North Somerset and Mendip Bats Special Area of Conservation (SAC) Guidance on Development: Supplementary Planning Document

Adopted January 2018

(Photo: Frank Greenaway. Courtesy Vincent Wildlife Trust)

This supplementary planning document (SPD) was adopted by North Somerset Council on 9 January 2018.

The SPD contains guidance on development regarding impacts on the North Somerset and Mendip Bats Special Area of Conservation (SAC), one of four European sites (sites of international importance for wildlife) in North Somerset. It was designated because of its importance for Greater and Lesser Horseshoe Bats.

The guidance was jointly produced by the Council, Natural England and Somerset local authorities. In May 2017 the guidance, (just titled "North Somerset and Mendip Bats Special Area of Conservation (SAC) Guidance on Development"), was approved by Natural England in May 2017. The guidance, bearing the logos of Natural England, Somerset County Council, North Somerset Council, Sedgemoor District Council and Mendip District Council, was published on Somerset County Council's website.

Subsequent to that, North Somerset Council felt it would be beneficial for the guidance to be converted into a formal supplementary planning document (SPD) for North Somerset. The National Planning Policy Framework (glossary) indicates that "supplementary planning documents add further detail to the policies in the Local Plan. They can be used to provide further guidance for development on specific sites, or on particular issues, such as design. Supplementary planning documents are capable of being a material consideration in planning decisions but are not part of the development plan".

Therefore, as part of the process towards becoming an SPD for North Somerset, public consultation on a Draft SPD document, incorporating the guidance, was undertaken between 20 October and 2 December 2017. There was a large number of respondents, whose comments were carefully considered. As a result of the public consultation some changes to the document were proposed, and incorporated in the SPD when it was adopted by the Full Council.

North Somerset Council will now apply the guidance as an adopted SPD within the North Somerset area. It is possible that the Somerset local authorities may also seek to make the guidance into SPD for their areas, in due course.

North Somerset and Mendip Bats
Special Area of Conservation (SAC)

Guidance on Development

This guidance was prepared by Larry Burrows, Ecologist, Somerset Ecology Services, Planning Control, Somerset County Council working in partnership with North Somerset Council and Natural England

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Cover Photo: Frank Greenaway. Courtesy Vincent Wildlife Trust (http://www.vwt.org.uk/)

SOMERSET AND MENDIP BATS SPECIAL AREA OF CONSERVATION (SAC): GUIDANCE ON DEVELOPMENT

Contents

A. Non-technical Guidance
(includes a summary of the guidance and a flow chart to assist users)

B. Technical Guidance
1. Introduction
2. Sensitive Zones for Horseshoe Bats
(covers Juvenile Sustenance and Bat Consultation Zones)
3. Consultation and Surveys
4. Mitigation within the Consultation Zone

C. Annexes
Annex 1: Details on the North Somerset and Mendip Bats SAC
Annex 2: Bat Consultation Zones
Annex 3: Survey Specifications
Annex 4: Habitat Requirements of Greater and Lesser Horseshoe bats
Annex 5: Methodology for Calculating the Amount of Replacement Habitat Required
Annex 6: Habitat Creation Prescriptions
Annex 7: Application of Habitats Regulations

D. Appendices
Appendix 1: Comparison of home ranges of Horseshoe Bats derived from radio-tracking studies
Appendix 2: Greater Horseshoe Bat Habitat Suitability Index
Appendix 3: Lesser Horseshoe Bat Habitat Suitability Index
Appendix 4: Risk factors for restoring or recreating different habitats
Appendix 5: Feasibility and timescales of restoring: examples from Europe
Appendix 6: Example of HEP calculation
Appendix 7: "Favourable Conservation Status" and Lesser Horseshoe Bats

PART A

Non-technical guidance

1. Who is the guidance aimed at and why?

1.1 This advice is aimed at developers, consultants, and planners involved in planning and assessing development proposals in the landscapes surrounding the North Somerset and Mendip Bats SAC.

1.2 The overall aim is for a clearer approach to considering impacts of development on the SAC. The guidance provides a consistent basis for understanding how rare horseshoe bats use the landscape and where there is likely to be greater risk or opportunity for development. This will help inform strategic planning for the area's future housing needs.

1.3 The guidance will comprise a component of the development management process, to be considered in line with relevant policies, such as policy DM8 (Nature Conservation) of the adopted Development Management Policies of the North Somerset Local Plan; Policy D15 (Bat Consultation Zone) of the Revised Sedgemoor District Council Local Plan; Policy DP6 (Bat Protection Zone) of the Mendip District Council Local Plan; Policy DM2: Biodiversity and geodiversity of the Somerset County Council Minerals Plan; and Policy DM3: Impacts on the environment and local communities of the Somerset County Council Waste Core Strategy

1.4 At project level the guidance will help identify key issues at pre-application stage that can inform the location and sensitive design of development proposals and minimise delays and uncertainty. Within the areas identified, there will be clear requirements for survey information and a strong emphasis on retaining and enhancing key habitat for bats and effective mitigation where required. This will demonstrate that development proposals avoid harm to the designated bat populations and support them where possible.

1.5 The guidance explains how development activities can impact the SAC and the steps required to avoid or mitigate any impacts. It applies to development proposals that could affect the SAC and trigger the requirements of the Habitats Regulations (see Annex 7).The local planning authority will consider, on the basis of evidence available, whether proposals (planning applications) are likely to impact on horseshoe bats and hence require screening for Habitats Regulations Assessment (HRA). Those are the proposals to which the guidance will be applied. This will reduce the likelihood that it would be applied to minor developments which would not have an impact on the SAC.

1.6 The guidance brings together best practice and learning from areas with similar approaches, such as Somerset County Council and South Hams, and the best scientific information available at the time of writing. It will be kept under review by North Somerset Council and Somerset County Council and their partners and is fully endorsed by Natural England. The planning guidance is part of a wider approach that is being pursued by partner organisations to safeguard and improve habitat for rare bats that includes farm management. The guidance is also consistent with Natural England's Site Improvement Plan for the SAC.

2. What is the Bats SAC?

2.1 Special Areas of Conservation (SAC) are European sites of international importance for wildlife. The Bat SAC is important for two bat species, Greater and Lesser Horseshoe bats. The SAC itself comprises component SSSIs which in North Somerset include, for example, the two maternity roosts at the Brockley Hall Stables SSSI and King's Wood SSSI, and also hibernation roosts like the Banwell Bone Caves and, in Somerset, the maternity and hibernation roosts in the Cheddar Complex SSSI and the hibernation roosts at Wookey Hole SSSI.

2.2 However the landscapes around the SAC itself are also important in providing foraging habitat needed to maintain the favourable conservation status of the horseshoe bats. Therefore the guidance sets out strong requirements for consultation, survey information and appropriate mitigation, to demonstrate that development proposals will not adversely impact on the designated bat populations.

3. Juvenile Sustenance Zones

3.1 The guidance identifies the Juvenile Sustenance Zones of 1 kilometre (km) around the maternity roosts.

3.2 New build development on green field sites should be avoided in the Juvenile Sustenance Zones (JSZs) in view of their sensitivity and importance as suitable habitat as foraging areas for young bats, being within 1km of maternity roosts for Greater Horseshoe bats and 600 metres for Lesser Horseshoe bats.

4. Bat Consultation Zone

4.1 The guidance also identifies the "Bat Consultation Zone" where horseshoe bats may be found, divided into bands A, B and C, reflecting the likely importance of the habitat for the bats and proximity to maternity and other roosts.

4.2 Within the Consultation Zone development is likely to be subject to particular requirements, depending on the sensitivity of the site.

5. Need for early consultation

5.1 Section 3 of Part B of the guidance stresses the need for pre-application consultation for development proposals.

5.2 Within bands A or B of the Consultation Zone, proposals with the potential to affect features important to bats (identified in Section B paragraph 3.2 below) should be discussed with the local authority and/or Natural England as necessary.

5.3 Within band C developers should take advice from their consultant ecologist.

6. Survey requirements

6.1 Section 3 of Part B and Annex 3 of the guidance sets out the survey requirements normally applying to development proposals within the Bat Consultation Zone. Outside the Bat Consultation Zone development proposals may still have impacts on bats, and developers should have regard to best practice guidelines, such as Bat Conservation Trust survey guidelines and Natural England's Standing Advice for Bats. North Somerset Council has also produced a Bat Survey Requirements leaflet.

6.2 For proposals within the Consultation Zone (all Bands), developers must employ a consultant ecologist at an early stage to identify and assess any impacts.

6.3 For proposals within bands A and B of the Bat Consultation Zone, full season surveys will be needed (unless minor impacts can be demonstrated), and must include automated bat detector surveys. Survey results are crucial for understanding how bats use the site, and therefore how impacts on horseshoe bats can be avoided, minimised or mitigated. Where mitigation is needed the survey results will inform the metric for calculating the amount of habitat needed (see Annex 5).

6.4 Within band C survey effort required will depend on whether a commuting structure is present and the suitability of the adjacent habitat to support prey species hunted by horseshoe bats.

7. Proposed developments with minor impacts

7.1 In some circumstances a developer may be able to clearly demonstrate (from their qualified ecologist's site visit and report) that the impacts of a proposed development are proven to be minor and can be avoided or mitigated (or do not require mitigation) without an impact on SAC bat habitat, so a full season's survey is not needed. This should be substantiated in a suitably robust statement submitted as part of the development proposals.

8. Need for mitigation, possibly including provision of replacement habitat

8.1 Within the Bat Consultation Zone (all Bands), where SAC bats could be adversely affected by development appropriate mitigation will be required.

8.2 Development proposals should seek to retain and enhance existing habitats and / or features of value to bats such as those listed in paragraph 3.2 of Part B in this guidance. Where this is not, or is only partially possible appropriate mitigation such as the provision of replacement habitat will be required. The council's ecologist will have regard to relevant considerations in determining the mitigation requirements, including survey results and calculations relating to quantity of replacement habitat. Annex 5 sets out the methodology and metric for calculating how much replacement habitat should be provided[1].

8.3 Any replacement habitat must be accessible to the horseshoe bat population affected.

8.4 Where the replacement provision is to be made on land off-site (outside the red line development boundary for the planning application) any existing value of that land as bat habitat will also have to be factored in to the calculation.

8.5 Where the replacement provision is to be off site, and land in a different ownership is involved, legal agreements are likely to be needed to ensure that the mitigation is secured in perpetuity.

8.6 An Ecological Management Plan for the site must be provided setting out how the site will be managed for SAC bats in perpetuity.

8.7 Where appropriate a Monitoring Strategy must also be provided to ensure continued use of the site by SAC bats, and include measures to rectify the situation if negative results occur.

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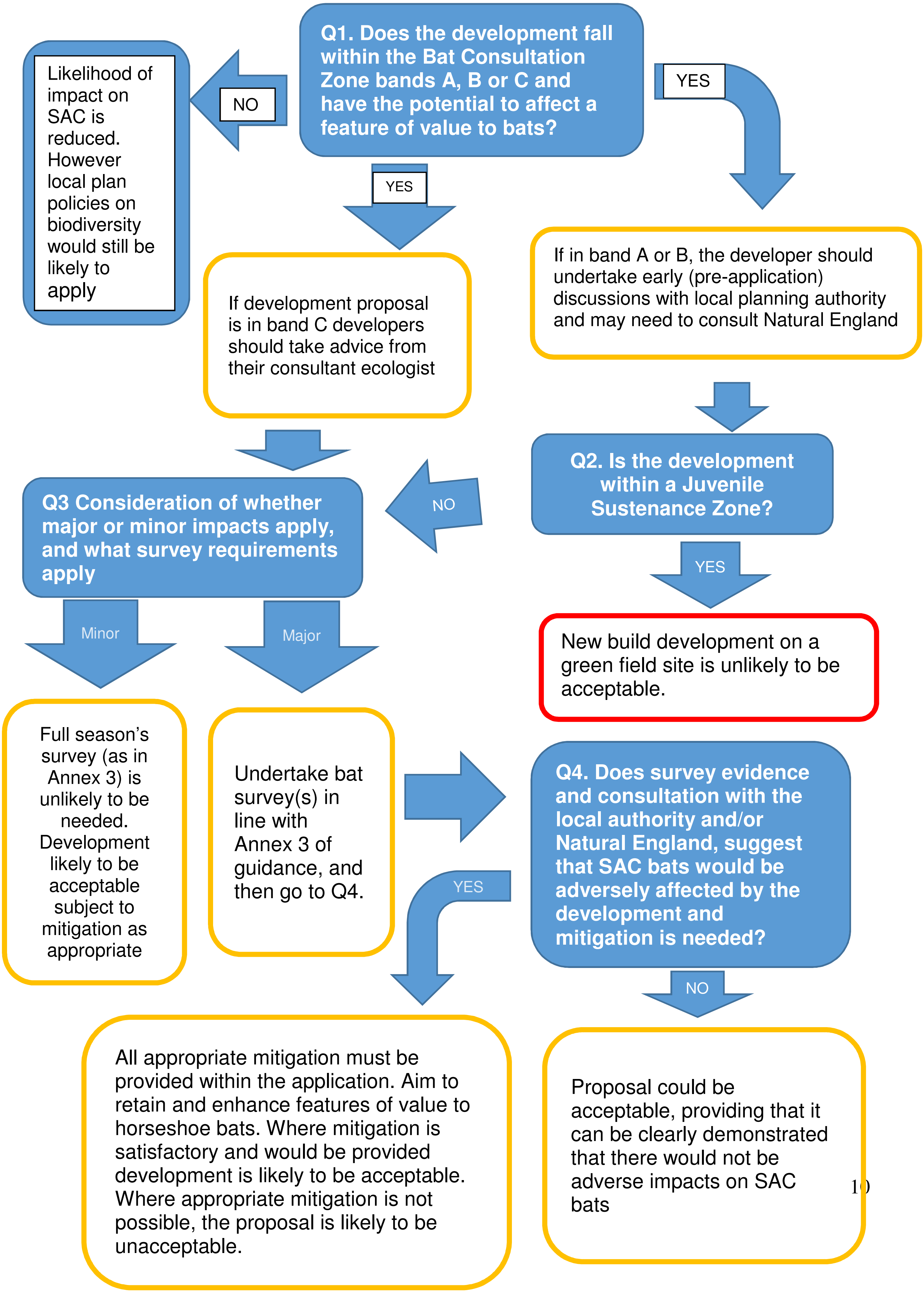
[1] In the Somerset County area developers may ask the Local Planning Authority to carry out the calculation for the amount of habitat required to replace the value of that lost to horseshoe bats prior to the application being submitted, to check that the proposed master plan for the site has adequate land dedicated to the purpose. A charge may be levied for this service.


Q1. Does the development fall within the Bat Consultation Zone bands A, B or C and have the potential to affect a feature of value to bats?
NO
Likelihood of impact on SAC is reduced. However local plan policies on biodiversity would still be likely to apply
YES
If development proposal is in band C developers should take advice from their consultant ecologist
YES
If in band A or B, the developer should undertake early (pre-application) discussions with local planning authority and may need to consult Natural England
Q2. Is the development within a Juvenile Sustenance Zone?
NO
YES
New build development on a green field site is unlikely to be acceptable.
Q3 Consideration of whether major or minor impacts apply, and what survey requirements apply
Minor
Major
Full season's survey (as in Annex 3) is unlikely to be needed. Development likely to be acceptable subject to mitigation as appropriate
Undertake bat survey(s) in line with Annex 3 of guidance, and then go to Q4.
Q4. Does survey evidence and consultation with the local authority and/or Natural England, suggest that SAC bats would be adversely affected by the development and mitigation is needed?
YES
All appropriate mitigation must be provided within the application. Aim to retain and enhance features of value to horseshoe bats. Where mitigation is satisfactory and would be provided development is likely to be acceptable. Where appropriate mitigation is not possible, the proposal is likely to be unacceptable.
NO
Proposal could be acceptable, providing that it can be clearly demonstrated that there would not be adverse impacts on SAC bats

PART B

Technical Guidance

1. Introduction

1.1 The North Somerset and Mendip Bats SAC is designated under the Habitats Directive 92/43/EEC, which is transposed into UK law under the Conservation of Habitats and Species Regulations 2010 (as amended) ('Habitat Regulations). This means that the populations of bats supported by this site are of international importance and therefore afforded high levels of protection, placing significant legal duties on decision-makers to prevent damage to bat roosts, feeding areas and the routes used by bats to travel between these locations.

1.2 The primary reason for designation of the bat SAC are two Annex II species:

- the Greater Horseshoe bat *Rhinolophus ferrumequinum;* and
- the Lesser Horseshoe bats *Rhinolophus hipposideros*

1.3 References in this document to 'SAC bats' refers to <u>both bat species</u> protected by the SAC designation. Where a distinction needs to be made between different requirements for different species, the particular species will be referred to. Greater Horseshoe bats are taken to be the most sensitive species therefore the 'Precautionary Principle' dictates that if their requirements are met, then the other SAC bat species are also likely to be protected. For more detail on the SAC see Annex 1.

1.4 The Conservation Objectives for the SAC[2] are: With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' which include the bat species listed above), and subject to natural change, ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and,
- The distribution of qualifying species within the site.

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[2] http://publications.naturalengland.org.uk/publication/6252034999189504

1.5 Therefore, planners and prospective developers need to be aware that the habitats and features which support the populations of SAC bats outside the designated site are a material consideration in ensuring the integrity of the designated site.

1.6 The purpose of this advice is not to duplicate or override existing legal requirements for protected bat species or their roosts. These aspects are well governed by the Natural England licensing procedures (Wildlife Management and Licensing Unit) for protected species.

1.7 This document should serve as an evidence base and provide guidance on the planning implications for development control in the relevant local planning authority (LPA). There are opportunities beyond the scope of this document to use this evidence base to inform the preparation of land use plans through the local plans. This document should be read in conjunction with the Bath and Bradford-on-Avon SAC Technical Advice. This Guidance for the North Somerset and Mendip Bats SAC should be considered to cover the Mendip Limestone Grasslands SAC which is cited for its Greater Horseshoe bat hibernation roosts. A Technical Guidance note will also be produced specifically for the Mendip District Council area and in addition include the Mells Valley SAC, which is also designated for Greater Horseshoe bats.

1.8 This advice is aimed at applicants, agents, consultants and planners involved in producing and assessing development proposals in the landscapes surrounding the SAC. Within these areas there will be a strong requirement for survey information and mitigation for bats and their habitat in order to demonstrate that development proposals will not impact on the designated bat populations.

1.9 The guidance explains how development activities can impact the SAC and the steps required to avoid or mitigate any impacts. It applies to development proposals that could affect the SAC and trigger the requirements of the Habitats Regulations (see Annex 7).The local planning authority will consider, on the basis of evidence available, whether proposals (planning applications) are likely to impact on horseshoe bats and hence require screening for Habitats Regulations Assessment (HRA). Those are the proposals to which the guidance will be applied. This will reduce the likelihood that it would be applied to minor developments which would not have an impact on the SAC.

1.10 An important objective of the advice is to identify areas in which development proposals might impact on the designated populations at an early stage of the planning process, in order to inform sensitive siting and design, and to avoid unnecessary delays to project plans by raising potential issues at the outset.

1.11 This technical guidance is based on the advice from experts and ecological consultants[3], current best practice and the best scientific information available at the time of writing. It will be kept under review by North Somerset Council, Somerset County Council and Natural England.

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[3] See acknowledgements

2. Sensitive Zones for Horseshoe Bats

Introduction

2.1 To facilitate decision making and in order to provide key information for potential developers at an early stage, using the best available data a Bat Consultation Zone affecting North Somerset, Sedgemoor and Mendip districts, and Juvenile Sustenance Zones affecting North Somerset and the Cheddar area (See Plans 1 to 4 below) have been identified. This is based on an accumulation of known data, beginning with the 1999 and 2001 Radio Tracking Studies of Greater Horseshoe bat maternity roosts.[4] The data is constantly being added to and updated. Therefore the Plans reflect the current understanding of key roosts and habitat associated with the SAC.

Bat Consultation Zone (orange, yellow and pale yellow shading on Plans 1 and 2 below)

2.2 The Bat Consultation Zone illustrates the geographic area where horseshoe bats may be found. It is divided into three bands, A, B and C, reflecting the density at which horseshoe species may be found at a distance from a roost site. The basis for these distances is set out in Annex 2 and is based on the distances recorded through radio tracking studies at Brockley Hall Stables and Cheddar Caves and research into densities of occurrence throughout the species range. Note that the radio tracking studies only recorded the movements of a small number of bats from each of the maternity roosts and therefore it is likely that any area within the Bat Consultation Zone could be exploited by horseshoe bats. Although it is recognised that Greater Horseshoe bats mostly forage within 2.2km of a maternity roost, i.e. within Band A, they can also make regular use of key foraging habitat within 4km, i.e. within Band B. Furthermore some key areas in Band C can be up to 8km away.[5] The zoning band widths are set out in Table 1 below and in Annex 2.

Table 1: Band Widths for Horseshoe Bats

Band	Greater Horseshoe bat (metres)		Lesser Horseshoe bat (metres)	
	Maternity Roost	Other Roost	Maternity Roost	Other Roost
A	0 – 2200		0 - 600	
B	2201 - 4000	0 - 610	601 - 2500	0 - 300
C	4001 - 8000	611 – 2440	2501 - 4100	301 - 1250

2.3 The banding within the Bat Consultation Zone is centred on the maternity roosts at Brockley Stables, Kings Wood and in Cheddar Gorge. In North Somerset this Zone includes the urban areas of Nailsea, Congresbury, Yatton and Cheddar. Smaller bands are formed around hibernation and subsidiary roosts and these may occur within the bands formed from the maternity roosts

2.4 Band A is shown in orange shading; Band B in yellow; and Band C in pale yellow reflecting the decreasing density at which Greater and Lesser Horseshoe bats are likely to occur away from the home roost.

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[4] Billington, G. 2001. *Radio tracking study of Greater Horseshoe bats at Brockley Hall Stables Site of Special Scientific Interest, May – August 2001.*English Nature Research Report No. 442. Peterborough: English Nature; Jones, G. & Billington, G. 1999. *Radio tracking study of Greater Horseshoe bats at Cheddar, North Somerset.* Taunton: English Nature.

[5] BCT Bat Survey Guidelines and see footnote 10 above. Also Geoff Billington pers comm. 16/09/2016

2.5 Note that not all Lesser Horseshoe bat hibernation roosts lie within the SAC's designated boundaries (See Plan's 5 and 6). It is estimated that these roosts support about 15% of the known summer populations in the geographic area covered by North Somerset and north west Somerset but the proportion of the population is likely to be less if unknown maternity roosts, male bats and bats migrating from a wider area are included. Inclusion within a Habitats Regulations Assessment should be considered on a case by case basis. Nonetheless, local populations, taken to be maternity colony, are subject to assessment for 'Favourable Conservation Status' (see Appendix 7) for impacts from proposed developments prior to permission being given.

Lesser Horseshoe Bats: Mother and Pup (Photo: Frank Greenaway. Courtesy Vincent Wildlife Trust)

Juvenile Sustenance Zones (red and pink shading on Plans 3 and 4 below)

2.6 Juvenile Sustenance Zones within Band A are formed around maternity roosts to a distance of 1 kilometre (km) for Greater Horseshoe bats, to include whole fields that fall within that zone which have been under appropriate management, and to a distance of 600 metres for Lesser Horseshoe bats.

2.7 Juvenile Greater Horseshoe bats are highly dependent on prey produced by cattle grazed pasture within this zone.[6] It is highly unlikely that this can be replaced within development proposals. Bontadina et al (2002)[7] recommended that a radius of 600 metres around a Lesser Horseshoe bat maternity roost should have special consideration. These areas are particularly sensitive and new build development on green field sites should be avoided in these zones.

3. Consultation and Surveys

3.1 For development proposals within the Juvenile Sustenance Zone it is essential that Natural England and the appropriate planning authority are consulted at an early stage of the process, as it is unlikely that new build development on green field sites could be made acceptable, due to the critical nature of the area in supporting the population of a maternity roost.

3.2 Where a proposal within Bands A or B of the Consultation Zone has the potential to affect the features identified below, early discussions with the local planning authority (who will consult Natural England as necessary) are also essential.

- Known bat roost
- On or adjacent to a Site of Special Scientific Interest (SSSI)
- Linear features: hedgerows, tree lines, watercourses, stone walls, railway cuttings
- Pasture, hay meadow, stream line, woodland, parkland, woodland edge
- Wetland habitat: ponds, marsh, reedbed, rivers, streams, rhynes
- Buildings or bridges, especially if these are not used or are undisturbed and particularly if there is a large void with potential access
- Cellars, mines, ice houses, tunnels or other structures with voids which produce tunnel-like conditions
- Development which introduces new lighting
- New wind turbine proposals (in respect of displacement)[8]

3.3 Early discussion refers to pre application stage prior to submission of a planning application; and, essentially, *before* any Master Plan proposals are submitted or finalised. This will ensure that adequate survey data is obtained. Please note that early discussions will also help inform likely mitigation requirements, and ensure, for example, that proposals seek to retain and enhance key features and habitats, and that sufficient land can be allocated for such avoidance and/or mitigation measures as may be required. This should result in appropriate bespoke mitigation measures that are designed in at an appropriately early stage. A site lighting plan with existing (pre-development) night time lux levels should also be provided.

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[6] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*: *English Nature Research Reports Number 174.* Peterborough: English Nature.

[7] Bontadina, F., Schofield, H. & Naef-Daenzer, B. 2002. Radio-tracking reveals that Lesser Horseshoe bats (Rhinolophus hipposideros) forage in woodland. *J. Zool. Lond. (2002) 258, 281-290.*

[8] Horseshoe bat casualties are very rare with only one Greater Horseshoe being recorded in Europe over the ten year period 2003 to 2013. (Eurobats. 2014. *Report of the Intercessional Working Group on Wind Turbines and Bat Populations*. EUROBATS.StC9-AC19.12)

3.4 In Band C developers should take advice from their consultant ecologist and planners from their ecologist colleagues.

3.5 Failure to provide the necessary information in support of an application is likely to lead to delays in registration and determination, and the application may need to be withdrawn. If insufficient information is submitted to allow the local planning authority to assess the application in accordance with the Habitats Regulations, the application is likely to be considered unacceptable.

3.6 For proposals within the Bat Consultation Zone (all Bands), an ecological consultant[9] should be commissioned at an early stage to identify and assess any impacts the proposals may have.

3.7 Surveys should determine the use of the site by horseshoe bats, whether the site is being used as a commuting route or contains hunting territories or both. Survey results inform the metric for calculating the amount of replacement habitat required in the methodology set out in Annex 5. Consideration should be given to the site within the wider landscape.

3.8 Surveys should be carried out in accordance with the Survey Specification at Annex 3. Exact survey requirements will reflect the sensitivity of the site, and the nature and scale of the proposals. The ecological consultant will advise on detailed requirements following a preliminary site assessment and desk study.

3.9 It is essential to note that bat surveys are seasonally constrained. For proposals which have the potential to impact on the SAC, a full season (April to October inclusive) will be required, but this may not be necessary in certain circumstances, where this is demonstrable to the council's ecologist. (See Section B paragraphs 4.17 to 4.18 on minor impacts.) Winter surveys may be required for those developments in proximity to hibernation roosts. This will need to be included in the plan for project delivery at an early stage to avoid a potential 12-month delay to allow appropriate surveys to be undertaken.

3.10 Outside the Bat Consultation Zone, development proposals may still have impacts on bats. All species of bat and their roosts are protected by the Wildlife and Countryside Act (1981, as amended) and the Habitats Regulations. Further advice on potential impacts to bats is contained in Natural England's Standing Advice for Development Impacts on Bats, English Nature's Bat Mitigation Guidelines (2004) and the Bat Conservation Trust Bat Survey Guidelines for Professionals (2016).[10] North Somerset Council has also produced a Bat Survey Requirements leaflet.

[9] Consultants should be members of CIEEM www.cieem.net or taken from the Environmental Consultants Directory www.endsdirectory.com

[10] http://www.naturalengland.org.uk/ourwork/planningdevelopment/spatialplanning/standingadvice/default.aspx ; Collins, J. (ed). 2016. *Bat Survey Guidelines for Professional Ecologists: Good Practice Guidelines*. (3rd Edition). London: Bat Conservation Trust; Mitchell-Jones, A. J. 2004. *Bat Mitigation Guidelines*. Peterborough: English Nature.[As updated]

4. Mitigation within the Consultation Zone

4.1 Within the Bat Consultation Zone, where SAC bats would be affected or potentially affected by development appropriate mitigation will be required. The aim should be to retain and enhance habitat and features of value to horseshoe bats, such as those listed in paragraph 3.2 of Part B of this guidance. Where this is not possible replacement habitat may be needed. The council's ecologist will have regard to relevant considerations in determining the mitigation requirements, including survey results and calculations relating to replacement habitat. (See the methodology and metric in Annex 5.) The developer's ecologist should carry out the calculations when requested by the council's ecologist. Replacement habitat should always aim to be the optimal for the species affected.

4.2 The following are examples of habitats to which the above principles will apply:

- Hunting habitat such as grazed pasture, hedgerows, woodland edges, tree lines, hay meadows.
- Connecting habitat, which is important to ensure continued functionality of commuting habitats. (Proposals should seek to retain existing linear commuting features as replacement of hedgerows is likely to require a significant period to establish).

4.3 The following are also important principles:

- Seek to maintain the quality of all semi-natural habitats and design the development around enhancing existing habitats to replace the value of that lost making sure that they remain accessible to the affected bats
- Maintain bat roosts in situ and maintain or replace night roosts, and consider enhancing provision of night roosting features. Night roosts are important for resting, feeding and grooming, particularly those located at distance from the main roost

4.4 Loss of habitat refers not only to physical removal but also from the effects of lighting. A development proposal will be expected to demonstrate that bats will not be prevented from using features by the introduction of new lighting or a change in lighting levels. Reference to specific lux levels will be expected. Lighting refers to both external and internal light sources. Applicants will be expected to demonstrate that considerations of site design, including building orientation; and the latest techniques in lighting design have been employed in order to, ideally, avoid light spill to retained bat habitats. Applicants will similarly be expected to demonstrate use of the latest techniques to avoid or reduce light spill from within buildings.

4.5 Where replacement habitat provision is necessary, the type(s) of habitat to be provided shall be agreed with the local authority's ecologist and/or Natural England as appropriate.

4.6 Where replacement habitat is required off site in mitigation the land should not be a designated Site of Special Scientific Interest, be contributing already to supporting conservation features or in countryside stewardship to enhance for bats.

4.7 Replacement habitat should aim to be the optimal for the species affected (See Annex 6). The following are examples of habitats of value to horseshoe bats and which may be created or enhanced as the replacement provision. Planting will be expected to consist of native species that produce an abundance of invertebrates, particularly moth species.

- Hedgerows with trees – tall, bushy hedgerows at least 3 metres wide and 3 metres tall managed so that there are perching opportunities
- Wildflower meadow - managed for moths, e.g. Long swards[11]
- Grazed pasture (essential for juveniles) – difficult to impossible to recreate on site and only feasible with management agreements with local landowners over and above existing regimes. Even so there may be issues which prevent grazing in the future[12]
- Ponds - for drinking and a prey source for Lesser Horseshoe bats
- Woodland / copses
- Provision of night roosting opportunities on site

4.8 The method for checking the adequacy of replacement habitat provided with an application or then in Master Planning of a proposed development, is given in Annex 5.

4.9 It is important that provision of the replacement habitat is carried out to timescales to be agreed by the local authority and/or Natural England as appropriate.

4.10 In the case of quarries, waste sites or other large scale sites where restoration is proposed this should not be considered as mitigation for habitat lost to horseshoe bats. The timescale to when these restorations are likely to be implemented, i.e. 40 years after the quarry has been worked, is too long to provide any replacement to maintain the existing population at the time of impact.

4.11 **It is vital that any replacement habitat is accessible to the horseshoe bat population affected.**

4.12 An Ecological Management Plan for the site must be provided setting out how the site will be managed for SAC bats for the duration of the development. Where appropriate a Monitoring Strategy also needs to be included in order to ensure continued use of the site by SAC bats and includes measures to rectify the situation if negative results occur.

Lighting

4.13 Horseshoe bats are known to be a very light sensitive species, and are linked to linear habitat features. Recent research suggests that preferred commuting routes for Lesser

[11] The main species of moth species eaten by Greater Horseshoe bats are Large Yellow Underwing; Small Yellow Underwing; Heart and Dart; and Dark Arches at Woodchester.(Jones, G., Barlow, K., Ransome, R. & Gilmour, L. 2015. *Greater Horseshoe bats and their insect prey: the impact and importance of climate change and agri-environment schemes*. Bristol: University of Bristol) See Annex 5 for information on habitats and food plants used by these species.

[12] For example see paragraphs 41 to 50 of Appeal Ref: APP/X1165/A/13/2205208 Land at Churston Golf Club, Churston, Devon, TQ5 0LA. https://acp.planninginspectorate.gov.uk/ViewCase.aspx?Caseid=2205208&CoID=0

Horseshoe bats are at lux levels even lower than previously thought: "*under natural, unlit conditions ... 0.04 lux*" [13]

4.14 in addition many night flying species of insect such as moths, a key prey species for horseshoe bats, are attracted to light, especially those lamps that emit a ultra-violet component and particularly if it is a single light source in a dark area. It is also considered that insects are attracted to illuminated areas from further afield resulting in adjacent habitats supporting reduced numbers of insects. This is likely to further impact on the ability of the horseshoe bats to be able to feed.[14]

4.15 A variety of techniques will be supported to facilitate development that will avoid, minimise and/or compensate for light spill:

- Use of soft white LED lights with directional baffles as required (LED light lacks a UV element and minimises insect migration from areas accessed by SAC bats)
- use of building structure, design, location and orientation to avoid/minimise lighting impacts on retained habitats
- use of landscaping and planting to protect and/or create dark corridors on site.
- use of SMART glass where appropriate
- use of internal lighting design solutions to minimise light spill from places such as windows
- use of SMART lighting solutions

4.16 Prospective developers will be expected to provide evidence, ideally in the form of a lux contour plan and sensitive lighting strategy, with their application to demonstrate that introduced light levels will not affect existing and proposed features used by SAC bats to above 0.5 lux; or not exceeding baseline light levels where this is not feasible.

Proposed developments with minor impacts

4.17 In circumstances of overall less potential impact, especially in Band C, mitigation may be put forward without the need for a full season's survey. (See Annex 3) This approach will only be suitable where it can be clearly demonstrated that the impacts of a proposed development are proven to be minor and can be fully mitigated without an impact upon the existing (& likely) SAC bat habitat. In order to adopt this approach, it will be necessary for a suitably qualified ecologist to visit the site and prepare a report with an assessment of existing (& likely) SAC bat habitat. The information from this report should provide the basis to determine appropriate mitigation measures associated with the proposed development. The proposed mitigation should clearly demonstrate that there will be no interruption of suitable SAC bat commuting habitat. Replacement of foraging habitat may be required as appropriate.

4.18 There may also be situations where mitigation will not be required because the proposed development does not have an impact upon existing (& likely) SAC bat

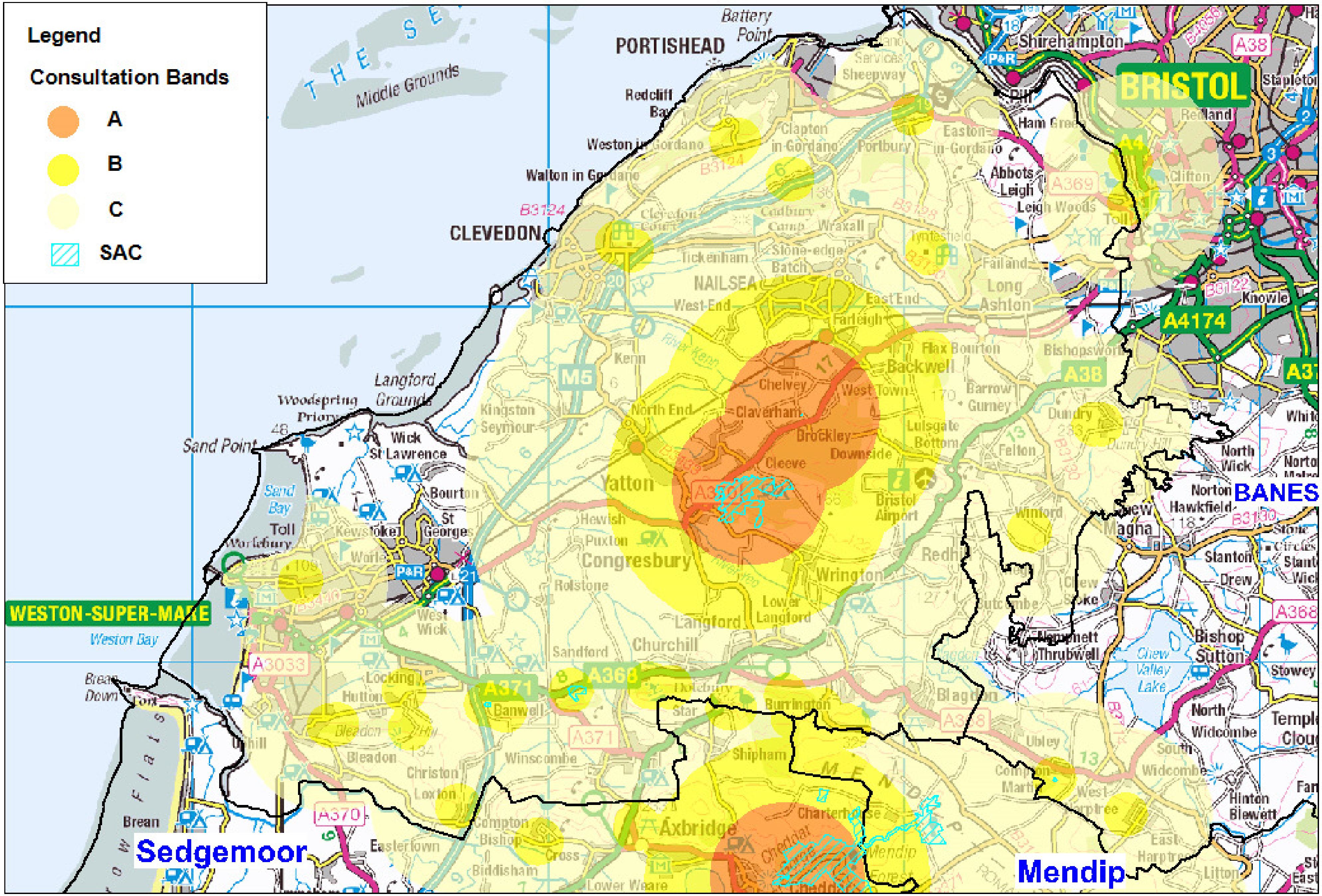
[13] Average light levels recorded along preferred commuting routes of *Rhinolophus hipposideros* under natural unlit conditions were 0.04 lux across eight sites (Stone, E.L 2013. *Bats and Lighting – Overview of current evidence and mitigation.* Bristol: University of Bristol)

[14] Bat Conservation Trust/Institute of Lighting Engineers. 2008. *Bats and Lighting in the UK: Version 2*; pers. comm. Dr Emma Stone, University of Bristol, 2009.

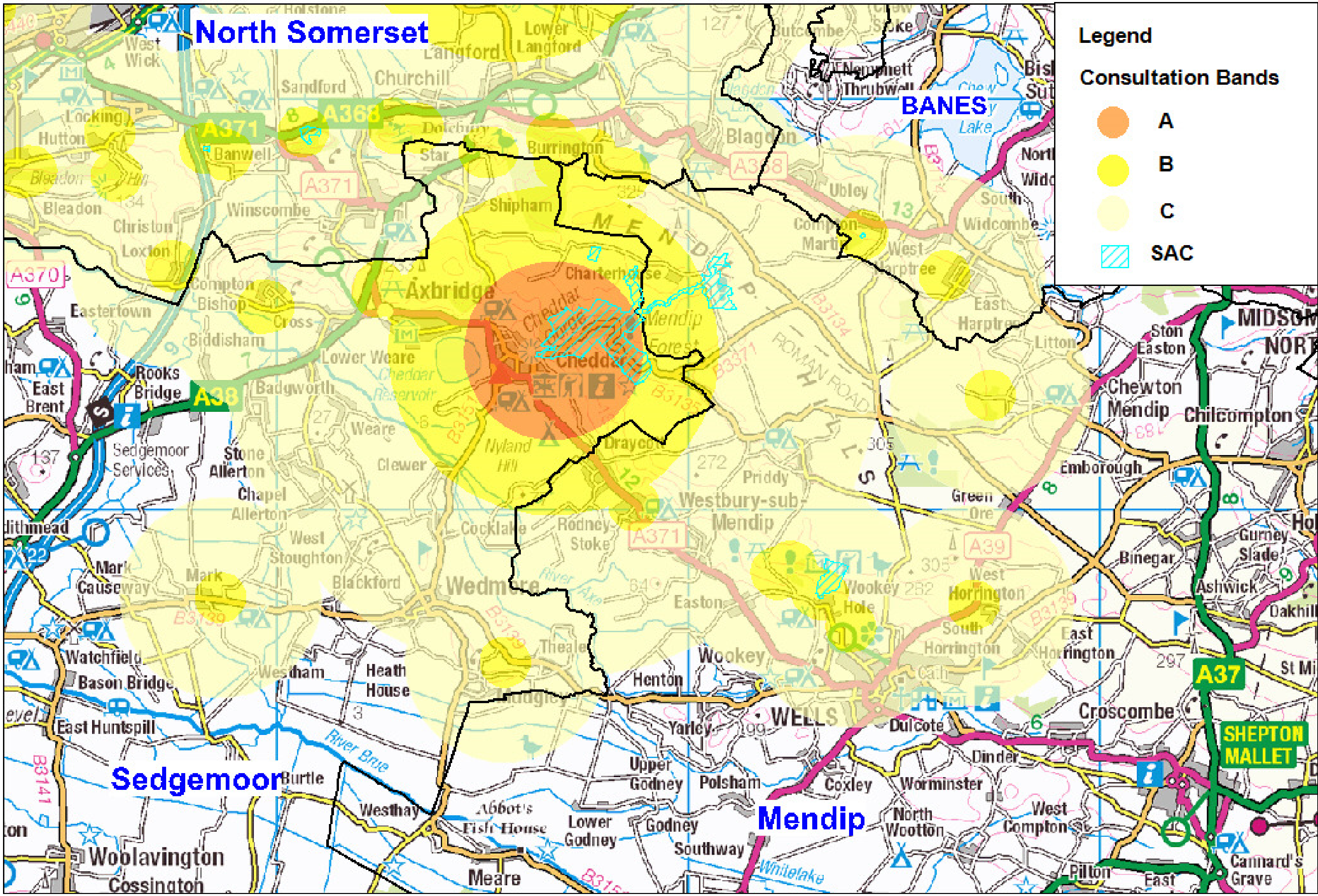
habitat. In adopting this approach it will be necessary to substantiate this with a suitably robust statement as part of the submission of the development proposals. In terms of impacts on SAC bats and habitat, it is important to bear in mind that minor proposed developments do not necessarily equate with small developments.

Lesser Horseshoe Bat (Photo: Frank Greenaway. Courtesy Vincent Wildlife Trust)

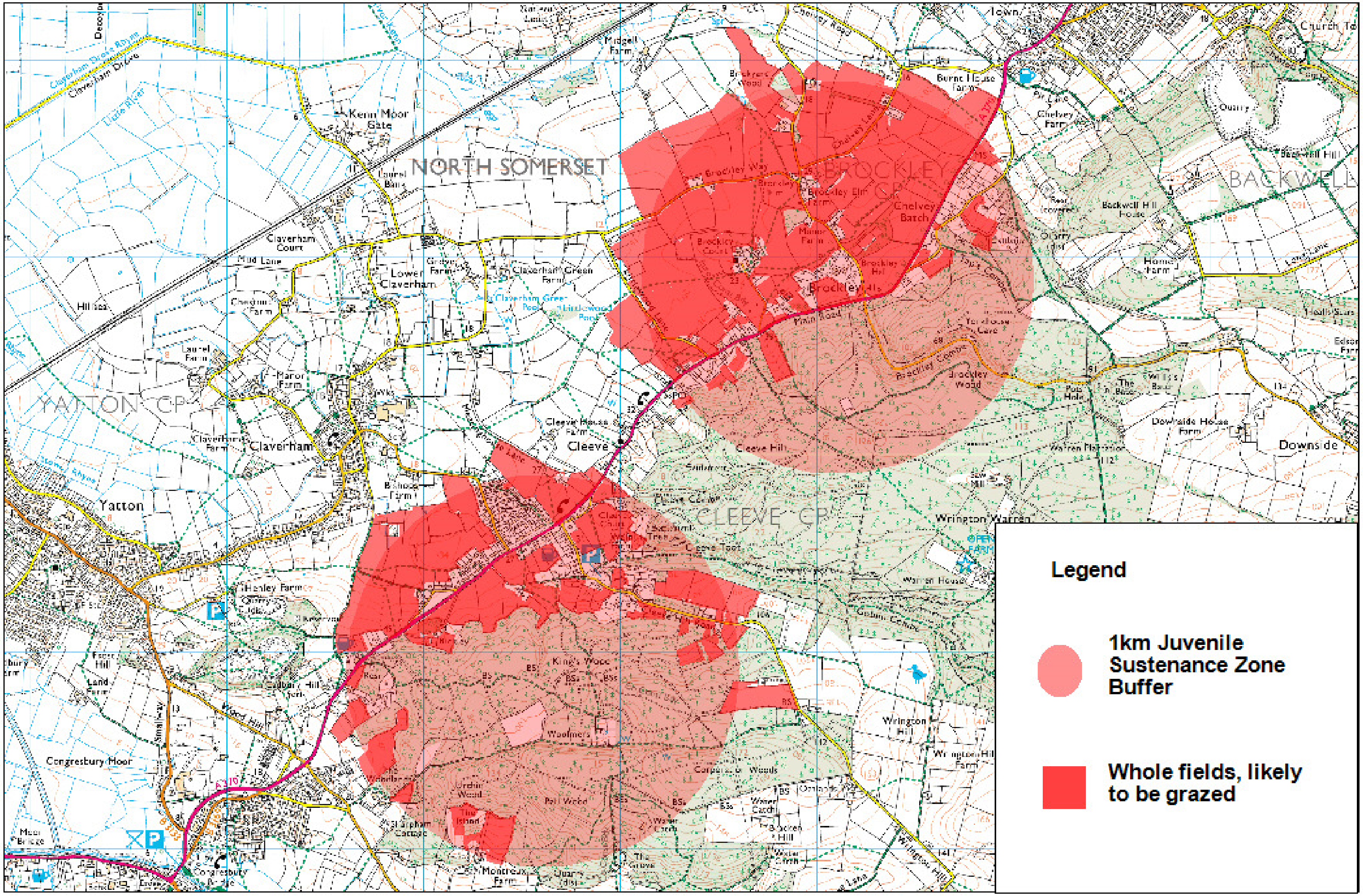
Plan 1: Bat Consultation Zone (North Somerset)



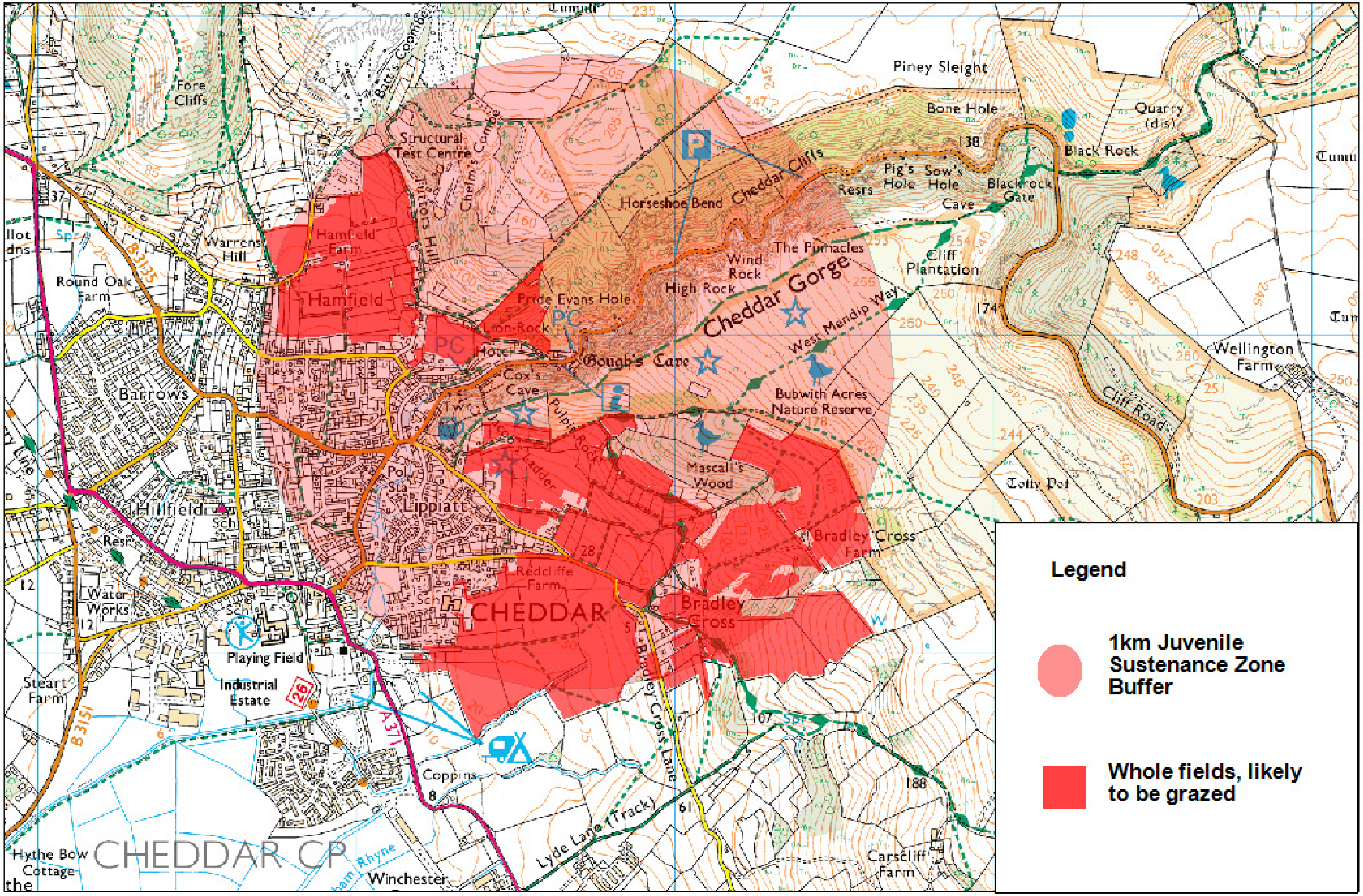
Plan 2: Bat Consultation Zone (Sedgemoor and Mendip Districts)



Plan 3: Juvenile Sustenance Zone (North Somerset)



Plan 4: Juvenile sustenance Zone (Cheddar)



PART C Annexes

Annex 1: Details on the North Somerset and Mendip Bats Special Area of Conservation

A1.1 The North Somerset and Mendip Bats SAC is made up of 7 component Sites of Special Scientific Interest (SSSI):

- Compton Martin Ochre Mine SSSI (B&NES)
- Banwell Caves SSSI (NSC)
- Banwell Ochre Mine SSSI (NSC)
- Brockley Hall Stables SSSI (NSC)
- King's Wood and Urchin Wood SSSI (NSC)
- The Cheddar Complex SSSI (SCC & SDC)
- Wookey Hole SSSI (SCC & MDC)

A1.2 This site in south-west England is selected on the basis of the size of population represented (3% of the UK **Greater Horseshoe bat *Rhinolophus ferrumequinum*** population) and its good conservation of structure and function, having both maternity and hibernation sites. This site contains an exceptionally good range of the sites used by the population, comprising two maternity sites in lowland north Somerset and a variety of cave and mine hibernation sites in the Mendip Hills. The limestone caves of the Mendips provide a range of important hibernation sites for **Lesser Horseshoe bat *Rhinolophus hipposideros*.**

A1.3 Greater Horseshoe bats are long lived (over 30 years in some cases) with the bats remaining faithful to these important roosting sites, returning year after year for generations.

A1.4 In terms of physical area, the SAC designation applies to a very tiny element of the habitat required by the bat population (the maternity roosts and entrances to their hibernation sites). It is clear that the wider countryside supports the bat populations because of the following combination of key elements of bat habitat:

A1.5 *The area has to be large enough to provide a range of food sources capable of supporting the whole bat population; the bats feed at a number of locations through the night and will select different feeding areas through the year linked to the seasonal availability of their insect prey:*

1. SAC bats regularly travel through the administrative areas of the Somerset authorities between feeding sites and their roosts via a network of established flyways. Radio tracking of Greater Horseshoe bats[15] has shown that they also travel greater distances between Brockley Hall Stables and Cheddar Gorge and further afield to the Bath and Bradford on Avon Bat and Mells Valley Bat SACs at certain times of the year, for example, in the spring and autumn between

[15] Billington, G. 2001. *Radio tracking study of Greater Horseshoe bats at Brockley Hall Stables Site of Special Scientific Interest, May – August 2001.* Peterborough: English Nature

hibernacula and maternity sites, and in the autumn to mating sites occupied by single males. Bats need a range of habitats during the year in response to the annual cycle of mating, hibernating, giving birth and raising young;

2. It follows that SAC bats need to be able to move through the landscape between their roosts and their foraging areas in order to maintain 'Favourable Conservation Status'. They require linear features in the landscape to provide landscape permeability. Compared to most other bat species, the echolocation call of the Greater Horseshoe bat attenuates rapidly in air due to its relatively high frequency. This means it cannot 'see' a great distance and is one reason why it tends to use landscape features to navigate, such as lines of vegetation (e.g. hedgerows, woodland edge, vegetated watercourses, etc.). The Greater Horseshoe bat will tend to commute close to the ground up to a height of 2 metres, and mostly beneath vegetation cover. Radio tracking studies[16] and observations in the field confirm that Greater Horseshoe bats will regularly use the interconnected flyways associated with lines of vegetation. Further studies[17] have shown that landscapes with broadleaved woodland, large bushy hedgerows and watercourses are important as they provide habitat continuity. Habitat is therefore very important to SAC bats in terms of *quality* (generation of insect prey) and *structure* (allowing them to commute and forage);

3. SAC bats are sensitive to light and will avoid lit areas[18]. The interruption of a flyway by light disturbance, as with physical removal/ obstruction, would force the bat to find an alternative route which is likely to incur an additional energetic burden and will therefore be a threat to the viability of the bat colony. In some circumstances, an alternative route is not available and can lead to isolation and fragmentation of the bat population from key foraging areas and/or roosts. The exterior of roost exits must be shielded from any artificial lighting and suitable cover should be present to provide darkened flyways to assist safe departure into the wider landscape[19].

4. The feeding and foraging requirements of the Greater Horseshoe bat have been reasonably well studied in the south west of England and Europe[20]. From this work we know that most feeding activity is concentrated in an area within 4km of the roost (juvenile bats will forage within 3km at a stage in their life when they are most susceptible to mortality). The most important types of habitat for feeding have been shown to be permanent pasture grazed by cattle or sheep, hay meadows, and wetland features such as stream lines and wet woodland. Depending upon the availability of suitable flyways and feeding opportunities, most urban areas will provide limited Greater Horseshoe bat habitat. The North Somerset and Mendip Bats SAC situation is unusual in that the wintering

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[16] Radio tracking studies have been undertaken by NE in the following research reports R344, R496 & R573.

[17] A L Walsh & S Harris, (1996), Foraging habitat preferences of vespertilionid bats in Britain. *Journal of Applied Ecology, 33, 508 – 518*

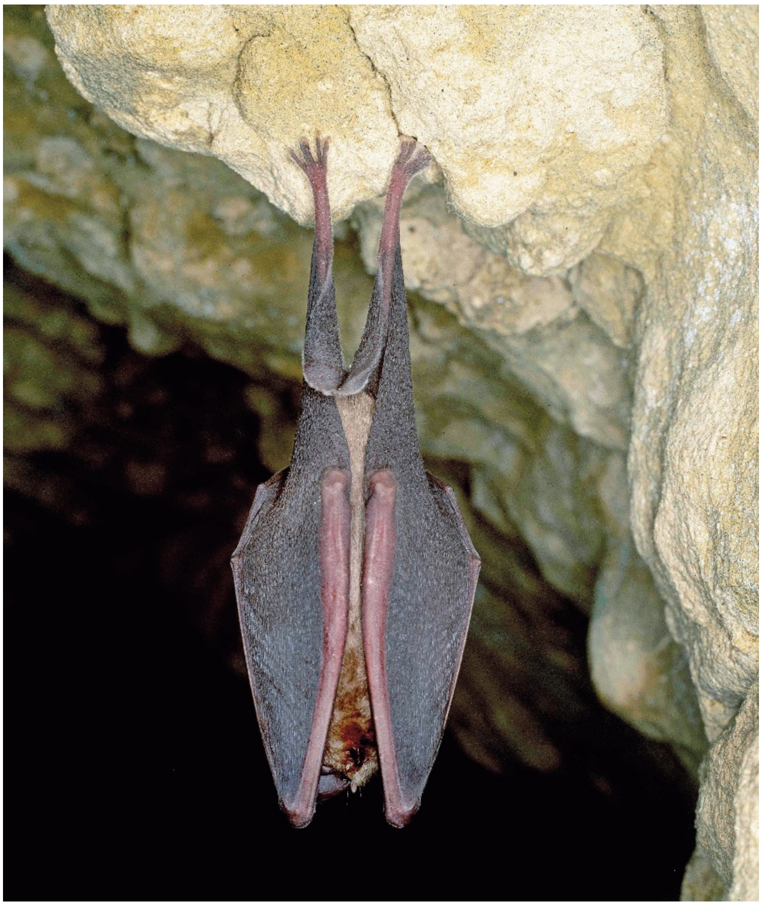
[18] http://www.batsandlighting.co.uk/

[19] see EN research reports R174

[20] R D Ransome and A M Hutson, (2000), Action plan for the conservation of the greater horseshoe in Europe (Rhinolophus ferrumequinum), Convention on the Conservation of European Wildlife and Natural Habitats, Nature and Environment No 109. http://www.swild.ch/Rhinolophus/PlanII.pdf Also see EN research reports R174, R241, R341 & R532

Greater Horseshoe bat population mainly hibernates in caves in Cheddar Gorge and Wookey Hole, which are located close to urban areas and are subject to visitor disturbance. Commuting routes follow the urban edge, the Cheddar Yeo and within the urban area of Cheddar.[21]

A1.6 The populations of bats from the North Somerset and Mendips SAC are currently under particular stress from a number of factors, particularly the number of development applications and proposals on the urban edges of Yatton, Congresbury, Nailsea and Cheddar.



Greater Horseshoe Bat (Photo Frank Greenaway: Courtesy Vincent Wildlife Trust)

[21] Rush, T. & Billington, G. 2013. *Cheddar Reservoir 2: Radio tracking studies of greater horseshoe and Lesser Horseshoe bats, June and August 2013*. Witham Friary: Greena Ecological Consultancy

Annex 2: Bat Consultation Zones

A2.1 The Bat Consultation Zone density Band widths will vary from species to species depending on its characteristic use of its home range. Those for Greater and Lesser Horseshoe bats are given in the Table below. As both these species use a single focus for a population, a roost, they are likely to occur at a decreasing density in the landscape the further removed from the centre (e.g. see Rainho & Palmeirim, 2011; Rosenberg & McKelvey, 1999[22]).

A2.2 Around Cheddar it was reported that Greater Horseshoe bats spent most of time roaming along hedgerows whilst foraging, moving onto different hedgerows after visiting several in their 'patch'. Individuals use foraging areas that could be over 200 or more metres in length or over 6 to 7 hectares. Within these foraging areas each bat has localised feeding spots of about 0.35 hectares. In Germany they visit 11 – 25 such areas per night.

A2.3 A similar study of frequency of home range use away from a maternity roost site was carried out by Bontadina & Naef-Daenzer (2002) [23] at Grisons in Switzerland. It showed a higher frequency of use than would be expected at 1.2 to 1.6km distance when compared with uniform spatial use over the whole foraging range up to 4km. Above 4km the trend in spatial use declined up to the maximum range of 7.4km. In a radio tracking study carried out by Rossiter et al (2002) [24] at Woodchester Manor, overlaps in core foraging areas were nearly all within 1km of the roost with only two overlaps recorded at ~2km and then both corresponded to a mother / daughter pair.

A2.4 The bands in the above table for a maternity roost of Greater Horseshoe bats are derived from radio tracking distances carried out by Billington (2001)[25] of the Brockley Hall Stables Greater Horseshoe bat roost in North Somerset. Although the Swiss study (Bontadina & Naef-Daenzer, 2002) [26] found greatest spatial density at 1.2 to 1.6km it is considered that 2.2km is used to determine the width of Band A in this case derived from Duvergé (1996)[27]. Billington notes that there has been deterioration in habitat near to the Brockley Hall roost where hedgerows have been removed, poorly managed or neglected. Duvergé (1996) carried out radio tracking studies in North Somerset where the summer foraging areas of adults were found to be located within 3 – 4 km of maternity roosts, and the mean adult range in one extensive study was 2.2km. About

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[22] Rainho, A. & Palmeirim, J. W. 2011. The Importance of Distance to Resources in the Spatial Modelling of Bat Foraging Habitat. *PLoS ONE, April 2011, 6, 4, e19227*; Rosenberg, D. K. & McKelvey, K. S. 1999. Estimation of Habitat Selection for Central-place Foraging Animals. *Journal of Wildlife Management 63 (3): 1028 -1038.*

[23] Bontadina, F. & Naef-Daenzer, B, 2002. *Analysing spatial data of different accuracy: the case of Greater Horseshoe bats foraging*. PhD Thesis, Universität Bern

[24] Rossiter, S. J., Jones, G., Ransome, R. D. & Barratt, E. M. 2002 Relatedness structure and kin-based foraging in the Greater Horseshoe bat (*Rhinolophus ferrumequinum*). *Behav. Ecol. Sociobiol. (2002) 51: 510-518*

[25] Billington, G. 2001. *Radio tracking study of Greater Horseshoe bats at Brockley Hall Stables Site of Special Scientific Interest, May – August 2001.* Peterborough: English Nature.

[26] Bontadina, F. & Naef-Daenzer, B, 2002. *Analysing spatial data of different accuracy: the case of Greater Horseshoe bats foraging*. PhD Thesis, Universität Bern

[27] Duvergé, L. 1996 quoted in Roger Ransome. 2009. *Bath Urban Surveys: Dusk Bat Surveys for horseshoe bats around south-western Bath. Assessments Summer 2008 & Spring 2009*. Bat Pro Ltd.

75% of the foraging areas are located within the mean adult range. A number of radio tracking studies have shown the maximum foraging range for most Greater Horseshoe bats is 4km and this distance is quoted in the requirements of habitat conservation from a roost site.[28] Billington (2001) tracked the maximum distance travelled by bats at Brockley Hall as 6.8km, discounting one bat which travelled 10.2km to Shipham and then subsequently day roosted in Cheddar Gorge. However, measuring the distances in GIS the furthest recorded bat fix was 7.8km ("as the crow flies").The Band widths for the non-breeding and winter roosts are derived from a radio tracking study of non-breeding roosts of Greater Horseshoe bats in Dorset carried out by Flanders (2008).[29] A comparison of foraging ranges from various studies on Greater Horseshoe bats is given in Appendix 1.

Table 2: Band Widths for Horseshoe Bats

Band	Greater Horseshoe bat (metres)		Lesser Horseshoe bat (metres)	
	Maternity	Other	Maternity	Other
A	0 – 2200		0 - 600	
B	2201 - 4000	0 - 610	601 - 2500	0 - 300
C	4001 - 8000	611 – 2440	2501 - 4100	301 - 1250

A2.5 The Band widths for Lesser Horseshoe bats are derived from the radio tracking study carried out by Knight (2006)[30] for a lowland study area (as opposed to high quality and upland landscapes) which was located in North Somerset. The maximum distance travelled in this study was 4.1km for an adult female and 4.5km for a nulliparous female. The mean maximum range was 2.2km. Bontadina et al (2002)[31], whose study found a similar maximum foraging range, recommended that conservation management should be concentrated within 2.5km of the roost with special consideration within 600 metres of the roost where the colony foraged half the time. The same result was found for the North Somerset study.

A2.6 Radio tracking of Lesser Horseshoe bats carried out by Bontadina et al (2002) [32] estimated the density of Lesser Horseshoe bat foraging in their study area was 5.8 bats per hectare within 200 metres of the maternity roost, decreasing to 1 bat per hectare at 390 metres and 0.01 bats per hectare at 1200 metres. Knight (2006) [33] when carrying out a radio tracking for a Lesser Horseshoe bat roost of 200 individuals in North Somerset estimated a foraging density of 0.13 bat/hectare within 2 km of the roost and, like the Bontadina et al study, density declined sharply within the first

[28] See Appendix 1; e.g. also see Duvergé, P. L. & Jones, G. 1994. Greater Horseshoe bats - Activity, foraging behaviour and habitat use. *British Wildlife 6, 2, 69 -77;* Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Ransome, R. 2009. *Bath Urban Surveys: Dusk Bat Surveys for horseshoe bats around south-western Bath. Assessments Summer 2008 & Spring 2009*. Bat Pro Ltd..

[29] Flanders, J. R. 2008. Roost use, ranging behaviour and diet of the Greater Horseshoe bat *Rhinolophus ferrumequinum* in Dorset: in Flanders, J. R. 2008. *An integrated approach to bat conservation: applications of ecology, phylogeny and spatial modelling of bats on the Isle of Purbeck, Dorset*. PhD Thesis, University of Bristol.

[30] Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD thesis. University of Bristol.

[31] Bontadina, F., Schofield, H. & Naef-Daenzer, B. 2002. Radio-tracking reveals that Lesser Horseshoe bats (Rhinolophus hipposideros) forage in woodland. *J. Zool. Lond. (2002) 258, 281-290*.

[32] Bontadina, F., Schofield, H. & Naef-Daenzer, B. 2002. Radio-tracking reveals that Lesser Horseshoe bats (*Rhinolophus hipposideros*) forage in woodland. *J. Zool. Lond. (2002) 258, 281-290*.

[33] Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD thesis. University of Bristol.

kilometer in two of the study sites and subsequently at a lower rate out to the extent of the recorded foraging distance. A third study site in a high quality landscape showed a steadier rate of decline in density throughout the range.

A2.7 The Band widths for the non-breeding roost are derived from England radio-tracking of Lesser Horseshoe bats carried out in the winter. This study revealed that they foraged on average to a maximum distance of 1.2 kilometers from the hibernation site. One bat travelled to an absolute maximum distance of 2.1 kilometers. The winter foraging range appears to be approximately half that of the distance covered in the summer months. (Bat Conservation Trust/BMT Cordah, 2005)[34] For the purposes of this study the ranges are similarly halved. A comparison of foraging ranges is given in Appendix 1.

Lesser Horseshoe Bat (Photo: Frank Greenaway. Courtesy Vincent Wildlife Trust)

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[34] Bat Conservation Trust / BMT Cordah. 2005. *A Review and Synthesis of Published Information and Practical Experience on Bat Conservation within a Fragmented Landscape.* Cardiff: The Three Welsh National Parks, Pembrokeshire County Council, Countryside Council for Wales

Annex 3: Survey Specification for Surveys for Planning Applications Affecting SAC bat Consultation Zones.

A3.1 Three types of survey are required to inform the impact of proposed development. These are:

- Bat Surveys
- Habitats / Land use Surveys
- Light Surveys

Bat Surveys

A3.2 The following sets out the survey requirements for development sites within the Bat Consultation Bands A and B in part based on the guidance given by the Bat Conservation Trust (2016)[35] and on the advice of consultants experienced in surveying for horseshoe bats. Note that the objective is to detect commuting routes and foraging areas rather than roosts.

A3.3 The following specification is recommended in relation to development proposals within Bands A and B of the Bat Consultation Zone. It is also worth mentioning the difficulty associated with detecting the Greater Horseshoe bat's echolocation call compared to most other British bat species due to the directionality and rapid attenuation of their call. This fact emphasises the requirement for greater surveying effort and the value of broadband surveying techniques. It is recommended that the most sensitive equipment available should be used. It is also recommended that the local planning authority ecologist be contacted with regard to survey effort.

(i) Surveys should pay particular attention to linear landscape features such as watercourses, transport corridors (e.g. roads, sunken lanes railways), walls, and to features that form a linear feature such as hedgerows, coppice, woodland fringe, tree lines, ditches and rhynes and areas of scrub and pasture that may provide flight lines.

(ii) The main survey effort should be that using automated detectors. Automatic bat detector systems need to be deployed at an appropriate location (i.e. on a likely flyway). Enough detectors should be deployed so that each location is monitored through the survey period in order that temporal comparisons can be made. The period of deployment should be at least 50 days from April to October and would include at least one working week in each of the months of April, May, August, September and October (50 nights out of 214; ≈25%). For development within Band B of the Bat Consultation Zone of hibernation roosts winter surveys may be required.

(iii) The number of automated detectors will vary in response to the number of linear landscape elements and foraging habitat types, the habitat structure, habitat quality, used by horseshoe bats and taking into account their flight-altitude. Every site is

[35] Collins, J. (ed). 2016. *Bat Survey Guidelines for Professional Ecologists: Good Practice Guidelines*. (3rd Edition) London: Bat Conservation Trust

different, but the objective would be to sample each habitat component equally[36]. Generally:

- With hedges it depends on the height and width, and also whether they have trees, as to how many detectors might be needed to ensure the coverage is comprehensive no matter what the wind decides to do.
- With grassland, the number depends on whether the site is grazed or not; if it is we need a comparison of the fields with livestock and the fields without.
- In a woodland situation a sample with three detectors: one on the woodland edge, two in the interior with one in the canopy and one at eye-level.
- The open areas of a quarry are sampled with two detectors reflecting the un-vegetated and vegetated cliffs so the two can be compared.

(iv) Results from automated detectors recording should be analysed to determine whether the site supports foraging or increased levels activity as this affects the Band used in calculating the amount of replacement habitat required to mitigate losses to horseshoe bats.

(v) Manual transect surveys[37] should be carried out on ten separate evenings; at least one survey should be undertaken in each month from April to October[38], as the bats' movements vary through the year. Transects should cover all habitats likely to be affected by the proposed development, including a proportion away from commuting features in field. Moreover, manual surveys only give a snap shot of activity (10 nights out of 214; ≈5%) and less effective at detecting horseshoe bats therefore automated bat detector systems should also be deployed see section (ii).

(vi) Surveys should be carried out on warm (>10 °C but >15°C in late summer), still evenings that provide optimal conditions for foraging (insect activity is significantly reduced at low temperatures; see commentary below). Details of temperature and weather conditions during surveys should be included in the final report.

(vii) Surveys should cover the period of peak activity for bats from sunset for at least the next 3 hrs.

(viii) Transect surveys should preferably be with most sensitive equipment available. Digital echolocation records of the survey should be made available with the final report; along with details of the type and serial number of the detector.

(ix) Surveys should be carried out by suitably qualified and experienced persons. Numbers of personnel involved should be agreed beforehand with the appropriate Somerset authority or Natural England, be indicated in any report and be sufficient to thoroughly and comprehensively survey the size of site in question.

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[36] Pers. Comm. Henry Andrews, AEcol, 23/09/2016

[37] Collins, J. (ed). 2016. *Bat Survey Guidelines for Professional Ecologists: Good Practice Guidelines*. (3rd Edition) London: Bat Conservation Trust

[38] The active bat season can vary e.g. shortened by prolonged cold winters and lengthened by warm 'Indian summers'

(x) Surveys should also include desktop exercises in collating any records and past data relating to the site via Bristol Environmental Records Centre (BRERC) or Somerset Environmental Records Centre (SERC), local Bat Groups etc.

(xi) All bat activity should be clearly marked on maps and included within the report.

(xii) Basic details of records for the site should be passed to BRERC and/or SERC after determination of the application.

A3.4 Survey effort in Band C is dependent on whether commuting structure is present and the suitability of the adjacent habitat to support prey species hunted by horseshoe bats. Nonetheless this should be in accordance with Bat Conservation Trust guidelines (Collins, 2016[39])

Habitats Surveys

A3.5 Phase 1 habitat surveys should be carried out for all land use developments within the Bat Consultation Zone and be extended to include the management and use of each field, e.g. whether the field is grazed or used as grass ley, and the height, width and management of hedgerows in the period of bat activity. Information can be sought from the landowner. If grazed, the type of stock and management regimes should be detailed if possible. Habitat mapping should include approximate hectarage of habitats to inform the methodology for calculating replacement habitat required.

Lighting Surveys

A3.6 Surveys of existing light levels on proposed development sites should be undertaken and submitted with the planning application. This should cover the full moon and dark of the moon periods so that an assessment of comparative horseshoe bat activity on a proposed site can be ascertained. Light levels should be measured at 1 metre above ground level. This survey data can then be used to inform the masterplan of a project.

A3.7 A lux contour plan of light levels down to 0.5 Lux, modelled at 1 metre above ground level, should be submitted with the application.

[39] Collins, J. (ed). 2016. *Bat Survey Guidelines for Professional Ecologists: Good Practice Guidelines* (3rd Edition). London: Bat Conservation Trust

Annex 4: Habitat Requirements of Greater and Lesser Horseshoe bats

.

Greater Horseshoe Bats

Prey

A4.1 Dietary analysis of Greater Horseshoe bat droppings shows three main prey items: cockchafer *Melolontha melolontha*; dung beetles *Aphodius* sp. (Coleoptera: Scarabaeidae); and moths (Lepidoptera). Of these moths form the largest part of the diet but the other two are important at certain times of year.[40] They are conservative in their food sources. Three secondary prey sources are also exploited: crane flies (Diptera: Tipulidae), ichneumonids (Hymenoptera: Ichneumonidae) of the *Ophian luteus* complex, and caddis flies (Trichoptera) [but less so at Brockley Hall Stables].[41]

General

A4.2 Greater Horseshoe bat populations are sustained by a foraging habitat which consists primarily of permanently-grazed pastures interspersed with blocks or strips of deciduous woodland, or substantial hedgerows. Such pasture/woodland habitats can generate large levels of their favoured prey, especially moths and dung beetles, but also tipulids and ichneumonids. Preferably pastures should be cattle-grazed, as their dung sustains the life-cycles of the most important beetles to Greater Horseshoe bats, but sheep and horse grazing can also be beneficial in a rotation to reduce parasite problems. Sheep-grazing, which results in a short sward, may also benefit the life-cycles of tipulids and cockchafers.

A4.3 The periods through the year when these prey species are hunted is outlined below:

(a) The preferred key prey in April for all bats that have survived the previous winter is the large dung beetle *Geotrupes*.
(b) In May, the preferred key prey is the cockchafer *Melolontha melolontha*.
(c) In April and May, in the absence of sufficient key prey, bats switch to secondary prey such as tipulids, caddis flies and the ichneumonid *Ophion*. As a last resort they eat small dipterans.
(d) In June and early July, pregnant females feed on moths, their key prey at that time, and continue to do so after giving birth, until late August. They usually avoid *Aphodius rufipes* even when they are abundant, as long as moths are in good supply. If both are in poor supply they switch to summer chafers (*Amphimallon* or *Serica*).
(e) Moth supplies usually fall steadily in August and September, due to phonological population declines, or rapidly at a particular dawn or dusk due to temporary low temperatures. If either happens adult bats switch to secondary, single prey items, or combine moths with them. Tipulids are often the first alternative, but *Aphodius rufipes* is also taken. In very cold spells ichneumonids, of the *Ophion luteus*

[40] Ransome (1996) carried out dietary analyses of Greater Horseshoe bats in June and July and found that 60 – 80% of their diet was moths.
[41] Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature.

complex are consumed. They are common prey in October and through the winter as they can fly at low ambient temperatures. However in summer they are used as a last resort.

(f) Juvenile bats do not feed at all until they are about 29 or 30 days old, when they normally feed on *Aphodius rufipes*, which is their key prey. This dung beetle species is a fairly small (90mg), easily-caught and usually abundant prey, which reaches peak numbers at the time that the young normally start to feed in early August.[42]

A4.4 The top five feeding areas for Greater Horseshoe bats over the active period in North Somerset include:

- pasture with cattle as single stock or part of mixed stock (38.6%);
- ancient semi natural woodland (16.6%);
- pastures with stock other than cattle (10.3%);
- meadows grazed by cattle in the autumn (9.4%); and
- other meadows and broadleaved woodland (4.9%).[43]

A4.5 These habitats are not used according to the fore listed proportions throughout the year but change with the seasons. Woodlands and pasture adjoining wood are used in spring and early summer. As summer progresses, feeding switches to areas further away and tends to be fields used for grazing cattle and other types of stock. Meadows that have been cut and where animals are grazing are also used. A balance of woodland and pasture of about 50% and 50% provides optimum resources for Greater Horseshoe bats.[44] Billington (2000)[45] identified that there were four principal habitat types: scrub, meadow, deciduous woodland and grazed pasture.

A4.6 Within suitable habitat, a range of three roosts types must be present for a colony to exist. A single maternity roost, with many surrounding night roosts nearby (usually up to 4 km, but exceptionally up to 14 km) for resting between foraging bouts and a range of suitable hibernacula within a 60 km radius. Three types of hibernaculum have been identified which should be as close as possible, but within 15 km of the maternity roost.[46]

<u>Grassland</u>

A4.7 The most important factor for supporting Greater Horseshoe bat populations is grazed pasture[47]. Cattle are preferred to smaller grazers, since they create the ideal structural

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[42] Ransome, R. D. & Priddis, D. J. 2005. *The effects of FMD-induced mass livestock slaughter on greater horseshoe bats in the Forest of Dean.* English Nature Research Reports Number 646. Peterborough: English Nature.

[43] Duvergė, P. L. & Jones, G. 1994. Greater Horseshoe bats - Activity, foraging behaviour and habitat use. *British Wildlife Vol. 6 No 2*

[44] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Bontadina, F. & Naef-Daenzer, B, 2002. *Analysing spatial data of different accuracy: the case of Greater Horseshoe bats foraging*. PhD Thesis, Universität Bern

[45] Billington, G. 2000. *Radio tracking study of Greater Horseshoe bats at Mells, Near Frome, Somerset*. Peterborough: English Nature

[46] R D Ransome and A M Hutson, (2000), Action plan for the conservation of the greater horseshoe in Europe (Rhinolophus ferrumequinum), Convention on the Conservation of European Wildlife and Natural Habitats, Nature and Environment No 109. http://www.swild.ch/Rhinolophus/PlanII.pdf

[47] Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature.

conditions for perch-hunting bats in hedgerows and woodland edge. Within 1 kilometre of the roost the presence of permanent grazed pasture is critical for juvenile Greater Horseshoe bats. A high density of grazing animals should be present giving high presence of dung. Within the remainder of the roost foraging range grazing regimes can be more flexible provided adequate pasture is available.[48]

A4.8 *Aphodius* beetles live in cow, sheep and horse dung. Short grazed habitat, such as produced by sheep, benefits *Melontha* and Tupilid species which require short grass to oviposit. Sheep dung also provides dung based prey. Large dung beetles, *Geotrupes* spp., can provide a major dietary component of Greater Horseshoe bats. Most favour cattle dung, but some also use sheep dung.

A4.9 Longer swards benefit the larvae of noctuid moths.[49] The main species of moth eaten by Greater Horseshoe bats at Woodchester in Gloucestershire are Large Yellow Underwing; Small Yellow Underwing; Heart and Dart; and Dark Arches. The former two species are on the increase whilst the latter two are in decline.[50]

- Large Yellow Underwing are found in a range of habitats, including agricultural land, gardens, waste ground, and has a range of food plants including dandelion, dock, grasses and a range of herbaceous plants both wild and cultivated, including dog violet and primrose. It will also visit flowers such as Buddleia, ragwort, and red valerian. The larva is one of the 'cutworms' causing fatal damage at the base of virtually any herbaceous plant, including hawkweeds, grasses, plantains and dandelions and a range of cultivated vegetables and flowers. This moth flies at night from July to September and is freely attracted to light.

- Small Yellow Underwing are found on flower-rich grassland, including meadows, roadside verges, open woodland and grassy embankments. The food plants are as for those listed for the Large Yellow Underwing but also include foxglove, sallow, hawthorn, blackthorn and silver birch. The larvae feed on the flowers and seeds of mouse-ear (*Cerastium spp.*), especially common mouse-ear. This moth flies in May and June in the daytime so may be gleaned at night.

- Heart and Dart are found in agricultural land, meadows, waste land, gardens and places where their food plants grow. Food plants include dock, plantain, chickweed, fat hen, turnip, sugar beet and many other herbaceous plants. The larvae feed on various wild and garden plants. The moth flies from May to July, when it is readily attracted to light.

- Dark Arches are found in meadows and other grassy place and food plants include cocksfoot, couch grass and other grasses. The larvae feed on the bases and

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[48] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature

[49] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature

[50] Jones, G., Barlow, K., Ransome, R. & Gilmour, L. 2015. *Greater Horseshoe bats and their insect prey: the impact and importance of climate change and agri-environment schemes.* Bristol: University of Bristol.

stems of various grasses. The moth is on the wing from July to August and is readily attracted to light.[51]

Woodland

A4.10 Rides and footpaths are used by Greater Horseshoe bats when flying in woodland feeding areas. Grassy rides and glades in woodland increase the range of food and provide opportunity for perch hunting.[52]

A4.11 Woodland supports high levels of moth abundances. Macro (and micro) moths are densest where there is grass or litter, less so where there are ferns, moss, bare ground or herbs. They are richer where there is native tree diversity and trees with larger basal areas. Species such as oak, willow and birch have large numbers of moths, whereas beech has small numbers even when compared to non-native species such as sycamore. Uniform stands of trees are poorer in invertebrates than more diversely structured woodland.[53]

A4.12 Greater Horseshoe bats feed through the winter when prey species become active, for example when *Ophian* wasps swarm in woodlands above 5˚C. They have been found to spend significant times in woodland, being sheltered, often warmer at night, and insects are much more abundant than in open fields. However, in another study Billington (2000) carried out in the summertime found that there was limited foraging of adults recorded in woodlands, of only a few minutes duration, except during medium-heavy rainfall when most of the foraging time was spent in broadleaf and coniferous woodland. Use, therefore, is likely to be dependent on season and weather conditions.[54]

Hedgerow

A4.13 Larger hedgerows are required for commuting as well as foraging by Greater Horseshoe bats. Continuous lines of vegetation of sufficient height and thickness to provide darkness when light levels are still relatively high are needed for commuting bats. Ransome (1997) recommended the retention of existing hedgerows and tree lines linking areas of woodland, encouraging hedgerow improvement to become 3 to 6 metres wide, mean 3 metres high with frequent standard emergent trees.[55]

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[51] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; http://ukmoths.org.uk/species/noctua-pronuba/; http://ukmoths.org.uk/species/panemeria-tenebrata/; http://ukmoths.org.uk/species/agrotis-exclamationis; http://ukmoths.org.uk/species/apamea-monoglypha/

[52] Duvergė, P. L. & Jones, G. 1994. Greater Horseshoe bats - Activity, foraging behaviour and habitat use. *British Wildlife Vol. 6 No 2;* Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Bontadina, F. & Naef-Daenzer, B, 2002. *Analysing spatial data of different accuracy: the case of Greater Horseshoe bats foraging*. PhD Thesis, Universität Bern.

[53] Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature; Fuentes-Montemayor, E.,Goulson, D., Cavin, L., Wallace, J.M. & Park, K. J. 2012. Factors influencing moth assemblages in woodland fragments on farmland: Implications for woodland management and creation schemes. *Biological Conservation 153 (2012) 265–275*; Kirby, K. J. (ed). 1988. *A woodland survey handbook*. Peterborough: Nature Conservancy Council.

[54] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Billington, G. 2000. *Radio tracking study of Greater Horseshoe bats at Mells, Near Frome, Somerset*. Peterborough

[55] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature

A4.14 Substantial broad hedgerows with frequent emergent trees can provide suitable structure for foraging conditions for Greater Horseshoe bats if woodland is scarce. Cattle are preferred to smaller grazers, since they create the ideal structural conditions for perch-hunting bats in hedgerows and woodland edge. A tall thick hedgerow is a very efficient way of producing a maximum level of insect prey using a minimum land area and important creators of physical conditions that enhance insect concentrations and reduce wind speeds for economical hunting flight. The vast majority of insects (over 90%) found near hedge lines do not originate in the hedge but come from other habitats brought in on the wind.[56]

<u>Scrub</u>

A4.15 Scrub also seems to be an important foraging habitat for Greater Horseshoe bats. Billington (2000) records the frequent use by the species during radio tracking carried out for the Mells Valley SAC in June. Scrub in disused quarries is important.[57]

A4.16 Large Yellow Underwing moths are attracted to Buddleia or Butterfly Bush. Butterfly Bush grows in abundance in limestone quarries and flowers from July to September, when demands on lactating female horseshoe bats are high. There is potential to deprive horseshoe bats of a foraging ground by restoring large areas of butterfly bush scrub all in one hit and at the wrong time of year.[58]

A4.17 However, similarly to Lesser Horseshoe bats, large areas of continuous scrub are likely to be avoided by Greater Horseshoe bats.[59]

<u>Others</u>

A4.18 Ditches and rhynes are used as flight corridors to access foraging areas in the Somerset Moors south of Cheddar, flying below ground level. This is also likely to be the case in North Somerset. They have also been radio tracked flying straight across the open water of Cheddar Reservoir.[60]

A4.19 Tipulid larval development is favoured by damp conditions. Therefore, any aquatic environments and/or marshes can provide a secondary prey source. Aquatic environments could also favour the production of caddis flies in certain months, such as May and late August / September when other food supplies may be erratic. There is significant caddis fly consumption at roosts close to extensive river or lake habitats.[61]

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[56] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Bat Conservation Trust. 2003. *Agricultural practice and bats: A review of current research literature and management recommendations*. London: Defra project BD2005

[57] Billington, G. 2000. *Radio tracking study of Greater Horseshoe bats at Mells, Near Frome, Somerset.* Peterborough: English Nature

[58] Pers. comm. Henry Andrews. AEcol, 22/09/2016

[59] Schofield, H. W. 2008. *The Lesser Horseshoe Bat Conservation Handbook*. Ledbury: The Vincent Wildlife Trust.

[60] Jones, Dr. G. & Billington, G. 1999. *Radio tracking study of Greater Horseshoe bats at Cheddar, North Somerset*. Taunton: English Nature; Rush, T. & Billington, G. 2013. *Cheddar Reservoir 2: Radio tracking studies of greater horseshoe and Lesser Horseshoe bats, June and August 2013*. Witham Friary: Greena Ecological Consultancy

[61] Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature

A4.20 In Devon the River Dart, a large river system, mostly banked by broadleaved woodland was also found to be a key habitat.[62]

A4.21 Habitats which are of little use to Greater Horseshoe bats include urban areas, arable land and amenity areas such as playing fields. Lights, such as street lights or security lamps, are strong deterrents to Greater Horseshoe bats, both when they emerge from roosts, and when they forage. However, radio tracking shows that bats regularly pass through urban areas of Cheddar and will fly along hedgerows adjoining arable areas to reach hunting grounds. It is suspected that they will fly through (but not along) a line of street lights, probably at the darker points between lamps, as evidenced by radio tracking. In North Somerset they have been recorded within urban areas but here lights are switched off after midnight.

A4.22 During the winter period Greater Horseshoe bats are likely to forage closer to roost sites than during the summer and in areas sheltered from the wind, and on south and southwest facing slopes.[63]

Lesser Horseshoe Bats

Prey

A4.23 The diet of the Lesser Horseshoe bat consists mostly of Diptera of the crepuscular sub-order Nematocera. Families of Nematocera Diptera recorded in the diet include Tipulidae (crane-flies), Ceratopogonidae (biting midges), Chironomidae (non-biting midges), Culicidae (mosquitoes), and Anisopodidae (window midges). Lepidoptera (moths), Trichoptera (caddis-flies) and Neuroptera (lacewings) are also eaten.[64]

A4.24 Due to their small body size they cannot cope with large prey, such as cockchafers. By comparison they eat smaller moth species than the Greater Horseshoe bat. The principal prey species for Lesser Horseshoe bats, using data collected at Hestercombe House SAC are from the Diptera and Lepidoptera families. At this location there were seven major prey categories comprised over 70% of the diet: Tipulidae (crane flies), Anisopodidae (window gnats), Lepidoptera (moths), Culicidae (mosquitoes), Hemerobiidae (brown lacewings), Trichoptera (caddis flies) and Ichneumonidae (ichneumon wasps)[65]

General

A4.25 '*The primary foraging habitat for Lesser Horseshoe bats is broadleaf woodland where they often hunt high in the canopy. However, they will also forage along hedgerows,*

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[62] Billington, G. 2003. *Radio tracking study of Greater Horseshoe bats at Buckfastleigh Caves, Site of Special Scientific Interest*. Peterborough: English Nature.

[63] Ransome, R. D. 2002. *Winter feeding studies on Greater Horseshoe bats*: English Nature Research Reports Number 449. Peterborough: English Nature

[64] Vaughan, N., Jones, G. & Harris, S. 1997. Habitat use by bats (Chirpotera) assessed by means of a broad-band acoustic method. *Journal of Applied Ecology 1997, 34, 716-730*; Boye, Dr. P. & Dietz, M. 2005. English Nature Research Reports Number 661: *Development of good practice guidelines for woodland management for bats*. Peterborough: English Nature

[65] Boye, Dr. P. & Dietz, M. 2005. English Nature Research Reports Number 661: *Development of good practice guidelines for woodland management for bats*. Peterborough: English Nature; Knight Ecology. 2008. *Hestercombe House, Taunton, Somerset: Lesser Horseshoe bat Diet Analysis*. Clutton: Knight Ecology

tree-lines and well-wooded riverbanks.'[66] Lesser Horseshoe bats are primarily a woodland feeding bat using deciduous woodland or mixed coniferous woodland and hedgerows. It has been found that landscapes that were most important contained a high proportion of woodland, parkland and grazed pasture, linked with linear features, such as overgrown hedgerows.

Woodland

A4.26 In the Wye valley in Monmouthshire studies revealed that Lesser Horseshoe bats significantly spend the majority of their time foraging in woodland. Broadleaved woodland predominated over other types of woodland and was shown to be a key habitat for the species. In the core foraging areas used by bats woodland accounted for 58.7 ± 5.2% of the habitats present. Although Lesser Horseshoe bats prefer deciduous woodland as foraging habitat they will occasionally hunt in conifer plantations. However, the biomass in coniferous woodland is smaller, but where smaller blocks are surrounded by habitat productive in insect prey they will be used.[67]

A4.27 The Ciliau SSSI, designated for its Lesser Horseshoe bats, and also the River Wye, is surrounded by predominately pastoral habitats, with cattle grazing on lowlands and sheep grazing on higher areas. There are, however, high densities of broadleaved woodland, especially along watercourses, and some conifer plantations. Again Lesser Horseshoe bats foraged predominately in broadleaved woodland along the banks of the River Wye and its tributary streams. Woodland with watercourses has more importance. They were also recorded foraging in conifer plantations.[68]

A4.28 Furthermore, radio tracking carried out in the spring also revealed that coniferous woodland appeared to be more used for foraging than deciduous woodland and that coniferous woodland close to maternity colonies may provide refuge in certain weather conditions[69]

A4.29 Although Lesser Horseshoe bats prefer woodland in which to forage there is a further requirement as to the structure of the woodland. In Bavaria, except in one area, the distance between trees was large and in dense stands no activity was recorded. In Belgium it was found that the density of taller trees, either broadleaved or coniferous, must be low enough to allow the development of an under storey of shrub and coppice.[70]

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[66] Schofield, H. W. 2008. *The Lesser Horseshoe bat Conservation Handbook*. Ledbury: The Vincent Wildlife Trust.

[67] Bontadina, F., Schofield, H. & Naef-Daenzer, B. 2002. Radio-tracking reveals that Lesser Horseshoe bats (Rhinolophus hipposideros) forage in woodland. *J. Zool. Lond. (2002) 258, 281-290*; Schofield, H. W. 2008. *The Lesser Horseshoe bat Conservation Handbook*. Ledbury: The Vincent Wildlife Trust.

[68] Schofield, H., Messenger, J., Birks, J. & Jermyn, D. 2003. *Foraging and Roosting Behaviour of Lesser Horseshoe bats at Ciliau, Radnor.* Ledbury: The Vincent Wildlife Trust; Barataud, M., Faggio, G., Pinasseau, E. & Roué, S. G. 2000. *Protection et restauration des habitats de chasse du Petit rhinolophe*. Paris : Société Français pour l'Etude et la Protection des Mammifères.

[69] Bat Conservation Trust. 2005. A Review and Synthesis of Published Information and Practical Experience on Bat Conservation within a Fragmented Landscape. Cardiff: The Three Welsh National Parks, Pembrokeshire County Council, Countryside Council for Wales

[70] Holzhaider, J., Kriner, E., Rudolph, B-U. & Zahn, A. 2002. Radio-tracking a Lesser Horseshoe bat (Rhinolophus hipposideros) in Bavaria: an experiment to locate roosts and foraging sites. *Myotis, 49, 47-54*; Motte, G. & Libois, R. 2002. Conservation of the Lesser Horseshoe bat (*Rhinolophus hipposideros* Bechstein, 1800) (Mammalia: Chiroptera) in Belgium. A case study in feeding requirements. *Belg. J. Zool., 132 (1): 47-52.*

Grassland

A4.30 Radio tracking research of Lesser Horseshoe bats shows that in foraging over pasture cattle must be actively grazing the field. Once cattle are removed from a field foraging by Lesser Horseshoe bats ceases immediately. However, pasture in such use offers a valuable and predictable food source at a time of year when bats are energetically stressed (pre- to post-weaning), because they are feeding their young. The report recommended a grazing density of 0.5 -1 cows per hectare. Scatophagidae can be one of the major prey categories in the diet of Lesser Horseshoe bats. The larvae of the Yellow Dung-fly *Scatophaga stercoraria* develop in cattle dung. The presence of pasture is also indispensable to the larval stage of development for certain species (Tipulids), which form a significant proportion of the prey hunted by Lesser Horseshoe bats.[71]

Hedgerows

A4.31 Belgian research similarly showed that the feeding grounds for Lesser Horseshoe bats were deciduous woodland along with copses or mixed coniferous woodland. Woodland occupied 25% of the area within 1 kilometre of the roost. However, some foraging was observed in hedgerows. Hedgerows had an average density of 47 metres per hectare. Generally, bats selected areas that were of undulating countryside with hedgerows, tree lines and woodland in preference to flat open intensively farmed areas. In Austria hedgerows, tree lines and streams were only exploited where there was less forest.[72]

A4.32 Commuting corridors, such as tall bushy hedgerows, are important features for Lesser Horseshoe bats as they avoid crossing open areas and are vulnerable to the loss of these corridors. In Belgium no bat was recorded more than 1 metre from a feature. Stonewalls have been reported in use as commuting routes in Ireland.[73]

A4.33 At Ciliau SSSI Lesser Horseshoes only crossed the River Wye when fully dark. Lesser Horseshoe bats have been observed crossing roads where the tops of trees have touched.[74]

Scrub

A4.34 Lesser Horseshoe bats avoid dense scrub cover[75].

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[71] Cresswell Associates. 2004. *Bats in the Landscape Project.* The National Trust, Sherborne Park Estate; Knight,T. 2006. *The use of landscape features and habitats by the lesser horseshoe bat* (Rhinolophus hipposideros). PhD Thesis: University of Bristol

[72] Holzhaider, J., Kriner, E., Rudolph, B-U. & Zahn, A. 2002. Radio-tracking a Lesser Horseshoe bat (Rhinolophus hipposideros) in Bavaria: an experiment to locate roosts and foraging sites. *Myotis, 49, 47-54*; Motte, G. & Libois, R. 2002. Conservation of the Lesser Horseshoe bat (*Rhinolophus hipposideros* Bechstein, 1800) (Mammalia: Chiroptera) in Belgium. A case study in feeding requirements. *Belg. J. Zool., 132 (1): 47-52*.

[73] Motte, G. & Libois, R. 2002. Conservation of the Lesser Horseshoe bat (*Rhinolophus hipposideros* Bechstein, 1800) (Mammalia: Chiroptera) in Belgium. A case study in feeding requirements. *Belg. J. Zool., 132 (1): 47-52;* Biggane, S. & Dunne, J. 2002. A study of the ecology of the lesser horseshoe colony at the summer roost in Co. Clare, Ireland: In *European Bat Research Symposium (9, 2002, Le Havre). Abstracts of presentations at the 9th European Bat Research Conference, August 26-30 at Le Havre, France. Bat Research News 43(3): 77*.

[74] Schofield, H., Messenger, J., Birks, J. & Jermyn, D. 2003. *Foraging and Roosting Behaviour of Lesser Horseshoe bats at Ciliau, Radnor. Ledbury*: The Vincent Wildlife Trust;

[75] Schofield, H. W. 2008. *The Lesser Horseshoe Bat Conservation Handbook*. Ledbury: The Vincent Wildlife Trust.

Annex 5: Methodology for Calculating the Amount of Replacement Habitat Required

Introduction

A5.1 The method used to calculate the amount of habitat required to replace that lost to a horseshoe bat population due to development is based on the requirements for maintaining that needed to support viable populations. It uses an approach similar to the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (1980) to provide '…*for mitigation and compensation that can allow fair use of the land and maintain healthy habitats for affected species'*.[76] HEP is structured around the calculation of Habitat Units (HU), which are the product of a Habitat Suitability Index (quality) and the total area of habitat (quantity) affected or required[77].

A5.2 A key assumption is that habitat type, amount and distribution influence the distribution of associated animal species. It is also important to recognise that Habitat Suitability Index (HSI) models predict habitat suitability, not actual occurrence or abundance of species populations.[78]

A5.3 The HEP uses the Integrated Habitat System (IHS) developed by Somerset Environmental Records Centre, described below. It requires a Habitat Suitability Index for the horseshoe bat species scored on IHS descriptions, which are given in Appendices 2 and 3.

A5.4 Such methods are necessary to obtain an objective quantitative assessment that provides improved confidence that the mitigation agreed is likely to be adequate; and that a development will not significantly reduce the quantity or quality of habitat available to a horseshoe bat population; whereas current ecological impact assessments are often based on subjective interpretations. In Somerset they have been used since 2009 including for effects on Greater and Lesser Horseshoe bats to inform the adequacy of replacement habitat provided by the developer. The method has gone through planning inquiries including for a Nationally Significant Infrastructure Project.

A5.5 The methodology has also been reviewed and further developed with the Bat Conservation Trust.

Integrated Habitat System Mapping

A5.6 The Integrated Habitat System coding is used as a basis for describing and calculating habitat values used as a base in applying scores in Habitat Suitability Indices. The Integrated Habitat System (IHS)[79] classification comprises over 400 habitat categories, the majority drawn from existing classifications, together with descriptions, authorities and correspondences arranged in a logical hierarchy that allow application for different

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[76] http://www.fort.usgs.gov/Products/Software/HEP/

[77] U. S. Fish and Wildlife Service. 1980. *Habitat Evaluation Procedures ESM102*. Washington, D. C.: Department of the Interior.

[78] Dijak, W. D. & Rittenhouse, C. D. 2009. Development and Application of Habitat Suitability Models to Large Landscapes: in Millspaugh, J. J. & Thompson, F. R. 2009. *Models for Planning Wildlife Conservation in Large Landscapes*. London: Academic Press.

[79] http://www.somerc.com/integrated+habitat+system/

purposes. The classification can be customised for a geographical area or special project use without losing data integrity.

A5.7 The IHS represents a coded integration of existing classifications in use in the UK with particular emphasis on Broad Habitat Types, Priority Habitat Types, Annex 1 of the Habitats Directive and Phase 1[80].

A5.8 Standard habitat definitions from these classifications are combined into a hierarchy starting at the level of Broad Habitat Types, through Priority Habitat types, Annex 1 to vegetation communities which are coded. These are the Habitat Codes.

A5.9 Within IHS Habitat Codes are hierarchical with the numbers in the code increasing as the habitat becomes more specific. Descriptions of habitats can be found in IHS Definitions (Somerset Environmental Records Centre)[81]. For example:

- WB0 Broadleaved, mixed and yew woodland (Broad Habitat Type)
- WB3 Broadleaved woodland
- WB32 Upland mixed ashwoods (Priority Habitat Type)
- WB321 Tilio-Acerion forests on slopes, screes and ravines (upland) (Annex 1 Habitat)

A5.10 As well as Habitat Codes IHS provides Matrix, Formation and Land Use/Management Codes which are added as a string to the main Habitat Code to provide further description.

A5.11 Ideally habitat information for the whole of the geographic area of the Somerset authorities should be mapped in a GIS programme, such as MapInfo or ArcGIS. However, when used in ecological impact assessment for calculating the value of impacts of habitat change on a species population then at minimum it is only necessary that IHS coding is applied to the habitat types present on the proposed development site to enable the use of Habitat Suitability Indices in the HEP metrics.

Habitat Suitability Indices

Introduction

A5.12 A form of Habitat Suitability Indices (HSI) has been used in the United States and Canada since the early 1980s as a way of assessing the impacts of development on species' populations and distributions. In addition, they have been used to predict what replacement habitat needs to be created to maintain species' populations. The process assumes that the suitableness of habitat for a species can be quantified - the HSI. The overall suitability of an area for a species can be represented as a product of the geographic extents of each habitat and the suitability of those habitats for the species[82].

Description

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[80] Phase 1 (JNCC, 1993) habitat mapping can be converted to IHS by using the software provided by Somerset Environmental Records Centre.

[81] http://www.somerc.com/integrated+habitat+system/

[82] http://www.fort.usgs.gov/Products/Software/HEP/

A5.13 In constructing the HSI the index scores are applied to each Habitat, and Matrix, Formation and Land Use / Management codes in the Integrated Habitat System (IHS) based on analysis of the ecological requirements, from existing literature and professional judgement, for each species assessed or mapped.

A5.14 Each IHS 'Habitat' category is scored on a scale of 0 to 6 (as defined below) using a potential or precautionary approach as a starting point, e.g. Broadleaved, mixed and yew woodland is assumed to be the Annex 1 broadleaved woodland habitat unless otherwise proved not. The score will be the same across each of the hierarchical levels of the IHS Habitat coding (e.g. poor is scored as 1 whether this is at broadest habitat level or priority habitat level unless there is discernible differences in the type of habitat used, e.g. oak or beech woodland)[83]. This means that the full range of scoring is used before the modifiers (the IHS Formation and Management codes) are applied.

A5.15 The Habitat Code scoring is considered in combination with the IHS Matrix codes[84]. These are either added or subtracted from the Habitat code, e.g. grassland score 3 + scrub score 2 would equal 5. This is to account for species, for example that use grassland with a matrix of scattered scrub or single trees, which would otherwise avoid open grassland habitat.[85] Habitat Codes have a range of 0 to 6 but when considered in combination must not exceed a score of 6 or fall below a score of 0, Where there is no effect from a Matrix type then a default score of 0 is used.

A5.16 All other Codes are scored between 0 and 1 and are multipliers. Where there is no effect from Formation, Management then a default score of 1 is used.

Table 3: Example of HSI Calculation

	Habitat Code	Matrix Code	Formation Code	Land Use / Management Code	HSI Score
Code	GI0	SC2	-	GM12	
Description	Improved Grassland	Scattered Scrub	-	Sheep Grazed	
HSI Score	3	1	1	0.75	3

A5.17 Scores will be applied such that a precautionary approach or 'potential' approach is taken, e.g. if a species requires grassland which is most valuable when grazed then grassland scores the top score. This potential score will take into account a combination of the Habitat and Matrix codes. The management modifier would then maintain the habitat score at this high level by a multiplier of 1. If the management is not grazed a decimal multiplier is applied to reduce the value of the habitat. For

[83] The 1 to 6 scale matches Defra's habitat distinctiveness range used in its metric.

[84] IHS considers that patches of scrub and single trees are matrix habitat acting in combination with main habitats types rather than separate habitats in their own right. It is possible that further sub codes be added to the grassland habitat codes, e.g. calcareous grassland with scattered scrub, etc. but this would lead to a proliferation of coding and current IHS GIS mapping would need amending to take this into account. Therefore by providing a positive multiplier the needs of those species which require a mosaic of grassland and scrub is taken into account.

[85] IHS considers that patches of scrub and single trees are matrix habitat acting in combination with main habitats types rather than separate habitats in their own right.

example a grassland habitat is valued at 6 but by applying the relevant management code, i.e. either mown or other management type, the value of the habitat will be reduced. Only one management code is allowed. An example (non-horseshoe bat) is set out in Table 3 above.

A5.18 The definition of poor, average, good and excellent habitat is adapted from the 'Wildlife Habitat Handbook for the Southern Interior Ecoprovince', British Columbia, Ministry of Environment[86] and expanded, in consultation with the Bat Conservation Trust, as follows:

Excellent - provides for essential life requisites, including feeding, reproduction or special needs and supports a relatively high population density, implied >70% chance of occurrence, can support positive recruitment. Can be a critical life-cycle association.
Very good - provides for essential life requisites, including feeding, reproduction or special needs and supports a relatively high population density, implied 50 - 70% chance of occurrence, can support positive recruitment.
Good - provides for a life requisites, including feeding, reproduction or special needs and supports a relatively high population density, implied 40 -50% chance of occurrence, can support a stable population.
Average - provides for moderately required life needs, including feeding, reproduction or special needs and supports a relatively moderate population density, implied 25 - 40% chance of occurrence, can support a stable population.
Marginal - provides for marginally required life needs, including feeding, reproduction or special needs and supports a relatively modest population density, implied 15 - 25% chance of occurrence, can support a small population.
Poor - provides for a non-essential life needs, including feeding, reproduction or special needs and supports a relatively low population density, implied <15% chance of occurrence.

A5.19 It is recognised that not all habitat patches of the same type have equal value in terms of resource to a species, for example see Dennis, 2010[87]. However, in scoring the overall HSI, i.e. including all Habitat, Matrix, Formation codes, etc., it is considered that a higher value is given as a precaution. However, there is a factor in the HEP taking into account survey results which is partly aimed to account for variability in habitat quality.

A5.20 No allowance for seasonal variations, i.e. due to the availability of prey species at different times of year, has been made in developing the HSI. It is considered a habitat valued at 6 at a particular period but not at other times will remain at a value of 6 being necessary to support that species at that time of year when other prey or other resources may not be so readily available.

A5.21 The HSI score arising from the above calculation can be joined into a GIS base habitat map and displayed using thematic mapping to give a graphical representation of the value of a landscape to horseshoe bats.

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[86] For example http://www.env.gov.bc.ca/wld/documents/techpub/r20.pdf
[87] Dennis, R.L.H. 2010. *A Resource-Based Habitat View for Conservation. Butterflies in the British Landscape.* Chichester: Wiley-Blackwell.

A5.22 The Habitat Suitability Index for Greater Horseshoe Bats can be found in Appendix 2 and that for Lesser Horseshoe bats in Appendix 3.

Validation

A5.23 A HSI model can be reviewed against occurrence data held by the biological records centre. The Gulf of Maine HSI work[88] established the principle of producing several HSI models for one species and retained the model, which had the best association with known occurrences. The mapping is produced and matched with species data at the biological records centre and the model refined to fit the records with a view to errors of omission and commission.

A5.24 Garshelis (2000)[89] concluded that the '...*utility of the models is to guide further study or help make predications and decisions regarding complicated systems; they warrant testing but the testing should be viewed as a never-ending process of refinement, properly called bench-marking or calibration*.' The validation should be seen as a continuous refinement process and HSI scoring should be reviewed from time to time and up dated[90].

A5.25 In this study HSI have initially been researched and scored by the author. However, the scores can be varied through review, further research findings or to reflect local conditions based on survey. Where varied by consultants the reason for the variation should be given and supported by evidence.

Density Band

A5.26 The HSI score is multiplied by the location of the proposed site in relation to that of the horseshoe bat roost. The Consideration Zone (CZ) is divided into three Density Bands. The three Bands are, ‘A’ closest to the record, ‘B’ and ‘C’ furthest from the record valued at 3, 2 and 1 respectively. The values are given in Table 4 below.

Table 4: CZ Band

Band	Score
A	3
B	2
C	1

A5.27 When two Bands occur within one field take the higher value as the score. The Density Band widths can be found in Table 1 above.

A5.28 Following ecological surveys for horseshoe bats carried out for the proposed development the Density Band score may be modified up depending on whether

[88] http://www.fws.gov/r5gomp/gom/habitatstudy/Gulf_of_Maine_Watershed_Habitat_Analysis.htm

[89] Garshelis, D. L. 2000. Delusions in Habitat Evaluation: Measuring Use, Selection, and Importance: in Boitam, L. & Fuller, T. K. (eds.) 2000. *Research Techniques in Animal Ecology: Controversies and Consequences*. New York: Columbia University Press.

[90] http://www.fws.gov/r5gomp/gom/habitatstudy/Gulf_of_Maine_Watershed_Habitat_Analysis.htm

feeding activity was recorded or not or whether absence is recorded. This reflects uneven use of a home range and refines the value of the habitat for a species (e.g. see Bontadina & Naef-Daenzer, 2002[91]). Note that sufficient automated detectors should be deployed

A5.29 The following criteria should be used to modify the Band following the results of site surveys and applied to the whole of the proposed development site:

- Not present – Where potential habitat is present reduce the Band score down by 0.5, e.g. at A from 3 to 2.5; at B from 2 to 1.5; except at C where it reduced to 0.
- Commuting only – as the Band the site falls within
- Commuting and Foraging – increase the band score by 0.5 e.g. at C from 1 to 1.5; at B from 2 to 2.5; A stays as it is.

A5.30 The identification of 'foraging' (i.e. a higher level of activity) for horseshoe bat species is defined as:

- An average of 1 pass per night on one automated detector in any one of the monthly recording periods over the total survey year

Calculating the Habitat Unit Value

A5.31 For information the value of the proposed site to a horseshoe bat species in Habitat Suitability value is calculated by using the HSI Score and the Density Band (See Table 5). The outcome of the Habitat Suitability Units used in the HEP is on a scale of 0 to 18[92].

Table 5: Matrix Combining Habitat Suitability Score and Density Band

		Habitat Suitability Score					
		Poor 1	Marginal 2	Average 3	Good 4	Very Good 5	Excellent 6
Band	A (3)	3	6	9	12	15	18
	B (2)	2	4	6	8	10	12
	C (1)	1	2	3	4	5	6

A5.32 The habitat replacement value required is calculated by multiplying the score by the hectarage of the habitat affected (hectares x [HSI x Band]) giving figure in **Habitat Units.** For example a HSI x Band score of 12 for an area of 1.50 hectares would give a

[91] Bontadina, F. & Naef-Daenzer, B. 2002. Analysing spatial data of different accuracy: the case of Greater Horseshoe bats foraging: in Bontadina, F. 2002. Conservation Ecology in Horseshoe Bats. PhD thesis. Universität Bern.

[92] This range is in line with that used for the habitat metric used by Defra in its pilot projects 2012 -2014.

value of 18 Habitat Units.

A5.33 The resultant total of Habitat Units for the whole proposed development site could then be divided by 18 (6 [HS] x 3 [Band]) to arrive at the minimum area in hectares of accessible replacement habitat required to develop the proposed site

A5.34 Hedgerows and some watercourses are not mapped as separate polygons in OS Mastermap and if a width is not known a default width of 3 metres is used and multiplied by the length to give an area in hectares. These values are usually small and do not significantly affect the overall area of a site, and for simplicity's sake and considering their value to wildlife are not deducted from the area of bordering fields, compartments or OS Mastermap polygons. If preferred calculations can be carried out separately for these features using linear measurements but the end result is the same, especially if a direct replacement value of the hedgerow or watercourse is required.

A5.35 Nonetheless hedgerow and other commuting structure should be seen as having a functional role, and should normally be maintained or replaced to maintain horseshoe bat commuting across a proposed development site.

A5.36 HEP calculations for development sites should be made on the basis that the total site area would be lost to a species and would therefore produce a maximum replacement requirement to develop the site. This saves a separate calculation for the value of the existing habitat on which enhanced habitat is created. Where habitat remains unchanged and is retained by the development it is not included in the calculation.

A5.37 To calculate the amount of replacement habitat provided as mitigation within a master plan for a proposed development site the same procedure as described above is used for each area of created or enhanced habitat. These habitats should in the first instance be aimed at providing optimal foraging habitat for horseshoe bats (although it is unlikely that some habitats such as grazed pasture would be possible to re-create within a development site).

A5.38 Standard prescriptions that can be used for replacement habitats can be found in Annex 6. Habitats will need to be accessible and undisturbed by introduced lighting to count towards mitigation. As all habitats are considered optimal the HSI score would automatically be 6.

A5.39 In addition to the standard calculation described above Fraction Multipliers are also applied to the calculation to allow for temporal effects and the difficulty in restoring or creating a habitat (See below).

Fraction Multipliers

A5.40 In delivering the replacement habitat there may also be an issue or risk with delivering a functional offset and the timing of the impact. A loss in biodiversity would result and there could potentially be a risk to maintaining a species population during the intervening period even though it would recover in time. Therefore, it is important and desirable that where feasible replacement habitat is in place and functional just before development commences on site. However, functionality may not be achieved until several years after replacement habitat has been created and there is a risk that it may fail due to the difficulty in recreating or restoring. To account for these possibilities Fraction Multipliers are used. These are usually applied only once to the calculation for the value of the habitat lost to horseshoe bats. However, in some circumstances the Fraction Multipliers may be applied to habitat created as replacement for that lost where this has been designed and there are multiple habitat types. In this case they are not applied to the habitat lost calculation.

A5.41 *The aim of a multiplier is to correct for a disparity or risk. In practice this is very difficult to achieve, not least because of uncertainty in the measurement of the parameters and the complexity of gathering the required data.'*[93] In order that any habitat creation or enhancement would functionally replace habitat lost to development (and the need to take a precautionary approach in the case of horseshoe bats, as features of European sites and European protected species) a 'fraction multiplier' is applied to the resultant Habitat Units needed to replace habitat lost to development in order to provide robust mitigation, e.g. to maintain 'favourable conservation status'.

A5.42 '*There is wide acknowledgement that ratios should be generally well above 1:1. Thus, compensation ratios of 1:1 or below should only be considered when it is demonstrated that with such an extent, the measures will be 100% effective in reinstating structure and functionality within a short period of time (e.g. without compromising the preservation of the habitats or the populations of key species likely to be affected by the plan or project.*[94] The Environment Bank recommend a two for one ratio where habitats are easily re-creatable contiguous to the development or on similar physical terrain as a minimum.[95]. In many other situations a significantly higher multiplier may be appropriate[96]. *The conclusion of the BBOP* [Business Biodiversity Offsets Programme] paper *(Ekstrom et al, 2008) is that where there are real risks around the methods and certainty of restoration or creation then the Moilanen framework is applicable; but for some other situations, (averted risk ...and where restoration techniques are tried and tested), lower ratios can be used.*[97]

A5.43 Appendices 4 and 5 give a guide to difficulty in creating and restoring habitats and the time frame required to reach maturity or functionality.

Delivery Risk

A5.44 As different habitats have different levels of difficulty in creation or restoration there will be different risks associated with each. '*Once there is an estimate of the failure risk, it is possible to work out the necessary multiplier to achieve a suitable level of confidence (Bill Butcher pers com; Moilanen, 2009; Treweek & Butcher, 2010). The work of Moilanen provides a basis for different multipliers of various levels of risk. We have used this work to come up with categories of difficulty of restoration/expansion,*

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[93] Defra. 2011. *Biodiversity Offsetting. Technical paper: proposed metric for the biodiversity pilot in England.* London: Department for Environment, Food and Rural Affairs.

[94] European Communities. 2007. *Guidance document on Article 6(4) of the'Habitats Directive' 92/43/EEC: Clarification of the concepts of: alternative solutions*, *imperative reasons of overriding public interest*, *compensatory measures*, o*verall coherence, opinion of the commission.* Brussels: Office for Official Publications of the European Communities.

[95] Briggs, B., Hill, D. & Gillespie, R. 2008. Habitat banking – how it could work in the U.K. http://www.environmentbank.com/docs/Habitat-banking.pdf

[96] Moilanen, A., Van Teeffelen, A., Ben-Haim, Y. & Ferrier, S. 2009. How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restoration Ecology 17, 470-478*.

[97] Defra. 2011. *Biodiversity Offsetting. Technical paper: proposed metric for the biodiversity pilot in England.* London: Department for Environment, Food and Rural Affairs.

and associated multipliers, as set out in [Table 6] *below.*'[98]

A5.45 In most cases a multiplier will be applied to the calculation of the habitat lost on the development site and the figure (≥1) shown in middle column of Table 6 below will be used. This assumes that the optimal habitat for horseshoe species will be created. The resultant figure can either be checked against that provided in the Master Plan to confirm that there is sufficient to mitigate the loss or then be used to design the area into a Master Plan.

A5.46 Where the replacement habitat has been designed, and includes several types, in an offsite location, for example, this needs to be checked to ensure that adequate mitigation habitat has been provided. In this case, due to the nature of the calculation the multiplier is inversed (≤1) as shown in the right hand column of Table 6 and applied to the replacement habitat not the lost habitat.

Table 6: Multipliers for different categories of delivery risk (Defra, 2011)

Difficulty of recreation/restoration	Multiplier	*Multiplier (Where the replacement site has been designed and consists of multiple habitat types)*
Very High	10	*0.1*
High	3	*0.33*
Medium	1.5	*0.67*
Low	1	*1*

A5.47 For information Appendix 4 gives an indicative guide to risk levels which have been assigned to habitats to these broad categories using expert opinion by Defra (2011). Factors such as substrate, nutrient levels, state of existing habitat, etc. will have an impact on the actual risk factor, which may need to be taken into account.

<u>Temporal Risk</u>

A5.48 In delivering replacement habitat there may be a difference in timing between the implementation of the development and the functionality and maturity of the replacement habitat in terms of providing a resource for the affected species . This time lag would be minimised by calculation of existing habitat value in the pre application stage and implementation of the habitat creation and / or restoration in consultation with the local authority and other nature conservation organisations. In some cases the replacement habitat may be planted or managed concurrently with that of the site development.

A5.49 Where a time lag occurs a multiplier will be applied to take account of the risk involved to the 'no net loss' objective. These are set out in Table 7 below. Appendix 5 gives general guidance on how long different habitats would be expected to reach maturity.

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[98] Defra. 2011. *Biodiversity Offsetting. Technical paper: proposed metric for the biodiversity pilot in England.* London: Department for Environment, Food and Rural Affairs.

The actual multiplier used needs to be judged on a case by case basis. As with Delivery Risk the multiplier in the left hand column is likely to apply in most cases (see paragraphs A5.45 and A5.46 above).

A5.50 It is considered that some priority habitats cannot be recreated due to the length of time that they have evolved and the irreplaceability of some constituent organisms, at least in the short and medium terms. It is also considered that in the medium and longer terms the management of any replacement habitat may be uncertain. Therefore Table 7 has been constrained to a maximum period of 20 years. In some cases the time lag for the development of a habitat to support a population may be too long to be acceptable.

Table 7: Multipliers for different time periods using a 3.5% discount rate

Years to target condition	Multiplier	Multiplier *(Where the replacement site has been designed and multiple habitat types)*
5	1.2	*0.83*
10	1.4	*0.71*
15	1.7	*0.59*
20	2.0	*0.5*

A5.51 An Excel spread sheet in which figures used in the calculation for the HEP just as an example is shown in Appendix 6. It is likely that a full spread sheet will be made available by the Council..

Summary

A5.52 The total replacement habitat required therefore comprises the following metric for each habitat type within a proposed development site. The whole proposed development site should be included in the calculation.

The HSI = Habitat Code (Range 0 to 6) + or – Matrix Code (Range 0 to 6, Default 0) x Formation Code (Range 0 to 1) x Management Code (Range 0 to 1)

HSI x Band x hectares x Delivery Risk x Temporal Risk = Habitat Units required.

Habitat Units divided by 18 = hectares required

Off Site Replacement Habitat

A5.53 Where there are residual offsets, i.e. where the replacement habitat cannot be created within the proposed development sites red line boundary an allowance is calculated for the value of the existing habitat on the intended habitat creation site as this will be lost or included in the value of any enhancement. Where replacement habitat is located offsite then the value of that site needs to be taken into account. The formula applied to offset losses of existing habitat at the offset site is:

<u>Area Equivalent of Habitat Units Needed to Offset from Development</u>
(Habitat Value of Desired Habitat Type – Habitat Value of Offsite Habitat Creation Site)

A5.54 This figure is then added to the Habitat Units derived from the calculation from the proposed development site and the total divided by 18 to find the amount of offsite replacement habitat required. For example the proposed development requires 32HUs to replace that lost to horseshoe bats. The habitat to be created is valued at a suitability score of 6 and the field intended for the creation of replacement habitat at 1. The calculation would be 32/ (6-1) + 32 = 38.4HU (or, divided by 18, 2.13 hectares).

A5.55 It is critical that the replacement site where habitat has been enhanced is accessible to the population of horseshoe bats affected.

Annex 6: Habitat Creation Prescriptions

A6.1 The following are standard prescriptions that can be used as replacement habitat both on development sites and at off-site locations. They are all considered to be scoring 6 in terms of HSI.

Greater Horseshoe Bats[99]

Pasture

A6.2 Ideally grazed pasture should be created or existing enhanced for Greater Horseshoe bats. It is unlikely that a grazing regime could continue within a development site and the following is more likely to constitute off site enhancements. Ransome (1996) set out prescriptions for grazing regimes:

Enhancement within 3 kilometres of the roost preferably revert arable to grassland managed to be improved by non-hazardous methods to provide high levels of grass productivity to cope with high densities of livestock between July and September. Where currently grazed the existing regime should be adjusted so that between March and May these pastures should be stocked with cattle, sheep and possibly a few horses at 1.4 cattle/ha or 8 sheep/ha as the weather permits and rotated between cattle and sheep in specific fields to keep a short, but not seriously damaged sward. The fields should be rested in June to allow grass growth to recover, which is likely to be necessary, Silage cutting should not be permitted. From the first of July until mid-September grazing should be at least at 2-3 cattle/ha or cattle mixed with 11-16 plus sheep/ha (maximum level depending on quality and quantity of grass). If weather permits, continue grazing at lower levels into early October. From July onwards primarily mature cattle, in either beef or milking herds, should be used. NB stocking levels may need to be adjusted in the light of climatic conditions influencing the growth of grass in a particular summer.

Grazing has been shown to have a detrimental effect on moth abundance. Outside the 3 kilometres zone in the wider roost sustenance zone cattle may be grazed at 1/ha and sheep at 5/ha. At these lower grazing rates longer swards are likely to be maintained to the benefit of Noctuid moths.

Ivermectin is a broad spectrum antiparasitic drug approved for the use in cattle, sheep and horses. The drug is absorbed systemically after administration and is excreted mainly in the faeces. Being insecticidal, residues of ivermectin in cow dung can reduce the number of dung beetles, appearing to inhibit larval development and/or prevent pupation from taking place and thus could reduce prey availability to Greater

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[99] Derived from Ransome, R. D. 1996. The management of feeding areas for greater horseshoe bats. English Nature research report No.174. Peterborough: English Nature; Fuentes-Montemayor,E., Goulson, D.,Cavin, L., Wallace, J. M. & Park, K. J. 2012. Factors influencing moth assemblages in woodland fragments on farmland: Implications for woodland management and creation schemes. *Biological Conservation* 153 (2012) 265–275; Merckx, T. & Macdonald, D. W. 2015. Landscape-scale conservation of farmland moths: in Macdonald, D. W. & Feber, R. E. (eds) 2015. *Wildlife Conservation on Farmland. Managing for Nature on Lowland Farms.* Oxford: Oxford University Press; Fuentes-Montemayor, E., Goulsion, D.& Park, K. J. 2010, The effectiveness of agri-environment schemes for the conservation of farmland moths: assessing the importance of a landscape-scale management approach. *Journal of Applied Ecology* 48, 532-542

Horseshoe bats.[100] In one study higher numbers of *Aphodius* sp. were found in dung in long swards from cattle treated with ivermectin[101]. However, it appears that smaller numbers emerge from the dung, compared with the dung of untreated cattle, as the number of eggs per female *A. rufipes* can be significantly reduced but the magnitude of the decline is not large[102].

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However, it must be emphasised there are inherent issues in using third parties to create new pasture as replacement habitat in perpetuity in terms of reasonableness and enforceability. These were highlighted in the Churston Golf Club planning appeal which was refused as grazing could not be sustained.[103]

Grassland

A6.3 The creation of species rich grassland is likely to be more feasible in response to providing replacement habitat to mitigate the impacts of a development. This will need to be managed to produce a long sward to support an abundance of Noctuid moths, one of the main prey items hunted by Greater Horseshoe bats. Specified seed mixes should include food plants, as well as grasses, such as dandelion, dock, hawkweeds, plantains, ragwort, chickweed, fat hen, mouse-ear and red valerian and other herbaceous plants. Buddleia and bramble in particular, and other scrub species may be planted within or on the edges of the grassland. The grassland should be divided into parcels and cut in rotation once a year in October and the cuttings removed. Where grassland is established as a field margin this should be at least 6 metres wide.

Woodland

A6.4 Again off-site the replacement of coniferous woodland with broad-leaved woodland would benefit Greater Horseshoe bats. This should be carried out gradually over a period of time to avoid extensive clear-felling. Macromoth abundance is higher at the edge of woodland than in the interior. All woodlands should be permeated by grassy rides, and contain grassy glades. They should be managed without insecticide treatments. Glades probably need to be 10 - 15 metres across before they will be used by the bats for feeding. Macromoth abundance and species richness were positively affected by tree species richness and by the relative abundance of native trees in a woodland patch. Of dominant ground types, 'grass' and 'litter' had higher abundances and species richness than bare ground, herbs, moss or ferns. Woodland size is positively related to macromoth abundance.

Woodlands over 5ha have the highest values of moth diversity and abundance. However, relatively small patches (e.g. woodlands between 1 and 5 ha) seem to contain relatively large moth populations.

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[100] http://jncc.defra.gov.uk/page-2736

[101] Foster, G., Bennett, J. & Bateman, M. 2014. Effects of ivermectin residues on dung invertebrate communities in a UK farmland habitat. *Insect Conservation and Diversity*, 7 (1): 64-72; Beynon, S.A., Peck, M., Mann, D.J. & Lewis, O.T. 2012. Consequences of alternative and conventional endoparasite control in cattle for dung-associated invertebrates and ecosystem functioning. *Agriculture, Ecosystems & Environment*, 162, 36-44.

[102] O'Hea, N.M., Kirwan, L., Giller, P.S. & Finn, J.A. 2010. Lethal and sub-lethal effects of ivermectin on north temperate dung beetles, *Aphodius ater* and *Aphodius rufipes* (Coleoptera: Scarabaeidae). http://repository.wit.ie/1974/2/Bioassays_final.pdf

[103] See paragraphs 41 to 50 of Appeal Ref: APP/X1165/A/13/2205208 Land at Churston Golf Club, Churston, Devon, TQ5 0LA. https://acp.planninginspectorate.gov.uk/ViewCase.aspx?Caseid=2205208&CoID=0

However, when creating woodland for horseshoe bats the target species should be considered as the specification will be different (see Lesser Horseshoe bats below)

Hedgerow

A6.5 Hedgerow acts as commuting structure and provides feeding perches for Greater Horseshoe bats. Over 90% of prey caught by bats is brought in on the wind from adjacent habitats. New hedge lines could be planted off-site to divide up large grazed fields into smaller units and link them to blocks of woodland. Hedgerows should be 3 to 6 metres wide and 3 metres high with standard trees planted frequently along its length. The provision of trees increases moth abundance. Cutting should be restricted to the minimum needed to ensure visibility or retain hedgerow structure. Hedgerows are best cut every 2-3 years, working on only one part or side at any time.

A6.6 A species-rich grass strip, a minimum of 6 metres wide, with a long sward, managed as described above, should accompany hedgerow creation as this will enhance moth abundance[104].

Lesser Horseshoe Bats[105]

Woodland with Water

A6.7 Lesser Horseshoe bats hunt a variety of insects which are generally smaller than those consumed by Greater Horseshoe bats. These include micromoths, gnats, midges, mosquitoes, craneflies, brown lacewings, caddis flies and ichneumon wasps. Barataud et al (2000) found the woodland associated with water was the most preferred habitat by Lesser Horseshoe bats.

A6.8 Micromoth abundance is positively related to the relative abundance of native trees[106] and unlike macromoths the percentage cover of understory in a woodland patch. Micromoth abundance was higher within the woodland interior than at the edge. The shape of the woodland patch was important particularly for woodland micromoth species, indicating that patches of compact shapes (with proportionally less edge exposed to the surrounding matrix) sustain a larger number and larger populations of woodland species of micromoths. This highlights the importance of designing patches

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104 Merckx, T. & Macdonald, D. W. 2015. Landscape-scale conservation of farmland moths: in Macdonald, D. W. & Feber, R. E. 2015. *Wildlife Conservation on Farmland. Managing for Nature on Lowland Farms*. Oxford: Oxford University Press.

105 Derived from Barataud, M., Faggio, G., Pinasseau, E. & Roué, S. G. 2000. *Protection et restauration des habitatas de chasse du Petit rhinolophe (*Rhinolophus hipposideros*) Année 2000.* Paris: Ministère de l'Environnement – Direction de la Nature et des Paysages ; Fuentes-Montemayor,E., Goulson, D.,Cavin, L., Wallace, J. M. & Park, K. J. 2012. Factors influencing moth assemblages in woodland fragments on farmland: Implications for woodland management and creation schemes. *Biological Conservation* 153 (2012) 265–275; Chinery, M. 2007. *Insects of Britain and Western Europe*. London: A & C Black; Fuentes-Montemayor, E., Goulsion, D.& Park, K. J. 2010, The effectiveness of agri-environment schemes for the conservation of farmland moths: assessing the importance of a landscape-scale management approach. *Journal of Applied Ecology* 48, 532-542; Entwistle, A. C., Harris, S., Hutson, A. M., Racey, P. A., Walsh, A., Gibson, S. D., Hepburn, I. & Johnston, J. 2001. *Habitat management for bats: A guide for land managers, land owners and their advisors*. Peterborough: Joint Nature Conservation Committee.

106 '*Many native tree species (e.g. Betula sp., Quercus sp. and Salix sp.) have large numbers of moth species associated with them (i.e. feeding on them), although this is not always the case and there are native trees (e.g. Fagus sylvatica) which support relatively few moth species, comparable in number to those supported by non-native trees (e.g. Acer pseudoplatanus; Young, 1997)*' [Fuentes-Montemayor,E., Goulson, D.,Cavin, L., Wallace, J. M. & Park, K. J. 2012. Factors influencing moth assemblages in woodland fragments on farmland: Implications for woodland management and creation schemes. *Biological Conservation* 153 (2012) 265–275]; Entwistle, A. C., Harris, S., Hutson, A. M., Racey, P. A., Walsh, A., Gibson, S. D., Hepburn, I. & Johnston, J. 2001. *Habitat management for bats: A guide for land managers, land owners and their advisors*. Peterborough: Joint Nature Conservation Committee.

of compact shapes, especially when the patch to be created is small. Brown lacewings can be found amongst conifers. Woodland trees and shrubs should be planted in naturalistic non-linear patterns. Scalloped edges and bays will provide sheltered areas with higher insect concentrations. Provide a variety of types of vegetation from trees to shrubs and rough grass. Overhanging branches and bushy shrubs should be left to provide cover. Woodland edges can be used both by bats that fly in woodland and in the open. When developed the woodland should not be coppiced.

A6.9 Mosquitoes and caddies fly larvae are aquatic, as can be gnat larvae. Gnats and midges also use damp places near water to breed. Therefore the incorporation of ponds in association with the woodland habitat is likely to increase their value to Lesser Horseshoe bats. Ponds with permanent water should be created. It is possible that these could form attenuation features as part of the surface water mitigation for a development. They should be designed so that water is maintained within them throughout the year.

A6.10 Variation on the banks of ponds favours high insect and structural diversity. Design in as many natural features as possible, including varied depths, diverse aquatic and bankside vegetation, and overhanging trees. Grassy margins, scrub and overhanging vegetation provide excellent conditions for insects. Habitat diversity can often be achieved simply through allowing growth of taller vegetation. Where bank management is necessary, restrict it to a small area and work on one bank at a time. Carry out management sensitively, aiming to enhance variation in vegetation. Use fencing to prevent livestock from causing excessive damage to water margins.

Grassland

A6.11 Long sward grassland is also of benefit to Lesser Horseshoe bats as that described above for Greater Horseshoe bats. The management of grassland should be as that fro Great Horseshoe bats. Rough grassland and scrub is an important predictor of micro moth abundance

Hedgerow

A6.12 Hedgerow acts as commuting structure and provides feeding perches for Lesser Horseshoe bats. Over 90% of prey caught by bats is brought in on the wind from adjacent habitats. New hedge lines could be planted off-site to divide up large grazed fields into smaller units and link them to blocks of woodland. Hedgerows should be 3 to 6 metres wide and 3 metres high with standard trees planted frequently along their length. The provision of trees increases moth abundance.

Annex 7: Application of the Habitats Regulations

A7.1 The Habitats Regulations protect identified *sites* by designation as Special Areas of Conservation. However, the Habitats Regulations also protects *habitat* which is important for the Favourable Conservation Status of the species.[107]

A7.2 Achieving Favourable Conservation Status of a site's features "… *will rely largely on maintaining, or indeed restoring where it is necessary, the critical components or elements which underpin the integrity of an individual site. These will comprise the extent and distribution of the qualifying features within the site and the underlying structure, functions and supporting physical, chemical or biological processes associated with that site and which help to support and sustain its qualifying features*".[108]

A7.3 Regulation 61 Habitats Regulations states that:

A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which –

(a) is likely to have a significant effect on a European Site … (either alone or in combination with other plans or projects), and
(b) is not directly connected with or necessary to the management of that site must make an appropriate assessment of the implications for that site in view of that site's conservation objectives.

A7.4 Regulation 61 therefore describes a two-stage procedure: a screening stage where the "competent authority" has grounds to conclude whether a plan or project is likely to have a significant effect on a European site, and the appropriate assessment stage if it concludes that a significant effect is likely.

A7.5 In accordance with Regulation 61 information submitted with a planning application will be used by the Somerset Authorities to determine whether the proposal is likely to have a significant effect on the SAC. The Somerset authorities will apply a "Test of Likely Significant Effect" for proposals which involve or may involve:

- the destruction of a Greater Horseshoe and/or Lesser Horseshoe bat roost (maternity, hibernation or subsidiary roost);
- loss of foraging habitat for SAC bats
- fragmentation of commuting habitat for SAC bats
- increase in luminance in close proximity to a roost and/or increase in luminance to foraging or commuting habitat
- impacts on foraging or commuting habitat which supports the SAC bat populations structurally or functionally

[107] See European Site Conservation Objectives for Bath and Bradford on Avon Bats Special Area of Conservation at Annex [ ]
[108] Natural England Standard: Conservation Objectives for European Sites in England Standard 01.02.2014 V1.0 http://publications.naturalengland.org.uk/publication/6734992977690624

A7.6 When considering whether a project is likely to have a significant effect on a European site, the competent authority should take account of mitigation measures which are built into the project. Mitigation measures are measures which are designed to *avoid* or *reduce* adverse effects on a European site. It is important to distinguish these from compensatory measures which are designed to compensate for unavoidable adverse effects on a European site and follow the "3 tests"[109]. Compensatory measures will not be taken into account at the Test of Likely Significant Effect stage.

A7.7 The precautionary principle underpins the Habitats Directive[110] and hence the Habitats Regulations and must be applied by the local planning authority as Competent Authority as a matter of law.[111] It is clear that the decision whether or not an appropriate assessment is necessary must be made on a precautionary basis.[112] In addition, the Waddenzee judgement[113] requires a very high level of certainty when it comes to assessing whether a plan or project will adversely affect the integrity of a European site. The judgement states that the competent authority must be sure, certain, convinced that the scheme will not adversely affect the integrity of the site. It goes on to state that that there can be no reasonable scientific doubt remaining as to the absence of adverse effects on the integrity of the site.

A7.8 For the Somerset authorities to be able to conclude with enough certainty that a proposed project or development will not have a significant effect on the SAC, the proposal or project must therefore be supported by adequate evidence and bespoke, reasoned mitigation. Where appropriate a long term monitoring plan will be expected to assess whether the bat populations have responded favourably to the mitigation. It is important that consistent monitoring methods are used pre- and post-development, to facilitate the interpretation of monitoring data.

A7.9 Mitigation, an Ecological Management Plan and, (where required) monitoring during and / or post development, will be secured through either planning conditions or a S106 agreement or both. Data from monitoring will be used by the Somerset Authorities to determine how the bat populations have responded to mitigation and to increase the evidence base.

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[109] See ODPM circular 06/2005

[110] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the 'Habitats Directive')

[111] *Assessing Projects under the Habitats Directive: Guidance for Competent Authorities* 2011, CCW p.15

[112] ODPM Circular 06/2005 para13

[113] ECJ judgement: C-127/02 [2004] ECR-I

Part D: Appendices

Appendix 1: Comparison of Home Ranges of Horseshoe Bats Derived from Radio-Tracking Studies

Greater Horseshoe Bats

Results	Average Distance (km)	Maximum Distance (km)	Reference
Non-Breeding Roost			
Mean maximum distance from roost to foraging area (maximum distance for each tracked individual averaged over the colony, foraging areas estimated used 90% cluster analysis) 2.17km, range 0.95-2.93km (Boar Mill) and 2.44km, range 0.61-3.76 (Creech).	2.17	2.93	Flanders, J. & Jones, G., 2009. Roost use, ranging behaviour and diet of Greater Horseshoe bats (*Rhinolophus ferrumequinum)* using a transitional roost. *Journal of Mammalogy* 90: 888-896.
	2.44	3.76	
Maternity Roosts			
Maximum distance travelled from roost 4km for juveniles and 8km for adults. Majority of foraging areas are within 6km of roost.		8	Billington, G. 2003. *Radio tracking study of Greater Horseshoe bats at Buckfastleigh Caves Site of Special Scientific Interest*: English Nature Research Report no. 573. Peterborough: English Nature.
Maximum distance travelled from roost 7.5km for adult bats. The majority of foraging areas are within 5km of roost.		7.5	English Nature Research Report no. 496
Maximum distance travelled from roost 6.8km, mean 1.9km (22 May-5 June), 13.9km, mean 6.2km (18-31 July). Overall 92% of foraging time spent within 6km of the roost and 60% within 4km. In May-June 92.7% foraging was within 3km, in July only 9.7% occurred within 3km. Only one bat flew further than 6km during May.	1.9	6.8	Robinson, M. F., Webber, M. & Stebbins, R. E. 2000. *Dispersal and foraging behaviour of Greater Horseshoe bats, Brixham, Devon*. English Nature Research Report No. 344. Peterborough: English Nature.
Maximum distance travelled from roost 4.5km (juvenile) and 6.8km (adult). Majority of time spent within 4km. However,, measured in GIS the range is 8km		8.0	Billington, G. 2001. *Radio tracking study of Greater Horseshoe bats at Brockley Hall Stables Site of Special Scientific Interest, May – August 2001.*English Nature Research Report No. 442. Peterborough: English Nature.
Maximum distance travelled from roost 3.6km (juvenile) 4.5km (adult).	2.2	4.5	Duverge, P., 1996. Foraging activity, habitat use, development of juveniles, and diet of the Greater Horseshoe bat (*Rhinolophus ferrumequinum* - Schreber 1774) in south-west England. PhD Thesis, University of Bristol.
Maximum distance travelled from roost 5.52km, mean distance from roost to foraging event (extended period of relatively stable signal strength indicating foraging behaviour), averaged over all fixes		5.52	Rossiter, S.J., Jones, G., Ransome, R.D., Barratt, E.M., 2002. Relatedness structure and kin-biased foraging in the Greater Horseshoe bat (*Rhinolophus ferrumequinum*). *Behavioural Ecology and Sociobiology* 51: 510-518.

Results	Average Distance (km)	Maximum Distance (km)	Reference
of all individuals tracked 1.68km ± 0.09.			
Maximum distance 5.75km measured from radio tracking fixes in GIS		5.75	Jones, Dr. G. & Billington, G. 1999. *Radio tracking study of Greater Horseshoe bats at Cheddar, North Somerset*. Taunton: English Nature.
Greater Horseshoe bat maximum foraging distance from the roost was 5.81km in June and 5.98km in August, with average distances being approximately 3.58km and 3.83km, respectively. These are similar figures to the 1999 study, where greater horseshoes were proven to forage up to 5.75km from the roost (Jones and Billington, 1999).	3.58	5.81	Rush,T. & Billington, G. 2013. *Cheddar Reservoir 2: Radio tracking studies of greater horseshoe and Lesser Horseshoe bats, June and August 2013*. Witham Friary: Greena Ecological Consultancy.
	3.83	5.98	
Maximum distance 4km measured from radio tracking fixes in GIS		4	Billington, G. 2000. *Radio tracking study of Greater Horseshoe bats at Mells, Near Frome, Somerset*. Peterborough: English Nature
Average distance to foraging areas was <3km until the end of May and after that it was around 5km. The longest distance travelled by one bat was 10.5km.		5	Billington, G. 2000. *Combe Down Greater Horseshoe bats: radio tracking study*. Bat Pro Ltd on behalf of Bath & North East Somerset Council
Maximum distance travelled from roost 7.4km. 50% of bat locations were within 1.7km of the roost.	1.7	7.4	Bontadina, F. 2002. Conservation ecology in the horseshoe bats *Rhinolophus ferrumequinum* and *Rhinolophus hipposideros*. PhD Thesis, University of Bern.

Lesser Horseshoe Bats

Results	Average Distance (km)	Maximum Distance (km)	Reference
Maximum distance travelled from roost, where home range had reached asymptote 273 - 4177m, mean maximum distance 1955m. Fifty percent of tracking locations were within 600m of maternity roost.	1.96	4.177	Bontadina, F., Schofield, H., Naef-Daenzer, B., 2002. Radio-tracking reveals that Lesser Horseshoe bats (*Rhinolophus hipposideros*) forage in woodland. *Journal of Zoology* 258: 281-290.
Bats were recorded ranging 6km to the north, 1.5km east, 2km south and 5km to the west.		6	Billington, G. 2005. *Radio tracking study of Lesser Horseshoe bats at Hestercombe House Site of Special Scientific Interest, July 2005.* English Nature Somerset & Gloucestershire Team.

Results	Average Distance (km)	Maximum Distance (km)	Reference
The bats foraged within a radius of 1.0-4.0km from the roost, with the majority remaining within 2.0km. The average foraging radius in May was slightly higher than that recorded in August (1.93km v/s 1.52km)	1.93	4	Duvergé, L. 2008. *Report on bat surveys carried out at Hestercombe House SSSITaunton, Somerset, in 2007 and 2008.* Cullompton: Kestrel Wildlife Consultants.
Lesser Horseshoe bat maximum foraging distance from the roost was 3.24km in June and 6.08km in August, with average distances being approximately 2.26km and 3.72km, respectively.	2.26	3.42	Billington, G. 2013. *Cheddar Reservoir 2: Radio tracking studies of greater horseshoe and Lesser Horseshoe bats, June and August 2013*. Witham Friary: Greena Ecological Consultancy.
	3.72	6.08	
The mean maximum range distance from the maternity roost for adult females was identical in each landscape (2.0 km) although the maximum distance an individual adult female was recorded flying to did vary. The value was 4.1 km for lowland, 3.5 km for high quality and 3.3 km for upland. Nulliparous females and juveniles were recorded a maximum of 4.5 km and 3.8 km respectively from the maternity roost in the lowland landscape.	2	4.1	Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD Thesis, University of Bristol.
	2	3.5	
	2	3.3	
Maximum distance from maternity roost to centre of furthest foraging area 3.6km, 3.2km and 2.8km respectively. Mean distance from maternity roost to night roosts 1.71km ± 0.98 SD, 2.4km ± 1.44 SD and 1.34km ± 0.86 SD respectively.		3.6	Knight, T., Jones, G., 2009. Importance of night roosts for bat conservation: roosting behaviour of the Lesser Horseshoe bat *Rhinolophus hipposideros. Endangered Species Research 9: 79-86.*
		3.2	
		2.8	
One individual tracked - Maximum distance travelled from roost 3.6km, mean distance between roost and foraging area (calculated using MCPs, no further info given) 2.4km	2.4	3.6	Holzhaider, J., Kriner, E., Rudolph, B.-U., Zahn, A., 2002. Radio-tracking a Lesser Horseshoe bat (*Rhinolophus hipposideros*) in Bavaria: an experiment to locate roosts and foraging sites. *Myotis 40: 47-54.*

Appendix 2: Greater Horseshoe Bat Habitat Suitability Index

Text Colour
Black = Habitat Codes
Blue = Matrix Codes
Green = Formation Codes
Red = Management Codes

NP = Not permissible. It is considered that the habitat is not replaceable

A complete list with full descriptions and parameters of the habitat labels can be obtained from Somerset Environmental Records Centre[114].

Code	Label	HSI	Notes
WB0	Broadleaved, mixed, and yew woodland	6	Four principal habitat types: scrub, meadow, deciduous woodland and grazed pasture (Billington, 2000b) High over grown hedges and tree lines surrounding pasture, rough grassland or scrub, with nearby woodland edge and riparian habitat (Billington, 2003; Billington, 2000a) Limited foraging recorded within woodland itself (Billington, 2003) Macro and micro moths densest where grass or litter, less so where there are ferns, moss, bare ground, herbs. Richer where native tree diversity and larger basal area. Species such as oak, willow and birch have large numbers of moths whereas beech has little comparable to non-native species such as sycamore (Fuentes-Montemayor et al, 2012) Woodland has high levels of moths (Ransome, 1997a) Have been found to spend significant times in woodland, being sheltered, often warmer at night, and insects are much more abundant than open fields (Billington, 2000) Support the retention of all mature ancient semi natural deciduous woodland, old orchards and parkland (Ransome, 1997) Extensive use of woodland edge (Ransome, 1997) Limited foraging of adults were recorded in woodlands of only a few minutes duration except during medium-heavy rainfall when most of the foraging time was spent in broadleaf and coniferous woodland (Billington, 2000)
WB1	Mixed woodland	5	
WB2	Scrub woodland	1	
WB3	Broadleaved woodland	6	
WB31	Upland oakwood [=Old sessile oak woods with Ilex and Blechnum in the British Isles(AN1)]	NP	
WB32	Upland mixed ashwoods	NP	
WB33	Beech and yew woodlands	3	
WB331	Lowland beech and yew woodland	NP	
WB3311	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	NP	
WB3312	Asperulo-Fagetum beech forests	NP	
WB3313	Taxus baccata woods of the British Isles	NP	
WB331Z	Other lowland beech and yew woodland	3	
WB33Z	Other beech and yew woodlands	3	
WB34	Wet woodland	3	
WB341	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	NP	
WB342	Bog woodland	NP	
WB34Z	Other wet woodland	3	
WB36	Lowland mixed deciduous woodland	6	
WB361	Old acidophilous oak woods with Quercus robur on sandy plains	NP	
WB362	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	NP	
WB363	Tilio-Acerion forests of slopes, screes and ravines [lowland]	NP	
WB36Z	Other lowland mixed deciduous woodland	6	
WB3Z	Other broadleaved woodland	6	

[114] SERC, 34 Wellington Road, Taunton TA1 5AW **Telephone**: 01823 664450 **Fax**: 01823 652411

Code	Label	HSI	Notes
WC0	Coniferous woodland	1	
WCZ	Other coniferous woodland	1	
IH0	Introduced shrub	0	Note: Introduced shrub can include Buddleia, which attracts Large Yellow Underwing. If present the HSI score should +1 or 2 according to abundance
WF0	**Unidentified woodland formation**	1	
WF1	Semi-natural	1	
WF11	Native semi-natural	1	
WF111	Canopy Cover >90%	0.1	
WF112	Canopy Cover 75 - 90%	0.25	
WF113	Canopy Cover 50 - 75%	0.75	
WF114	Canopy Cover 20 - 50%	1	
WF12	Non-native semi-natural	1	
WF121	Canopy Cover >90%	0.1	
WF122	Canopy Cover 75 - 90%	0.25	
WF123	Canopy Cover 50 - 75%	0.75	
WF124	Canopy Cover 20 - 50%	1	
WF2	Plantation	0.75	
WF21	Native species plantation	0.75	Uniform stands of trees are poorer in invertebrates than more diversely structured woodland (Kirby, 1988).
WF22	Non-native species plantation	0.25	
WF3	Mixed plantation and semi-natural	0.75	
WF31	Mixed native species semi-natural with native species plantation	0.75	
WF32	Mixed native species semi-natural with non-native species plantation	0.5	
WF33	Mixed non-native species semi-natural with native species plantation	0.25	
WF34	Mixed non-native species semi-natural with non-native species plantation	0.1	
WM0	Undetermined woodland management	1	
WM1	High forest	1	
WM2	Coppice with standards	0.25	
WM3	Pure coppice	0.25	
WM4	Abandoned coppice	0.25	Support the retention of all mature ancient semi natural deciduous woodland, old orchards and parkland (Ransome, 1997a) Deer and sheep grazing in woodland results in short cropped open glades (Ransome, 2007a) In woodland mainly used clearings and woodland edge (Billington, 2009) Rides, footpaths … were used by greater horseshoe bats when flying in these feeding areas. (Duvergé & Jones, 1994)
WM5	Wood-pasture and parkland	1	
WM51	Currently managed wood pasture/parkland	1	
WM52	Relic wood pasture/parkland	1	
WM6	Pollarded woodland	0.75	
WM7	Unmanaged woodland	1	
WMZ	Other woodland management	1	
WG0	Unidentified woodland clearing	1	
WG1	Herbaceous woodland clearing	1	
WG2	Recently felled/coppiced woodland clearing	1	
WG3	Woodland ride	1	
WG4	Recently planted trees	0.5	
WGZ	Other woodland clearings/openings	1	
GA0	Acid grassland	6	
GA1	Lowland dry acid grassland	6	
GC0	Calcareous grassland	6	
GC1	Lowland calcareous grassland	6	
GC11	Semi-natural dry grasslands and scrubland facies on calcareous substrates [Festuco-Brometalia]	NP	

Code	Label	HSI	Notes
GC12	Semi-natural dry grasslands and scrubland facies on calcareous substrates [Festuco-Brometalia] [important orchid sites]	NP	
GN0	Neutral grassland	6	
GN1	Lowland meadows	6	
GN11	Lowland hay meadows [Alopecurus pratensis, Sanguisorba officinalis]	NP	
GI0	Improved grassland	3	
GP0	Grassland, probably improved	3	
GU0	Grassland, semi improved	4	
SC1	Dense/continuous scrub	-3	The Integrated Habitat System considers scrub as a matrix habitat when less than 0.25ha. Otherwise use WB2
SC11	Dense/continuous scrub: native shrubs	-3	
SC12	Dense/continuous scrub: introduced shrubs	-3	
SC2	Open/scattered scrub	1	
SC21	Open/scattered scrub: native shrubs	1	
SC22	Open/scattered scrub: introduced shrubs	1	
TS0	Scattered trees	0	
TS1	Scattered trees some veteran	1	
TS11	Broadleaved	1	
TS12	Mixed	0	
TS13	Coniferous	0	
TS2	Scattered trees none veteran	0	
TS21	Broadleaved	0	
TS22	Mixed	0	
TS23	Coniferous	0	
PA0	Patchy bracken	0	
PA1	Patchy bracken communities with a diverse vernal flora (NVC U20a)	0	
PA2	Small continuous bracken stands	0	
PA3	Scattered bracken	0	
OT0	Tall herb and fern (excluding bracken)	0	
OT3	Tall ruderal	0	
OT4	Non-ruderal	0	
OT41	Lemon-scented fern and Hard-fern vegetation (NVC U19)	0	
OT4Z	Other non-ruderal tall herb and fern	0	
OTZ	Other tall herb and fern	0	
HS0	Ephemeral/short perennial herb	0	
BG1	Bare ground	0	
GM0	Undetermined grassland etc. management	1	
GM1	Grazed	1	
GM11	Cattle grazed	1	
GM12	Sheep grazed	0.75	Most important factor is grazed pasture (Ransome, 1997) Within 1 kilometre of the roost the presence of permanent grazed pasture is critical for juvenile greater horseshoe bats. A high density of grazing animals should be present giving high presence of dung. Within the remainder of the roost foraging
GM13	Horse grazed	0.8	
GM14	Mixed grazing	0.8	
GM1Z	Other grazing	0.75	
GM2	Mown	0.3	
GM21	Silage	0.2	
GM22	Hay	0.3	

Code	Label	HSI	Notes
GM23	Frequent mowing	0	range grazing regimes can be more flexible provided adequate pasture is available. Longer swards benefit the larvae of noctuid moths. (Ransome, 1996) The short turf produced by sheep grazing may be responsible for high *Melolontha* levels (Ransome, 1997) Sheep dung provides prey Short grazed habitat for *Melolontha* and Tupilids. All species requires short grass to oviposit. (Ransome, 1997; Ransome, 1997) *Aphodius* live in cow, sheep and horse dung (Ransome, 1997) Meadows which have been cut, and where animals are grazing, were also used (Duverge & Jones, 1994)
GM2Z	Other mowing regime	0.2	
GM3	Hay and aftermath grazing	0.8	
GM4	Unmanaged	1	
GM5	Burning/swaling	0	
GMZ	Other grassland etc. management	0	
GL1	Amenity grassland	0.1	
GL11	Golf course	0.25	
GL12	Urban parks, playing and sports fields	0	
GL1Z	Other amenity grassland	0.1	
GL2	Non-amenity grassland	1	
GL21	Permanent agricultural grassland	1	
GL211	Arable reversion grassland	1	
GL2111	Species-rich conservation grassland	1	
GL211Z	Other arable reversion grassland	1	Support the retention of all ,,, old orchards (Ransome, 1997)
GL21Z	Other permanent agricultural grassland	1	
GL2Z	Other grassland use	0.25	
CL3	Un-intensively managed orchards	1	
CL31	Traditional orchards	1	
CL32	Defunct orchards	1	
CL3Z	Other un-intensively managed orchards	1	
CF1	Coastal and floodplain grazing marsh	1	
BR0	Bracken	0	
HE0	Dwarf shrub heath	0	
HE1	European dry heaths	0	
HE2	Wet heaths	0	
EO0	Bog	NP	
EM0	Fen, marsh and swamp	2	
EM1	Swamp	0	Tipulid larval development is favoured by damp conditions, any aquatic environments and/or marshes should be retained Aquatic environments will also favour the production of caddis flies (Trichoptera) (Ransome, 1997b; Ransome, 1997a) in certain months, May and late August/September when other food supplies may be erratic (Ransome 1997a) Significant Trichopteran consumption at roosts close to extensive river or lake habitats (Ransome, 1997)
EM11	Reedbeds	0	
EM2	Marginal and inundation vegetation	1	
EM21	Marginal vegetation	1	
EM22	Inundation vegetation	0	
EM3	Fens	2	
EM31	Fens [and flushes - lowland]	2	
EM312	Springs	1	
EM313	Alkaline fens [lowland]	1	
EM4	Purple moor grass and rush pastures [Molinia-Juncus]	1	
AS0	Standing open water and canals	4	
AS1	Dystrophic standing water	2	
AS11	Natural dystrophic lakes and ponds	2	
AS1Z	Other dystrophic standing water	2	
AS2	Oligotrophic standing waters	3	
AS21	Oligotrophic lakes	2	
AS3	Mesotrophic standing waters	4	
AS31	Mesotrophic lakes	2	
AS3Z	Other mesotrophic standing waters	2	
AS4	Eutrophic standing waters	3	

Code	Label	HSI	Notes
AS5	Marl standing water	2	
AS6	Brackish standing water with no sea connection	0	
AS7	Aquifer fed naturally fluctuating water bodies	2	
ASZ	Other standing open water and canals	2	
AC0	Channel of unknown origin	1	Used for commuting. to cross the central Moors south of Cheddar where the bats frequently fly below ground level in drainage channels such as the Cheddar Canal (Jones & Billington, 1999)
AC1	Artificial channels	1	
AC11	Drains, rhynes and ditches	1	
AC111	Species-rich drains, rhynes and ditches	1	
AC11Z	Other drains, rhynes and ditches	1	
AC12	Artificially modified channels	1	
AC13	New artificial channels	0.75	
AC14	Canals	0.5	
AC1Z	Other artificial channels	1	
AC2	Natural/naturalistic channels	1	
AO0	Open water of unknown origin	0.25	
AO1	Artificial open water	0.25	
AO11	Reservoir	0.25	
AO12	Gravel pits, quarry pools, mine pools and marl pits	0.25	
AO13	Industrial lagoon	0	
AO14	Scrape	0	
AO15	Moat	0.5	
AO16	Ornamental	0	
AO1Z	Other artificial open water	0	
AO2	Natural open water	0.25	
AP1	Pond	0.1	
AP11	Ponds of high ecological quality	0.5	
AP1Z	Other pond	0.1	
AP2	Small lake	0.25	
AP3	Large lake	0.25	
LT1	Canal-side	0.25	
LT11	Canal-side with woodland	1	
LT12	Canal-side with scrub or hedgerow and standard trees	1	
LT13	Canal-side with scrub or hedgerow	1	
LT14	Canal-side with layered vegetation	0.8	
LT15	Canal-side with grassland	0.5	
LT16	Canal-side with damaged banks	0.25	
LT17	Canal-side with constructed banks	0	
LT18	Other canal-side type	0.25	
AR0	Rivers and streams	3	The River Dart, a large river system, mostly banked by broadleaved woodland was also a key habitat (Billington, 2003)
AR1	Headwaters	3	
AR11	Chalk headwaters	3	
AR12	Active shingle rivers [headwaters]	3	
AR1Z	Other headwaters	3	
AR2	Chalk rivers (not including chalk headwaters)	3	
AR21	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (chalk substrate)	3	

Code	Label	HSI	Notes
AR2Z	Other chalk rivers	3	
AR3	Active shingle rivers [non headwaters]	3	
ARZ	Other rivers and streams	3	
LT2	River-side	1	
LT21	River-side with woodland	1	
LT22	River-side with scrub or hedgerow and standard trees	1	
LT23	River-side with scrub or hedgerow	1	
LT24	River-side with layered vegetation	0.8	
LT25	River-side with grassland	0.5	
LT26	River-sdie with vertical banks	1	
LT27	River-side with damaged banks	0.25	
LT28	River-side with constructed banks	0	
LT29	Other river-side type	0.25	
CR0	Arable and horticulture	1	
CR1	Grass and grass-clover leys	1	
CR2	Cereal crops	1	
CR3	Non-cereal crops including woody crops	1	
CR31	Intensively managed orchards	1	
CR32	Withy beds	1	
CR33	Vineyards	2	The caterpillar of Large Yellow Underwing can feed on grape vines
CR34	Game crops	1	
CR35	Miscanthus	0	
CR3Z	Other non-cereal crops including woody crops	1	
CR5	Whole field fallow	2	
CR6	Arable headland or uncultivated strip	4	
CR61	Arable field margins	4	
CR6Z	Other arable headland or uncultivated strip	4	
CRZ	Other arable and horticulture	0	
CL1	Agriculture	1	
CL11	Organic agriculture	1	
CL12	Non-organic agriculture	0.5	
CL2	Market garden and horticulture	0	
CL21	Organic market garden and horticulture	0	
CL22	Non-organic market garden and horticulture	0	
CL3	Un-intensively managed orchards	1	
CL31	Traditional orchards	1	
CL32	Defunct orchards	1	
CL3Z	Other un-intensively managed orchards	1	
CL4	Intensively managed vineyards	0	
CL4Z	Non-intensively managed vineyards	0	
CL5	Cereal crops managed for wildlife	0.75	
CL5Z	Cereal crops not managed for wildlife	0.25	
RE0	Inland rock	0	
RE1	Natural rock exposure features	0	
RE11	Natural rock and scree habitats	0	
RE112	Lowland natural rock and scree habitats	0	
RE14	Caves	6	

Code	Label	HSI	Notes
RE141	Caves not open to the public	NP	
RE14Z	Other caves	5	
RE15	Exposed river gravels and shingles	0	
RE1Z	Other natural rock exposure feature	0	
RE2	Artificial rock exposures and waste	1	
RE21	Quarry	1	
RE22	Spoil heap	0	
RE23	Mine	5	
RE24	Refuse tip	0	
RE2Z	Other artificial rock exposure and waste	0	
LF0	Boundary and linear features	6	Support the retention of existing hedgerows and tree lines linking areas of woodland. Encourage hedgerow improvement to become 3 to 6 metres wide, mean 3 metres high with frequent standard emergent trees (Ransaome, 1997)
LF1	Hedges / Line of trees	6	
LF11	Hedgerows	6	
LF111	Important hedgerows	6	
LF11Z	Non-important hedgerows	6	
LF12	Line of trees	4	Hedges used as perching sites (Duverge & Jones, 1994)
LF1Z	Other hedges/line of trees	4	
LF2	Other boundaries and linear features	3	The vast majority (over 90%) of insects found near hedges do not originate in the hedge but come from other habitats brought in on the wind (BCT, 2003)
LF21	Line of trees (not originally intended to be stock proof)	3	
LF22	Bank	0	
LF23	Wall	2	Hedges managed under agri-environment Schemes did not offer any benefit over conventionally managed hedgerows with regard to macro-moths (Fuentes-Montemayor et al, 2010)
LF24	Dry ditch	1	
LF25	Grass strip	0	
LF26	Fence	1	
LF27	Transport corridors	0	
LF271	Transport corridor without associated verges	0	
LF272	Transport corridor associated verges only	0	
LF273	Transport corridor with natural land surface	0	
LH1	Intact hedge	1	
LH2	Defunct hedge	1	
LH3	Recently planted hedge (Only use for existing habitat)	0.2	
LM1	Cut hedge	0.3	Cut hedge is specified where height is below 2 metres
LM11	Cut hedge with standards	0.3	
LM12	Cut hedge without standards	0.2	
LM2	Uncut hedge	0.9	Uncut hedge is specified where the hedge is between 2 and 3 metres high
LM21	Uncut hedge with standards	0.9	
LM22	Uncut hedge without standards	0.8	
LM3	Overgrown hedge	1	Overgrown hedge is considered to be over 3 metres high
LM31	Overgrown hedge with standards	1	
LM32	Overgrown hedge without standards	1	
LT3	Rail-side	0.5	
LT4	Road-side	0.5	
LT5	Path- and track-side	1	
LTZ	Other transport corridor verges, embankments and cuttings	0.5	
UL1	Railway	0	
UL2	Roadway	0	
UL3	Path and trackway	0	

Code	Label	HSI	Notes
ULZ	Other transport corridor	0	
UR0	Built-up areas and gardens	1	
UA1	Agricultural	0.1	
UA2	Industrial/commercial	0	
UA3	Domestic	0	
UA31	Housing/domestic outbuildings	0	
UA32	Gardens	0	
UA33	Allotments	0	
UA34	Caravan park	0	
UA3Z	Other domestic	0	
UA4	Public amenity	0	
UA41	Churchyards and cemeteries	0.1	
UA4Z	Other public amenity	0	
UA5	Historical built environment	1	
UAZ	Other extended built environment	0	

Appendix 3: Lesser Horseshoe Bat Habitat Suitability Index

Text Colour
Black = Habitat Codes
Blue = Matrix Codes
Green = Formation Codes
Red = Management Codes

NP = Not permissible. It is considered that the habitat is not

A complete list with full descriptions and parameters of the habitat labels can be obtained from Somerset Environmental Records Centre.

Code	Label	HSI	Notes
WB0	Broadleaved, mixed, and yew woodland	6	‘*The primary foraging habitat for lesser horseshoe bats is broadleaf woodland where they often hunt high in the canopy. However, they will also forage along hedgerows, tree-lines and well-wooded riverbanks.*’ (Schofield, 2008)
WB1	Mixed woodland	6	
WB2	Scrub woodland	6	
WB3	Broadleaved woodland	6	
WB31	Upland oakwood [=Old sessile oak woods with Ilex and Blechnum in the British Isles(AN1)]	NP	In lowlands broadleaved and mixed woodland is the most used habitat (Knight, 2006)
WB32	Upland mixed ashwoods	NP	Avoids dense scrub cover (Schofield 2008), i.e. WB2
WB321	Tilio-Acerion forests of slopes, screes and ravines [upland]	NP	Lesser horseshoe bats are primarily a woodland feeding bat using deciduous woodland or mixed coniferous woodland and hedgerows. It has been found that habitats that were most important contained a high proportion of woodland, parkland and grazed pasture woodland, combined with linear features, such as overgrown hedgerows. Woodland with watercourses has more importance. Broadleaved woodland predominated over other types of woodland and was shown to be a key habitat for the species. In the core foraging areas used by bats woodland accounted for 58.7 ± 5.2% of the habitats present. (Barataud et al, 2000; Bontadina et al, 2002)
WB32Z	Other upland mixed ashwoods	6	
WB33	Beech and yew woodlands	4	
WB331	Lowland beech and yew woodland	4	
WB3311	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrub layer (Quercion robori-petraeae or Ilici-Fagenion)	NP	
WB3312	Asperulo-Fagetum beech forests	NP	
WB3313	Taxus baccata woods of the British Isles	NP	
WB331Z	Other lowland beech and yew woodland	4	
WB33Z	Other beech and yew woodlands	4	Non-native - biomass of fir trees is 16 compared to Ash 41 and Oak 284
WB34	Wet woodland	6	Window gnats present
WB341	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	NP	Juveniles select broadleaved woodland habitat (Knight, 2006)
WB342	Bog woodland	NP	
WB34Z	Other wet woodland	6	Broadleaved, mixed middle age mature woodland with the presence of a river or pond on at least one side most favourable (Barataud et al, 2000)
WB35	Upland birch woodland	6	
WB36	Lowland mixed deciduous woodland	6	
WB361	Old acidophilous oak woods with Quercus robur on sandy plains	NP	In Bavaria foraged in all available forest types (semi natural mountainous beech-spruce-fir forests and more artificial spruce dominated forests except dense riparian forest. The large part of the time foraging time in forest of deciduous trees (*Fagus sylvatica*) (Holzhaider et al, 2002)
WB362	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	NP	
WB363	Tilio-Acerion forests of slopes, screes and ravines [lowland]	NP	A habitat index produced as a result of surveys carried out in four different habitats; plantation woodland; improved grassland, semi improved grassland and arable (root crops) produced the following index 1, 0.33, 0.2 and 0.05 for lesser horseshoe bat prey species abundance (Biron, 2007)
WB36Z	Other lowland mixed deciduous woodland	6	
WB3Z	Other broadleaved woodland	6	
WC0	Coniferous woodland	3	
IH0	Introduced shrub	0	Known to make use of shrubs such as rhododendron (Robertson, 2002)
WF0	Unidentified woodland formation	1	

Code	Label	HSI	Notes
WF1	Semi-natural	1	There was very little difference recorded in the availability of prey in woodland in Switzerland. Variation is due to woodland formation and management (Bontadina et al, 2008)
WF11	Native semi-natural	1	
WF111	Canopy Cover >90%	0.2	
WF112	Canopy Cover 75 - 90%	0.7	
WF113	Canopy Cover 50 - 75%	1	
WF114	Canopy Cover 20 - 50%	1	
WF12	Non-native semi-natural	0.8	Determined by woodland habitat type
WF121	Canopy Cover >90%	0.2	
WF122	Canopy Cover 75 - 90%	0.7	The density of the taller trees (either deciduous or coniferous) must be low enough to allow development of understorey of shrub and small coppice. (Motte & Libois, 2002)
WF123	Canopy Cover 50 - 75%	1	
WF124	Canopy Cover 20 - 50%	1	
WF2	Plantation	0.8	
WF21	Native species plantation	0.8	Uniform stands of trees are poorer in invertebrates than more diversely structured woodland (Kirby, 1988)
WF22	Non-native species plantation	0.6	
WF3	Mixed plantation and semi-natural	0.8	
WF31	Mixed native species semi-natural with native species plantation	0.8	
WF32	Mixed native species semi-natural with non-native species plantation	0.7	Used conifer planation at Ciliau but overall time in the habitat was small (Schofield et al, 2003)
WF33	Mixed non-native species semi-natural with native species plantation	0.7	
WF34	Mixed non-native species semi-natural with non-native species plantation	0.6	
WM0	Undetermined woodland management	1	
WM1	High forest	1	
WM2	Coppice with standards	1	
WM3	Pure coppice	1	
WM4	Abandoned coppice	1	
WM5	Wood-pasture and parkland	1	Lesser horseshoe bats hunting and swerving between branches of and in the foliage of coppice, at 1 to 4m high (Motte & Libois, 2002)
WM51	Currently managed wood pasture/parkland	1	
WM52	Relic wood pasture/parkland	1	
WM6	Pollarded woodland	1	
WM7	Unmanaged woodland	1	
WMZ	Other woodland management	1	
WG0	Unidentified woodland clearing	1	
WG1	Herbaceous woodland clearing	1	
WG2	Recently felled/coppiced woodland clearing	0.5	Clear cutting must be avoided (Motte & Libouis, 2002)
WG3	Woodland ride	1	
WG4	Recently planted trees	0.5	
WGZ	Other woodland clearings/openings	1	
GA0	Acid grassland	3	The majority of foraging areas around Glynllifon are associated with semi improved pasture bounded by hedgerows and scrub (Billington & Rawlinson, 2006)
GC0	Calcareous grassland	3	
GN0	Neutral grassland	3	
GN1	Lowland meadows	3	The vast majority (over 90%) of insects found near hedges do not originate in the hedge but come from other habitats brought in on the wind (BCT, 2003)
GI0	Improved grassland	2	
GU0	Grassland, semi improved	3	
SC1	Dense/continuous scrub	-3	The Integrated Habitat System considers scrub as a matrix habitat when less than 0.25ha. Otherwise use WB2
SC11	Dense/continuous scrub: native shrubs	-3	
SC12	Dense/continuous scrub: introduced shrubs	-3	Avoids dense scrub cover (Schofield 2008)
SC2	Open/scattered scrub	1	
SC21	Open/scattered scrub: native shrubs	1	

Code	Label	HSI	Notes
SC22	Open/scattered scrub: introduced shrubs	1	
TS0	Scattered trees	1	
TS1	Scattered trees some veteran	1	
TS11	Broadleaved	1	
TS12	Mixed	1	Presence of scattered trees in grassland/arable is likely to increase opportunity for foraging and increase insect diversity/biomass. Parkland habitats have been noted for lesser horseshoe bat foraging. There are a high number of Tipulid species in this habitat
TS13	Coniferous	0	
TS2	Scattered trees none veteran	0	
TS21	Broadleaved	0	
TS22	Mixed	0	
TS23	Coniferous	0	
PA0	Patchy bracken	0	
OT0	Tall herb and fern (excluding bracken)	0.25	
OT3	Tall ruderal	0.25	
OT4	Non-ruderal	0.25	
OT41	Lemon-scented fern and Hard-fern vegetation (NVC U19)	0.25	
OT4Z	Other non-ruderal tall herb and fern	0.25	
OTZ	Other tall herb and fern	0.25	
HS0	Ephemeral/short perennial herb	0	
BG1	Bare ground	0	Area of bare ground is not specified - assumed patchy
GM0	Undetermined grassland etc. management	1	The presence of cattle is a factor in access to foraging (Cresswell Associates, 2004). Dung flies have been shown to be an element of the diet but less so at Hestercombe House (Knight, 2008). Scatophagidae are a key element of their diet, and together with Sphaeroceridae, are frequently associated with dung (Knight, 2006)
GM1	Grazed	1	
GM11	Cattle grazed	1	
GM12	Sheep grazed	0.75	
GM13	Horse grazed	0.8	
GM14	Mixed grazing	0.8	
GM1Z	Other grazing	0.75	The presence of pasture is indispensable to the larval stage of development for certain species (Tipulids), which form a significant part of lesser horseshoe bat diet (Motte & Libois, 2002; Boye & Dietz, 2005).
GM2	Mown	0.5	
GM21	Silage	0.1	
GM22	Hay	0.6	Possibility of presence of window gnats but heavily managed or lit. Need to have associated matrix codes TS
GM23	Frequent mowing	0.25	
GM2Z	Other mowing regime	0.25	Possibility of presence of window gnats but heavily managed or lit. Need to have associated matrix codes TS
GM3	Hay and aftermath grazing	0.8	
GM4	Unmanaged	1	
GM5	Burning/swaling	0	
GMZ	Other grassland etc. management	0.5	
GL1	Amenity grassland	0.1	
GL11	Golf course	0.1	
GL12	Urban parks, playing and sports fields	0.1	
GL1Z	Other amenity grassland	0.1	
GL2	Non-amenity grassland	1	
GL21	Permanent agricultural grassland	1	
GL211	Arable reversion grassland	1	
GL2111	Species-rich conservation grassland	1	
GL211Z	Other arable reversion grassland	1	
GL21Z	Other permanent agricultural grassland	1	
GL2Z	Other grassland use	0.25	
CL3	Unintensively managed orchards	1	
CL31	Traditional orchards	1	
CL32	Defunct orchards	1	

Code	Label	HSI	Notes
CL3Z	Other unintensively managed orchards	1	
CF1	Coastal and floodplain grazing marsh	1	
BR0	Bracken	2	
HE0	Dwarf shrub heath	2	Bracken cover hosts over 40 species of invertebrates. Bracken and heath are used by lesser horseshoe bats in upland areas (Knight, 2006)
HE1	European dry heaths	2	
HE2	Wet heaths	1	
EO0	Bog	NP	Bog habitats are avoided by lesser horseshoe bats (Irish Bats)
EM0	Fen, marsh and swamp	3	
EM1	Swamp	1	
EM11	Reedbeds	1	
EM12	Calcareous fens with Cladium mariscus and species of the Carex davallianae	NP	
EM1Z	Other swamp vegetation	1	
EM2	Marginal and inundation vegetation	2	
EM21	Marginal vegetation	2	
EM22	Inundation vegetation	0	
EM3	Fens	3	
EM31	Fens [and flushes - lowland]	3	
EM311	Calcareous fens with Cladium mariscus and species of the Carex davallianae	NP	Fen was intensively used in Bavaria where groups of trees are present (Holzhaider et al, 2002)
EM312	Springs	2	Fen was intensively used in Bavaria where groups of trees are present (Holzhaider et al, 2002)
EM313	Alkaline fens [lowland]	2	
EM314	Transition mires and quaking bogs [lowland]	2	Culicidae were more abundant in the Hestercombe House diet compared with previous studies in Britain (8% compared with 1%) suggesting that the colony is utilising standing water sources and adjacent areas for foraging. Caddis flies supply 5% of diet. Mayflies less than 5%. Midge larvae are small and wormlike and develop in lakes, ponds, slow-moving streams, drainage ditches, and wet mud and even in highly polluted sewage water.
EM31Z	Other lowland fens	3	
EM3Z	Other fens, transition mires, springs and flushes	1	
EM4	Purple moor grass and rush pastures [Molinia-Juncus]	2	
EM41	Molinia meadows on calcareous, peaty or clayey-silt-laden soils [Molinia caeruleae]	NP	
EM42	Non-Annex 1 Molinia meadow and rush pasture habitats (SWT)	2	
EM421	Species-rich rush pastures (SWT)	2	
EM422	Non-Annex 1 Molinia meadows (SWT)	2	
EM4Z	Other purple moor grass and rush pastures [Molinia-Juncus]	2	
AS0	Standing open water and canals	6	
AS1	Dystrophic standing water	3	In Ireland activity as found to be greater around expanses of water than along roadside hedgerows. Foraging was concentrated around tree lined rivers and ponds (McAney & Fairley, 1988)
AS11	Natural dystrophic lakes and ponds	1	
AS1Z	Other dystrophic standing water	3	
AS2	Oligotrophic standing waters	4	
AS21	Oligotrophic lakes	1	The larvae of freshwater species usually live in cold clean flowing waters, but some species prefer warmer slower waters. They are very particular about water temperature and speed, dissolved minerals and pollutants, as http://animals.jrank.org/pages/2512/Caddisflies-Trichoptera.html#ixzz14E3GO5ZH
AS2Z	Other oligotrophic standing waters	4	
AS3	Mesotrophic standing waters	5	
AS31	Mesotrophic lakes	2	
AS3Z	Other mesotrophic standing waters	5	
AS4	Eutrophic standing waters	6	An increase in the number of chironomids results from eutrophication. Daubenton's feed downstream of sewage outputs (Racey, 1998) Adults generally fly quickly from the water. Mating takes place on the ground or vegetation. Adults are commonly found near lights at night or on foliage near water .http://insects.tamu.edu/fieldguide/cimg245.html
AS41	Eutrophic standing waters	5	
AS4Z	Other eutrophic standing waters	6	
AS5	Marl standing water	1	
AS6	Brackish standing water with no sea connection	3	
AS7	Aquifer fed naturally fluctuating water bodies	4	

Code	Label	HSI	Notes
ASZ	Other standing open water and canals	6	The larvae of freshwater species usually live in cold clean flowing waters, but some species prefer warmer slower waters. They are very particular about water temperature and speed, dissolved minerals and pollutants, as http://animals.jrank.org/pages/2512/Caddisflies-Trichoptera.html#ixzz14E3GO5ZH
AC0	Channel of unknown origin	1	
AC1	Artificial channels	1	
AC11	Drains, rhynes and ditches	1	
AC111	Species-rich drains, rhynes and ditches	1	
AC11Z	Other drains, rhynes and ditches	1	Lesser horseshoe bats are likely to use ditch and rhyne systems for foraging (greater horseshoe bats have been radio tracked doing so [Jones & Billington, 1999]. It is considered that a large roost at Theale, near Wedmore, is supported thus due to lack of woodland and hedgerow connectivity otherwise but needs to be supported by radio tracking and /or other surveys in the future. Watercourses are the most used habitat in uplands (Trichoptera in diet) (Knight, 2006)
AC12	Artificially modified channels	1	
AC13	New artificial channels	0.1	
AC14	Canals	0.3	
AC1Z	Other artificial channels	0.3	
AC2	Natural/naturalistic channels	1	
AO0	Open water of unknown origin	1	
AO1	Artificial open water	0.75	
AO11	Reservoir	1	
AO12	Gravel pits, quarry pools, mine pools and marl pits	1	
AO13	Industrial lagoon	0.2	
AO14	Scrape	1	
AO15	Moat	1	
AO16	Ornamental	0.75	
AO1Z	Other artificial open water	0.75	
AO2	Natural open water	1	
AP1	Pond	1	
AP11	Ponds of high ecological quality	1	
AP1Z	Other pond	1	
AP2	Small lake	1	
AP3	Large lake	0.5	
LT1	Canal-side	1	
LT11	Canal-side with woodland	1	
LT12	Canal-side with scrub or hedgerow and standard trees	1	
LT13	Canal-side with scrub or hedgerow	1	
LT14	Canal-side with layered vegetation	0.75	
LT15	Canal-side with grassland	0.5	
LT16	Canal-side with damaged banks	0	
LT17	Canal-side with constructed banks	0	
LT18	Other canal-side type	0	
AR0	Rivers and streams	5	
AR1	Headwaters	5	Watercourses are the most used habitat in uplands (Trichoptera in diet) (Knight, 2006)
AR11	Chalk headwaters	5	
AR12	Active shingle rivers [headwaters]	5	
AR1Z	Other headwaters	5	Broadleaved, mixed middle age mature woodland with the presence of a river or pond on at least one side most favoured habitat by lesser horseshoe bats (Barataud et al, 2000)
AR2	Chalk rivers (not including chalk headwaters)	4	
AR3	Active shingle rivers [non headwaters]	5	
ARZ	Other rivers and streams	4	
LT2	River-side	1	
LT21	River-side with woodland	1	
LT22	River-side with scrub or hedgerow and standard trees	1	
LT23	River-side with scrub or hedgerow	1	
LT24	River-side with layered vegetation	0.75	

Code	Label	HSI	Notes
LT25	River-side with grassland	0.5	
LT26	River-sdie with vertical banks	0.5	
LT27	River-side with damaged banks	0	
LT28	River-side with constructed banks	0	
LT29	Other river-side type	0	
CR0	Arable and horticulture	1	
CR1	Grass and grass-clover leys	1	
CR2	Cereal crops	1	
CR3	Non-cereal crops including woody crops	1	
CR31	Intensively managed orchards	1	
CR32	Withy beds	1	
CR33	Vineyards	1	
CR34	Game crops	2	
CR35	Miscanthus	0	Miscanthus is not palatable to most insects. This is likely to include those species preyed upon by lesser horseshoe bats
CR3Z	Other non-cereal crops including woody crops	1	
CR5	Whole field fallow	2	
CR6	Arable headland or uncultivated strip	3	
CR61	Arable field margins	3	
CR6Z	Other arable headland or uncultivated strip	2	
CRZ	Other arable and horticulture	1	
CL1	Agriculture	1	
CL11	Organic agriculture	1	
CL12	Non-organic agriculture	0.5	It has been shown that organic farms are more heavily used by bats than otherwise (Wickramasinghe et al, 2003).
CL2	Market garden and horticulture	0	
CL21	Organic market garden and horticulture	0	
CL22	Non-organic market garden and horticulture	0	
CL4	Intensively managed vineyards	0	
CL4Z	Non-intensively managed vineyards	1	
CL5	Cereal crops managed for wildlife	1	
CL5Z	Cereal crops not managed for wildlife	0.5	
RE0	Inland rock	0	
RE1	Natural rock exposure features	0	
RE11	Natural rock and scree habitats	0	
RE111	Upland natural rock and scree habitats	0	
RE112	Lowland natural rock and scree habitats	0	.
RE14	Caves	NP	
RE141	Caves not open to the public	NP	
RE14Z	Other caves	5	Winter roost sites.
RE15	Exposed river gravels and shingles	2	
RE1Z	Other natural rock exposure feature	0	
RE2	Artificial rock exposures and waste	0	Caves occur in disused quarries in Somerset
RE21	Quarry	2	
RE22	Spoil heap	0	
RE23	Mine	3	
RE24	Refuse tip	0	
RE2Z	Other artificial rock exposure and waste	0	
LF0	Boundary and linear features	6	
LF1	Hedges / Line of trees	6	
LF11	Hedgerows	6	

Code	Label	HSI	Notes
LF111	Important hedgerows	6	In a report for the three Welsh National Parks, Pembrokeshire County Council and the Countryside Commission for Wales by the Bat Conservation Trust (2005) it is stated that in fragmented habitats linear features, such as hedgerows, provided valuable corridors between roosts and foraging areas. Commuting corridors are important features for lesser horseshoe bats as they avoid crossing open areas and are vulnerable to the loss of these corridors. Where lesser horseshoes bats foraged along linear features, such as hedgerows, it was always within 10 metres of the feature (Bat Conservation Trust, 2005). In Belgium no bat was recorded more than 1 metre from a feature (Motte & Dubois, 2002).
LF11Z	Non-important hedgerows	6	
LF12	Line of trees	6	
LF1Z	Other hedges/line of trees	6	
LF2	Other boundaries and linear features	4	
LF21	Line of trees (not originally intended to be stock proof)	4	
LF22	Bank	0	
LF23	Wall	1	
LF24	Dry ditch	1	
LF25	Grass strip	0	
LF26	Fence	0	Linking features in a landscape of fragmented woodlands are highly important to the survival of lesser horseshoe bats. Motte & Dubois (2002) in their study wrote that, '*What is striking is that all places were linked to the roost and to each other by a wooded element.*'
LF27	Transport corridors	0	
LF271	Transport corridor without associated verges	0	
LF272	Transport corridor associated verges only	0	The vast majority (over 90%) of insects found near hedges do not originate in the hedge but come from other habitats brought in on the wind (BCT, 2003)
LF273	Transport corridor with natural land surface	0	
LH1	Intact hedge	1	Hedges managed under Agri-environment Schemes did not offer any benefit over conventionally managed hedgerows with regard to micro and macro-moths (Fuentes-Montemayor et al, 2010)
LH2	Defunct hedge	1	
LH3	Recently planted hedge (Only use for existing habitat)	0.25	
LM1	Cut hedge	0.3	
LM11	Cut hedge with standards	0.3	Cut hedge is specified where height is below 2 metres
LM12	Cut hedge without standards	0.2	
LM2	Uncut hedge	0.9	Uncut hedge is specified where the hedge is between 2 and 3 metres high
LM21	Uncut hedge with standards	0.9	
LM22	Uncut hedge without standards	0.8	
LM3	Overgrown hedge	1	Overgrown hedge is considered to be over 3 metres high
LM31	Overgrown hedge with standards	1	
LM32	Overgrown hedge without standards	1	
LT3	Rail-side	0.5	
LT4	Road-side	0.5	
LT5	Path- and track-side	1	
LTZ	Other transport corridor verges, embankments and cuttings	1	
UL1	Railway	0	
UL2	Roadway	0	
UL3	Path and trackway	0	
ULZ	Other transport corridor	0	
UR0	Built-up areas and gardens	1	
UA1	Agricultural	0.1	
UA2	Industrial/commercial	0	Lesser horseshoe bat summer roosts are typically in the loft spaces of old buildings
UA3	Domestic	0	
UA31	Housing/domestic outbuildings	0.1	Urban and sub urban areas are exploited by lesser horseshoe bats (Knight, 2006) but it is assumed that these are small unlit villages
UA32	Gardens	0.1	
UA33	Allotments	0.1	
UA34	Caravan park	0	Farmyards most used by lesser horseshoe in Ireland (McAney & Fairley, 1988). Night roosts possible
UA3Z	Other domestic	0	
UA4	Public amenity	0	
UA41	Churchyards and cemeteries	1	
UA4Z	Other public amenity	0	
UA5	Historical built environment	1	

Code	Label	HSI	Notes
UAZ	Other extended built environment	0	

Appendix 4: Risk Factors for Restoring or Recreating Different Habitats

N.B.: These assignments are meant purely as an indicative guide. The starting position with regard to substrate, nutrient levels, state of existing habitat, etc. will have a major impact in the actual risk factor. Final assessments of risk may need to take other factors into account.

Habitats	Technical difficulty of recreating	Technical difficulty of restoration
Arable Field Margins	Low	n/a
Coastal and Floodplain Grazing Marsh	Low	Low
Eutrophic Standing Waters	Medium	Medium
Hedgerows	Low	Low
Lowland Beech and Yew Woodland	Medium	Low
Lowland Calcareous Grassland	Medium	Low
Lowland Dry Acid Grassland	Medium	Low
Lowland Meadows	Medium	Low
Lowland Mixed Deciduous Woodland	Medium	Low
Open Mosaic Habitats on Previously Developed Land	Low	Low
Ponds	Low	Low
Wood-Pasture & Parkland	Medium	Low

Appendix 5: Feasibility and Timescales of Restoring: examples from Europe

Ecosystem type	Time-scale	Notes
Temporary pools	1-5 years	Even when rehabilitated, may never support all pre-existing organisms.
Eutrophic ponds	1-5 years	Rehabilitation possible provided adequate water supply. Readily colonised by water beetles and dragonflies but fauna restricted to those with limited specialisations.
Mudflats	1-10 years	Restoration dependent upon position in tidal frame and sediment supply. Ecosystem services: flood regulation, sedimentation.
Eutrophic grasslands	1-20 years	Dependent upon availability of propagules. Ecosystem services: carbon sequestration, erosion regulation and grazing for domestic livestock and other animals.
Reedbeds	10-100 years	Will readily develop under appropriate hydrological conditions. Ecosystem services: stabilisation of sedimentation, hydrological processes.
Saltmarshes	10-100 years	Dependent upon availability of propagules, position in tidal frame and sediment supply. Ecosystem services: coastal protection, flood control.
Oligotrophic grasslands	20-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Chalk grasslands	50-100 years +	Dependent upon availability of propagules and limitation of nutrient input. Ecosystem services: carbon sequestration, erosion regulation.
Yellow dunes	50-100 years +	Dependent upon sediment supply and availability of propagules. More likely to be restored than re-created. Main ecosystem service: coastal protection.
Heathlands	50-100 years +	Dependent upon nutrient loading, soil structure and availability of propagules. No certainty that vertebrate and invertebrate assemblages will arrive without assistance. More likely to be restored than re-created. Main ecosystem services: carbon sequestration, recreation.
Grey dunes and dune slacks	100-500 years	Potentially restorable, but in long time frames and depending on intensity of disturbance Main ecosystem service: coastal protection, water purification.
Ancient woodlands	500 – 2000 years	No certainty of success if ecosystem function is sought – dependent upon soil chemistry and mycology plus availability of propagules. Restoration is possibility for plant assemblages and ecosystem services (water regulation, carbon sequestration, erosion control) but questionable for rarer invertebrates.
Blanket/Raised bogs	1,000 – 5,000 years	Probably impossible to restore quickly but will gradually reform themselves over millennia if given the chance. Main ecosystem service: carbon sequestration.
Limestone pavements	10,000 years	Impossible to restore quickly but will reform over many millennia if a glaciation occurs.

Appendix 6: Example of HEP Calculation

The following table gives an example (for Lesser Horseshoe bats) of the HEP calculation for a complex site which straddles two Consideration Zone bands.

Field No	Habitat	Primary Habitat		Matrix		Formation		Management / Land use		HSI Score	Density Band Score	Hectares	Habitat Units
		IHS Code	Score	IHS Code	Score	IHS Code	Score	IHS Code	Score				
F1	Miscanthus	CR35	0		0		1.00		1.00	0.00	2	4.975	0.00
P2	Pond	AS0	6		0	AP1	1.00		1.00	6.00	2	0.053	0.64
F3	Maize (Cereal crops, non-organic)	CR2	1		0		1.00	CL12	0.50	0.50	2	0.034	0.03
P4	Pond (Standing open water and canals)	AS0	6		0		1.00		1.00	6.00	2	0.362	4.34
F5	Improved grassland, Frequent mowing (Other amenity)	GI0	2		0		1.00	GM23	0.25	0.50	2	0.344	0.34
F6	Mixed woodland, Mixed plantation and semi natural, high forest	WB1	6		0	WF3	0.80	WM1	1.00	4.80	2	0.362	3.48
F7	Built-up Areas and Gardens, gardens	UR0	1		0		1.00	UA32	0.10	0.10	2	0.2	0.04
F8	Arable (wheat & barley)	CR2	1		0		1.00	CL12	0.50	0.50	2	0.086	0.09
F9	Arable (type not stated)	CR0	1		0		1.00		1.00	1.00	2	0.154	0.31
F10	Improved grassland; Hay aftermath grazing	GI0	2		0		1.00	GM3	0.80	1.60	2	3.484	11.15
F11	Improved grassland, Silage	GI0	2		0		1.00	GM21	0.50	1.00	2	0.833	1.67
F12	Built-up Areas and Gardens, scattered trees	UR0	1	TS0	1		1.00	UA32	0.25	0.50	1	2.844	1.42
F13	Mixed Woodland Plantation	WB1	6		0	WF3	0.80		1.00	4.80	1	1.214	5.83
F14	Cereal Crops, Bare Ground	CR2	1	BG1	0		1.00	CL1	1.00	1.00	1	0.642	0.64
H1	Hedgerow, overgrown without standards	LF11	6		0		1.00	LM32	1.00	6.00	2	0.149	1.79
H2	Hedgerow, cut without standards	LF11	6		0		1.00	LM12	0.20	1.20	2	0.58	1.39
H3	Line of trees	LF21	4		0		1.00		1.00	4.00	2	0.203	1.62
H4	Hedgerow, uncut without standards	LF11	6		0		1.00	LM22	0.80	4.80	2	0.04	0.38
H5	Hedgerow, uncut with standards	LF11	6		0		1.00	LM21	0.90	5.40	2	0.02	0.22
H6	Hedgerow, cut without standards	LF11	6		0		1.00	LM12	0.20	1.20	2	0.07	0.17

Field No	Habitat	Primary Habitat		Matrix		Formation		Management / Land use		HSI Score	Density Band Score	Hectares	Habitat Units
		IHS Code	Score	IHS Code	Score	IHS Code	Score	IHS Code	Score				
H7	Hedgerow, uncut without standards	LF11	6		0		1.00	LM22	0.80	4.80	1	0.02	0.10
H8	Hedgerow, cut without standards	LF11	6		0		1.00	LM12	0.20	1.20	1	0.01	0.01
													35.65
		(Habitat required, e.g. Woodland with ponds being optimal habitat for the species)									Delivery Risk		1.5
		(Habitat required, e.g. Woodland with ponds being optimal habitat for the species)									Temporal Risk		1.7
											Habitat Units		90.92
											Hectares Required		5.05

The calculation recommends that a minimum of 5.05 hectares (ha) of the 16.68ha site is needed to replace the value of the habitat lost to the species affected.

If the replacement habitat is to be provided off-site the value of the receptor site also needs to be taken into account. The calculation is as follows assuming that the replacement habitat enhancement is located on a field of low value to the species with a HSI score of 1.

$$[5.05 / (6-1)] + 5.05 = 6.06\text{ha}.$$

Appendix 7: 'Favourable Conservation Status' and Lesser Horseshoe Bats

The Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') under Article 1 set out the requirements for the protection of species of Community interest, listed under Annex II, IV and/or V[115]. These species are required to be maintained at 'favourable conservation status' (FCS), which is defined as when:

- the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The goals of the Habitats Directive for species conservation require two basic conditions[116]:

- Quality of habitat (allowing enough for reproduction)
- Habitat area (to prevent extinction by accident)

The Conservation of Habitats and Species Regulations state under Regulation 41 that it is an offence to deliberately disturb wild animals of a European Protected Species (EPS), such as Lesser Horseshoe bats, in such a way as to be likely to:

a) impair their ability—
(i) to survive, to breed or reproduce, or to rear or nurture their young; or
(ii) in the case of animals of a hibernating or migratory species, to hibernate or migrate; or
(b) affect <u>significantly the local distribution or abundance</u> of the species to which they belong.

Regulation 9(5) requires that all public bodies have regard to the requirements of the Habitats Directive when carrying out their functions. Recent court cases (Regina versus Cheshire East Borough Council and Morge V Hampshire County Council) and a Supreme Court judgement have '… *confirmed that the judgement is one for the relevant decision maker to make (e.g. the local planning authority) based on all the facts of the case*.'[117]

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[115] <u>Annex IV species</u> are defined as 'animal and plant species in need of strict protection.' <u>Annex II species</u> are those for whose conservation require the designation of Special Areas of Conservation (SAC). Any potential impacts affecting the integrity of a SAC, including those designated for Annex II species, are required to undergo a 'Habitats Regulations Assessment'. <u>Annex IV</u> species are listed on Schedule 2 of the Conservation of Habitats and Species Regulations 2010 and includes Lesser Horseshoe bats. <u>Annex V species are</u> 'Animal and plant species of Community interest whose taking in the wild and exploitation may be subject to management measures' which are likewise required to be maintained at 'Favourable Conservation Status'.

[116] Opdam, P., Steingröver, E., Vos, C. & Prins, D. 2002. *Effective protection of the Annex IV species of the EU-Habitats Directive: The landscape approach*. Wageningen: Alterra. http://www.ocs.polito.it/biblioteca/ecorete/590.pdf

[117] Simpson, P. 2011.*Supreme Court rules on Habitats Directive*. DLA Piper, UK

It is the local planning authority's responsibility to ensure that the FCS of local populations of EPS is maintained, aside from any subsequent licensing requirement. Before granting planning permission to a development the local authority needs to ensure that the proposed development is not detrimental to the affected population of Lesser Horseshoe bats' FCS, i.e. that there are no adverse effects on the habitat to support and hence abundance of the local population from the proposed development. The Council must be satisfied that each of the three tests for EPS is met which besides FCS includes statements concerning whether 'the development is of overriding public interest' and whether 'there are no satisfactory alternatives. These should be reported in the officer's report to the planning committee.

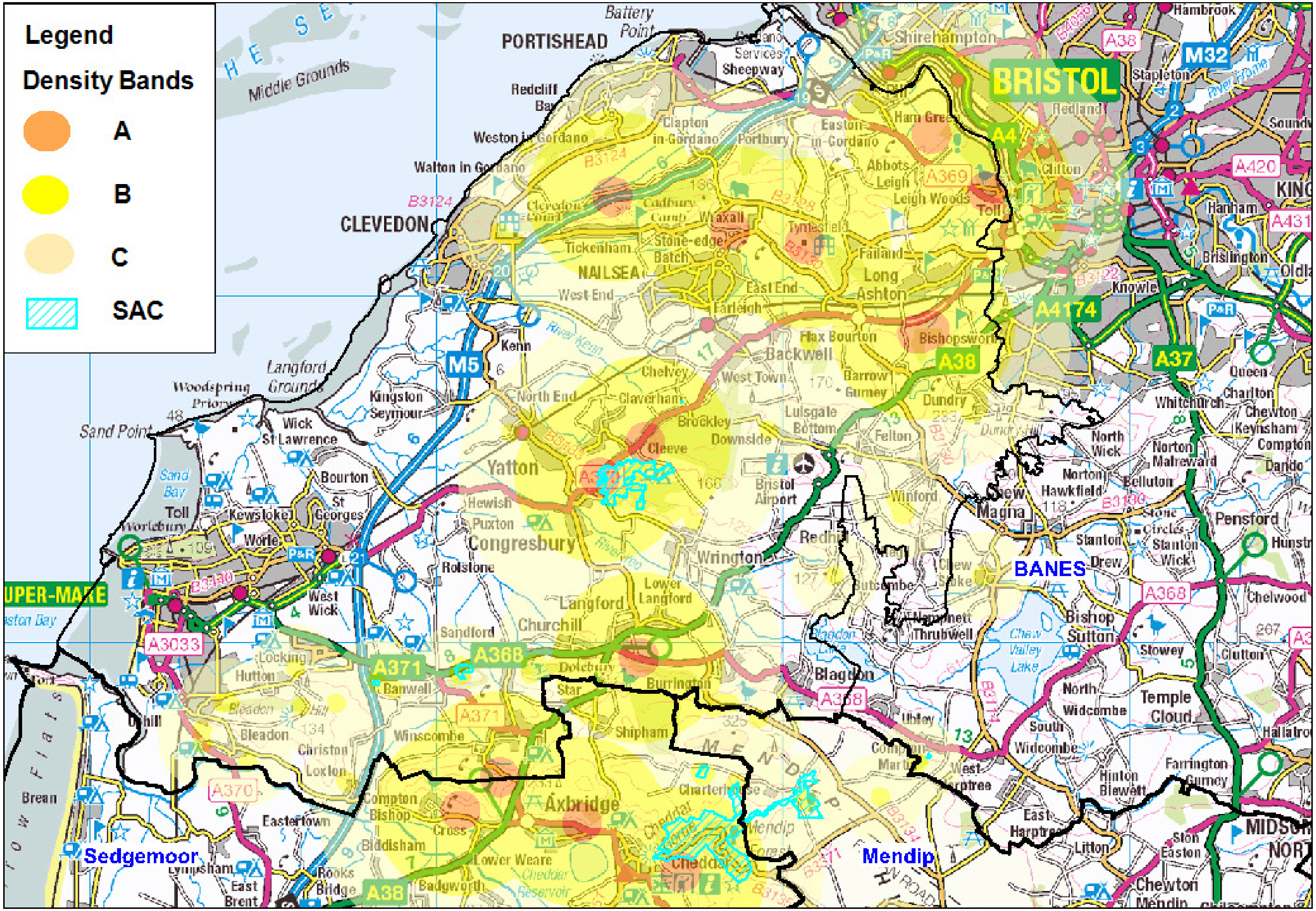
However, this should not be seen as a requirement of every development where EPS are present but, as the Supreme Court makes clear, should be judged on a case by case, species by species basis. Penny Simpson (2011)[118] writes that *"'deliberate disturbance' offence is likely to apply to an activity which is likely to negatively impact on the demography (survival and breeding) of the species at the local population level… disturbing one of two individuals is not necessarily below the threshold (i.e. outside the offence) because for a rare species, a species in decline, or a species at the edge of its range, a harmful disturbing impact on a very small number of individuals may impact negatively on the demography of the local population*".

Ideally the forward planning process, such as consideration of development sites for allocation, should be informed by a sound knowledge of the distribution of EPS within a geographic area. Awareness of the maps in this guidance would help towards that, regarding horseshoe bats. This would help local authorities to exercise their functions in line with the Conservation of Habitats and Species (Amendment) Regulations 2012, Regulations 9 (1) and 9(3). It would also help the local authorities meet Article 16 of the Habitats Directive, since consideration of the maps in the allocation process could potentially help to avoid adverse impacts on horseshoe bats in the first place, although it is recognised that this is not always possible due to other factors such as the need for transport infrastructure.

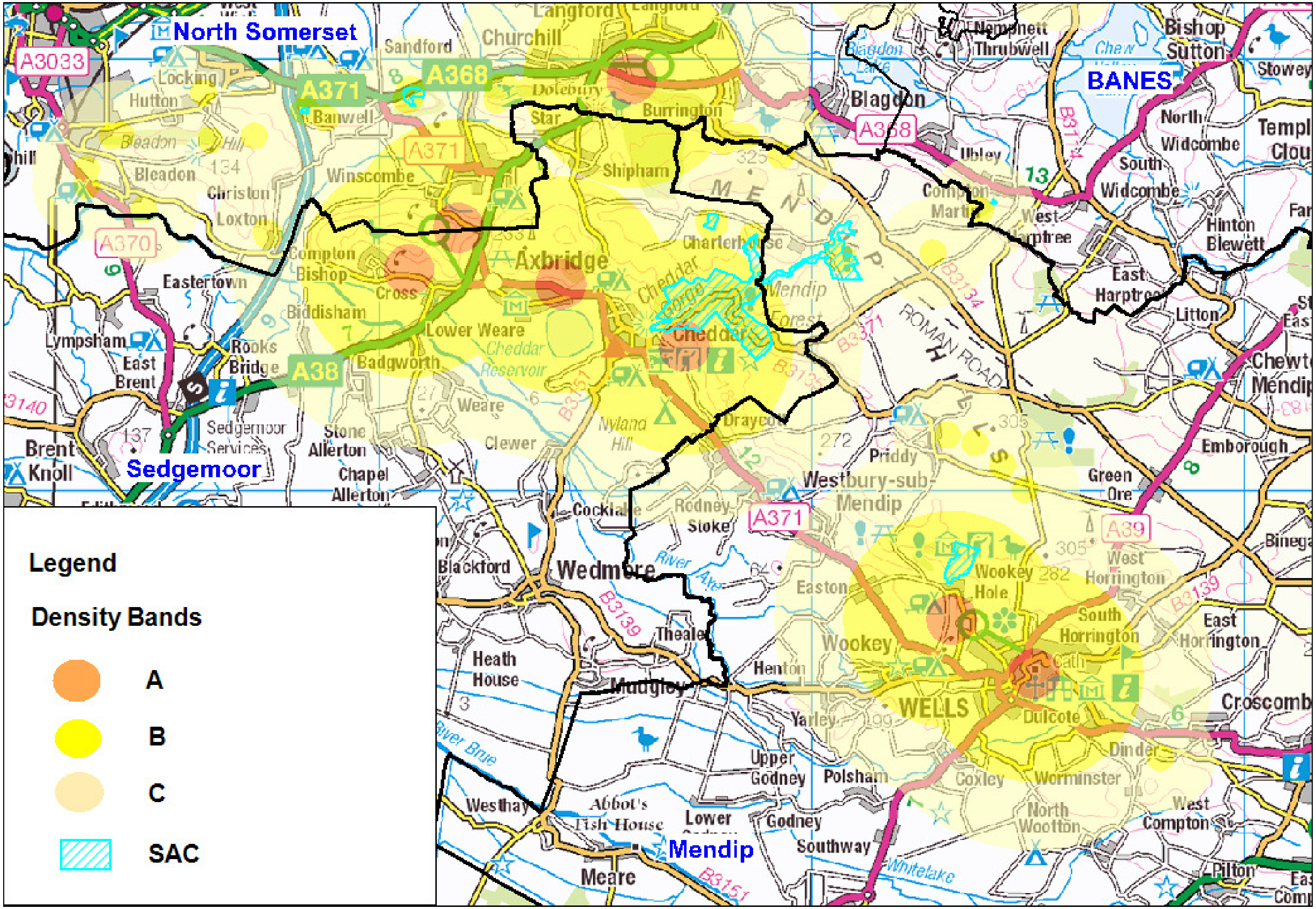
Plans 5 and 6 below show the distribution of known Lesser Horseshoe bats in North Somerset, Sedgemoor and Mendip council areas

[118] Simpson, P. 2011.*Supreme Court rules on Habitats Directive.* DLA Piper, UK

Plan 5: Lesser Horseshoe Bats (North Somerset)



Plan 6: Lesser Horseshoe Bats (Sedgemoor and Mendip)



Roosting Lesser Horseshoe Bats (Photo Jim Mullholland)