Hestercombe House

Special Area of Conservation (SAC)

Guidance on Development

Version 2.2 – May 2019

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Cover Photo: **Lesser Horseshoe Bat,** Frank Greenaway. Courtesy Vincent Wildlife Trust (http://www.vwt.org.uk/)

HESTERCOMBE HOUSE SPECIAL AREA OF CONSERVATION (SAC): GUIDANCE ON DEVELOPMENT

Contents

Hestercombe House Special Area of Conservation (SAC)

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 Hestercombe House 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 DP8 (Environment) of the of the Taunton Deane Adopted Core Strategy 2011 - 2028; policies TAU2 and TAU3 of the Taunton Deane Adopted Site Allocations and Development Management Plan; Policy D15 (Bat Consultation Zone) of the Sedgemoor 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 Somerset West and Taunton Council, 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 SAC is important for Lesser Horseshoe bats. The SAC itself comprises the component Hestercombe House Site of Special Scientific Interest.

2.2 However the landscapes around the SACs themselves itself are also important in providing foraging habitat needed to maintain the favourable conservation status of Lesser Horseshoe bats. This is termed Functionally Linked Land. 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. Bat Consultation Zone

3.1 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.

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

4. Juvenile Sustenance Zones

4.1 It is considered that mature woodland within 600 metres (m) of a Lesser Horseshoe bat maternity roost is also sensitive as the habitat is likely to be used by juveniles. New build developments should avoid the loss of such woodland and connecting habitat between the maternity roost and woodland.

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.

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 Hestercombe Lesser Horseshoe bat population.

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.

9. Enhancement

9.1 Development will be expected to provide enhancement for horseshoe bats. The National Planning Policy Framework (July 2018)[2] states that '*Planning… decisions should contribute to and enhance the natural… environment by… providing net gains for biodiversity*…' It is expected that development sides would provide a greater quantum of habitat in value than that lost due to the built development and associated infrastructure.

9.2 An example of the Excel worksheets used in calculating the quantum of replacement habitat required is given in Appendix 5 with a box showing the amount gained or lost due to a proposed development. It is expected that a percentage gain will be defined by Defra in due course.

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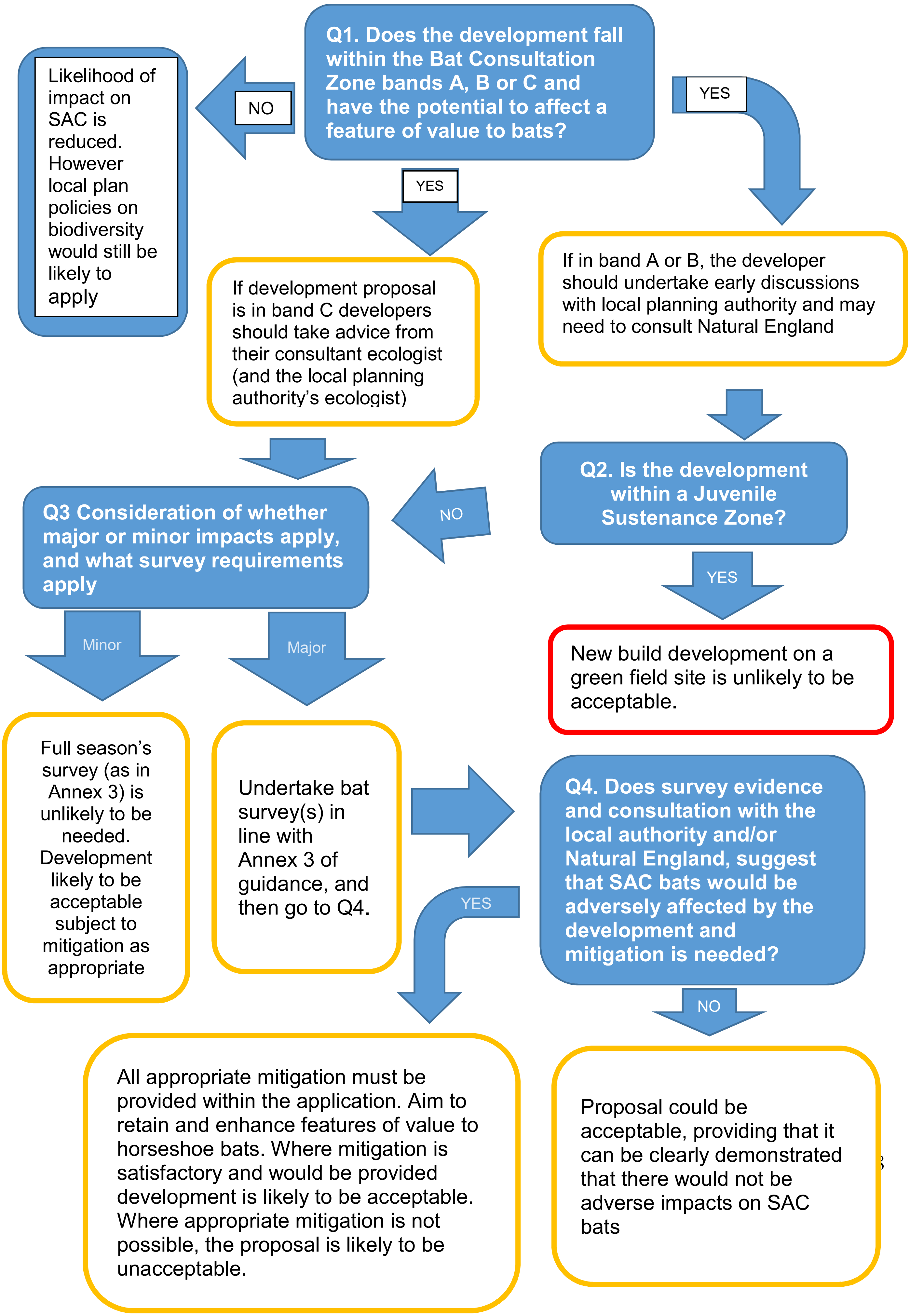
[1] In the Somerset County area developers may ask the Local Planning Authority to carry out the calculation for the amount of habitat required to replace the value of that lost to horseshoe bats prior to the application being submitted, to check that the proposed master plan for the site has adequate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

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf



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 (and the local planning authority's ecologist)
YES
If in band A or B, the developer should undertake early 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
NO
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.
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 Hestercombe House SAC is designated under the Habitats Directive 92/43/EEC, which is transposed into UK law under the Conservation of Habitats and Species Regulations 2017 (‘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 SAC is the Annex II species, the Lesser Horseshoe bats *Rhinolophus hipposideros*

1.3 The Conservation Objectives for the SAC[3] is: 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 habitats of the qualifying species;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which the habitats of qualifying species rely;
- The populations of qualifying species; and,
- The distribution of qualifying species within the site.

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

1.5 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.

[3] http://publications.naturalengland.org.uk/publication/5039159320248320

1.6 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.

1.7 This advice is aimed at applicants, agents, consultants and planners involved in producing and assessing development proposals in the landscapes surrounding the Hestercombe House 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 Lesser Horseshoe bat population.

1.8 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 Hestercombe House 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 Lesser 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.

1.9 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.

1.10 This technical guidance is based on the advice from experts and ecological consultants[4], current best practice and the best scientific information available at the time of writing. It will be kept under review by Somerset West and Taunton Council, Somerset County Council and Natural England.

2. Sensitive Zones for Lesser 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 (See Plans 1 below) have been identified. This is based on an accumulation of known data, beginning with the on-going Somerset Bat Group monitoring of the Hestercombe House from the 1990s and including radio tracking studies of the Lesser Horseshoe bat maternity roost.[5] The data is constantly being added to and updated. Therefore, the

[4] See acknowledgements

[5] 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; Duvergé, L. 2008. *Report on bat surveys carried out at Hestercombe House SSSI Taunton, Somerset, in 2007 and 2008.* Cullompton: Kestrel Wildlife Consultants.

Plan reflect the current understanding of key roosts and habitat associated with the SAC.

Bat Consultation Zone (orange, yellow and pale yellow shading on Plan 1 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 Hestercombe House 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 the maternity roost and therefore it is likely that any area within the Bat Consultation Zone could be exploited by Lesser Horseshoe bats.

Table 1: Band Widths for Horseshoe Bats

Band	Lesser Horseshoe bat (metres)	
	Maternity Roost	Other Roost
A	0 - 600	
B	601 - 2500	0 - 300
C	2501 - 6000	301 - 1250

2.3 The banding within the Bat Consultation Zone is centred on the maternity roosts at Hestercombe House. A smaller band is formed around the subsidiary roost in West Monkton which occurs within the bands formed from the maternity roost. Bontadina et al (2002)[6] recommended that a radius of 600 metres around a Lesser Horseshoe bat maternity roost should have special consideration. This area is particularly sensitive and new build development on green field sites should be avoided in this zone.

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 Lesser Horseshoe bats are likely to occur away from the home roost.

Horseshoe Bat 'Juvenile Sustenance Zones' (red and pink shading on Plan 2 below)

2.8 The Juvenile Sustenance Zone for Lesser Horseshoe bats includes all mature woodland within 600 metres of the maternity roost[7]. Juveniles select broadleaved woodland habitat[8]. It is highly unlikely that the biomass or shelter that such woodland provides can be replaced within development schemes. Consideration also needs to be given to connecting flight routes between the maternity roost and the woodlands.

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[6] 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*.

[7] Bontadina et al recommends that conservation management should have special consideration within 600 metres of the roost. (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] Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD thesis. University of Bristol.

3. Consultation and Surveys

3.1 For development proposals within the Juvenile Sustenance Zone it is essential that Natural England and the Somerset West and Taunton planning authority are consulted at an early stage of the process, as it is unlikely that new build development on or adjacent to woodland or links between the maternity roost and woodland sites could be made acceptable, due to the critical nature of the area in supporting the SAC population.

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)[9]

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.

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

[9] 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)

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[10] 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 Lesser 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).[11]

4. Mitigation within the Consultation Zone

4.1 Within the Bat Consultation Zone, where Lesser Horseshoe 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 Lesser 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

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

[11] 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]

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 woodland, ponds, watercourses, hedgerows, woodland edges, tree lines, rough grassland and pasture
- 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 lacewings, small aquatic flies and moth species.

- Woodland, especially associated with water features
- 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

- Grazed pasture is 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
- 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 Lesser Horseshoe bat population affected.**

4.12 A Landscape and 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 Lesser 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 Horseshoe bats are at lux levels even lower than previously thought: "*under natural, unlit conditions ... 0.04 lux*" but avoid levels above 3.6 Lux. (Stone, 2009; Stone et al, 2009) They regularly use dark hedgerows which are an average of 0.45 Lux. Stone et al (2009) stated, '*It is unsurprising that few bats flew along the unlit side of the hedge, given that light levels on the unlit side on lit nights (mean 4.17 lux) were significantly higher than those along dark hedges (mean 0.45 lux); even these relatively low light levels may make established routes unsuitable for commuting*.' They are potentially disrupted from flying along flight structures, such as hedgerows by introduced artificial light levels above 0.5 Lux. It was also found that continued disruption increased the effect, i.e. Lesser Horseshoe bats do not become habituated to the presence of artificial lighting.[13]

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[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

[13] Stone, E. L. 2009. The impact of street lighting on lesser horseshoe bats *Presented at the South West Bat Conservation Trust Conference, 25 April, 2009;* Stone, E. L., Jones, G. & Harris, S. 2009. Street Lighting Disturbs Commuting Bats. *Current Biology* 19, 1123–1127, July 14, 2009; Stone, E.L 2013. *Bats and Lighting – Overview of current evidence and mitigation.* Bristol: University of Bristol)

4.14 in addition many night flying species of insect such as moths, a prey species for Lesser 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

See also the 'Guidance Note 08/18 Bats and artificial lighting in the UK' (Institute of Lighting Engineers/ Bat Conservation Trust, 2018) and widths of lighting zones illustrated in the Trowbridge Bat Mitigation Strategy SPD: Draft for Consultation.[15]

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) Lesser Horseshoe 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) Lesser Horseshoe bat habitat. The information from this report should provide the basis to determine appropriate mitigation measures associated with the proposed development. The

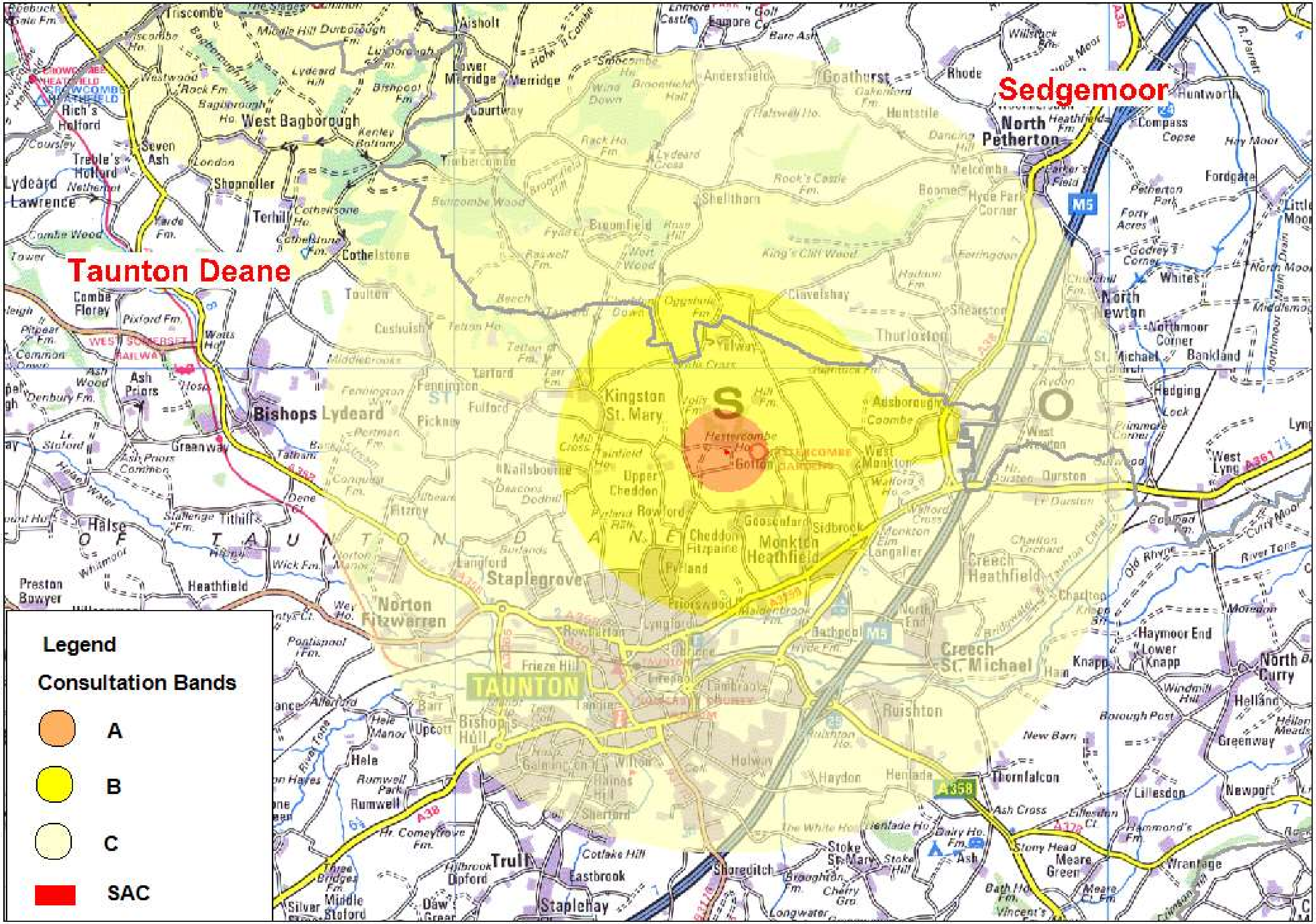
[14] Bat Conservation Trust/Institute of Lighting Engineers. 2008. *Bats and Lighting in the UK: Version 2*; pers. comm. Dr Emma Stone, University of Bristol, 2009.

[15] Institute of Lighting Engineers/ Bat Conservation Trust. 2018. *Guidance Note 08/18 Bats and artificial lighting in the UK* https://www.theilp.org.uk/documents/guidance-note-8-bats-and-artificial-lighting/; Bennet, J. & Mitchell, B. 2019. *Trowbridge Bat Mitigation Strategy SPD: Draft for Consultation*. Bradford-on-Avon: Johns Associates. http://wiltshire.objective.co.uk/portal/spatial_planning/spds/trowbridge_bat_mitigation_strategy_spd/the_trowbridge_bat_mitigation_strategy_spd?tab=files

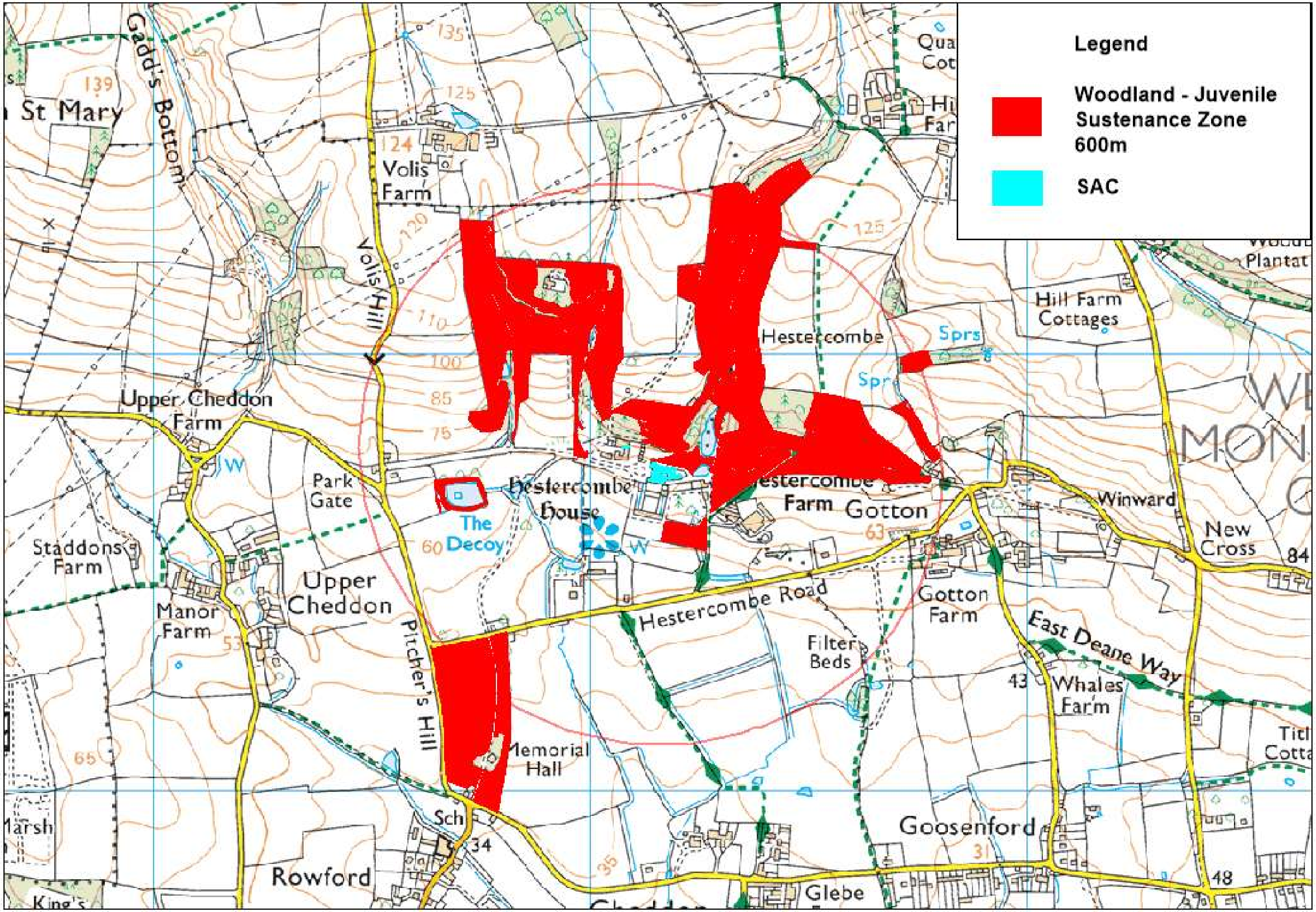
proposed mitigation should clearly demonstrate that there will be no interruption of suitable SAC bat commuting habitat. Replacement of foraging habitat may be required as appropriate.

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) Lesser Horseshoe bat 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.

Plan 1: Bat Consultation Zone



Plan 2: Juvenile Sustenance Zone



PART C Annexes

Annex 1: Details of the Hestercombe House Special Area of Conservation

A1.1 The Hestercombe House SAC is made up of 1 component Site of Special Scientific Interest (SSSI):

- Hestercombe House SSS! (TDBC)

A1.2 A large Lesser Horseshoe bat *Rhinolophus hipposideros* maternity site in the vale of Taunton Deane. The bats roost in the roof void of part of a large building. Although only a small proportion of the UK population, this site has been included as representative of the species in south-west England. The designation also covers the stable loft which has been converted to a roost for Lesser Horseshoe bats.

A1.3 The SSSI citation states, '*Hestercombe House is a former country house and estate consisting of mixed woodland, pasture, lakes and landscaped gardens. The colony of lesser horseshoes utilise two roof voids within the former stable block and domestic outbuildings as maternity (breeding) roosts during the summer months, with a small number of bats also using the roofs as hibernation sites during the winter*'.

A1.4 Natural England recorded that the baseline population as being 250 Lesser Horseshoe bats on designation16. Although there are natural fluctuations in the population size of the roost there has been a trend that shows a decline in numbers. Since 2008 when a total of around 120 bats were counted in June the trend has continued the with a total of around 90 being counted in 2010. Counts for 2009 were conducted earlier in late May and later in mid-June. In 2012 the counts for the "main roost" at the back of the house were only 47 on 6th June and 55 on the 13th June. At the stables we had 78 and 76 respectively. Although this is a slight rise in numbers from 2010 the overall trend remains downward and the count is below the starting baseline.

A1.5 Total counts of Lesser Horseshoe bats using both roosts for 2013 and 2014 in mid-June are 139 and 137 respectively. On the 14th June 2017 the number of Lesser Horseshoe bats counted emerging from the house roost was 34 and from the stables 107, a total of 141 bats. On the 22nd June the numbers were 86 from the house and 41 from the stable, a total of 127 bats. There has been an increase in numbers from 2010, which has levelled off since 2012 at around 131 to 141 Lesser Horseshoe bats annually.

A1.6 However, roost counts carried out by Gekoella in 2018 has shown that Lesser Horseshoe bats exit the house roost in other directions than that used annually by the Somerset Bat Group. This survey recorded 248 Lesser Horseshoe bats in August but would include juveniles.[17]

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[16] http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0030168.pdf.

[17] Pers. Comm. Jason Ball, Gekoella, 30/08/2018

A1.7 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:

A1.8 *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. Lesser Horseshoe bats regularly travel through the administrative areas of the Taunton Deane and Sedgemoor between feeding sites and their roosts via a network of established flyways. In the spring and autumn Lesser Horseshoe bats travel between 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 Lesser Horseshoe 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 Lesser 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 Lesser 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 and observations in the field confirm that Lesser Horseshoe bats will regularly use the interconnected flyways associated with lines of vegetation. Further studies have shown that landscapes with broadleaved woodland, large bushy hedgerows and watercourses are important as they provide habitat continuity.[18] Habitat is therefore very important to Lesser Horseshoe bats in terms of *quality* (generation of insect prey) and *structure* (allowing them to commute and forage);

3. Lesser Horseshoe bats are sensitive to light and will avoid lit areas[19]. 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

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[18] 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; Duvergé, L. 2008. *Report on bat surveys carried out at Hestercombe House SSSI Taunton, Somerset, in 2007 and 2008.* Cullompton: Kestrel Wildlife Consultants; 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.

[19] Stone, E. L., Jones, G. & Harris, S. 2009. Street Lighting Disturbs Commuting Bats. *Current Biology* 19, 1123–1127, July 14, 2009

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[20].

4. The feeding and foraging requirements of the Lesser Horseshoe bat have been reasonably well studied in the south west of England and Europe[21]. From this work we know that most feeding activity is concentrated in an area within 2.5km of the roost. The most important types of habitat for feeding have been shown to be woodland particularly where associated with water, and pasture. Depending upon the availability of suitable flyways and feeding opportunities, most urban areas will provide limited Lesser Horseshoe bat habitat.[22]

A1.9 The population of Lesser Horseshoes bats from the Hestercombe House SAC is currently under particular stress from a number of factors, particularly the number of development applications and proposals on the urban edges of Taunton.

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[20] see EN research reports R174

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

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

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 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[23]).

A2.2 The Band widths for Lesser Horseshoe bats are derived from the radio tracking study carried out by Knight (2006)[24] 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)[25], 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) [26] 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) [27] 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 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.

Table 2: Band Widths for Horseshoe Bats

Band	Lesser Horseshoe bat (metres)	
	Maternity	Other
A	0 - 600	
B	601 - 2500	0 - 300
C	2501 - 4100	301 - 1250

[23] 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.*
[24] Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD thesis. University of Bristol.
[25] 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.*
[26] 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.*
[27] Knight, T. 2006. *The use of landscape features and habitats by the Lesser Horseshoe bat* (Rhinolophus hipposideros). PhD thesis. University of Bristol.

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)[28] 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)

[28] 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 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)[29] 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 Lesser 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

[29] 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[30]. 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[31] should be carried out on ten separate evenings; at least one survey should be undertaken in each month from April to October[32], 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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[30] Pers. Comm. Henry Andrews, AEcol, 23/09/2016

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

[32] 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 Somerset Environmental Records Centre (SERC), 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 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[33])

Habitats Surveys

A3.5 Phase 1 habitat, Integrated Habitat System or UK Habitat Classification surveys should be carried out for all land use developments within the Bat Consultation Zone. Surveys should also include information on the habitats on site for the five years previous to the current survey.

A3.6 Surveys must 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

A3.7 Surveys of existing light levels on proposed development sites should be undertaken and submitted with the planning application in accordance with guidelines given in the 'Guidance Note 08/18 Bats and artificial lighting in the UK' (Institute of Lighting Engineers/ Bat Conservation Trust, 2018)[34]. This should cover the full moon and dark of the moon periods so that an assessment of comparative SAC bat activity on a proposed site can be ascertained.

A3.8 Baseline measurements should be taken systematically across the site or features in question. At each sample location, a reading should be taken at ground level on the horizontal plane (to give illuminance hitting the ground) and vertical readings should also be taken at each sample location at 1.5m above ground level. The orientation for vertical readings should be perpendicular to the surface/edge of the habitat feature in question (such as a hedgerow) to produce a 'worst case' reading. Further measurements at other orientations may prove beneficial in capturing influence of all

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

[34] Institute of Lighting Engineers/ Bat Conservation Trust. 2018. *Guidance Note 08/18 Bats and artificial lighting in the UK* https://www.theilp.org.uk/documents/guidance-note-8-bats-and-artificial-lighting/

luminaires in proximity to the feature or principal directions of flight used by bats. This survey data can then be used to inform the masterplan of a project.

A3.9 Surveys should also consider lighting, and the absence of such where a road would be subsequently street lit post development, outside the red line boundary of the proposed development site.

A3.10 A lux contour plan of light levels at least down to 0.5 Lux, modelled at 1.5 metre above ground level, should be submitted with the application. As a guide to master planning proposed development, the desired zonation for Lux levels from built areas are shown in the Trowbridge Bat Mitigation Strategy SPD[35].

Roosting Lesser Horseshoe Bats (Photo Jim Mullholland)

[35] Bennet, J. & Mitchell, B. 2019. *Trowbridge Bat Mitigation Strategy SPD: Draft for Consultation*. Bradford-on-Avon: Johns Associates.

Annex 4: Habitat Requirements of Lesser Horseshoe bats

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Prey

A4.1 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.[36]

A4.2 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)[37]

General

A4.3 '*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*.'[38] 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

A4.4 Lesser horseshoe bats prefer to hunt in woodland interiors where micromoth abundance is greatest. 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,

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[36] 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

[37] 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

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

but where smaller blocks are surrounded by habitat productive in insect prey they will be used.[39]

A4.5 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.[40]

A4.6 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[41]

A4.7 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.[42]

Grassland

A4.8 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

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[39] 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.

[40] 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.

[41] 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

[42] 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.*

(Tipulids), which form a significant proportion of the prey hunted by Lesser Horseshoe bats.[43]

Hedgerows

A4.9 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.[44]

A4.10 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.[45]

A4.11 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.[46]

Others

A4.12 Lesser Horseshoe bats avoid dense scrub cover[47].

A4.13 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.[48]

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[43] 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

[44] 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*.

[45] 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*.

[46] 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;

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

[48] 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

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'*.[49] 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[50].

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.[51]

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 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)[52] 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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[49] http://www.fort.usgs.gov/Products/Software/HEP/

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

[51] 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.

[52] 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[53].

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)[54]. 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[55].

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[53] Phase 1 (JNCC, 1993) habitat mapping can be converted to IHS by using the software provided by Somerset Environmental Records Centre.
[54] http://www.somerc.com/integrated+habitat+system/
[55] http://www.fort.usgs.gov/Products/Software/HEP/

Description

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)[56]. 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[57]. 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.[58] 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

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

[57] 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.

[58] 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.

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 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. The HSI has a maximum score of 6.

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[59] 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[60]. 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.

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

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

value of a landscape to horseshoe bats.

A5.22 The Habitat Suitability Index for Lesser Horseshoe Bats can be found in Appendix 2.

Lighting

A5.23 The value of a habitat may be affected by lighting, either from street lighting or other sources such as security or flood lights. This would have the effect of reducing the value of a habitat to horseshoe bats. This can be accounted for by either removing the area of habitat affected from that used in the metric or reducing the HSI score. It is advised that a note is made in the Excel spreadsheet used in calculating the habitat amount (see A5.39 below).

Validation

A5.24 An HSI model can be reviewed against occurrence data held by the biological records centre. The Gulf of Maine HSI work[61] 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.

A5.25 Garshelis (2000)[62] 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[63].

A5.26 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

A5.27 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.

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

[62] 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.

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

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 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[64]). 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 either:

a) The criteria for foraging for horseshoe bat species, which have low intensity calls, makes use of Miller's (2001) Activity Index.[65] '*Call sequences with a negative minute on either side (i.e. a minute in which the species was not recorded) are judged to be commuting contacts, whereas contacts in two consecutive minutes or more are judged to be foraging contacts*.' 'Foraging' is defined as 6[66] or more such minutes over any three nights in the five nights on any one automated detector during the recording period.

b) Observed hunting behaviour in the field.

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[64] For example, see 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.
[65] Miller, B. 2001. A method for determining relative activity of free flying bats using a new activity index for acoustic monitoring. *Acta Chiropterologica* 3 (1): 93 – 105.
[66] Miller uses 9 consecutive passes when recording mostly *Myotis* species. As the hunting behaviour of *Rhinolophus* species is more difficult to record the number of passes has reduced by the coefficient applied to European bats species by Barataud for open to semi open environments, *Myotis* 1.67 compared to *Rhinolophus ferrumequinum* 2.5. (Barataud, M. 2015. *Acoustic Ecology of European Bats: Species Identification, Study of their Habitats and Foraging Behaviour*. Paris: Muséum nationale d'Histpire naturelle

Calculating the Habitat Unit Value

A5.32 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 7 below). The outcome of the Habitat Suitability Units used in the HEP is on a scale of 0 to 18[67].

A5.33 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, an HSI x Band score of 12 for an area of 1.50 hectares would give a value of 18 Habitat Units.

A5.34 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

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

A5.35 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.

A5.36 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.

A5.37 <u>HEP calculations for development sites should be made on the basis that the total site</u>

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

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.

Summary

A5.38 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 = Habitat Units required.

Habitat Units divided by 18 = hectares required

A5.39 An Excel spread sheet in which figures used to the calculate the amount of replacement habitat required as mitigation for a proposed development is available on Local Authority websites. This also contains linked spreadsheets to calculate the value of the replacement habitat provided (see A5.40 to A5.52), on or off site and a further spreadsheet for the value for an offsite receptor site (see A5.53 to A 5.54).

Replacement Habitat

A5.40 To check whether the master plan for the development site provides enough habitat equivalent to that lost due in mitigation a second Excel spreadsheet is provided. The scores for the new habitat are entered as for the calculation for the amount required to replace that lost. 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 woodland with water would be possible to re-create within a development site).

A5.41 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.

A5.42 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.

A5.43 *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.*'[68] 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'.

A5.44 '*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.*[69] 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.[70]. In many other situations a significantly higher multiplier may be appropriate[71]. *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.*[72]

A5.45 Appendices 3 and 4 give a guide to difficulty in creating and restoring habitats and the time frame required to reach maturity or functionality.

Delivery Risk

A5.46 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, and associated multipliers, as set out in* [Table 8] *below*.'[73]

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

[69] 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, overall coherence, opinion of the commission.* Brussels: Office for Official Publications of the European Communities.

[70] 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

[71] 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*.

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

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

A5.47 Appendix 3 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.

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

Difficulty of recreation/restoration	Multiplier
Very High	0.1
High	0.33
Medium	0.67
Low	1

<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 9 below. Appendix 6 gives general guidance on how long different habitats would be expected to reach maturity. The actual multiplier used needs to be judged on a case by case basis.

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[74]

Years to target condition	Multiplier
1	0.965
5	0.837
10	0.70
15	0.59
20	0.49

Spatial Risk

A5.51 A factor is added for spatial risk to cover instances where the replacement habitat is provided off-site and where to site of the replacement habitat is located in another Density Band than that of the development site, for example the development occurred in Band B and the off-site replacement habitat is located in Band A.

A5.52 In all cases, the creation of replacement habitat in a lower band, i.e. Band C for a development occurring in Band B should be avoided.

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.

A5.54 It is critical that the replacement site where habitat has been enhanced is accessible to the population of horseshoe bats affected.

Enhancement

A5.55 The National Planning Policy Framework (July 2018) states that states that '*Planning policies and decisions should contribute to and enhance the natural… environment by… providing net gains for biodiversity…*' The result of the metric should show a gain in hectares in order that enhancement is achieved.

A5.56 In December 2018 Defra published its consultation on net gain in biodiversity[75]. This stated '*Our initial view is that a 10% gain in biodiversity units would be a suitable level of net gain to require in order to provide a high degree of certainty that overall gains will be achieved, balanced against the need to ensure any costs to developers are proportionate. In practice, this means that if a site is worth 50 biodiversity units before development, the site (and any offset sites and tariff payments) should be worth 55 units at the scheme's conclusion. The proposed 10% would be a mandatory national*

[74] http://publications.naturalengland.org.uk/publication/6020204538888192
[75] https://consult.defra.gov.uk/land-use/net-gain/supporting_documents/netgainconsultationdocument.pdf

requirement, but should not be viewed as a cap on the aspirations of developers that want to voluntarily go further or do so in the course of designing proposals to meet other local planning policies.'

Annex 6: Habitat Creation Prescriptions for Lesser Horseshoe Bats[76]

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.

Woodland with Water

A6.2 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 that woodland associated with water was the habitat most preferred by Lesser Horseshoe bats.

A6.3 Micromoth abundance is positively related to the relative abundance of native trees[77] 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 of compact shapes, especially when the patch to be created is small. Brown lacewings can be found amongst conifers.

A6.4 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.

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[76] 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.

[77] '*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.

A6.5 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.

A6.6 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

A6.7 Long sward grassland is of benefit to Lesser 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. 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.

Hedgerow

A6.8 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.

A6.9 One study found that night flying moth abundance and diversity correlated positively with the number of bramble (*Rubus fruticosus*) clumps along a hedgerow[78].

A6.9 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[79].

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[78] Coulthard, E. 2015. The Visitation of Moths (Lepidoptera) to Hedgerow Flowering Plants in Intensive Northamptonshire Farmland: in Coulthard, E. 2015. ***Habitat and landscape-scale effects on the abundance and diversity of macro-moths (Lepidoptera) in intensive farmland***. PhD. University of Northampton.

[79] 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.

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.[80]

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*".[81]

A7.3 Regulation 63 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 63 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 63 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 Hestercombe House SAC. The Somerset authorities will apply a "Test of Likely Significant Effect" for proposals which involve or may involve:

- the destruction of a Lesser Horseshoe bat roost (maternity, hibernation or subsidiary roost);
- loss of foraging habitat for Lesser Horseshoe bats
- fragmentation of commuting habitat for Lesser Horseshoe bats
- increase in luminance in close proximity to a roost and/or increase in luminance to foraging or commuting habitat from artificial lighting

[80] See European Site Conservation Objectives for Bath and Bradford on Avon Bats Special Area of Conservation at Annex [ ]

[81] Natural England Standard: Conservation Objectives for European Sites in England Standard 01.02.2014 V1.0 http://publications.naturalengland.org.uk/publication/6734992977690624

- impacts on foraging or commuting habitat which supports the Lesser Horseshoe bat population structurally or functionally

A7.6 The Court of Justice of the European Union clarified what is required in that there is a '…. *need to identify and examine the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of the site. Provided those implications are liable to affect the conservation objectives of the site'*[82]

A7.7 When considering whether a project is likely to have a significant effect on a European site, the competent authority in Stage 1 of the Habitats Regulations Assessment, does not take account of mitigation measures for effects on the features of the European site[83]. Where mitigation measures are required a Stage 2 Appropriate Assessment is required.

A7.8 Mitigation measures are measures which are designed to *avoid* or *reduce* adverse effects on a European site. Where compensatory measures are required (i.e. for impacts within the designated site) these will not be taken into account in Stage 2 the Appropriate Assessment. It is important to distinguish mitigation from compensatory measures which are designed to compensate for unavoidable adverse effects on a European site and follow the "3 tests"[84].

A7.9 The precautionary principle underpins the Habitats Directive[85] and hence the Habitats Regulations and must be applied by the local planning authority as Competent Authority as a matter of law.[86] It is clear that the decision whether or not an appropriate assessment is necessary must be made on a precautionary basis.[87] In addition, the Waddenzee judgement[88] 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.

A7.10 For the Local Planning Authority 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

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[82] Court of Justice of the European Union (Holohan, Guifoyle, Guifoyle & Donegan v An Bord Pleanála. Case C-461 /17)
[83] The Court of Justice of the European Union (*People Over Wind and Sweetman v Coillte Teoranta* (C-323/17)) decision means that mitigation (avoidance and reduction) measures may no longer be taken into account by competent authorities at the HRA "screening stage" i.e. when judging whether a proposed project is likely to have a significant effect on a European site.
[84] See ODPM circular 06/2005
[85] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the 'Habitats Directive')
[86] *Assessing Projects under the Habitats Directive: Guidance for Competent Authorities* 2011, CCW p.15
[87] ODPM Circular 06/2005 para13
[88] ECJ judgement: C-127/02 [2004] ECR-I

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.

A7.11 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 Local Planning Authority to determine how the bat populations have responded to mitigation and to increase the evidence base.

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Part D: Appendices

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

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.
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	

Results	Average Distance (km)	Maximum Distance (km)	Reference
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: Lesser Horseshoe Bat Habitat Suitability Index

<u>Text Colour</u>
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
Woodland Habitat Codes			‘*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) In lowlands broadleaved and mixed woodland is the most used habitat (Knight, 2006) Avoids dense scrub cover (Schofield 2008), i.e. WB2 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) Non-native - biomass of fir trees is 16 compared to Ash 41 and Oak 284 Window gnats present Juveniles select broadleaved woodland habitat (Knight, 2006) 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) 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) 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)
WB0	Broadleaved, mixed, and yew woodland	6	
WB1	Mixed woodland	6	
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	
WB321	Tilio-Acerion forests of slopes, screes and ravines [upland]	NP	
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	
WB34	Wet woodland	6	
WB341	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	NP	
WB342	Bog woodland	NP	
WB34Z	Other wet woodland	6	
WB35	Upland birch woodland	6	
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	
WC0	Coniferous woodland	3	
Woodland Matrix Codes			Known to make use of shrubs such as rhododendron (Robertson, 2002)
IH0	Introduced shrub	0	

Code	Label	HSI	Notes
Woodland Formation Codes			
WF0	Unidentified woodland formation	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)
WF1	Semi-natural	1	
WF11	Native semi-natural	1	
WF111	Canopy Cover >90%	0.2	Determined by woodland habitat type
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	
WF121	Canopy Cover >90%	0.2	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)
WF122	Canopy Cover 75 - 90%	0.7	
WF123	Canopy Cover 50 - 75%	1	
WF124	Canopy Cover 20 - 50%	1	
WF2	Plantation	0.8	
WF21	Native species plantation	0.8	
WF22	Non-native species plantation	0.6	Uniform stands of trees are poorer in invertebrates than more diversely structured woodland (Kirby, 1988) Used conifer plantation at Ciliau but overall time in the habitat was small (Schofield et al, 2003)
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	
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	
Woodland Management Codes			
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	Clear cutting must be avoided (Motte & Libouis, 2002)
WG2	Recently felled/coppiced woodland clearing	0.5	
WG3	Woodland ride	1	
WG4	Recently planted trees	0.5	
WGZ	Other woodland clearings/openings	1	
Grassland Habitat Codes			The majority of foraging areas around Glynllifon are associated with semi improved pasture bounded by hedgerows and scrub (Billington & Rawlinson, 2006)
GA0	Acid grassland	3	
GC0	Calcareous grassland	3	
GN0	Neutral grassland	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)
GN1	Lowland meadows	3	
GI0	Improved grassland	2	
GU0	Semi improved grassland	3	The Integrated Habitat System considers scrub as a

Code	Label	HSI	Notes
Grassland Matrix Codes			matrix habitat when less than 0.25ha. Otherwise use WB2
SC1	Dense/continuous scrub	-3	Avoids dense scrub cover (Schofield 2008)
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	1	
TS1	Scattered trees some veteran	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
TS11	Broadleaved	1	
TS12	Mixed	1	
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	Area of bare ground is not specified - assumed patchy
BG1	Bare ground	0	
Grassland Management Codes			
GM0	Undetermined grassland etc. management	1	
GM1	Grazed	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)
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	
GM23	Frequent mowing	0.25	Possibility of presence of window gnats but heavily managed or lit. Need to have associated matrix codes TS
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	

Code	Label	HSI	Notes
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	
CL3Z	Other unintensively managed orchards	1	
CF1	Coastal and floodplain grazing marsh	1	
Bracken Habitat Codes			
BR0	Bracken	2	Bracken cover hosts over 40 species of invertebrates. Bracken and heath are used by lesser horseshoe bats in upland areas (Knight, 2006)
Heathland Habitat Codes			Bog habitats are avoided by lesser horseshoe bats (Irish Bats)
HE0	Dwarf shrub heath	2	
HE1	European dry heaths	2	
HE2	Wet heaths	1	
Bog Habitat Codes			
EO0	Bog	NP	
Wetland Habitat Codes			Fen was intensively used in Bavaria where groups of trees are present (Holzhaider et al, 2002)
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	
EM312	Springs	2	
EM313	Alkaline fens [lowland]	2	
EM314	Transition mires and quaking bogs [lowland]	2	
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	
Standing Water and Canals Habitat Codes			

Code	Label	HSI	Notes
AS0	Standing open water and canals	6	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. 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) 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 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 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 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 confirmed by radio tracking and /or other surveys in the future. Watercourses are the most used habitat in uplands (Trichoptera in diet) (Knight, 2006)
AS1	Dystrophic standing water	3	
AS11	Natural dystrophic lakes and ponds	1	
AS1Z	Other dystrophic standing water	3	
AS2	Oligotrophic standing waters	4	
AS21	Oligotrophic lakes	1	
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	
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	
ASZ	Other standing open water and canals	6	
Standing Water and Canals Formation Codes			
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	
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	
Standing Water and Canals Management Codes			
LT1	Canal-side	1	
LT11	Canal-side with woodland	1	
LT12	Canal-side with scrub or hedgerow and standard trees	1	

Code	Label	HSI	Notes
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	
Running Water Habitat Codes			
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	
AR2	Chalk rivers (not including chalk headwaters)	4	
AR3	Active shingle rivers [non headwaters]	5	
ARZ	Other rivers and streams	4	
Running Water Management Codes			
LT2	River-side	1	
LT21	River-side with woodland	1	
LT22	River-side with scrub or hedgerow and standard trees	1	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)
LT23	River-side with scrub or hedgerow	1	
LT24	River-side with layered vegetation	0.75	
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	
Arable Habitat Codes			
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	Miscanthus is not palatable to most insects. This is likely to include those species preyed upon by lesser horseshoe bats
CR35	Miscanthus	0	
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	
Arable Management Codes			
CL1	Agriculture	1	
CL11	Organic agriculture	1	
CL12	Non-organic agriculture	0.5	
CL2	Market garden and horticulture	0	It has been shown that organic farms are more heavily

Code	Label	HSI	Notes
CL21	Organic market garden and horticulture	0	used by bats than otherwise (Wickramasinghe et al, 2003).
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	
Inland Rock Habitat Codes			
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	Winter roost sites.
RE141	Caves not open to the public	NP	
RE14Z	Other caves	5	
RE15	Exposed river gravels and shingles	2	Caves occur in disused quarries in Somerset
RE1Z	Other natural rock exposure feature	0	
RE2	Artificial rock exposures and waste	0	
RE21	Quarry	2	
RE22	Spoil heap	0	
RE23	Mine	3	
RE24	Refuse tip	0	
RE2Z	Other artificial rock exposure and waste	0	
Linear Habitat Codes			
LF0	Boundary and linear features	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). 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*.' 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) 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)
LF1	Hedges / Line of trees	6	
LF11	Hedgerows	6	
LF111	Important hedgerows	6	
LF11Z	Non-important hedgerows	5	
LF12	Line of trees	6	
LF1Z	Other hedges/line of trees	5	
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	
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	
Linear Management Codes			
LH3	Recently planted hedge (Only use for existing habitat)	0.25	
LM1	Cut hedge	0.3	Cut hedge is specified where height is below 2 metres

Code	Label	HSI	Notes
LM11	Cut hedge with standards	0.3	Uncut hedge is specified where the hedge is between 2 and 3 metres high Overgrown hedge is considered to be over 3 metres high
LM12	Cut hedge without standards	0.2	
LM2	Uncut hedge	0.9	
LM21	Uncut hedge with standards	0.9	
LM22	Uncut hedge without standards	0.8	
LM3	Overgrown hedge	1	
LM31	Overgrown hedge with standards	1	
LM32	Overgrown hedge without standards	0.9	
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	
Built Up Areas and Gardens Habitat Codes			
UR0	Built-up areas and gardens	1	
Built UP Areas and Gardens Management Codes			
UA1	Agricultural	0.1	
UA2	Industrial/commercial	0	Lesser horseshoe bat summer roosts are typically in the loft spaces of old buildings Urban and sub urban areas are exploited by lesser horseshoe bats (Knight, 2006) Farmyards most used by lesser horseshoe in Ireland (McAney & Fairley, 1988). Night roosts possible
UA3	Domestic	0	
UA31	Housing/domestic outbuildings	0.1	
UA32	Gardens	0.1	
UA33	Allotments	0.1	
UA34	Caravan park	0	
UA3Z	Other domestic	0	
UA4	Public amenity	0	
UA41	Churchyards and cemeteries	1	
UA4Z	Other public amenity	0	
UA5	Historical built environment	1	
UAZ	Other extended built environment	0	

Appendix 3: 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 4: 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 5: 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

Field No	Habitat	Primary Habitat IHS Code	Primary Habitat Score	Matrix IHS Code	Matrix Score	Formation IHS Code	Formation Score	Management / Land use IHS Code	Management / Land use Score	HSI Score	Density Band Score	Hectares	Habitat Units
H6	Hedgerow, cut without standards	LF11	6		0		1.00	LM12	0.20	1.20	2	0.07	0.17
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.

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