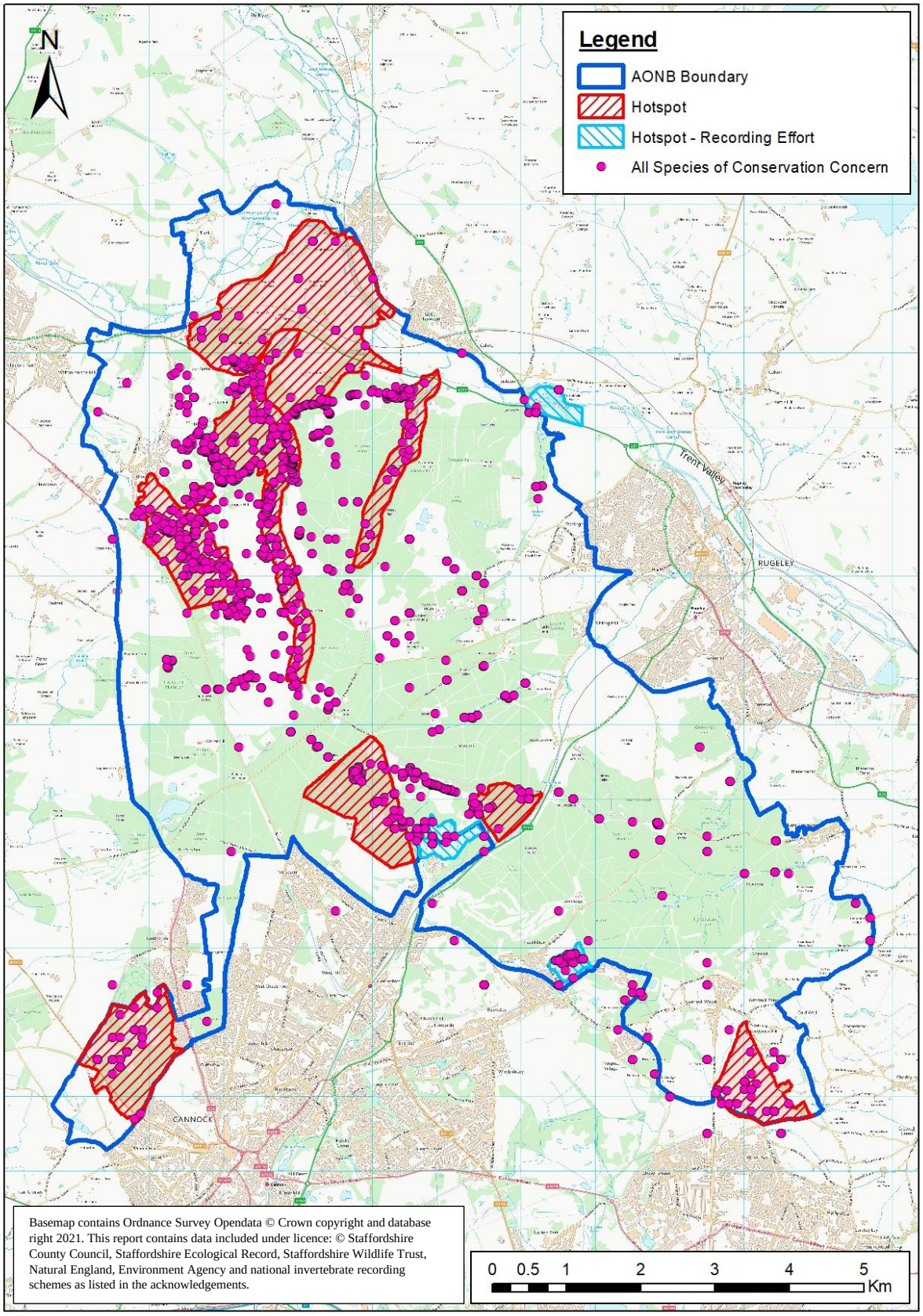

Figure 8 *Map showing sites with hotspots of records of species of conservation concern. Sites with red lines indicate what is considered to be a genuine key site for invertebrates of conservation concern, whereas sites with blue lines have multiple records but are more likely to be a result of access and recording effort*

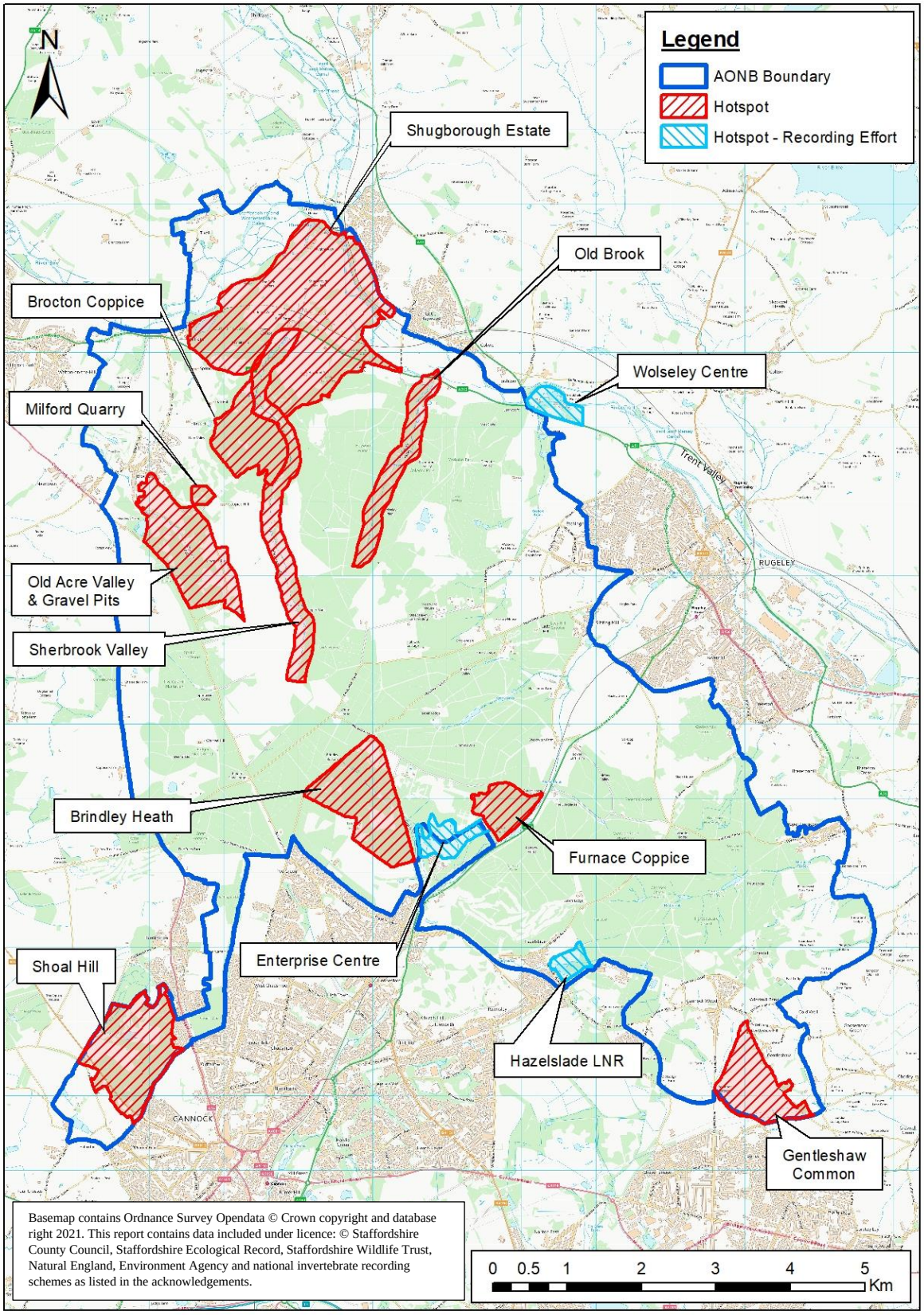

Figure 9 *Map showing named hotspots for species of conservation concern. Sites with red lines indicate what is considered to be a genuine key site for invertebrates of conservation concern, whereas sites with blue lines have multiple records but are more likely to be a result of access and recording effort.*

For each of these hotspot sites, the invertebrate audit database was used to calculate the number of post 1995 species records contained and to identify all species with a conservation status as shown in Table 3.

Hotspot name	No. of species	No. of species of conservation concern	% of species with a status
Brindley Heath	309	31	10.0
Brocton Coppice	763	79	10.4
Furnace Coppice	205	17	8.3
Gentleshaw Common	649	34	5.2
Milford Quarry	374	28	7.5
Old Acre Valley & Gravel Pits	533	39	7.3
Old Brook	532	38	7.1
Sherbrook Valley	674	49	7.3
Shoal Hill	249	21	8.4
Shugborough Estate	444	33	7.4

Table 3 *Number of species and species of conservation concern within each of the 10 identified hotspots*

4.5 Pantheon analysis of Cannock Chase AONB

Pantheon was used to identify key habitat and resource associations across the Chase, to identify those of most significance for invertebrates (Tables 4 & 5). This can help to guide management, as management focused on the most significant habitat types and features can ensure that even as yet recorded interest associated with high value features can be retained.

As discussed in Section 3.5, Pantheon contains a database for over 13,000 invertebrate species where their ecology is sufficiently understood. This includes habitat associations and more specific requirements for individual species. For the purpose of this exercise, the higher level habitat associations are defined as a mid-level category that are readily identifiable and recognisable by conservation workers. However, the resource associations, of which there can be several within any given habitat, refer to requirements or links to structural habitats (e.g. sparse vegetation) or environmental factors (e.g. fast flowing water). For example, a species can be easily understood through the habitat association of 'arboreal', or tree associated, however, the habitat resource association might be the more fine-scale feature such as 'mature tree canopy', 'leaves and/or stems' or 'understorey'.

Pantheon compares species lists against a national list of associations to show the number of species associated with them and the proportion of the national fauna represented. A high representation suggests that a site supports a high proportion of characteristic species for a habitat or resource, indicating it is of good quality. It is suggested that 10-20% may indicate a good quality score, with scores over 20% certainly suggesting that a good proportion of characteristic species are found (Pantheon, 2021). As some sites and datasets here are small, lower scoring habitat associations with a minimum of 5% representation have been provided, for information only.

The Species Quality Index (SQI) is a measure of the number of rare species in a sample, divided by the total number of species in the sample with scores assigned based on modern statuses. A minimum number of species is required for each resource or habitat feature, with a score of over 100 given, allowing for numerical comparison of sites.

Broad biotope	Habitat	No. of species	% representation	SQI	Species with conservation status
tree-associated	arboreal	420	32	113	21
open habitats	tall sward & scrub	731	28	111	44
tree-associated	wet woodland	65	26	130	5
wetland	wet woodland	64	24	130	5
tree-associated	decaying wood	268	23	189	62
wetland	Marshland	173	21	123	7
tree-associated	shaded woodland floor	222	20	125	12
open habitats	short sward & bare ground	241	19	150	39
wetland	running water	164	16	127	11
wetland	Lake	19	15	100	0
wetland	Peatland	156	14	129	10
open habitats	Upland	16	10	140	0

Table 4 *Habitat associations identified for the entirety of the Cannock Chase AONB, ordered by representation of the national fauna, as identified in Pantheon*

Pantheon is also able to examine more specific resource associations, for which 67 were found with over 10% of the national list for that association recorded and sufficient number of records for the data to be considered meaningful. The full list is provided as Appendix 2. Open habitat and tree-associated species dominate the highest scoring habitats based on representation, with between 29 and 54% of species recorded, all indicating that the Chase has records of a significant proportion of the invertebrate fauna for these habitats (Table 5). Of particular note, 12 of the highest represented resources are related to arboreal habitats and six with tall sward and scrub.

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	tall sward & scrub	habitats >> exposed sand	15	54	119	0
tree-associated	arboreal	canopy >> mature tree canopy	44	52	107	4
tree-associated	arboreal	canopy >> scrub at wood edge/glade	118	49	117	10
tree-associated	arboreal	terrestrial aspect >> larvae ground active/pupate in soil	25	47	140	2
tree-associated	arboreal	flowers (adult)	61	41	110	8
tree-associated	arboreal	foliage >> inflorescence	39	37	100	2
tree-associated	arboreal	carr/wet woodland	25	36	128	4
open habitats	tall sward & scrub	habitats >> soil & roots	66	35	109	3
tree-associated	decaying wood	flowers (adult)	62	35	155	10
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	333	33	110	20
tree-associated	arboreal	foliage	158	33	120	9
tree-associated	arboreal	canopy >> understorey	32	33	100	0
tree-associated	arboreal	canopy	406	32	113	21
tree-associated	arboreal	foliage>> leaves and/or stems	79	32	133	2
open habitats	tall sward & scrub	habitats >> sward/field layer	494	31	110	35
open habitats	tall sward & scrub	soil humidity >> dry	222	31	108	15
open habitats	tall sward & scrub	dung & carrion >> dung	22	31	114	1
open habitats	tall sward & scrub	soil humidity >> damp	120	30	111	8
tree-associated	shaded woodland floor	woodland habitat >> undergrowth	36	30	108	1
tree-associated	decaying wood	sapwood & bark decay >> dead trunks & branches	140	29	178	29

Table 5 *The 20 highest percentage represented habitat resource associations in the Cannock Chase invertebrate audit dataset*

It is notable that some resource associations with large species lists do not appear as the highest ranking due to the larger species pool of their resource. For example, six of the ten highest ranking habitat resource associations with species lists from 161- 494 (Table 6), fail to make the highest 20 scoring associations by percentage represented (Table 5), despite scoring 20-25% representation. These are 'shaded woodland floor-broadleaved only', 'short sward and bare ground- soil humidity dry', 'decaying wood- sapwood and bark decay', 'short sward and bare ground- sward/field layer', 'decaying wood- broadleaved only' and 'tall sward and scrub- litter and ground layer'. This emphasises that there is no single approach to ranking the importance of difference habitats or sites for invertebrates- e.g. total number of species, representativeness, number of species of conservation concern. For example, a long species list might simply indicate that a site has been well

worked by surveyors, representativeness might also indicate that a certain habitat type has been more heavily surveyed, while there may be more species of conservation concern associated with one habitat type but these might be more widespread and common than a habitat type with a shorter list.

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	tall sward & scrub	habitats >> sward/field layer	494	31	110	35
tree-associated	arboreal	canopy	406	32	113	21
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	333	33	110	20
open habitats	tall sward & scrub	soil humidity >> dry	222	31	108	15
tree-associated	shaded woodland floor	conifer or broadleaved >> broadleaved only	217	20	126	12
open habitats	short sward & bare ground	soil humidity >> dry	206	20	146	32
tree-associated	decaying wood	sapwood & bark decay	191	25	175	37
open habitats	short sward & bare ground	habitats >> sward/field layer	186	24	141	31
tree-associated	decaying wood	conifer or broadleaved >> broadleaved only	176	23	213	51
open habitats	tall sward & scrub	habitats >> litter & ground layer	161	25	109	5

Table 6 *The 10 highest scoring habitat resource associations by species number in the Cannock Chase invertebrate audit dataset*

Although no wetland habitat resource associations feature in the highest ranking 20 resources, it is important to note that wetland resource associations still scored impressively in the Chase, as shown in Table 7.

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
wetland	marshland	shallow freshwater pond >> aquatic: well vegetated	46	29	124	2
wetland	running water	woodland stream	42	26	131	3
wetland	wet woodland	woodland stream	42	26	131	3
wetland	peatland	shallow freshwater pond >> aquatic: sparsely vegetated	15	23	100	0
wetland	running water	flow >> fast flow	22	23	100	0
wetland	running water	seepages >> shaded seepage	15	23	160	3
wetland	marshland	shallow freshwater pond	85	22	113	2
wetland	marshland	wetland vegetation	34	22	127	3
wetland	running water	unmodified fast flowing streams	44	21	126	5
wetland	marshland	drawdown zone: mud/shallow litter	61	18	114	2

Table 7 *The 10 highest percentage represented wetland habitat resource associations in the Cannock Chase invertebrate audit dataset*

Invertebrate records were also clipped to the 10 individual hotspot site boundaries. This enabled the Pantheon analysis to be undertaken for each site individually to identify the key habitat and resource associations of the invertebrate assemblage over time. It is important to note that by sub-dividing the entire Chase, the Pantheon analysis is of course being undertaken with a series of smaller species lists. As a result, lower levels of representation are expected.

4.6 Cannock Chase invertebrate hotspots

A map was produced for each of the hotspot sites for invertebrates identified in section 4.4, displaying the invertebrate records in and around the agreed boundary, highlighting species of conservation concern. A species count and list of species of conservation concern was produced, as well as the Pantheon analysis for the higher level habitat and more specific habitat resource associations, as outlined in section 4.5.

This effectively provides an overview of the key interest for each of the hotspots in terms of invertebrates recorded of greatest conservation concern, and the best represented invertebrate assemblages of specific habitats and resource associations.

4.6.1 Brindley Heath

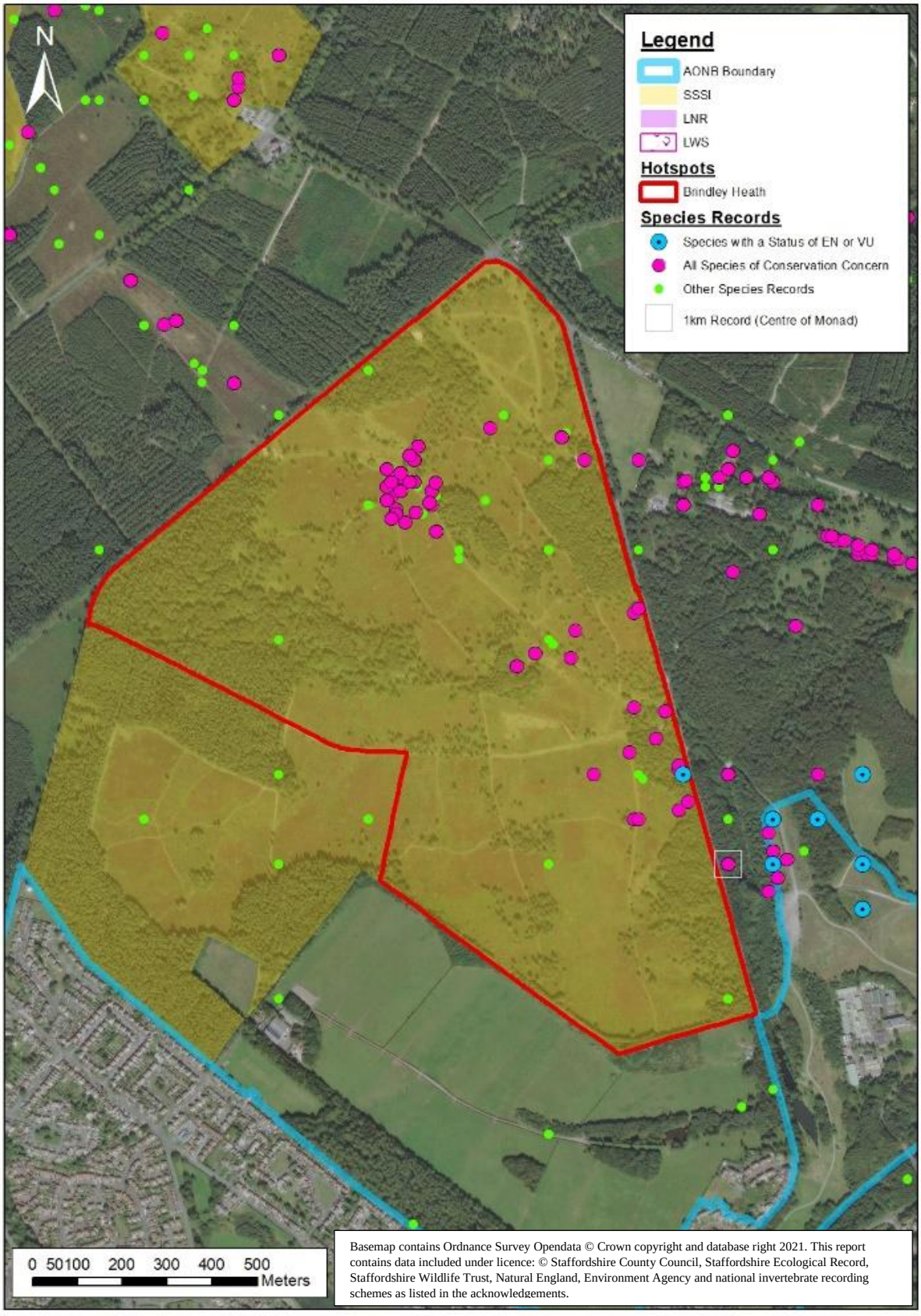

Figure 10 *Map of Brindley Heath and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 309 invertebrate species were collated, including 31 species with a conservation status (Table 8).

Group	Taxon Name	Section 41	GB Threat Status	GB Rarity	Other
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera-butterfly	*Erynnis tages*	S.41		VU	
Lepidoptera- moth	*Acronicta rumicis*	S.41- research only			
Lepidoptera- moth	*Amphipyra tragopoginis*	S.41- research only			
Lepidoptera- moth	*Apamea remissa*	S.41- research only			
Lepidoptera- moth	*Atethmia centrago*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Chiasmia clathrata*	S.41- research only			
Lepidoptera- moth	*Diarsia rubi*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Ennomos erosaria*	S.41- research only			
Lepidoptera- moth	*Eugnorisma glareosa*	S.41- research only			
Lepidoptera- moth	*Euxoa tritici*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Litoligia literosa*	S.41- research only			
Lepidoptera- moth	*Lycia hirtaria*	S.41- research only			
Lepidoptera- moth	*Scotopteryx chenopodiata*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Stilbia anomala*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Lepidoptera- moth	*Xestia agathina*	S.41- research only			
Lepidoptera- moth	*Xestia castanea*	S.41- research only			
Lepidoptera- moth	*Dioryctria sylvestrella*		PNS		
Coleoptera	*Elaphropus parvulus*		NS		
Coleoptera	*Pterostichus quadrifoveolatus*		NS		
Lepidoptera- moth	*Xylena solidaginis*		NS		
Diptera	*Rhipidia uniseriata*				RDB 3
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

Table 8 *List of species of conservation concern with post 1995 records in the Brindley Heath hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	87	7	105	3
habitats	tall sward & scrub	95	4	100	14
open habitats	short sward & bare ground	16	1	125	1

Table 9 *Habitat associations in Brindley Heath*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> scrub at wood edge/glade	25	10	113	0
tree-associated	arboreal	canopy	83	7	106	3
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	73	7	107	3
open habitats	tall sward & scrub	habitats >> sward/field layer	84	5	100	14

Table 10 *Habitat resource associations with over 5% representation in Brindley Heath*

4.6.2 Brocton Coppice

Figure 11 *Map of Brocton Coppice and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 763 invertebrate species were collated, including 79 species with a conservation status (Table 11).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Boloria selene*	S.41		NT	
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Coleoptera	*Ampedus rufipennis*	S.41			RDB 2
Lepidoptera- moth	*Acronicta psi*	S.41- research only			
Lepidoptera- moth	*Acronicta rumicis*	S.41- research only			
Lepidoptera- moth	*Agrochola helvola*	S.41- research only			
Lepidoptera- moth	*Agrochola litura*	S.41- research only			
Lepidoptera- moth	*Allophyes oxyacanthae*	S.41- research only			
Lepidoptera- moth	*Amphipyra tragopoginis*	S.41- research only			
Lepidoptera- moth	*Apamea remissa*	S.41- research only			
Lepidoptera- moth	*Aporophyla lutulenta*	S.41- research only			
Lepidoptera- moth	*Caradrina morpheus*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Cirrhia icteritia*	S.41- research only			
Lepidoptera- moth	*Diarsia rubi*	S.41- research only			
Lepidoptera- moth	*Diloba caeruleocephala*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Ennomos erosaria*	S.41- research only			
Lepidoptera- moth	*Eugnorisma glareosa*	S.41- research only			
Lepidoptera- moth	*Eulithis mellinata*	S.41- research only			
Lepidoptera- moth	*Graphiphora augur*	S.41- research only			
Lepidoptera- moth	*Hoplodrina blanda*	S.41- research only			
Lepidoptera- moth	*Hydraecia micacea*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Litoligia literosa*	S.41- research only			
Lepidoptera- moth	*Lycia hirtaria*	S.41- research only			
Lepidoptera- moth	*Melanchra persicariae*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Tholera cespitis*	S.41- research only			
Lepidoptera- moth	*Tholera decimalis*	S.41- research only			
Lepidoptera- moth	*Trichiura crataegi*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Watsonalla binaria*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Coleoptera	*Anaspis costai*		NS		
Coleoptera	*Anitys rubens*		NS		
Diptera	*Chalcosyrphus eunotus*		NS		
Coleoptera	*Corticeus unicolor*		NS		
Coleoptera	*Dorcatoma flavicornis*		NS		
Coleoptera	*Ernobius nigrinus*		NR		
Coleoptera	*Euglenes oculatus*		NS		
Coleoptera	*Hallomenus binotatus*		NS		
Coleoptera	*Malthinus frontalis*		NS		
Coleoptera	*Malthodes maurus*		NS		
Coleoptera	*Megatoma undata*		NS		

Orthoptera	*Metrioptera brachyptera*		NS		
Araneae	*Pardosa lugubris sensu lato*		NS		
Coleoptera	*Phloiotrya vaudoueri*		NS		
Coleoptera	*Pterostichus quadrifoveolatus*		NS		
Coleoptera	*Saperda scalaris*		NS		
Lepidoptera- moth	*Synanthedon culiciformis*		NS		
Coleoptera	*Synchita humeralis*		NS		
Coleoptera	*Thymalus limbatus*		NS		
Coleoptera	*Triphyllus bicolor*		NS		
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3
Coleoptera	*Uleiota planatus*				Na
Coleoptera	*Acalles ptinoides*				Nb
Coleoptera	*Acidota cruentata*				Nb
Coleoptera	*Ampedus pomorum*				Nb
Coleoptera	*Caenopsis fissirostris*				Nb
Coleoptera	*Cis festivus*				Nb
Coleoptera	*Magdalis carbonaria*				Nb
Coleoptera	*Melasis buprestoides*				Nb
Coleoptera	*Platypus cylindrus*				Nb
Coleoptera	*Quedius brevicornis*				Nb
Coleoptera	*Quedius scitus*				Nb
Coleoptera	*Rhizophagus nitidulus*				Nb
Coleoptera	*Scolytus mali*				Nb
Coleoptera	*Strigocis bicornis*				Nb
Coleoptera	*Trypodendron signatum*				Nb
Coleoptera	*Xyleborus dryographus*				Nb
Diptera	*Ctenophora pectinicornis*				Notable
Coleoptera	*Haploglossa marginalis*				Notable
Coleoptera	*Omalium rugatum*				Notable
Coleoptera	*Phloeopora corticalis*				Notable
Diptera	*Tanyptera atrata*				Notable
Coleoptera	*Traumoecia picipes*				Notable
Coleoptera	*Micrambe pilosula*				RDB K

Table 11 *List of species of conservation concern with post 1995 records in the Brocton Coppice hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	decaying wood	174	15	173	36
tree-associated	arboreal	176	13	102	8
open habitats	tall sward & scrub	213	8	101	17
tree-associated	shaded woodland floor	39	3	124	3
open habitats	short sward & bare ground	23	2	127	4

Table 12 *Habitat associations in Brocton Coppice*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> scrub at wood edge/glade	59	24	105	4
tree-associated	arboreal	flowers (adult)	30	20	110	2
tree-associated	arboreal	foliage >> inflorescence	21	20	100	1
tree-associated	decaying wood	flowers (adult)	34	19	156	5
tree-associated	decaying wood	sapwood & bark decay >> dead trunks & branches	86	18	183	21
tree-associated	decaying wood	sapwood & bark decay >> bark & cambium	68	18	158	12
tree-associated	decaying wood	fungal fruiting bodies	33	17	160	7
tree-associated	decaying wood	conifer or broadleaved >> broadleaved only	124	16	194	32
tree-associated	decaying wood	sapwood & bark decay	123	16	178	26
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	148	15	102	8
tree-associated	decaying wood	heartrot >> decaying wood	25	15	242	9
tree-associated	decaying wood	heartrot >> decaying wood	25	15	242	9
tree-associated	decaying wood	heartrot	36	14	214	11
tree-associated	arboreal	canopy	170	13	102	8
tree-associated	arboreal	foliage	51	11	107	2
open habitats	tall sward & scrub	dung & carrion	17	11	100	0
open habitats	tall sward & scrub	soil humidity >> variable humidity	43	10	100	1
open habitats	tall sward & scrub	habitats >> soil & roots	18	10	100	1
open habitats	tall sward & scrub	habitats >> sward/field layer	144	9	102	17
open habitats	tall sward & scrub	soil humidity >> dry	54	8	100	5
tree-associated	arboreal	foliage >> leaves and/or stems	20	8	117	0
open habitats	tall sward & scrub	habitats >> litter & ground layer	44	7	100	0
open habitats	tall sward & scrub	soil humidity >> damp	30	7	100	4
tree-associated	shaded woodland floor	humidity >> damp	17	6	117	1
tree-associated	shaded woodland floor	woodland habitat >> woodland litter	16	5	143	2

Table 13 *Habitat resource associations with over 5% representation in Brocton Coppice*

4.6.3 Furnace Coppice

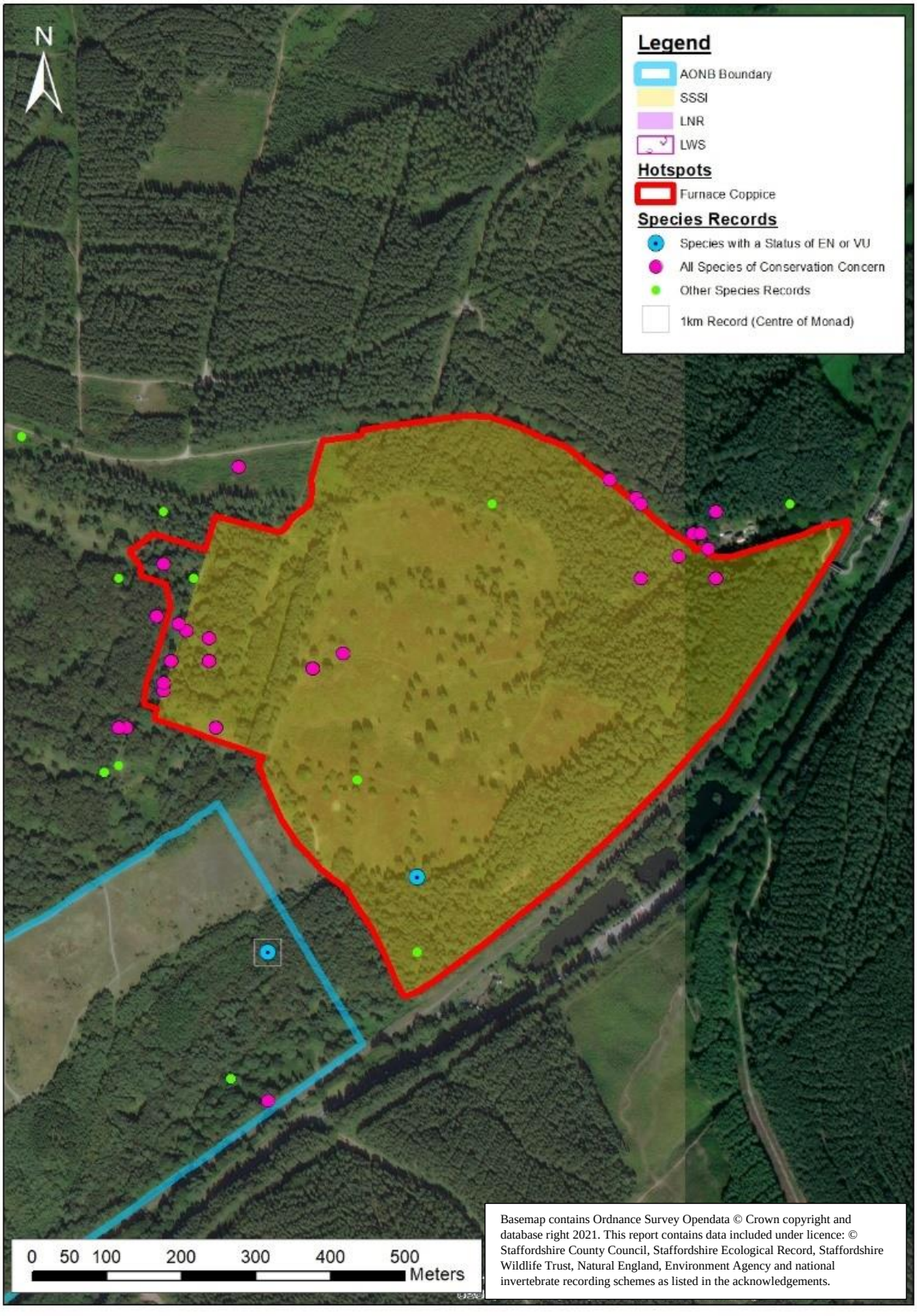

Figure 12 *Map of Furnace Coppice and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 205 invertebrate species were collated, including 17 species with a conservation status (Table 14).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera - butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera - butterfly	*Erynnis tages*	S.41		VU	
Lepidoptera- moth	*Rheumaptera hastata*	S.41			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Diarsia rubi*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Scotopteryx chenopodiata*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Hymenoptera	*Formica rufa*				NT (Global)
Coleoptera	*Clytra quadripunctata*		NS		
Lepidoptera- moth	*Ancylis upupana*		PNS		
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

Table 14 *List of species of conservation concern with post 1995 records in the Furnace Coppice hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	66	5	119	1
open habitats	tall sward & scrub	77	3	105	11

Table 15 *Habitat associations in Furnace Coppice*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> scrub at wood edge/glade	21	9	130	1
open habitats	tall sward & scrub	habitats >> sward/field layer	74	5	100	9
tree-associated	arboreal	canopy	65	5	119	1
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	55	5	123	1

Table 16 *Habitat resource associations with over 5% representation in Furnace Coppice*

4.6.4 Gentleshaw Common

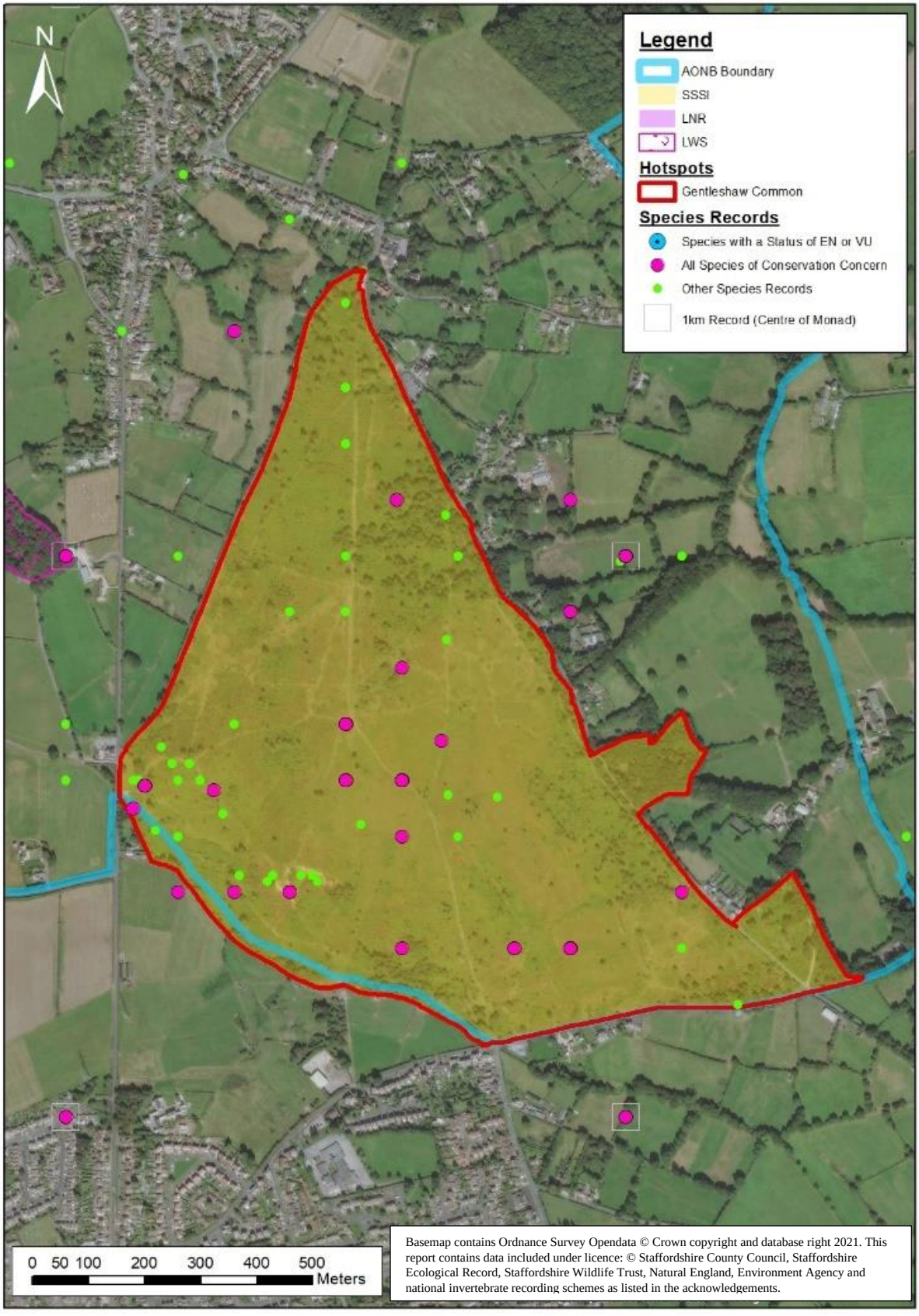

Figure 13 *Map of Gentleshaw Common and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 649 invertebrate species were collated, including 34 species with a conservation status (Table 17).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera-butterfly	*Lasiommata megera*	S.41		NT	
Lepidoptera- moth	*Acronicta psi*	S.41- research only			
Lepidoptera- moth	*Aporophyla lutulenta*	S.41- research only			
Lepidoptera- moth	*Eugnorisma glareosa*	S.41- research only			
Lepidoptera- moth	*Hydraecia micacea*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Watsonalla binaria*	S.41- research only			
Lepidoptera- moth	*Xestia castanea*	S.41- research only			
Coleoptera	*Aphodius merdarius*		NS		
Diptera	*Callicera aurata*		NS		
Diptera	*Rhaphium lanceolatum*		NS	NT	
Hymenoptera	*Andrena labiata*				Na
Hymenoptera	*Crossocerus distinguendus*				Na
Hymenoptera	*Dolichovespula media*				Na
Hymenoptera	*Nomada fucata*				Na
Hymenoptera	*Nomada integra*				Na
Hymenoptera	*Andrena humilis*				Nb
Hymenoptera	*Andrena nigriceps*				Nb
Hymenoptera	*Andrena similis*				Nb
Hymenoptera	*Andrena trimmerana*				Nb
Hymenoptera	*Bombus rupestris*				Nb
Hymenoptera	*Ectemnius ruficornis*				Nb
Hymenoptera	*Methocha articulata*				Nb
Hymenoptera	*Sphecodes crassus*				Nb
Diptera	*Conisternum decipiens*				Notable
Diptera	*Dicranomyia distendens*				Notable
Hymenoptera	*Nomada signata*				RDB 2
Hymenoptera	*Philanthus triangulum*				RDB 2
Hymenoptera	*Halictus confusus*				RDB 3
Hymenoptera	*Nomada lathburiana*				RDB 3
Hymenoptera	*Pemphredon lethifer*				RDB 3
Hymenoptera	*Dolichovespula saxonica*				RDB K

Table 17 *List of species of conservation concern with post 1995 records in the Gentleshaw Common hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	tall sward & scrub	273	10	101	10
open habitats	short sward & bare ground	123	10	119	16
tree-associated	shaded woodland floor	58	5	114	1
tree-associated	arboreal	52	4	100	4
wetland	peatland	30	3	141	3
tree-associated	decaying wood	17	1	138	3
wetland	marshland	17	2	126	0

Table 18 *Habitat associations in Gentleshaw Common*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	short sward & bare ground	habitats >> exposed sand	97	17	124	14
open habitats	short sward & bare ground	habitats >> sward/field layer	110	14	118	15
open habitats	tall sward & scrub	habitats >> soil & roots	26	14	100	0
open habitats	tall sward & scrub	soil humidity >> dry	96	13	100	4
open habitats	short sward & bare ground	soil type >> sand	65	13	131	11
open habitats	tall sward & scrub	soil humidity >> damp	53	13	100	1
open habitats	tall sward & scrub	habitats >> sward/field layer	184	12	100	9
open habitats	short sward & bare ground	soil humidity >> dry	118	12	120	16
open habitats	tall sward & scrub	soil humidity >> variable humidity	56	12	100	2
open habitats	tall sward & scrub	habitats >> litter & ground layer	64	10	100	0
tree-associated	arboreal	foliage >> leaves and/or stems	16	7	100	0
tree-associated	arboreal	foliage	29	6	100	2
tree-associated	shaded woodland floor	conifer or broadleaved >> broadleaved only	56	5	115	1

Table 19 *Habitat resource associations with over 5% representation in Gentleshaw Common*

4.6.5 Milford Quarry

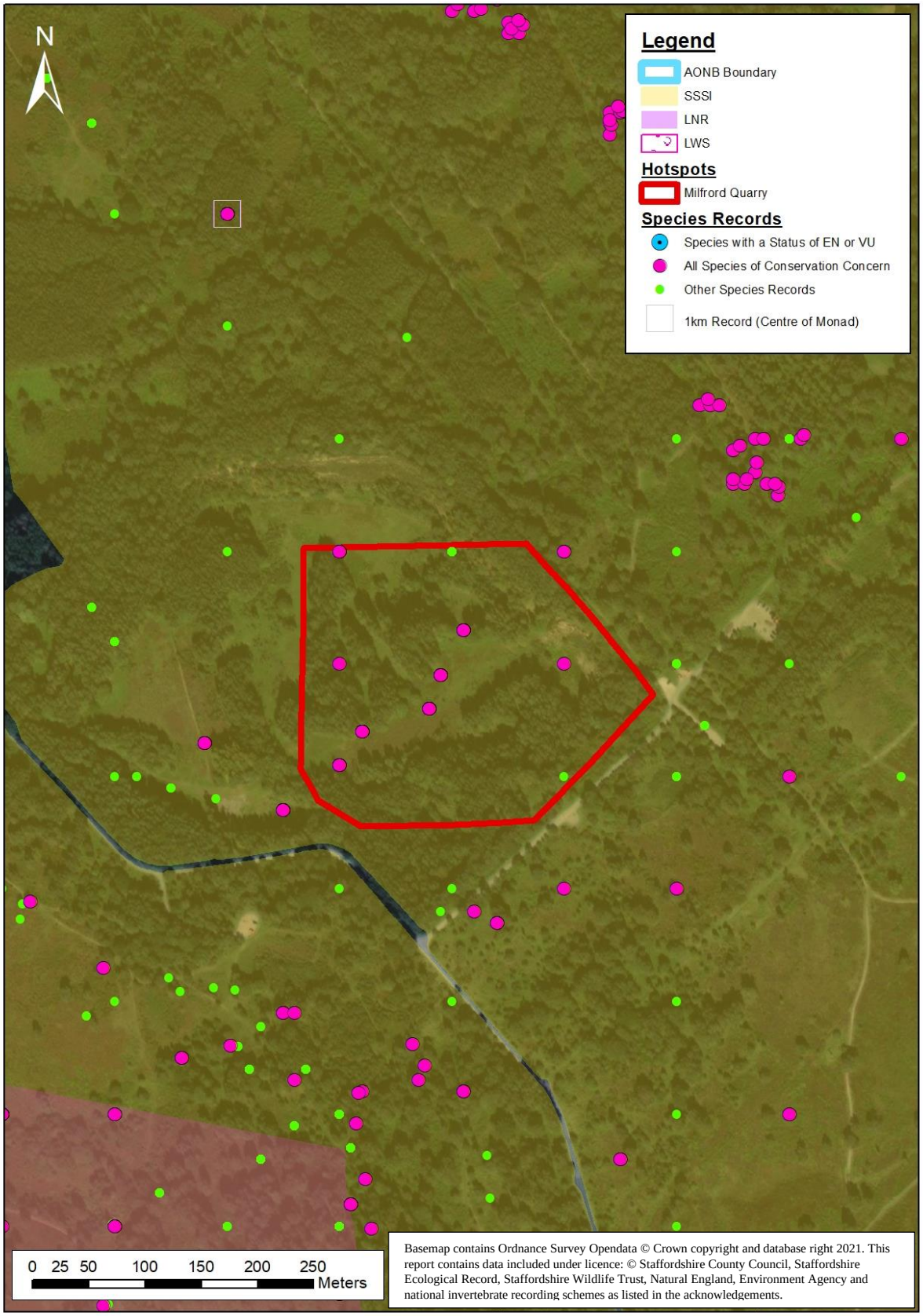

Figure 14 *Map of Milford Quarry and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 374 invertebrate species were collated, including 28 species with a conservation status (Table 20).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera- moth	*Amphipoea oculea*	S.41- research only			
Lepidoptera- moth	*Amphipyra tragopoginis*	S.41- research only			
Lepidoptera- moth	*Apamea remissa*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Ennomos erosaria*	S.41- research only			
Lepidoptera- moth	*Euxoa tritici*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Litoligia literosa*	S.41- research only			
Lepidoptera- moth	*Scotopteryx chenopodiata*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Watsonalla binaria*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Coleoptera	*Aphodius fasciatus*		NS		
Orthoptera	*Metrioptera brachyptera*		NS		
Lepidoptera- moth	*Aethes piercei*		PNS		
Hymenoptera	*Nomada integra*				Na
Hymenoptera	*Andrena apicata*				Nb
Hymenoptera	*Andrena similis*				Nb
Coleoptera	*Grypus equiseti*				Nb
Hymenoptera	*Sphecodes crassus*				Nb
Coleoptera	*Ernoporus tiliae*		PNR		RDB 1
Hymenoptera	*Nomada lathburiana*				RDB 3
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

Table 20 *List of species of conservation concern with post 1995 records in the Milford Quarry hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	short sward & bare ground	73	6	148	9
open habitats	tall sward & scrub	120	5	103	10
tree-associated	arboreal	68	5	106	2

Table 21 *Habitat associations in Milford Quarry*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	short sward & bare ground	habitats >> exposed sand	55	10	155	7
tree-associated	arboreal	canopy >> scrub at wood edge/glade	24	10	113	0
open habitats	short sward & bare ground	habitats >> sward/field layer	62	8	129	8
open habitats	short sward & bare ground	soil type >> sand	41	8	173	6
habitats	tall sward & scrub	habitats >> sward/field layer	90	6	100	10
open habitats	short sward & bare ground	soil humidity >> dry	63	6	148	8
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	60	6	107	2
tree-associated	arboreal	canopy	66	5	106	2

Table 22 *Habitat resource associations with over 5% representation in Milford Quarry*

4.6.6 Old Acre Valley & Gravel Pits

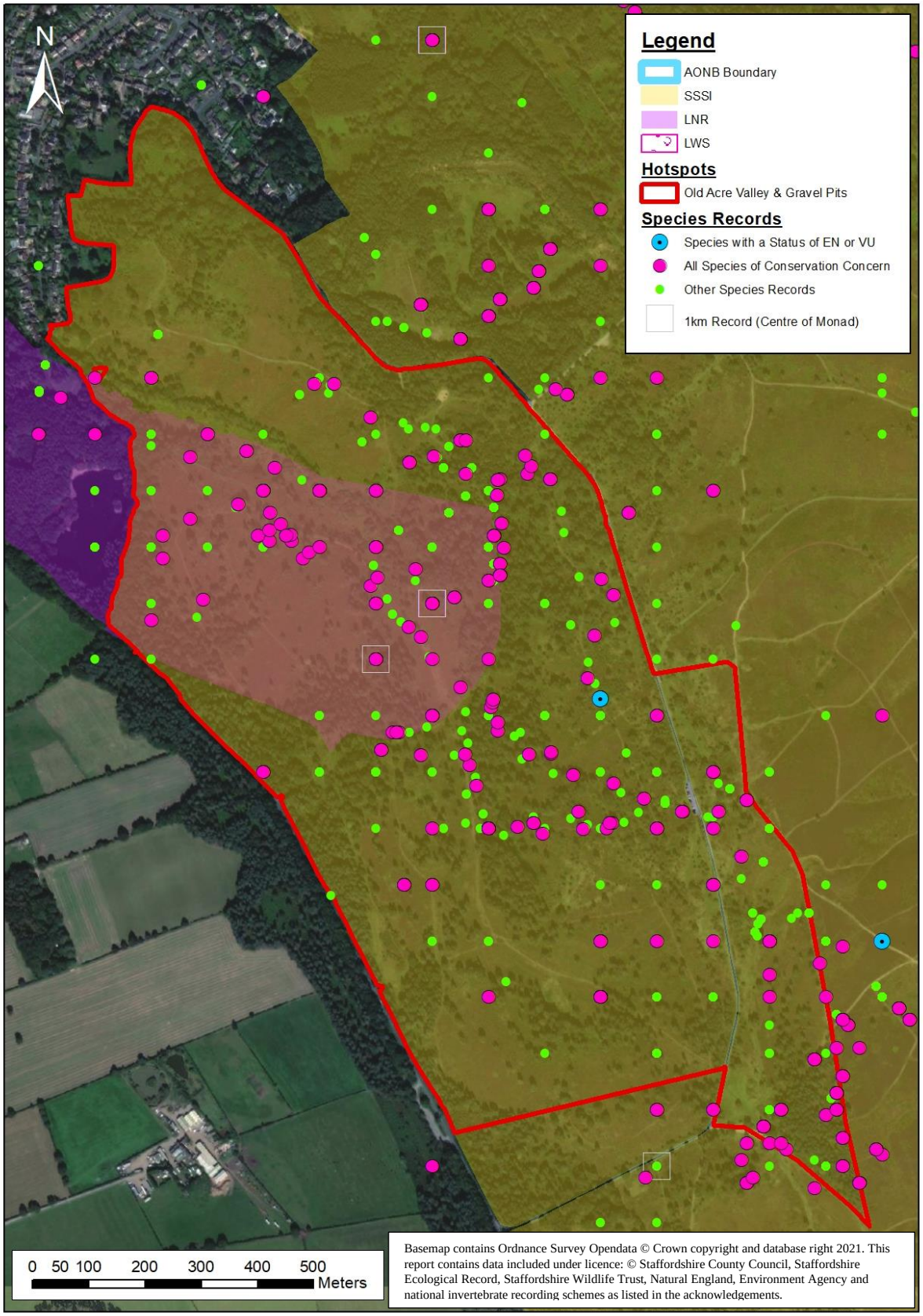

Figure 15 *Map of Old Acre Valley & Gravel Pits and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 533 invertebrate species were collated, including 39 species with a conservation status (Table 23).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Boloria selene*	S.41		NT	
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera-butterfly	*Erynnis tages*	S.41		VU	
Lepidoptera- moth	*Agrochola helvola*	S.41- research only			
Lepidoptera- moth	*Agrochola litura*	S.41- research only			
Lepidoptera- moth	*Apamea remissa*	S.41- research only			
Lepidoptera- moth	*Caradrina morpheus*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Chiasmia clathrata*	S.41- research only			
Lepidoptera- moth	*Cirrhia icteritia*	S.41- research only			
Lepidoptera- moth	*Diarsia rubi*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Ennomos fuscantaria*	S.41- research only			
Lepidoptera- moth	*Eugnorisma glareosa*	S.41- research only			
Lepidoptera- moth	*Eulithis mellinata*	S.41- research only			
Lepidoptera- moth	*Euxoa tritici*	S.41- research only			
Lepidoptera- moth	*Hepialus humuli*	S.41- research only			
Lepidoptera- moth	*Hoplodrina blanda*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Litoligia literosa*	S.41- research only			
Lepidoptera- moth	*Lycia hirtaria*	S.41- research only			
Lepidoptera- moth	*Melanchra persicariae*	S.41- research only			
Lepidoptera- moth	*Scotopteryx chenopodiata*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Lepidoptera- moth	*Xestia castanea*	S.41- research only			
Hymenoptera	*Formica rufa*				NT (Global)
Coleoptera	*Amara lucida*		NS		
Coleoptera	*Bembidion obliquum*		NS		
Araneae	*Erigonella ignobilis*		NS		
Lepidoptera- moth	*Eurois occulta*		NS		
Araneae	*Euryopis flavomaculata*		NS		
Orthoptera	*Metrioptera brachyptera*		NS		
Lepidoptera- moth	*Xylena solidaginis*		NS		
Hymenoptera	*Bombus rupestris*				Nb
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

Table 23 *List of species of conservation concern with post 1995 records in the Old Acre Valley & Gravel Pits hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	108	8	104	2
open habitats	tall sward & scrub	182	7	102	20
open habitats	short sward & bare ground	49	4	120	3
tree-associated	shaded woodland floor	21	2	100	0
wetland	marshland	18	2	143	1

Table 24 *Habitat associations in old Acre Valley & Gravel Pits*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> scrub at wood edge/glade	39	16	108	1
tree-associated	arboreal	flowers (adult)	19	13	116	1
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	88	9	105	2
habitats	tall sward & scrub	habitats >> sward/field layer	135	8	100	17
tree-associated	arboreal	canopy	107	8	104	2
open habitats	tall sward & scrub	habitats >> soil & roots	15	8	100	2
open habitats	tall sward & scrub	soil humidity >> dry	53	7	100	7
open habitats	short sward & bare ground	habitats >> exposed sand	31	6	119	1
open habitats	tall sward & scrub	soil humidity >> damp	24	6	113	4
open habitats	short sward & bare ground	habitats >> sward/field layer	41	5	123	3
open habitats	tall sward & scrub	habitats >> litter & ground layer	32	5	110	3
open habitats	short sward & bare ground	soil type >> sand	25	5	124	1
open habitats	tall sward & scrub	soil humidity >> variable humidity	24	5	100	2
tree-associated	arboreal	foliage	23	5	121	1

Table 25 *Habitat resource associations with over 5% representation in Old Acre Valley & Gravel Pits*

4.6.7 Old Brook

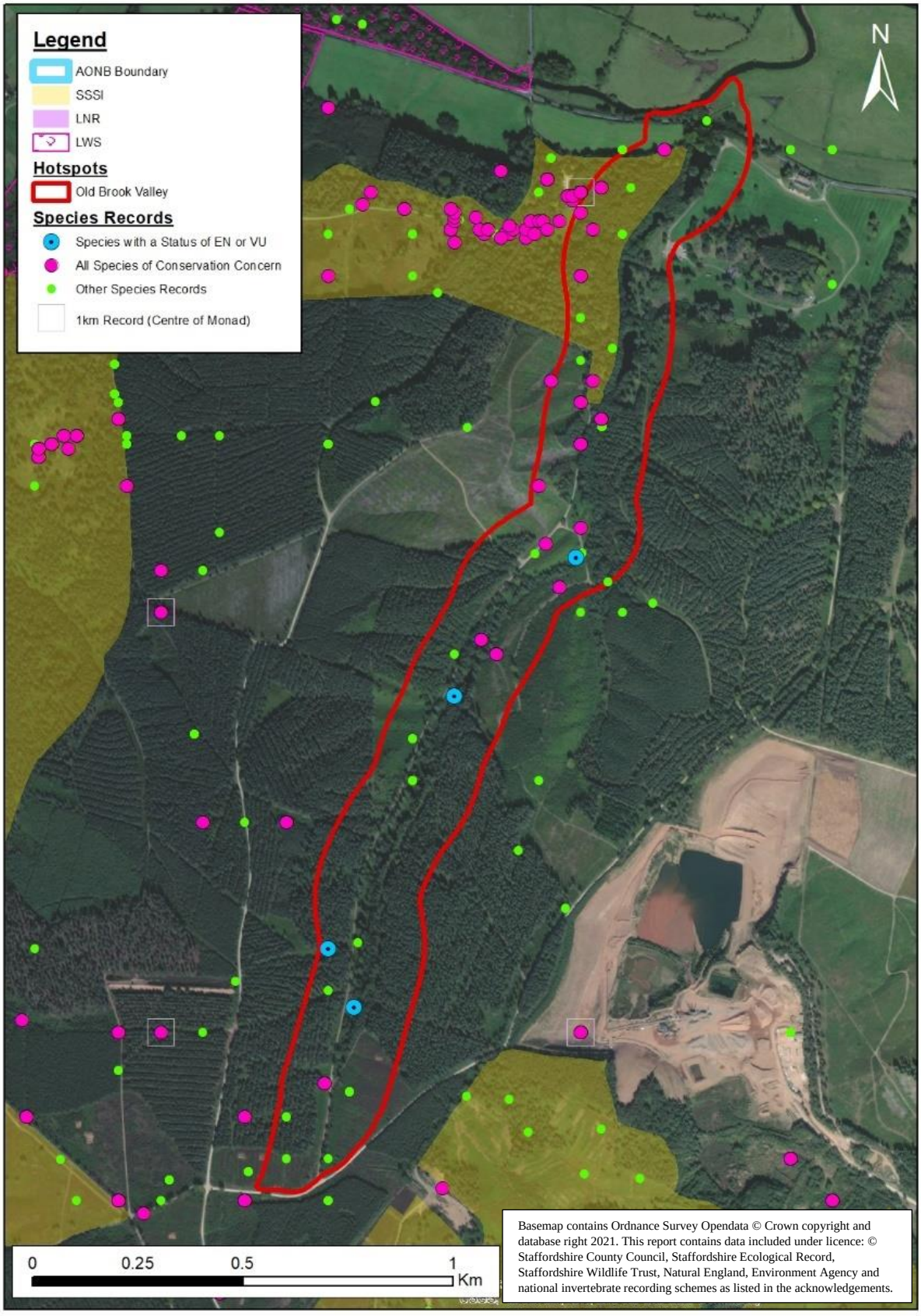

Figure 16 *Map of Old Brook and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 532 invertebrate species were collated, including 38 species with a conservation status (Table 26).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera- moth	*Rheumaptera hastata*	S.41			
Lepidoptera- butterfly	*Coenonympha pamphilus*	S.41		NT	
Crustacean	*Austropotamobius pallipes*	S.41			EN (Global)
Lepidoptera- moth	*Acronicta psi*	S.41- research only			
Lepidoptera- moth	*Amphipoea oculea*	S.41- research only			
Lepidoptera- moth	*Apamea remissa*	S.41- research only			
Lepidoptera- moth	*Caradrina morpheus*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Chiasmia clathrata*	S.41- research only			
Lepidoptera- moth	*Diarsia rubi*	S.41- research only			
Lepidoptera- moth	*Ecliptopera silaceata*	S.41- research only			
Lepidoptera- moth	*Ennomos erosaria*	S.41- research only			
Lepidoptera- moth	*Hepialus humuli*	S.41- research only			
Lepidoptera- moth	*Hoplodrina blanda*	S.41- research only			
Lepidoptera- moth	*Leucania comma*	S.41- research only			
Lepidoptera- moth	*Melanchra persicariae*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Watsonalla binaria*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Coleoptera	*Agelastica alni*		NR		
Coleoptera	*Amara praetermissa*		NS		
Diptera	*Brachyopa pilosa*		NS		
Diptera	*Chalcosyrphus eunotus*		NS		
Coleoptera	*Cryptocephalus parvulus*		NS		
Lepidoptera- moth	*Cydia coniferana*		PNS		
Diptera	*Dolichopus phaeopus*		NS		
Orthoptera	*Metrioptera brachyptera*		NS		
Lepidoptera- moth	*Synanthedon culiciformis*		NS		
Lepidoptera- moth	*Synanthedon spheciformis*		NS		
Diptera	*Dolichopus lineatocornis*		NR	VU	
Coleoptera	*Caenopsis fissirostris*				Nb
Lepidoptera- moth	*Crambus hamella*		PNS		Nb
Hemiptera	*Globiceps juniperi*				Nb
Hymenoptera	*Methocha articulata*				Nb
Diptera	*Conops strigatus*				Notable
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

Table 26 *List of species of conservation concern with post 1995 records in the Old Brook hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	127	10	115	6
open habitats	tall sward & scrub	159	6	108	16
wetland	wet woodland	15	6	114	1
tree-associated	wet woodland	15	6	114	1
tree-associated	shaded woodland floor	40	4	107	1
wetland	running water	40	4	106	2
open habitats	short sward & bare ground	33	3	128	3
tree-associated	decaying wood	18	2	212	3
wetland	peatland	16	1	163	2

Table 27 *Habitat associations in Old Brook*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> mature tree canopy	20	24	100	1
tree-associated	arboreal	canopy >> scrub at wood edge/glade	37	15	117	2
tree-associated	arboreal	conifer or broadleaved >> conifer only	15	11	100	0
tree-associated	arboreal	canopy	121	10	116	6
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	103	10	119	6
wetland	running water	unmodified fast flowing streams	18	9	100	1
open habitats	tall sward & scrub	habitats >> sward/field layer	131	8	105	14
open habitats	tall sward & scrub	habitats >> soil & roots	15	8	100	2
open habitats	tall sward & scrub	soil humidity >> dry	49	7	112	6
tree-associated	arboreal	foliage >> leaves and/or stems	17	7	267	2
tree-associated	arboreal	foliage	30	6	200	2
tree-associated	shaded woodland floor	humidity >> wet	16	6	114	1
tree-associated	shaded woodland floor	shadiness	30	5	108	1
open habitats	tall sward & scrub	soil humidity >> damp	19	5	100	2

Table 28 *Habitat resource associations with over 5% representation in Old Brook*

4.6.8 Sherbrook Valley

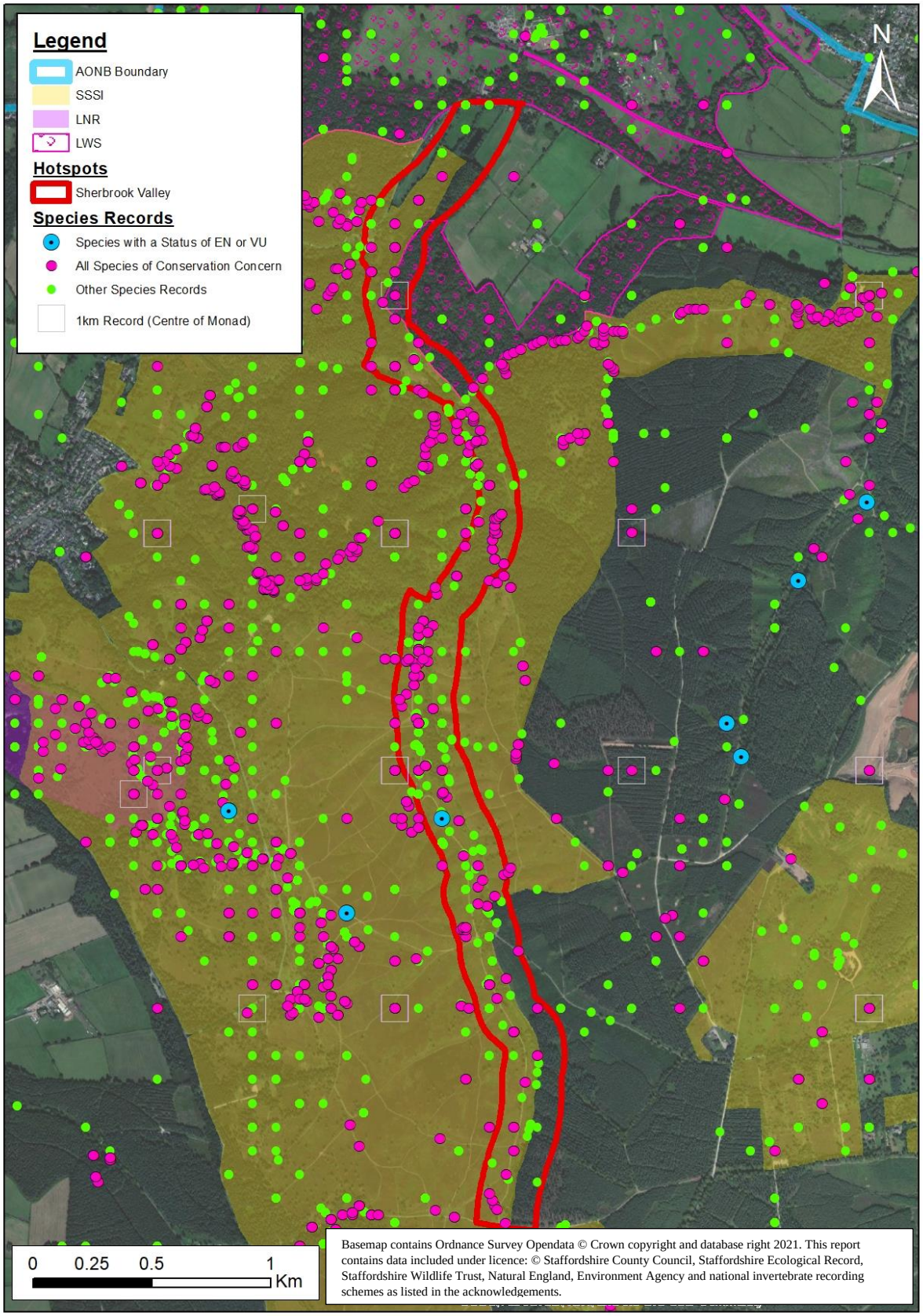

Figure 17 *Map of Sherbrook Valley and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 249 invertebrate species were collated, including 49 species with a conservation status (Table 29).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Boloria selene*	S.41		NT	
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera-butterfly	*Erynnis tages*	S.41		VU	
Lepidoptera-butterfly	*Lasiommata megera*	S.41		NT	
Lepidoptera- moth	*Coleophora vitisella*	S.41	PNS		
Lepidoptera- moth	*Acronicta rumicis*	S.41- research only			
Lepidoptera- moth	*Agrochola litura*	S.41- research only			
Lepidoptera- moth	*Amphipyra tragopoginis*	S.41- research only			
Lepidoptera- moth	*Ceramica pisi*	S.41- research only			
Lepidoptera- moth	*Chiasmia clathrata*	S.41- research only			
Lepidoptera- moth	*Ennomos erosaria*	S.41- research only			
Lepidoptera- moth	*Eugnorisma glareosa*	S.41- research only			
Lepidoptera- moth	*Euxoa tritici*	S.41- research only			
Lepidoptera- moth	*Hepialus humuli*	S.41- research only			
Lepidoptera- moth	*Litoligia literosa*	S.41- research only			
Lepidoptera- moth	*Lycia hirtaria*	S.41- research only			
Lepidoptera- moth	*Scotopteryx chenopodiata*	S.41- research only			
Lepidoptera- moth	*Spilosoma lubricipeda*	S.41- research only			
Lepidoptera- moth	*Spilosoma lutea*	S.41- research only			
Lepidoptera- moth	*Timandra comae*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Lepidoptera- moth	*Xanthorhoe ferrugata*	S.41- research only			
Lepidoptera- moth	*Xestia agathina*	S.41- research only			
Lepidoptera- moth	*Xestia castanea*	S.41- research only			
Coleoptera	*Agelastica alni*		NR		
Diptera	*Chalcosyrphus eunotus*		NS		
Coleoptera	*Elodes minuta*		NS		

Araneae	*Euryopis flavomaculata*		NS		
Trichoptera	*Hydatophylax infumatus*		NS		
Orthoptera	*Metrioptera brachyptera*		NS		
Lepidoptera- moth	*Pasiphila debiliata*		NS		
Coleoptera	*Psylliodes cuprea*		NS		
Lepidoptera- moth	*Synanthedon spheciformis*		NS		
Coleoptera	*Trypocopris vernalis*		NS		
Lepidoptera- moth	*Xylena solidaginis*		NS		
Lepidoptera- moth	*Ectoedemia weaveri*		PNS		
Hymenoptera	*Nomada integra*				Na
Coleoptera	*Acalles ptinoides*				Nb
Hymenoptera	*Andrena humilis*				Nb
Coleoptera	*Hippodamia variegata*				Nb
Coleoptera	*Orthoperus nigrescens*				Nb
Hymenoptera	*Sphecodes crassus*				Nb
Diptera	*Atypophthalmus inustus*				Notable
Diptera	*Conops vesicularis*				Notable
Diptera	*Ctenophora pectinicornis*				Notable
Diptera	*Eloeophila trimaculata*				Notable
Coleoptera	*Latridius consimilis*				Notable
Diptera	*Tanyptera atrata*				Notable
Lepidoptera- moth	*Synanthedon scoliaeformis*		NS		RDB 3

***Table 29**: List of species of conservation concern with post 1995 records in the Sherbrook Valley hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	wet woodland	34	14	108	1
wetland	wet woodland	33	12	108	1
wetland	running water	76	8	118	3
open habitats	tall sward & scrub	195	7	110	14
tree-associated	arboreal	96	7	116	2
tree-associated	shaded woodland floor	64	6	114	2
wetland	marshland	42	5	107	1
tree-associated	decaying wood	50	4	172	9
wetland	peatland	44	4	113	0
open habitats	short sward & bare ground	39	3	116	6

***Table 30** Habitat associations in Sherbrook Valley*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
wetland	running water	flow >> fast flow	17	18	100	0
open habitats	tall sward & scrub	base status >> acidic	18	17	186	2
wetland	wet woodland	woodland stream	24	15	111	1
wetland	running water	woodland stream	24	15	111	1
tree-associated	shaded woodland floor	humidity >> wet	34	13	108	1
wetland	running water	unmodified fast flowing streams	28	13	110	1
tree-associated	arboreal	canopy >> scrub at wood edge/glade	28	12	111	0
habitats	tall sward & scrub	habitats >> soil & roots	23	12	100	2
tree-associated	arboreal	flowers (adult)	17	11	118	0
wetland	running water	drawdown zone: mud/shallow litter	22	10	100	0
open habitats	tall sward & scrub	habitats >> sward/field layer	145	9	114	14
tree-associated	shaded woodland floor	shadiness >> heavy shade	40	9	107	1
wetland	running water	seepages	15	9	114	1
tree-associated	shaded woodland floor	shadiness	48	8	111	1
open habitats	tall sward & scrub	soil humidity >> damp	32	8	109	0
tree-associated	arboreal	canopy	92	7	117	2
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	73	7	116	2
tree-associated	arboreal	foliage	32	7	150	1
tree-associated	arboreal	foliage >> leaves and/or stems	18	7	176	1
tree-associated	shaded woodland floor	conifer or broadleaved >> broadleaved only	62	6	114	2
open habitats	tall sward & scrub	soil humidity >> dry	45	6	107	5
open habitats	tall sward & scrub	soil humidity >> variable humidity	27	6	100	1
wetland	peatland	wet/damp peat	17	6	130	0
tree-associated	decaying wood	sapwood & bark decay >> bark & cambium	20	5	156	2
wetland	marshland	drawdown zone: mud/shallow litter	18	5	100	0

Table 31 *Habitat resource associations with over 5% representation in Sherbrook Valley*

4.6.9 Shoal Hill

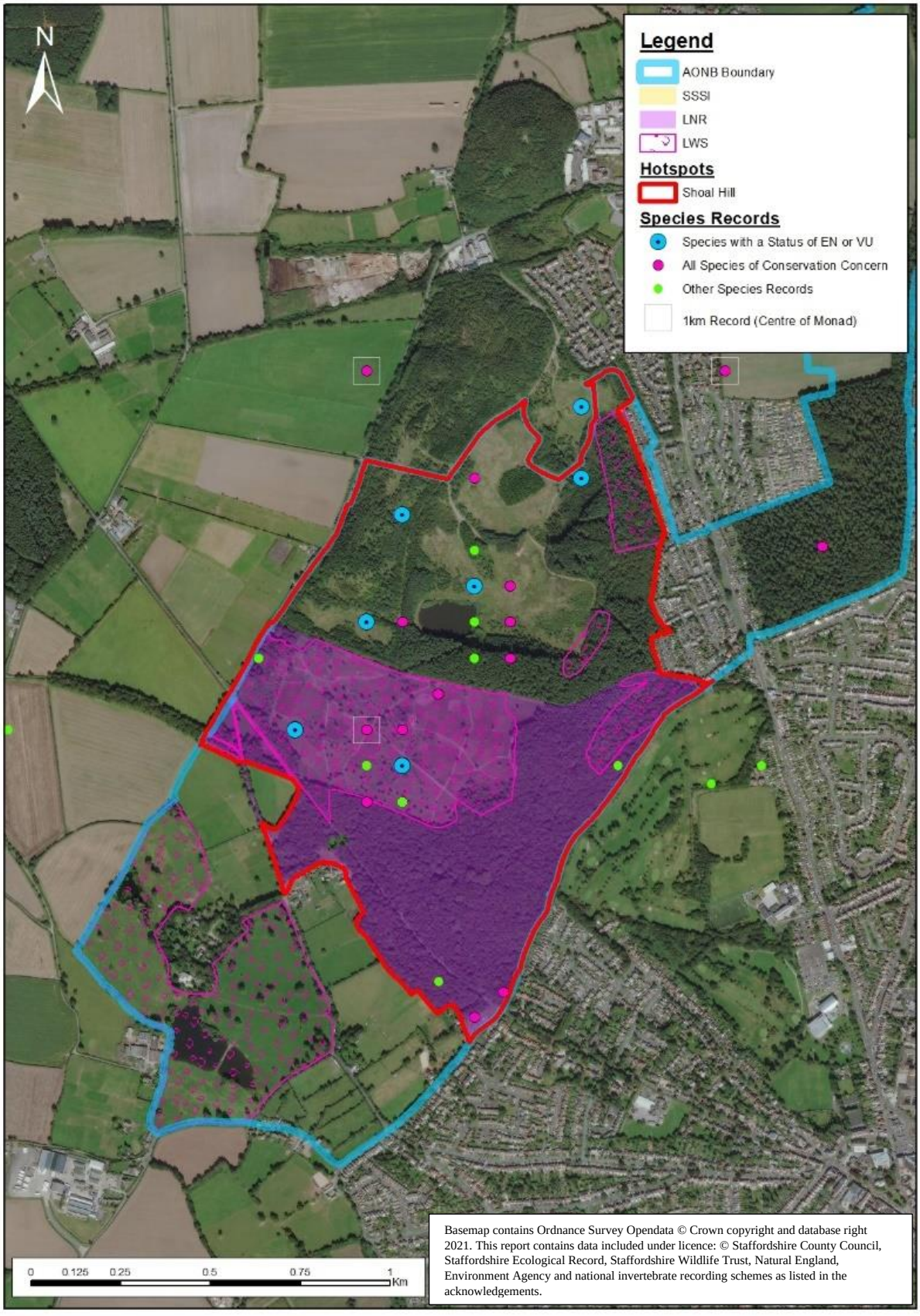

Figure 18 *Map of Shoal Hill and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 674 invertebrate species were collated, including 21 with a conservation status (Table 32).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Lepidoptera-butterfly	*Coenonympha pamphilus*	S.41		NT	
Lepidoptera-butterfly	*Erynnis tages*	S.41		VU	
Lepidoptera- moth	*Arctia caja*	S.41- research only			
Lepidoptera- moth	*Chiasmia clathrata*	S.41- research only			
Lepidoptera- moth	*Tyria jacobaeae*	S.41- research only			
Hymenoptera	*Lasioglossum quadrinotatum*				Na
Hymenoptera	*Nomada integra*				Na
Hymenoptera	*Sphecodes rubicundus*				Na
Hymenoptera	*Andrena apicata*				Nb
Hymenoptera	*Andrena humilis*				Nb
Hymenoptera	*Andrena similis*				Nb
Hymenoptera	*Bombus rupestris*				Nb
Coleoptera	*Hippodamia variegata*				Nb
Hymenoptera	*Hylaeus signatus*				Nb
Hymenoptera	*Methocha articulata*				Nb
Hymenoptera	*Nysson trimaculatus*				Nb
Hymenoptera	*Sphecodes crassus*				Nb
Hymenoptera	*Nomada lathburiana*				RDB 3
Hymenoptera	*Pemphredon lethifer*				RDB 3
Hymenoptera	*Sphecodes niger*				RDB 3
Hymenoptera	*Dolichovespula saxonica*				RDB K

Table 32 *List of species of conservation concern with post 1995 records in the Shoal Hill hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	short sward & bare ground	93	7	122	12
open habitats	tall sward & scrub	72	3	100	7
tree-associated	decaying wood	17	1	100	1
tree-associated	shaded woodland floor	15	1	100	1

Table 33 *Habitat associations in Shoal Hill*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	short sward & bare ground	habitats >> exposed sand	83	15	125	11
open habitats	short sward & bare ground	soil type >> sand	56	12	138	8
open habitats	short sward & bare ground	habitats >> sward/field layer	87	11	120	11
open habitats	short sward & bare ground	soil humidity >> dry	88	9	124	12

Table 34 *Habitat resource associations with over 5% representation in Shoal Hill*

4.6.10 Shugborough Estate

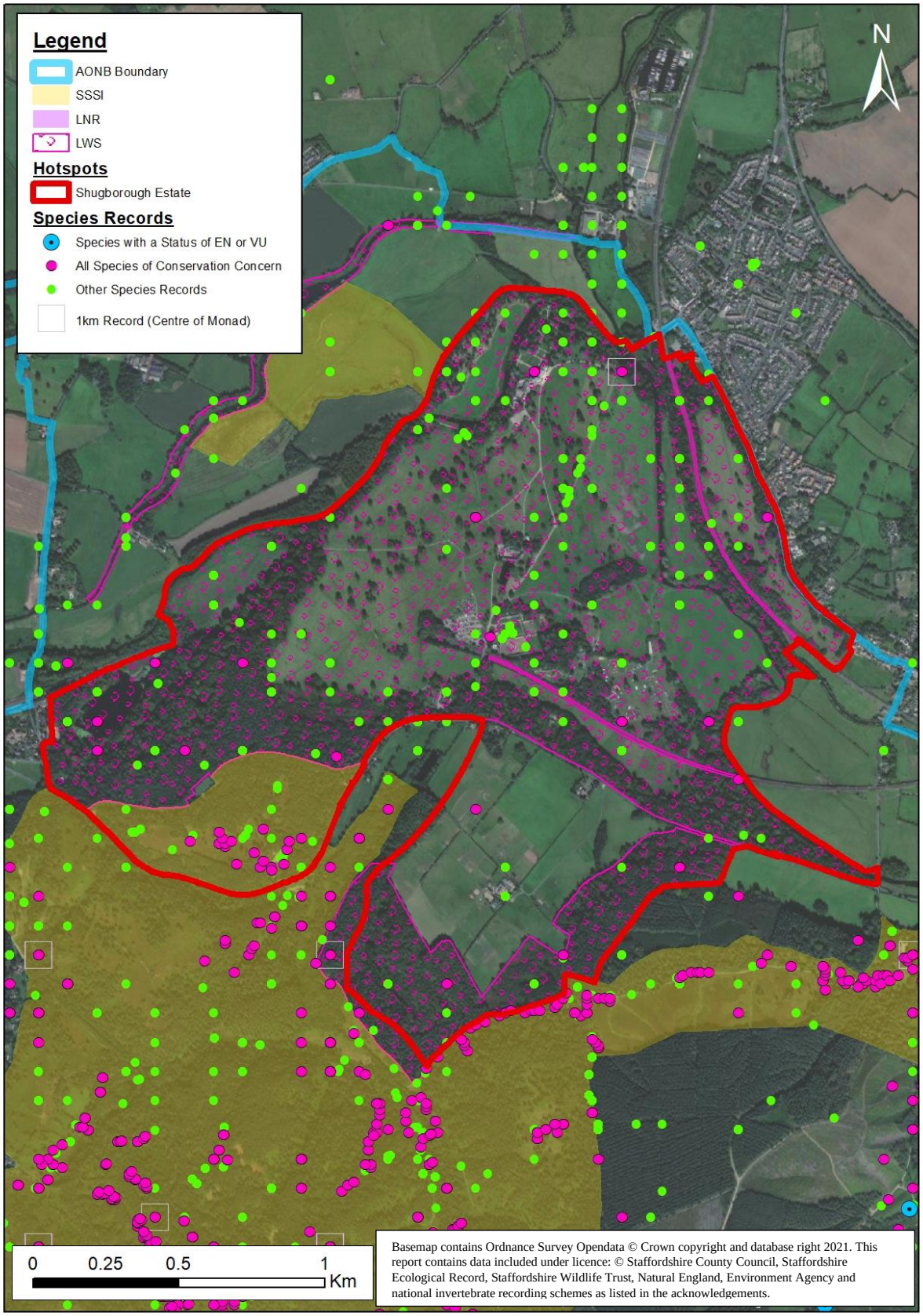

Figure 19 *Map of Shugborough Estate and the distribution of records of invertebrate species, highlighting those of conservation concern*

Records for a total of 444 invertebrate species were collated, including 33 species with a conservation status (Table 35).

Group	Taxon Name	Section 41	GB Threat	GB Rarity	Other
Crustacea	*Austropotamobius pallipes*	S.41			EN (Global)
Mollusca	*Pseudanodonta complanata*	S.41	NS		
Lepidoptera-moth	*Hoplodrina blanda*	S.41- research only			
Lepidoptera-moth	*Tyria jacobaeae*	S.41- research only			
Mollusca	*Anodonta cygnea*				NT (European)
Coleoptera	*Anitys rubens*		NS		
Coleoptera	*Bembidion obliquum*		NS		
Coleoptera	*Corticeus unicolor*		NS		
Coleoptera	*Dorcatoma flavicornis*		NS		
Coleoptera	*Euglenes oculatus*		NS		
Orthoptera	*Metrioptera brachyptera*		NS		
Coleoptera	*Orchesia minor*		NS		
Coleoptera	*Phloiophilus edwardsii*		NS		
Coleoptera	*Phloiotrya vaudoueri*		NS		
Diptera	*Pocota personata*		NS		
Coleoptera	*Psylliodes cuprea*		NS		
Coleoptera	*Thymalus limbatus*		NS		
Coleoptera	*Ernoporicus fagi*				Na
Coleoptera	*Uleiota planatus*				Na
Coleoptera	*Cis festivus*				Nb
Coleoptera	*Diplocoelus fagi*				Nb
Coleoptera	*Platypus cylindrus*				Nb
Coleoptera	*Platyrhinus resinosus*				Nb
Coleoptera	*Quedius truncicola*				Nb
Coleoptera	*Rhizophagus nitidulus*				Nb
Coleoptera	*Silvanus bidentatus*				Nb
Coleoptera	*Stenus argus*				Nb
Coleoptera	*Enicmus brevicornis*				Notable
Diptera	*Tanyptera atrata*				Notable
Hemiptera	*Ctenophora pectinicornis*				Notable
Lepidoptera-moth	*Synanthedon scoliaeformis*		NS		RDB 3
Hymenoptera	*Dolichovespula saxonica*				RDB K
Hymenoptera	*Stigmus pendulus*				RDB K

Table 35 *List of species of conservation concern with post 1995 records in the Shugborough Estate hotspot*

Broad biotope	Habitat	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	decaying wood	96	8	185	24
wetland	marshland	66	8	122	2
open habitats	tall sward & scrub	110	4	103	3
tree-associated	arboreal	57	4	100	1
wetland	peatland	23	2	100	0
tree-associated	shaded woodland floor	22	2	115	1
wetland	running water	21	2	100	1
tree-associated	shaded woodland floor	19	2	117	1

Table 36 *Habitat associations in the Shugborough Estate*

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
wetland	marshland	shallow freshwater pond >> aquatic: well vegetated	21	13	125	0
tree-associated	decaying wood	fungal fruiting bodies	21	11	179	5
tree-associated	decaying wood	sapwood & bark decay >> dead trunks & branches	49	10	181	12
tree-associated	decaying wood	sapwood & bark decay >> bark & cambium	39	10	174	7
wetland	marshland	shallow freshwater pond	38	10	115	0
tree-associated	decaying wood	conifer or broadleaved >> broadleaved only	72	9	199	21
tree-associated	decaying wood	sapwood & bark decay	66	9	186	15
wetland	marshland	drawdown zone: mud/shallow litter	26	8	133	2
tree-associated	decaying wood	heartrot	17	7	231	5
open habitats	tall sward & scrub	habitats >> sward/field layer	76	5	104	3
open habitats	tall sward & scrub	soil humidity >> variable humidity	24	5	100	0
tree-associated	arboreal	foliage	23	5	100	1
open habitats	tall sward & scrub	soil humidity >> damp	22	5	100	0
wetland	peatland	shallow freshwater pond	15	5	100	0

Table 37 *Habitat resource associations with over 5% representation in the Shugborough Estate*

4.6.11 Sites with raised recording effort

3 sites were identified as clearly supporting higher numbers of species of conservation concern, but which were likely to be the result of recorder effort rather than supporting habitat of raised value- Hazelslade Local Nature Reserve (LNR), the Enterprise Centre which straddles the AONB boundary, and the Wolseley Centre which is outside but immediately adjacent to the AONB boundary so included for the sake of completion. It is notable that the Wolseley Centre is the base for many field study courses, so likely to be regularly visited by experts as well as to practice identification routinely.

All three of these sites were considered to be recording hotspots but not necessarily sites of raised conservation concern- a view support as part of consultation with local entomologists.

Figure 20 *Map of Hazelslade LNR and the distribution of records of invertebrate species, highlighting those of conservation concern*

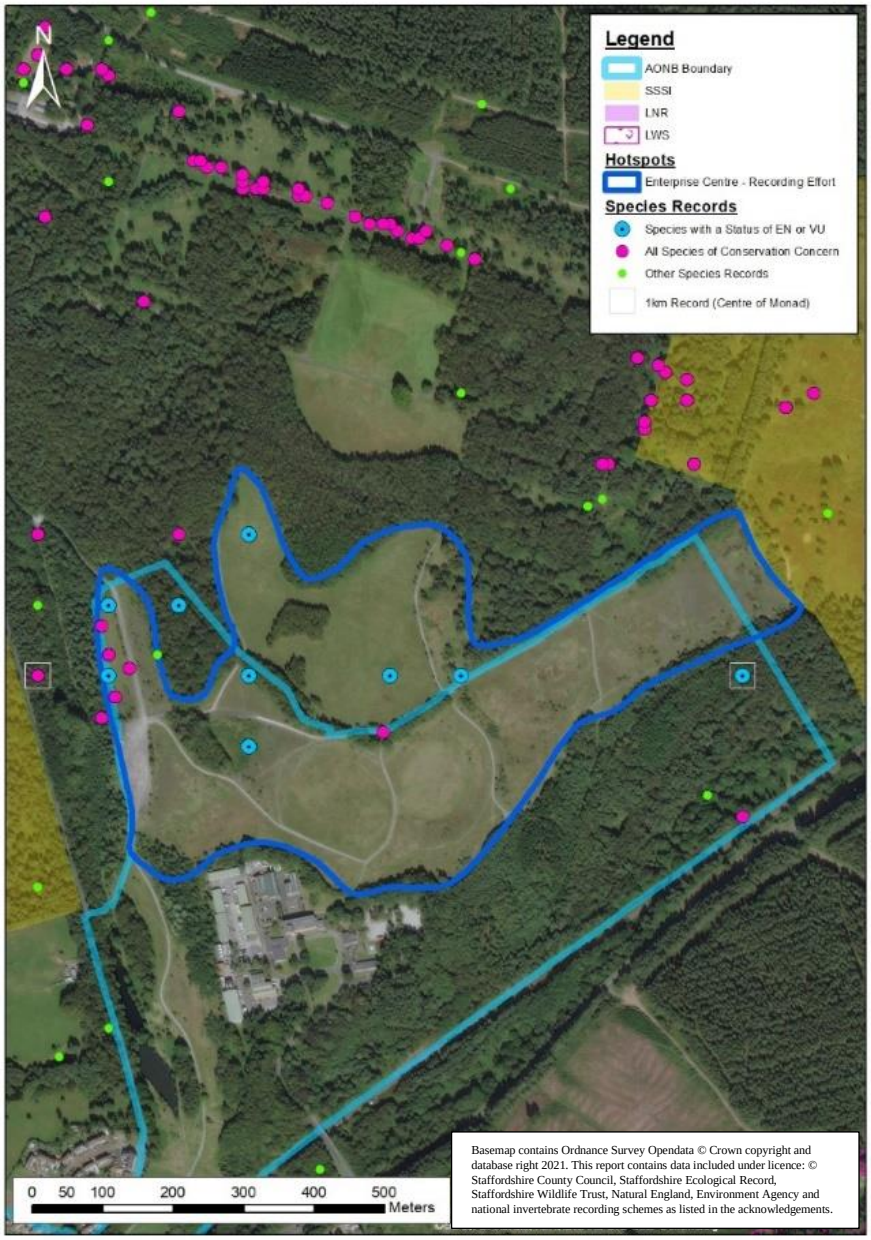

Figure 21 *Map of the Enterprise Centre and the distribution of records of invertebrate species, highlighting those of conservation concern*

Figure 22 *Map of The Wolseley Centre and the distribution of records of invertebrate species, highlighting those of conservation concern*

4.7 Distribution of key species groups

Maps were also created for high profile species groups with large volumes of records to ensure that species of conservation concern are adequately captured by the identified hotspots. It is important to note that considering the mobile nature of some invertebrates and the widespread nature of habitats within the Chase, that it is expected that many records for species of conservation concern will be outside hotspots, but expected that hotspots will encompass a notable proportion.

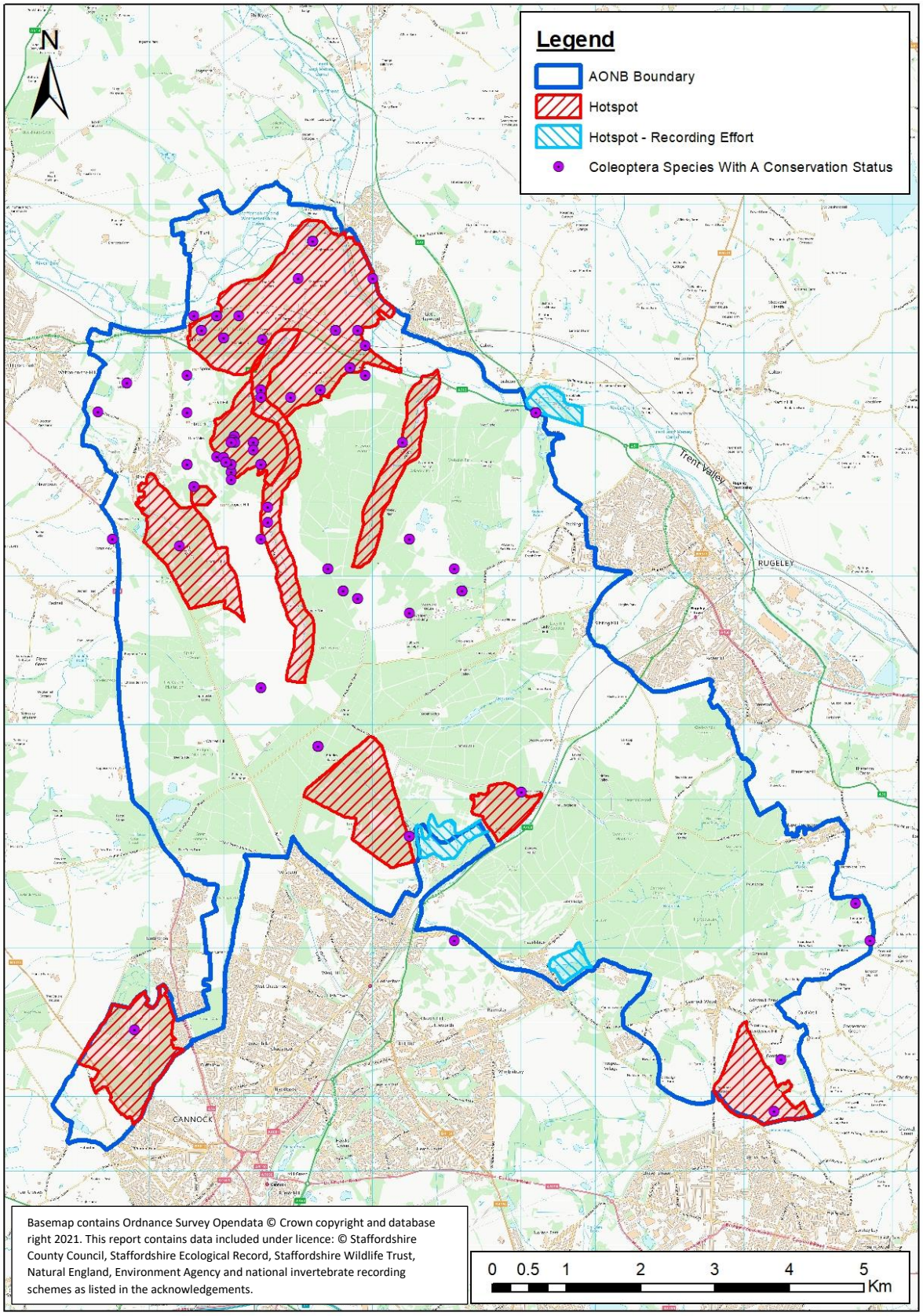

Figure 23 *Distribution of Coleoptera of conservation concern relative to identified invertebrate hotspots*

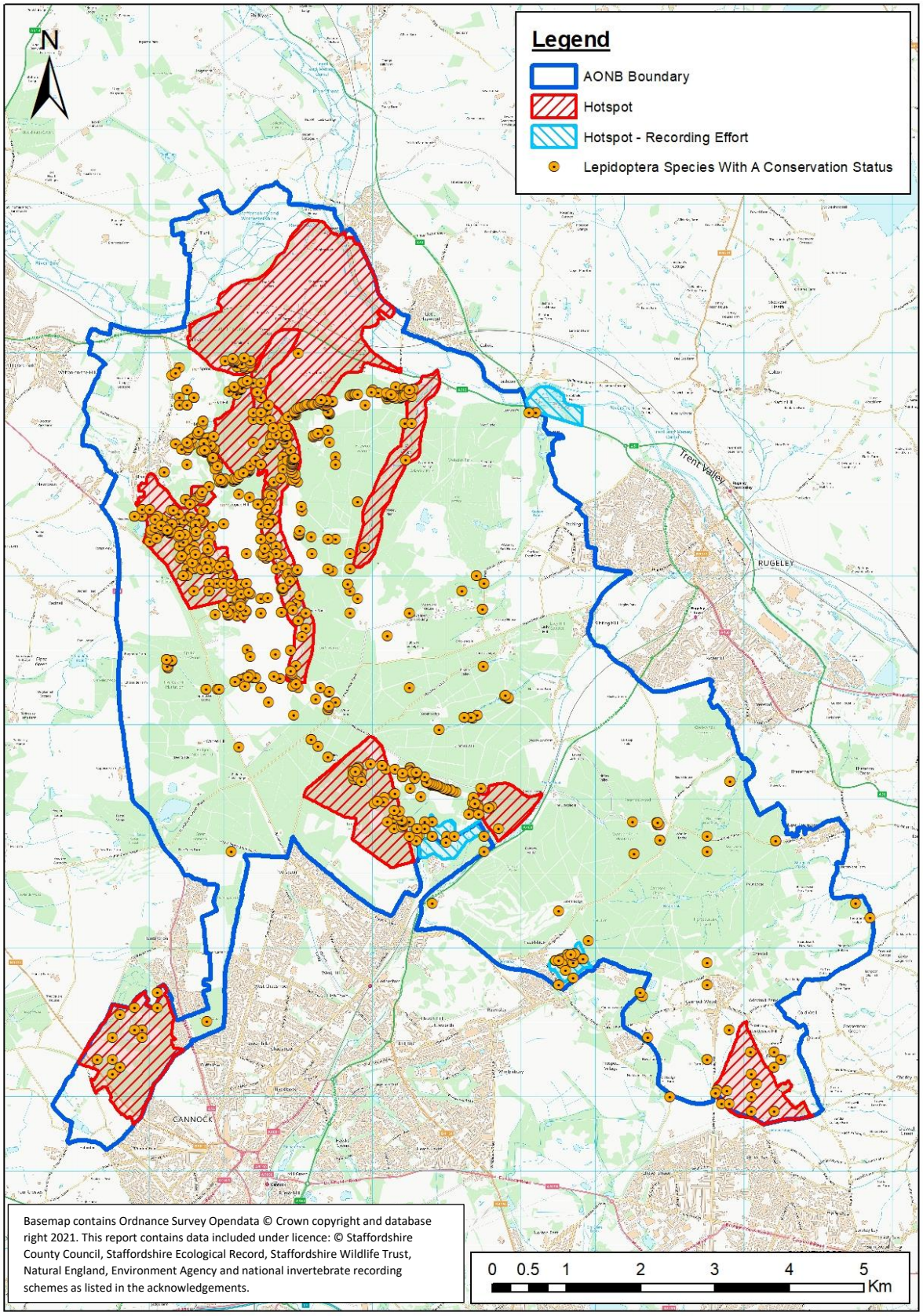

Figure 24 *Distribution of Lepidoptera of conservation concern relative to identified invertebrate hotspots*

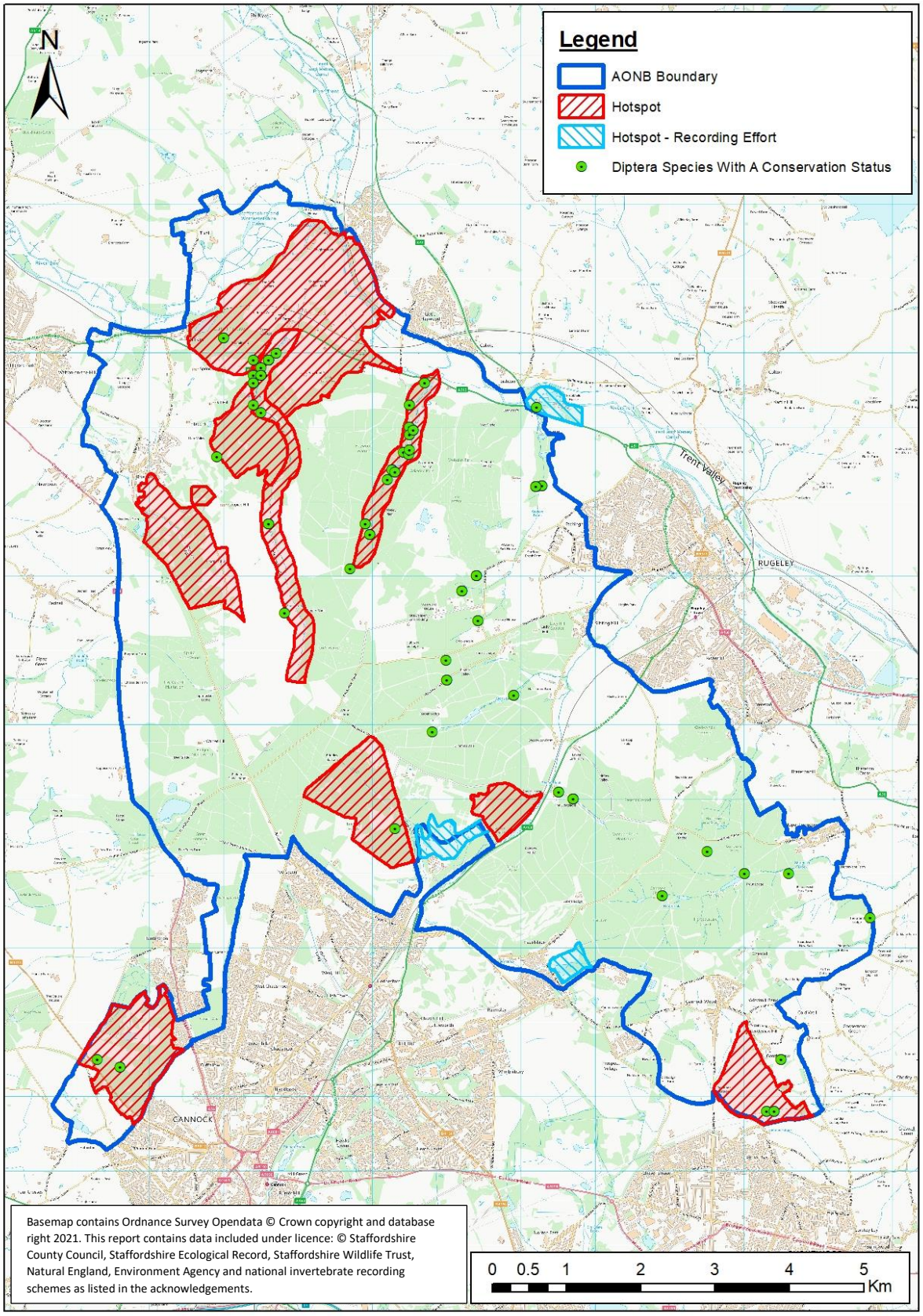

Figure 25 *Distribution of Diptera of conservation concern relative to identified invertebrate hotspots*

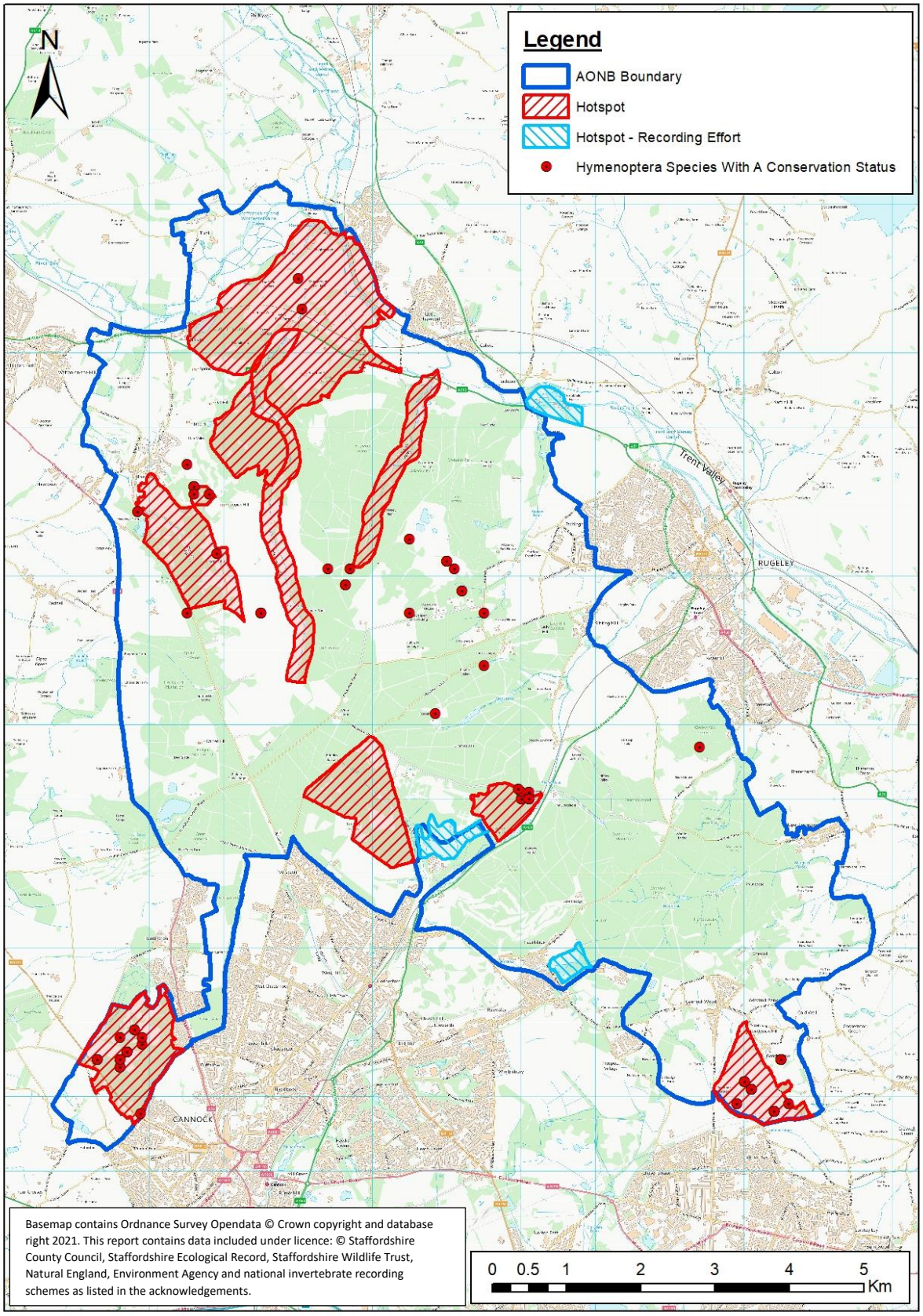

Figure 26 *Distribution of Hymenoptera of conservation concern relative to identified invertebrate hotspots*

4.8 Species 'lost' from Cannock Chase

The primary analysis of the Cannock Chase Invertebrate Audit dataset was to interrogate records post-1995 to help identify key areas for invertebrate conservation and the quality of key sites and assemblages. However, as all historic data was obtained from relevant data sources, it also allowed for the opportunity to identify any potential species which were recorded pre-1995 but have not been recorded in the last 25 years.

However, although some species may be genuinely lost as a species from the Chase fauna, as a result of habitat or climate changes, a lack of records in the past 25 years is not indicative of local extinction. An absence of records may be due to a lack of survey effort, particularly for less surveyed species groups. It must also be noted that where there was no specific dated and grid referenced record for a species, it was not included in the post 1995 dataset. This is particularly problematic where species lists for some sites have been compiled for long date ranges that include spanning the pre-1995 period, preventing a species from being included.

The Cannock Chase Invertebrate Audit identified 791 invertebrate species that have pre-1995 records or that have been highlighted on site lists, but have no usable post 1995 data, as presented in Annex 4. A summary table of the species breakdown of these absent species by species group is presented in Table 38. This includes 137 species with a conservation status.

Group	No. of species
Coleoptera	273
Lepidoptera	145
Diptera	142
Araneae	109
Hemiptera	52
Hymenoptera	36
Trichoptera	20
Ephemeroptera	7
Opiliones	3
Mollusca	2
Plecoptera	2
Total	**791**

Table 38 *Number of species with no post-1995 acceptable record by species group*

A single species with a pre-1995 record is confirmed to be extinct in the UK- the Small lappet moth (*Phyllodesma ilicifolia*). However, three species are listed as Endangered in modern status reviews- the Stout dart moth (*Spaelotis ravida*) last recorded in 1973, the ground beetle *Amara famelica* which was last recorded in 1949 and the pot beetle *Cryptocephalus querceti* last recorded in 1923 (with unsuccessful searches undertaken). There are a further three Vulnerable species, the Grizzled skipper (*Pyrgus malvae*) last recorded in 1992, the Blue Pepper-pot beetle (*Cryptocephalus punctiger*) last seen in 1976 and the ground beetle *Nebria livida* which was last recorded in 1908. It must be noted that many these Endangered and Vulnerable species have suffered significantly contracting ranges so are considered unlikely to be re-discovered, but are worthy of noting.

It is notable that although there are only 109 species of Araneae not recorded since 1995, fewer than some species groups, this is one more than the 108 species with records post 1995. This also represents over 15% of the UK spider fauna- significantly higher than for Coleoptera (6%), Lepidoptera (5%) and Diptera (2%). Examining the last records (Annex 4) shows that 96 of these spider species were last recorded during the 1990-1994 period, during a period of apparent significant recording. It is not unreasonable to suggest that the apparent 'loss' of this tranche of spiders is more a result of a decline in the recording of spiders during the recording period, highlighting a significant potential knowledge gap within the Chase.

Other notable high proportions of the UK fauna in the 'lost species' list include Trichoptera, where 20 species represents 10% of the UK fauna and the Ephemeroptera at 13%. However, for these riverflies the last records are more widely spread across the period of 1935 to 1994, indicating that potential losses seem more likely.

4.9 Composition of invertebrate records

With the considerable data collated as part of this report, an analysis of the spread of data recording across species groups can be made. Some invertebrate groups have a tendency to be over-represented in invertebrate data, notably popular groups such as butterflies, moths, dragonflies and bumblebees. This is both a result of the popularity of these groups, the ease with which they can be observed, the ease with which some more distinctive species can be recorded in the field by the general public, and also in the case of moths, the ability to collect significant data through light traps. Conversely, it is important to note that an area being the focus of a specialist in a less widely surveyed species group can also lead to sites being elevated in their perceived significance for that group nationally.

Some individual species are also often subject to a sustained survey effort either due to their national rarity or local importance, or as a consequence of ongoing efforts to understand their use of a landscape. Species that are notably very well represented in the Cannock Chase dataset and the target of specific dedicated survey include Welsh clearwing and Small pearl-bordered fritillary- with 517 and 214 records respectively. The 20 most recorded species within the dataset, which includes 17 Lepidoptera, produces a total dataset of 3,846 records, or 14% of the entire Cannock Chase AONB invertebrate audit dataset's 27,566 records.

Common name	Scientific name	Order	No. of records
Welsh clearwing	*Synanthedon scoliaeformis*	Lepidoptera	517
Meadow brown	*Maniola jurtina*	Lepidoptera	292
Small pearl-bordered fritillary	*Boloria selene*	Lepidoptera	214
Small heath	*Coenonympha pamphilus*	Lepidoptera	212
Large yellow underwing	*Noctua pronuba*	Lepidoptera	197
Speckled wood	*Pararge aegeria*	Lepidoptera	195
Peacock butterfly	*Aglais io*	Lepidoptera	190
Large skipper	*Ochlodes sylvanus*	Lepidoptera	189
Lesser swallow prominent	*Pheosia gnoma*	Lepidoptera	182
Common carder bee	*Bombus pascuorum*	Hymenoptera	180
Green hairstreak	*Callophrys rubi*	Lepidoptera	176
Common grey moth	*Scoparia ambigualis*	Lepidoptera	169
Green-veined white	*Pieris napi*	Lepidoptera	165
Brown-silver line	*Petrophora chlorosata*	Lepidoptera	155
True lover's knot	*Lycophotia porphyrea*	Lepidoptera	147
Ringlet	*Aphantopus hyperantus*	Lepidoptera	139
White-tailed bumblebee	*Bombus lucorum*	Hymenoptera	135
Common drone fly	*Eristalis tenax*	Diptera	133
Common heath	*Ematurga atomaria*	Lepidoptera	132
Gatekeeper	*Pyronia tithonus*	Lepidoptera	127
TOTAL			3,846

Table 39 *20 most recorded invertebrate species within the Cannock Chase AONB invertebrate audit dataset*

It can therefore be useful to examine the split of the overall dataset across these taxonomic groups, to identify which species groups are over and under-represented than would be expected (Table 40).

Although moth species records account for 26.3% of the species recorded in the Chase, they represent 39.9% of all records- an average of 15.7 records per species. Butterflies, however, have a limited number of species at the national level, with only 31 recorded in the Chase, but due to their highly recorded nature, contribute 2,608 records- equivalent to an average of 84.1 records per species. Similarly, the 21 species of Odonata contribute 847 records, or an average of 40.3 records per species. Hymenoptera have an average of 17.6 records per species and Orthoptera 14.2 records.

Conversely, although 745 Coleoptera have been recorded the chase, making them the most populous species group, this is based on only 3,391 records, or an average of 4.6 records per species. Similarly, Hemiptera average 3.5, Araneae 6.2 and Diptera 6.9 records per species. This indicates that the more popular or accessible groups are being more frequently recorded in the 25 year period.

Species group	No. of species	No. of records
Coleoptera	745	3,391
Lepidoptera- moths	701	10,988
Diptera	494	3,397
Hymenoptera	232	4,083
Hemiptera	197	686
Araneae	108	672
Trichoptera	45	361
Mollusca	33	140
Lepidoptera- butterfly	31	2,608
Odonata	21	847
Misc. e.g. Crustacean, Mecoptera, Annelids, Collembola, etc	17	56
Orthoptera	12	170
Plecoptera	9	62
Opiliones	8	21
Ephemeroptera	6	61
Dilpoda	4	17
Chilopoda	3	6
TOTAL	**2,666**	**27,566**

Table 40 *Number of species for major groups containing data*

An assessment of the spread of records across the recording period of the audit was also undertaken, examining five increments of five years. A clear trend for increased recording can be seen, potentially as a result of increased interest in wildlife recording or an increase in the availability of identification resources or tools such as moth traps. However, there is a notable peak in the middle of the audit period, between 2005 and 2010, which correlates with an increase in commissioned survey work, including data digitised as part of this audit exercise.

Time period	Number of records
1995-1999	3,284
2000-2004	2,909
2005-2009	10,948
2010-2014	5,906
2015-2020	4,519

Table 41 *Changes in invertebrate recording effort over the 25 year audit period*

5. Discussion

5.1 Key habitats for invertebrates

The impressive list of species of conservation concern and number of invertebrate hotspots, clearly confirms the Cannock Chase AONB's importance to invertebrates, as indicated in its SSSI and SAC citations. Thanks to the legacy of invertebrate recording, data from the last 25 years indicates that many of the habitat types traditionally viewed as important for invertebrates have records of species strongly associated with them. It is important again to note that as this audit captures records across the entire AONB over a 25-year period, it is a picture of the value of the AONB across this whole period. The usefulness of habitats and sites for invertebrates will vary over time, so looking at data for a site over a 25-year period prevents an assessment of their current value or the effectiveness of current management approaches. Rather it is an assessment of how these habitats and sites have supported species across the 25-year period, in which time habitats on site may have changed significantly as a result of natural ecological processes or site management.

The SSSI citation notes the importance of the Chase's populations of woodland moths. heathland and mire Lepidopteran assemblages, and beetles of wetlands and mature tree and deadwood habitats. Meanwhile the SAC citation details the importance of the early successional habitats of the dry heathland and the assemblages of valley mire/wet heath habitats. The Pantheon analysis in Tables 5, 6 and 7 support these citations, confirming that for invertebrates, the habitat conservation priorities within the Chase are the early successional heathland mosaics, river valley and wetland features, and the diverse range of woodland and tree associated habitats.

The Pantheon analysis clearly suggests that across the Chase, species associated with early successional habitats of the dry heath remain represented. Six of the top 20 habitat resource associations in Table 5 are for open habitat, with all associated with 'tall sward and scrub' rather than 'short sward and bare ground' indicative of extensive areas of taller heathland vegetation and potentially a limited resource of bare and sparsely vegetated habitats. It is assumed that if there were more extensive areas of bare ground within heathland and grassland that more species of short sward and bare ground habitats would be found.

Habitats and resource association assemblages of vegetated grassland and heathland environments are well represented. It is notable that 54% of the species associated with exposed sand in tall sward and scrub habitats in the national lists on Pantheon are represented, although this numbers only 15 species and notably none with a conservation status. This suggests a high importance for bare ground features within the grassland and heathland environment, but it is also likely that this habitat type is well surveyed, with the highest representation of any association in the Chase. Other habitat associations within tall sward and scrub habitats show a strong representation of those in the Pantheon database, with 31% of species associated with sward/field layer, soil humidity – dry, and dung, suggesting a range of diverse habitat features across the Chase. However, it is important to note that the Cannock Chase-wide assemblage assessments do not address any spatial variation in the value of habitats across the Chase for invertebrates, or their relative value for invertebrates in 2021. As discussed, the invertebrate records assessed here cover a 25-year period, which prevents an assessment of their current importance, or the success of management regimes.

For the highest scoring habitat resource associations by total number of species shown in Table 5, five of the top 10 scoring are of open habitats, with two for 'short sward and bare ground habitats', however these are

for ‘soil humidity- dry’ and ‘sward/field layer’. Both have high percentages of representation of the national list in Pantheon, at 20% and 24% respectively, and 32 species with conservation status associated with them. The invertebrate fauna of wet grassland and heath areas also appears to be well represented, with 30% of those associated with tall sward and scrub- soil humidity damp, which again demonstrates a diversity of tall sward and scrub habitat resources in the Chase.

There has been a significant amount of targeted survey effort of river valleys and wetland areas in the Chase, with much data also mobilised/digitised by this invertebrate audit exercise from static reports. Although wetland habitats do not feature in the highest-ranking habitat resource associations, many still have significant assemblages of invertebrates as shown in Table 7. The lower ranking of wetland habitat and resource types compared to terrestrial habitats, may simply be a function of the significantly greater size of the terrestrial invertebrate dataset, following many years of survey by terrestrial ecologists and entomologists. The Pantheon analysis suggests that habitats of marshland, running water, peatland and wet woodland in particular are well represented, including diverse resources such as well vegetated shallow pond margins (29% representation), woodland streams (26%), sparsely vegetated ponds (23%), fast flowing running water (23%) and shaded seepages (23%) among a number of habitat resources. This suggests that the Cannock Chase AONB audit dataset contains an important assemblage of wetland invertebrates, both associated with standing and running water.

Tree-associated species were extremely well represented in the Cannock Chase dataset, notably with an impressive 32% of all Pantheon arboreal species recorded over the past 25 years- 420 species. Three of the top five broad habitat associations outlined in Table 4 were tree-associated, with 26% of wet woodland (65) and 23% of all decaying wood (268) species recorded. Of the highest ranking habitat resource associations in Table 5, 14 of the top 20 are tree-associated, 12 related to arboreal features, suggesting a significant value to invertebrates of the tree canopy, foliage, flowers and a varied woodland structure, in addition to mature tree and decaying wood features. Table 42 highlights the breadth of resource associations across the entire Cannock Chase AONB, with representation of the national fauna ranging from 15-52%.

Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
tree-associated	arboreal	canopy >> mature tree canopy	44	52	107	4
tree-associated	arboreal	canopy >> scrub at wood edge/glade	118	49	117	10
tree-associated	arboreal	terrestrial aspect >> larvae ground active/pupate in soil	25	47	140	2
tree-associated	arboreal	flowers (adult)	61	41	110	8
tree-associated	arboreal	foliage >> inflorescence	39	37	100	2
tree-associated	arboreal	carr/wet woodland	25	36	128	4
tree-associated	decaying wood	flowers (adult)	62	35	155	10
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	333	33	110	20
tree-associated	arboreal	foliage	158	33	120	9
tree-associated	arboreal	canopy >> understorey	32	33	100	
tree-associated	arboreal	canopy	406	32	113	21
tree-associated	arboreal	foliage>> leaves and/or stems	79	32	133	2
tree-associated	shaded woodland floor	woodland habitat >> undergrowth	36	30	108	1
tree-associated	decaying wood	sapwood & bark decay >> dead trunks & branches	140	29	178	29

tree-associated	arboreal	terrestrial aspect >> pupate in foliage on ground	20	29	100	
tree-associated	shaded woodland floor	shadiness >> light shade	53	27	131	4
tree-associated	decaying wood	sapwood & bark decay	191	25	175	37
tree-associated	shaded woodland floor	humidity >> wet	66	25	129	5
tree-associated	shaded woodland floor	shadiness	152	24	127	10
tree-associated	decaying wood	sapwood & bark decay >> bark & cambium	93	24	177	18
tree-associated	decaying wood	fungal fruiting bodies	47	24	221	16
tree-associated	decaying wood	conifer or broadleaved >> broadleaved only	176	23	213	51
tree-associated	shaded woodland floor	shadiness >> heavy shade	100	23	125	6
tree-associated	arboreal	conifer or broadleaved >> conifer only	30	23	171	1
tree-associated	shaded woodland floor	humidity >> dry	28	22	150	2
tree-associated	shaded woodland floor	conifer or broadleaved >> broadleaved only	217	20	126	12
tree-associated	decaying wood	heartrot >> decaying wood	32	20	252	12
tree-associated	shaded woodland floor	woodland habitat >> woodland litter	61	19	135	4
tree-associated	shaded woodland floor	humidity >> damp	56	19	116	2
tree-associated	decaying wood	heartrot	47	19	235	17
tree-associated	decaying wood	heartrot >> hollow tree cavities	19	15	263	8
tree-associated	decaying wood	conifer or broadleaved >> conifer only	18	15	118	2

Table 42 *Tree-associated habitat associations*

The data suggests that in line with the SSSI and SAC citations, the Cannock Chase AONB remains an important site for its invertebrate populations. However, it must again be emphasised that this assessment is Chase-wide, meaning that a small number of sites supporting diverse habitat features and that are well surveyed, can effectively uplift the overall assessed value. To better understand the habitat quality for invertebrates of individual sites, the results in Section 4.6 must be reviewed.

For example, Brocton Coppice clearly demonstrates it has significant arboreal and decaying wood habitats for invertebrates with scrub wood edge/glade, flowers (adult), and inflorescence all exceeding 20% representation within arboreal habitat resource associations and eight decaying wood habitat resource associations showing representation scores of between 15-19%. At the higher habitat association level, it has representation scores for 15% of decaying wood and 13% of arboreal species overall. Old Brook is also well represented by good arboreal associations notably those of the mature tree canopy, with 24% of species represented. The Shugborough Estate also supports significant decaying wood interest, with representation scores for fungal fruiting bodies, sapwood & bark decay of both dead trunk & branches, and bark & cambium of over 10% representation.

Gentleshaw Common, Milford Quarry and Shoal Hill all support bare exposed sand associated species within open short sward & bare ground, with representations of between 10 and 17%. Shoal Hill appears to be

dominated by short sward & bare ground associated invertebrates, while Gentleshaw Common supports good populations of these species alongside those of taller sward & scrub, with over ten habitat resource associated assemblages scoring between 10 and 17% representation. Overall, for habitat association level short sward & bare ground and tall sward & scrub, Gentleshaw Common supports 10% of the representative lists for each.

Sherbrook Valley is undoubtedly the most significant site for invertebrate records associated with wetland features- scoring 14% of species associated with the higher level of wet woodland habitats. This includes running water resource associations including fast flow, woodland stream, unmodified fast flowing streams and drawdown zone with representation scores of between 10 and 18%. This is complimented by its considerable tree -associated interest including those of damp humidity and diverse scrub and flower opportunities. In other wetland habitats, the Shugborough Estate scores well for shallow freshwater ponds of marshland.

When viewed on this site by site basis, it is clear that the Chase as a whole has significant interest with the different hotspots often supporting quite different suites of invertebrates with Brocton Coppice, Gentleshaw Common and Sherbrook Valley of greatest importance over the last 25 years for the assemblages identified above.

5.2 Invertebrate species of conservation concern

The Cannock Chase AONB invertebrate audit yielded an impressive list of 2,698 species recorded and 226 species of conservation concern in the last 25 years, representing a significant list for an area of only 6,900 hectares. The 10 hotspots identified by this invertebrate audit include a high proportion of the Chase's species of conservation concern but also a significant proportion of the characteristic habitats. As shown in Figure 27, records of species of conservation concern correlate well with the 10 hotspots identified as part of this audit.

As expected, there is variation in how well different species groups are represented within these hotspots. The maps in Section 4.7 showing the relative distribution of Coleoptera, Diptera, Hymenoptera and Lepidoptera species of conservation concern (Figures 23-26) demonstrate this clearly. Lepidoptera are notably well represented within the 10 hotspots, which is unsurprising considering that they contribute 732 species to the list and a significant proportion of the Section 41 species. The strong bias of Lepidoptera records and their relative representation within the list of UK conservation statuses means that they have strongly dictated the selection of hotspots. Their readily recordable nature has also ensured that records appear frequently along public rights of way or concentrated along woodland rides where their activity is often focused, however, and in areas of less value for many other invertebrates.

Coleoptera are more distributed across the Chase, but clusters of records can be seen at Brocton Coppice and the Shugborough Estate, two sites which were well represented by tree associated and decaying wood species in the Pantheon analysis. Many beetle specialists of conservation concern are likely to be present across much of the Chase, but their short period as adults can make their survey difficult.

Diptera records were clustered within the Sherbrook Valley and Old Brook, which scored highly for representative species of wet woodland and running water, highlighting their importance for this group. However, there are a notable number of scattered records of Diptera of conservation concern throughout the Chase, appearing to overlap with the plantation habitat, so are unlikely to feature significantly in an invertebrate hotspot exercise.

Finally, the Hymenoptera of conservation concern are strongly represented in the hotspots at Gentleshaw Common and Shoal Hill, likely due to the opportunities for ground nesting aculeate Hymenoptera associated with the bare ground offered within drought stressed areas of grassland and heathland. However, these records may also be concentrated as they are known sites for Hymenoptera within the Chase and that smaller pockets of nearby habitat might yield interesting results.

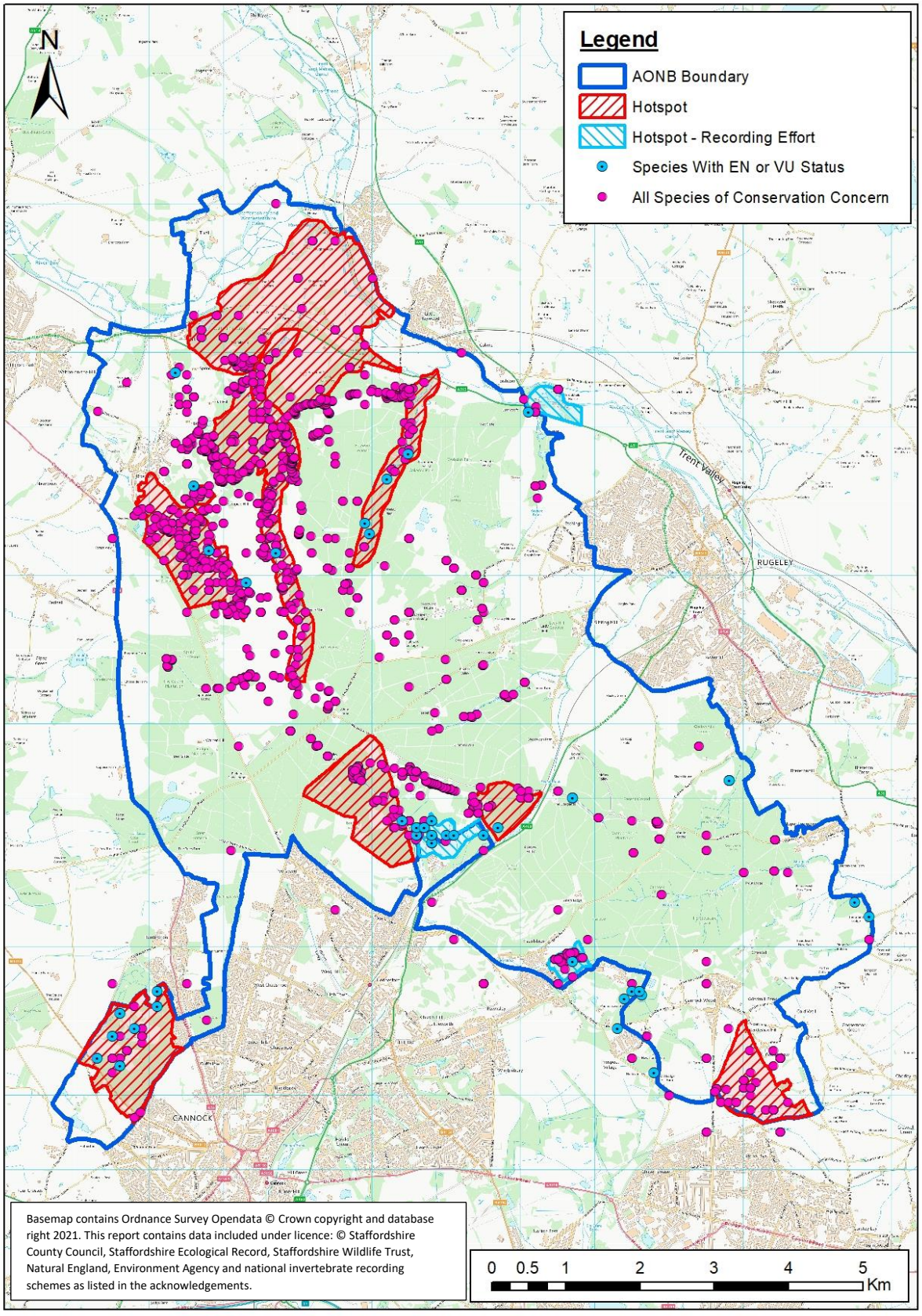

Figure 27 *Map of records of species of conservation concern relative to the 10 hotspots and 3 sites of raised recording effort identified*

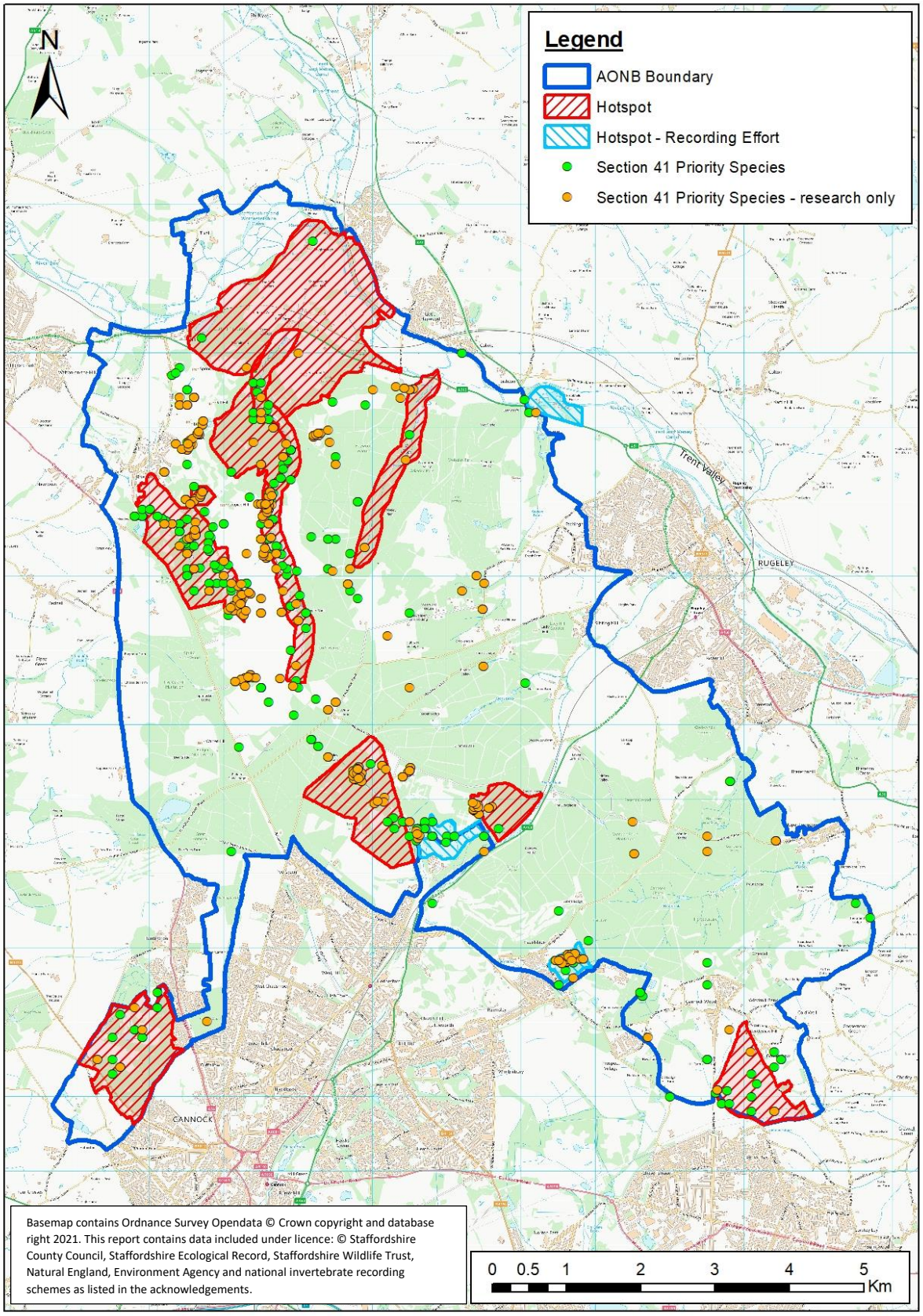

Figure 28 *Map of records of Section 41 priority species relative to the 10 hotspots and 3 sites of raised recording effort identified*

5.3 Land management in Cannock Chase

It is difficult to make clear management recommendations with the data covering a 25 year period, as this gives no indication of the current condition of areas of habitat. Management recommendations and suggestions were sought from local experts as part of the local consultation phase, but only limited feedback was received. However, some general and broad recommendations of management for invertebrates can be made based on the nature of the habitats and the character of some key sites.

5.3.1 Trees and decaying wood

The Chase clearly supports significant tree associated habitats, with assemblages associated with a range of features of both woodlands and mature trees, as well as of decaying wood features. Both, however, require a long-term approach to maintaining their biodiversity interest to ensure that there is a continuous supply of habitats into the future. In many parts of the UK, there are future age gaps in woodland and parkland trees, without the recruitment of trees in train to replace the current generation of mature trees and decaying wood features. It is advisable that efforts should be made to retain all mature trees and deadwood features, including looking at management activity that could extend the life of these habitat resources including pollarding and removal of limbs likely to lead to the tree losing stability, however this demands expert advice on a site-by-site basis. If a shortage of mature trees with an open canopy is predicted, efforts should be made to allow trees to mature free of competition through haloing. It might also be necessary to exclude grazing in some areas or to plant native trees to provide opportunities for trees to fully establish.

A strategy for encouraging the retention of deadwood in situ should also be developed across the Chase, avoiding practices such as the piling up of dead wood that often removes the diversity of habitat conditions for invertebrates. Where possible decaying wood features should be left standing or left where they have fallen undisturbed. Considering the public use of the Chase it may also be helpful to discourage the collection of dead wood for home use, which has become a growing problem across the UK.

Linked to the management of veteran trees and decaying wood features is the maintenance of diverse woodland habitats, that include varied aged trees and an understorey that includes nectar and pollen sources, such as thorny shrubs, umbellifers and brambles. This can be achieved by either planting flowering shrubs or excluding grazing. These nectar and pollen sources are essential for the adult forms of many species of woodlands and decaying wood.

5.3.2 Heathlands and grassland mosaics

Cannock Chase is well known for its important heathland habitats, a habitat that can be of very different value for invertebrates dependent on the management approach. As discussed, this audit is a picture over 25 years, so does not allow for an assessment of the heathland resources at present, although across the Chase during this period of time, there are records of species associated with the varying successional stages of heathland, including exposed sands and bare ground.

A homogeneous heathland site offers limited opportunities for invertebrates, which thrive on heathlands managed as a diverse mosaic of successional stages. A mixture of short sward, tall sward, establishing scrub and bare ground is ideal to provide the necessary diverse opportunities needed for species to complete their lifecycle, including nesting, feeding and overwintering. Bare ground and early successional vegetation are a key feature which is often lacking within heathlands, providing basking opportunities in sheltered areas, nesting for ground nesting species, hunting ground for ground active species as well as opportunities for key early successional flowering species to provide nectar and pollen. These mosaics are best achieved using flexible approaches to site management that are less prescriptive across broad areas such as traditional management units, to enable natural mosaics to develop and for the developing diverse habitats to have fuzzy boundaries.

The best heathland sites for invertebrates are therefore less heather dominated, with heather stands part of a mixed vegetation which includes grassland, valley mire, ponds, scrub and trees. Heathland sites can also support important invertebrate populations associated with decaying wood and the dung of grazing animals, including rabbits which also support the creation of localised disturbed areas within open vegetation for invertebrates. Viewed across their mosaics with grasslands and other habitats, however, it is useful for invertebrates to aim for further diversity in management by grazing animals, to include some areas that are

excluded from grazing in any given year, to provide opportunities for species which complete their lifecycle within standing stems and seed heads for example and to provide permanent cover throughout the year.

5.3.3. Landscape linkages

It appears that although heathland and associated habitats remain in scattered areas such as Gentleshaw Common and Shoal Hill, the resource remains fragmented in the Chase. Should opportunities arise to restore stepping stones of heathland and acid grassland mosaics to improve connectivity in the Chase, this would likely be extremely beneficial to the invertebrate fauna associated with both short sward & bare ground and tall sward & scrub habitats identified within this report. It would not only allow species to move across the landscape to colonise new areas and establish new populations but reduce the risk of local losses of invertebrate species on remaining sites. The national B-Lines network follows the chain of heathland and grassland SSSIs in the west of the Chase, which may be a potential route to encouraging the creation or reversion of habitats that can act as effective stepping stones.

It was also notable that two of the recording hotspots identified were on or straddled the border of the AONB, while a number of reports and experts emphasised the value of the remnant heathland and acid grassland in the Hednesford Hills LNR which is immediately adjacent to the AONB. There is also the network of lowland heath mosaic SSSI sites in the surrounding landscape, such as the Chasewater and the Southern Staffordshire Coalfield Heaths SSSI. It is essential that that the Cannock Chase AONB looks to align its management objectives and planning beyond its own boundaries, particularly with regards to the current approaches to ecological network mapping, to be best deliver its own conservation objectives.

Coniferous plantations are commonplace within the Chase; however, these are of limited biodiversity value. Where there are opportunities to restore such habitats to either open habitats or broad-leaved woodland, effort should be made to provide linkages to existing habitats of known value.

Improving the linkages between habitats will help to enable movement between sites to help local populations of invertebrates to thrive, which is likely to become increasingly important in response to climate change, where slight changes in local habitat conditions and environmental conditions could lead to species loss from sites. An increase in the extent of these open habitats, would also diversify the microclimate options available to species trying to adapt.

5.4 Recording in Cannock Chase

As discussed, invertebrates are often under-recorded, due to the technical skills required and need for extensive long-term study to fully understand species distributions. For some species, such as the Small pearl-bordered fritillary, Bog bush cricket and Welsh clearwing, their distributions are well established thanks to sustained effort and the recognised importance of the Chase for these species. Overall, groups such as Lepidoptera and Odonata are often well studied in the UK, but the majority of invertebrates are much less well recorded. Both tree-associated and early successional assemblages often include many of the species of greatest conservation concern in the UK, with both habitats suffering extensive losses of habitats in the previous decades (e.g. agriculture, afforestation) and a combination of under management (e.g. loss of coppicing, loss of fine-scale techniques and disturbance) and over management (e.g. wild grazing preventing recruitment, loss of flower resources).

The data collated and analysed indicates that over the last 25 years, the Cannock Chase AONB has had abundant records of species associated with its open tall sward habitats, woodland and wetland habitats. These habitats are well represented within the Cannock Chase SSSI and LWS series, which is likely to lead to an amplification of data for these sites as they are the target of both formal and informal survey. Local organisations and teams such as Cannock Chase AONB, Staffordshire County Council, Staffordshire Wildlife Trust and Natural England are likely to have targeted historic surveys in known areas of high invertebrate value as was evident from the newly digitised data, which effectively continues to amplify the relative value of these 'honeypot sites'. It is notable that many of the digitised surveys were from named hotspots, as this exercise digitised 2,659 records from reports undertaken by local organisations such as the Cannock Chase AONB, Staffordshire County Council and Staffordshire Wildlife Trust, that had previously not been available for spatial

mapping- increasing the dataset from 24,907 to 27,566 records, contributing 9.6% of all post 1995 Cannock Chase AONB area invertebrate records.

Access will also continue to have significant influence on the distribution of records. The map of all records shown in Figure 2 shows a series of linear clusters of records, which follow established footpath routes, which are both accessible to the skilled recorder but also the general public. This makes both these routes and some common species very prevalent in the dataset.

It is not unexpected to see a significant proportion of records come from a handful of charismatic and/or easy to identify invertebrates- with 3,846 of the 27,566 records, or 14% being of just 20 species. Of this list, 17 species were Lepidoptera, clearly demonstrating that the popularity of butterflies as a group, being readily identifiable in the field, and the popularity of moth trapping which allows vast species lists to be compiled for individual sites.

Some of the perceived flagship species of the Cannock Chase AONB clearly fare well within these surveys, such as the Welsh clearwing and Small pearl-bordered fritillary, with 517 and 214 records respectively. As one of a handful of English sites for the Welsh clearwing, the target of extensive survey and awareness raising, it is unsurprising that it tops the list of records.

Although this audit analysed the data as a single 25-year dataset, preventing any changes to recording focus over time from being detected. Some observations can be made from the results in Section 4.8 for Cannock's 'lost' species. For example, 109 species of spider have not been recorded post 1995, a significant proportion of the UK fauna, which suggests that spider recording has declined in the last 25-30 years for this important group. In contrast, there are only 36 species of Hymenoptera which have not been recorded since 1995 but were recorded historically, which might reflect the modern trend seen across the UK for increased recording of this group as resources have become available and supported by online identification groups.

5.5 'Not spots' of recording

The map of all invertebrate records (Figure 2) and hotspot maps (Figures 3 & 4) clearly show that recording effort in Cannock Chase is not evenly spread. This can be attributed to many reasons, including access and the tendency for recording effort to be focused on areas of historically know interest. Some areas of Cannock Chase show very high levels of invertebrate recording, but there are some areas, notably in the east of the Chase, where the density of records is significantly lower and showing as clear 'not spots'. When considering the causes of not spots, it is important to consider the land uses within Cannock Chase and how these might support invertebrate populations. For example, much of the Chase support agriculture and plantation woodlands, both of which are likely to support a smaller range of species.

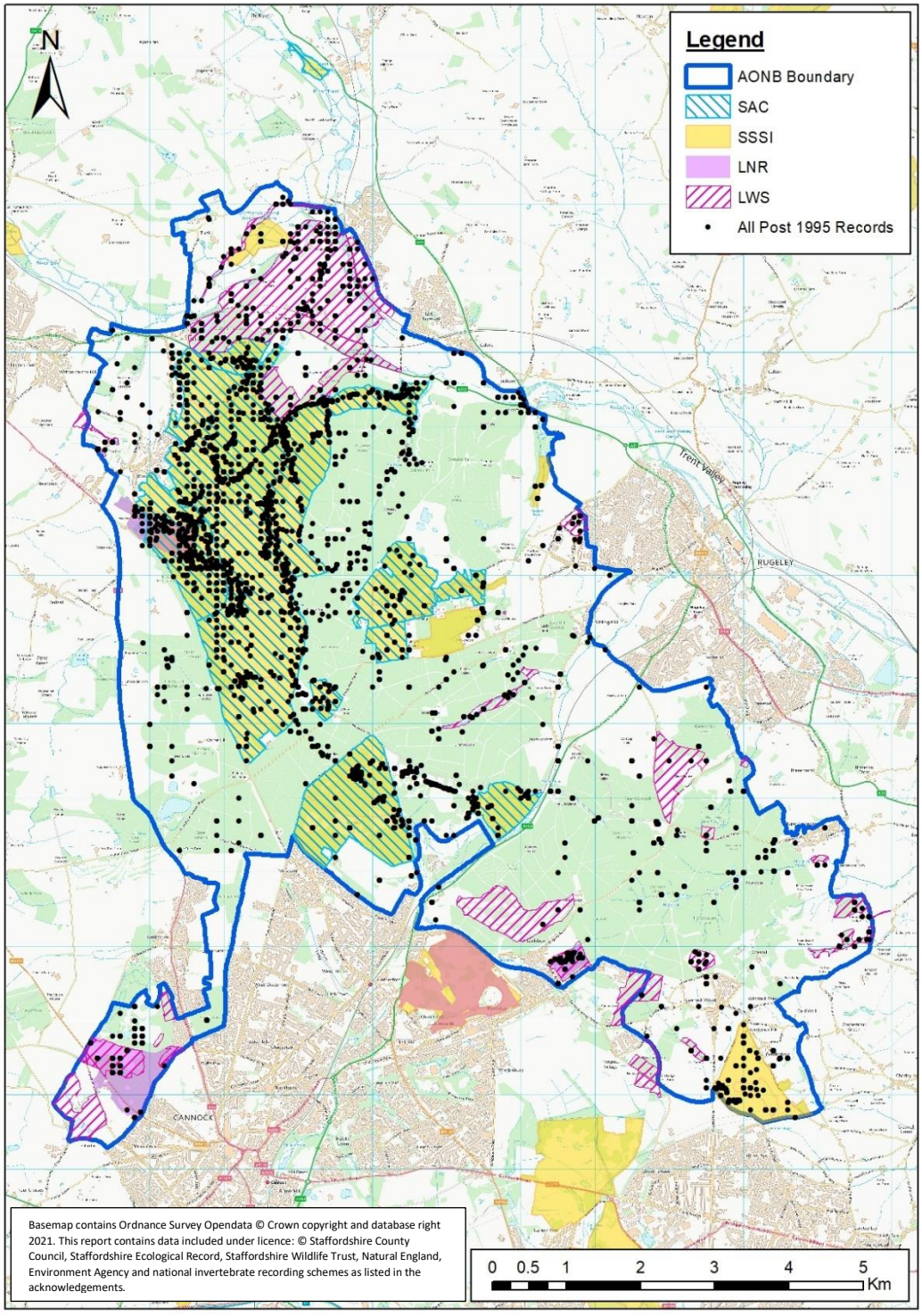

***Figure 29**: Distribution of invertebrate records relative to the protected area network*

As recording is often strongly associated with the network of protected and LWS sites, a western bias to recording effort is relatively unsurprising, given the western distribution of the protected and LWS networks in the Chase (Figure 29). To investigate whether this distribution is related to purely the wildlife sites network or the presence of semi-natural habitats, the Natural England Habitat Network data was sourced and presented alongside all post 1995 invertebrate records (Figure 30). This showed a high proportion of invertebrate records were within areas of semi-natural habitat that qualifies as Priority Habitat. Particularly clear cut is the focus of recording hotspots on lowland heathland and acid grassland sites as shown in Figure 30.

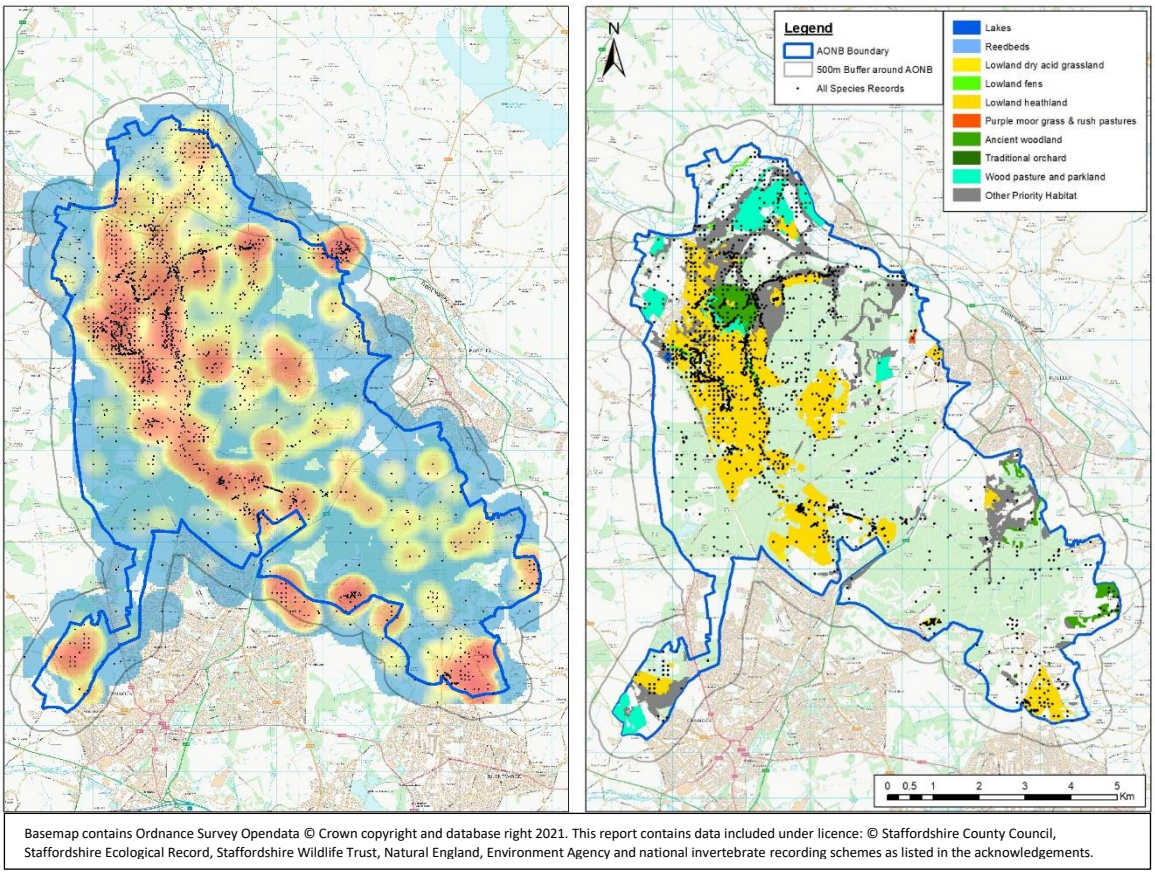

***Figure 30**: Left- hotspot map presented previously in Figure 3. Right- Map of species records relative to Priority Habitats in the Natural England Habitat Networks map. Lowland heath and acid grassland are shown in two shades of yellow.*

Away from the main red hotspots, it is notable that wood pasture and parkland is relatively poorly surveyed compared to the hotspots on open habitats, albeit with a few hotspots such as the Shugborough Estate. This may be a function of them being more likely to be privately owned but considering the known value of arboreal and decaying wood habitats within the Chase is significant. Based on assessment of aerial imagery, much of the remainder of the AONB with lower recording effort, is dominated by either farmland or non-Priority Habitat woodland that is likely not managed with wildlife as its primary objective. Such areas are unlikely therefore to be not spots purely due to a lack of recording effort, but also due to their much lower potential value for invertebrates. The plantation areas are likely to also support some populations of species associated with coniferous woodland and decaying wood habitats, however, their value for invertebrates is likely to be much more limited than nearby broad-leaved woodland areas.

However, as it is notable that there are a number of linear clusters of records, which align with both public rights of way and the ride network in forested areas, it is likely that there remain other rides which are not publicly accessible that have yet to be surveyed. There is also a notable lack of any records in the farmed environment, not just of species of conservation concern, likely due to access and not solely the limited habitat resources for invertebrates that they support. Within Priority habitats, it is notable that the grouped 'Other Priority Habitat' in the east of the Chase, which supports extensive woodland habitats represents a clearly under-recorded area.

5.6 Future survey work & flagship species

The composition of existing invertebrate records is unsurprisingly showing that Lepidopteran records combined account for nearly half of all records (49.3%) despite only representing 27.5% of all species recorded at Cannock Chase. Despite there being fewer additional species that can potentially be added to the list for

Lepidoptera, relative to other species groups, it is likely that this over-representation in the dataset will amplify over time.

As highlighted, Araneae, Coleoptera, Diptera and Hemiptera are all important groups of invertebrates, with 1,544 species in the Chase, but represented by only 8,146 records. This is an average of only 5.3 records per species over the entire AONB in 25 years, indicating that targeted survey could yield valuable information on how these groups are faring.

The drive for Welsh clearwing records across the Chase has clearly been a success, with this nationally scarce species now the most recorded invertebrate species in the Chase over the last 25 years. The Welsh clearwing is clearly a strong flagship for mature birch trees associated with heathland. Similar flagship survey schemes could yield positive results and improve our understanding the distribution of charismatic species associated with priority habitats in the Chase. Flagship species need to be readily identifiable to the public or at least reasonably skilled naturalist but also be a genuine indicator of good quality habitat.

Flagship species for Cannock Chase should undoubtedly continue to include Welsh clearwing, due to the significant proportion of the English population supported by the AONB. The ongoing national declines of Small pearl-bordered fritillary and the association of Bog bush cricket with a threatened and restricted habitat type, mean that they too remain worthy of being used as flagships within the chase.

Potential flagships for invertebrate habitats of significance, with the potential to be recognised by the public include:

- Beewolf (*Philanthus triangulum*) which is strongly associated with bare ground in sandy sites and is one of the more identifiable of the ground nesting Hymenoptera. As a readily identifiable species that rapidly colonises bare ground, it is a useful indicator of success for bare ground creation efforts within heathland sites.
- Lesser stag beetle (*Dorcus parallelipipedus*) although not a rarity, could be considered a good indicator of deadwood habitats that support rarer and harder to survey species, and is easy to identify while also being large and charismatic.
- Bog bush cricket may also be a suitable flagship for valley mire and wet heath habitats. Damp habitats of restricted extents are likely to be increasingly vulnerable to a changing climate, so this charismatic species might be a useful tool to both highlight the importance of this often overlooked habitat, but also to monitor any changes in its extent over time.

However, it is important to also consider the potential role of assemblages rather than individual species within this approach. Individual flagship species are useful for elements of engagement work, but can result in management being tailored towards the needs of an individual species. In contrast managing for an assemblage of invertebrates can encourage a more diverse approach to site management. Suggested assemblages of importance at Cannock Chase that could form the focus of concerted effort include the Hymenoptera of open heathland habitats, deadwood beetles, and the riverflies.

Riverflies are useful flagships and biological indicators of the value of running water habitats and of water quality. They have high potential as a useful flagships group, demonstrated by the success of partnerships with anglers nationally. The Chase contains records of 60 species of caddisfly, mayfly and stonefly recorded over the last 25 years, represented by 484 records. This represents only 8 records per species in average over 25 years- to help assess the biodiversity value of aquatic habitats, targeted survey would be beneficial and long-term monitoring data could be a useful resource for the AONB. The 'lost species' exercise also revealed that there are 27 species of riverfly without post 1995 records- which may help to enthuse the angling community and freshwater ecologists further. The establishment of a local Riverfly Partnership with entomologists training anglers to survey for riverflies would be a practical route to increasing recording of this important indicator species, providing not just invertebrate data to fill a gap but also to allow for long-term monitoring of freshwater quality.

However, in addition to more public or general naturalist focused flagship efforts, it might also be that there is a place for targeted survey of flagship species among entomologists, such as of the Logjammer hoverfly (*Chalcosyrphus eunotus*), which is associated with decaying wood in woodland streams.

The review of 'lost species' not recorded since 1995 but with a historic record in Section 4.8, also identifies a host of species which could form the focus of future survey work. Making this list of species widely available to local entomologists might have the positive effect of encouraging experts to purposefully seek out these species to fill the knowledge gap or to submit any existing records that they have which have not been submitted to SER or recording schemes. Where survey work is being commissioned within the Chase, it might also interest contractors to be aware of these 'lost' species so that they can be aware of them, especially as in many instances they might be common species which have simply not had records collated in recent years. The lost species data has also revealed a lack of modern records for many species of spider, which could be a useful focus for future survey, with many spider species being good indicators for habitat quality.

Away from individual species group, the 'not spots' assessment in Section 5.5 indicates that much of the east of the Chase is less recorded, likely due to the westward skew of the protected area network and semi-natural habitats identified in the Natural England Habitat Networks maps. The lowland heathland and acid grassland areas of the Chase have long been the target of survey, reflected in them being clear hotspots for recording in the Chase. It is unlikely that surveys of the extensive forestry and agricultural areas of the Chase would yield significant interest, however, the Chase's wood pasture and parkland, and remaining broad-leaved woodland areas would likely benefit from significant further invertebrate survey work, particularly with a focus on saproxylic beetles and hoverflies as indicators of habitat quality and diversity. This saproxylic focus is supported by 62 of the Chase's species of conservation concern being identified as having a decaying wood association in Pantheon (Table 4).

It is important to note that although flagship species which are readily identifiable can lead to significant volumes of useful data and that entomologists and naturalists will continue to visit the Chase as part of their own interests, it is likely that funded and contracted entomological surveys will be essential to filling current knowledge gaps and to inform future management of the Chase.

6. Acknowledgements

Thank you to Richard Harris at the Cannock Chase AONB and Sue Lawley at Staffordshire County Council for their assistance throughout this work. Thanks also to Pete Boardman at Natural England, Shona Frost at Staffordshire County Council and Rory Middleton at Staffordshire Ecological Record for their help producing this report.

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This report also used national recording scheme data kindly provided for this purpose direct by these organisations or accessed through the NBN Atlas, these are used under licence where not shared under a creative commons OpenData licence (CC-BY): Aquatic Heteroptera Recording Scheme, National Trust, Cranefly Recording Scheme, Tachinid Recording Scheme, Tenebrionoidea Recording Scheme, Bumblebee Conservation Trust - Bee Walk Data, Chrysomelidae Recording Scheme, Natural Resources Wales, Longhorn Beetle Recording Scheme, Riverfly Recording Schemes, Orthoptera Recording Scheme, Conchological Society of Great Britain & Ireland, Empididae & Dolichopodidae Recording Scheme, UK Ladybird Survey, Environment Agency, Silphid Recording Scheme, Ground Beetle Recording Scheme , Caddisfly Recording Scheme, Soldierflies and Allies Recording Scheme, Dragonfly Recording Network, Hoverfly Recording Scheme, British Arachnological Society and Bees, Wasps and Ants Recording Scheme.

Many thanks to the many dedicated invertebrate recorders who make such exercises possible.

7. References

Webb, J., Heaver, D., Lott, D., Dean, H.J., van Breda, J., Curson, J., Harvey, M.C., Gurney, M., Roy, D.B., van Breda, A., Drake, M., Alexander, K.N.A., and Foster, G. (2018). Pantheon - database version 3.7.6.

8. List of Annexes

Annex 1- Cannock Chase AONB Invertebrate Audit dataset in Excel and as Shapefiles for use in GIS. For use of the Cannock Chase AONB only.

Annex 2- Summary table of species with post 1995 records in the Cannock Chase AONB on Excel.

Annex 3- JPEGS maps of all maps within this report, in addition to individual JPEG distribution maps for all species with a Section 41 status or with a GB threat status of Vulnerable or Higher, excluding White-clawed crayfish and Depressed river mussel.

Annex 4- Excel table of 'Lost Cannock species' with no records since 1995.

9. Appendices

9.1 Appendix 1

All species of conservation concern with post 1995 records within the Cannock Chase AONB

Group	Taxon name	Section 41	GB Threat	GB Rarity	Other
Araneae	*Cercidia prominens*			NS	
Araneae	*Erigonella ignobilis*			NS	
Araneae	*Euryopis flavomaculata*			NS	
Araneae	*Gongylidiellum latebricola*			NS	
Araneae	*Pardosa lugubris*			NS	
Coleoptera	*Acalles ptinoides*				Nb
Coleoptera	*Acidota cruentata*				Nb
Coleoptera	*Agelastica alni*			NR	
Coleoptera	*Amara lucida*			NS	
Coleoptera	*Amara praetermissa*			NS	
Coleoptera	*Ampedus pomorum*				Nb
Coleoptera	*Ampedus rufipennis*	*Section 41 Priority Species*			RDB 2
Coleoptera	*Anaspis costai*			NS	
Coleoptera	*Anitys rubens*			NS	
Coleoptera	*Aphodius fasciatus*			NS	
Coleoptera	*Aphodius merdarius*			NS	
Coleoptera	*Bembidion obliquum*			NS	
Coleoptera	*Bryoporus cernuus*			NR	RDB K
Coleoptera	*Caenopsis fissirostris*				Nb
Coleoptera	*Cis festivus*				Nb
Coleoptera	*Clytra quadripunctata*			NS	
Coleoptera	*Corticeus unicolor*			NS	
Coleoptera	*Cryptocephalus parvulus*			NS	
Coleoptera	*Diplocoelus fagi*				Nb
Coleoptera	*Dorcatoma flavicornis*			NS	
Coleoptera	*Elaphropus parvulus*			NS	
Coleoptera	*Elodes minuta*			NS	
Coleoptera	*Enicmus brevicornis*				Notable
Coleoptera	*Ernobius nigrinus*			NR	
Coleoptera	*Ernoporicus fagi*				Na
Coleoptera	*Ernoporus tiliae*			PNR	RDB 1
Coleoptera	*Euglenes oculatus*			NS	
Coleoptera	*Grypus equiseti*				Nb
Coleoptera	*Hallomenus binotatus*			NS	
Coleoptera	*Haploglossa marginalis*				Notable
Coleoptera	*Helochares punctatus*			NS	

Coleoptera	*Helophorus strigifrons*			NS	
Coleoptera	*Hippodamia variegata*				Nb
Coleoptera	*Latridius consimilis*				Notable
Coleoptera	*Luperus flavipes*			NS	
Coleoptera	*Magdalis carbonaria*				Nb
Coleoptera	*Malthinus frontalis*			NS	
Coleoptera	*Malthodes maurus*			NS	
Coleoptera	*Megatoma undata*			NS	
Coleoptera	*Melasis buprestoides*				Nb
Coleoptera	*Micrambe pilosula*				RDB K
Coleoptera	*Notaris scirpi*				Nb
Coleoptera	*Omalium rugatum*				Notable
Coleoptera	*Orchesia minor*			NS	
Coleoptera	*Orthoperus nigrescens*				Nb
Coleoptera	*Phloeopora corticalis*				Notable
Coleoptera	*Phloiophilus edwardsii*			NS	
Coleoptera	*Phloiotrya vaudoueri*			NS	
Coleoptera	*Platypus cylindrus*				Nb
Coleoptera	*Platyrhinus resinosus*				Nb
Coleoptera	*Poecilus lepidus*			NS	
Coleoptera	*Psylliodes cuprea*			NS	
Coleoptera	*Pterostichus quadrifoveolatus*			NS	
Coleoptera	*Quedius brevicornis*				Nb
Coleoptera	*Quedius scitus*				Nb
Coleoptera	*Quedius truncicola*				Nb
Coleoptera	*Rhinocyllus conicus*				Nb
Coleoptera	*Rhizophagus nitidulus*				Nb
Coleoptera	*Saperda scalaris*			NS	
Coleoptera	*Scolytus mali*				Nb
Coleoptera	*Scymnus schmidti*				Nb
Coleoptera	*Sibinia primita*				Nb
Coleoptera	*Silvanus bidentatus*				Nb
Coleoptera	*Stenus argus*				Nb
Coleoptera	*Strigocis bicornis*				Nb
Coleoptera	*Symbiotes latus*				Nb
Coleoptera	*Synchita humeralis*			NS	
Coleoptera	*Thymalus limbatus*			NS	
Coleoptera	*Traumoecia picipes*				Notable
Coleoptera	*Triphyllus bicolor*			NS	
Coleoptera	*Trypocopris vernalis*			NS	
Coleoptera	*Trypodendron signatum*				Nb
Coleoptera	*Uleiota planatus*				Na
Coleoptera	*Xyleborus dryographus*				Nb

Decapoda	*Austropotamobius pallipes*	*Section 41 Priority Species*			EN (Global)
Diptera	*Atypophthalmus inustus*				Notable
Diptera	*Brachyopa pilosa*			NS	
Diptera	*Callicera aurata*			NS	
Diptera	*Chalcosyrphus eunotus*			NS	
Diptera	*Conisternum decipiens*				Notable
Diptera	*Conops strigatus*				Notable
Diptera	*Conops vesicularis*				Notable
Diptera	*Ctenophora pectinicornis*				Notable
Diptera	*Dicranomyia distendens*				Notable
Diptera	*Didea intermedia*			NS	
Diptera	*Diogma glabrata*				Notable
Diptera	*Dolichopus lineatocornis*		VU	NR	
Diptera	*Dolichopus phaeopus*			NS	
Diptera	*Eloeophila trimaculata*				Notable
Diptera	*Hercostomus nigrilamellatus*			NS	
Diptera	*Hybomitra bimaculata*			NS	
Diptera	*Hydrotaea cinerea*			pNS	
Diptera	*Lasiopogon cinctus*			NS	
Diptera	*Metalimnobia quadrimaculata*				RDB 2
Diptera	*Micropeza lateralis*			PNS	
Diptera	*Nephrotoma crocata*			PNR	RDB 3
Diptera	*Pherbellia nana*				Notable
Diptera	*Pocota personata*			NS	
Diptera	*Ptychoptera longicauda*			PNR	
Diptera	*Rhaphium lanceolatum*		NT	NS	
Diptera	*Rhipidia uniseriata*				RDB 3
Diptera	*Tabanus cordiger*			NS	
Diptera	*Tanyptera atrata*				Notable
Diptera	*Tetanocera punctifrons*				Notable
Diptera	*Thereva bipunctata*			NS	
Diptera	*Tipula yerburyi*				Notable
Hemiptera	*Alydus calcaratus*			NS	
Hemiptera	*Aphrophora major*				Nb
Hemiptera	*Ceratocombus coleoptratus*			NS	
Hemiptera	*Globiceps juniperi*				Nb
Hemiptera	*Saldula orthochila*			NS	
Hymenoptera	*Andrena apicata*				Nb
Hymenoptera	*Andrena humilis*				Nb

Hymenoptera	*Andrena labiata*				Na
Hymenoptera	*Andrena nigriceps*				Nb
Hymenoptera	*Andrena similis*				Nb
Hymenoptera	*Andrena trimmerana*				Nb
Hymenoptera	*Bombus muscorum*	*Section 41 Priority Species*			EN (European)
Hymenoptera	*Bombus rupestris*				Nb
Hymenoptera	*Crossocerus distinguendus*				Na
Hymenoptera	*Dolichovespula media*				Na
Hymenoptera	*Dolichovespula saxonica*				RDB K
Hymenoptera	*Ectemnius ruficornis*				Nb
Hymenoptera	*Formica rufa*				NT (Global)
Hymenoptera	*Halictus confusus*				RDB 3
Hymenoptera	*Hylaeus signatus*				Nb
Hymenoptera	*Lasioglossum quadrinotatum*				Na
Hymenoptera	*Methocha articulata*				Nb
Hymenoptera	*Nomada fucata*				Na
Hymenoptera	*Nomada integra*				Na
Hymenoptera	*Nomada lathburiana*				RDB 3
Hymenoptera	*Nomada signata*				RDB 2
Hymenoptera	*Nysson dimidiatus*				Nb
Hymenoptera	*Nysson trimaculatus*				Nb
Hymenoptera	*Pemphredon lethifer*				RDB 3
Hymenoptera	*Philanthus triangulum*				RDB 2
Hymenoptera	*Sphecodes crassus*				Nb
Hymenoptera	*Sphecodes niger*				RDB 3
Hymenoptera	*Sphecodes rubicundus*				Na
Hymenoptera	*Stigmus pendulus*				RDB K
Hymenoptera	*Tiphia minuta*				Nb
Lepidoptera	*Acronicta psi*	*Section 41 Priority Species - research only*			
Lepidoptera	*Acronicta rumicis*	*Section 41 Priority Species - research only*			
Lepidoptera	*Aethes piercei*			PNS	
Lepidoptera	*Agrochola helvola*	*Section 41 Priority Species - research only*			
Lepidoptera	*Agrochola litura*	*Section 41 Priority Species - research only*			

Lepidoptera	*Allophyes oxyacanthae*	*Section 41 Priority Species - research only*			
Lepidoptera	*Amphipoea oculea*	*Section 41 Priority Species - research only*			
Lepidoptera	*Amphipyra tragopoginis*	*Section 41 Priority Species - research only*			
Lepidoptera	*Ancylis upupana*			PNS	
Lepidoptera	*Apamea remissa*	*Section 41 Priority Species - research only*			
Lepidoptera	*Aporophyla lutulenta*	*Section 41 Priority Species - research only*			
Lepidoptera	*Arctia caja*	*Section 41 Priority Species - research only*			
Lepidoptera	*Atethmia centrago*	*Section 41 Priority Species - research only*			
Lepidoptera	*Batrachedra pinicolella*			PNS	
Lepidoptera	*Boloria selene*	*Section 41 Priority Species*	NT		
Lepidoptera	*Caradrina morpheus*	*Section 41 Priority Species - research only*			
Lepidoptera	*Ceramica pisi*	*Section 41 Priority Species - research only*			
Lepidoptera	*Chesias legatella*	*Section 41 Priority Species - research only*			
Lepidoptera	*Chiasmia clathrata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Cirrhia icteritia*	*Section 41 Priority Species - research only*			
Lepidoptera	*Coenonympha pamphilus*	*Section 41 Priority Species*	NT		
Lepidoptera	*Coleophora vitisella*	*Section 41 Priority Species*		PNS	
Lepidoptera	*Crambus hamella*			PNS	Nb
Lepidoptera	*Crambus pratella*			PNS	Nb
Lepidoptera	*Crassa tinctella*			PNS	
Lepidoptera	*Cydia coniferana*			PNS	
Lepidoptera	*Diarsia rubi*	*Section 41 Priority Species - research only*			

Lepidoptera	*Diloba caeruleocephala*	*Section 41 Priority Species - research only*			
Lepidoptera	*Dioryctria sylvestrella*			PNS	
Lepidoptera	*Ecliptopera silaceata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Ectoedemia weaveri*			PNS	
Lepidoptera	*Ennomos erosaria*	*Section 41 Priority Species - research only*			
Lepidoptera	*Ennomos fuscantaria*	*Section 41 Priority Species - research only*			
Lepidoptera	*Erynnis tages*	*Section 41 Priority Species*	VU		
Lepidoptera	*Eugnorisma glareosa*	*Section 41 Priority Species - research only*			
Lepidoptera	*Eulithis mellinata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Eurois occulta*			NS	
Lepidoptera	*Euxoa tritici*	*Section 41 Priority Species - research only*			
Lepidoptera	*Graphiphora augur*	*Section 41 Priority Species - research only*			
Lepidoptera	*Hepialus humuli*	*Section 41 Priority Species - research only*			
Lepidoptera	*Hoplodrina blanda*	*Section 41 Priority Species - research only*			
Lepidoptera	*Hydraecia micacea*	*Section 41 Priority Species - research only*			
Lepidoptera	*Lasiommata megera*	*Section 41 Priority Species*	NT		
Lepidoptera	*Leucania comma*	*Section 41 Priority Species - research only*			
Lepidoptera	*Litoligia literosa*	*Section 41 Priority Species - research only*			
Lepidoptera	*Lycia hirtaria*	*Section 41 Priority Species - research only*			
Lepidoptera	*Melanchra persicariae*	*Section 41 Priority Species - research only*			

Lepidoptera	*Ocnerostoma piniariella*			PNS	
Lepidoptera	*Orthonama vittata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Pasiphila debiliata*			NS	
Lepidoptera	*Polia hepatica*			NS	
Lepidoptera	*Pseudococcyx posticana*			PNS	
Lepidoptera	*Pseudotelphusa paripunctella*			PNS	
Lepidoptera	*Rheumaptera hastata*	*Section 41 Priority Species*			
Lepidoptera	*Satyrium w-album*	*Section 41 Priority Species*	EN		
Lepidoptera	*Scotopteryx chenopodiata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Spilosoma lubricipeda*	*Section 41 Priority Species - research only*			
Lepidoptera	*Spilosoma lutea*	*Section 41 Priority Species - research only*			
Lepidoptera	*Stilbia anomala*	*Section 41 Priority Species - research only*			
Lepidoptera	*Synanthedon culiciformis*			NS	
Lepidoptera	*Synanthedon scoliaeformis*			NS	RDB 3
Lepidoptera	*Synanthedon spheciformis*			NS	
Lepidoptera	*Tholera cespitis*	*Section 41 Priority Species - research only*			
Lepidoptera	*Tholera decimalis*	*Section 41 Priority Species - research only*			
Lepidoptera	*Timandra comae*	*Section 41 Priority Species - research only*			
Lepidoptera	*Trichiura crataegi*	*Section 41 Priority Species - research only*			
Lepidoptera	*Tyria jacobaeae*	*Section 41 Priority Species - research only*			
Lepidoptera	*Watsonalla binaria*	*Section 41 Priority Species - research only*			

Lepidoptera	*Xanthorhoe ferrugata*	*Section 41 Priority Species - research only*			
Lepidoptera	*Xestia agathina*	*Section 41 Priority Species - research only*			
Lepidoptera	*Xestia castanea*	*Section 41 Priority Species - research only*			
Lepidoptera	*Xylena solidaginis*			NS	
Orthoptera	*Metrioptera brachyptera*			NS	
Trichoptera	*Hydatophylax infumatus*			NS	
Trichoptera	*Stenophylax vibex*			NS	
Unionoida	*Pseudanodonta complanata*	*Section 41 Priority Species*		NS	
Unionoida	*Unio tircis*			NS	
Unionoida	*Anodonta cygnea*				NT (European)
Veneroida	*Sphaerium rivicola*			NS	VU (Global)

9.2 Appendix 2

List of resources identified in Pantheon exceeding 10% of the national list on Pantheon represented and sufficient data to be considered meaningful

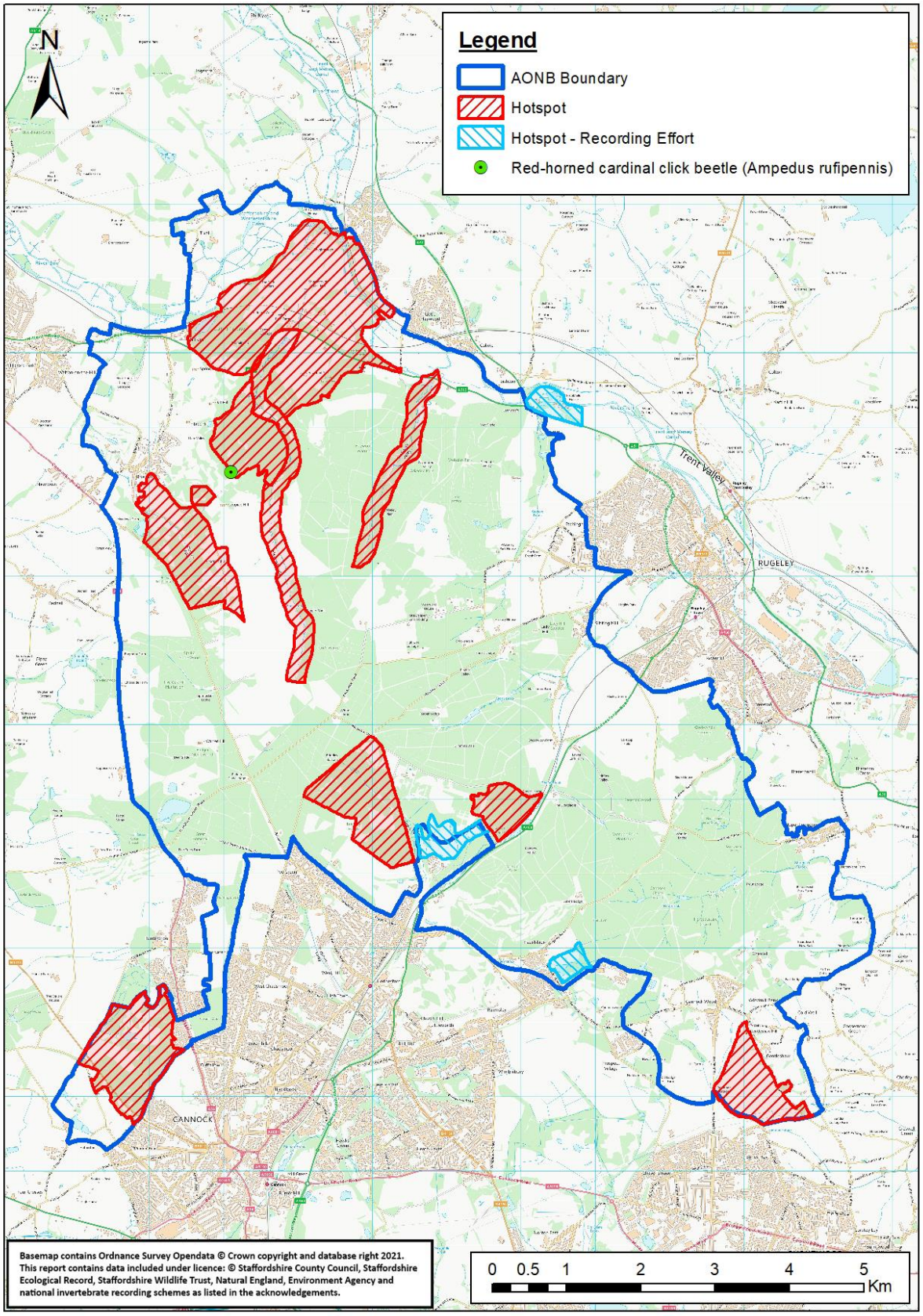
Broad biotope	Habitat	Resource	No. of species	% repre-sentation	SQI	Species with conservation status
open habitats	tall sward & scrub	habitats >> exposed sand	15	54	119	
tree-associated	arboreal	canopy >> mature tree canopy	44	52	107	4
tree-associated	arboreal	canopy >> scrub at wood edge/glade	118	49	117	10
tree-associated	arboreal	terrestrial aspect >> larvae ground active/pupate in soil	25	47	140	2
tree-associated	arboreal	flowers (adult)	61	41	110	8
tree-associated	arboreal	foliage >> inflorescence	39	37	100	2
tree-associated	arboreal	carr/wet woodland	25	36	128	4
open habitats	tall sward & scrub	habitats >> soil & roots	66	35	109	3
tree-associated	decaying wood	flowers (adult)	62	35	155	10
tree-associated	arboreal	conifer or broadleaved >> broadleaved only	333	33	110	20
tree-associated	arboreal	foliage	158	33	120	9
tree-associated	arboreal	canopy >> understorey	32	33	100	
tree-associated	arboreal	canopy	406	32	113	21
tree-associated	arboreal	foliage>> leaves and/or stems	79	32	133	2
open habitats	tall sward & scrub	habitats >> sward/field layer	494	31	110	35
open habitats	tall sward & scrub	soil humidity >> dry	222	31	108	15
open habitats	tall sward & scrub	dung & carrion >> dung	22	31	114	1
open habitats	tall sward & scrub	soil humidity >> damp	120	30	111	8
tree-associated	shaded woodland floor	woodland habitat >> undergrowth	36	30	108	1
tree-associated	decaying wood	sapwood & bark decay >> dead trunks & branches	140	29	178	29
wetland	marshland	shallow freshwater pond >> aquatic: well vegetated	46	29	124	2
open habitats	tall sward & scrub	base status >> acidic	30	29	184	3

tree-associated	arboreal	terrestrial aspect >> pupate in foliage on ground	20	29	100	
open habitats	tall sward & scrub	soil humidity >> variable humidity	127	28	102	2
tree-associated	shaded woodland floor	shadiness >> light shade	53	27	131	4
open habitats	short sward & bare ground	habitats >> exposed sand	146	26	162	29
wetland	running water	woodland stream	42	26	131	3
wetland	wet woodland	woodland stream	42	26	131	3
tree-associated	decaying wood	sapwood & bark decay	191	25	175	37
open habitats	tall sward & scrub	habitats >> litter & ground layer	161	25	109	5
tree-associated	shaded woodland floor	humidity >> wet	66	25	129	5
open habitats	short sward & bare ground	habitats >> sward/field layer	186	24	141	31
tree-associated	shaded woodland floor	shadiness	152	24	127	10
tree-associated	decaying wood	sapwood & bark decay >> bark & cambium	93	24	177	18
tree-associated	decaying wood	fungal fruiting bodies	47	24	221	16
tree-associated	decaying wood	conifer or broadleaved >> broadleaved only	176	23	213	51
tree-associated	shaded woodland floor	shadiness >> heavy shade	100	23	125	6
tree-associated	arboreal	conifer or broadleaved >> conifer only	30	23	171	1
wetland	running water	flow >> fast flow	22	23	100	
wetland	peatland	shallow freshwater pond >> aquatic: sparsely vegetated	15	23	100	
wetland	running water	seepages >> shaded seepage	15	23	160	3
open habitats	short sward & bare ground	soil type >> sand	108	22	181	24
wetland	marshland	shallow freshwater pond	85	22	113	2
wetland	marshland	wetland vegetation	34	22	127	3
tree-associated	shaded woodland floor	humidity >> dry	28	22	150	2
wetland	running water	unmodified fast flowing streams	44	21	126	5
open habitats	tall sward & scrub	dung & carrion	34	21	109	1
tree-associated	shaded woodland floor	conifer or broadleaved >> broadleaved only	217	20	126	12

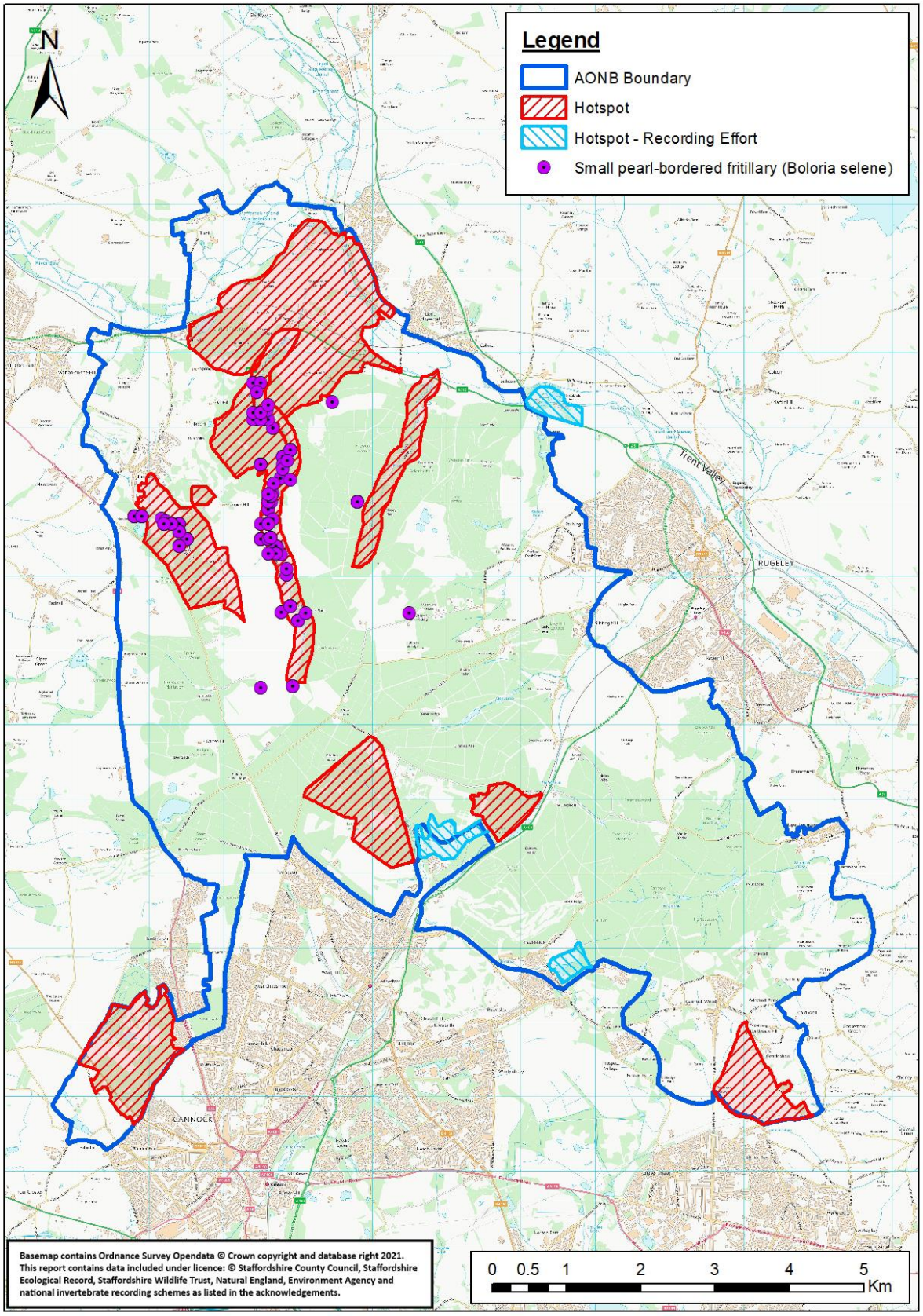
open habitats	short sward & bare ground	soil humidity >> dry	206	20	146	32
tree-associated	decaying wood	heartrot >> decaying wood	32	20	252	12
tree-associated	shaded woodland floor	woodland habitat >> woodland litter	61	19	135	4
tree-associated	shaded woodland floor	humidity >> damp	56	19	116	2
tree-associated	decaying wood	heartrot	47	19	235	17
wetland	marshland	drawdown zone: mud/shallow litter	61	18	114	2
wetland	running water	drawdown zone: mud/shallow litter	41	18	113	2
wetland	peatland	shallow freshwater pond	55	17	111	2
open habitats	short sward & bare ground	habitats >> litter & ground layer	39	17	143	5
wetland	peatland	wet/damp peat	41	16	167	4
wetland	peatland	shallow freshwater pond >> aquatic: well vegetated	36	16	117	2
wetland	running water	seepages	27	16	136	4
wetland	running water	flow >> slow flow	26	16	122	2
wetland	running water	seepages >> unshaded seepage	17	16	126	2
wetland	peatland	wetland vegetation	58	15	125	5
tree-associated	decaying wood	heartrot >> hollow tree cavities	19	15	263	8
tree-associated	decaying wood	conifer or broadleaved >> conifer only	18	15	118	2
wetland	marshland	shallow freshwater pond >> aquatic: sparsely vegetated	17	14	100	
wetland	peatland	deep litter	17	13	118	1

9.3 Appendix 3

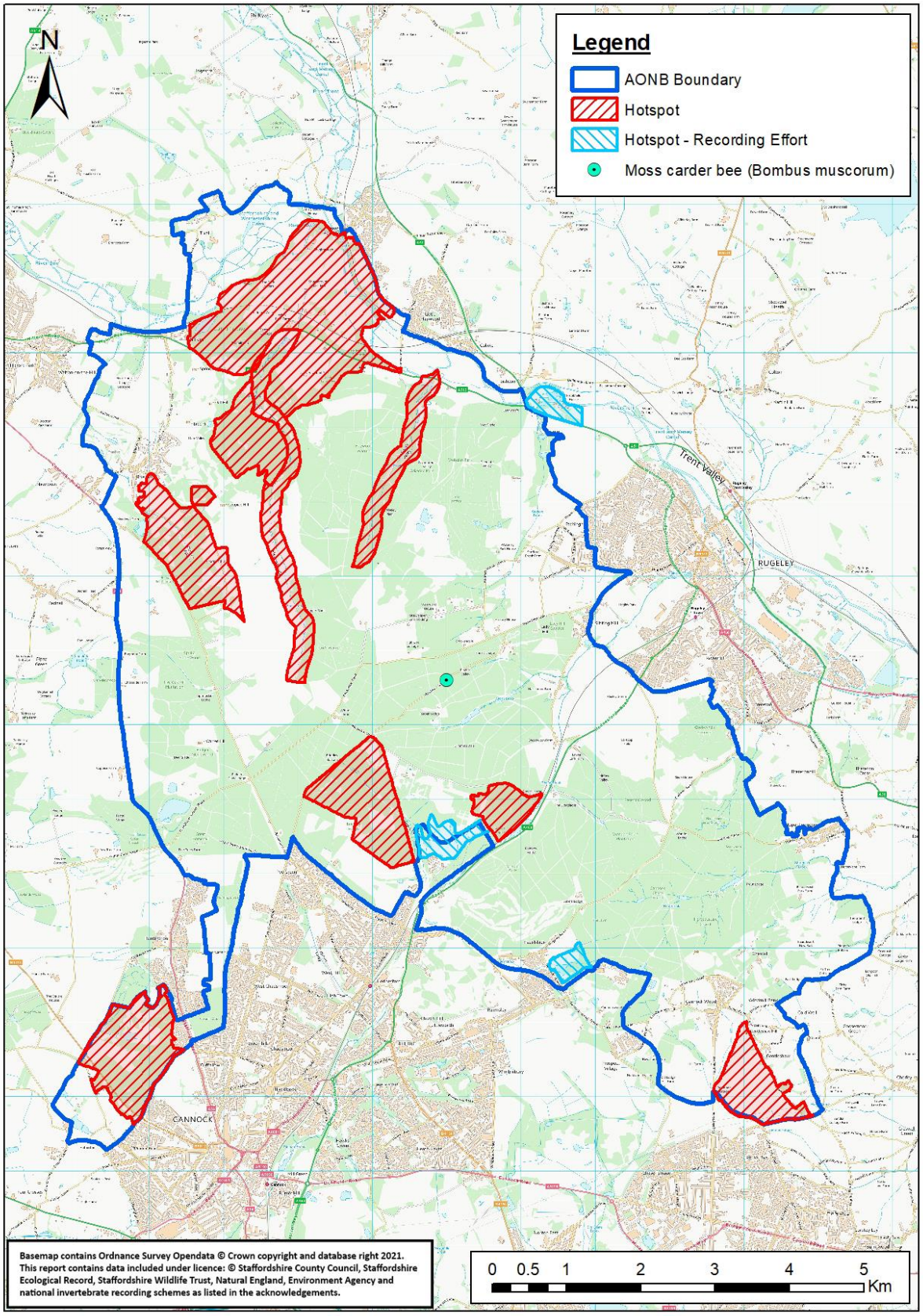
Maps of individual species of conservation concern with post-1995 records in the Cannock Chase AONB, including all species listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006, species with a Vulnerable or Endangered GB Threat status in a modern status review, and the Welsh clearwing due the national importance of the Cannock Chase population.



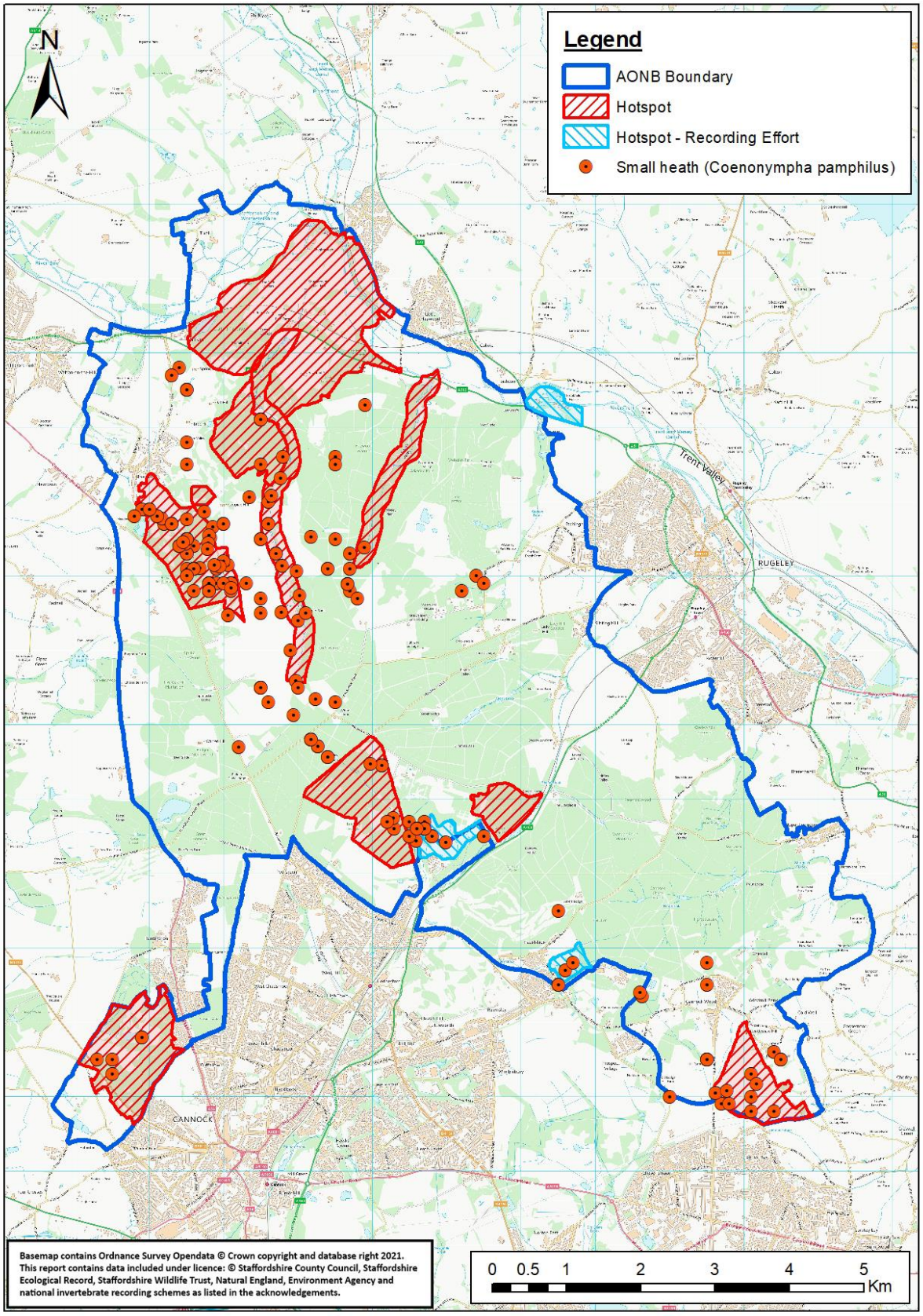
Map of post-1995 records for the Section 41 listed Red-horned cardinal click beetle (Ampedus rufipennis) in the Cannock Chase AONB



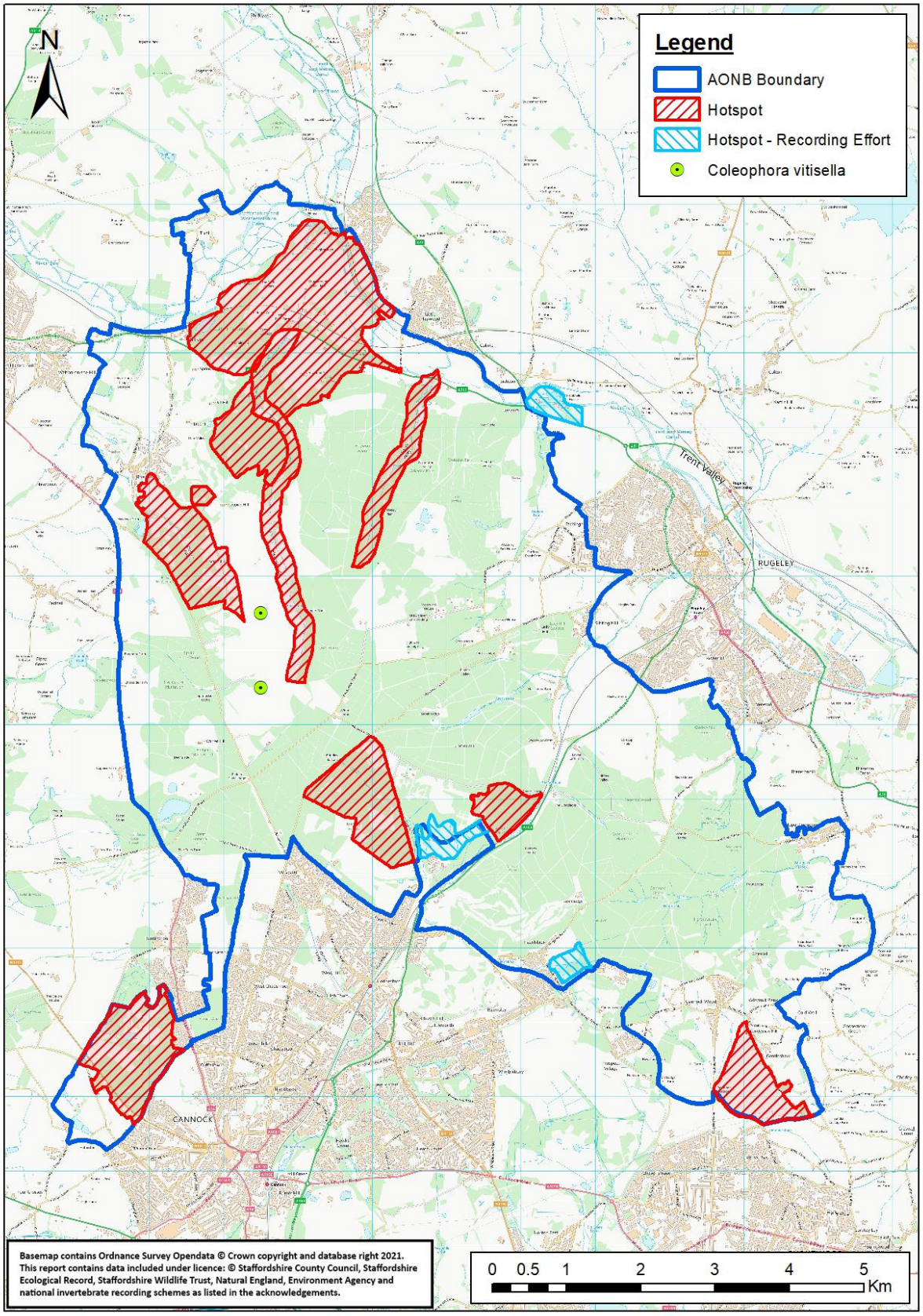
Map of post-1995 records for the Section 41 listed Small-pearl-bordered fritillary (Boloria selene) in the Cannock Chase AONB



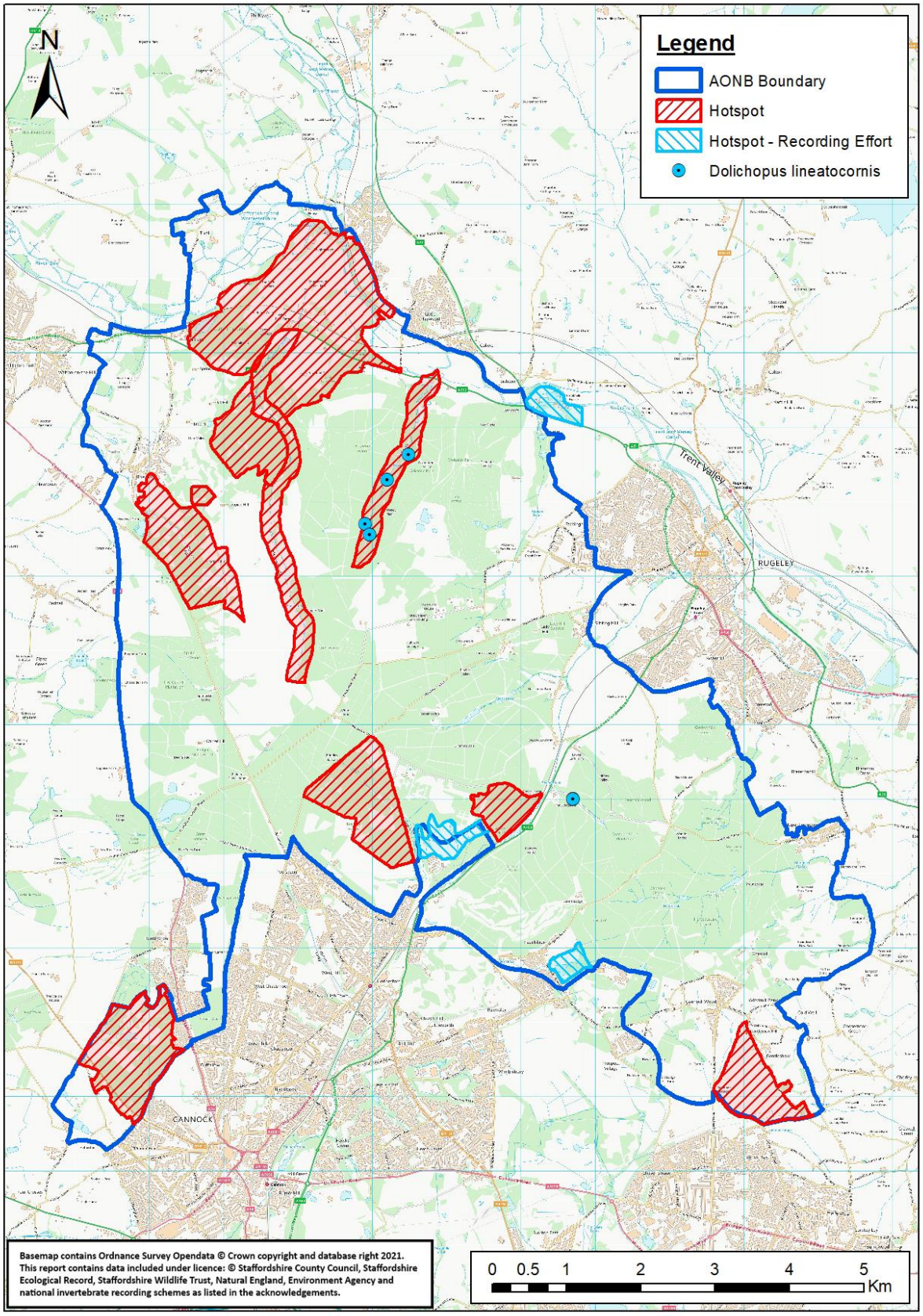
Map of post-1995 records for the Section 41 listed Moss carder bee (Bombus muscorum) in the Cannock Chase AONB



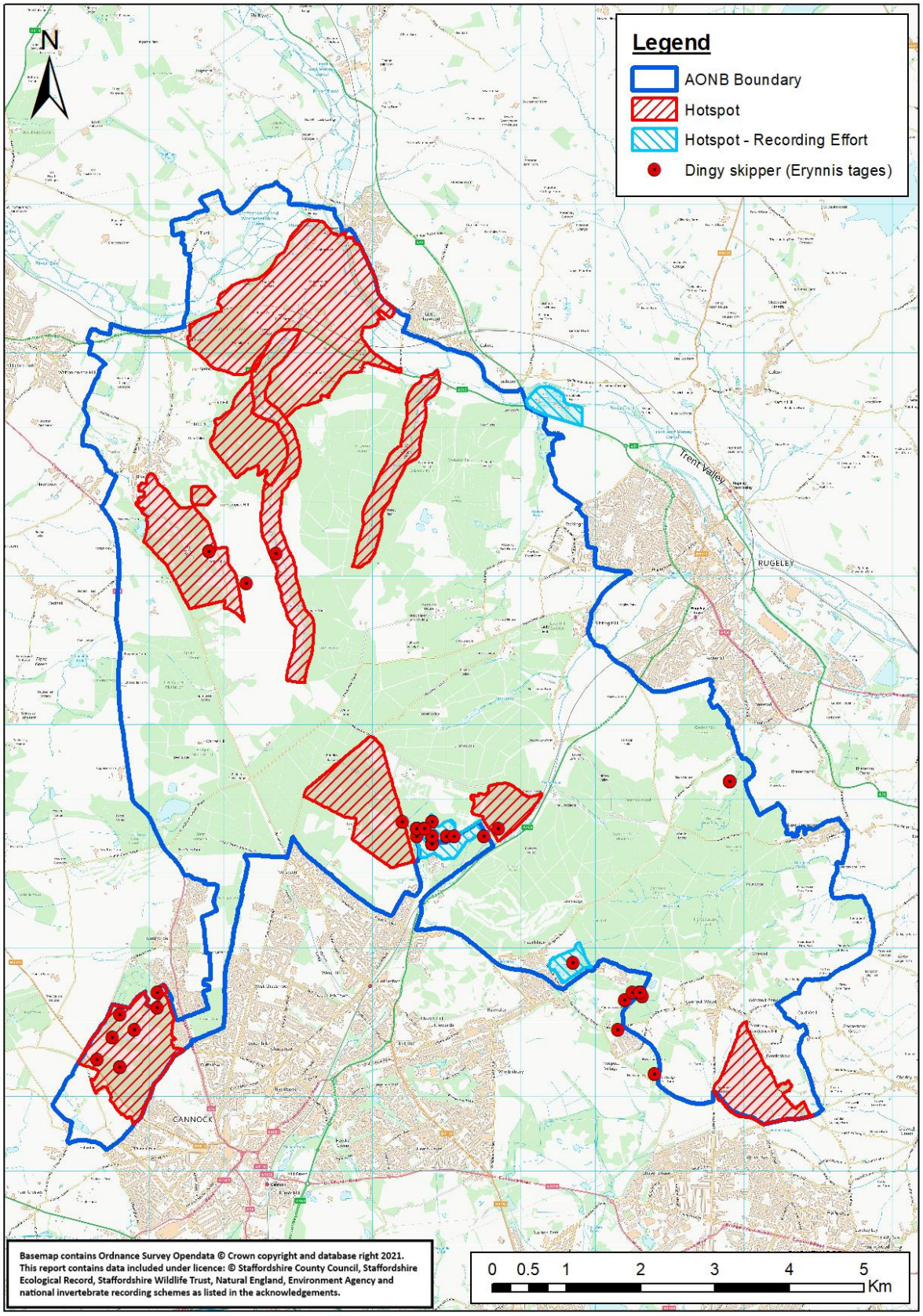
Map of post-1995 records for the Section 41 listed Small heath (Coenonympha pamphilus) in the Cannock Chase AONB



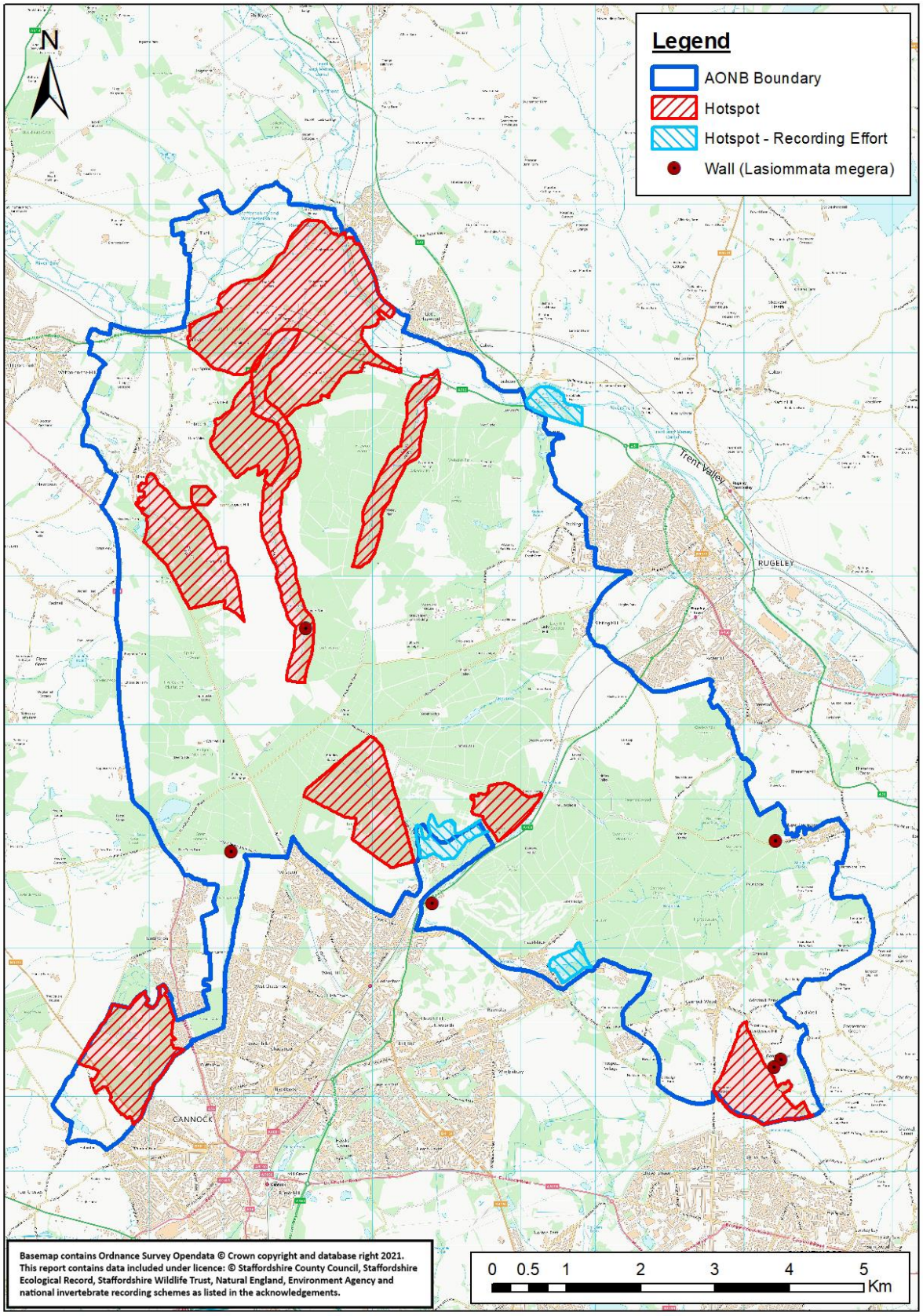
Map of post-1995 records for the Section 41 listed Northern case-bearer (Coleophora vitisella) in the Cannock Chase AONB



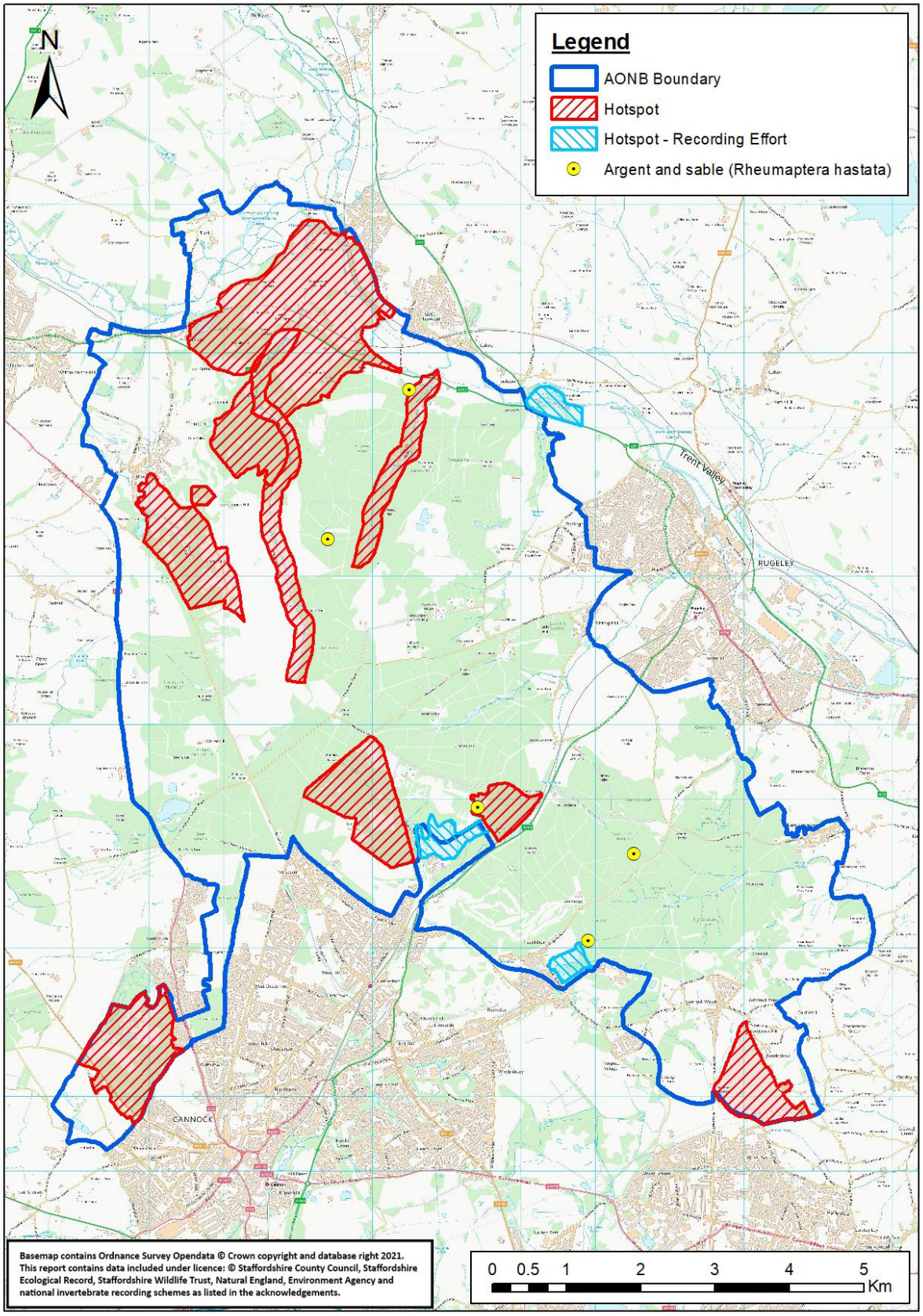
Map of post-1995 records for the Vulnerable long-legged fly Dolichopus lineatocornis in the Cannock Chase AONB



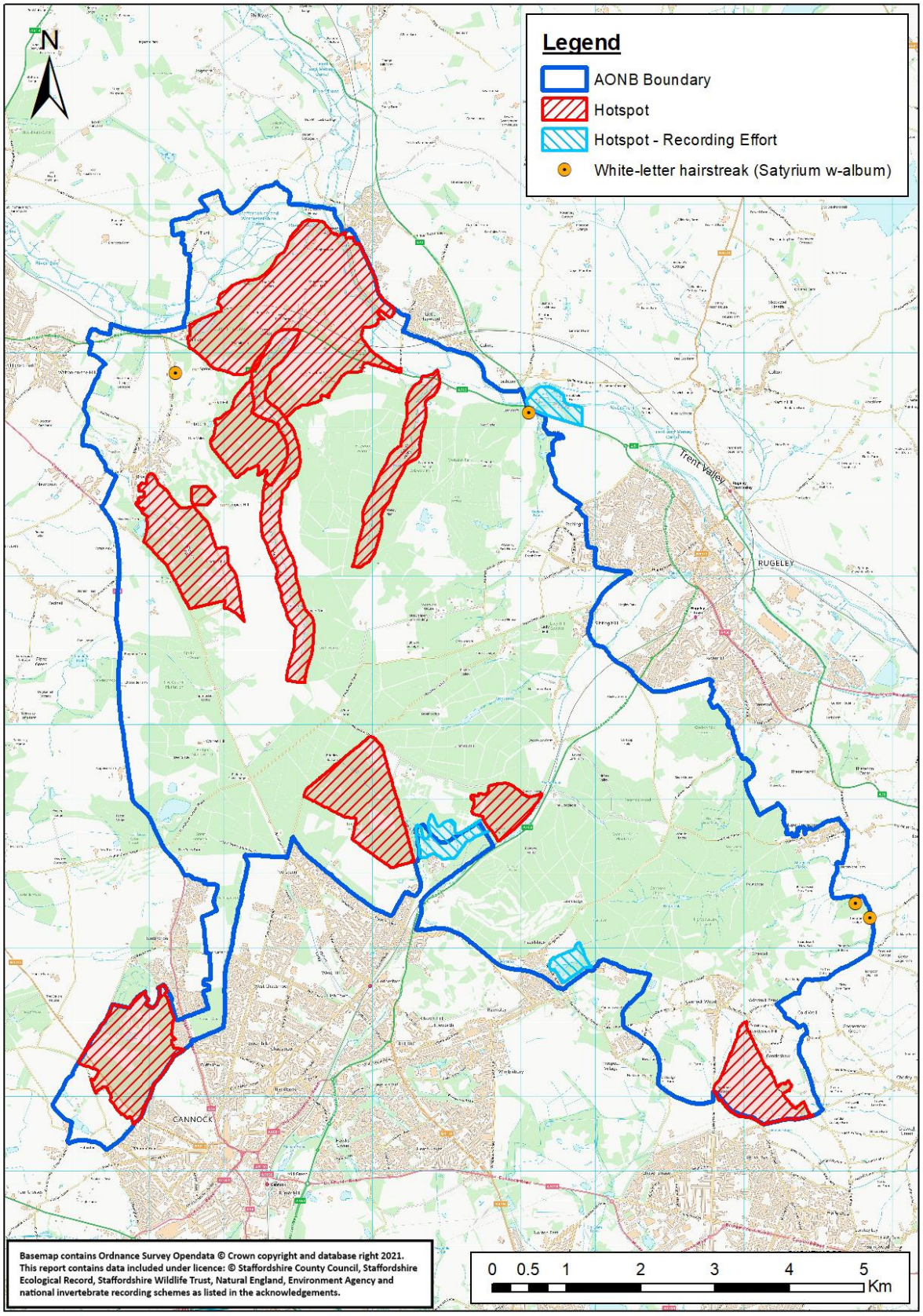
Map of post-1995 records for the Section 41 listed and Vulnerable Dingy skipper (Erynnis tages) in the Cannock Chase AONB



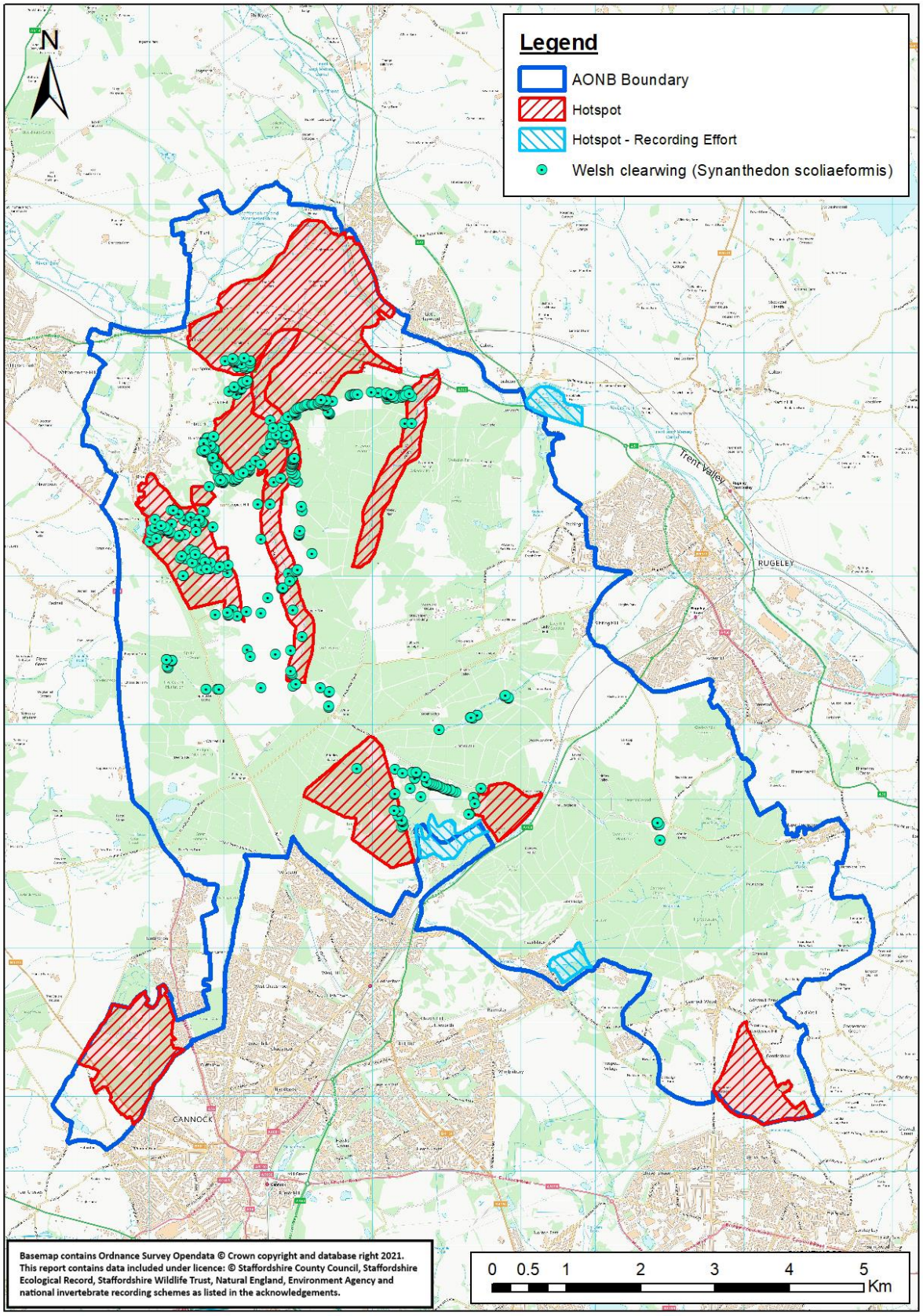
Map of post-1995 records for the Section 41 listed Wall butterfly (Lasiommata megera) in the Cannock Chase AONB



Map of post-1995 records for the Section 41 listed Argent and Sable (Rheumaptera hastata) in the Cannock Chase AONB



Map of post-1995 records for the Section 41 listed and Endangered White-letter hairstreak (Satyrium w-album) in the Cannock Chase AONB



Map of post-1995 records for the Welsh clearwing (Synanthedon scoliaeformis) in the Cannock Chase AONB

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