Exmoor and Quantocks Oak Woodlands Special Area of Conservation (SAC)

Guidance on Development

Version 2.1 – May 2019

EXMOOR NATIONAL PARK

Sedgemoor IN SOMERSET

Somerset West and Taunton

SOMERSET County Council

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EXMOOR AND QUANTOCKS OAK WOODLANDS
SPECIAL AREA OF CONSERVATION (SAC): GUIDANCE ON DEVELOPMENT

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Exmoor and Quantocks Oak Woodlands 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 used by Barbastelle and Bechstein's bats surrounding the North Exmoor and Quantocks component sites of the Exmoor and Quantocks Oak Woodlands 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 Barbastelle bats use the landscape and where there is likely to be greater risk or opportunity for development. This will help inform strategic planning for the area's future housing needs.

1.3 The guidance will comprise a component of the development management process, to be considered in line with relevant policies, such as policy DM8 (Nature Conservation) of the Sedgemoor District Council Local Plan; NH3 of the West Somerset District Council Local Plan; Policy CE-S3 of the Exmoor National Park Authority Local Plan; and Policy DM2: Biodiversity and Geodiversity of the Somerset County Council Minerals Plan; and Policy DM3: Impacts on the environment and local communities in 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 8). The local planning authority will consider, on the basis of evidence available, whether proposals (planning applications) are likely to impact on Barbastelle 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 the Exmoor National Park Authority and Somerset County Council and their partners and is fully endorsed by Natural England. The planning guidance is part of a wider approach that is being pursued by partner organisations to safeguard and improve habitat for rare bats that includes farm management. The guidance is also consistent with Natural England's Site Improvement Plan for the SACs.

2. What is the Bats SAC?

2.1 Special Areas of Conservation (SAC) are European sites of international importance for wildlife. The Exmoor and Quantocks Oak Woodlands SAC is important for two bat species, Barbastelle and Bechstein's bats present in the both the North Exmoor SSSI and the Quantocks SSSI components of the SAC.

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

2.3 However the landscapes around the SACs themselves itself are also important in providing foraging habitat needed to maintain the favourable conservation status of Barbastelle and Bechstein's bat populations. 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 Barbastelle 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 may be permitted but is likely to be subject to particular requirements, depending on the sensitivity of the site.

4. Juvenile Sustenance Zones for Barbastelle Bats

4.1 The guidance identifies the Juvenile Sustenance Zones of 1 kilometre (km) around the Barbastelle bat maternity woodlands. New build development on green field sites should be avoided in the Juvenile Sustenance Zones (JSZs) in view of their sensitivity and importance as suitable habitat as foraging areas for young bats.

5. Sensitive Zones for Bechstein's Bats

5.1 Bechstein's maternity colonies make use of mature woodland or groups of woodland joined by commuting routes such as mature hedgerows. As it is not possible to mitigate the loss of this woodland development affecting the woodlands and intervening habitat are unlikely to be permitted.

6. Need for early consultation

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

6.2 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.

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

6. Survey requirements

7.1 Section 3 and Annex 4 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.

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

7.3 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 Barbastelle 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 6).

7.4 Within band C survey effort required will depend on the suitability habitat to support prey species hunted by Barbastelle bats.

8. Proposed developments with minor impacts

8.1 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 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.

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

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

9.2 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 6 sets out the methodology and metric for calculating how much replacement habitat should be provided[1].

9.3 Any replacement habitat must be accessible to the Barbastelle bat population affected.

9.4 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.

9.5 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.

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

9.7 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.

10. Enhancement

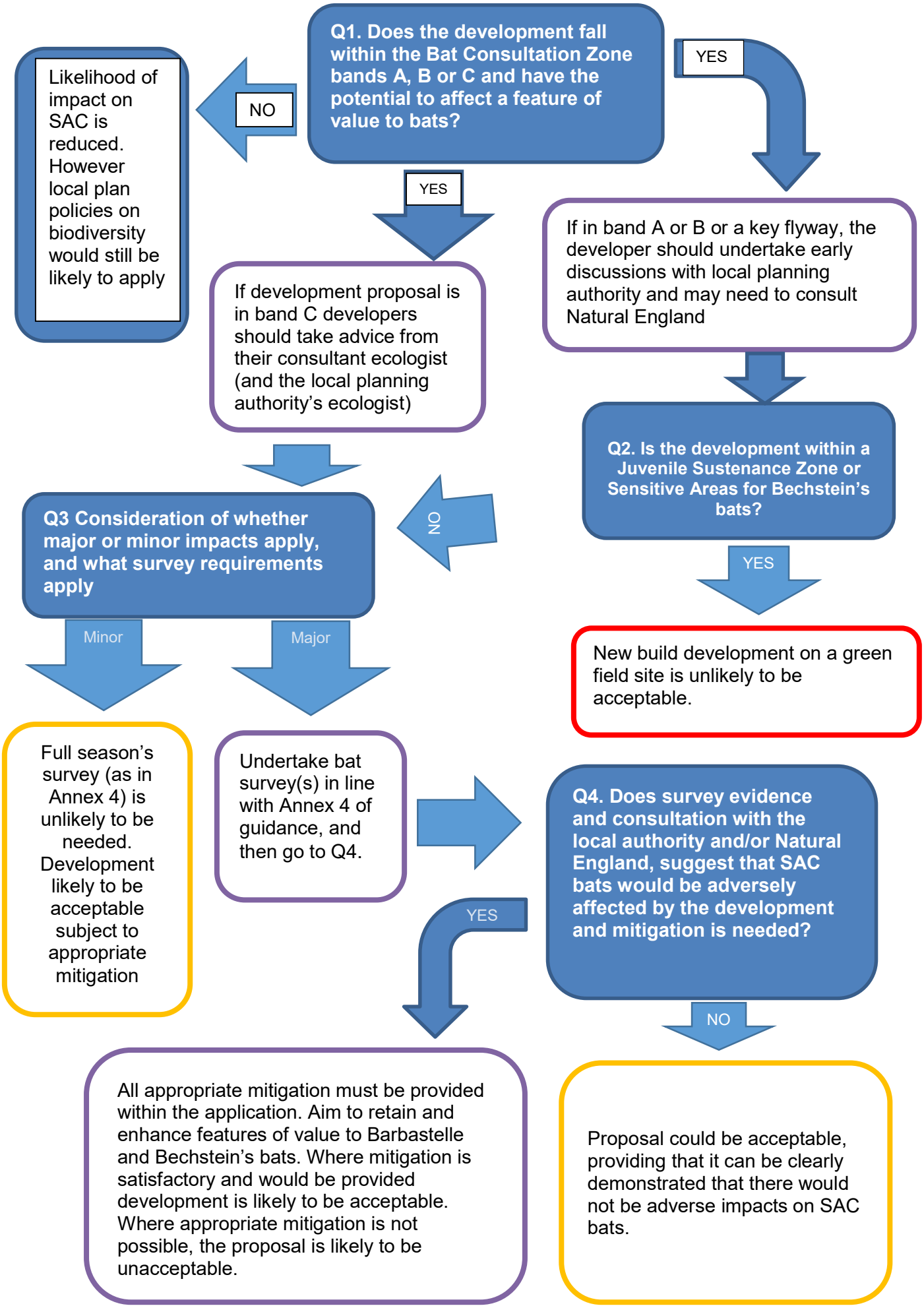
10.1 Development will be expected to provide enhancement for barbastelle and Bechstein's bats. The National Planning Policy Framework (July 2018)[2] states that '*Planning… decisions should contribute to and enhance the natural… environment by… providing net gains for biodiversity*…' It is expected that

[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 Barbastelle 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

development sides would provide a greater quantum of habitat in value than that lost due to the built development and associated infrastructure.

10.2 An example of the Excel worksheets used in calculating the quantum of replacement habitat required is given in Appendix 6 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.


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 or a key flyway, 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 or Sensitive Areas for Bechstein's bats?
YES
New build development on a green field site is unlikely to be acceptable.
NO
Q3 Consideration of whether major or minor impacts apply, and what survey requirements apply
Minor
Major
Full season's survey (as in Annex 4) is unlikely to be needed. Development likely to be acceptable subject to appropriate mitigation
Undertake bat survey(s) in line with Annex 4 of guidance, and then go to Q4.
Q4. Does survey evidence and consultation with the local authority and/or Natural England, suggest that SAC bats would be adversely affected by the development and mitigation is needed?
YES
All appropriate mitigation must be provided within the application. Aim to retain and enhance features of value to Barbastelle and Bechstein's bats. Where mitigation is satisfactory and would be provided development is likely to be acceptable. Where appropriate mitigation is not possible, the proposal is likely to be unacceptable.
NO
Proposal could be acceptable, providing that it can be clearly demonstrated that there would not be adverse impacts on SAC bats.

PART B
Technical Guidance

1. Introduction

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

1.2 Amongst the qualifying features for the SAC are two Annex II species:
- the Barbastelle bat *Barbastella barbastellus*; and
- the Bechstein's bat *Myotis bechsteinii*

1.3 Bechstein's bats are present in the Exmoor component site at Horner Wood and in the Quantocks component site at Alfoxton where activity is likely to be confined to the local woodland. However, longer range dispersals by Bechstein's bats, for example to swarm, is likely to benefit from habitat structure used by the Barbastelle bat and therefore the conservation and provision of such structure is given emphasis in the guidance. The 'Precautionary Principle' dictates that if their requirements are met, then the other SAC bat species is also likely to be protected. For more detail on the SAC see Annex 1.

1.4 The Conservation Objectives for the SAC[3] are: With regard to the SAC and the natural habitats and/or species for which the site has been designated (the 'Qualifying Features' which include the bat species listed above), and subject to natural change, ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

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

[3] http://publications.naturalengland.org.uk/publication/5696090506526720?category=5374002071601152

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

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

1.7 This document should serve as an evidence base and provide guidance on the planning implications for development control in the relevant local planning authority (LPA). There are opportunities beyond the scope of this document to use this evidence base to inform the preparation of land use plans through the local plans.

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

1.9 The guidance explains how development activities can impact the SAC and the steps required to avoid or mitigate any impacts. It applies to development proposals that could affect the SAC and trigger the requirements of the Habitats Regulations[4] (see Annex 8). The local planning authority will consider, on the basis of evidence available, whether proposals (planning applications) are likely to impact on SAC bats and hence require screening for Habitats Regulations Assessment (HRA). Those are the proposals to which the guidance will be applied. This will reduce the likelihood that it would be applied to minor developments which would not have an impact on the SAC.

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

1.11 This technical guidance is based on the advice from experts and ecological consultants[5], current best practice and the best scientific information available at the time of writing. It will be kept under review by Somerset County Council and the Exmoor National Park Authority.

2. Sensitive Zones for Barbastelle Bats

Introduction

2.1 To facilitate decision making and in order to provide key information for potential developers at an early stage, using the best available data a Bat Consultation Zone affecting Somerset West and Taunton and Sedgemoor districts and Exmoor National Park, and Juvenile Sustenance Zones affecting Somerset West and Taunton and the

[4] Conservation of Habitats and Species Regulations 2010, SI 2716, Regulation 61
[5] See acknowledgements

National Park (See Plans 1 to 4 below) have been identified. This is an accumulation of known data, beginning with the 2000 radio tracking study of the Horner Wood colony and the 2012 Quantocks radio tracking studies of Barbastelle bat roosts.[6] The data is constantly being added to and updated. Therefore, the Plans reflect the current understanding of key roosts and habitat associated with the SAC.

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

2.2 Barbastelle bats are spread very thinly in the landscape. At the Ebernoe roost in Sussex the density of bats in late summer was rather less than one female or juvenile to six square kilometres. This area would include very large areas of land that are not or seldom used, such as those consisting of arable fields. The hunting territories themselves form a select and vulnerable set of more stable and productive habitats; a small percentage of the total area, but rich in diversity.[7]

2.3 The Bat Consultation Zone illustrates the area where Barbastelle bats may be found. It is divided into three bands, A, B and C reflecting the density at which Barbastelle bats 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 Horner Wood on Exmoor, in the Quantocks, Dartmoor and at Mottisfont in Wiltshire; field survey records; and research into the spatial use of the home range by the species. Note that the radio tracking studies only recorded the movements of a small number of bats from each of the maternity roosts and therefore it is likely that any area within the Bat Consultation Zone could be exploited by Barbastelle bats. The zone's band widths are set out in Table 1 below and in Annex 2.

Table 1: Band Widths for Barbastelle Bat (from Maternity Woodlands)

Band	Distance (metres)
A	7000
B	10100
C	15500

2.4 The Bat Consultation Zone radius circle is centred on the maternity roosts around Alfoxton and Waltham's Wood in the Quantocks and around Horner Wood on Exmoor. The Consultation Zone is further defined by the coastline east of the Quantocks and at Porlock and by forming a buffered Minimum Convex Polygon on the extents of recorded occurrences of the species to produce the broad directional dispersal of Barbastelle bats through a colony's home range. (See Annex 2)

2.5 Band A is shown in orange shading, Band B in yellow and Band C in pale yellow reflecting the decreasing density at which Barbastelle bats are likely to occur away from the home roost. However, if foraging activity or a key flyway is recorded in Band B or C then they should be treated as for Band A (see Annexes 3 and 6).

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[6] Rush, T. & Billington, G. 2012. *Report on a radio tracking study of Barbastelle bats at Hinkley Point C*. Witham Friary: Greena Ecological Consultants.

[7] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

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

2.6 Juvenile Sustenance Zones are formed around woodland containing maternity roosts to a distance of 1 kilometre (km) for Barbastelle bats. Although patches closest to the roost area are usually shared by the colony members these may seasonally be left clear by adults as exclusive juvenile foraging zones. Most colonies seem to have one large productive foraging zone very close to the roost woodlands to fulfil the juvenile and shared requirement. The availability of productive habitat producing abundant prey close to the roost in this period is a major key to the success of any bat colony. Examples of such foraging areas are small woodland floodplains and ponds or small river systems with a plentiful shrubby growth of species like willows. These foraging areas also need to be on the adult female bats' flyway.[8]

3. Sensitive Zones for Bechstein's Bats

Bat Consultation Zone (orange, yellow and pale yellow shading on Plans 5 and 6 below)

3.1 The Bat Consultation Zone radius circle is centred on the maternity roosts around Alfoxton and Holford Combe in the Quantocks and around Horner Wood on Exmoor.

3.2 The Density Bands for maternity colonies of Bechstein's bats are measured from the edge of the home woodland. The foraging range 1000m metres from the Beckett's Coppice study is the base for Band A. (The 600m buffer is considered a Sensitive Zones for Bechstein's bats[9] and is included within Band A) Band B is based on the mean maximum foraging range of 1240metres (from a number of studies).

Table 2: Band Widths for Bechstein's Bats (from Maternity Woodlands)

Band	Distance (metres)
A	0 - 1000
B	1001 - 1240
C	1241 - 1716

3.3 Individual female Bechstein's bats forage within closed broadleaved woodland in Sussex. Radio tracking at Beckets Coppice also showed that bats stayed within the home woodland and form socially closed units. Bechstein's bats use old beech and oak woodland (deciduous woodland) with plenty of structure and mixed species understorey. This habitat, its biomass in prey species and shelter, cannot be replaced in the short or medium term. Therefore, it is unlikely that woodland or a group of linked woodlands supporting a maternity colony of Bechstein's bats could be replaced to maintain the integrity of the SAC population.

[8] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Greenway, F. & Hill, D. 2005. *Woodland management advice for Bechstein's bat and barbastelle bat*. Peterborough, English Nature.

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

2.17 A buffer of 600m is formed around woodlands known to support or potentially Bechstein's maternity populations[10]. New development of greenfield or residential brownfield sites within this zone is likely to result in high and unacceptable risks because of increased recreational pressure on these woodland sites and/or as a result of habitat loss.[11]

4. Consultation and Surveys

3.1 Where a proposal within 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: watercourses, hedgerows, tree lines
- Riparian, broadleaved woodland, unimproved grassland, improved grassland, mixed woodland, coniferous woodland, scrub, and gorse habitats
- Wetland habitat: ponds, rivers, streams, rhynes
- New wind turbine proposals (in respect of displacement)[12]
- Development which introduces new lighting

3.2 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.

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

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

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[10] Woodland in the B&NES area was not surveyed in the Bat Conservation Trust's national survey for Bechstein's bats in woodlands 2007 /2011. https://www.bats.org.uk/our-work/national-bat-monitoring-programme/past-projects/bechsteins-bat-project

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

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

3.5 For proposals within the Bat Consultation Zone (all Bands) an ecological consultant[13] should be commissioned at an early stage to identify and assess any impacts the proposals may have.

3.6 Surveys should determine the use of the site by Barbastelle and or Bechstein's 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 6. Consideration should be given to the site within the wider landscape.

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3.7 Surveys should be carried out in accordance with the Survey Specification at Annex 4. 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.

3.8 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 August inclusive plus October) 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 4.14 to 4.15 on minor impacts.) 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.

3.9 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. [14]

4. Mitigation within the Consultation Zone

4.1 Within the Bat Consultation Zone, where SAC bats would be affected or potentially affected by development appropriate mitigation will be required. The aim should be to retain and enhance habitat and features of value to Barbastelle bats, such as those listed in paragraph 3.2 of Part B of this guidance. Where this is not possible replacement habitat may be needed. The council's ecologist will have regard to relevant considerations in determining the mitigation requirements, including survey results and calculations relating to replacement habitat. (See the methodology and metric in Annex 6) 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:

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

[14] 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.

- Hunting habitat such as grassland; hedgerows; woodland; scrub; riparian vegetation; tree lines; arable margins; and ponds. They also need water to drink from.
- Connecting habitat, which is important to ensure continued functionality of commuting habitats including both sides of a track where it occurs. (Proposals must seek to retain existing linear commuting features as replacement of hedgerows is likely to require a significant period to establish). Note that strategic or key flyways are important to barbastelle bats and are sued by several members of a colony whilst dispersing to individual feeding areas (See Annex 3).

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

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 Barbastelle bats and which may be created or enhanced as the replacement provision. Planting will be expected to consist of native species that produce an abundance of invertebrates, particularly moth species.

- Hedgerows with trees – tall, bushy hedgerows at least 3 metres wide and 3 metres tall
- Unimproved grassland / wildflower meadow - managed for moths, e.g. Long swards[15].
- Scrub including gorse
- Riparian vegetation

[15] Ransome, R. D. 1996. *The management of feeding areas for Greater Horseshoe bats*. Peterborough: English Nature; Ransome, R. D. 1997. *The management for Greater Horseshoe bat feeding areas to enhance population levels*: English Nature Research Reports Number 241. Peterborough: English Nature. Noctuid moths form a large element of Barbastelle bat diet

- Wide field margins at least 6 metres wide
- Ponds - for drinking

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 6.

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 Barbastelle bats. The timescale to when these restorations is 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 SAC 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 Lighting is considered to have a high impact on Barbastelle bat roosts and a lesser impact on foraging and commuting habitats. This does not mean that there are no effects at all - Barbastelle bats do not feed through street lights as some more tolerant bat species even though their prey is attracted to them - and lighting on features used by these bats should be minimised. Other bat species, including Bechstein's bats, present at a proposed development site could be light sensitive and it is recommended that prospective developers provide evidence with their application of introduced light levels so as not to disturb the behaviour of the more sensitive species.[16]

4.14 in addition, many night flying species of insect such as moths, a key prey species for Barbastelle bats, are attracted to light, especially those lamps that emit an 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 Barbastelle bats to be able to feed.[17]

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

- Use of warm white LED lights with directional baffles as required (LED light lacks a UV element and minimises insect migration from areas accessed by SAC bats

[16] Stone, E. L. 2013. *Bats and Lighting Overview of current evidence and mitigation*. Bristol: University of Bristol. Light levels for lesser horseshoe bats are used lacking evidence for Bechstein's bats

[17] Institute of Lighting Engineers/ Bat Conservation Trust. 2018. *Guidance Note 08/18 Bats and artificial lighting in the UK*; pers. comm. Dr Emma Stone, University of Bristol, 2009.

- use of building structure, design, location and orientation to maintain and/or provide a functional
- use of landscaping to protect and/or create dark corridors on site. Planting will be expected to consist of native species, with provision for invertebrates, and planting will be expected to be managed for ecology rather than practicality
- use of SMART glass
- use of internal lighting design solutions to minimise light spill
- 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.[18]

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.

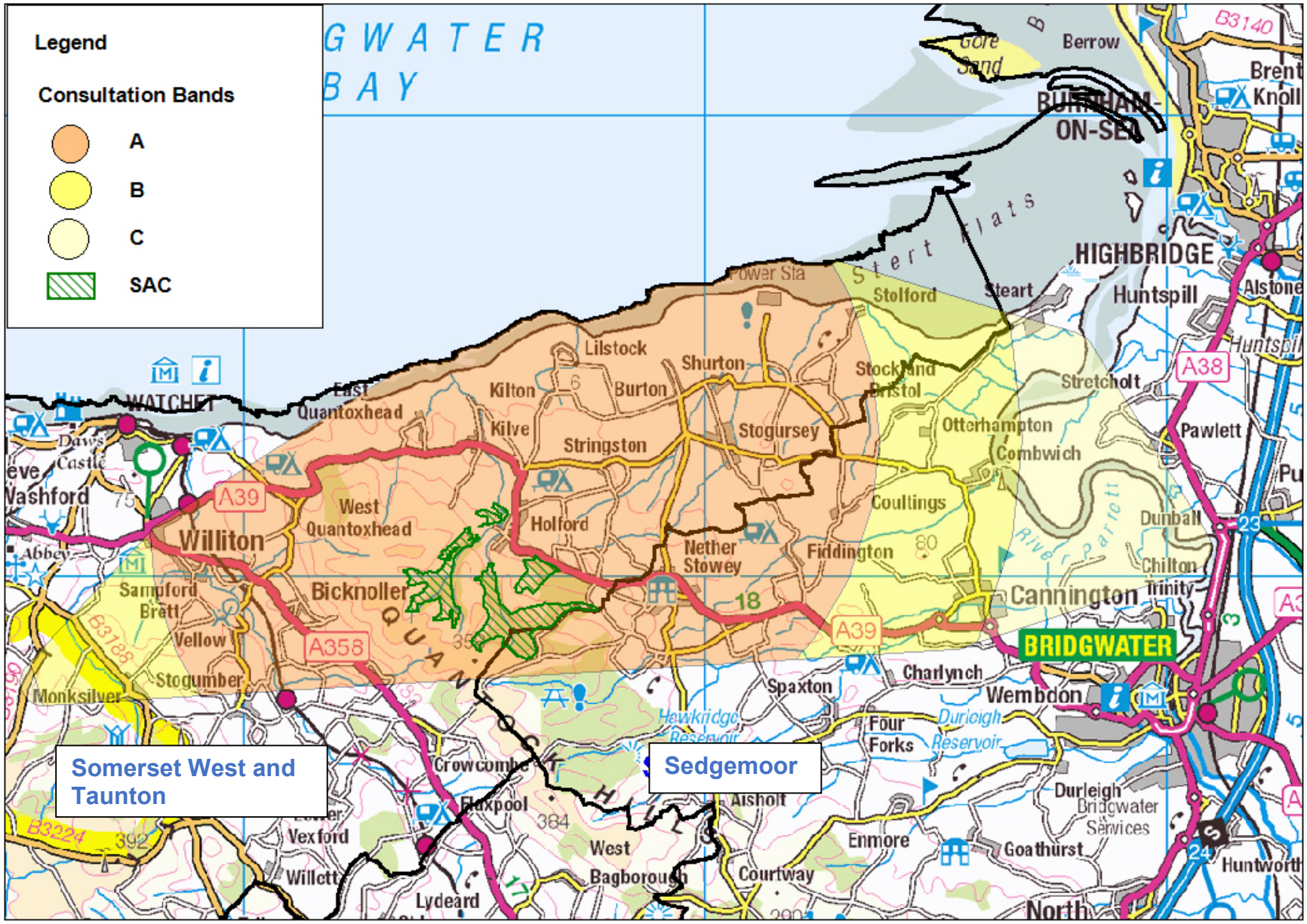
Proposed developments with minor impacts

4.17 In circumstances where this is likely to be overall less potential impact, especially in Band C, mitigation may be put forward without the need for a full season's survey. (See Annex 4) This approach will only be suitable where it can be clearly demonstrated that the impacts of a proposed development are proven to be minor and can be fully mitigated without an impact upon the existing (& likely) SAC bat habitat. In order to adopt this approach, it will be necessary for a suitably qualified ecologist to visit the site and prepare a report with an assessment of existing (& likely) SAC bat habitat. The information from this report should provide the basis to determine appropriate mitigation measures associated with the proposed development. The proposed mitigation should clearly demonstrate that there will be no interruption of suitable SAC bat commuting habitat and replacement of foraging habitat as appropriate.

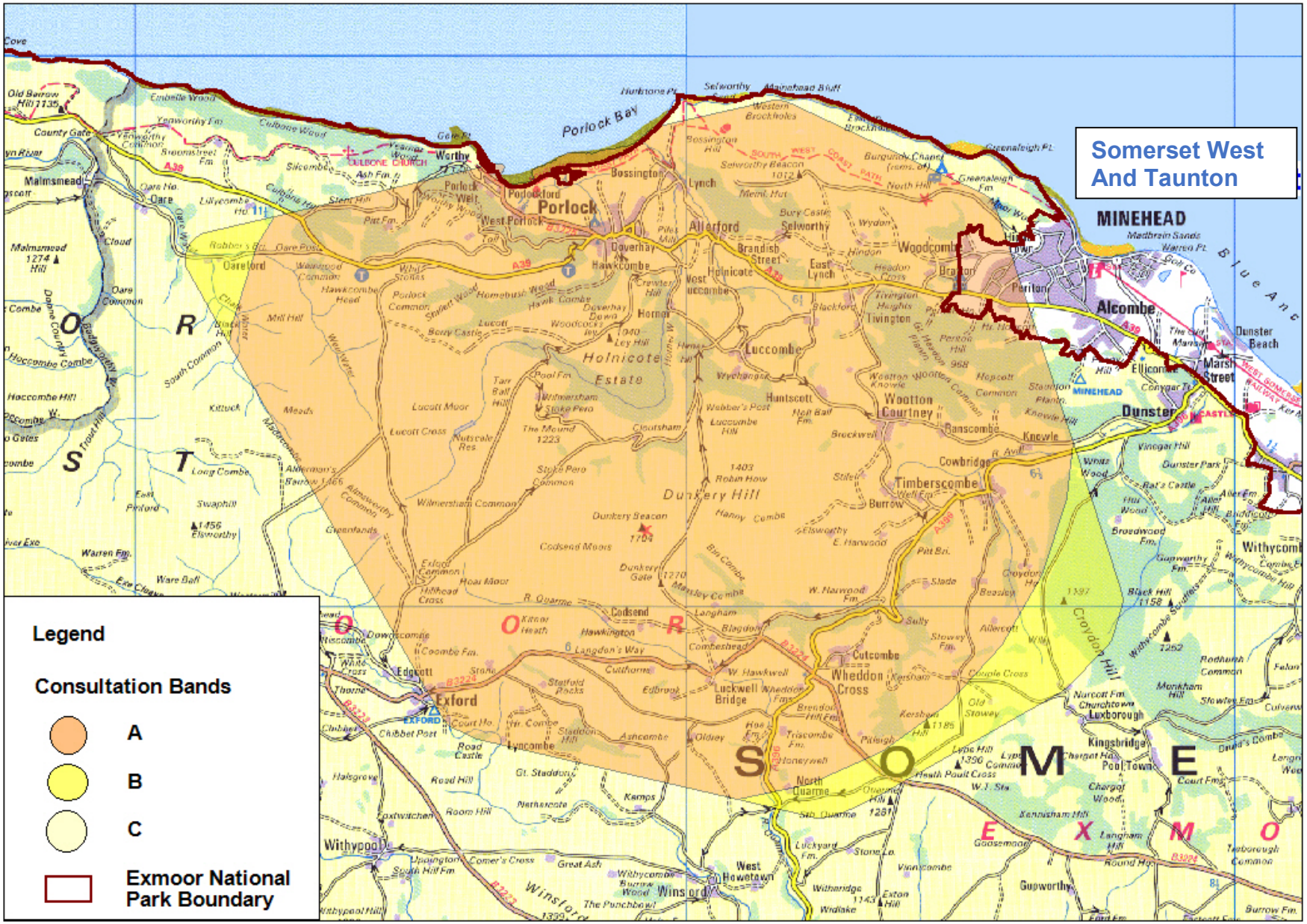
4.18 There may also be situations where mitigation will not be required because the proposed development does not have an impact upon existing (& likely) SAC bat habitat. In adopting this approach, it will be necessary to substantiate this with a suitably robust statement as part of the submission of 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.

[18] 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

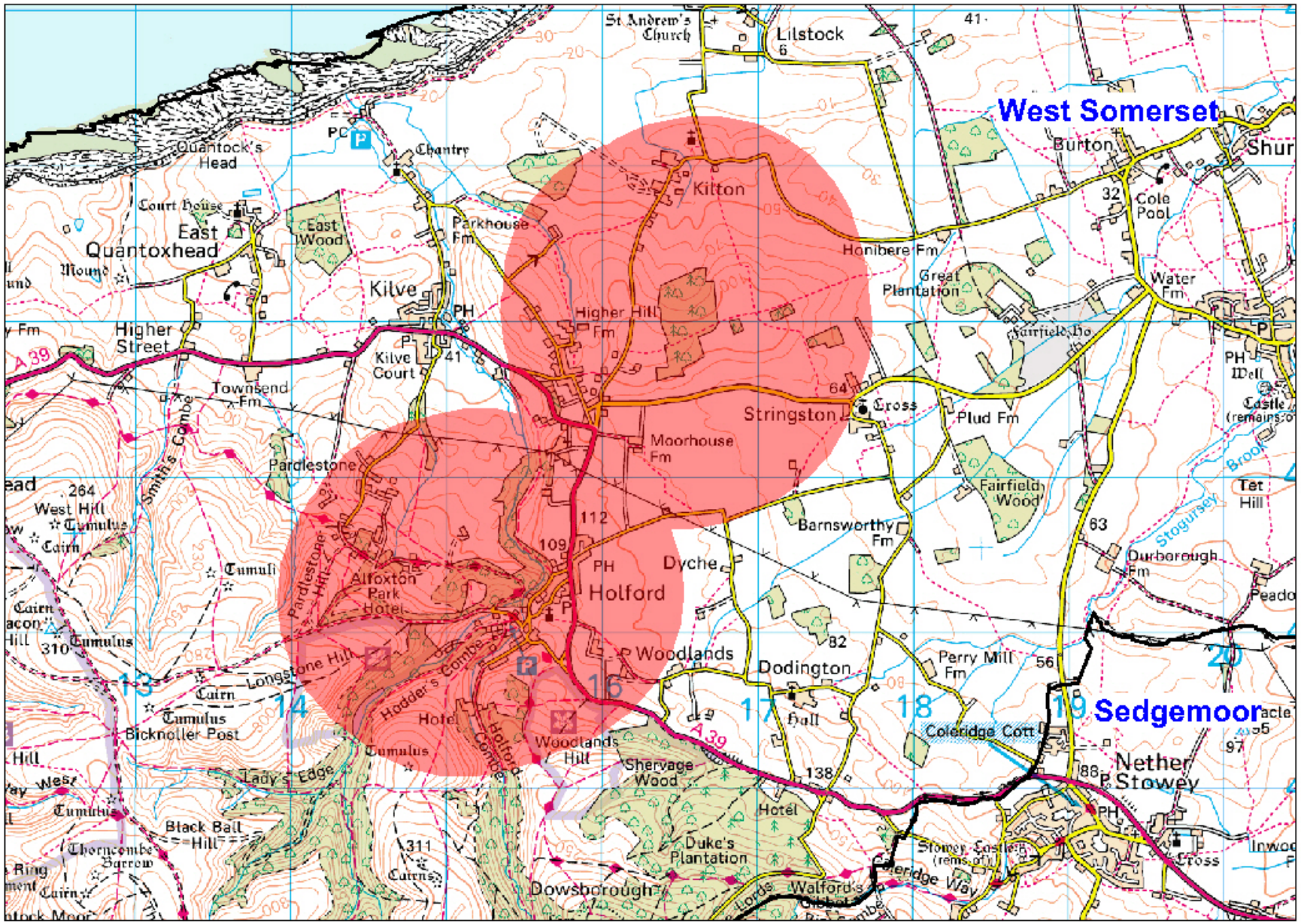
Plan 1: Bat Consultation Zone (Quantocks Roosts)



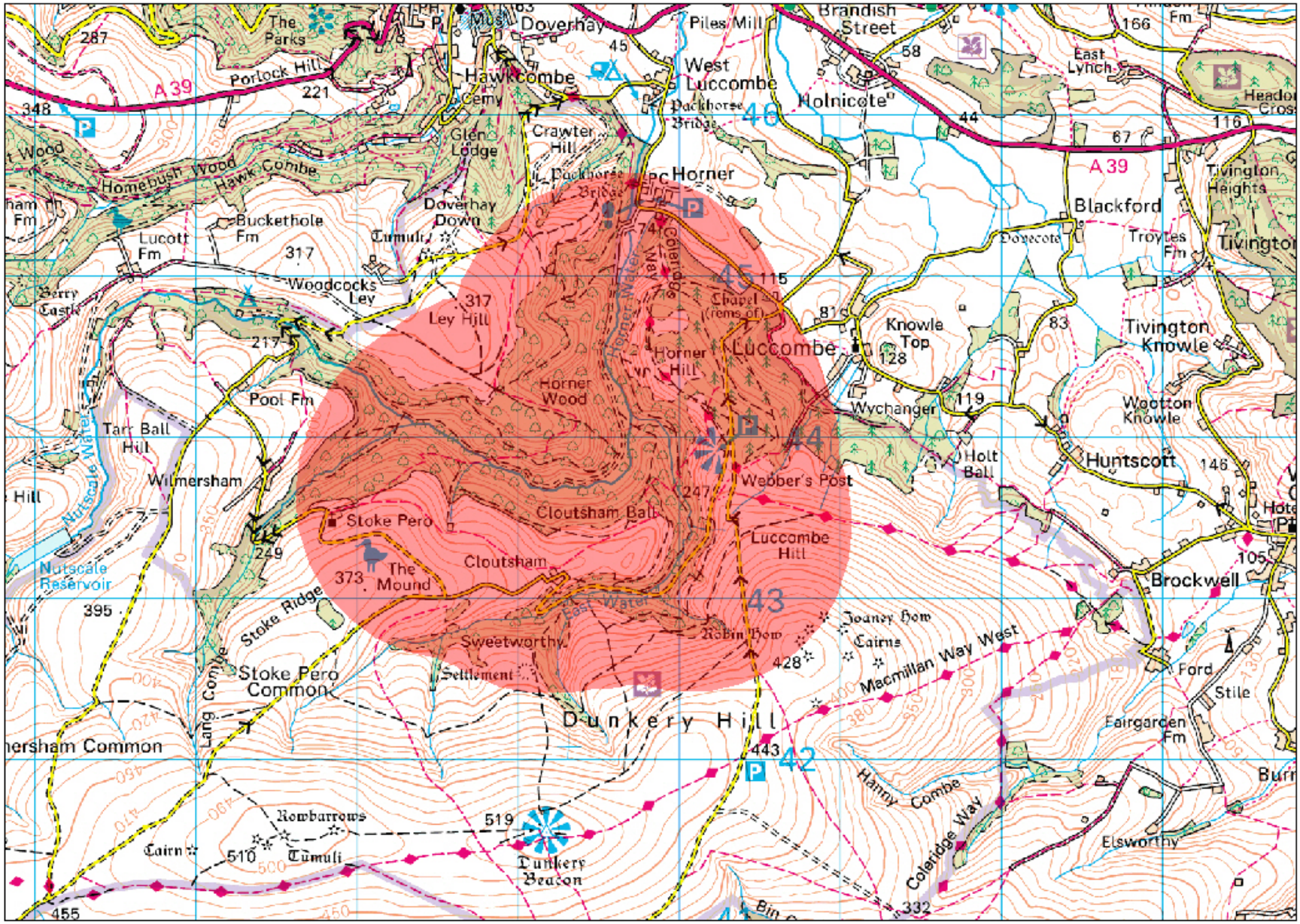
Plan 2: Bat Consultation Zone (Exmoor Roosts)



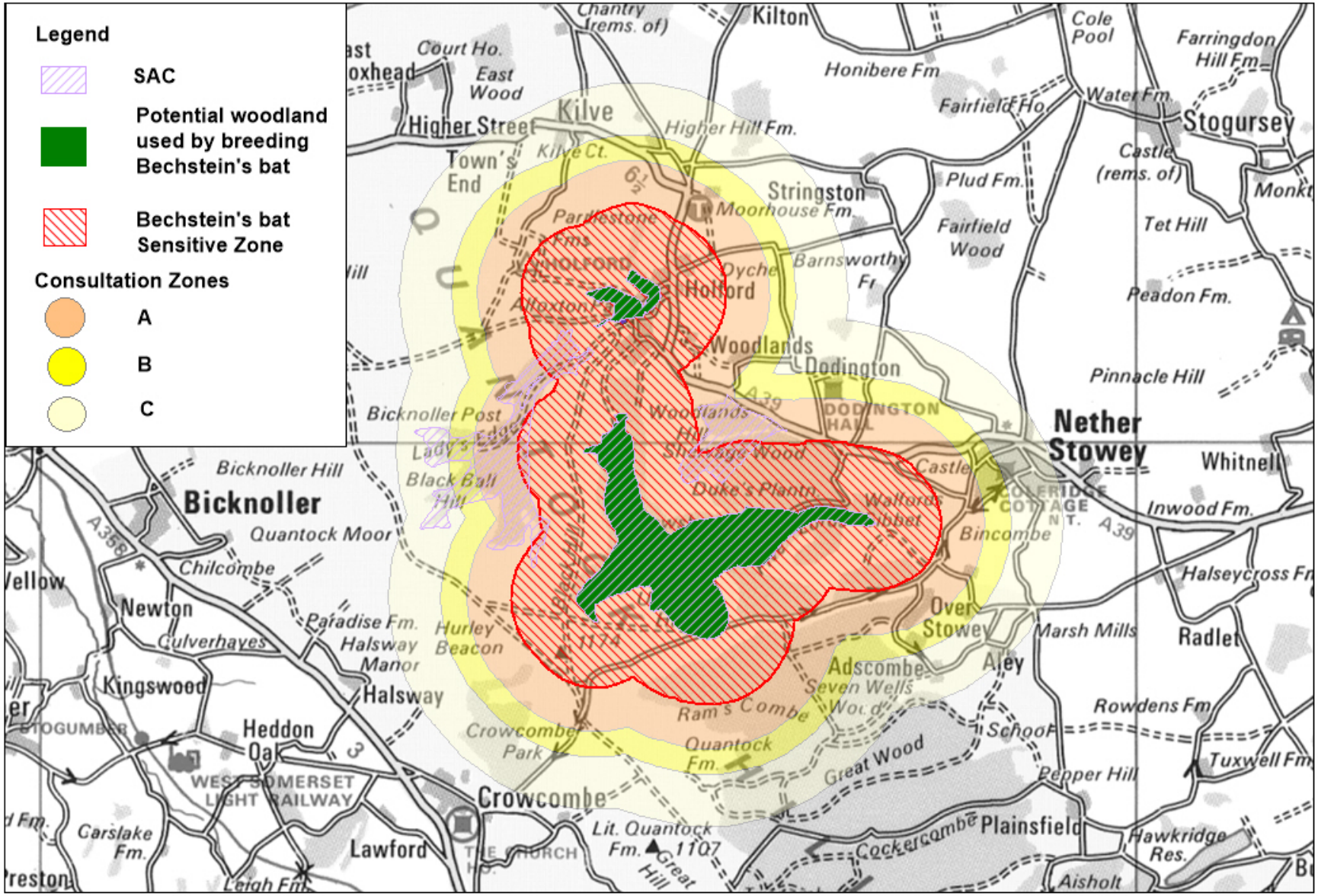
Plan 3: Juvenile Sustenance Zone (Quantocks)



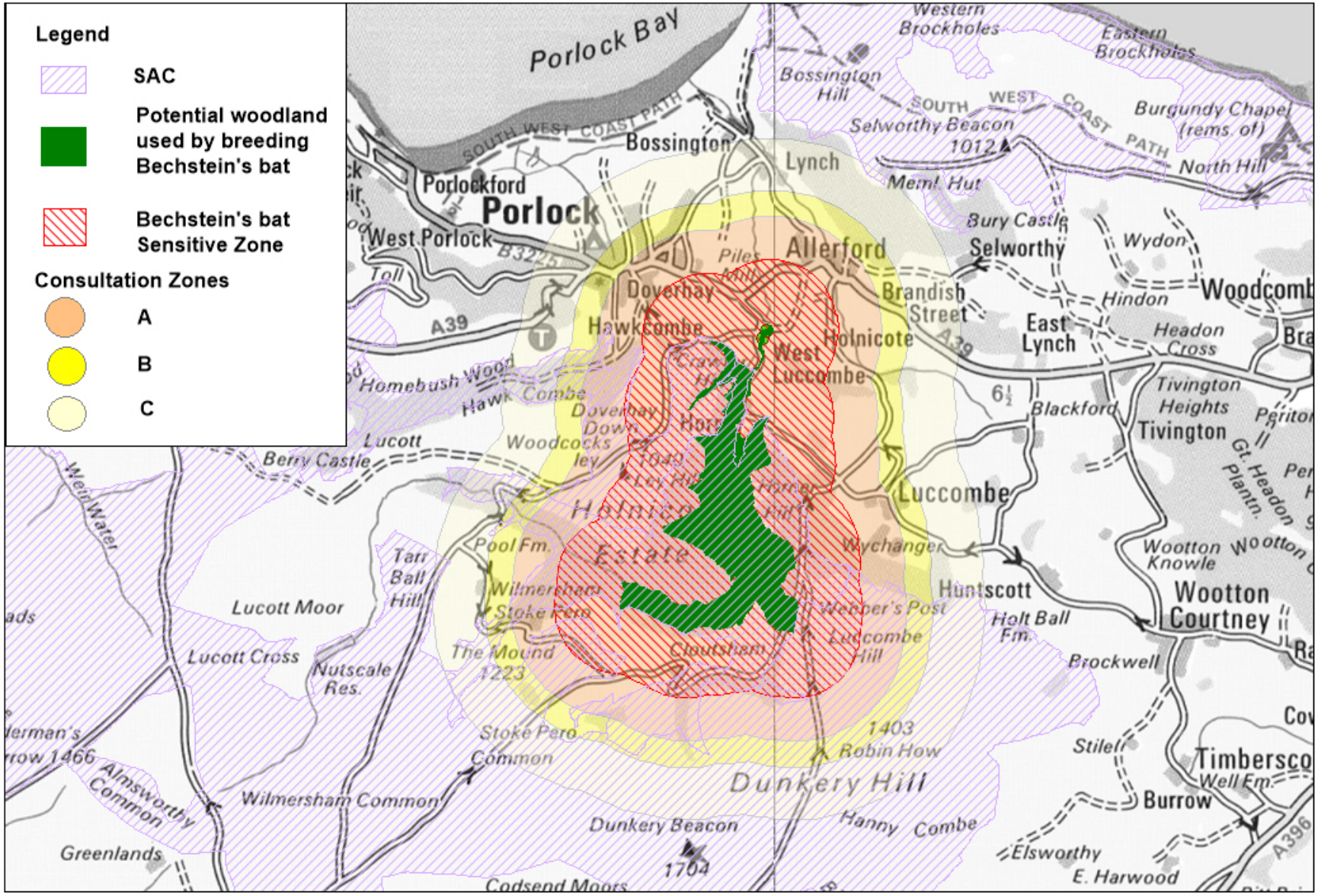
Plan 4: Juvenile Sustenance Zone (Exmoor)



Plan 5: Bechstein's Bat Consultation Zone and Sensitive Zone (Quantocks)



Plan 6: Bechstein's Bat Consultation Zone and Sensitive Zone (Exmoor)



Annex 1: Details of the Exmoor and Quantocks Oak Woodlands Special Area of Conservation

A1.1 The SAC is made up of 7 component Sites of Special Scientific Interest (SSSI):

- **North Exmoor SSSI**
- Barle Valley SSSI
- Watersmeet SSSI
- West Exmoor Coast & Woods SSSI
- **The Quantocks SSSI**

A1.2 The SAC is primarily designated, aside from its habitats, for a maternity colony of Barbastelle bats *Barbastella barbastellus* that utilises a number of tree roosts in an area of predominantly of oak (*Quercus* spp) woodland. The designation of Barbastelle bats for the SAC was originally due to the Horner Wood maternity sites in the North Exmoor SSSI component site. However, since the date of designation Barbastelle bats have been found roosting in The Quantocks SSSI component site of the SAC with one of the associated maternity roosting areas located in a nearby woodland outside the designated site. Even so this latter roosting area would support the integrity of the roosts located within the SAC. Barbastelle bats frequently switch roosts from one to another on average within 300 metres but up to 1 kilometre apart[19].

A1.3 Bechstein's bats are not the primary reason for designation of the SAC but, nonetheless, needs to be considered in carrying out a 'Test of Likely Significant Effect'. Like the Barbastelle bat they are present in Horner Woods on Exmoor and have since the SACs designation also been found in the Quantocks component site as well.

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

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

1. Barbastelle bats regularly travel through the administrative areas of Somerset West and Taunton and Sedgemoor District Councils, and Exmoor National Park between their roosts and feeding sites via a network of established flyways. Barbastelle bats leave the home woodland as a group and 'peel off' into foraging territories. It is likely that female Barbastelle bats seek out male roosts in September, accompanied by their young, and return to their home woodland for the winter.[20] It may be that bats from the colony of breeding females move considerable distances in late summer to find a mate. Bats need a range of habitats during the year in response to the annual cycle of mating, hibernating, giving birth and raising young;

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[19] Russo, D., Cistrone, L. & Jnes, G. 2005. Spatial and temporal patterns of roost use by tree-dwelling barbastelle bats *Barbastellus barbastella*. *Ecography* 28: 769 – 776. 2005

[20] Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants.

2. It follows that Barbastelle 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. Barbastelle bats have three types of echolocation call. Compared to most other bat species, the amplitude of echolocation call of the Barbastelle bat is between ten and a hundred times lower than other bats and then at short range when hunting.[21] The Barbastelle bat will tend to fly at tree top height, amongst the woodland canopy and margins and mostly alongside hedgerow cover in a continual forward progression. Over open ground and water they fly at low level.[22] Radio tracking studies[23] and observations in the field confirm that Barbastelle bats will use regular flyways associated with lines of hedgerows and woodland. Further studies[24] have shown that landscapes with broadleaved woodland, large bushy hedgerows and watercourses are important as they provide habitat continuity up to 7km from the roost, after which it is considered dark enough to enable more open spaces to be crossed. Habitat is therefore very important to SAC bats in terms of *quality* (generation of insect prey) and *structure* (allowing them to commute and forage);

3. SAC bats are sensitive to light and will avoid lit areas[25]. Although Barbastelle bats will use areas of low intensity illumination[26] the interruption of a flyway by light disturbance, as with physical removal/ obstruction, would force the bat to find an alternative route which is likely to incur an additional energetic burden and will therefore be a threat to the viability of the bat colony. In some circumstances, an alternative route is not available and can lead to isolation and fragmentation of the bat population from key foraging areas and/or roosts. The exterior of roost exits must be shielded from any artificial lighting and suitable cover should be present to provide darkened flyways to assist safe departure into the wider landscape[27].

4. The feeding and foraging requirements of the Barbastelle bats have been reasonably well studied in the southern England and Europe[28]. From this work we know that most feeding activity is concentrated in an area within 7km of the

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[21] Goerlitz, H. R., ter Hofstede, H. M., Zeale, M. R. K, Jones, G. & Holderleed, M. W. 2010. An Aerial-Hawking Bat Uses Stealth Echolocation to Counter Moth Hearing. *Current Biology, 20, 1568 – 1572*.

[22] Greenaway, F. 2008. Barbastelle *Barbastella barbastellus*: in Harris, S. & Yalden, D. W. (eds.) 2008. *Mammals of the British Isles: Handbook, 4th Edition*. Southampton: The Mammal Society.

[23] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust

[24] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

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

[26] Billington, G. 2000. *Holnicote Estate, Somerset - Horner Woods Barbastelle Bat: radio tracking study*. Holnicote: The National Trust.

[27] Stone, E. L. 2013. *Bats and Lighting Overview of current evidence and mitigation*. Bristol: University of Bristol.

[28] Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd; Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Hillen, J., Kiefer, A. & Veith, M. 2009. Foraging site fidelity shapes the spatial organisation of a population of female western barbastelle bats. *Biological Conservation, 142 (2009) 817 – 823*; Zeale, M. R. K. 2011. *Conservation biology of the barbastelle (*Barbastella barbastellus*): applications of spatial modelling, ecology and molecular analysis of diet*. PhD Thesis. University of Bristol, Bristol, UK; Eriksson, A. 2004. *Habitat selection in a colony of* Barbastella barbastellus *in south Sweden*. Uppsala: Institutionen för naturvårdsbiologi; etc.

roost (even juvenile bats will forage up to 7km at a stage in their life when they are most susceptible to mortality). The most important types of habitat for feeding have been shown to be grassland, hedgerows, riverine vegetation, wetlands and woodland that support an abundance of moths with ears. Depending upon the availability of suitable flyways and feeding opportunities, most urban areas will provide limited habitat of any value to Barbastelle bats.

Bechstein's Bat: Henry Schofield. Courtesy Vincent Wildlife Trust

Annex 2: Bat Consultation Zones

Barbastelle Bat

A2.1 The Bat Consultation Zone density band widths will vary from species to species depending on its characteristic use of its home range. The summer foraging range of Barbastelle bats was recorded as being up to 9 kilometres (km) in the Horner Wood area on Exmoor (English Nature, Conservation Objectives for North Exmoor SSSI). Other studies have shown that Barbastelle bats can fly up to 20km from roost sites although the average was about 8km. On Dartmoor the individual mean maximum foraging range of radio tracked Barbastelle bats varied from 3.16 to 20.38km. In Brandenburg hunting grounds are within 4.5km of a nursery colony and young bats and males forage on average closer to their roost sites.[29]

A2.2 Foraging grounds have been recorded in excess of 25km from the roost area in the woodland. Even 6-week-old juveniles have been recorded travelling 7km from the roost site. Barbastelle bats fly very fast and often fly more or less directly to their foraging areas and have been recorded covering 20km in approximately 45 minutes.[30]

A2.3 Individual home ranges varied considerably, with bats traveling between 1 and 20 km to reach foraging areas [$\bar{X}$ = 6.8 km ± 4.8 SD][31].

A2.4 The Barbastelle bats radio tracked in the study by Hillen et al (2009) spent the first 1-2 hours in their roost woodland but would often forage 6-7km from their roost throughout the night with some individuals travelling as far as 12-17km.[32]

A2.5 Foraging takes place within the home range in individual core areas of between 2 and 70 hectares (ha). Dietz et al (2009) report foraging areas of 8.8ha with single bats hunting each night in up to 10 separate areas. There is minimal overlap of individual core foraging areas although the home wood is shared. In the Hillen et al study (2009) the core area sizes ranged from 5 to 285ha (median: 67ha). On Dartmoor the mean core foraging area was 82.49ha ± 21.93ha. In Germany seven radio tracked Barbastelle bats had a total of 24 distinct foraging sites, sizes between 2ha and 48ha, with each individual bat visiting between 1 and 7 sites. A home range and core area overlap analysis showed that site fidelity across years seems to be more important for home range distribution than competition among colony members. Although the home wood is shared, as afore stated, there is minimal overlap of individual core foraging areas, females being highly faithful to more or less “private” foraging areas which constituted a small fraction ($\bar{X}$ = 10.1% +/- 8.8 SD) of home ranges. [33]

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[29] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd.

[30] Warren, J. n/d. Barbastelle Bats. www.ewebmagazine.co.uk

[31] Zeale, M. R. K., Davidson-Watts, I, & Jones, G. 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus): implications for conservation. Journal of Mammalogy* 93(4):1110-1118. 2012.

[32] Hillen, J., Kiefer, A. & Veith, M. 2009. Foraging site fidelity shapes the spatial organisation of a population of female western barbastelle bats. *Biological Conservation, 142 (2009) 817 – 823*.

[33] 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; Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd; Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Hillen, J., Kiefer, A. & Veith, M. 2009. Foraging site fidelity shapes the spatial organisation of a population of female western

A2.6 Barbastelle bats go out in groups from the roosting area then disperse to individual hunting grounds. Barbastelle bats are reliant on darkened connecting habitat features between roost sites and feeding areas. Typically, these are along vegetated rivers and streams or lines of trees and large hedgerows and paths. Barbastelle bats' foraging paths are generally within 200 metres of water features. Commutes were typically rapid and direct and bats moved freely across large open areas. When Barbastelle bats cross open ground they will fly at low level. At the maternity roost at Longforth Farm, Wellington located in a single tree in the middle of a field Barbastelle bats cross an open space of 100 metres on emergence (pers.comm. Liz Biron, Somerset Environmental Records Centre, 2011).[34]

A2.7 The entire home range of the colony is used by individuals having hunting territories both close to and far from the roosting area and of equal importance considering the size of Barbastelle maternity colonies. They commute at high speed making for the most productive foraging area of the night and ignore foraging opportunities along the way[35].

A2.8 Barbastelle bats are spread very thinly in the landscape. At the Ebernoe roost in Sussex the density of bats in late summer was rather less than one female or juvenile to six square kilometres. This area would include very large areas of land that are not or seldom used consisting of arable fields. The hunting territories themselves form a select and vulnerable set of more stable and productive habitats; a small percentage of the total area, but rich in diversity.[36]

A2.9 Radio tracking of Barbastelle bats from Horner Wood in autumn/ early winter showed that they ranged up to 4km from their roosts compared to at least 9km in summer, with one exception in November when a radio tagged male bat was briefly recorded moving around 16km west of Horner Wood in a wooded valley at Hillsford Bridge, near Lynmouth, Devon. However, this was probably associated with a seasonable movement/ dispersal.[37]

A2.10 Zeale (2009) identified that the majority of foraging areas occurred within 6km of the home wood although 5km had been previously given particular importance. Subsequently Zeale et al (2012) suggested that land managers must consider areas of up to 7km radius around maternity roosts, based on their data, when designing and

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barbastelle bats. *Biological Conservation, 142 (2009) 817 – 823*; Zeale, M. R. K. 2011. *Conservation biology of the barbastelle (*Barbastella barbastellus*): applications of spatial modelling, ecology and molecular analysis of diet*. PhD Dissertation. University of Bristol, Bristol, UK; Simon, M., Hüttenbügel, S. & Smit-Viergutz, J. 2004. *Ecology and Conservation of Bats in Villages and Towns*. Bonn: Bundesamt für Naturschutz.

[34] Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd; Greenway, F. 2001. The Barbastelle in Britain. *British Wildlife 12, 5, 327-334*; Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Greenaway, F. 2008*. Barbastelle Bats in the Sussex West Weald 1997- 2008.* Sussex Wildlife Trust/ West Weald Landscape Partnership; Zeale, M. 2009*. Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Zeale, M. R. K., Davidson-Watts, I, & Jones, G. 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy 93(4):1110-1118. 2012*

[35] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[36] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[37] Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants.

implementing management plans for Barbastelle bats and that feeding sites outside of this range, when identified through radio tracking or by other means, should also be protected. Based on this a 7km buffer around the maternity woodland is used as the basis for Band A.[38] The woodland is chosen as Barbastelle bats are likely to roost switch within a few days within the woodland[39].

A2.11 Band B has been determined by the average recorded maximum summer range recorded for the Quantock roosts, which are 10.2km (See Appendix 1 - the mean for all studies, excluding one in Germany where only short distances were recorded, is 10.1km). Band C is 15.5km based on the recorded Barbastelle bat fixes from field surveys carried out east of the Quantocks roosts. Zones are further defined by the by a Minimum Convex Polygon is formed of all records associated or potentially associated with the maternity roosts. This is buffered by 500 metres to allow for possible unrecorded occurrences outside this area, based on the range of the species' principal prey species, noctuid moths. The Bat Consideration Zone is then confined by this parameter given the directional nature of home range use by Barbastelle bats. [40]

Bechstein's Bat

A2.8 Bechstein's bats have a small range of movement around summer roost of about 1 kilometre. The main foraging areas are usually from 500 to 1500 metres from the roost. Sometimes they will fly up to 3.8 kilometres. Foraging range is smaller in continuous woodlands than those in fragmented forests. Radio tracking of Bechstein's bats from Bracket's Coppice was carried out in 1998 and 1999 by the Vincent Wildlife Trust in the months between May and August. The maximum range of foraging was 0.98 kilometres from a roost site within the woodland. At Ebernoe in Sussex the distance from roost site to the middle of foraging area was an average of 700 metres with a maximum of 1.4 kilometres.[41]

A2.9 All individuals foraged within closed broadleaved woodland in Sussex. Radio tracking at Beckets Coppice also showed that bats stayed within woodland. Maternity colonies, such as at Bracket's Coppice, form socially closed units with all the females being related over the summer period from May to August. During this period male Bechstein's bats occupy separate roosting areas, often in sub-optimal habitat.[42]

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[38] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Zeale, M. R. K., Davidson-Watts, I, & Jones, G. 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy 93(4):1110-1118. 2012*

[39] Russo, D., Cistrone, L. & Jnes, G. 2005. Spatial and temporal patterns of roost use by tree-dwelling barbastelle bats *Barbastellus barbastella*. *Ecography* 28: 769 – 776. 2005

[40] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; the 500 metres buffer is based on the dispersal distance of noctuid moths that are the prey of Barbastelle bats (e.g. see Dulieu, R., Merckx, T., Paling, N. & Holloway, G. 2007. Using mark-release-recapture to investigate habitat use in a range of common macro-moth species. *Centre for Wildlife Assessment & Conservation E-Journal, 1: 1-19*)

[41] Boye, P. & Dietz, M. 2005. *English Nature Research Reports Number 661: Development of good practice guidelines for woodland management for bats*. Peterborough: English Nature; Fitzsimmons, P., Hill, D. & Greenaway F. 2002. *Patterns of habitat use by female Bechstein's bats (Myotis bechsteinii) from a maternity colony in a British woodland*. Brighton: University of Sussex; Schofield, H. & Morris, C. 2000. *Ranging Behaviour And Habitat Preferences Of Female Bechstein's Bat,* Myotis Bechsteinii (*Kuhl, 1818), In Summer.* Ledbury: The Vincent Wildlife Trust.

[42] Schofield, H. & Morris, C. 2000. *Ranging Behaviour And Habitat Preferences Of Female Bechstein's Bat,* Myotis Bechsteinii (*Kuhl, 1818), In Summer.* Ledbury: The Vincent Wildlife Trust; Schofield, H. W. & Greenway, F. 2008. Bechstein's Bat *Myotis bechsteinii*: in Harris, S. & Yalden, D. W. (eds.) 2008. *Mammals of the British Isles: Handbook, 4th Edition*. Southampton: The Mammal Society; Safi, K. & Kerth, G. 2003. Secretions of the interaural gland contain information

A2.10 The Density Bands for maternity colonies of Bechstein's bats are measured from the edge of the home woodland. The foraging range 1000m metres from the Beckett's Coppice study is the base for Band A. (The 600m buffer is considered a Sensitive Zones for Bechstein's bats[43] and is included within Band A) Band B is based on the mean maximum foraging range of 1240metres (from a number of studies).

Table 3: Band Widths for Bechstein's Bats

Band	Distance (metres)
A	0 - 1000
B	1001 - 1240
C	1241 - 1716

A2.11 Bechstein's bats form demographically independent breeding colonies comprising maternally closely related bats. Males are solitary. Like other temperate bats, Bechstein's bats swarm at the end of summer in front of caves. Because the sexes meet there, such swarming sites are potentially important for gene flow. Genetic analyses reveal that swarming sites have greater mitochondrial DNA gene diversity than colonies. Box Mine SSSI is a swarming site for Bechstein's bats from maternity woodlands east and south of Trowbridge in Wiltshire[44].

A2.12 In a Belgian study[45] radio tracked female Bechstein's bat from autumn swarming sites to their summer maternity colony ranges. Of 22 individuals tagged, 18 were subsequently recovered at nine different roost sites up to 20.6 km away. Females from multiple colonies visited the same swarming site on a single night.

A2.13 There is little information about the winter activity of Bechstein's bats. In one study in Bavaria, *Myotis* species were not observed at all between mid-November and March[46]. A Hampshire study of the winter activity of Natterer's bat *Myotis nattereri* found bouts of torpor lasted longer than that of horseshoe bats and flight activity of one bat was restricted to 100m of the roost site[47]. However, given the potential for disturbance for new residential development the wintering sites are considered are buffered by a sensitive zone of 600 metres[48]. There are no Consultation Zones for these sites. The swarming sites for the SAC maternity roosts are not known.

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about individuality and colony membership in the Bechstein's bat. *Animal Behaviour*, 2003, 65, 363–369; Fitzsimmons, P., Hill, D. & Greenaway F. 2002. *Patterns of habitat use by female Bechstein's bats (Myotis bechsteinii) from a maternity colony in a British woodland*. Brighton: University of Sussex

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

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

[45] Dekeukeleire, D., Janssen, R., Haarsma, A-J., Bosch, T. & Van Schaik, J. 2016. Swarming Behaviour, Catchment Area and Seasonal Movement Patterns of the Bechstein's Bats: Implications for Conservation. *Acta Chiropterologica*, 18(2):349-358.

[46] Zhan, A, & Kriner, E. 2016. Winter foraging activity of Central European Vespertilionid bats. *Mammalian Biology* 81, 1, January 2016, 40-45

[47] Hope, P.R. & Jones, G. Warming up for dinner: torpor and arousal in hibernating Natterer's bats (*Myotis nattereri*) studied by radio telemetry. *J Comp Physiol B* (2012) 182:569–578

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

Annex 3: Key Barbastelle Bat Flyways

A3.1 Maternity colonies are located within mature woodland, which is used year after year. Females disperse from the woodland to feed along established flyways to hunting areas which may be several kilometres away. Flyways consist of tracks and paths through woodland, overgrown hedgerows, and paths with hedgerows on both sides. In open country flyways follow watercourses lined with vegetation. To some extent the ability of the female to feed herself and dependent young depends on the condition of these flyways. A female will repeatedly use the same flyway to visit her hunting territories located along it. [49]

A3.2 Close to the roost females will share common flyways but the longest flyway at its end is likely to only be used by one bat. The initial sections of flyway may be used by up to 20 individual bats. However, Billington observed that female Barbastelle bats would split up individually to small connected foraging zones, and then meet up again to forage together, or to move off to another foraging area where they repeated the same behavior.[50]

A3.3 The flyways of Barbastelle bats are usually within 200 metres of water.[51]

A3.4 Key flyways are not mapped but where flyways are identified in field surveys they should be treated as for Band A and will need to be maintained and secured from any impacts arising from development.

Barbastelle Bat. Photo: C. Robiller / Naturlichter.de

[49] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[50] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Billington, G. 2002. The Bats of Horner Woods. *Somerset Wildlife News* – January 2002, 10 -11.

[51] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

Annex 4: Survey Specification for Surveys for Planning Applications Affecting Consultation Zones.

A4.1 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

A4.2 The following table sets out the survey requirements for development sites within the Bat Consultation Zone based on the guidance given by the Bat Conservation Trust (2016) but adapted to Barbastelle bat ecology.[52] Note that the objective is to detect commuting routes and foraging areas rather than roosts. Barbastelle bats emerge in early dusk and often in the light and are active sporadically throughout the night. Typically, they emerge from their roosts about 17 to 27 minutes after sunset but then spend another 11 to 45 minutes foraging within the home woodland before setting out to commute to their individual hunting territories[53].

A4.3 The following specification is recommended in relation to development proposals within a Barbastelle bat key flyways and zones A and B of the Bat Consultation Zone. It is also worth mentioning the difficulty associated with detecting the Barbastelle bat's echolocation call when hunting. This fact emphasises the requirement for greater surveying effort and the value of broadband surveying techniques. It is recommended that the most sensitive equipment for detecting lower frequencies 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 hedgerows, paths and tracks between hedgerows, tree lines, watercourses, ditches and rhynes that may provide flyways and areas of grassland, arable margins, scrub and meadow. Ensuring all wider habitat links to woodland are surveyed.

(ii) Automatic bat detector systems should be deployed at an appropriate location (i.e. on a likely flyway; the precise location can also be adjusted from the manual survey findings). The total period of deployment should be at least 50 days from April to October and must include at least one working week in each of the months of April, May, June, August and October (50 nights out of 153; ≈33%).

(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, the suite of bat species likely to be present, their foraging strategy and flight-altitude. Every site is different, but the objective would be to sample each habitat component equally[54]. Generally:

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

[53] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust

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

- Riparian corridors, both banks and vegetated edges
- 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 and arable margins, the number depends on whether the site is of long sward height or not
- In a woodland situation a sample with three detectors: one on the woodland edge, two in the interior.
- Areas of scrub particularly gorse and buddleia
- Ponds

(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 Barbastelle bats.

(v) Manual transect surveys[55] should be carried out on ten separate evenings; at least one survey should be undertaken in each month from April to August plus October[56], as the bats' movements vary through the year. Transects should cover the area of and 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 183; ≈5.5%), are less effective at detecting Barbastelle bat behaviour and unreliable[57], therefore automated bat detector systems should also be deployed see section (vi).

(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 2.5 hours.[58]

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

[56] Female Barbastelle bats are absent from the home woodland during September when they disperse to find male roosts.

[57] Warren, J. n/d. Barbastelle Bats. www.ewebmagazine.co.uk

[58] Barbastelle bats can cover 20km in 45 minutes (Warren, J. n/d. www.ewebmagazine.co.uk). Note that some individual Barbastelle bats may not leave the home woodland for an hour after emergence.

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

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

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

A4.4 Survey effort in Band C is to some extent dependent on whether commuting structure is present but not entirely so. More regard should be given to the suitability of the habitat to support prey species hunted by Barbastelle bats. Nonetheless this should be in accordance with Bat Conservation Trust guidelines (Collins, 2016[59])

Habitat Surveys

A4.5 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.

A4.6 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 Survey

A4.7 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)[60]. 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.

A4.8 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 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.

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

[60] 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/

A4.9 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.

A4.10 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[61].

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

Annex 5: Habitat Requirements of Barbastelle Bats

Barbastelle Bats

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Prey

A5.1 Barbastelle bat specialize in preying upon small tympanate moths. Over 90% of their diet comes from the families Pyralidae; Geometridae; Arctiidae; Noctuidae: Tortricidae and Gelechiidae, particularly of the families Noctuidae and Geometridae. In one study 49 species of moth were identified. Most of the species taken amongst these have hearing organs as a defense against bats. The most frequent moth species taken were White Ermine; Buff Ermine; Riband Wave; White-pinion Spotted; Scalloped Hazel; Brown Silver-line; Heart and Dart; Shuttle-shaped Dart; Dark Arches; The Dun-bar; Vine's Rustic; Large Yellow Underwing; and Angle Shades.[62]

A5.2 Barbastelle bats also eat micro moths, a few Diptera, including Tipulids (craneflies), small beetles and other flying insects. They are heavily reliant on small moths throughout the year but have a more diverse diet in winter eating flies, earwigs and spiders.[63]

General

A5.3 Greenaway (2002)[64] states that '*The ideal example of a Barbastelle colony of the distant past would be of a small catchment with dense woodland on its headwaters and wooded river valleys leading down to a wide zone of water meadows and finally reed beds and sand dunes before reaching the sea. Roosts would be in the headwater woodlands and the Barbastelle bats would have individual foraging areas spread up and down the catchment's tributaries and the main river. The colony's territory boundaries would be set by the extent of the catchment area.*' However, radio tracking at Horner Wood shows that no all Barbastelle bat colonies conform to this pattern and individuals cross over into different catchments.

A5.4 In the radio tracking study carried out by Zeale on Dartmoor in 2008 the most significant habitat preferences were shown to be the following in order:

- Riparian vegetation;
- Broad-leaved woodland;
- Unimproved grassland

A5.5 All three habitats support a high density of insects and often associated with the common species of moth hunted by Barbastelle bats. Other habitats used were improved grassland; mixed woodland; coniferous woodland; scrub; urban; open water; arable and upland moor, the latter four being avoided.

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[62] Zeale, M. 2009. Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park. *Presentation at the South West Bat Conservation Trust Conference, 25 April 2009;* Zeale, M. R. H. 2011. *Conservation Biology of the Barbastelle* (Barbastella barbastellus): *Applications of Spatial Modelling, Ecology and Molecular Analysis of Diet*. PhD Dissertation, University of Bristol; Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature.

[63] Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd; Greenaway, F. 2008. Barbastelle bat *Barbastella barbastellus*: in Harris, S. & Yalden, D. W. (eds.) 2008. *Mammals of the British Isles: Handbook, 4th Edition*. Southampton: The Mammal Society.

[64] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

A5.6 For Barbastelle bats at Horner Wood on Exmoor foraging in summer occurred mostly out of woodlands and included areas of scrub, heath, unimproved grassland, along hedgerows and streams and salt marsh. By contrast in the autumn/ early winter bats almost exclusively foraged in woodlands with up to half of the time spent in conifer plantations. Habitats recorded as being used to the east of Porlock Weir during these surveys include patches of scrub (including bramble, gorse, nettles, blackthorn and dog rose); patches of bramble scrub on shingle; saltmarsh; trees lining dry shingle-lined channels; strips of tall vegetation; and short improved turf grazed by sheep. Billington (2012) stated for the Horner Wood maternity colony that, '*The most important single habitat was rough/ unimproved grassland 94.5% of the habitat in the colonies range was used for foraging. The next most important (>57% use) habitats were scattered (Gorse) scrub and broadleaved woodland and other important (>25% use) habitats were Bracken, running water and dense (Gorse) scrub*.' [65]

A5.7 In Sussex habitat use can be summarised as old meadows, hedgerows and woodlands often in rich valley bottoms during summer and dense old growth deciduous woodland habitats in the colder months. The final destination of most bats is larger floodplain meadows as can be found towards the River Parrett and its estuary. Many of the known British colonies, as is the Quantocks SAC colony, are also within commuting distance of the sea, and besides the SAC colony at least three other colonies are recorded as utilising dune, marsh and established coastal grasslands.[66]

Grassland

A5.8 During the summer there is a super abundance of moths, and particularly micro moths, over unimproved grasslands. This is a primary habitat for Barbastelle bats. Longer swards benefit the larvae of Noctuid moths.[67]

A5.9 Improved grassland is the fourth most used habitat in the Dartmoor study. Typically, it is species poor and likely to be of little importance, but they are smaller than arable fields and consequently have a higher density of boundary features. Zeale (2009) considered that caution should be taken when assessing this habitat's true value as it is likely that most foraging activity is focused along hedgerows. Moths are likely to be negatively affected by moderate and high levels of cattle grazing. However, the vast majority (over 90%) of insects found near hedges does not originate in the hedge but come from other habitats brought in on the wind. Nonetheless, field margins, including hedgerows, and woodland edge support comparatively high densities of moths and Barbastelle bats have been observed foraging in these areas.[68]

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[65] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants.

[66] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[67] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Ransome, R. D. 1996. *The management of feeding areas for Greater Horeseshoe bats*. Peterborough: English Nature; Ransome, R. D. 1997.

[68] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Ekroos, J., Heliola, J. & Kuussaari, M. 2010. Homogenization of lepidopteron communities in intensively cultivated agricultural landscapes. *Journal of Applied Ecology, 2010, 47, 459 – 467*; Bat Conservation Trust. 2003. *Agricultural practice and bats: A review of current research literature and management recommendations*. London: Defra project BD2005; Zeale, M., Davidson-Watts, I. & Jones, G., 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy 93: 1110-1118.*

A5.10 The wider the field margin the higher the abundance of macro-moths compared to standard margins. The presence of trees has no significant effect on moth abundance. Sites with higher nectar availability also had higher abundances of moths. Plant species richness and vegetation height may provide higher larval food availability and shelter from potential predators.[69]

Woodland

A5.11 When Barbastelle bat flyways cut across woodland blocks these are usually utilised as secondary foraging areas. Unbroken strips of dense mature woodland connecting down to water with continued woodland features are an ideal pattern of vegetation. If track ways are available, they are used as flyways. They will also hunt above the canopy. Trees producing a low spreading twiggy structure over a thick understorey will increase shade, but the bats will require a clear central track way. They rarely forage along woodland edges.[70]

A5.12 Barbastelle bats foraging in summer occurred mostly out of woodlands. By contrast in the autumn/ early winter bats almost exclusively foraged in woodlands with up to half of the time spent in conifer plantations.[71]

A5.13 The occurrence of moth eating bats is higher in large and well-connected woodland patches with dense understorey cover. Understorey plants are the larval foods of many small moths, the Geometridae in particular. Macro and micro moths are most abundant where there is grass or litter but less so where there are ferns, moss, bare ground or herbs. They are also more abundant where there is native tree diversity and with larger basal areas. Species such as oak, willow and birch have large numbers of moths, whereas beech has little comparable to non-native species such as sycamore. Moth diversity is greatest on oak and willow species and oak woodlands support high moth diversity. Thermophilous bushes are the most attractive host plants for micro Lepidoptera: 60 species feed on hawthorn and 48 on blackthorn. Oak is the most attractive tree with 83 species.[72]

A5.14 Uniform stands of trees are poorer in invertebrates than more diversely structured woodland. It is also indicated that small woodlands of less than 1 hectare do not have characteristic woodland moth communities.[73]

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[69] Dulieu, R, Merckx, T., Paling, N. & Holloway, G. 2007. Using mark-release-recapture to investigate habitat use in a range of common macro-moth species. *Centre for Wildlife Assessment & Conservation E-Journal (2007), 1, 1 – 9;* Fuentes-Montemayor, E., Goulson, D & Park K. J. 2010. The effectiveness of agri-environmental schemes for the conservation of farmland moths: assessing the importance of landscape-scale management approach. *Journal of Applied Ecology, 2010*

[70] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Billington, G. 2000. *Holnicote Estate: Horner Woods Barbastelle Bat: radio tracking study*. Cullompton: Greena Ecological Consultancy; Eriksson, A. 2004. *Habitat selection in a colony of* Barbastella barbastellus *in south Sweden*. Uppsala: Institutionen för naturvårdsbiologi

[71] Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants

[72] 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*; Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Sierro, A. 1999. Habitat selection by barbastelle bats (Barbastella barbastellus) in the Swiss Alps (Valais). *J. Zool. Lond. (1999) 248, 429 – 432;*

[73] Kirby, K. J. (ed). 1988. *A woodland survey handbook*. Peterborough: Nature Conservancy Council; Usher, M.B., Keiller, S.W.J., 1998. The macrolepidoptera of farm woodlands: determinants of diversity and community structure. Biodivers. Conserv. *7, 725–748*.

A5.15 Where coppicing is necessary it should be carried out in small patches.[74]

A5.16 In Switzerland Barbastelle bats avoided open woodland on stony outcrops and rocky slopes[75]

Hedgerow

A5.17 Hedgerows under stewardship management do not offer any benefit over conventionally managed hedgerows for hunting micro and macro moths. However, for commuting Barbastelle bats the structure of hedgerows is more important than species composition. High wide hedgerows are preferred especially where they occur either side of a track or path way and where trees develop to form a tunnel. Hedgerows need to be at least 1.5m high. Trimmed hedges provide very poor cover to commuting bats.[76]

Others

A5.18 Riparian vegetation is the most used habitat by Barbastelle bats in a study on Dartmoor (Zeale, 2009)[77]. However, open water was the least selected habitat. The report also stated that it is the riparian vegetation rather than the water that is important to foraging Barbastelle bats, although the secondary importance of water in supporting riparian vegetation should be noted. In summer there is a super-abundance of moths, and particularly micro-moths, over wooded riversides and water meadows.[78]

A5.19 Greenway states that, '*The habitat types utilised by the Ebernoe nursery colony consist largely of the flood plains of rivers and streams together with woodlands in proximity to the watercourse. As bats move away from the roost area, woodlands form most of the intermediate foraging zones. Many of these are quite wet. The final destinations of most bats are larger floodplain meadows, particularly on the Arun and the Rother. Normally each bat has a territory of open meadows with an adjoining area of scrub or woodland. To the north and west of Ebernoe the foraging areas are much more enclosed by woodland and the streams are much smaller. In consequence the major foraging areas here are very tightly linear following streams and their floodplains. Several of the bats have a tributary stream each.*'[79]

A5.20 In other studies Barbastelle bats are highly associated with foraging habitats over water, such as the pond at Hinkley power station. In south western Germany Barbastelle bats have been observed to forage above water in a similar way to Daubenton's bats.[80]

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[74] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[75] Sierro, A. 1999. Habitat selection by barbastelle bats (Barbastella barbastellus) in the Swiss Alps (Valais). *J. Zool. Lond. (1999) 248, 429 – 432.*

[76] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature; Fuentes-Montemayor, E., Goulson, D & Park K. J. 2010. The effectiveness of agri-environmental schemes for the conservation of farmland moths: assessing the importance of landscape-scale management approach. *Journal of Applied Ecology, 2010*; Simon, M., Hüttenbügel, S. & Smit-Viergutz, J. 2004. *Ecology and Conservation of Bats in Villages and Towns*. Bonn: Bundesamt für Naturschutz

[77] Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust

[78] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[79] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[80] 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.

A5.21 Billington (2000) found that a patchwork of scrub was an important foraging habitat for Barbastelle bats from Horner Woods. Gorse, which attracts an abundance of moths, was shown to be particularly important. [81]

A5.22 Large Yellow Underwing moths are attracted to Buddleia or Butterfly Bush. Butterfly Bush flowers from July to September. There is potential to deprive Barbastelle bats of a foraging ground by restoring large areas of butterfly bush scrub all in one hit and at the wrong time of year.[82]

A5.23 Coastal habitats, such as saltmarsh and dunes, were used for foraging both by Barbastelle bats from Horner Woods and the Quantocks roost sites.[83]

A5.24 Apart from its edge heathland / upland moor was avoided by Barbastelle bats despite the abundance of moths it supports on both Dartmoor and Exmoor, probably due to low temperatures and exposure to winds.[84]

Habitat Associations of Moth Species

A5.25 A number of moth species have been identified as being preyed upon by Barbastelle bats through DNA analysis of droppings. The following gives some of the characteristics of those species most often found within the droppings of Barbastelle bats on Dartmoor.[85]

- White Ermine is widely distributed and fairly common over much of Britain. It is found in a range of habitats including gardens, hedgerows, grassland, heathland, moorland and woodland. The larvae eat a range of herbaceous plants, including stinging nettle, common broom, viper's bugloss and dandelion. It generally flies from May to July and sometimes later in the south.

- Buff Ermine is a common to most of Britain and is found in woods, gardens and parks. The larva feeds on a wide variety of trees, shrubs and herbaceous plants, including oak, alder, birch, plantain, dock, sorrel, ragwort, nettle, bramble, elder and honeysuckle. The adult flies from May to July.

- Riband Wave is a common species throughout Britain and tends to fly between June and August, and sometimes has a second autumn brood in the south. It is found in a wide range of habitats, including gardens, hedgerows, woodland, heathland, calcareous grassland and fens. The larvae feed on a range of low plants such as dock and dandelion.

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[81] Billington, G. 2000. *Holnicote Estate: Horner Woods Barbastelle Bat: radio tracking study*. Cullompton: Greena Ecological Consultancy; Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants

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

[83] Billington, G. 2012. *Further research on the Barbastelle Bat, Holnicote National Trust Estate, Exmoor, North Somerset*. Report for Natural England. Witham Friary: Greena Ecological Consultants; Rush, T. & Billington, G. 2012. *Report on a radio tracking study of Barbastelle bats at Hinkley Point C*. Witham Friary: Greena Ecological Consultants

[84] Zeale, M. R. K. 2011. *Conservation Biology of the Barbastelle* (Barbastella barbastellus): *Applications of Spatial Modelling, Ecology and Molecular Analysis of Diet*. Thesis: University of Bristol.

[85] Zeale, M. R. K. 2011. *Conservation Biology of the Barbastelle* (Barbastella barbastellus): *Applications of Spatial Modelling, Ecology and Molecular Analysis of Diet*. Thesis: University of Bristol.

- White-pinion Spotted is thought to survive in low densities. It has been found amongst hedgerows, in parks and woodland and along riversides. The larvae feed on the foliage of English elm and have also been reported to feed on wych elm. The adults fly at night from late July to September.

- Scalloped Hazel is moderately common and found in woodland, heaths and suburban habitats, and feeds on a number of deciduous as well as coniferous trees. It flies in May and June. The larvae feed on a wide range of plants including oak, ash, birch, hawthorn, ivy, Norway spruce, larch, willow, poplar, mugwort and burdock.

- Brown Silver-line is a fairly common moth over much of Britain and can often be disturbed in the daytime by walking through bracken, its food plant. It is often found near bracken, occurring in woodland, heathland and moorland. It flies in a single generation during May and June and occupies woodland and upland areas where its food plant grows in profusion.

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

- Shuttle-shaped Dart is fairly common in southern England and Wales it is found in a range of habitats including gardens, farmland, grassland, heathland and open woodland. There are possibly three generations during the year, with moths on the wing from May to October. The larvae feed on a number of low plants.

- Dark Arches are found in meadows and other grassy place and food plants include cocksfoot, couch grass and other grasses. The larvae feed on the bases and stems of various grasses. The moth is on the wing from July to August and is readily attracted to light.

- The Dun-bar is commonly distributed over much of Britain. It is found in woodland, gardens and hedgerows. It flies at night from July to September and is attracted to light and sugar and sometimes to nectar-rich flowers. The larvae feed on a variety of plants, mainly trees and shrubs, including maple, birch, hazel, hawthorn and oak, and also on the larvae of other Lepidoptera species, even occasionally its own species.

- Vine's Rustic is fairly frequent in the southern part of England up to south Wales and probably enjoying an increase in recent years. It is found in grassland, heathland, woodland rides and gardens. There are two generations with moths occurring between May and October, with the second brood somewhat more numerous.

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

- Angle Shades occurs throughout Britain, commonly in places, and more so in the south. The adults generally fly between May and October, in at least two generations, but can be found in any month. It may be found almost anywhere. The larvae feed on a

variety of herbaceous plants, including oak, birch, ivy, dead nettle, red valerian, bramble, dock and nettle.[86]

Bechstein's Bats

Prey

A5.26 Bechstein's bats prey on woodland inhabiting arthropods which includes a high proportion of non-flying insects. Prey changes according to the changing availability through the seasons. To a large extent prey is mainly moths but also includes crane-flies and Brachycera, beetles. lacewings and spiders. In addition, caterpillars, earwigs, harvestmen, bush-crickets, bugs and ground beetles are also taken seasonally according to local availability. Hymenoptera, centipedes, caddis flies and aphids are also sometimes caught.[87]

General

A5.27 All individual Bechstein's bats forage within deciduous woodland. Bechstein's bats use old beech and oak woodland (deciduous woodland) with plenty of structure and mixed species understorey; mixed woodland; and fir and pine woodland but only if there is a rich structure and shrub layer. They also use derelict hazel coppice where oak has closed the canopy. The woods where foraging occurs generally have small streams with some water in summer. Another good habitat type is orchards with old trees and they will sometimes visit open habitats as well as using woodland during the summer.[88]

Woodland

A5.28 Bechstein's bat prefers woodland with a closed canopy and a dense understorey. The ideal woodland is unevenly aged, deciduous woodland with a high number of oaks in the species mix. The woodland be 40 to 50 hectares in extent and be semi-natural or ancient woodland with a dense mixed species understorey. Oak and mixed hardwood forestry plantations can support a colony, but this depends on roost availability and the age, pattern and size of the plantation.[89]

A5.29 Bechstein's bats fly slowly and are maneuverable, can hover and also hunt by gleaning. Hunting takes place from 1 to 5 metres from vegetation and at ground level or in the canopies of trees. They frequently take prey from the substrate and. leaves.[90]

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

[87] Schofield, H. W. & Greenway, F. 2008. Bechstein's Bat *Myotis bechsteinii*: in Harris, S. & Yalden, D. W. (eds.) 2008. *Mammals of the British Isles: Handbook, 4th Edition*. Southampton: The Mammal Society; Dietz, C., von Helversen, O. & Dietmar, N. 2008. *Bats of Britain, Europe and Northwest Africa*. London: A & C Black Publishers Ltd

[88] Boye, P. & Dietz, M. 2005. *English Nature Research Reports Number 661: Development of good practice guidelines for woodland management for bats*. Peterborough: English Nature; Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd; Fitzsimmons, P., Hill, D. & Greenaway F. 2002. *Patterns of habitat use by female Bechstein's bats (Myotis bechsteinii) from a maternity colony in a British woodland*. Brighton: University of Sussex; Greenaway, F. & Hill, D.A. 2004. *Woodland management advice for Bechstein's and barbastelle bat.* English Nature Research Reports. 658. Peterborough: English Nature

[89] Greenaway, F. & Hill, D.A. 2004. *Woodland management advice for Bechstein's and barbastelle bat.* English Nature Research Reports. 658. Peterborough: English Nature

[90] Dietz, C., von Helversen, O. & Nill, D. 2009. *Bats of Britain, Europe and Northwest Africa*. London: A. & C. Black Publishers Ltd

A5.30 Maternity colonies of Bechstein's bat favour woodpecker holes. Green=away & Hill state that 'Both greater spotted woodpecker holes and green woodpecker holes are used, but there is some preference for the cavities originally formed by the latter species as they are a little larger and usually sited in slightly decayed trees with rotten trunk centres. Large live oak trees are preferred to smaller trees, dead trees or other species.'[91]

Hedgerows

A5.31 Bechstein's bats commute and occasionally forages along hedgerows. Hedgerows are important in linking several smaller woodlands used as roosting and foraging site. Greenaway & Hill (2004) report that it is normally the case in central southern England that smaller nursery roost woodlands are well connected by hedgerows. Occasionally these links are well enough developed and short enough to allow several smaller woodlands to act as one colony territory for a single large colony.[92]

Water

A5,32 Small streams with at least some water in summer are usually a feature of nursery roost woodlands.[93]

Pasture

A5.33 Pasture was the third most used habitat at a breeding colony in Bracket's Coppice in Dorset.[94]

Caves and Mines

A5.34 Occasionally mines or caves are used to hibernate, and these are mostly male. However, during the late summer and early autumn female Bechstein's bat swarm at the entrances to underground hibernation sites to mate and so preform an important function in the maintenance of populations.[95]

Annex 6: Methodology for Calculating the Amount of Replacement Habitat Required

Introduction

A6.1 The method used to calculate the amount of habitat required to replace that lost to the SAC Barbastelle bat population due to development is based on the requirements for

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[91] Greenaway, F. & Hill, D.A. 2004. *Woodland Management advice for Bechstein's and barbastelle bat*. English Nature Research Reports. 658. Peterborough: English Nature.

[92] Greenaway, F. & Hill, D.A. 2004. *Woodland Management advice for Bechstein's and barbastelle bat.* English Nature Research Reports. 658. Peterborough: English Nature.

[93] Greenaway, F. & Hill, D.A. 2004. *Woodland Management advice for Bechstein's and barbastelle bat.* English Nature Research Reports. 658. Peterborough: English Nature.

[94] Schofield, H. & Morris, C. 2000. *Ranging Behaviour and Habitat Preferences Of Female Bechstein's Bat,* Myotis Bechsteinii (*Kuhl, 1818), In Summer.* Ledbury: The Vincent Wildlife Trust.

[95] Schofield, H. W. & Greenway, F. 2008. Bechstein's Bat *Myotis bechsteinii*: in Harris, S. & Yalden, D. W. (eds.) 2008. *Mammals of the British Isles: Handbook, 4th Edition*. Southampton: The Mammal Society

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'*.[96] 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[97].

A6.2 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.[98]

A6.3 The HEP uses the Integrated Habitat System (IHS) developed by Somerset Environmental Records Centre, described below. It requires a Habitat Suitability Index for the Barbastelle bat scored on IHS descriptions, which are given in Appendices 2 and 3.

A6.4 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 the Barbastelle 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 Barbastelle, Greater and Lesser Horseshoe bats to inform the adequacy of replacement habitat provided by the developer. The method has gone through planning inquiries including for a Nationally Significant Infrastructure Project.

A6.5 The methodology has also been reviewed and further developed with the Bat Conservation Trust.

Integrated Habitat System Mapping

A6.6 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)[99] 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 purposes. The classification can be customised for a geographical area or special project use without losing data integrity.

A6.7 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[100].

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

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

[98] 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.

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

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

A6.8 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.

A6.9 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)[101]. 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)

A6.10 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.

A6.11 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

A6.12 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[102].

Description

A6.13 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.

A6.14 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

[101] http://www.somerc.com/integrated+habitat+system/
[102] http://www.fort.usgs.gov/Products/Software/HEP/

level or priority habitat level unless there are discernible differences in the type of habitat used, e.g. oak or beech woodland)[103]. This means that the full range of scoring is used before the modifiers (the IHS Formation and Management codes) are applied.

A6.15 The Habitat Code scoring is considered in combination with the IHS Matrix codes[104]. 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.[105] 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.

A6.16 All other Codes are scored between 0 and 1 and are multipliers. Where there is no effect from Formation or Management of the habitat then a default score of 1 is used.

Table 4: 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	2	1	1*	0.5	1.5

*default score

A6.17 Scores will be applied such that a precautionary approach or 'potential' approach is taken, e.g. if a species requires grassland which is most valuable when grazed then grassland scores the top score. This potential score will take into account a combination of the Habitat and Matrix codes. The management modifier would then maintain the habitat score at this high level by a multiplier of 1. If the management is not grazed a decimal multiplier is applied to reduce the value of the habitat. For 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 is set out in Table 4 above.

A6.18 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[106] and expanded, in consultation with the Bat Conservation Trust, as follows:

Excellent - provides for essential life requisites, including feeding, reproduction or

[103] The 1 to 6 scale matches Defra's habitat distinctiveness range used in its metric.
[104] 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.
[105] 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.
[106] For example, http://www.env.gov.bc.ca/wld/documents/techpub/r20.pdf

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.

A6.19 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[107]. However, in scoring the overall HSI, i.e. including all Habitat, Matrix, Formation codes, etc., it is considered that a higher value is given as a precaution. However, there is a factor in the HEP taking into account survey results which is partly aimed to account for variability in habitat quality.

A6.20 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.

A6.21 The HSI score arising from the above calculation can be joined into a GIS base habitat map and displayed using thematic mapping to give a graphical representation of the value of a landscape to Barbastelle bats.

A6.22 The Habitat Suitability Index for Barbastelle bat can be found in Appendix 2 and for Bechstein's bat.in Appendix 3.

Validation

A6.23 An HSI model can be reviewed against occurrence data held by the biological records centre. The Gulf of Maine HSI work[108] 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.

[107] Dennis, R.L.H. 2010. *A Resource-Based Habitat View for Conservation. Butterflies in the British Landscape.* Chichester: Wiley-Blackwell.
[108] http://www.fws.gov/r5gomp/gom/habitatstudy/Gulf_of_Maine_Watershed_Habitat_Analysis.htm

A6.24 Garshelis (2000)[109] 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[110].

A6.25 In this study HSI have initially been researched and scored by the author. However, the scores can be varied through review, further research findings or to reflect local conditions based on survey. Where varied by consultants the reason for the variation should be given and supported by evidence.

Density Band

A6.26 The HSI score is multiplied by the location of the proposed site in relation to that of the Barbastelle 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 5 below.

Table 5: CZ Band

Band	Score
A	3
B	2
C	1

A6.27 When two Bands occur within one field take the higher value as the score. The Density Band widths can be found in Table 1 and 2 above.

A6.28 Following ecological surveys for Barbastelle bats carried out for the proposed development the Density Band score may be modified up depending on whether feeding activity or a key flyway 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 Zeale 2009, 2012[111]). Note that sufficient automated detectors should be deployed.

A6.30 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

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[109] 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.

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

[111]. Zeale, M. 2009. *Barbastelles in the Landscape: Ecological Research and Conservation in Dartmoor National Park*. Report for Dartmoor National Park/ SITA Trust; Zeale, M. R. K., Davidson-Watts, I, & Jones, G. 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy 93(4):1110-1118. 2012*

- 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.

A6.31 The identification of 'foraging' (i.e. a higher level of activity) for Barbastelle and Bechstein's bat species is defined as either:

a) The criteria for foraging for bat species makes use of Miller's (2001) Activity Index.[112] '*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 9 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.

Calculating the Habitat Unit Value

A6.32 For information the value of the proposed site to a Barbastelle or Bechstein's bat in Habitat Suitability value is calculated by using the HSI Score and the Density Band (See Table 6 below). The outcome of the Habitat Suitability Units used in the HEP is on a scale of 0 to 18[113].

A6.33 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.

A6.34 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 6: 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

A6.35 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

[112] 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.

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

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.

A6.36 Nonetheless hedgerow and other commuting structure should be seen as having a functional role and should normally be maintained or replaced to maintain Barbastelle and Bechstein's bat commuting across a proposed development site.

A6.37 HEP calculations for development sites should be made on the basis that the total site area would be lost to a species and would therefore produce a maximum replacement requirement to develop the site. This saves a separate calculation for the value of the existing habitat on which enhanced habitat is created. Where habitat remains unchanged and is retained by the development it is not included in the calculation.

Summary

A6.38 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

A6.39 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 A6.40 to A6.52), on or off site and a further spreadsheet for the value for an offsite receptor site (see A6.53 to A6.54).

Replacement Habitat

A6.40 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 Barbastelle or Bechstein's bats (although it is unlikely that some habitats such as grazed pasture would be possible to re-create within a development site).

A6.41 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.

A6.42 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 Barbastelle or Bechstein's bats.

A6.43 *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.*'[114] 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 Barbastelle or Bechstein's 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'.

A6.44 '*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.*[115] 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.[116]. In many other situations a significantly higher multiplier may be appropriate[117]. *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.*[118]

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

Delivery Risk

A6.46 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,*

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

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

[116] 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

[117] 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*.

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

and associated multipliers, as set out in [Table 7] *below*.'[119]

A6.47 Appendix 4 gives an indicative guide to risk levels which have been assigned to habitats to these broad categories using expert opinion by Defra (2011). Factors such as substrate, nutrient levels, state of existing habitat, etc. will have an impact on the actual risk factor, which may need to be taken into account.

Table 7: 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

Temporal Risk

A6.48 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.

A6.49 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 8 below. Appendix 5 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.

A6.50 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 8 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 8: Multipliers for different time periods using a 3.5% discount rate[120]

Years to target condition	Multiplier

[119] Defra. 2011. *Biodiversity Offsetting. Technical paper: proposed metric for the biodiversity pilot in England.* London: Department for Environment, Food and Rural Affairs.
[120] http://publications.naturalengland.org.uk/publication/6020204538888192

1	0.965
5	0.837
10	0.70
15	0.59
20	0.49

Spatial Risk

A6.51 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.

A6.52 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

A6.53 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.

A6.54 It is critical that the replacement site where habitat has been enhanced is accessible to the population of Barbastelle bats affected.

Enhancement

A6.55 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.

A6.56 In December 2018 Defra published its consultation on net gain in biodiversity[121]. 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 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*.'

[121] https://consult.defra.gov.uk/land-use/net-gain/supporting_documents/netgainconsultationdocument.pdf

Annex 7: Habitat Creation Prescriptions

Barbastelle Bats

A7.1 The principal prey for Barbastelle bats is small moths. Most moths require food for their caterpillars (For some species this is a single type of plant, although most species are not so restricted – see Annex 5). Energy in the form of nectar from flowers is required for the adult. Many species have favoured nectar plants, but some moths do not feed at all in the adult stage; and somewhere to over-winter safely – usually in taller vegetation, scrub or ivy. One study found that night flying moth abundance and diversity correlated positively with the number of bramble (*Rubus fruticosus*) clumps along a hedgerow[122].

Grassland[123]

A7.2 The creation of species rich grassland is likely to be more feasible in response to providing replacement habitat to mitigate the impacts of a development. This will need to be managed to produce a long sward to support an abundance of Noctuid moths, one of the main prey items hunted by Barbastelle bats. Specified seed mixes should include food plants, as well as grasses, such as dandelion, dock, hawkweeds, plantains, ragwort, chickweed, fat hen, mouse-ear and red valerian and other herbaceous plants.

A7.3 Wetter areas of grassland and ponds, such as can be created through sustainable drainage systems, are also favourable to Barbastelle bats

A7.4 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.

A7.5 Where grassland is established as a field margin this should be at least 6 metres wide out from the face of the bounding hedgerow. Cuts should be made once a year in the autumn to avoid harming moth populations.

Hedgerow

A7.6 Hedgerows should be maintained as large as possible and a second row of trees and shrubs parallel to the existing or planted hedgerow leaving a pathway between will create effective flight line conditions. The larger the hedgerow the better the flight line for Barbastelle bats.[124]

A7.7 Uniformity of species or structure is undesirable and trees with a tall clean trunk, such as ash or beech avoided. Trimmed hedgerows provide poor cover for commuting Barbastelle bats. Where necessary only one side a double hedge line should be trimmed in any one year or then cut back in short sections in rotation on one side of the

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[122] 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.

[123] Merckx, T. & Macdonald, D. W. 2015. Landscape-scale conservation of farmland moths: in Macdonald, D. W. & Feber, R. E. (eds) 2015. *Wildlife Conservation on Farmland. Managing for Nature on Lowland Farms*. Oxford: Oxford University Press; Fuentes-Montemayor, E., Goulsion, D.& Park, K. J. 2010, The effectiveness of agri-environment schemes for the conservation of farmland moths: assessing the importance of a landscape-scale management approach. *Journal of Applied Ecology* 48, 532-542

[124] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

hedge only. This may not be able to be controlled if hedgerows form the boundaries of residential properties which should be taken into account when master planning a proposed development site.[125]

A.7.8 If not present bramble should be planted at regular intervals in hedgerows and should be included in the planting schedule for new hedgerows[126]. Cow parsley (*Anthriscus sylvestris*) should also be seeded in association with hedgerow enhancement and creation. Bramble is also closely related to other cultivated species such as raspberry (*Rubus idaeus*), Loganberry (*Rubus loganobaccus*); and cloudberry (*Rubus chamaemorus*).

Watercourses

A7.9 Watercourses and their margins form a major component of Barbastelle bat flyways and vary from larger hedgerow ditches up to medium sized rivers with their bankside vegetation, this latter forming the structure of the flyway. A stream with trees either side and canopies touching is ideal.[127] Watercourses forming part of proposed developments should be maintained and enhanced so that there is sufficient structure to support a flyway. Existing vegetation should not be removed.

Woodland and Trees

A7.10 Macro moth communities were influenced to some extent by the surrounding landscape. Fuentes-Montemayor et al (2012) found that moth abundance was influenced by the percentage cover of woodland in the surrounding landscape at relatively small spatial scales (<500 m), suggesting that local habitat management (or a landscape management at this spatial scale) would be suitable for moth conservation.

A7.11 Woodland supports high levels of moth abundances. Macro moths are densest where there is grass or litter, less so where there are ferns, moss, bare ground or herbs. Understorey plants often provide larval foods for small moths, the Geometridae in particular. Within development trees can be planted within grassland areas to form small copses. A diverse mix of tree species should be used using species such as oak, willow and birch which can support large numbers of moths. Species such as beech should be avoided as it has small numbers of moths even when compared to non-native species such as sycamore. Uniformity of stands of trees should also be avoided as they are poorer in invertebrates than more diversely structured woodland.[128]

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[125] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[126] 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.

[127] Greenaway, F. 2004. *Advice for the management of flightlines and foraging habitats of the barbastelle bat* Barbastella barbastellus. Peterborough: English Nature

[128] 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*; Grenaway, F. 2005. *Advice for the management of flightlines and foraging habitats of the barbastelle bat Barbastella barbastellus*. Peterborough:English Nature; Kirby, K. J. (ed). 1988. *A woodland survey handbook*. Peterborough: Nature Conservancy Council.

Bechstein's Bats

Woodland

A7.12 Although it is not viable to re-create mature semi-natural or ancient woodland which is generally used by Bechstein's bats, some colonies are known to exist in plantation woodlands and measures to improve the suitability of the habitat is possible. This can include, extracted form Greenaway & Hill (2004)[129]:

a) Creating non-intervention strips along all watercourses within the woodlands.
b) Creating a series of suitable areas within which Green Woodpeckers can forage for ants. These areas should be over and above the woodland area required by the bats to forage in.
c) Ensuring, by new planting if necessary, that all hardwood blocks in a maternity colony area have deciduous woodland connections.
d) Erecting bat boxes (Bechstein's bats prefer Schwegler 2FN)

A7.13 'In general, woodland blocks should be as large as possible; and should be directly connected to suitable bat habitats in the surrounding landscape. Woodlands should support a diverse and species-rich mix of native tree and shrub species in the canopy and understory layers. Trees and shrubs for new woodland should be planted in naturalistic non-linear patterns. Specifications for new woodlands must include adequate detail, including a planting schedule that specifies species, stock, ground preparation, planting density, timing, planting methodology, weed control, plant protection and long-term maintenance. Aftercare management, until such point that the woodland is established, will be particularly important.'[130]

Hedgerows

A7.14 Hedgerows act as commuting structure and provide important links between smaller blocks of woodland and between Maternity roosts and swarming sites in August. Hedgerows should be 3 to 6 metres wide and 3 metres high with standard trees planted frequently along its length. Cutting should be restricted to the minimum needed to ensure visibility or retain hedgerow structure. Hedgerows are best cut every 2-3 years, working on only one part or side at any time.

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[129] Greenaway, F. & Hill, D.A. 2004. *Woodland Management advice for Bechstein's and barbastelle bat*. English Nature Research Reports. 658. Peterborough: English Nature.

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

Annex 8: 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* (Functionally Linked Land) which is important for the Favourable Conservation Status of the species.[131]

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*".[132]

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: (Stage 1) 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 (Stage 2) 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 Local Planning Authority to determine whether the proposal is likely to have a significant effect on the SAC. The local planning authorities carry out a Habitats Regulations Assessment for proposals which involve or may involve:

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

[131] See European Site Conservation Objectives for North Somerset and Mendip Bats Special Area of Conservation at Part B, paragraph 1.4
[132] Natural England Standard: Conservation Objectives for European Sites in England Standard 01.02.2014 V1.0 http://publications.naturalengland.org.uk/publication/6734992977690624

A7.6 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'*[133]

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[134]. 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"[135].

A7.9 The precautionary principle underpins the Habitats Directive[136] and hence the Habitats Regulations and must be applied by the local planning authority as Competent Authority as a matter of law.[137] It is clear that the decision whether or not an appropriate assessment is necessary must be made on a precautionary basis.[138] In addition, the Waddenzee judgement[139] 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 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

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[133] Court of Justice of the European Union (Holohan, Guifoyle, Guifoyle & Donegan v An Bord Pleanála. Case C-461 /17)
[134] 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.
[135] See ODPM circular 06/2005
[136] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the 'Habitats Directive')
[137] *Assessing Projects under the Habitats Directive: Guidance for Competent Authorities* 2011, CCW p.15
[138] ODPM Circular 06/2005 para13
[139] ECJ judgement: C-127/02 [2004] ECR-I

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.

Part D: Appendices

Appendix 1: Comparison of Home Ranges of Barbastelle and Bechstein's Bats Derived from Radio-Tracking Studies

Barbastelle Bats

Home range distance	Minimum Distance	Average Distance	Maximum Distance	Home range area	Reference
On average, bats travelled 8.4 km +/- 4.9 *SD* (range 1.1– 20.4 km) from roosts to foraging areas.	1.1	8.4	13.3	Females were highly faithful to more or less "private" foraging areas which constituted a small fraction ($\bar{X}$ = 10.1 % +/- 8.8 *SD*) of home ranges.	Zeale, M. R. K. 2011. *Conservation biology of the barbastelle (*Barbastella barbastellus*): applications of spatial modelling, ecology and molecular analysis of diet*. PhD Thesis. University of Bristol, Bristol, UK.
The foraging areas ranged from 0.75km up to 10.2km away from the roosting site.	0.75		10.2	The bats multi-lateral polygon range (MLP) was over a distance of 9.8km (east/ west and using an area of 31.6km^2. This is a more accurate method compared to the commonly used academic analysis method of multi convex polygon, which would exaggerate the area by 34.2% to 48km^2.	Rush, T. & Billington, G. 2013. *Report on a radio tracking study of Barbastelle bats at Hinkley Point C.* Witham Friary: Greena Ecological Consultancy.
Bats ranged 3.5km northwest,4.5km north, 6km northeast, 6km east, 9km southeast and 6 km south			9		Billington, G. 2000. *Horner Woods Barbastelle Bat: radio tracking study*. The National Trust.
In October and November 2001 Barbastelle bats ranged up to 3km from their roosts compared to at least 9km in summer, there was one in November a radio tagged male bat was briefly recorded moving around 16km west of Horner Wood at Hillsford Bridge, near Lynmouth, Devon			*3*		Billington, G. 2012. *Further research on the Barbastelle Bat Holnicote National Trust Estate, Exmoor, North Somerset*. Natural England Research Report. Witham Friary: Greena Ecological Consultancy
Ebemore roosts – 1.17km to 10.46km, mean 5.2km (lactating 5.09km)	1.17	5.2	10.46	Ebemore roosts – 50% kernel 20.88 – 368.25 ha, mean 178.15ha.	Greenaway, F. 2008. *Barbastelle Bats In The Sussex West Weald 1997 – 2008.* Sussex Wildlife Trust/ West Weald Landscape Partnership
The Mens roosts – 2.64km to 11.98km, mean 7.11km (lactating 7.67km)	2.64	7.11	11.98	The Mens roosts – 50% kernel 61.33 – 1152.24ha, mean 379.75	
				Individual 95% kernel, 125 – 2551ha, median 403ha. Individual 50% ernel 5-285 ha, median 67 ha.	Hillen, J., Kiefer, A., Veith, M., 2009. Foraging site fidelity shapes the spatial organisation of a population of female western barbastelle bats. *Biological Conservation* 142: 817-823.

Home range distance	Minimum Distance	Average Distance	Maximum Distance	Home range area	Reference
				Individual MCP mean 222ha ± 88.5, individual 50% ernel 16ha ± 10.	Kerth, G., Melber, M., 2009. Species-specific barrier effects of a motorway on the habitat use of two threatened forest-living bat species. *Biological Conservation* 142: 270-279.
Mean maximum distance from roost to furthest edge of core foraging area (80% cluster cores) 6.8km ± 4.8. Per colony the mean maximum distances were 8.5km (5.6-11.3km) and 5.2km (2.7-7.7km).	2	8.5	11.3	Colony MCPs 10,660ha and 14,804 ha.	Zeale, M., Davidson-Watts, I., Jones, G., 2012. Home range use and habitat selection by barbastelle bats (*Barbastella barbastellus*): implications for conservation. *Journal of Mammalogy 93: 1110-1118.*
		5.2	7.7		
				95% kernel 183 ha and 50% kernel 27 ha.	Hillen, J., Kiefer, A., Veith, M., 2010. Interannual fidelity to roosting habitat and flight paths by female western barbastelle bats. *Acta Chiropterologica 12: 187-195*
Maximum home range was 5km. The distance between roosts in the forest to foraging sites was less than 1km for males and between 3km and 4.5km for females.		(*3.75*)	(*5*)	Core regions (calculated using harmonic means) are 100-500m in diameter. Nine tracked animals used a total area of 35km²	Steinhauser, D., Burger, F., Hoffmeister, U., Matez, G., Teige, T., Steinhauser, P., Wolz, I., 2002. Untersuchungen zur Okologie der Mopsfledermaus, Barbastella barbastellus (Schreber, 1774), und der Bechsteinfledermaus, Myotis bechsteinii (Kuhl, 1817) im Suden des Landes Brandenburg. Schriftenr. *Landschaftspflege. Naturschutz 71: 81–98.*
				Mean individual home range 8.8 ha ±5.8 SD	Sierro, A., 1999. Habitat selection by barbastelle bats (*Barbastella barbastellus*) in the Swiss Alps (Valais). *Journal of Zoology 248: 429-432.*
				Home range approximately 1000 ha	Greenaway, F., 2001. The barbastelle in Britain. *British Wildlife* 12: 327-334.
Distance between roost and foraging sites was between 0.8km and 8.2 km (average 3.9km)	0.8	3.9	8.2	Seven Barbastelle radio tracked had a total of 24 distinct foraging sites, sizes between 2ha and 48ha. Each individual bat visiting between 1 and 7 sites.	Simon, M., Hüttenbügel, S. & Smit-Viergutz, J. 2004. *Ecology and Conservation of Bats in Villages and Towns*. Bonn: Bundesamt für Naturschutz
Mean Distances	**1.41**	**6.385**	**10.1**		

Bechstein's Bat

Results	Average Distance (km)	Maximum Distance (km)	Reference
	0.7	1.4	Fitzsimmons, P., Hill, D. & Greenaway F. 2002. *Patterns of habitat use by female Bechstein's bats (Myotis bechsteinii) from a maternity colony in a British woodland*. Brighton: University of Sussex.
The MCPs ranged from 6.9 – 50.5 ha (mean = 21.9 ha). The MCP for the colony, of 76.63 ha, was determined by constructing a polygon around all the buffered fixes of the ten study animals. The maximum distance, from day roost to the furthest edge of the MCP, was between 310 and 930 m (mean = 620 m, std 250).	0.62	0.93	Schofield, H. & Morris, C. 2000. *Ranging Behaviour and Habitat Preferences of Female Bechstein's Bat,* Myotis Bechsteinii (*Kuhl, 1818), In Summer.* Ledbury: The Vincent Wildlife Trust.
Female Bechstein's bats foraged on a mean area of 46 ha (MCP) with small core feeding areas (mean: 2.1 ha) which show no, or only a small overlap with each other. In the majority of cases female bats had two foraging areas, one of them close to the day-roost (< 500 m) and a further one within 1 km.	0.49	0.61	Dietz, M.& Pir, J.B. 2009. Distribution and habitat selection of *Myotis bechsteinii* in Luxembourg: implications for forest management and conservation. *Folia Zool.* 58(3): 327–340 (2009)

Appendix 2: Barbastelle Bat Habitat Suitability Index

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

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

A complete list with full descriptions and parameters of the habitat labels can be obtained from Somerset Environmental Records Centre[140].

The columns on the right refer to scores given by three Barbastelle bat specialists to broad habitat types on a decimal scale of 0 to 1 through a Delphi process and are given for information only. Figures in italics refer to scores given to a Habitat Type rather than a Matrix Code and should be compared with the modified HSI score not that shown which is a multiplier.

Code	Label	HSI	Notes	ZE	BI	GR
Woodland Habitat Codes			Barbastelle bats prefer riparian vegetation, broad leaved woodland, unimproved grassland, improved grassland, scrub, mixed woodland, coniferous woodland and avoid urban, upland moor, arable habitats and areas of open water (Zeale, 2009). Over 90% of barbastelle bats from Horner Wood in Somerset foraged along linear wooded scrub strips including along watercourses, overgrown hedgerows, uncut grassland, heather moorland edge (within Exmoor Heath SAC), gardens and areas of low-level street lighting. Gorse was also important. (Billington, 2002). Barbastelle bats foraging in summer occurred mostly out of woodlands and included areas of scrub, heath, unimproved grassland, along hedgerows and streams and salt marsh. By contrast in the autumn/ early winter bats almost exclusively foraged in woodlands with up to half of the time spent in conifer plantations. Habitats recorded as being used to the east of Porlock Weir during these surveys include patches of scrub (including bramble, gorse, nettles, blackthorn and dog			
WB0	Broadleaved, mixed, and yew woodland	6				
WB1	Mixed woodland	4				
WB2	Scrub woodland	2				
WB3	Broadleaved woodland	6		1	1	1
WB31	Upland oakwood [=Old sessile oak woods with Ilex and Blechnum in the British Isles(AN1)]	NP				
WB32	Upland mixed ashwoods	5				
WB321	Tilio-Acerion forests of slopes, screes and ravines [upland]	NP				
WB32Z	Other upland mixed ashwoods	5				
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	4				
WB341	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	NP				
WB342	Bog woodland	NP				
WB34Z	Other wet woodland	4				

[140] http://www.somerc.com/products-services/integrated-habitat-system-ihs/ and http://www.somerc.com/wp-content/uploads/2019/01/IHS-Definitions.pdf

Code	Label	HSI	Notes	ZE	BI	GR
WB36	Upland birch woodland	NP	rose); patches of bramble scrub on shingle; saltmarsh; trees lining dry shingle-lined channels; strips of tall vegetation; and short improved turf grazed by sheep. (Billington, 2012). Oak woodlands support high moth diversity (Zeale, 2009a) Moth diversity is greatest on oak and willow species Understorey plants are the larval foods of many small moths, the Geometridae in particular. (Greenaway, 2004) It is indicated that small woodlands of less than 1ha do not have characteristic woodland moth communities (Usher & Keiller, 1998) Scrub, mixed and coniferous woodland of relatively little importance (Zeale, 2009) However, Billngton (2000) found Barbastelle bats using coniferous plantations especially in early winter. In Switzerland Barbastelle bats avoided open woodland on stony outcrops and rocky slopes (Sierro, 1999). Moth eating bats are higher in large and well-connected woodland patches with dense understorey cover. Accordingly, a well-developed woodland understorey has been linked to the occurrence of moth eating bats (Fuentes-Montemayor et al, 2013) Uniform stands of trees are poorer in invertebrates than more diversely structured woodland (Kirby, 1988)			
WB361	Lowland mixed deciduous woodland	6				
WB362	Old acidophilous oak woods with Quercus robur on sandy plains	NP				
WB363	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	NP				
WB36Z	Tilio-Acerion forests of slopes, screes and ravines [lowland]	NP				
WB3Z	Other lowland mixed deciduous woodland	6				
WC0	Coniferous woodland	3				
WCZ	Other coniferous woodland	3				
Woodland Matrix Codes						
IH0	Introduced shrub	0				
Woodland Formation Codes						
WF0	Unidentified woodland formation	1				
WF1	Semi-natural	1				
WF11	Native semi-natural	1				
WF111	Canopy Cover >90%	0.5				
WF112	Canopy Cover 75 - 90%	0.8				
WF113	Canopy Cover 50 - 75%	1				
WF114	Canopy Cover 20 - 50%	1				
WF12	Non-native semi-natural	0.7				
WF121	Canopy Cover >90%	0.3				
WF122	Canopy Cover 75 - 90%	0.5				
WF123	Canopy Cover 50 - 75%	0.7				
WF124	Canopy Cover 20 - 50%	0.7				
WF2	Plantation	0.75		*1*	*0.8*	*0.9*
WF21	Native species plantation	0.75				
WF22	Non-native species plantation	0.5				
WF3	Mixed plantation and semi-natural	0.75				
WF31	Mixed native species semi-natural with native species plantation	0.75				
WF32	Mixed native species semi-natural with non-native species plantation	0.75				
WF33	Mixed non-native species semi-natural with native species plantation	0.5				
WF34	Mixed non-native species semi-natural with non-native species plantation	0.5				
Woodland Management Codes			Trees in unmanaged woodland are preferred over open woodland and parkland (Russo *et al*, 2004)			
WM0	Undetermined woodland management	1				
WM1	High forest	1				
WM2	Coppice with standards	0.5	Where coppicing is necessary it should be carried out in small patches (Greenaway, 2004)			
WM3	Pure coppice	0.5				
WM4	Abandoned coppice	0.75				
WM5	Wood-pasture and parkland	0.75				
WM51	Currently managed wood pasture/parkland	0.75				
WM52	Relic wood pasture/parkland	0.75				
WM6	Pollarded woodland	0.5				
WM7	Unmanaged woodland	1				
WMZ	Other woodland management	1				
WG0	Unidentified woodland clearing	1				
WG1	Herbaceous woodland clearing	1				
WG2	Recently felled/coppiced woodland clearing	0.5				

Code	Label	HSI	Notes	ZE	BI	GR
WG3	Woodland ride	1				
WG4	Recently planted trees	0.25				
WGZ	Other woodland clearings/openings	1				
Grassland Habitat Codes						
GA0	Acid grassland	4				
GAZ	Upland acid grassland	0				
GC0	Calcareous grassland	4		0.8	0.7	0.5
GC1	Lowland calcareous grassland	4				
GC2	Upland calcareous grassland	1				
GN0	Neutral grassland	4				
GN1	Lowland meadows	4				
GI0	Improved grassland	2		0.5	0.2	0.3
GU0	Semi improved grassland	3		0.7	0.4	0.5
Grassland Matrix Codes						
SC1	Dense/continuous scrub	1		*0.8*	*0.7*	*0.5*
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				
TS11	Broadleaved	1				
TS12	Mixed	0.75				
TS13	Coniferous	0				
TS2	Scattered trees none veteran	0				
TS21	Broadleaved	0				
TS22	Mixed	0				
TS23	Coniferous	0				
PA0	Patchy bracken	0				
PA3	Scattered bracken	0				
OT0	Tall herb and fern (excluding bracken)	0				
OT2	Upland species-rich ledges	0				
OT3	Tall ruderal	0				
OT4	Non-ruderal	0				
OT41	Lemon-scented fern and Hard-fern vegetation (NVC U19)	0				
OT4Z	Other non-ruderal tall herb and fern	0	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)			
OTZ	Other tall herb and fern	0				
HS0	Ephemeral/short perennial herb	0				
BG1	Bare ground	0				
Grassland Management Codes						
GM0	Undetermined grassland etc. management	1				
GM1	Grazed	0.7				
GM11	Cattle grazed	0.7	Butterflies and other arthropods are negatively affected by moderate and high levels of cattle grazing (Ekroos, J., Heliola, J. & Kuussaari, M. 2010. Homogenization of lepidopteron communities in intensively cultivated agricultural landscapes. *Journal of Applied Ecology,* 2010, 47, 459 - 467			
GM12	Sheep grazed	0.5				
GM13	Horse grazed	0.6				
GM14	Mixed grazing	0.5				
GM1Z	Other grazing	0.6				
GM2	Mown	0.3				
GM21	Silage	0.2				
GM22	Hay	0.3	Hay cutting has great effect on biomass suddenly altering local			
GM23	Frequent mowing	0				

Code	Label	HSI	Notes	ZE	BI	GR
GM2Z	Other mowing regime	0.2	insect availability at a very susceptible time of year for pregnant bats (Greenaway, 2004)			
GM3	Hay and aftermath grazing	0.2				
GM4	Unmanaged	1				
GM5	Burning/swaling	0				
GMZ	Other grassland etc. management	1				
GL1	Amenity grassland	0.2				
GL11	Golf course	0.5				
GL12	Urban parks, playing and sports fields	0.1				
GL1Z	Other amenity grassland	0.1				
GL2	Non-amenity grassland	1				
GL21	Permanent agricultural grassland	1				
GL211	Arable reversion grassland	1				
GL2111	Species-rich conservation grassland	1				
GL211Z	Other arable reversion grassland	1				
GL21Z	Other permanent agricultural grassland	1				
GL2Z	Other grassland use	1				
CL3	Unintensively managed orchards	1				
CL31	Traditional orchards	1				
CL32	Defunct orchards	1				
CL3Z	Other unintensively managed orchards	1				
Bracken Habitat Codes						
BR0	Bracken	3				
Heathland Habitat Codes			Zeale (2009) found that Barbastelle bats avoided upland moors although they support unimproved habitat are highly exposed with colder temperatures and stronger winds likely to reduce insect abundance and the energetic costs of flight. However, Billington (2002) found Barbastelle using moorland edge			
HE0	Dwarf shrub heath	1				
HE1	European dry heaths	1				
HE2	Wet heaths	1				
Bog Habitat Codes						
EO0	Bogs	NP				
Wetland Habitat Codes						
EM0	Fen, marsh and swamp	2				
EM1	Swamp	2				
EM11	Reedbeds	3				
EM12	Calcareous fens with Cladium mariscus and species of the Carex davallianae	NP				
EM1Z	Other swamp vegetation	2				
EM2	Marginal and inundation vegetation	1				
EM21	Marginal vegetation	2				
EM22	Inundation vegetation	0				
EM3	Fens	2				
EM31	Fens [and flushes - lowland]	2				
EM3Z	Other fens, transition mires, springs and flushes	1				
EM4	Purple moor grass and rush pastures [Molinia-Juncus]	3				
EM41	Molinia meadows on calcareous, peaty or clayey-silt-laden soils [Molinia caeruleae]	NP				
EM42	Non-Annex 1 Molinia meadow and rush pasture habitats	3				
EM421	Species rich rush pastures	3				
EM422	Non-Annex 1 Moilinia meadows	3				
EM4Z	Other purple moor grass and rush pastures	3				

Code	Label	HSI	Notes	ZE	BI	GR
	[Molinia-Juncus]					
Standing Water and Canal Habitat Codes						
AS0	Standing open water and canals	3		0.2	0.6	0.8
AS1	Dystrophic standing water	2				
AS11	Natural dystrophic lakes and ponds	1				
AS1Z	Other dystrophic standing water	2				
AS2	Oligotrophic standing waters	1				
AS21	Oligotrophic lakes	1				
AS21Z	Other oligotrophic lakes	1				
AS2Z	Other oligotrophic standing waters	2				
AS3	Mesotrophic standing waters	3	Riparian vegetation is the most used habitat by Barbastelle bats in a study on Dartmoor (Zeale, 2009). However, open water was the least selected habitat. The report also stated that it is the riparian vegetation rather than the water that is important to foraging Barbastelle bats, although the secondary importance of water in supporting riparian vegetation should be noted. In SW Germany have been observed to forage above water in a similar way to Daubenton's (Boye & Dietz, 2005) Surveys at Hinkley LWS recorded intensive activity above pond (EDP, 2010) Barbastelle bats' foraging paths are generally within 200 metres of water features (Greenaway, 2008) An ideal example of breeding colony of Barbastelle bats in the distant past would be of a small river catchment with dense woodland on its headwaters and wooded valleys leading to a wide zone of water meadows and finally reed beds and sand dunes before reaching the sea. The colony's territorial boundary would be the catchment area. In modified landscapes colony territories are difficult to define as now they often have unnatural access to new foraging possibilities in adjacent catchments - through plantations for example. (Greenaway, 2004)			
AS31	Mesotrophic lakes	1				
AS31Z	Other mesotrophic lakes	1				
AS3Z	Other mesotrophic standing waters	3				
AS4	Eutrophic standing waters	4				
AS41	Eutrophic standing waters	1				
AS4Z	Other eutrophic standing waters	4				
AS5	Marl standing water	3				
AS6	Brackish standing water with no sea connection	0				
AS7	Aquifer fed naturally fluctuating water bodies	1				
ASZ	Other standing open water and canals	4				
Standing Water 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	0.75				
AC1Z	Other artificial channels	0.5				
AC2	Natural/naturalistic channels	1				
AO0	Open water of unknown origin	1				
AO1	Artificial open water	1				
AO11	Reservoir	0.5				
AO12	Gravel pits, quarry pools, mine pools and marl pits	0.75				
AO13	Industrial lagoon	0				
AO14	Scrape	1				
AO15	Moat	1				
AO16	Ornamental	0.25				
AO1Z	Other artificial open water	0.25				
AO2	Natural open water	1				
AP1	Pond	1				
AP11	Ponds of high ecological quality	1				
AP1Z	Other pond	0.8				
AP2	Small lake	1				
AP3	Large lake	1				
Standing Water Management Codes						
LT1	Canal-side	1				
LT11	Canal-side with woodland	1				

Code	Label	HSI	Notes	ZE	BI	GR
LT12	Canal-side with scrub or hedgerow and standard trees	1				
LT13	Canal-side with scrub or hedgerow	1				
LT14	Canal-side with layered vegetation	1				
LT15	Canal-side with grassland	0.5				
LT16	Canal-side with damaged banks	0.2				
LT17	Canal-side with constructed banks	0.1				
LT18	Other canal-side type	0.5				
Running Water Habitat Codes						
AR0	Rivers and streams	6		0.8	0.9	1
AR1	Headwaters	6				
AR11	Chalk headwaters	6				
AR1111	Tufa streams (Ranunculion fluitantis)	6				
AR111Z	Non-tufa Ranunculion fluitantis headwaters	6				
AR112	Other tufa streams	6				
AR11Z	Other chalk headwaters	6				
AR12	Active shingle rivers [headwaters]	6				
AR1Z	Other headwaters	6				
AR2	Chalk rivers (not including chalk headwaters)	6				
AR2Z	Other chalk rivers	6				
AR3	Active shingle rivers [non headwaters]	6				
ARZ	Other rivers and streams	6				
Standing Water Management Codes			Zeale (2009) found a preference for foraging in riparian vegetation followed by broadleaved woodland			
LT2	River-side	1				
LT21	River-side with woodland	1				
LT22	River-side with scrub or hedgerow and standard trees	1				
LT23	River-side with scrub or hedgerow	1				
LT24	River-side with layered vegetation	1				
LT25	River-side with grassland	0.5				
LT26	River-sdie with vertical banks	1				
LT27	River-side with damaged banks	0.2				
LT28	River-side with constructed banks	0				
LT29	Other river-side type	0.5				
Arable Habitat Codes			Avoids arable habitats (Zeale, 2009)			
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	1				
CR35	Miscanthus	0				
CR3Z	Other non-cereal crops including woody crops	1				
CR4	Freshly ploughed	0				
CR5	Whole field fallow	2				
CR6	Arable headland or uncultivated strip	5				
CR61	Arable field margins	5				
CR6Z	Other arable headland or uncultivated strip	5				
CR7	Freshly harvested/stubble	0				

Code	Label	HSI	Notes	ZE	BI	GR
CRZ	Other arable and horticulture	0				
Arable Management Codes						
CL1	Agriculture	1				
CL11	Organic agriculture	1				
CL12	Non-organic agriculture	0.75				
CL2	Market garden and horticulture	0				
CL21	Organic market garden and horticulture	0				
CL22	Non-organic market garden and horticulture	0				
CL4	Intensively managed vineyards	0				
CL4Z	Non-intensively managed vineyards	1				
CL5	Cereal crops managed for wildlife	1				
CL5Z	Cereal crops not managed for wildlife	0.5				
Inland Rock Habitat Codes						
RE0	Inland rock	0				
RE1	Natural rock exposure features	0				
RE2	Artificial rock exposures and waste	0				
Linear Habitat Codes						
LF0	Boundary and linear features	5				
LF1	Hedges / Line of trees	5				
LF11	Hedgerows	5				
LF111	Important hedgerows	5		0.9	0.8	1
LF11Z	Non-important hedgerows	4		0.4	0.6	0.8
LF12	Line of trees	5				
LF1Z	Other hedges/line of trees	4				
LF2	Other boundaries and linear features	2				
LF21	Line of trees (not originally intended to be stock proof)	5				
LF22	Bank	0				
LF23	Wall	1				
LF24	Dry ditch	1				
LF25	Grass strip	1				
LF26	Fence	0				
LF27	Transport corridors	1				
LF271	Transport corridor without associated verges	0				
LF272	Transport corridor associated verges only	1				
LF273	Transport corridor with natural land surface	2				
Linear Habitat Management Codes						
LH3	Recently planted hedge	0.25	Cut hedge is specified where height is below 2 metres			
LM1	Cut hedge	0.3				
LM11	Cut hedge with standards	0.3				
LM12	Cut hedge without standards	0.2	Uncut hedge is specified where the hedge is between 2 and 3 metres high			
LM2	Uncut hedge	0.9				
LM21	Uncut hedge with standards	0.9				
LM22	Uncut hedge without standards	0.8				
LM3	Overgrown hedge	1	Overgrown hedge is considered to be over 3 metres high			
LM31	Overgrown hedge with standards	1				
LM32	Overgrown hedge without standards	1				
LT3	Rail-side	1				
LT4	Road-side	1				
LT5	Path- and track-side	1				
LTZ	Other transport corridor verges, embankments and cuttings	1				

Code	Label	HSI	Notes	ZE	BI	GR
UL1	Railway	0				
UL2	Roadway	0				
UL3	Path and trackway	1				
ULZ	Other transport corridor	0.25				
Built Up Areas and Gardens Habitats Codes						
UR0	Built-up areas and gardens	1	Avoids urban areas (Zeale, 2009)			
Built Up Areas and Gardens Management Codes						
UA1	Agricultural	0				
UA2	Industrial/commercial	0				
UA3	Domestic	0.1				
UA31	Housing/domestic outbuildings	0.1	Buildings behind shutters and cladding are occasionally used for roosting (Boye & Dietz, 2005)			
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	0.2				
UA5	Historical built environment	0				
UAZ	Other extended built environment	0				
OV2	Undetermined gorse	5	Gorse is an important habitat (Billington, 2000)			
Coastal Habitat Codes						
SR1	Vegetated maritime cliff and slopes	3				
SR11	Vegetated sea cliffs of the Atlantic and Baltic coasts	3				
SR1Z	Other vegetated cliffs and lichen dominated cliffs	3				
SR2	Boulders and rock above the high tide mark	0				
SRZ	Other Supralittoral rock	0				
SS0	Supralittoral Sediment	0				
SS1	Coastal sand dunes	2	Three colonies have been recorded using dunes (Greenway, 2004)			
SS11	Embryonic shifting dunes	1				
SS14	Decalcified fixed dunes	2				
SS17	Humid dune slacks	2				
SS1Z	Other sand dunes	1				
SS3	Shingle above high tide mark	0				
SS31	Coastal vegetated shingle	1				
SS312	Annual vegetation of drift lines	0				
SS3Z	Other shingle above high tide mark	0				
SS4	Strandline vegetation	1				
SSZ	Other supralittoral sediment	0				
LS0	Littoral Sediment	0				
LS3	Coastal saltmarsh	2	Feeds over saltmarsh (Billington, 2000)			
LS3Z	Other saltmarsh	2				
ES1	Estuary	1	Will cross an estuary 500 metre wide (Zeale,2009)			

Appendix 3: Bechstein's Bat Habitat Suitability Index

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

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

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

Code	Label	HSI	References
Woodland Habitat Codes			Old beech and oak woodland (Deciduous woodland) with plenty of structure and mixed species understorey; Mixed woodland; Fir and pine woodland only if rich structure and shrub layer; All individuals foraged within deciduous woodland. Derelict hazel coppice where oak has closed the canopy. Small streams with some water in summer. (Boye & Dietz, 2005; Dietz et al, 2009; Fitzsimmons et al, 2002; Greenway & Hill, 2004) All individuals foraged within closed broadleaved woodland in Sussex (Fitzsimmons et al, 2002) Radio tracking at Beckets Coppice also showed that bats stayed within woodland. The ideal woodland is unevenly aged, deciduous woodland with a high number of oaks in the species mix. The woodland be of a minimum of 40 to 50 hectares in extent and be semi-natural or ancient woodland with a dense mixed species understorey. (Greenway & Hill, 2004) Non-woodland habitat of some importance are woodland edge, un-grazed grassland, tall herb habitat and hedgerows. (Research Grafton Wood) A typical bat of the temperate beech forest zone in deciduous and mixed woodlands, occurring in lowland plain up to high mountain ranges. The highest population densities are found in beech or oak forests with a high proportion of old trees. It also occurs however, in pine and fir forests, only occasionally in pure spruce forests, and have a pronounced species rich scrub layer (Dietz et al, 2009) mean % canopy cover female = 79.2% (Range 70 - 90%); mean % canopy cover male = 75.8% (Range 65 - 95%) [Miller, n/d]
WB0	Broadleaved, mixed, and yew woodland	6	
WB1	Mixed woodland	6	
WB2	Scrub woodland	3	
WB3	Broadleaved woodland	6	
WB31	Upland oakwood [=Old sessile oak woods with Ilex and Blechnum in the British Isles(AN1)]	4	
WB32	Upland mixed ashwoods	3	
WB33	Beech and yew woodlands	5	
WB331	Lowland beech and yew woodland	5	
WB3311	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	5	
WB3312	Asperulo-Fagetum beech forests	5	
WB3313	Taxus baccata woods of the British Isles	1	
WB331Z	Other lowland beech and yew woodland	5	
WB33Z	Other beech and yew woodlands	5	
WB34	Wet woodland	5	
WB341	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	5	
WB342	Bog woodland	4	
WB34Z	Other wet woodland	5	
WB36	Lowland mixed deciduous woodland	6	
WB361	Old acidophilous oak woods with Quercus robur on sandy plains	0	
WB362	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	6	
WB363	Tilio-Acerion forests of slopes, screes and ravines [lowland]	4	
WB36Z	Other lowland mixed deciduous woodland	6	
WB3Z	Other broadleaved woodland	6	
WC0	Coniferous woodland	1	
WCZ	Other coniferous woodland	1	
Woodland matrix Codes			
IH0	Introduced shrub	0	
Woodland Formation Codes			
WF0	Unidentified woodland formation	1	
WF1	Semi-natural	1	
WF11	Native semi-natural	1	
WF111	Canopy Cover >90%	0.75	
WF112	Canopy Cover 75 - 90%	1	
WF113	Canopy Cover 50 - 75%	1	
WF114	Canopy Cover 20 - 50%	0.75	
WF12	Non-native semi-natural	0.8	
WF121	Canopy Cover >90%	0.4	

Code	Label	HSI	References
WF122	Canopy Cover 75 - 90%	0.8	
WF123	Canopy Cover 50 - 75%	0.8	
WF124	Canopy Cover 20 - 50%	0.6	
WF2	Plantation	0.7	Oak and mixed hardwood forestry plantations can support colonies but depends on roost availability and the age, pattern and size of the plantation. Young plantations or plantations with a high percentage of conifer seem of limited use. (Greenway & Hill, 2004)
WF21	Native species plantation	0.7	
WF22	Non-native species plantation	0.25	
WF3	Mixed plantation and semi-natural	0.7	
WF31	Mixed native species semi-natural with native species plantation	0.7	
WF32	Mixed native species semi-natural with non-native species plantation	0.6	
WF33	Mixed non-native species semi-natural with native species plantation	0.3	
WF34	Mixed non-native species semi-natural with non-native species plantation	0.2	
Woodland Management Codes			
WM0	Undetermined woodland management	1	
WM1	High forest	1	
WM2	Coppice with standards	0.4	Many colonies are in derelict hazel coppice where oak standards have closed canopy over the old hazel (Greenway & Hill, 2004)
WM3	Pure coppice	0.2	
WM4	Abandoned coppice	0.8	
WM5	Wood-pasture and parkland	1	
WM51	Currently managed wood pasture/parkland	1	
WM52	Relic wood pasture/parkland	1	
WM6	Pollarded woodland	0.5	
WM7	Unmanaged woodland	1	
WMZ	Other woodland management	1	
WG0	Unidentified woodland clearing	1	
WG1	Herbaceous woodland clearing	1	
WG2	Recently felled/coppiced woodland clearing	0.25	Major removal of tree canopy by tree felling can potentially remove a whole colony's summer forage area. Even selected felling seems likely to swing the balance in favour of other gleaning species such as brown long-eared bats. (Greenway & Hill, 2004)
WG3	Woodland ride	1	
WG4	Recently planted trees	0.1	
WGZ	Other woodland clearings/openings	0.5	
Grassland Habitat Codes			Pasture was the third most used habitat at Bracket's Coppice (Schofield & Morris, 2000)
GA0	Acid grassland	1	
GA1	Lowland dry acid grassland	1	
GC0	Calcareous grassland	1	
GC1	Lowland calcareous grassland	1	
GC11	Semi-natural dry grasslands and scrubland facies on calcareous substrates [Festuco-Brometalia]	1	
GC12	Semi-natural dry grasslands and scrubland facies on calcareous substrates [Festuco-Brometalia] [important orchid sites]	1	
GN0	Neutral grassland	1	
GN1	Lowland meadows	1	
GN11	Lowland hay meadows [Alopecurus pratensis, Sanguisorba officinalis]	1	
GI0	Improved grassland	1	
GP0	Grassland, probably improved	1	
GU0	Grassland, semi improved	1	
Grassland Matrix Codes			Pasture was the third most used habitat at Bracket's Coppice (Schofield & Morris, 2000)
SC1	Dense/continuous scrub	1	
SC11	Dense/continuous scrub: native shrubs	1	
SC12	Dense/continuous scrub: introduced shrubs	1	
SC2	Open/scattered scrub	1	

Code	Label	HSI	References
SC21	Open/scattered scrub: native shrubs	1	
SC22	Open/scattered scrub: introduced shrubs	1	
TS0	Scattered trees	0	
TS1	Scattered trees some veteran	0	
TS11	Broadleaved	0	
TS12	Mixed	0	
TS13	Coniferous	0	
TS2	Scattered trees none veteran	0	
TS21	Broadleaved	0	
TS22	Mixed	0	
TS23	Coniferous	0	
PA0	Patchy bracken	0	
PA1	Patchy bracken communities with a diverse vernal flora (NVC U20a)	0	
PA2	Small continuous bracken stands	0	
PA3	Scattered bracken	0	
OT0	Tall herb and fern (excluding bracken)	0	
OT3	Tall ruderal	1	
OT4	Non-ruderal	0	
OT41	Lemon-scented fern and Hard-fern vegetation (NVC U19)	0	
OT4Z	Other non-ruderal tall herb and fern	0	
OTZ	Other tall herb and fern	0	
HS0	Ephemeral/short perennial herb	0	
BG1	Bare ground	0	
Grassland Management Codes			
GM0	Undetermined grassland etc. management	1	
GM1	Grazed	1	
GM11	Cattle grazed	1	
GM12	Sheep grazed	0.75	
GM13	Horse grazed	0.9	
GM14	Mixed grazing	0.8	
GM1Z	Other grazing	0.8	
GM2	Mown	0	
GM21	Silage	0	
GM22	Hay	0	
GM23	Frequent mowing	0	
GM2Z	Other mowing regime	0	
GM3	Hay and aftermath grazing	1	
GM4	Unmanaged	1	
GM5	Burning/swaling	0	
GMZ	Other grassland etc. management	0	
GL1	Amenity grassland	0	
GL11	Golf course	0	
GL12	Urban parks, playing and sports fields	0	
GL1Z	Other amenity grassland	0	
GL2	Non-amenity grassland	1	
GL21	Permanent agricultural grassland	1	
GL211	Arable reversion grassland	1	
GL2111	Species-rich conservation grassland	1	
GL211Z	Other arable reversion grassland	1	
GL21Z	Other permanant agricultural grassland	1	
GL2Z	Other grassland use	1	

Code	Label	HSI	References
CL3	Unintensively managed orchards	1	Male Bechstein's recorded roosting in orchard near Cheddar Reservoir
CL31	Traditional orchards	2	
CL32	Defunct orchards	2	
CL3Z	Other unintensively managed orchards	2	
CF1	Coastal and floodplain grazing marsh	1	
Bracken Habitat Codes			
BR0	Bracken	NP	
Heathland Habitat Codes			
HE0	Dwarf shrub heath	0	
HE1	European dry heaths	0	
HE2	Wet heaths	0	
HE2Z	Other wet heaths	0	
Bog Habitat Codes			
EO0	Bog	0	
Wetland Habitat Codes			
EM0	Fen, marsh and swamp	0	
EM1	Swamp	0	
EM11	Reedbeds	0	
EM2	Marginal and inundation vegetation	0	
EM21	Marginal vegetation	0	
EM22	Inundation vegetation	0	
EM3	Fens	0	
EM31	Fens [and flushes - lowland]	0	
EM312	Springs	0	
EM313	Alkaline fens [lowland]	0	
EM4	Purple moor grass and rush pastures [Molinia-Juncus]	0	
Standing water and Canal Habitat Codes			
AS0	Standing open water and canals	2	
AS1	Dystrophic standing water	2	
AS11	Natural dystrophic lakes and ponds	2	
AS1Z	Other dystrophic standing water	2	
AS2	Oligotrophic standing waters	2	
AS21	Oligotrophic lakes	0	
AS2Z	Other oligotrophic standing waters	2	
AS3	Mesotrophic standing waters	2	
AS31	Mesotrophic lakes	0	
AS3Z	Other mesotrophic standing waters	2	
AS4	Eutrophic standing waters	2	
AS5	Marl standing water	1	
AS6	Brackish standing water with no sea connection	0	
AS7	Aquifer fed naturally fluctuating water bodies	1	
ASZ	Other standing open water and canals	2	
Standing Water and Canals Formation Codes			
AC0	Channel of unknown origin	1	Small watercourses were the second most used habitat at Bracket's Coppice, and within woodland (Schofield & Morris, 2000). Note: streams identified by proximity % rather than IHS code - those outside woodland should score 0
AC1	Artificial channels	0.5	
AC11	Drains, rhynes and ditches	1	
AC111	Species-rich drains, rhynes and ditches	1.2	
AC11Z	Other drains, rhynes and ditches	1	
AC12	Artificially modified channels	0	
AC13	New artificial channels	0	
AC14	Canals	1	

Code	Label	HSI	References
AC1Z	Other artificial channels	1	
AC2	Natural/naturalistic channels	1	
AO0	Open water of unknown origin	1	
AO1	Artificial open water	0	
AO11	Reservoir	0	
AO12	Gravel pits, quarry pools, mine pools and marl pits	0	
AO13	Industrial lagoon	0	
AO14	Scrape	0	
AO15	Moat	0	
AO16	Ornamental	0	
AO1Z	Other artificial open water	0	
AO2	Natural open water	0	
AP1	Pond	1	
AP11	Ponds of high ecological quality	1	
AP1Z	Other pond	1	
AP2	Small lake	0	Never visited small lake at Bracket's Coppice (Scofield & Morris, 2000)
AP3	Large lake	0	
Standing Water and Canal Management Codes			
LT1	Canal-side	1	
LT11	Canal-side with woodland	1	
LT12	Canal-side with scrub or hedgerow and standard trees	1	
LT13	Canal-side with scrub or hedgerow	1	
LT14	Canal-side with layered vegetation	0.5	
LT15	Canal-side with grassland	0	
LT16	Canal-side with damaged banks	0	
LT17	Canal-side with constructed banks	0	
LT18	Other canal-side type	0.2	
Running Water Habitat Codes			
AR0	Rivers and streams	6	
AR1	Headwaters	6	
AR11	Chalk headwaters	6	
AR112	Other tufa streams	6	
AR12	Active shingle rivers [headwaters]	6	
AR1Z	Other headwaters	6	
AR2	Chalk rivers (not including chalk headwaters)	4	
AR21	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (chalk substrate)	4	
AR2Z	Other chalk rivers	4	
AR3	Active shingle rivers [non headwaters]	4	
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	
LT23	River-side with scrub or hedgerow	1	
LT24	River-side with layered vegetation	0.5	
LT25	River-side with grassland	0	
LT26	River-sdie with vertical banks	0.2	
LT27	River-side with damaged banks	0	
LT28	River-side with constructed banks	0	

Code	Label	HSI	References
LT29	Other river-side type	0.2	
Arable Habitat Codes			
CR0	Arable and horticulture	0	
CR1	Grass and grass-clover leys	0	
CR2	Cereal crops	0	
CR3	Non-cereal crops including woody crops	0	
CR31	Intensively managed orchards	0	
CR32	Withy beds	0	
CR33	Vineyards	0	
CR34	Game crops	0	
CR35	Miscanthus	0	
CR3Z	Other non-cereal crops including woody crops	0	
CR4	Freshly ploughed	0	
CR5	Whole field fallow	0	
CR6	Arable headland or uncultivated strip	0	
CR61	Arable field margins	0	
CR6Z	Other arable headland or uncultivated strip	0	
CR7	Freshly harvested/stubble	0	
CRZ	Other arable and horticulture	0	
Arable Management Codes			
CL1	Agriculture	0	
CL11	Organic agriculture	0	
CL12	Non-organic agriculture	0	
CL2	Market garden and horticulture	0	
CL21	Organic market garden and horticulture	0	
CL22	Non-organic market garden and horticulture	0	
CL4	Intensively managed vineyards	0	
CL4Z	Non-intensively managed vineyards	0	
CL5	Cereal crops managed for wildlife	0	
CL5Z	Cereal crops not managed for wildlife	0	
Inland Rock Habitat Codes			
RE0	Inland rock	0	
RE1	Natural rock exposure features	0	
RE11	Natural rock and scree habitats	0	
RE112	Lowland natural rock and scree habitats	0	
RE14	Caves	1	In winter a small number of males will go underground to hibernate (Greenway & Hill, 2004)
RE141	Caves not open to the public	1	
RE14Z	Other caves	1	
RE15	Exposed river gravels and shingles	0	
RE1Z	Other natural rock exposure feature	0	
RE2	Artificial rock exposures and waste	0	
RE21	Quarry	0	
RE22	Spoil heap	0	
RE23	Mine	1	
RE24	Refuse tip	0	
Linear Habitat Codes			If woodlands of lesser roosting quality roosts are fewer colony may need to roost outside foraging territory. One colony in a hedgerow tree 3.5 kilometres from main planation forage area. Roosting in hedgerow trees not uncommon for colonies foraging in plantations as may be the only available trees with woodpecker cavities. (Greenaway & Hill, 2004)
LF0	Boundary and linear features	6	
LF1	Hedges / Line of trees	6	
LF11	Hedgerows	6	
LF111	Important hedgerows	6	
LF11Z	Non-important hedgerows	6	

Code	Label	HSI	References
LF12	Line of trees	6	Good woodland or hedgerow connections to more distant woods will aid dispersal of males (Greenway & Hill, 2004)
LF1Z	Other hedges/line of trees	6	
LF2	Other boundaries and linear features	4	
LF21	Line of trees (not originally intended to be stock proof)	4	
LF22	Bank	0	
LF23	Wall	0	
LF24	Dry ditch	0	
LF25	Grass strip	0	
LF26	Fence	0	
LF27	Transport corridors	1	
LF271	Transport corridor without associated verges	0	
LF272	Transport corridor associated verges only	0	
LF273	Transport corridor with natural land surface	1	
Linear Habitat Management Codes			
LH3	Recently planted hedge (only use for existing habitat)	0.1	Cut hedge is specified where height is below 2 metres
LM1	Cut hedge	0.3	
LM11	Cut hedge with standards	0.3	Uncut hedge is specified where the hedge is between 2 and 3 metres high
LM12	Cut hedge without standards	0.2	
LM2	Uncut hedge	0.9	
LM21	Uncut hedge with standards	0.9	Overgrown hedge is considered to be over 3 metres high
LM22	Uncut hedge without standards	0.8	
LM3	Overgrown hedge	1	
LM31	Overgrown hedge with standards	1	
LM32	Overgrown hedge without standards	1	
LT3	Rail-side	0.2	
LT4	Road-side	0.1	
LT5	Path- and track-side	1	
LTZ	Other transport corridor verges, embankments and cuttings	0.5	
UL1	Railway	0	
UL2	Roadway	0	
UL3	Path and trackway	1	
ULZ	Other transport corridor	0.5	
Built Up Area and Gardens Habitat Codes			
UR0	Built-up areas and gardens	0	
Built UP Areas and Gardens Management Codes			
UA1	Agricultural	0	
UA2	Industrial/commercial	0	
UA3	Domestic	0	
UA31	Housing/domestic outbuildings	0	
UA32	Gardens	0	
UA33	Allotments	0	
UA34	Caravan park	0	
UA3Z	Other domestic	0	
UA4	Public amenity	0	
UA41	Churchyards and cemeteries	0	
UA4Z	Other public amenity	0	
UA5	Historical built environment	0	
UAZ	Other extended built environment	0	

Appendix 4: Risk Factors for Restoring or Recreating Different Habitats

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

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

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

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

Appendix 6: Example of HEP Calculation

The following table gives an example 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	Notes
		Code	Score	Code	Score	Code	Score	Code	Score					
F1	Miscanthus	CR35	0		0		1.00	CL12	1.00	0	2	4.975	0.00	
P2	Pond	AS0	3		0	AP1	1.00		1.00	3.00	2	0.053	0.32	
F3	Maize (Cereal crops, non-organic)	CR2	1		0		1.00	CL12	0.75	0.75	2	0.034	0.05	
F4	Mixed woodland, Mixed plantation and semi natural, high forest	WB1	4		0	WF3	0.75	WM1	1.00	3.00	2	0.362	2.17	
F5	Improved grassland, Frequent mowing (Other amenity)	GI0	2		0		1.00	GM23	0.00	0.00	2	0.344	0.00	
F6	Mixed woodland, Mixed plantation and semi natural, high forest	WB1	4		0	WF3	0.75	WM1	1.00	3.00	2	0.362	2.17	
F7	Built-up Areas and Gardens, gardens	UR0	1		0		1.00	UA32	0.00	0.00	2	0.2	0.00	
F8	Arable (wheat & barley)	CR2	1		0		1.00	CL12	0.75	0.75	2	0.086	0.13	
F9	Arable (type not stated)	CR0	1		0		1.00	CL12	0.75	0.75	2	0.154	0.23	
F10	Improved grassland; Hay Aftermath Grazing	GI0	2		0		1.00	GM3	0.20	0.40	2	3.484	2.79	
F11	Improved grassland, Silage	GI0	2		0		1.00	GM21	0.20	0.40	2	0.833	0.67	
F12	Built-up Areas and Gardens, scattered trees	UR0	1	TS0	1		1.00	UA32	0.00	0.00	1	2.844	0.00	
F13	Mixed Woodland Plantation	WB1	4		0	WF3	0.75		1.00	3.00	1	1.214	3.64	
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	5		0		1.00	LM32	1.00	5.00	2	0.149	1.49	
H2	Hedgerow, cut without standards	LF11	5		0		1.00	LM12	0.20	1.00	2	0.58	1.16	
H3	Line of trees	LF21	5		0		1.00		1.00	5.00	2	0.203	2.03	
H4	Hedgerow, uncut without standards	LF11	5		0		1.00	LM22	0.80	4.00	2	0.04	0.32	
H5	Hedgerow, uncut with	LF11	5		0		1.00	LM21	0.90	4.50	2	0.02	0.18	

Field No	Habitat	Primary Habitat		Matrix		Formation		Management / Land use		HSI Score	Density Band Score	Hectares	Habitat Units	Notes
		Code	Score	Code	Score	Code	Score	Code	Score					
	standards													
H6	Hedgerow, cut without standards	LF11	5		0		1.00	LM12	0.20	1.00	2	0.07	0.14	
H7	Hedgerow, uncut without standards	LF11	5		0		1.00	LM22	0.80	4.00	1	0.02	0.08	
H8	Hedgerow, cut without standards	LF11	5		0		1.00	LM12	0.20	1.00	1	0.01	0.01	
												16.679	18.22	

(Habitat required, e.g. Long sward species rich grassland)	Delivery Risk	1.5	
(Habitat required, e.g. Long sward species rich grassland)	Temporal Risk	1.2	
	Habitat Units	32.80	
	Hectares Required	1.82	