Natural England Research Report NERR024

Managing for species: Integrating the needs of England's priority species into habitat management. Part 1 Report

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Summary

1) New approaches to BAP delivery across the UK are placing greater emphasis on achieving our biodiversity targets through habitat-based delivery.
2) A new approach to species biodiversity is required for two reasons. Firstly, although successful at recovering the rarest species, the UK Biodiversity Action Plan has been less successful at achieving the recovery of habitats and widespread, but nonetheless threatened BAP species. Secondly, the large increase in the numbers of BAP habitats and species requiring action means a broader, habitat-based approach is necessary to allow effective action under current resource constraints.
3) The objective of this study was to compile lists of UK BAP species relevant to each priority habitat; collate and analyse the habitat niche and resource requirements for each species; and to produce guidance for each of the new Biodiversity Integration Groups (BIGs) on how species requirements can best be integrated into habitat plan targets.
4) Our findings suggest that for BAP species conservation to be properly integrated into habitat-based approaches we need to place much greater emphasis on creating the component niches and resources required by these species, rather than managing habitats in a generic way.

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1 Introduction

Background

1.1 Conservation effort for much of the 20th Century was primarily concerned with protecting and managing wildlife under legislation which allowed the designation of special sites and the protection of certain species (for example, Wildlife & Countryside Act, 1981). In 1994 the UK Biodiversity Action Plan (BAP) brought an additional focus on restoration through the development of action plans which aimed to secure the recovery of the UK's most threatened habitats and species.

1.2 Climate change presents us with new and urgent challenges that require us to review and change our approach to biodiversity conservation. We need to go beyond protected sites and separate species and habitat action plans. Halting (and ultimately reversing) biodiversity loss requires us to adopt integrated landscape-scale approaches that restore whole ecosystems.

1.3 We are now seeing a shift to a more integrated approach with the aim of recovering both habitats and species as well as the 'ecosystem services' (the value of natural systems in reducing environmental impacts such as flooding and carbon emissions) that they underpin (Natural England 2008a). There are two main reasons for this change of approach. Firstly, although successful at recovering the rarest species, the UK Biodiversity Action Plan has been less successful at achieving the recovery of threatened habitats and widespread species (Defra 2006). Shifting the emphasis to habitat-based work will, hopefully, help achieve these habitat-based targets as well as benefitting those species less suited to very narrowly focused recovery work. Secondly, the recent review in 2007 of the UK BAP priority list has generated a large increase in the number of habitats and species requiring action, with the new list containing 65 habitats and 1150 species. A broader, habitat-based approach is thus necessary to allow effective action planning and reporting without significantly adding to BAP bureaucracy which would place a greater burden on limited resources.

A new framework for the delivery of priority habitats and species in England

1.4 The approach to conserving biodiversity in England, as set out in the England Biodiversity Strategy (Defra 2002), comprises a combination of protecting the best wildlife sites; promoting the recovery of priority species and habitats; embedding biodiversity in relevant sectors of policy and decision-making; enthusing people; and developing the evidence base.

1.5 In 2008, the England Biodiversity Group published a new framework "Securing biodiversity" (Natural England 2008a) to drive the work on priority species and habitats in England. The framework aims to build on the strengths of the UK Biodiversity Action Plan (BAP), promote landscape-scale delivery and better embed an ecosystem approach and climate change adaptation principles in conservation action.

1.6 Nine Biodiversity Integrated Groups (BIGs) have been established to bring together habitat and associated species interests at an England level (see Appendix 1). The aim of these groups is to help set the standards for habitat-based working and identify and work closely with regional/local partnerships to carry out landscape-scale delivery projects across England.

1.7 This report presents the first step in this integration process: the identification of species' requirements which should be delivered by habitat based project and habitat/site managers.

The project aims and objectives

1.8 The overall aims of this project were to:

- Compile information on the requirements of UK BAP priority species to determine important habitat features.
- Produce guidance for each of the new Biodiversity Integration Groups (BIGs) on species whose recovery is at least partly dependent upon the delivery of the habitat targets owned by one or more BIGs.
- Make broad recommendations for how the requirements of priority species identified above can best be integrated into work delivering priority habitat targets.

1.9 The project had the following objectives:

- The compilation of a list of those priority species relevant to each BIG.
- An analysis of the known habitat features required by each species.
- An assessment of any regional variation required in habitat-based approaches due to species differences between regions.
- To identify the habitat requirements of all UK BAP species relevant to priority habitats.

2 Methodology

Defining the species and habitats to be covered

2.1 The species and habitat selected for the habitat requirements analysis were those on the list of species and habitats of principal importance in England, published under section 41 of the Natural Environment and Rural Communities (NERC) Act 2006; in essence these are the English species and habitats on the UK BAP. The list of priority habitats relevant to each BIG is shown in Appendix 1. Lists of UK BAP species associated with each priority habitat are provided in part 2 of this report.

2.2 All UK BAP species associated with priority habitats in England (including several considered to be extinct) were included in the analyses with the exception of 68 common and widespread but rapidly declining moth species which are included on the section 41 list because their decline requires further research. These are listed in part 2 of the report.

2.3 There has been no analysis of the niche requirements for the majority of marine species. This is partly due to the lack of information on the distribution and habitat requirements of marine species and also because the approach to marine conservation and BAP already adopts a species-habitat integrated approach.

Defining the evidence base

2.4 The list was split into broad taxonomic groupings consisting of mammals, birds, invertebrates, reptiles and amphibians, vascular plants, lower plants and fungi, and each one was analysed separately within spreadsheets in Microsoft Excel. Initially, a data trawl was undertaken to determine the species niche and resource requirements by referring to published atlases, primary data used in the latest UK BAP review, and a series of reference texts (see References).

2.5 This was followed by consultations, with experts in Natural England, specialist NGOs (Non-government organisations, for example, wildlife trusts, RSPB, BugLife) and other expert organisations. From this review and consultation the following types of data were derived:

1) A list of species associated with one or more BIG

The majority of UK BAP species in England were associated with the priority habitats or groupings of priority habitats (for example, grassland, woodland) led by one or more of the BIGs (see part 2 of this report). A small number of BAP species could not be associated with any priority habitats. These are listed in part 2 of the report. For many species the association with a priority habitat type, or even a BIG, was not a simple one, *for example, Does the presence of common toad in a few upland pools mean that it is associated with the uplands? Bats utilise wetlands for feeding but may not be inherently reliant on these habitats - should they be included?* As a general rule, species having only a transient and/or occasional association with a habitat were not included. For most species, the final decision for inclusion or omission was made in accordance with the views of relevant experts.

2) A pen-picture of habitat requirements

A pen-picture of the requirements for each species was derived. The available data to do this varied considerably between species:

- Where there was plenty of autecological information the drafting of the pen-picture was relatively simple (for example, many vertebrate species).

- Where data were lacking the pen picture was greatly informed by expert opinion.
- Despite the apparent lack of data there were only a few species for which requirements could not be concluded.

It was also often possible to infer further habitat requirements from data; as an example, many wetland species require bare mud, which, in terrestrial locations, is almost exclusively associated with drawdown zones due to seasonal inundation. This contributes to an understanding of how underlying hydrological regimes are important for many wetland species.

Note that for invertebrates it became apparent that many species required some form of shelter in the form of bays within scrub or trees. This was captured separately from an actual requirement for the physical structure of scrub as a place for roosting, feeding or nesting.

3) Distribution

The known distribution for each species was captured from published data (for example, atlases or using data from the National Biodiversity Network (NBN)). The terms for the distribution are defined as:

- Recorded from 1-5 sites - **very restricted**.
- Recorded from up to 15 10km squares and over 1-5 sites - **restricted**.
- Recorded from 16-100 10km squares - **localised**.
- Recorded from over 100 10km squares - **widespread**.

Where there were no published reviews available for taxonomic groups (for example, fungi), distributional data (for example, from national recording schemes and relevant experts) were consulted in order to classify species into one of the categories listed above.

These terms broadly equate to the British Red Data Book and Notable categories (Shirt 1987) with the exception of the '*very restricted*' term - which differentiates between number of sites and 10km squares. This was employed to determine those rare species for which conservation measures should be site-based and very specific.

Thus:

- **Restricted** refers to RDB categories 1,2 and 3.
- **Localised** refers to Nationally Notable / Nationally Scarce.
- **Widespread** refers to a species not in any of the above categories and which is not extinct.

It was difficult to employ the current IUCN guidelines (Gardenfors 1999, IUCN Species Survival Commission, 1994) as these are based on threat status (measured by loss) rather than overall distribution/rarity.

4) Geographical area

For each species the geographical range is shown. A particular emphasis was placed on presence within named Government regions in England. Species were divided into the following categories:

- **Throughout**, for common species found throughout all, or nearly all, of England. They are often present within the general countryside rather than restricted to semi-natural sites. This includes species such as the skylark *Alauda arvensis*, which is relatively ubiquitous, and the water vole *Arvicola terrestris*, which is widespread throughout most of England.
- **Scattered**, for species often restricted to sites (be they protected sites, local wildlife sites or other semi-natural areas) and are thus not considered to be 'wider countryside' species. This includes species such as lesser butterfly orchid *Platanthera bifolia*, found throughout England,

often in sites widely distant from each other. This category is subject to a degree of subjectivity.

- The inclusion of **named regions** (for example, West Midlands) for species that occur predominantly within them. These could be very rare species, found only in that region, or a more widely distributed species restricted to or strongly associated with more than one region for example, the Hornet Robberfly *Asilus crabroniformis*, is listed as occurring in the South West and South East.

Species' habitat requirements analysis

2.6 For each Biodiversity Integration Group (BIG), the associated UK BAP species were analysed further in Excel spreadsheets (a copy of each of these is available from Natural England's website: URL: **www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsppintegration.aspx**)

2.7 To achieve an overall answer as to what 'BAP species-friendly' habitats may look like, it was necessary to devise some method of pooling species requirements to produce a combined result. The approach of this analysis was to identify and create fields for particular requirements taken from the species' pen-pictures. Wherever possible, these fields were defined by simple yes/no answers (for example, *does the species require high water quality? Does the species require veteran trees?*). Where this was not possible multiple-entry fields were used (for example, *what critical species does the organism require for food*?). It was not always possible to provide a pooled assessment for the multiple-entry fields.

2.8 Wherever possible an over-arching 'ecological process' was used as the basis for defining the component fields within the spreadsheets. As an example, many species benefit from seasonal inundation, which creates muddy beaches; seasonal inundation is an ecological process.

2.9 This methodology is based on designs originally trialled for devising the Invertebrate Species-habitat Information System: ISIS, (Webb & Lott 2006) in which invertebrate assemblages were, wherever possible, based on underlying ecological process.

2.10 The main fields varied depending on habitat. For example:

- The major fields for lakes and ponds were: high water quality; seasonal inundation ('temporary water'); whether an aquatic or terrestrial species; whether requiring open or shaded habitat; a requirement for calcareous water; substrate and trophic state.
- The major fields for lowland heathland were early successional habitat including bare ground and ruderal plants; scrub and trees; heath type; grassland; seasonal inundation; and shelter.
- Most species have multiple requirements which are relevant to several field headings, for example, the oxbow diving beetle *Hydroporus rufifrons*, requires high water quality, seasonal inundation and open, shade-free habitat.

3 Results

3.1 The results of the analyses have been presented separately for each of the eight broad terrestrial and coastal habitat categories covered by the separate Biodiversity Integration Groups (BIGs): coastal; lowland farmland; upland; lakes and ponds; rivers; wetlands; urban and brownfield; and woodland. The results for each BIG category contains the following information:

- The total number of species associated with the BIG (see Table 1) and their relevant priority habitats (see Table 2), including a summary of numbers in each taxonomic group and range restriction class.
- A summarised overview of the habitat requirements for all the relevant species associated with the BIG habitats followed by separate sections covering each priority habitat (or groups of priority habitats, for example, grasslands, woodlands).
- An indication of regional distribution (assessed by pooling results from the geographical range information) of species for each priority habitat, and the relative importance of each region in terms of total number of BAP species supported. This information relates only to the more restricted species rather than those widespread or scattered throughout England.
- An analysis of habitat requirements for the species in each priority habitat, including any significant differences between broad taxonomic groups and species in different restriction classes.
- A summary, indicating what a priority habitat would consist of if it were managed to meet the needs of as many of its associated UK BAP species as possible.

Table 1 Total number of species associated with the BIGs and their relevant priority habitats

BIG Habitat Category	Number of Priority Habitats	Number of Associated UK BAP Species
Lowland farmland	9	358
Upland	9	98
Lakes and ponds	5	97
Rivers	2	76
Wetlands	4	119
Coastal	6	166
Marine	16	82
Urban and brownfield	1	108
Woodland	6	256

3.2 The data underlying this analysis is presented for the species within each priority habitat and under each BIG habitat category in Excel spreadsheets available on Natural England's website.

3.3 Table 2 lists the number of UK BAP species associated with different priority habitat types. Lowland heathland, woodlands and lowland grasslands (in particular lowland calcareous grassland) are particularly important for the conservation of priority BAP species. These habitats are extensive and the associated species can be categorised further according to specific habitat sub-types (and also geographical variation). For example, lowland heathland landscape may include ponds, valley mires and scrub, and each of these features have species specific to them. Conversely, habitats with fewer associated priority species tend to be less widespread and represent a more specific habitat type.

Table 2 Total number of species associated with priority habitat types

BIG Habitat Category	Priority Habitats	Number of Associated UK BAP Species
Lowland farmland	Grasslands – all lowland types (grouped)	206
	Lowland calcareous grassland	58
	Lowland heathland	133
	Hedgerows	83
	Arable field margins	65
	Traditional orchards	46
Upland	Upland heathland	35
	Montane heaths and willow scrub	6
	Blanket bog	10
	Upland flushes, fens and swamps	23
	Inland rock outcrops and scree	32
	Limestone pavement	7
	Upland calcareous grassland	27
	Upland hay meadows	14
Lakes and ponds	Lakes – all types (grouped)	40
	Ponds	77
Rivers	Rivers – all types (grouped)	76
	Chalk rivers	14
	Active shingle rivers	20
Wetlands	Lowland fens	75
	Reedbeds	22
	Lowland raised bog	23
	Coastal and floodplain grazing marsh	47
Coastal	Saline lagoons	12
	Coastal vegetated shingle	15
	Coastal sand dunes	72
	Maritime cliff and slopes	61
	Intertidal mudflats and Coastal saltmarsh	30

Table continued...

BIG Habitat Category	Priority Habitats	Number of Associated UK BAP Species
Brownfield and urban	Brownfield	108
Woodland	Woodland – all types (grouped)	169
	Wet woodland	36
	Lowland beech and yew woodland	55
	Wood-pasture and parkland (veteran trees)	105

3.4 The distribution of the taxonomic groups across the restriction classes follows a similar pattern across all semi-natural habitats: a large number of very restricted invertebrates and lower plants occurring alongside a smaller number of widespread vertebrates.

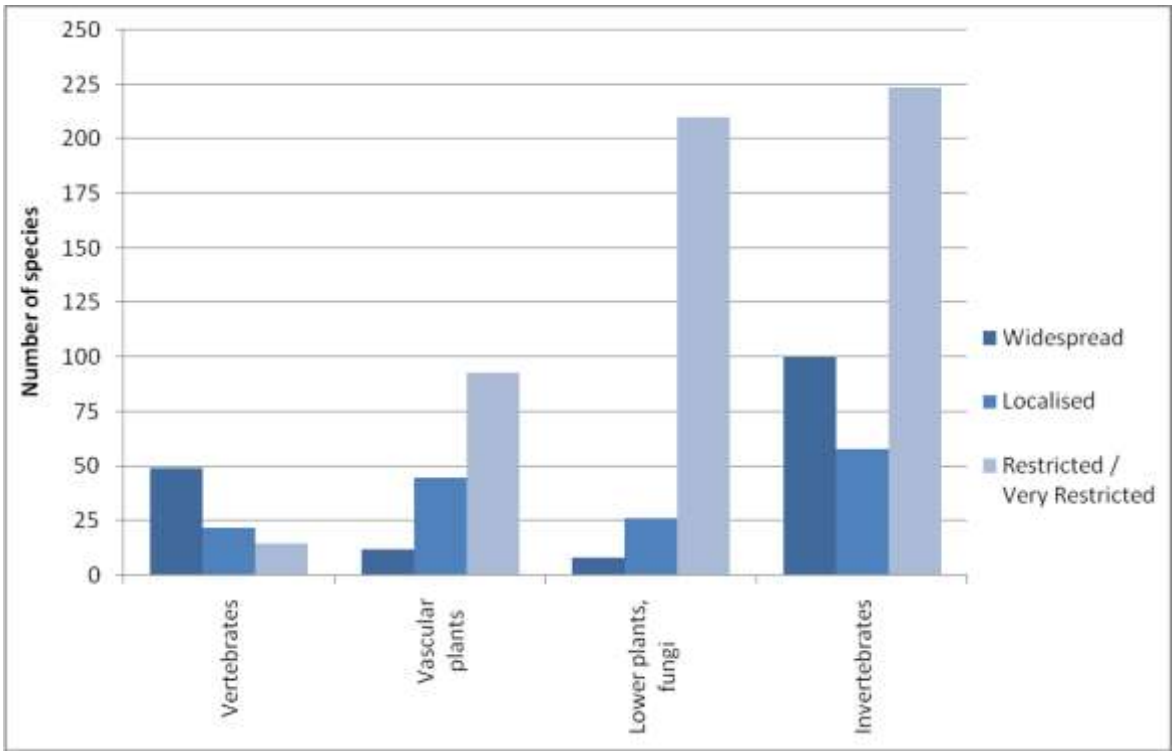

Figure 1 Relationship between taxonomic group and restriction class of UK BAP species

4 Discussion

4.1 In carrying out the analyses of species' requirements a number of key habitat attributes have been identified. In particular, a requirement common to most habitats is structural variation. This means different things for different habitats. For example, grassland species require areas of bare ground, variable sward heights and scrub matrices, whereas species in woodlands are associated with open glades, humid woodland interiors and veteran and mature trees.

4.2 Structural variation is provided by dynamic processes. For grassland and heathlands these processes are often associated with extensive management where occasional disturbance (for example, cattle grazing) and periods of stability generate an intimate mix of structures. There are no data to suggest how intimate the mix of structures needs to be, but as many of the species utilising these habitats are small (invertebrates and plants), they should tend to be relatively small-scale.

4.3 Taking woodland as an example, disturbances that operates over a short timescale promotes structural variation through clearings, glades and rides. On the other hand, a lack of disturbance over long timescales, promotes mature and veteran trees (although regular disturbance is associated with pollarding and grazing of some veteran trees).

4.4 Another requirement common to many plants and animals is for sheltered conditions, where habitats are exposed to sunlight but sheltered from the wind. This shelter is often provided in the form of scrub or topography. Many species are associated with soft rock cliffs because they provide shelter rather than any other specific habitat requirement.

4.5 For more generalist species, such as mammals and birds, large scale habitat mosaics are of importance. This relates to landscape scale diversity of habitats such as open grassland, scrub/hedgerows and wood edge, with each providing for a different ecological function such as foraging, nesting or roosting. Such large scale mosaics often incorporate several BAP priority habitats and, in some cases, also include non-priority habitats (for example farmland birds which depend on in-field arable habitats).

4.6 Species requirements in wetlands are strongly associated with two factors: water quality and hydrological process. High water quality is a requirement for the majority of UK BAP species associated with water and it is perhaps the single most important factor for wetland biodiversity. It is also the factor over which we have most control (as opposed to hydrological disturbance, which is often set by environmental processes outside our control - such as wave action on the coast).

4.7 Hydrological processes are an important determinant for species although there is no one particular process that is better than any another. Simply put, hydrological processes can occur along a disturbance gradient, from undisturbed sites where the water level is relatively high and stable (for example, bogs and fens) to sites that are inundated on a seasonal basis and gradually dry (floodplains and dune slacks) to sites that are inundated on a daily basis (saltmarsh and beaches) and are hence heavily disturbed.

4.8 The importance of hydrological disturbance is highlighted well by species associated with ponds. Although there are a number of generalist species that have no particular requirements (such as bats) a large proportion of specialist wetland species are associated with the drawdown zones around the edges of ponds - in particular bare, wet mud.

4.9 The same is also true of rivers, where flow rate is essential for the creation, composition and structure of exposed sediment in the form of sand bars and shingle banks - a critical habitat for many species. It must be pointed out that 'natural' hydrological disturbance is of a different nature to anthropomorphic disturbance. Flood events in rivers create and sort shingle banks in the winter

whereas grazing by farm animals disturbs and destroys shingle habitats in the critical spring and summer periods.

4.10 Exposure to sunlight is also an important factor for many species. This seems particularly true in the transition zone between terrestrial and aquatic habitats (such as along a river or the edge of a pond) and in wetlands (such as fens). Shade, created either by trees, scrub or by large blocks of vegetation (such as reeds) suppresses other plant growth and reduces water temperature. Although there are a number of species that thrive in such areas (for example, crane flies, *Tipulidae*) the majority of UK BAP species do not. Management that reduces tree and scrub cover (but does not eradicate it altogether) is a good starting point for managing for UK BAP priority species.

4.11 Major regional differences between species requirements could not be detected. Although there are some species that apparently require different habitats between regions (for example, the sandbowl snail *Quickella arenaria*, found in both dune slacks in Devon and in upland flushes in Pennines) these are so few that they have little effect on the overall results. It is apparent that the southern regions generally support the greatest numbers of UK BAP species and this can be largely attributed to climatic factors.

4.12 It should be relatively easy for regions to use the data within the Excel spreadsheets to formulate their own habitat requirements. This could be achieved by running analyses on a subset of species important for any given area. By doing this It may be possible to identify subtle regional differences that are difficult to isolate using the data nationally (for example, seasonal inundation of heathlands in the South West may be of particular importance).

Issues arising from the analyses

4.13 During consultation the majority of specialists confirmed that the summary results accurately reflected the accepted approach to the management of habitats. The strength of the analysis is that it backs up expert opinion with strong evidence rather than suggesting anything surprising. This, however, begs a further question: *if experts generally accept that species requirements are best served through structural diversity then why is the habitat management necessary for BAP species not put in practice more often?* The answer is complex and depends on a number of issues including:

- Perceived incompatibility / conflict between the needs of species groups.
- An overly prescriptive focus on a few specialist species whose requirements do not necessarily match those of other species.
- The focus of statutory site management on site ‘features’ (for example, focusing conservation effort on static biological targets for specific features rather than allowing for flux and change).
- Action may already have been taken, but issues of time-lag, fragmentation and/or isolation have prevented results being realised.
- On-site issues which do not readily allow for changes in management regimes, including lack of resources.
- The classification of many habitats by their vegetation types, which fails to take into account structure.

4.14 This work excludes non-UK BAP species. Some follow-up analysis of non-UK BAP invertebrates (Webb & Lott 2006) showed that the general principles of habitat structure and resources applied to all invertebrate species using those habitats tested. Although not conclusive, this work suggests that the habitat attributes important to BAP species are also important to many non-BAP species.

4.15 Habitat mosaics should be recognised as important in their own right both at small scales and landscape scales. This is an often difficult task when BAP habitat targets may push

restoration/creation towards tightly defined perceptions of ‘ideal’ habitats. Thus, for example, woody heathlands and heathy woodlands or scrubby grasslands should also be recognised and promoted.

4.16 Habitats should not be seen in isolation from one another. As an example, the association between rivers and various wetlands is very strong and what affects one will very often affect another. It is therefore critical that Biodiversity Integration Groups recognise this and take appropriate action (for example, attending each other’s meetings).

4.17 Although the analyses can be used to create ‘species-friendly habitats’ for regional and local delivery, care and thought should be taken before applying them. There are regional differences - for example, heathlands in the south west seemingly support more species associated with seasonal pools and heathland management proposals in this region should take this particular local feature into account on a site-by-site basis.

4.18 To conserve species, we need an emphasis on increasing appropriate habitat heterogeneity, between and within sites and over time. We suggest that this more dynamic approach to managing habitats has the potential to support the recovery of most species. This approach is also likely to facilitate adaption by species to climate changes, by increasing the opportunities for them to persist within their existing habitats and to colonise new sites.

5 Conclusions

5.1 The analyses for each Biodiversity Integration Groups habitat category shows, for the majority of the priority habitats, that the mosaics of structure with a variety of valuable resources (for example, shelter, nectar-rich flowers) will meet the needs of most UK BAP species. The particular resources differ with the habitat type, but the general tenet is that structural diversity at both a small and large scale is very important. Quality, in terms of unimproved or unpolluted habitats is also a common requirement (and these attributes also influence structure).

5.2 This analysis looks only at only the habitat-based requirements of species. Other more general factors have not been considered. For example, widespread impacts attributable to air pollution, introduced predators and introduced diseases have not been taken into account.

5.3 The general opinion of most habitats specialists is that acting on the summary management recommendations would be compatible with the conservation objectives for designated sites (Sites of Special Scientific Interest, Special Protection Areas and Special Areas of Conservation).

5.4 To properly take on board the recommendations given in many of the BIG reports would require a significant shift in the approach of both statutory and stakeholder organisations to assessing biodiversity. Rather than measuring species success by a prescriptive approach to numbers of particular individuals and species, this integrated approach requires a measurement of habitat success in terms of the overall diversity of BAP (and non-BAP) species it supports.

6 BIG habitat analyses

Lowland farmland habitat requirements

6.1 There are a total of 358 species associated with Lowland Farmland - more than any other BIG habitat category. This underlines the importance of lowland farmland habitats in delivering conservation gains for UK BAP species.

6.2 Species associated with each priority habitat have been identified and analysed for their habitat/niche requirements. For grasslands, a combined grassland analysis was undertaken, partly due to the expectation that individual grassland analyses would produce very similar results. The distribution of species across the different priority habitats is shown below.

6.3 A breakdown of species numbers across different taxonomic groups and restriction classes is given below. Vascular plants and invertebrates form the majority of UK BAP species associated with lowland farmland. A high proportion of species (mostly non-vascular and vascular plants and invertebrates) have a very restricted distribution.

Table 3 Distribution of species across the different priority habitats - Lowland Farmland

Priority habitat	No. of associated UK BAP species
Arable field margins	65
Hedgerows	83
Traditional orchards	46
Lowland heathland	133
Lowland dry acid grassland Lowland calcareous grassland Lowland meadows Purple moor-grass and rush pastures Calaminarian grasslands	All grasslands 206

Table 4 Species numbers across different taxonomic groups - Lowland Farmland

Taxonomic group	No. of species
Fungi	15
Lichens	29
Bryophytes	23
Vascular plants	82
Invertebrates	152
Amphibians/reptiles	9
Birds	36
Mammals	12

Table 5 Species numbers across different restriction classes - Lowland Farmland

Restriction class	No. of species
Widespread	78
Localised	84
Restricted	56
Very restricted	135
Extinct	5

Overall summary

6.4 Forty lowland farmland species depend on landscape-scale mosaics of different farmed habitats, including one or more priority habitats, and also often including more intensively farmed non-priority habitats (for example, intensive arable, improved grassland). They include widespread species such as the polecat *Mustela putorius*, brown hare *Lepus europaeus* and house sparrow *Passer domesticus*, as well as more localised species such as the greater horseshoe bat *Rhinolophus ferrumequinum*.

6.5 For those species associated with the two most important priority habitats, heathlands and grasslands, the critical factor is structural diversity brought about by dynamic process. In essence, management that disturbs and delays succession in such a way that a number of different states can be found at any one time is generally beneficial. Conversely, any management technique that promotes homogeneity is generally detrimental. Some important habitat attributes common to grassland and heathland species are:

- Structural diversity including small areas of bare ground in vegetation mosaics, scrub matrices including scrub-heath and wood-heath, and different sward heights and openness;
- Adjacent habitat such as woodland and wetlands which are important for wider ranging vertebrate species; and
- Patches of nectar-rich flowers and uncut tall vegetation to provide important feeding and overwintering areas for invertebrates.

6.6 Additionally, temporary pools are particularly important for many heathland species in that they prevent colonisation by predators and competitors.

6.7 For arable field margins and hedgerows, a major issue is the management and nature of the adjacent in-field habitats, particularly the overall amount of food (mostly seeds and invertebrates) that are available.

6.8 Orchards supports a small number of specialist species largely dependent upon open grown trees and woodland edge. A larger number of widespread vertebrates are associated that generally require large-scale mosaics, depending on orchards for roosting, breeding and feeding (for example, birds, mammals).

6.9 Hedgerows are important for a number of widespread bats and birds, requiring large scale mosaics of grassland, scrub and woodland for foraging, nesting and roosting, and more restricted lichens and invertebrates, again associated with open grown trees. For hedgerows, the combination of the woody structure of the hedge with the herbaceous vegetation of the hedge bank is critical for many species.

Arable field margins

6.10 Arable field margins are defined as herbaceous strips or blocks around arable fields (between the crop and the field boundary) that are managed specifically to provide benefits for wildlife. This includes the following types: Cultivated, low-input margins; Margins sown to provide seed for wild birds; Margins sown with wild flowers or agricultural legumes and managed to allow flowering to provide pollen and nectar resources for invertebrates; and Margins providing permanent, grass strips with mixtures of tussocky and fine-leaved grasses.

6.11 There is a total of 65 species associated with arable field margins, including a large proportion of widespread and localised species of birds, mammals and amphibians/reptiles. There are a large number of restricted or localised vascular plants; twelve invertebrates (for example large garden bumblebee *Bombus ruderatus*, Brighton wainscot moth *Oria musculosa* and set-aside downy-back beetle *Ophonus laticollis*) and three bryophytes (sausage beard-moss *Didymodon tomaculosus*, spreading-leaved beardless-moss *Weissia squarrosa* and Texas balloonwort *Sphaerocarpos texanus*) particularly associated with this habitat.

Table 6 Species numbers across different taxonomic groups - arable field margins

Taxonomic group	No. of species
Bryophytes	3
Vascular plants	28
Invertebrates	12
Birds	13
Amphibians/reptiles	5
Mammals	4

Table 7 Species numbers across different restriction classes - arable field margins

Restriction class	No. of species
Widespread	27
Localised	13
Restricted	7
Very restricted	14
Extinct?	4

6.12 Figure 2 shows the important regions identified for arable field margin species.

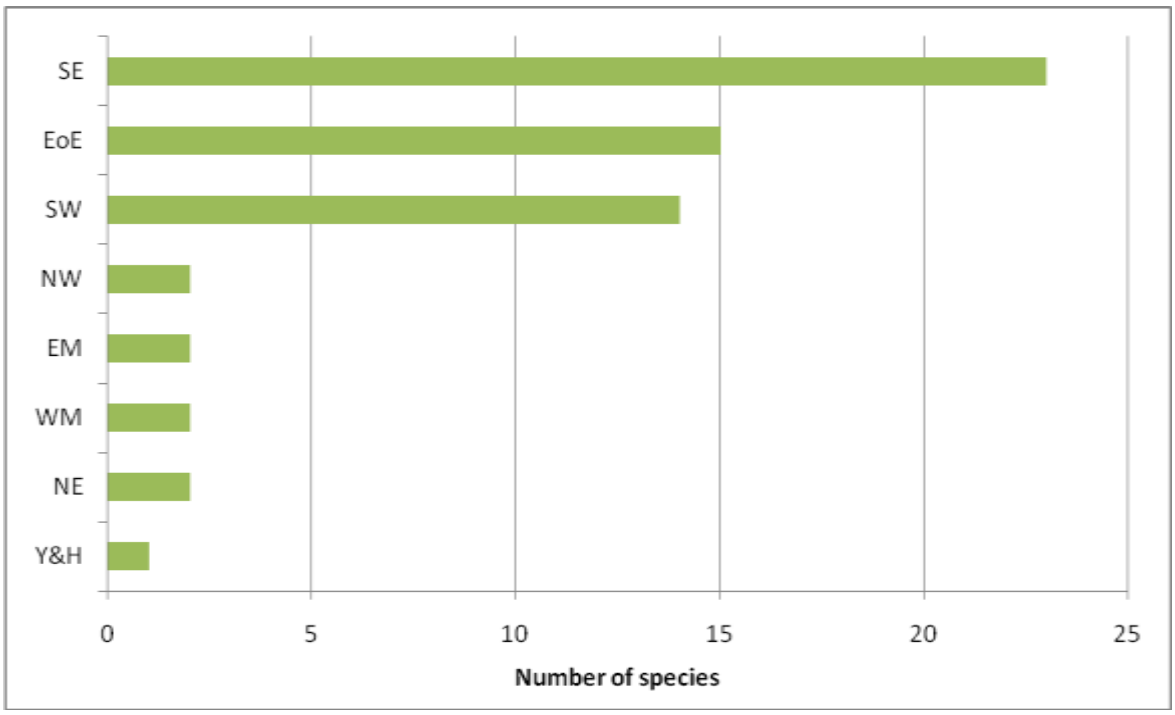

Figure 2 Regional distribution of UK BAP species associated with arable field margins

6.13 The highest number of species associated with arable field margins is found in the South East, the East of England and South West. Other regions have a limited number of species specifically associated with them. This may largely be a reflection of the predominance of arable habitats in the south-eastern England.

Habitat / niche requirements

6.14 Although some UK BAP species are associated with arable habitats generally, many are restricted to the margins. This may be because field margins are less disturbed by farm machinery, because edge habitats provide more shelter and because they are often adjacent to other habitats (for example, hedgerows, woodland, wetlands and grassland).

6.15 Figure 3 shows the main habitat requirement of arable margin species.

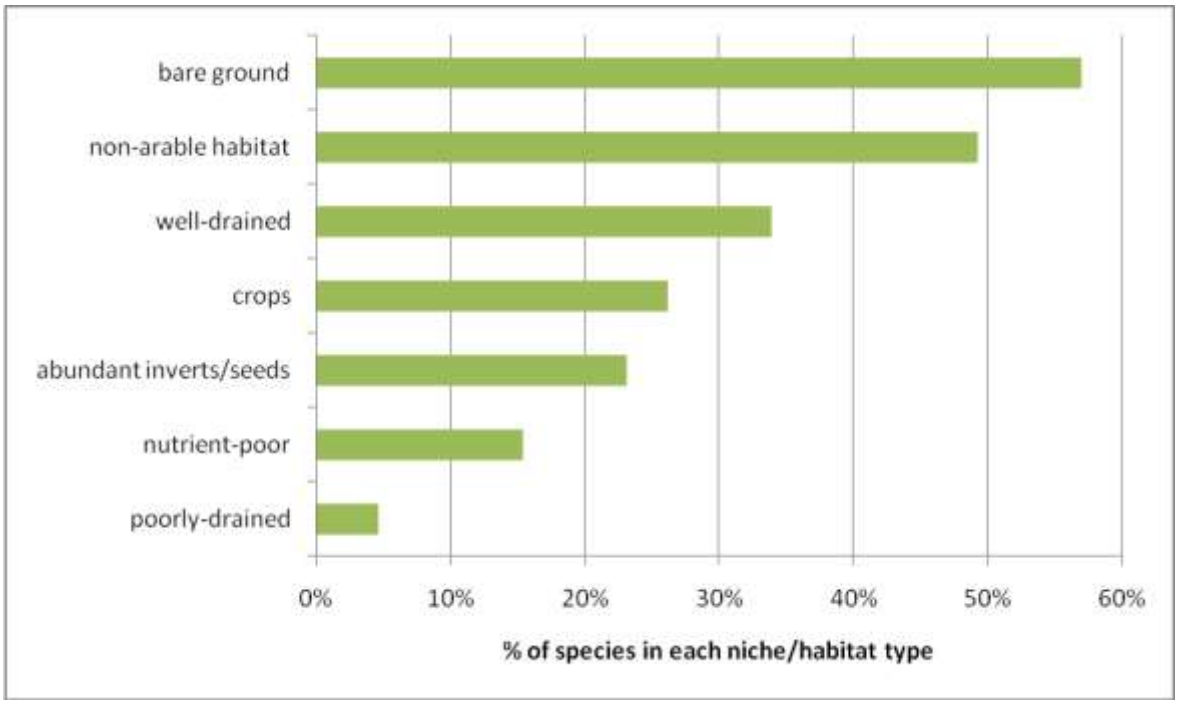

Figure 3 Habitat/niche requirements of UK BAP species associated with arable field margins

6.16 Figure 3 highlights the importance of **bare ground** for a large number of species (57%) which reflects the high abundance of this resource in cultivated arable fields. Vascular plants, such as pheasants eye *Adonis annua*, small-flowered catchfly *Silene gallica* and broad-leaved cudweed *Filago pyramidata*, show a strong preference for **well-drained nutrient poor conditions** (79% of plants are associated with well-drained sandy/calcareous soils). Other habitat associations include:

- Twenty-six percent of species utilise some element from the **field crop itself**, including nine species (birds such as the corn bunting *Milaria calandra* and lower plants such as the moss *Didymodon tomaculosus*) which require the presence of **winter stubbles**;
- Twenty-three percent of species are associated with an abundance of **seeds and/or invertebrate food** (nearly all birds, including the tree sparrow *Passer montanus* and cirl bunting *Emberiza cirlus*);
- Eight species of invertebrates are dependent on **flower-rich areas** (nectar/pollen) and **food plants** associated with arable margins (bumblebees and two moths grey carpet *Lithostege griseata* and Brighton wainscot *Oria musculosa*); and
- Five species show a preference for **poorly-drained/heavy-clay soils** or **seasonally inundated** (grass-poly *Lythrum hyssopifolia*, corn buttercup *Ranunculus arvensis* and the moss *Weissia squarrosa*).

6.17 Half of all species require the presence of other, **non-arable habitats** close by. These tend to be animals requiring separate habitats for different functions such as foraging and nesting/roosting and includes many of the more wide-ranging vertebrates (for example, yellowhammer *Emberiza citronella* (nesting in hedgerows/scrub) and harvest mouse *Micromys minutus* (requiring tall grass and brambles).

6.18 Of the 32 species requiring other habitats, around 80% require the presence of **scrub** (often in the form of hedgerows). **Tall herb vegetation**, often in mosaic with scrub, is needed by eleven species (for example, hedgehog *Erinaceus europaeus* and brown hare *Lepus europaeus*), perhaps because they are more permanent and less disturbed than the arable crop and provide important structural variation, for example for concealment.

Summary

6.19 In this highly modified and disturbed habitat, a large number of species are associated with bare ground and ruderal plants. Thus, regular cultivation without the use of herbicides and pesticides in field edges and corners is particularly important.

6.20 For species associated with this habitat the two critical objective are:

- To increase the availability of less intensively managed field margins for arable plants and for nesting, roosting and feeding animals.
- To reduce the intensity of farming methods overall in order to provide more food for foraging animals (i.e. invertebrates and seeds).

6.21 A large proportion of species associated with arable field margins are widespread and localised birds and mammals. Seemingly, a large number of the widespread vertebrates are just as dependant on the availability of seeds and invertebrates as they are on any specific niche type.

Traditional orchards

6.22 Traditional orchards are characterised by widely-spaced fruit trees planted on permanent grassland managed in a low-intensive way. They include a range of other habitats such as scrub, hedgerows, unimproved grasslands, ponds, streams and ditches.

6.23 Forty-six species are associated with traditional orchards. Only five species are largely restricted to orchards (for example noble chafer *Gnorimus nobilis*, apple lace-bug *Physatocheila smreczynski* and the orchard tooth fungus *Sarcodontia crocea*). The remaining are nearly all widespread and which generally require large-scale mosaics, depending on orchards for roosting, breeding and feeding (for example, birds, mammals and amphibians/reptiles).

Table 8 Species numbers across different taxonomic groups - orchards

Taxonomic group	No. of species
Fungi	1
Lichens	2
Bryophytes	1
Invertebrates	11
Amphibians/reptiles	5
Birds	17
Mammals	9

Table 9 Species numbers across different restriction classes - orchards

Restriction class	No. of species
Widespread	31
Localised	7
Restricted	3
Very restricted	5

6.24 Figure 4 shows that orchard species are more strongly associated with the South West than any other region. The South East and West Midlands also feature strongly, whereas the north contains far fewer species. The distribution largely reflects the distribution of orchards in England.

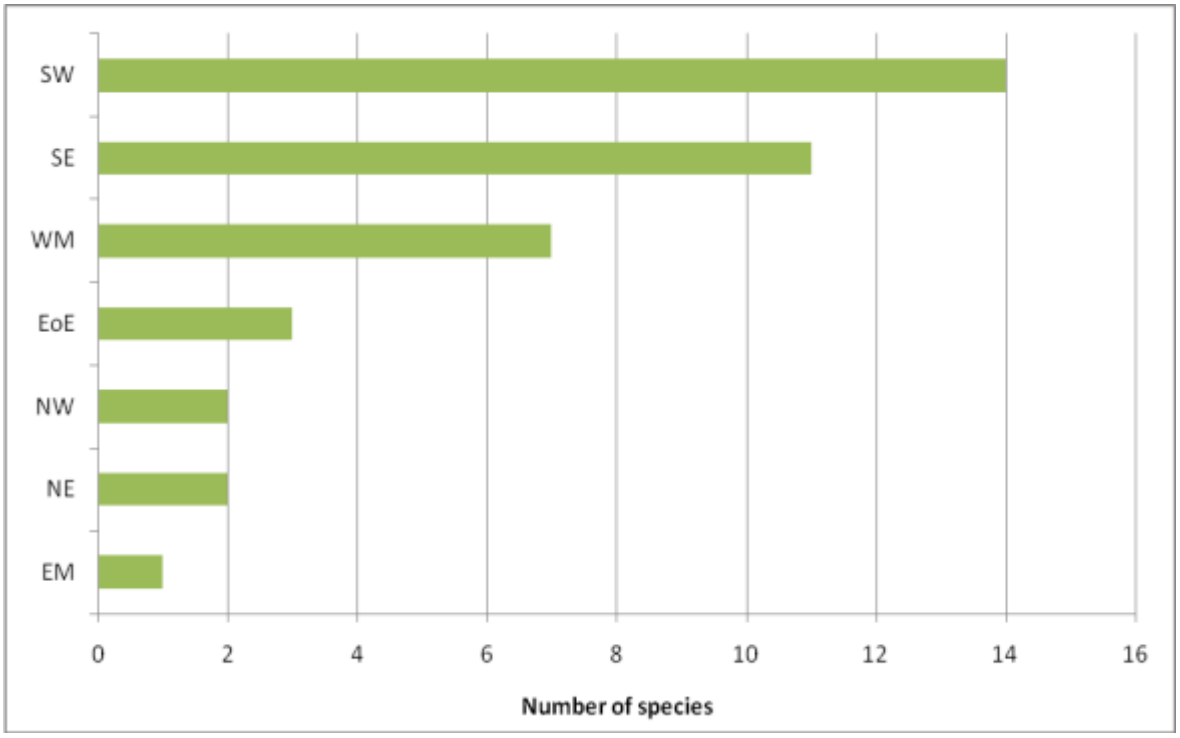

Figure 4 Regional distribution of UK BAP species associated with orchards

Habitat / niche requirements

6.25 Figure 5 shows the habitats and niches required by UK BAP species.

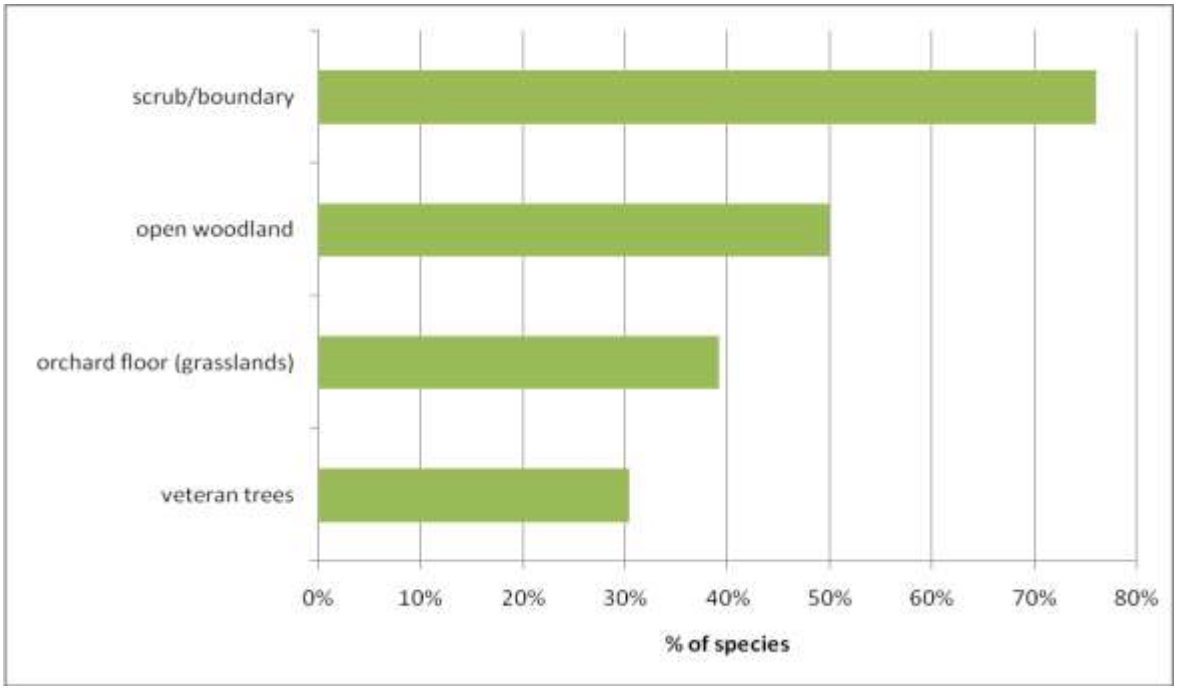

Figure 5 Habitat/niche requirements of UK BAP species associated with orchards

6.26 Not surprisingly, tree-associated species dominate the orchard priority habitat. Of the 44 orchard species:

- Thirty percent are associated with **veteran, open-grown trees**, living in fissures, on bark or in rot cavities (for example, the orchard tooth, the click-beetle *Ampedus rufipennis*, lesser spotted woodpecker *Dendrocopus minor* and Bechstein's Bat *Myotis bechsteinii*);
- Half of all species are associated with **open woodland**, that is, woodland with a **structurally diverse canopy** and including shelter bays and open grassy swards (for example, the lace bug *Physatocheila smreczynskii*, song thrush *Turdus philomelos* and brown long-eared bat *Plecotus auritus*);
- Boundary features such as **scrub and hedgerows** (76% of species) are mainly associated with animal species requiring food, nesting and roosting localities (for example, yellow hammer *Emberiza citronella*, noctule bat *Nyctalus noctula* and dormouse *Muscardinus avellanarius*); and
- Thirty-nine percent are associated with **orchard floor grasslands** used mainly for foraging (abundant invertebrates), (for example, birds and bats) and flower/food plant resources (for example, butterflies).

Summary

6.27 Traditional orchards provide habitat for a small group specialist invertebrates and a larger number of widespread vertebrates associated with open grown trees and woodland edge. Although orchards are often important for their grasslands there seems to be little direct association between this habitat and UK BAP species in this analysis. This result is probably due to limited data rather than reflecting a lack of any relationship and, as UK BAP species associated with grasslands will also occur in orchards, the summary findings for grasslands should be applied to orchard management.

6.28 Orchards, like wood pastures, are dynamic habitats and the habitat they provide for groups such as saproxylic invertebrates will change with the demography of orchard trees in a particular site. Continuity of habitat for long-term conservation requires trees at all stages of growth, either within one orchard or a series of orchards in a landscape.

6.29 The wildlife of orchard sites depends on the mosaic of habitats they encompass, including fruit trees, scrub, hedgerows, hedgerow trees, non-fruit trees within the orchard, the orchard floor habitats, fallen dead wood and associated features such as ponds and streams.

6.30 Orchards appear to be a significant part of a spatial series or network of habitats at a landscape scale, which are able sustain groups of species requiring a mosaic of habitats to complete their life-cycle (such as bats which breed or roost in adjacent woods and feed over surrounding orchard grasslands and hedgerows).

Hedgerows

6.31 A total of 83 species are associated with hedgerows, including a high proportion of lichens, invertebrates, mammals and, in particular, birds. The majority of species are widespread or localised. The following analysis excludes those 51 widespread moth species (larvae feed on plants associated with hedgerows) for which insufficient is known about their habitat requirements (Wolton, 2009).

Table 10 Species numbers across different taxonomic groups - hedgerows

Taxonomic group	No. of species
Fungi	4
Lichens	13
Bryophytes	2
Vascular plants	7
Invertebrates	22
Amphibians/reptiles	5
Birds	19
Mammals	11

Table 11 Species numbers across different restriction classes - hedgerows

Restriction class	No. of species
Widespread	35
Localised	19
Restricted	10
Very restricted	19

6.32 Figure 6 shows the relationship between taxonomic groupings and restriction class.

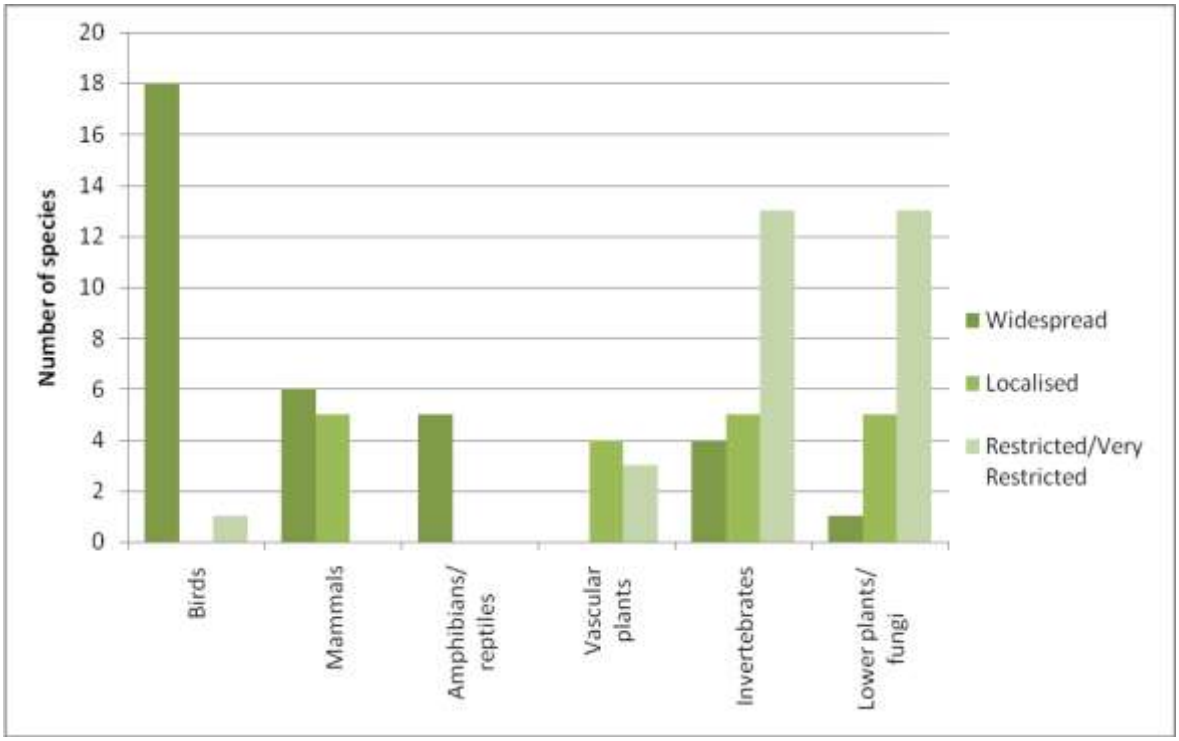

Figure 6 Relationship between taxonomic group and restriction class of UK BAP species associated with hedgerows

6.33 This indicates that the more restricted species associated with hedgerows are dominated by the invertebrates and lower plants, whereas the vertebrate groups are dominated by widespread birds, mammals and amphibians/reptiles.

6.34 Figure 7 shows that the distribution of the hedgerow species across the regions.

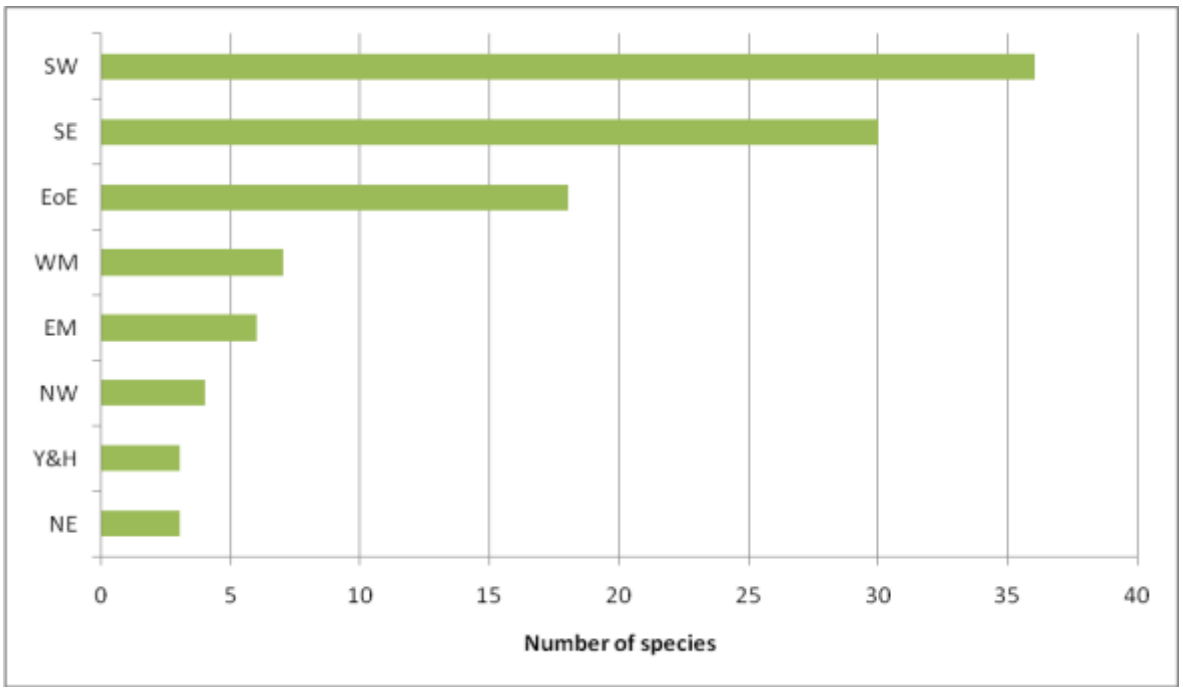

Figure 7 Regional distribution of UK BAP species associated with hedgerows

6.35 This shows that the southern regions have many more species than the Midlands and the north. This is probably due in part to the number of lower plants associated with the milder climatic conditions of southern England.

Habitat / niche requirements

6.36 Figure 8 shows the structural features utilised by hedgerow species.

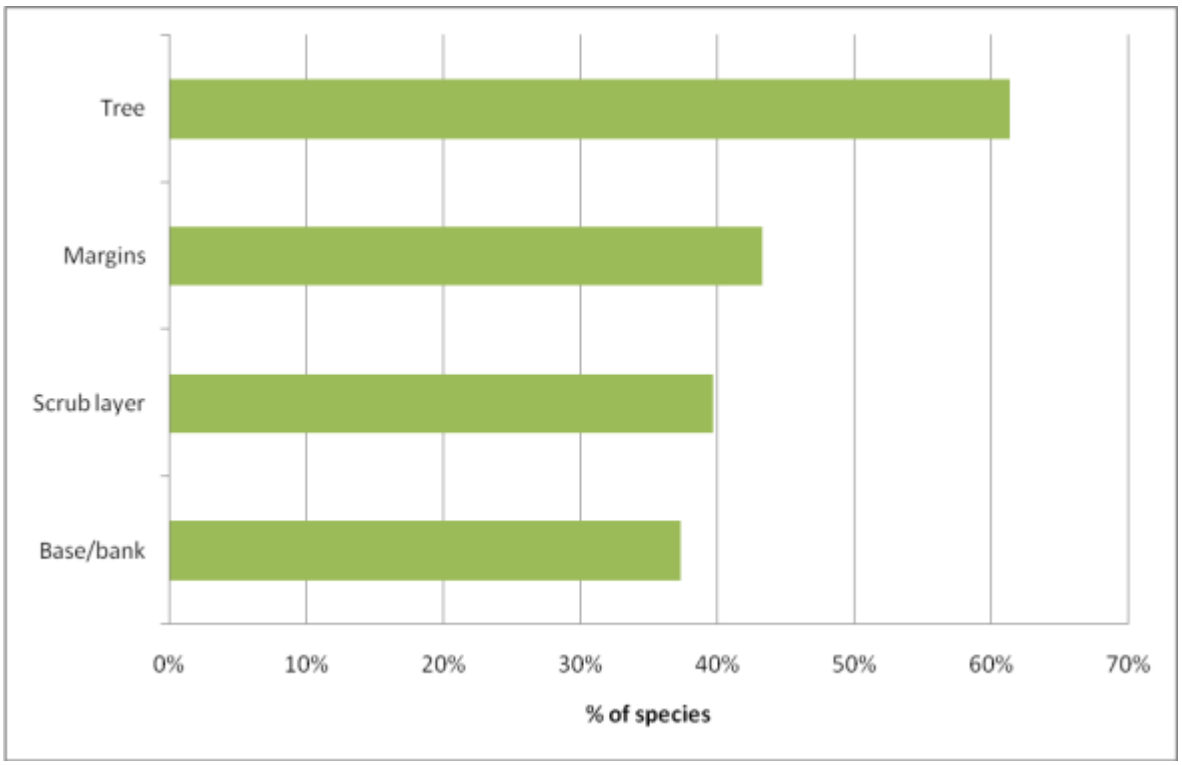

Figure 8 Association of UK BAP hedgerow species with different structural components

6.37 This shows that 61% of species are associated with trees. **Open-grown mature and veteran trees** are of particular importance (58% of these species), providing a suitable substrate for a large number of lichens (for example, *Caloplaca flavorubescens, Permelina quercina*) as well as feeding habitat for invertebrates (for example, the white-letter hairstreak *Satyrium w-album,* heart moth *Dicycla oo*) and roosting/nesting habitat for birds (for example, tree sparrow *Passer montanus*) and bats (for example, Noctule *Nyctalus noctula*). One priority species is a hedgerow tree itself, the rare Plymouth pear *Pyrus cordata*.

6.38 Forty percent of species depend on the **scrubby element of the hedgerow** itself, for feeding, breeding or shelter and protection from weather and predators (for example, brown hairstreak *Thecla betulae*, dormouse *Muscardinus avellanarius*, barberry carpet *Pareulype berberata*) and 51% require both trees and scrub (for example, spotted flycatcher *Muscicapa striata*, bullfinch *Pyrrhula pyrrhula*).

6.39 The **base of hedgerows** (beneath the canopy) is important for 37% of species. These includes six herbaceous plants (for example, starved wood-sedge *Carex depauperata*, bastard balm *Melittis melissophyllum*); fungi (for example, sandy stilt puffball *Battarrea phalloides*); a number of birds (for example, grey partridge *Perdix perdix*, yellow hammer *Emberiza citronella* which nest close to the base of hedges) and amphibians/reptiles (for example common toad *Bufo bufo*, great crested newt *Triturus cristatus* and grass snake *Natrix natrix* which move along, forage within and over-winter in the base of hedgerows and associated ditches).

6.40 Forty-three percent of species rely on **marginal habitats**. These are mostly areas of **tall grassland** and other habitat types (for example, bare ground required by purple ramping fumitory *Fumaria purpurea*) located adjacent to the hedgerow. Herbs and grasses provide nectar, pollen for bumblebees, seeds and invertebrates for majority of birds, and shelter and cover for mammals and amphibians/reptiles. Many of these species rely on both the hedgerow and the adjacent habitats to complete their life cycles. As such the **quality of the hedgerow and the hedge-bank are very important**.

6.41 Further analysis shows that:

- **Large scale habitat mosaics** (open fields, scrub, woodland) are required by 36% of species; the majority of these are wide-ranging mammals and birds (for example, cuckoo *Cuculus canorus* and brown long-eared bat *Plecotus auritus*); and
- Twenty-five percent of species rely on an abundance of **invertebrates and seeds**. They consist of bats and birds operating at a large scale.

Summary

6.42 Of the 83 species associated with hedgerows, two distinct types of users can be identified:

- Widespread birds and bats operating at a large scale and requiring an abundance of invertebrate and plant food.
- A number restricted lower plants, fungi and invertebrates associated with open-grown and veteran trees.

6.43 As well as the hedgerow itself, the adjacent marginal habitat is important for nearly half of all species. As such, the hedgerow should be considered to include both the woody element and adjacent herb-dominated habitat in the hedge-bank. Structure is vitally important and the best hedgerows will include:

- mature/veteran trees;
- varied structure and species composition; and
- a broad adjacent grassy margin of variable structure.

Grasslands

6.44 This category includes all of the following priority habitats:

- Lowland dry acid grassland
- Lowland calcareous grassland
- Lowland meadows
- Purple moor-grass and rush pastures
- Calaminarian grasslands

6.45 Note that upland hay meadows are covered in the section on Upland habitats (page 35).

6.46 A combined grassland analysis was undertaken because preliminary analysis suggested that individual analyses would produce very similar results. Fifty-eight of the species are associated with lowland calcareous grasslands but, for many of the others, no preference or association was established.

6.47 A total of 206 species are associated with grassland priority habitats; by far the largest number of species associated with a lowland farmland priority habitat. These are dominated by invertebrates and vascular plants.

Table 12 Species numbers across different taxonomic groups - grasslands

Taxonomic group	No. of species
Fungi	9
Lichens	13
Bryophytes	11
Vascular plants	51
Invertebrates	86
Amphibians/reptiles	6
Birds	23
Mammals	7

Table 13 Species numbers across different restriction classes - grasslands

Restriction class	No. of species
Widespread	46
Localised	55
Restricted	30
Very restricted	73
Extinct	2

6.48 Figure 9 shows the relationship between numbers of species in each taxonomic group with the different restriction classes.

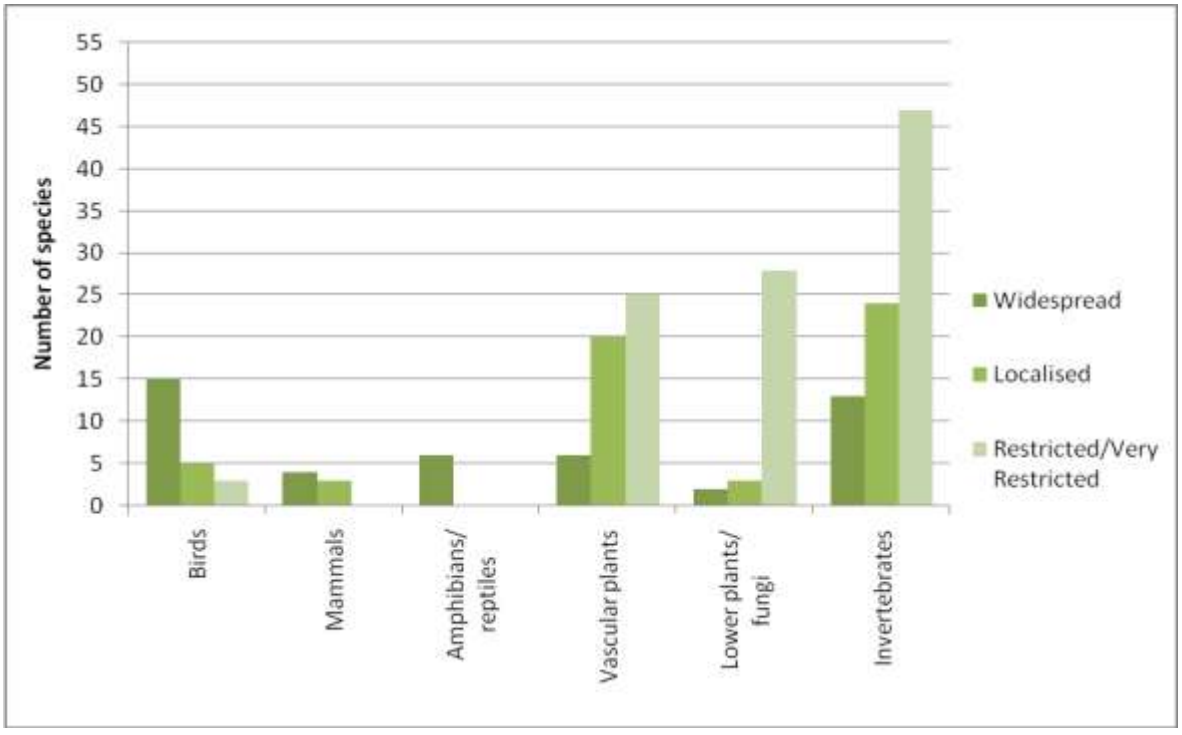

Figure 9 Relationship between taxonomic group and restriction class of UK BAP species associated with grasslands

6.49 This shows that the species associated with grasslands are quite different when compared to those associated with orchards, hedgerows and arable field margins as they contain a much higher proportion of restricted species.

6.50 Figure 10 identifies the important regions for grassland species.

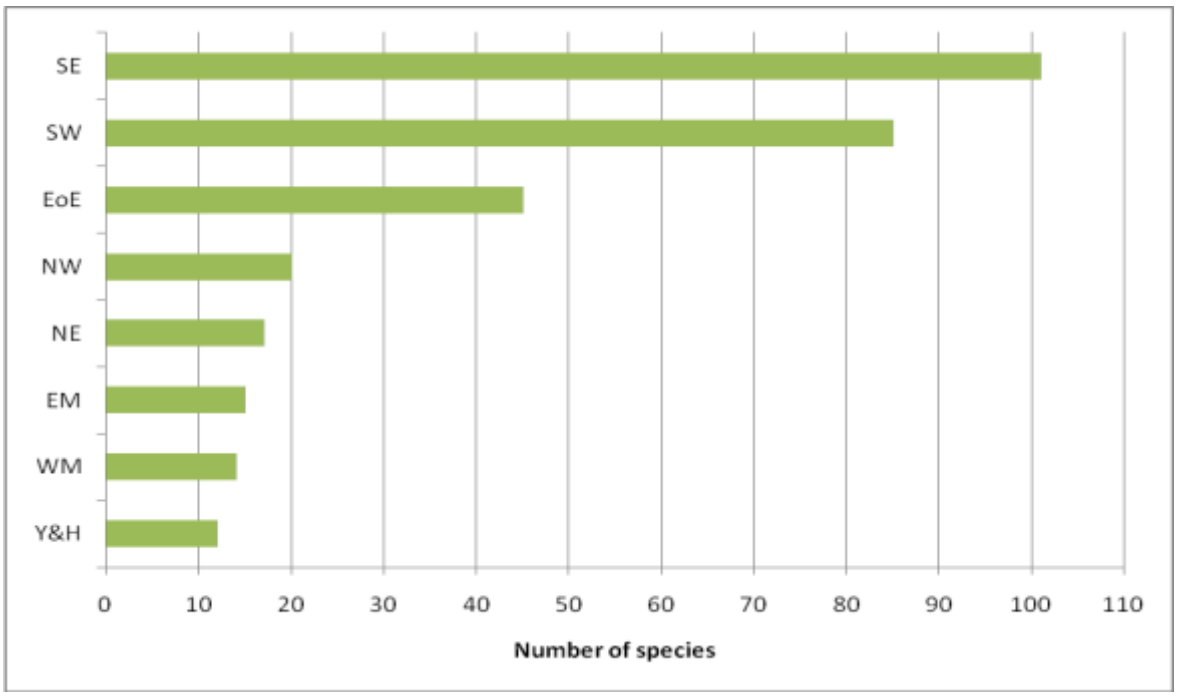

Figure 10 Regional distribution of UK BAP species associated with grasslands

6.51 The greatest number of species is associated with South East England. Both the South West and East of England also feature strongly, whereas the Midlands and northern England contain far fewer species. The distribution of grassland species closely mirrors the distribution of grasslands in England and may also largely reflect both climatic and geographic factors. However, the north is particularly important for species of upland hay meadows (covered by the Upland BIG).

Habitat / niche requirements

6.52 Figure 11 shows the habitats and niches required by UK BAP species.

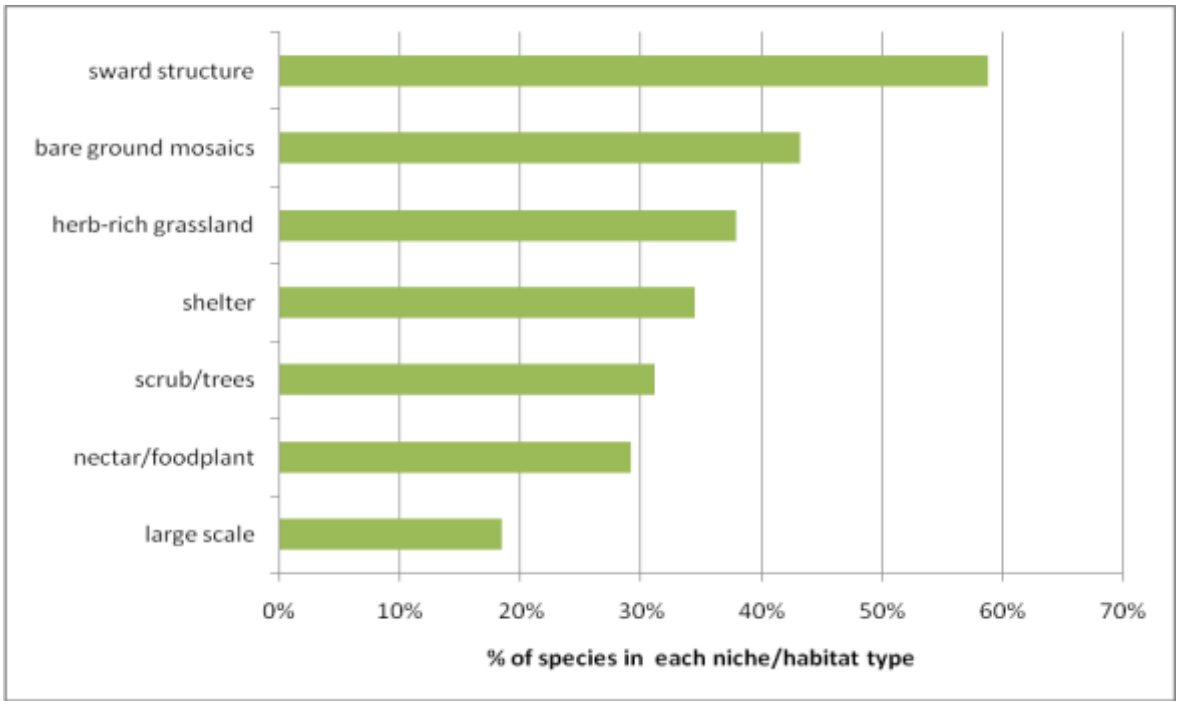

Figure 11 Habitat/niche requirements of UK BAP species associated with grasslands

6.53 This analysis shows that:

- Fifty-nine percent of all species are associated with a particular form of **grassland structure** (open and short, or tall/tussocks, or combinations of sward types);
- **Herb-rich, unimproved grassland** is important for 38% of species. These species are mainly plants and fungi (for example, frog orchid *Dactylorhiza viride* and the rust *Uromyces gentianae*) which cannot tolerate competition from more vigorous, dominant species associated with agriculturally improved, species-poor grasslands;
- Forty-three percent of all species require **early successional habitat** and **bare ground** (for example, Berkeley's earthstar *Geastrum berkeleyi*, the moss *Weissa condensa*, early gentian *Gentianella anglica*, and the field cricket *Gryllus campestris*). Such conditions are **often required in a mosaic** with other habitat types (for example, some invertebrates also require shelter, scrub, flower-rich resource etc). Thus small mosaics of bare ground within grasslands are probably more beneficial than large areas of heavily disturbed land; and
- **Scrub/trees** (31%) and **flower/foodplant resources** (29%) are both mainly associated with animal species requiring food, nesting and roosting localities (for example, the moth dingy mocha *Cyclophora pendularia* and the yellowhammer *Emberiza citronella*), and shelter (for example, hornet robber fly *Asilus crabroniformis* and the beetle *Cryptocephalus nitidulus*).

6.54 A further analysis was undertaken on the specific sward structure required by those species requiring vegetation rather than bare, early successional conditions (Figure 12).

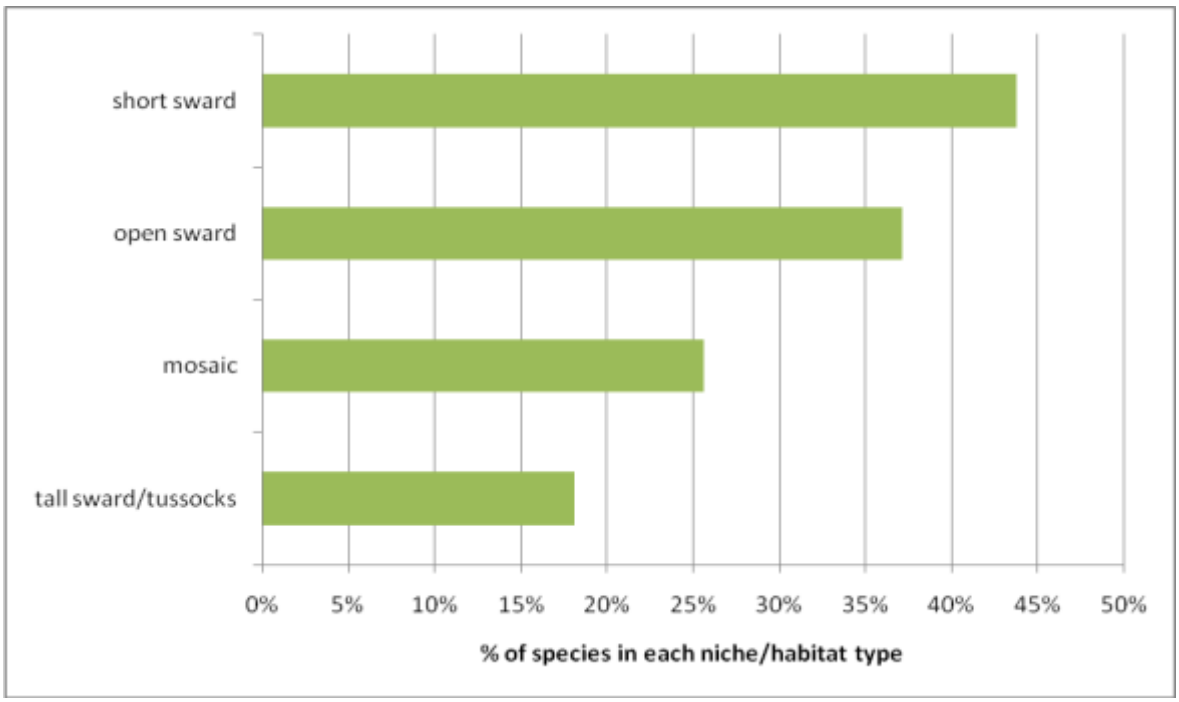

Figure 12 Sward requirements of UK BAP species associated with grasslands

6.55 The results suggest that species require widely different types of sward structure and that no single type is beneficial for all, although short and open swards are necessary for the greatest number of species. Some general conclusions can be drawn from this analysis:

- **Short swards**, often only a few centimetres high, are particularly favoured by vascular plants and birds (for example, Deptford pink *Dianthus armeria*, slender bedstraw *Galium pumilum* and lapwing *Vanellus vanellus*);
- **Open swards** can be short or tall but the open conditions are necessary for a large number of invertebrates (for example, large blue butterfly *Maculinea arion*) and shorter growing vascular plants (for example, pasqueflower *Pulstatilla vulgaris*), as well as some lower plants (for example, the lichen *Cladonia mediterranea*); and
- **Tall swards and mosaics** are particularly favoured by invertebrates and birds (for example, shrill carder bee *Bombus sylvarum*, reed bunting *Emberiza schoeniclus*).

6.56 Species were further grouped by their restriction class and their niche requirements, as shown in Figures 13 and 14.

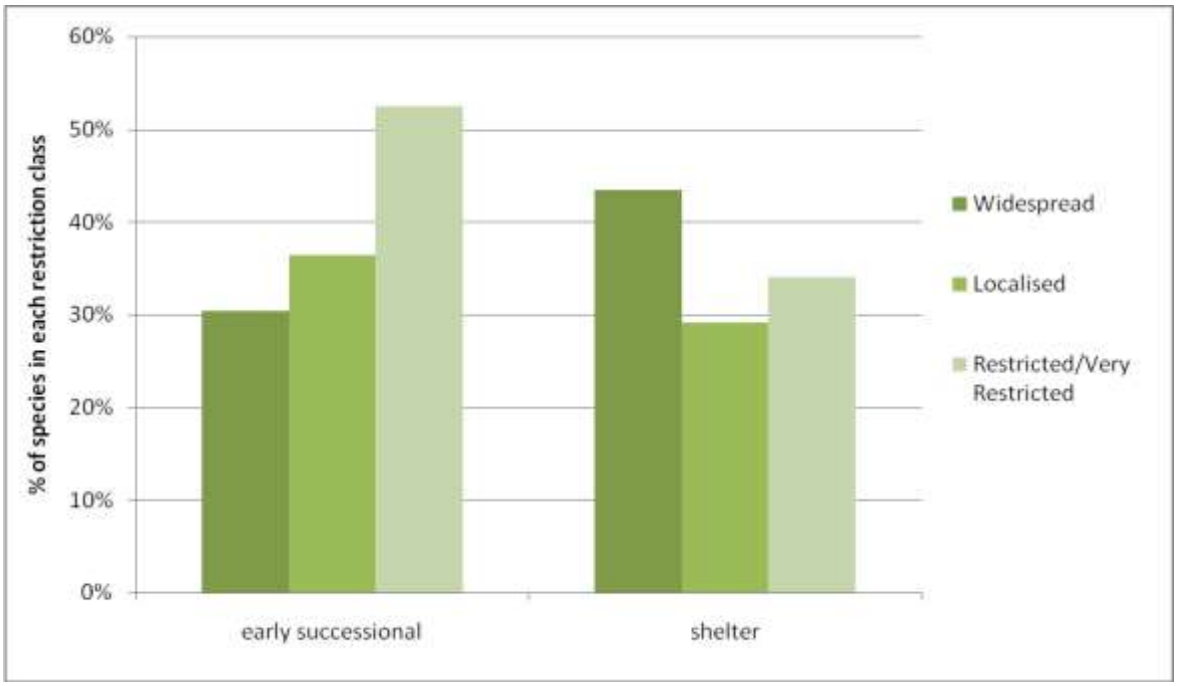

Figure 13 The relationship between habitat/niche requirement and restriction class of UK BAP species associated with grassland

6.57 Figure 13 shows that the more restricted species (for example, red star thistle *Centaurea calcitrapa* and the wart-biter *Decticus verrucivorus*) are associated with **early successional habitats** such as areas of bare ground and sparse vegetation whereas the requirement for **shelter** is more evenly spread across the restriction classes.

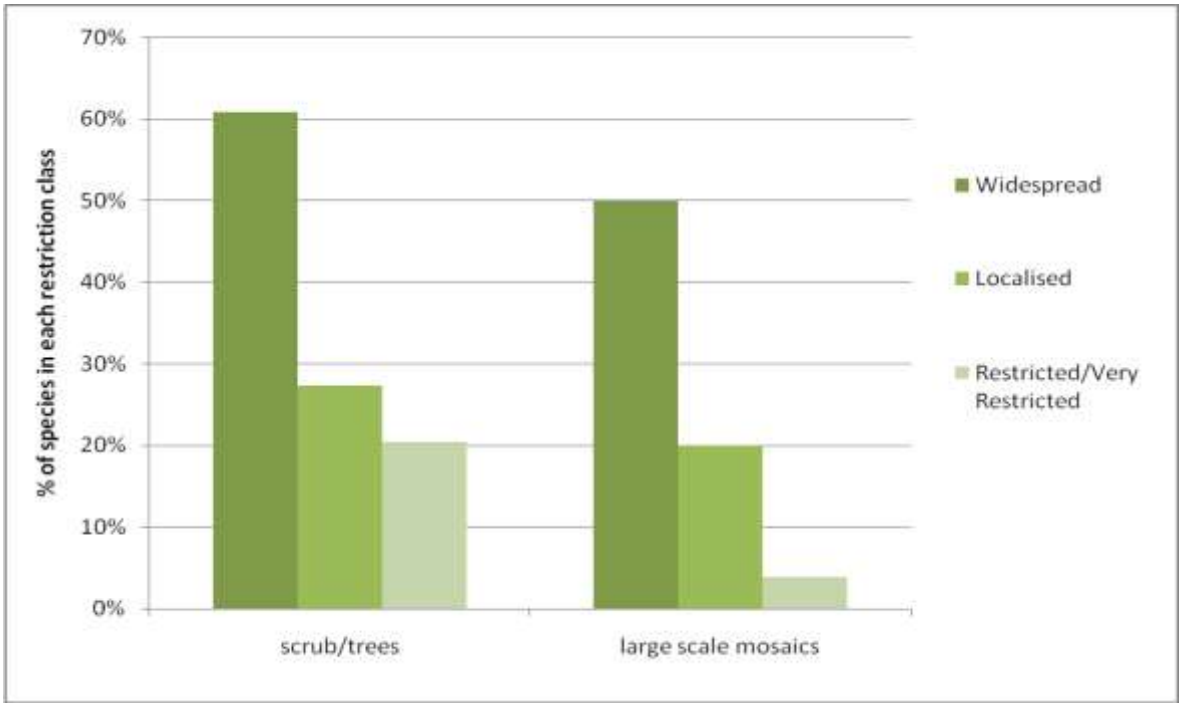

Figure 14 The relationship between habitat/niche requirement and restriction class of UK BAP species associated with grassland

6.58 Figure 14 shows that the widespread and localised species (particularly mammals and birds) are more associated with **scrub and/or trees** and **larger scale mosaics**.

Summary

6.59 Grasslands are often complex habitats used in different ways by a large number of species. Some species operate at a large scale, often utilising adjacent habitats such as hedgerows and woodlands. Others require small scale mosaics including patches of bare ground and flower-rich resources in botanically diverse open swards. It is very clear from the data that grassland structure is critical; bare ground and sward structural heterogeneity play a vital role in determining species composition. This means that grassland species need structural complexity at different scales:

- At the larger scale, adjacent areas such as hedgerows, dynamic scrub and woodland edge should all be considered as critical to grassland species.
- Smaller scale dynamics that help vary sward structure are also very important. This may include rabbit grazing, poaching, temporary inundation and management that promotes an abundance of flowers throughout the year.

6.60 Soil nutrients (in particular low nutrient status) and the availability of nutrients through management practices (for example, fertiliser and manure applications) plays an important role in determining the species composition of grasslands in much the same way that water quality is a major driver of wetland quality.

6.61 Particular resources are also important to the animals that utilise grasslands. The presence of flowers (nectar and pollen) and uncut, large herbs (food plants and shelter) throughout the spring and summer will be critical to a number of species. Therefore, managing sites by wide scale mowing and/or intensive periods of grazing over the whole site will be unsuitable for many species.

6.62 Grassland ecosystems require dynamic processes and short periods of stability to produce resources and niches for species in the form of scrub/grass matrices, bare ground and flowers and tall herbs. However, it is important to bear in mind that some very specialised grasslands (for example, hay meadows, Calaminarian grasslands), with small but distinct groups of species, are poorly represented by this analysis and care should be taken before applying these more general grassland conclusions to their management.

Lowland heathland

6.63 A total of 133 UK BAP species are associated with lowland heathlands in England. These are species found exclusively on heathland sites or for which a significant proportion of records come from heathlands. It does not include species that are only occasionally found on heathlands.

6.64 Many heathland species are also associated with other habitats, including woodlands, grasslands, uplands and wetlands.

Table 14 Species numbers across different taxonomic groups - lowland heathland

Taxonomic group	No. of species
Fungi	1
Lichens	3
Bryophytes	10
Vascular plants	21
Invertebrates	82
Amphibians/reptiles	6
Birds	10

Table 15 Species numbers across different restriction classes - lowland heathland

Restriction class	Number of species
Widespread	30
Localised	30
Restricted	23
Very restricted	49
Extinct	1

6.65 Figure 15 shows the relationship between numbers of species in each taxonomic group with the different restriction classes.

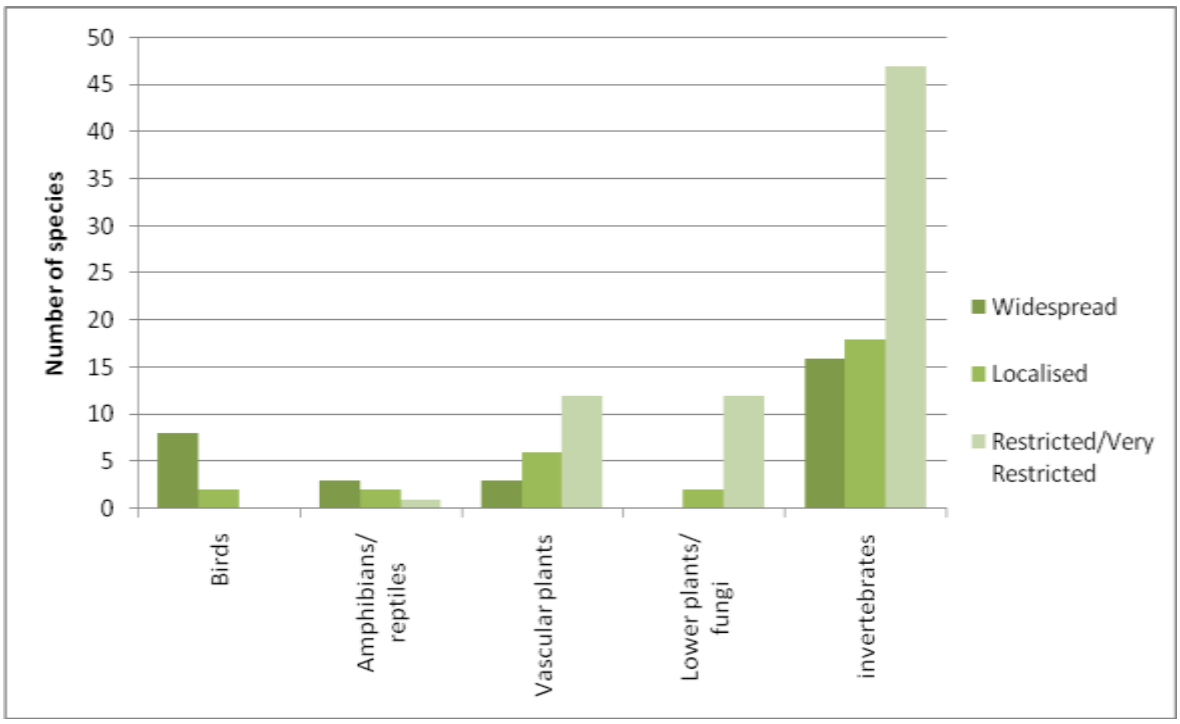

Figure 15 Relationship between taxonomic group and restriction class of UK BAP species associated with lowland heathland

6.66 Most of the restricted and very restricted species are invertebrates (47 species), although both the lower plants and vascular plants also include a high proportion of such species. Widespread species are not dominated by any one taxonomic group (see Figure 15).

6.67 Figure 16 shows the distribution of those heathland UK BAP species which are associated with particular regions.

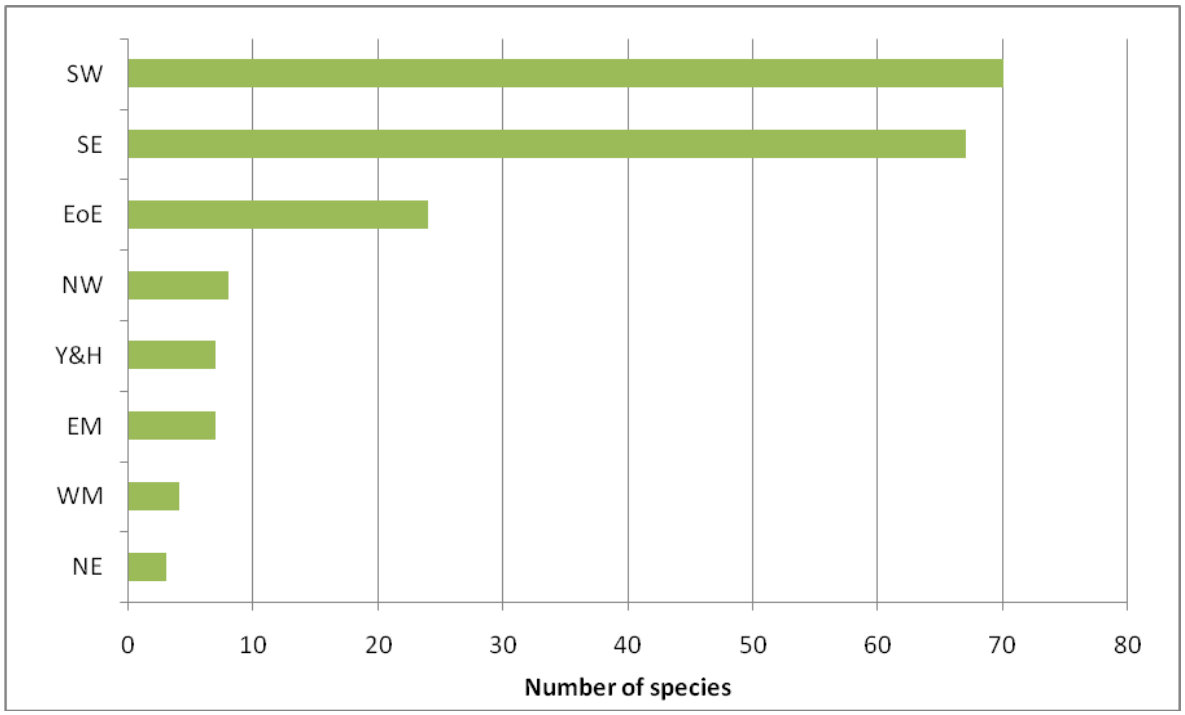

Figure 16 Regional distribution of UK BAP species associated with lowland heathland

6.68 UK BAP species associated with heathland are strongly represented in the South West and South East, and, to a lesser extent, the East of England. By contrast, very few are associated with the Midlands and the north. This distribution broadly reflects the national distribution of lowland heathland.

Habitat / niche requirements

6.69 A variety of niches are identified for UK BAP species associated with heathlands (see Figure 17).

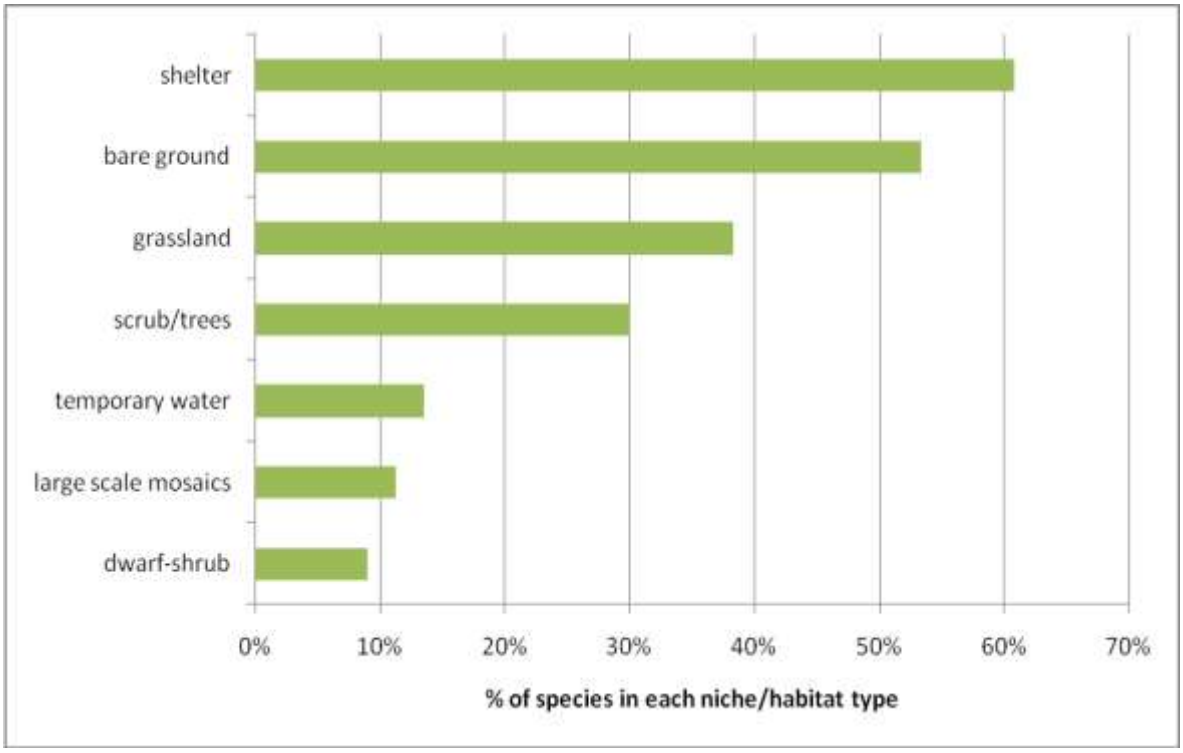

Figure 17 Habitat/niche requirements of UK BAP species associated with heathland

6.70 Many species occur in more than one niche as they have multiple requirements:

- **Shelter** (i.e. open sunny conditions but protected from wind by topography or vegetation) is required by 61% of species, including the black oil-beetle *Meloe proscarabeus*, dingy skipper *Erynnis tages* and the sand lizard *Lacerta agilis*. Species requiring shelter are often found in **bays in the scrub or woodland edge** or protected by slopes and rock outcrops. Such species cannot tolerate the dominance of even-aged, uniform heather *Calluna vulgaris*;
- Fifty-three percent of all species require **early successional habitats** (for example, the bryophyte *Riccia nigrella*, red-barbed ant *Formica rufibarbis*, silver-studded blue *Plebejus argus*, spring speedwell *Veronica verna* and the stone-curlew *Burhinus oedicnemus*). This type of habitat includes **bare sand** and **ruderal plants** which need bare ground for germination. These species are dependent on open conditions rather than being associated with any particular heathland stage (such as pioneer heather). As many of these species also require **shelter** then the open conditions often exist in mosaics with taller vegetation, such as heather and scrub which provide a sheltered microclimate within the heathland;
- Thirty-eight percent of species require **grasslands or grass-heath matrices**. Of these nearly 70% of species are dependent on **structural features** (for example, marsh fritillary *Euphydryas aurinia*), whereas 41% (mainly invertebrates) are associated with either **specific food plants** (for example, heath fritillary *Melitaea athalia*) or a **large nectar resource** (for example, heath bee-fly *Bombylius minor*, the forester *Adscita statices*). Many of the species associated with structure are vertebrates (for example, woodlark *Lullula arborea*) operating at larger scales than invertebrates and plants. More specific associations with grassland habitats within heathland are shown in Figure 18;
- Thirty percent of species are associated with **trees and scrub**. This can be in the form of scattered scrub (for example, dingy mocha *Cyclophora pendularia*, grasshopper warbler *Locustella naevia*), woodland edge (for example, nightjar *Caprimulgus europaeus*) or individual trees (for example, goat moth *Cossus cossus*). Large blocks of scrub and trees will, for the most, only be utilised by species along their edges;
- **Seasonal inundation** is required by 13% of species. The majority of these utilise **drawdown zones**, mainly bare mud or peat (for example, marsh clubmoss *Lycopodiella inundata*, three-lobed water crowfoot *Ranunculus tripartitus*), but some also require **temporary water bodies**, which are often shallow and warm, of high water quality and free of predators and competitive species (for example, tadpole shrimp *Triops cancriformis*, natterjack toad *Epidalea calamita*). Many of these seasonal pools are found on tracks where water collects in the winter; and
- Only 9% of species have a specific requirement for the presence of **dwarf shrubs** (rather than simply exploiting them as part of a general need for vegetational structure), including the moss *Dicranum spurium*, the mottled bee-fly *Thyridanthrax fenestratus* and the heath rustic *Xestia agathina*.

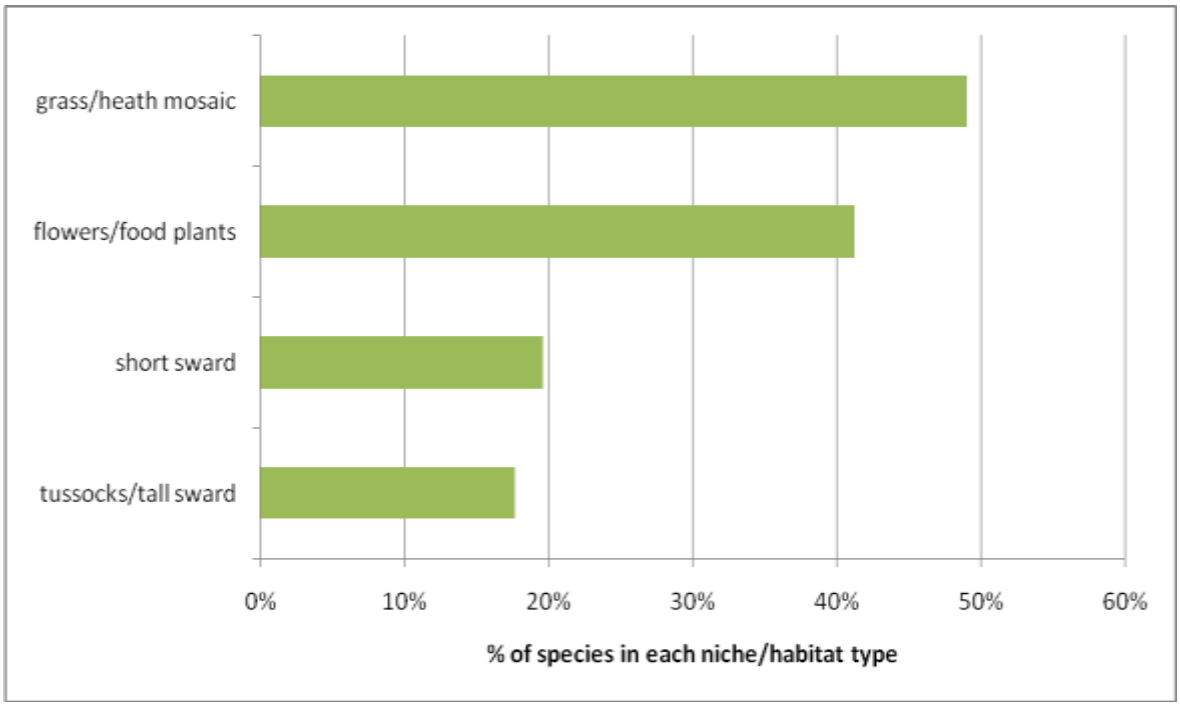

Figure 18 Grassland habitat/niche requirements of UK BAP species associated with lowland heathland

6.71 Figure 19 shows the relationship between restriction class and certain habitat attributes.

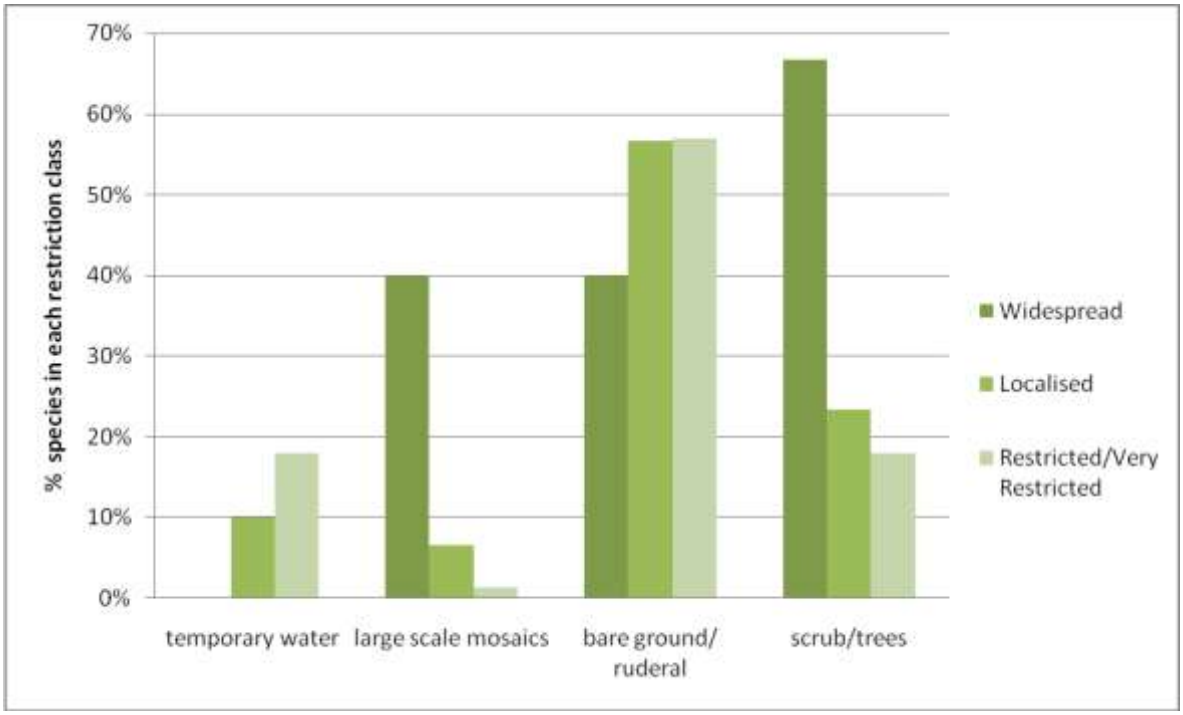

Figure 19 Geographical restriction of UK BAP species associated with habitat/niches of lowland heathland

6.72 **Seasonally inundated habitats** are dominated by the more restricted species (for example, tadpole shrimp) whereas a greater proportion of widespread species are associated with **large scale habitat mosaics** (for example, slow-worm *Anguis fragilis*, linnet *Carduelis cannabina*).

6.73 **Early successional habitats** such as bare ground and sparse vegetation are more evenly split across the restriction classes whereas a greater proportion of widespread species are associated with **scrub and trees** (for example, nightjar *Caprimulgus europaeus*, woodlark *Lullula arborea*).

Summary

6.74 There are very few ‘true’ heathland species; that is those associated with dwarf-shrubs. In fact, most species do not require ericaceous scrub to complete their life cycles. Thus the promotion of ericaceous scrub should not be the only target for heathland management. Rather, ericaceous scrub should be seen as the site fabric upon which other habitats can be maintained and created in order to provide a mosaic of dynamic, resource-rich habitats.

6.75 For species requirements to be fully incorporated into heathlands a large number of niches and resources need to be made available. Heathland ecosystems require dynamic processes to promote a variety of habitat niches such as scrub matrices, seasonal pools and patches of flowers and tall herbs - all of which provide valuable resources. All of these attributes should be seen as beneficial although they may not, historically, have been seen as such. There is no data to suggest how intimate the mix of structures needs to be but, as many of the species utilising these habitats are small (invertebrates and plants), they should tend to small-scale (any given hectare should have a number of different niches represented rather than one).

6.76 More specific requirements include:

- Localised nutrient enrichment (for example, animal dung) that leads to small patches of herbs, such as umbellifers, yellow composites and legumes.
- Dynamic scrub that develops throughout the site, in particular including species such as birch, willow, gorse and hawthorn. Scrub should not dominate a heathland or be present in large blocks. Often, a scatter of individual plants along with a few small blocks (represented by a small number of plants) would be ideal.
- Areas devoid of vegetation, in particular where this is in a small-scale mosaic with other habitat types. Bare sand and ruderal habitats are required by over half of all species.
- Temporary pools or wetlands such as those on un-surfaced paths, depressions and muddy/peaty areas are also of high importance and these provide very valuable habitats.
- Mosaics of habitats, such as woodland-heathland and grassland-heathland, are of high importance both for the shelter and the extra resources they provide.

Upland habitat requirements

6.77 The uplands embrace all land lying above 300 metres in England (defined by the 'Severely Disadvantage Area' boundary). Much of this is dominated by dwarf-shrub heaths and rough grassland, though there are considerable expanses of blanket bog habitat. This section deals with all open, upland terrestrial habitats, including fens, flushes and swamps, inland rock, juniper and montane willow scrub types (other woodland features, running and standing waters are treated in the Woodland, Rivers and Lakes and Ponds sections).

6.78 There are a total of 98 UK BAP species associated with the uplands. Of these 40 species utilise upland habitat mosaics and are associated with a range of habitat types to complete their life cycle, including non-priority BAP habitats such as upland rough pasture or priority habitats covered by another BIG category (for example, ponds). There are seven widespread species primarily associated with non-priority BAP habitats. These includes the common toad *Bufo bufo*, water vole *Arvicola terrestris*, polecat *Mustela putoriu*, otter *Lutra lutra*, tree pipit *Anthus trivialis*, slow worm *Anguis fragilis* and field gentian *Gentianella campestris*.

6.79 The UK BAP species have been associated, as far as possible, with various priority habitats within the Upland BIG category, and an analysis of each of these priority habitats is incorporated below.

Table 16 Distribution of species across the different priority habitats - Upland

Priority habitat	No. of associated UK BAP species
Blanket bog	10
Upland fens, flushes and swamps	23
Inland rock outcrops and scree	32
Limestone pavement	7
Upland calcareous grassland	27
Upland heathland	35
Montane heaths and willow scrub	6
Upland hay meadows	14
Upland habitat mosaics (incl. non-priority BAP habitats)	40

6.80 Species numbers across different taxonomic groups and restriction classes are given below. Vascular plants, invertebrates and birds form the majority of UK BAP species associated with upland priority habitats. A high proportion of species (mostly non-vascular and vascular plants and invertebrates) have a very restricted distribution.

Table 17 Species numbers across different taxonomic groups - Upland

Taxonomic group	No. UK BAP species
Fungi	3
Lichens	9
Bryophytes	8
Vascular plants	27
Invertebrates	29
Amphibians/reptiles	4
Birds	12
Mammals	6

Table 18 Species numbers across different restriction classes - Upland

Restriction class	No. UK BAP species
Widespread	24
Localised	20
Restricted	15
Very restricted	39

Overall summary

6.81 Upland priority habitats vary tremendously in their extent; upland heathland and blanket bogs can cover extensive areas, whereas flushes and rocky outcrops tend to be small scale and localised within the larger fabric of another habitat type.

6.82 For heathlands and grasslands, the critical factor is structural diversity brought about by dynamic process; in essence, management that disturbs and delays succession in such a way that a number of different states can be found at any one time. Any management technique that promotes homogeneity is generally detrimental for many UK BAP species.

6.83 For wetlands, low nutrient status and hydrology is of high importance, both in terms of structure (sphagnum pools seem very important) as well as the overall water quality required by many of the lower plants and invertebrates.

6.84 It should be noted that a large proportion of the uplands is dominated by non-priority habitats (for example, neutral, rough pastures and improved grassland).

Blanket bog

6.85 Blanket bogs encompass all areas supporting semi-natural blanket bog vegetation (*Sphagnum* spp., cotton grass, heathers *Calluna*, *Erica* spp.) restricted to cool wet climates in upland areas.

6.86 Ten species are associated with blanket bogs, primarily in northern England. These are: four widespread or localised vertebrates (adder *Vipera berus*, common lizard *Zootoca vivipara*, curlew *Numenius arquata* and black grouse *Tetrao tetrix*); three very restricted bryophytes (*Aplodon wormskjoldii*, *Sphagmum balticum* and *Splachnum vasculosum*); and three localised invertebrates (large heath *Coenonympha tullia* and the money spiders *Semljicola caliginosus* and *Notioscopus sarcinatus*).

Table 19 Species numbers across different taxonomic groups - blanket bog

Taxonomic group	No. of species
Bryophytes	3
Invertebrates	3
Reptiles	2
Birds	2

Table 20 Species numbers across different restriction classes - blanket bog

Restriction class	No. of species
Widespread	3
Localised	4
Restricted	0
Very restricted	3

Summary

6.87 This habitat does not support a very high number of UK BAP species. However, the invertebrates and bryophytes are localised and highly restricted respectively, being associated only with **nutrient-poor sphagnum** and **sedge-dominated wetlands**. The four vertebrate species are associated with a range of priority and non-priority BAP habitats and utilise blanket bogs where conditions are suitable. The widespread species have different requirements to those of the more restricted bryophytes and invertebrates and include a **mosaic of vegetation structures** (such cotton grass and *Juncus* tussocks, *Sphagnum* hummocks) and an **abundance of invertebrates and/or seeds**.

6.88 The bryophytes and invertebrates are all strongly associated with:

- permanently wet habitats;
- sphagnum, shallow pools and low vegetation cover;
- high water quality; and
- low pH.

6.89 Although upland blanket bogs do not support a large diversity of species (UK BAP priority species or otherwise), they are important for the small number of specialist species with localised/very restricted distributions. This factor should be taken into account when comparing this habitat with other upland habitats.

Upland fens, flushes and swamps

6.90 This is a varied habitat encompassing terrestrial wetlands in upland situations which receive water and nutrients from surface and/or groundwater sources as well as rainfall. It includes springs, flushes, valley fens and *Molinia* grasslands and rush pastures, but excludes bog habitats.

6.91 Twenty three species are associated with upland fens, flushes and swamps. These consist of twelve invertebrates (for example, sandbowl snail *Quickella arenaria*, Geyer's whorl snail *Vertigo geyeri*, bog hoverfly *Eristalis cyptarum*, Barred Green Colonel *Odontomyia hydroleon*, large heath *Coenonympha tullia* and small pearl-bordered fritillary *Boloria selene*); four vascular plants (flat-sedge *Blysmus compressus*, yellow marsh saxifrage *Saxifraga hirculus*, lesser butterfly-orchid

Platanthera bifolia and the eyebright *Euphrasia rivularis*); four bryophytes (*Jamesoniella undulifolia*, *Splachnum vasculosum*, *Leiocolea rutheana* and *Thamnobryum angustifolium*); two fungi (*Urocystis primulicola* and *Armillaria ectypa*) and one bird (curlew *Numenius arquata*). Only four of these species are widespread (curlew, marsh and small pearl-bordered fritillaries and lesser butterfly-orchid).

Table 21 Species numbers across different taxonomic groups - upland fens, flushes and swamps

Taxonomic group	No. of species
Birds	1
Fungi	2
Bryophytes	4
Vascular plants	4
Invertebrates	12

Table 22 Species numbers across different restriction classes - upland fens, flushes and swamps

Restriction class	No. of species
Widespread	4
Localised	5
Restricted	2
Very restricted	12

6.92 Figure 20 shows that these species are mostly associated with the north of England, particularly the North West.

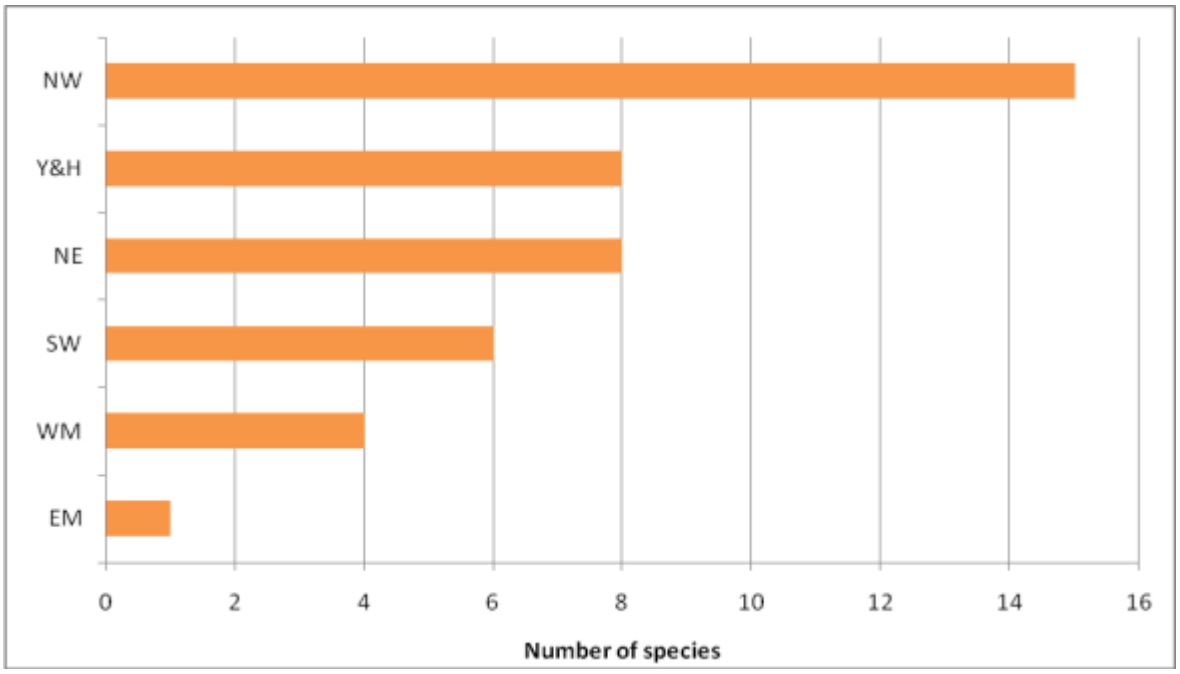

Figure 20 Regional distribution of UK BAP species associated with upland fens, flushes and swamps

Habitat / niche requirements

6.93 Figure 21 shows the habitat/niche requirements for these species. This analysis shows that all species are associated with **open, unshaded habitats** and the majority require **high water quality**. Additionally, many species require **permanently wet habitats dominated by sedges and mosses**.

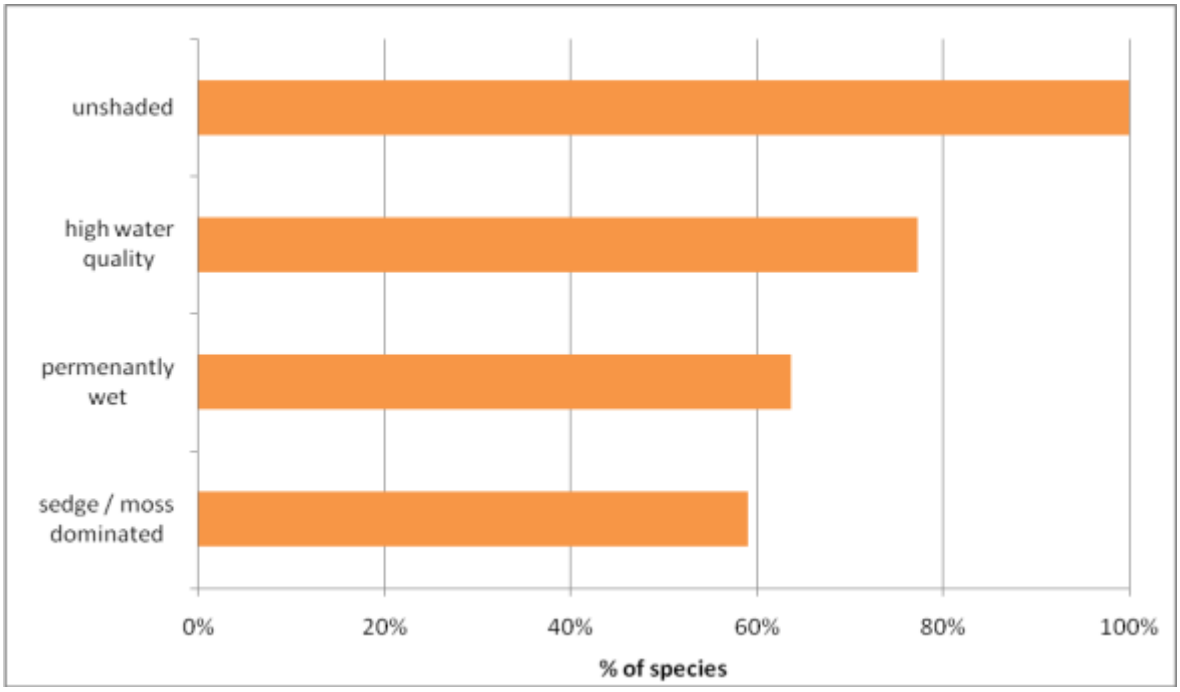

Figure 21 Habitat/niche requirements of UK BAP species associated with upland fens, flushes and swamps

Summary

6.94 The three critical requirements for species associated with upland fens, flushes and swamps appear to be:

- Hydrology: permanently wet/inundated habitats with little fluctuation of water levels;
- Water quality: low nutrients, little pollution; and
- Openness and lack of shade (which itself results from low nutrients, grazing and permanent water-logging, which reduces competition from other, faster growing species and prevents scrub encroachment).

6.95 It is unclear whether the direct effects of climate are critical to these species (in the sense that they can tolerate or require low temperatures). It is perhaps more likely that the nature of upland flushes and swamps (high water quality; low nutrients) is the more important factor.

6.96 In common with other low nutrient-input systems, this habitat does not support a very high number of UK BAP species. However, many of the species it supports are highly restricted in England and this factor should be taken into account when considering the importance of this habitat relative to other upland habitats.

Inland rock outcrops, scree and limestone pavement

6.97 Exposed rock habitats include a variety of types such as cliffs or crags, gullies and ravines, boulders and scree, and limestone pavements. They are widespread throughout the uplands and are found in all situations, from unenclosed mountain summits to enclosed valley grasslands and agricultural land in between (often in mosaics with other habitats).

6.98 A total of 32 species are associated with these priority habitats. Plants dominate, these being represented by fourteen vascular plants, three bryophytes and nine lichens. The other species are four butterflies, one mason bee *Osmia parietina* and a bird (the ring ouzel *Turdus torquatus).*

Table 23 Species numbers across different taxonomic groups - inland rock outcrops, scree and limestone pavement

Taxonomic group	No. of species
Lichens	9
Bryophytes	3
Vascular plants	14
Invertebrates	5
Birds	1

Table 24 Species numbers across different restriction classes - inland rock outcrops, scree and limestone pavement

Restriction class	No. of species
Widespread	3
Localised	4
Restricted	8
Very restricted	17

6.99 Note that the lichen *Strigula stigmatella* is now extinct in the uplands but has been retained here for completeness (now entirely lowland in South East).

6.100 Figure 22 shows that these species are best represented in the north, particularly in the North West, reflecting the occurrence of extensive areas of upland rock such limestone pavement, natural rock exposures and screes.

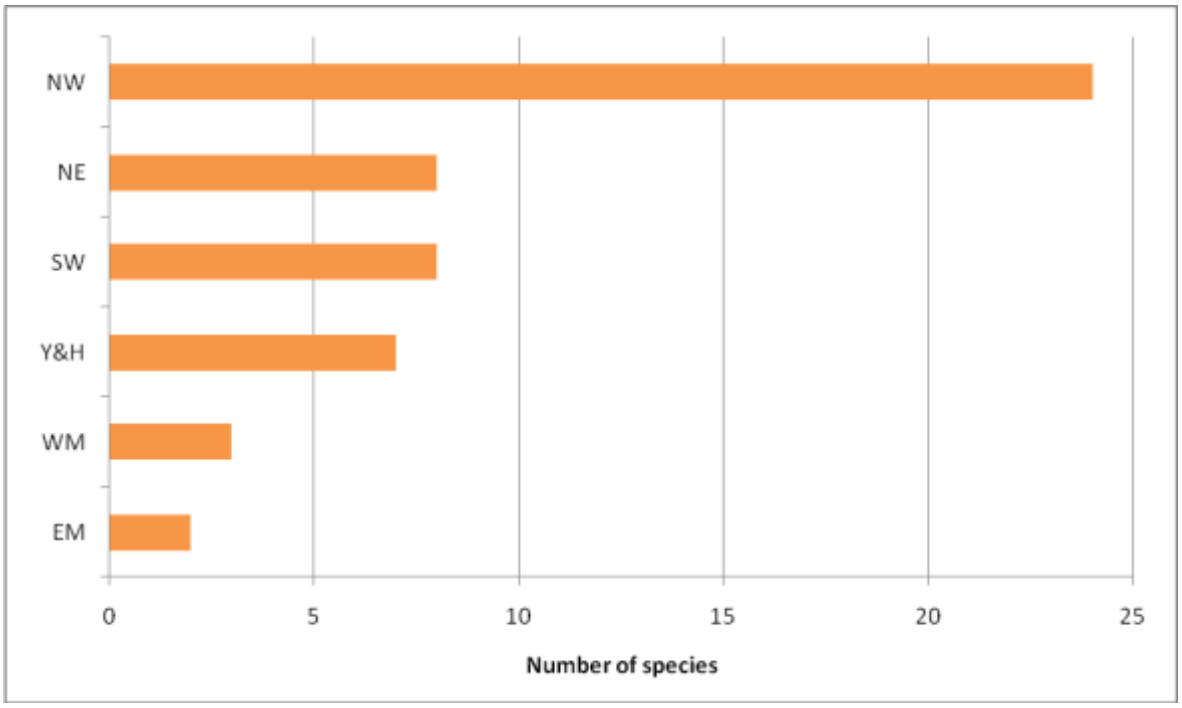

Figure 22 Regional distribution of UK BAP species associated with inland rock outcrops, scree and limestone pavement

Habitat / niche requirements

6.101 Figure 23 shows the niche/habitat requirements for UK BAP species associated with upland rock habitats.

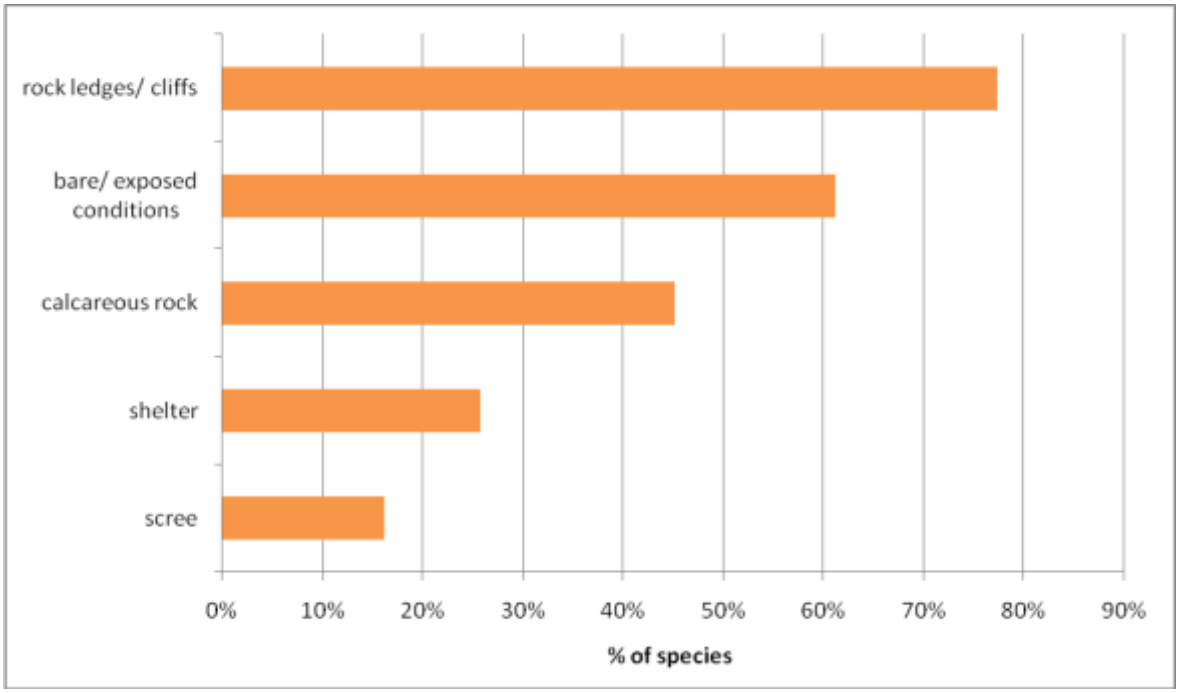

Figure 23 Habitat/niche requirements of UK BAP species associated with inland rock outcrops, scree and limestone pavement

6.102 Not surprisingly, a large proportion of species are associated with **rock ledges or open cliff faces** (77%) and also require **bare, exposed conditions** (61%). These include lichens such as *Stereocaulon delisei*, the moss *Grimmia elongata* and oblong woodsia *Woodsia ilvensis*.

6.103 Forty-five percent are found on **calcareous rocks**, including the lichen *Peltigera venosa* and red hemp-nettle *Galeopsis angustifolia*.

6.104 Seven species are associated with **limestone pavements**, two plants (holly-fern *Polystichum lonchitis* and frog orchid *Dactylorhiza viride*), one mason bee *Osmia parietina* and four butterflies (high brown *Argynnis adippe*, pearl-bordered *Boloria euphrosyne* and small pearl-bordered *B. selene* fritillaries and the northern brown argus *Aricia artaxerxes*.

6.105 The association with **open, unshaded conditions** is mostly exhibited by plants and probably relates to reduced competition in such a harsh environment. There is a lesser requirement for **sheltered conditions**, mainly by invertebrates (for example, pearl-bordered fritillary *Boloria euphrosyne*) using glades, crevices, grikes and the warm conditions on limestone pavements/rock outcrops.

Summary

6.106 There seems to be a strong association with open, exposed rock-faces for many of the species in this category. Whether this reflects a true requirement rather than a restriction due to competition with other species or a refuge from grazing animals is unclear. Conversely, the invertebrate species require some shelter in the form woodland glades or scrub.

6.107 Plants and animals associated with crags, scree and limestone pavements may require protection from damage or disturbance (for examples from walkers or rock climbers). Species associated with limestone pavement and screes and birds which nest on crags particularly require the habitat to remain intact and undisturbed.

Upland calcareous grassland

6.108 Upland calcareous grasslands occur on both enclosed and unenclosed land, largely on shallow lime-rich soils. They typically occur as components of habitat mosaics (for example, with rock outcrops, flushes, fens and swamps, scrub), which are managed as rough grazing land.

6.109 A total of 27 species are associated with upland calcareous grassland. These vary from generally more widespread bird and mammal species to rarer plants, lower plants and invertebrates.

Table 25 Species numbers across different taxonomic groups - upland calcareous grassland

Taxonomic group	No. of species
Fungi	2
Vascular plants	13
Invertebrates	8
Birds	3
Mammals	1

Table 26 Species numbers across different restriction classes - upland calcareous grassland

Restriction class	No. of species
Widespread	6
Localised	4
Restricted	4
Very restricted	13

6.110 Figure 24 shows that there are more UK BAP species associated with the north than the south, particularly the North West, thus reflecting the distribution of upland calcareous grassland. It should be noted that some species are also found in lowland habitats (South East and East of England – these have not been included in this distribution).

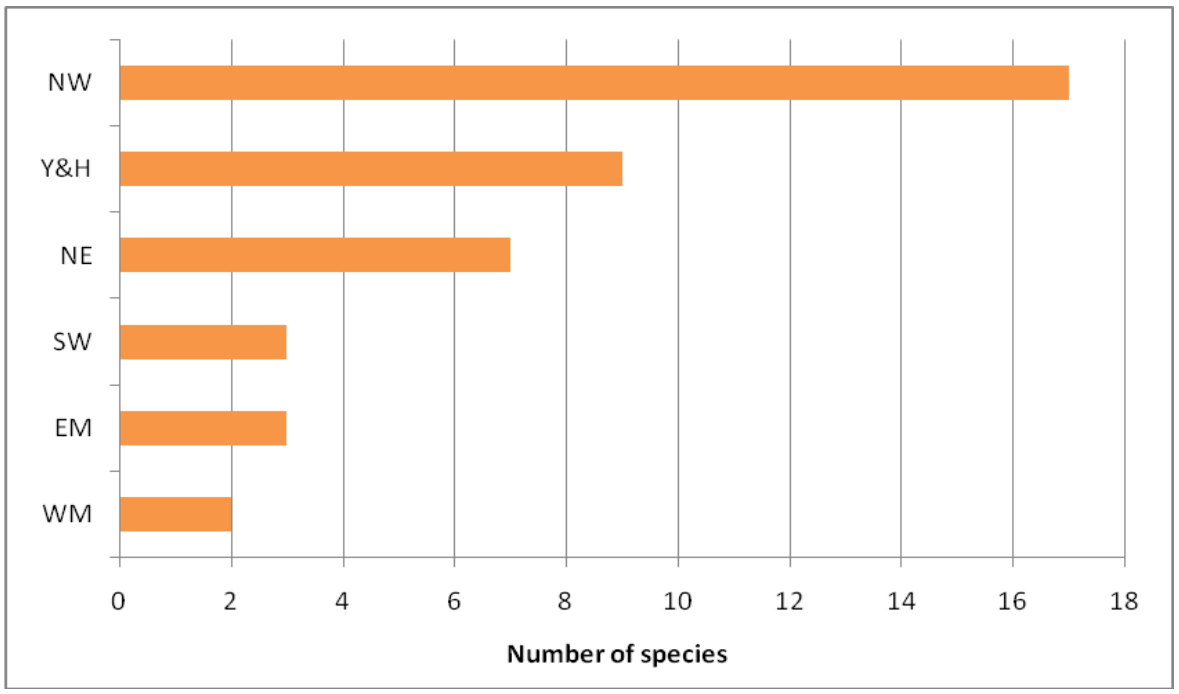

Figure 24 Regional distribution of UK BAP species associated with upland calcareous grassland

Habitat / niche requirements

6.111 Figure 25 shows the results of the habitat/niche analysis.

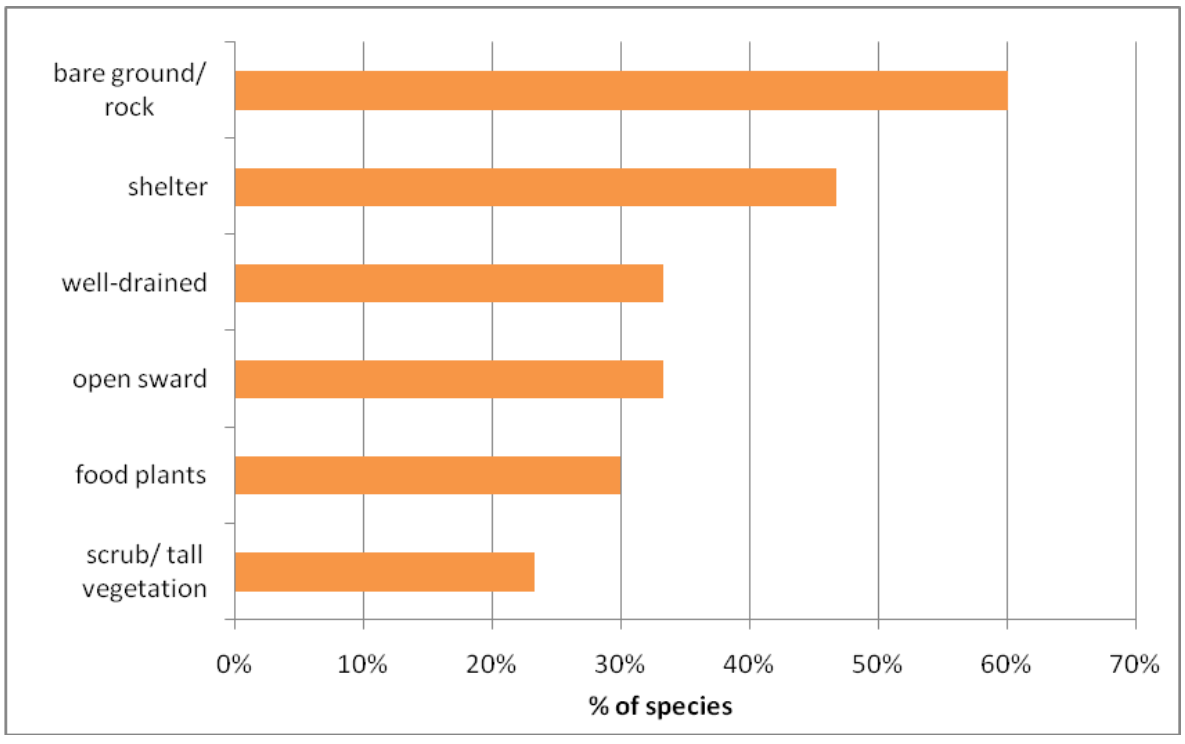

Figure 25 Habitat/niche requirements of UK BAP species associated with upland calcareous grassland

6.112 This analysis shows that:

- Sixty percent of species require **bare ground**, including **rock and sparsely vegetated habitats** (for example, the mining bee *Andrena tarsata*, pyramidal bugle *Ajuga pyramidalis*). Although not depicted in the figure, further analysis suggests that two thirds of these species also require **shelter** (mostly invertebrates such as the northern brown argus *Aricia artaxerxes* and small heath *Coenonympha pamphilus*);
- A third of species require **well-drained conditions** (for example, small white orchid *Pseudorchis albida*, mountain ringlet *Erebia epiphron)*, although hydrological requirements are not known for many of the other species;
- Twenty-three percent of species require **scrub** and/or other **tall vegetation** for nesting, roosting and foraging (for example, pearl-bordered fritillary *Boloria euphrosyne* and ring ouzel *Turdus torquatus*) and 30% depend on particular **food plants** (vegetation, nectar, pollen), including the butterflies and the forester *Adscita statices*; and
- Eighty percent of species require **unimproved grassland**, often associated with herb-rich areas and food plants (nectar/pollen).

Summary

6.113 The requirements for upland calcareous grassland species bear a strong resemblance to those of lowland grassland. As such, this summary suggests a very similar basis for integrating species' requirements into habitats as for lowland grassland.

6.114 It is very clear from the data that grassland structure is critical; small scale dynamics that help open and vary the sward structure should be seen as beneficial. This may include grazing, localised poaching, seasonal inundation and other activities that promote flower-rich patches. Calcareous grasslands that do not show structural complexity are likely to have a poor diversity and support fewer UK BAP species.

6.115 Particular resources are also important to the animals that utilise upland grasslands. The presence of flowers (nectar and pollen) and tall, large herbs (food plants and shelter) throughout the spring and summer are critical to a number of species. Therefore, intensive periods of grazing over extensive areas are not be suitable for many UK BAP species.

6.116 Grassland ecosystems require dynamic processes (such as extensive grazing or small-scale disturbance) and short periods of stability to produce valuable resources and niches such as scrub, bare ground, flowers and tall herbs.

Upland heathland and montane heaths

6.117 Upland heathland is characterised by the presence of dwarf shrubs covering at least 25% of an area on mineral soils or thin peat less that 0.5m deep. It is often found as part of a mosaic of habitats with blanket bog, grassland, scrub, woodland and rock habitats. Montane heaths are restricted to high-altitude mountain summits and ridges (above 600m) of northern England.

6.118 A total of 35 species are associated with upland heathland. Many heathland species also associated with other habitats, including woodland/scrub, grasslands and wetlands. Only twelve species are particularly associated with dwarf-shrub heath: five birds (red grouse *Lagopus lagopus*, black grouse *Tetrao tetrix*, hen harrier *Circus cyaneus*, twite *Carduelis flavirostris*, ring ouzel *Turdus torquatus*), two reptiles (adder *Vipera berus*, common lizard *Zootoca vivipara*), one mammal (mountain hare *Lepus timidus*) and four moths (grey mountain carpet *Entephria caesiata*, heath rustic *Xestia agathina*, northern dart *Xestia alpicola subsp. alpina* and neglected rustic *Xestia castanea*).

6.119 Six species are associated with montane heaths and willow scrub: one bird (ring ouzel *Turdus torquatus*); three plants (downy willow *Salix lapponum*, juniper *Juniperus communis*, small-white orchid *Pseudorchis albida)* and two invertebrate (northern dart moth *Xestia alpicola subsp. alpine*, mountain ringlet *Erebia epiphron*).

6.120 Widespread invertebrates and vertebrates (birds) form the majority of UK BAP species associated with upland heathland. A smaller number of species (mostly non-vascular and vascular plants and invertebrates) have a restricted distribution.

Table 27 Species numbers across different taxonomic groups - upland heathland / montane heaths

Taxonomic group	No. of species
Bryophytes	1
Vascular plants	6
Invertebrates	17
Reptiles	2
Birds	8
Mammals	1

Table 28 Species numbers across different restriction classes - upland heathland / montane heaths

Restriction class	No. of species
Widespread	14
Localised	14
Restricted	2
Very restricted	5

6.121 Figure 26 shows that more species are associated with the north, in particular the North West and North East, reflecting the most important regions for upland heathland in England. Some species are also associated with lowland heathland and are found in the south and eastern regions.

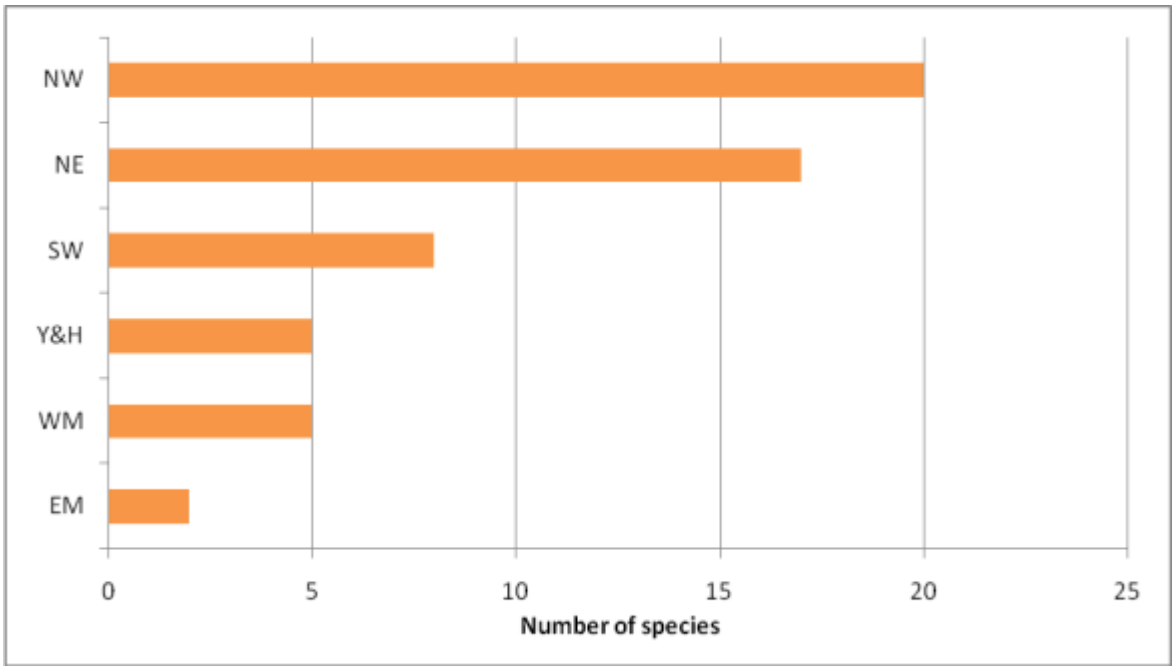

Figure 26 Regional distribution of UK BAP species associated with upland heathland

Habitat / niche requirements

6.122 Figures 27 and 28 show the habitat/niche requirements for species of upland heathland.

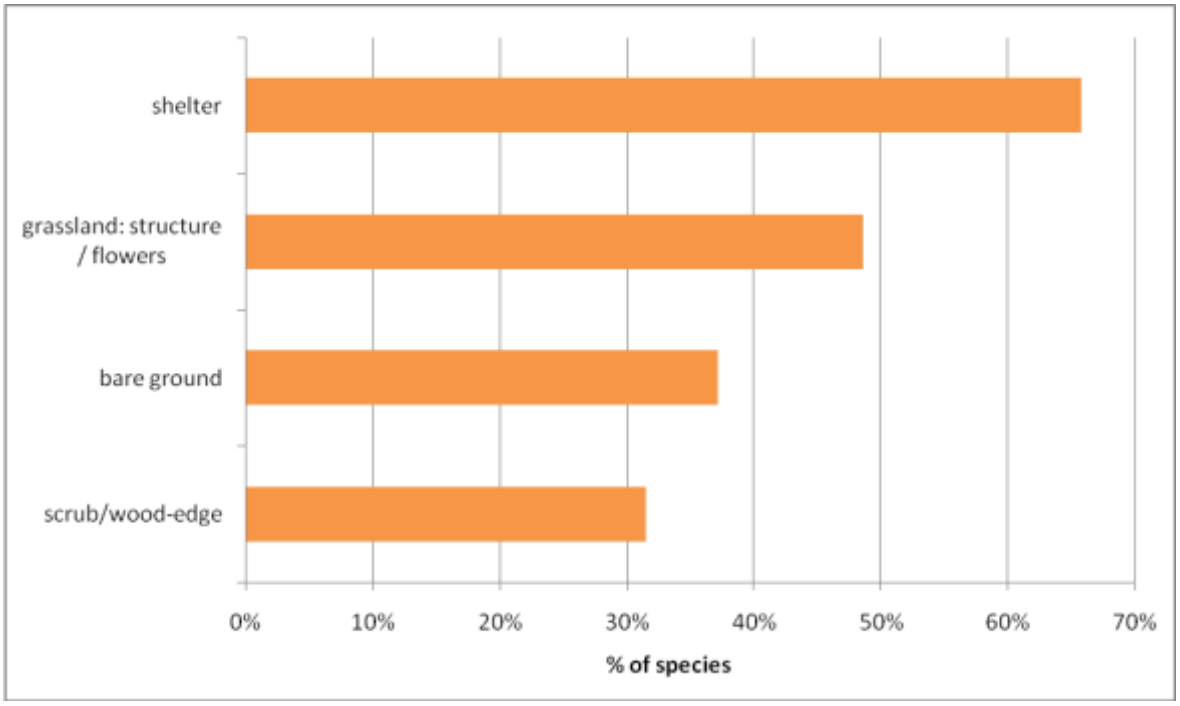

Figure 27 Habitat/niche requirements of UK BAP species associated with upland heathland

6.123 Figure 27 shows some of the most frequent requirements:

- **Shelter** is critical for 66% of all species (for example, the carder bee *Bombus muscorum*, common lizard *Zootoca vivipara*), whether this be **topographic shelter** or **scrub/woodland edge**;
- Thirty-one percent of species use **scrub/woodland edge** as resource for food, nesting or roosting (mainly birds and mammals such as black grouse *Tetrao tetrix*, cuckoo *Cuculus*

canorus) or are associated with it for the shelter it provides (mainly invertebrates such as petty whin weevil *Exapion genistae*);

- **Grassland** habitats are also a requirement for a half of all upland heathland species, providing both valuable shelter (important for 71% of species associated with grassland) for example, the adder *Vipera berus*, and a foodplant/nectar/pollen resource (40%) for example, the forester *Adscita statices*; and
- **Bare ground** is a requirement for a third of species (for example, northern dart moth *Xestia alpicola subsp. alpina*, common lizard *Zootoca vivipara*) and, of these, 77% also require shelter (thus a mosaic of bare ground within a matrix of scrub, tall vegetation and/or rocky outcrops is necessary).

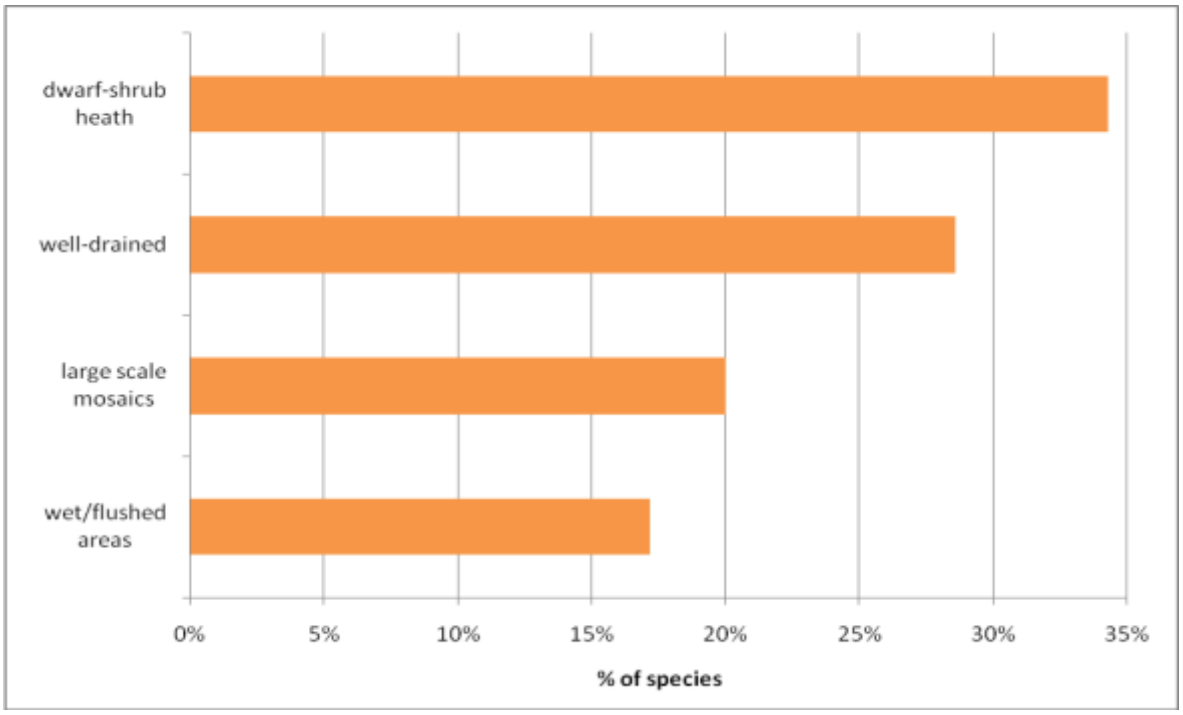

Figure 28 Habitat/niche requirements of UK BAP species associated with upland heathland

6.124 The further analysis of habitat/niche requirements shown in Figure 28 indicates that:

- Twenty-nine percent of species are associated with the **well-drained conditions of dry heath** (for example, juniper *Juniperus communis*, small-white orchid *Pseudorchis albida* and small heath *Coenonympha pamphilus*) whereas 17% require wetter conditions in the form of **wet heath, flushes and damp grassland** (for example, downy willow *Salix lapponum*, narrow-bordered bee hawk-moth *Hemaris tityus* and the curlew *Numenius arquata*);
- Only 34% of species have a particular association with **dwarf-shrubs** (for example, grey mountain carpet *Entephria caesiata*, red grouse *Lagopus lagopus*); and
- Twenty percent of species require **large scale mosaics** of heath, grassland, woodland and farmland. Most of these are birds (hen harrier *Circus cyaneus*, black grouse) or mammals (mountain hare *Lepus timidus*).

Summary

6.125 There are very few 'true' heathland species particularly associated with dwarf shrubs. In fact, most species do not require ericaceous scrub to complete their life cycles and are instead dependent on the overall structure and other niches/micro-habitats it supports. As a consequence, the maintenance and restoration of habitats dominated by ericaceous scrub should generally not be an overriding target for heathland management. Rather, dwarf shrubs should be seen as a single heathland feature which contributes to structural diversity, along with other features such as bare ground, grassland, scrub and wetlands.

6.126 Critically, for species requirements to be fully incorporated into upland heathland, a large number of niches and resources need to be made available. Upland heathland ecosystems require dynamic processes to produce and maintain mosaics of short and tall and open and closed vegetation along with patches of flowers and tall herbs. All these resources should be considered beneficial.

6.127 High quality heathlands are structurally diverse, containing stands of vegetation with heather at different stages of growth (including areas of mature heather). It is important to maintain as much structural diversity as possible in order to provide a range of habitats for species with widely differing requirements.

6.128 Some form of shelter is apparently of particular importance in the uplands. This can be defined as barriers (topographic or vegetational) that reduce wind speeds and encourage a warm and, for many species, humid microclimate.

6.129 Other examples of beneficial attributes which should be encouraged on heathland include:

- Small patches of herbaceous plants, such as umbellifers, yellow composites and legumes resulting from less intensive management/local nutrient enrichment;
- Dynamic scrub that develops throughout the site, in particular including birch, willow, gorse and hawthorn, without becoming dominant or developing into large blocks;
- Areas devoid of vegetation, in particular where this is in a small-scale mosaic with other habitat types; and
- Larger scale mosaics of habitats, such as wood-heath and grass-heath, are of high importance both for the shelter and the extra resources they provide.

6.130 Wet heathlands on shallow peaty soils also require structural diversity if they are to benefit the widest range of UK BAP species. Similar principles to those described above should be applied for these habitats, although hydrology and low nutrient status are also of critical importance for some species.

Upland hay meadows

6.131 Upland hay meadows are enclosed grasslands managed traditionally by cutting for hay or silage and with aftermath grazing by animals, and are largely confined to upland valleys of the north of England. They are characterised by tall, dense growth of grasses and abundance of herbaceous plant species.

6.132 Fourteen species are associated with upland hay meadows: eight birds (for example, sky lark *Alauda arvensis*, twite *Carduelis flavirostris*, curlew *Numenius arquata*), one mammal (brown hare *Lepus europaeus*) and five vascular plants (lady's mantles *Alchemilla* spp.).

Table 29 Species numbers across different taxonomic groups - upland hay meadows

Taxonomic group	No. of species
Birds	8
Mammals	1
Vascular plants	5

Table 30 Species numbers across different restriction classes - upland hay meadows

Restriction class	No. of species
Widespread	6
Localised	2
Restricted	3
Very restricted	3

6.133 The habitat / niche requirements of these species are very similar to other grassland species identified in the section on lowland farmland. These include the requirement of the widespread and localised vertebrates for **structure** and associated **trees and scrub** for food, nesting and shelter. Smaller scale structure at the sward level is also critical, with a wide range of **sward heights and openness** needed across the different species.

6.134 The vascular plants are associated with open **herb-rich swards** and thus unimproved, low nutrient soils and many of the bird species depend on an **abundance of invertebrates or seeds** for foraging.

6.135 Majority of the vertebrate species require **large scale mosaics** of heathland, grassland, woodland and farmland. Most of these are birds (for example, twite *Carduelis flavirostris*, lapwing *Vanellus vanellus*, black grouse *Tetrao tetrix*) which forage in grasslands and nest on adjacent moorland habitats.

6.136 Upland hay meadows support very few invertebrates compared to pastures. This is largely due to the annual cutting of the sward interrupts the life-cycle of many species. Hay meadows and surrounding hedgerows and scrub also provide an important food source for nectar feeding species during the period before they are cut. Aftermath grazing by animals also provide areas rich in dung which supports many invertebrates, an important food source for foraging bats and birds.

6.137 The value of upland hay meadows for different species groups depends upon the location, extent and management of the grassland. In general, to maintain the species composition and structure requires the existing management to be continued (such as low inputs of nutrients, grazing and annual cutting).

Lakes and ponds habitat requirements

6.138 A total of 97 UK BAP species are associated with the Lakes and Ponds BIG category. As well as aquatic and truly wetland species, it includes species that, although utilising lakes and ponds for foraging (for example, bats) are not necessarily reliant on them. The priority habitats included within this category, and the numbers of species associated with each, are shown below.

Table 31 Distribution of species across the different priority habitats - Lakes and Ponds

Priority habitat	No. of associated UK BAP species
Lakes including: Eutrophic standing waters Mesotrophic lakes Oligotrophic and dystrophic lakes Aquifer-fed naturally fluctuating water bodies	40
Ponds	77

6.139 Summaries of the taxonomic groupings and restriction classes of the lakes and ponds species are given below.

Table 32 Species numbers across different taxonomic groups - Lakes and Ponds

Taxonomic group	No. of species
Lichens	3
Fungi	1
Stoneworts	8
Bryophytes	11
Vascular plants	31
Invertebrates	23
Fish	7
Birds	1
Amphibians/reptiles	5
Mammals	7

Table 33 Species numbers across different restriction classes - Lakes and Ponds

Restriction class	No. of species
Widespread	11
Localised	18
Restricted	18
Very restricted	49
Unknown, probably very restricted or extinct	1

6.140 Lakes and ponds support a relatively high number of lower and vascular plant, invertebrate and fish species. Many of these are restricted or very restricted.

Overall summary

6.141 Twenty of the 40 UK BAP species associated with lakes are restricted to this habitat, with only one species restricted to Eutrophic standing waters, three restricted to Mesotrophic Lakes and one to Mesotrophic and Oligotrophic/Dystrophic Lakes. Two species are associated with Aquifer-fed Naturally Fluctuating Water Bodies, although they both occur in other water bodies as well.

6.142 Around half of the 77 species associated with ponds are restricted to this habitat.

6.143 Three regions hold the largest concentration of UK BAP lake-associated species (East of England, North West and South West) and the South East, South West and East of England hold the largest concentrations of UK BAP pond-associated species. No variation in species requirements between regions could be detected.

6.144 For both lakes and ponds, general resources such as high water quality, seasonal fluctuation (i.e. natural hydrology) and open, unshaded habitat are identified as being very important and, for ponds in particular, should form the basis for landscape projects (for example, creation of pools in unpolluted catchments).

6.145 For lakes, other factors more closely associated with particular sites/geographical areas, such as cool water fish (for example, Vendace *Coregonus albula*, Artic charr *Salvelinus alpines*) and base-rich water, are also clearly important but are not general requirements.

6.146 Connectivity with other water bodies and other habitats is an important attribute for widespread generalist species in both habitat types.

6.147 The Lakes and Ponds, Wetlands and Rivers BIG categories should not be considered in isolation. Each one shares traits and characteristics and, as such, each shares a number of species. As well as sharing many similar traits, they often grade into one another - a valley will contain a floodplain, water bodies and flowing water, all of which comprise a wetland complex consisting of a number of priority habitats in the different BIGs.

6.148 Rivers, in particular will have a profound effect on other habitat types including the formation of fens, oxbow lakes and temporary water bodies. It is therefore particularly important that the Rivers BIG recognises this and acts as a custodian for all of the associated habitats.

Lakes

6.149 The distribution of the 40 UK BAP species associated with lakes across the different restriction classes (excluding one extinct species) and taxonomic groups is shown below:

Table 34 Species numbers across different taxonomic groups - lakes

Taxonomic group	No. of species
Lichens	3
Stoneworts	4
Bryophytes	3
Vascular plants	10
Invertebrates	3
Fish	7
Amphibians/reptiles	2
Birds	1
Mammals	7

Table 35 Species numbers across different restriction classes - lakes

Restriction class	No. of species
Widespread	10
Localised	9
Restricted	5
Very restricted	15

6.150 Only five species are restricted to or strongly associated with particular priority habitats:

- Floating water plantain *Luronium natans* (Mesotrophic or Oligotrophic Lakes);
- Grass-wrack pondweed *Potamogeton compressus* (Mesotrophic or Eutrophic Lakes and rivers/canals);
- Slender naiad *Najas flexilis* (Mesotrophic Lakes);
- Holly-leaved naiad *Najas marina* (Mesotrophic Lakes); and
- Ribbon-leaved water-plantain *Alisma gramineum* (Eutrophic Standing Waters).

6.151 Four of these species are found in five or less sites in England.

6.152 Figure 29 shows the relationship between the numbers of species in each taxonomic groups and their restriction class within England for UK BAP lake-associated species.

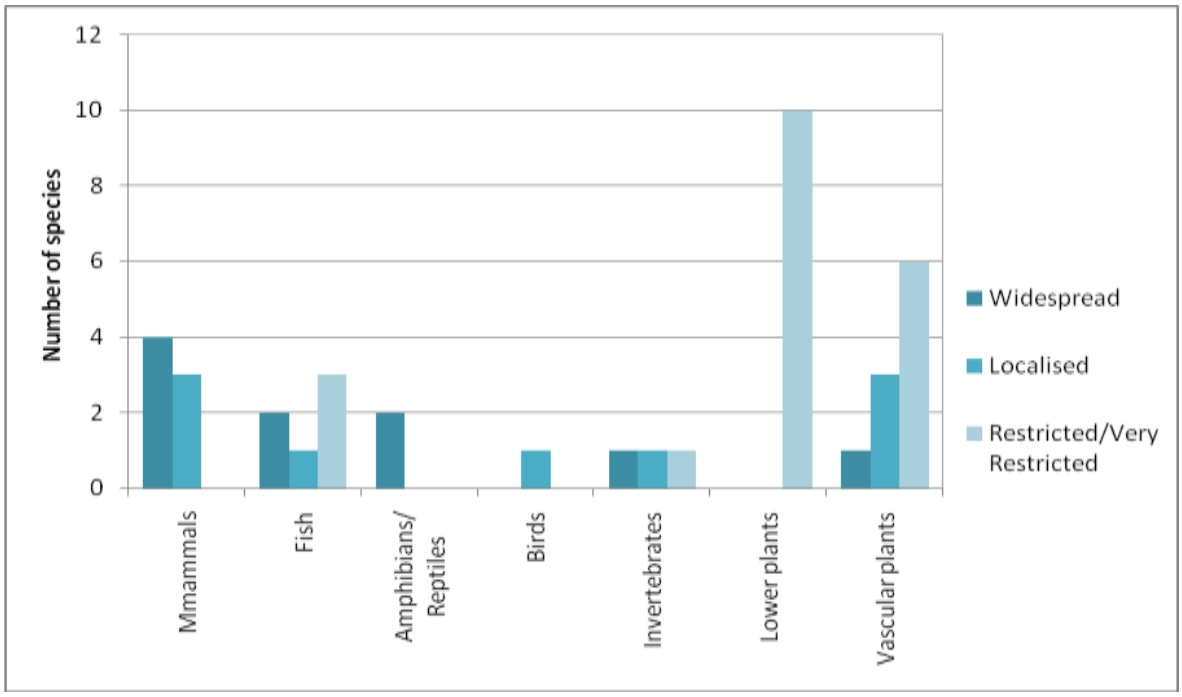

Figure 29 Relationship between taxonomic group and restriction class of UK BAP species associated with lakes

6.153 Vascular and lower plants (including stoneworts), fish and mammals are the best represented taxonomic groups, with a high proportion of all except the mammals being restricted or very restricted. Widespread and localised species are all vertebrates (mainly mammals including bats and the otter *Lutra lutra*) with the exception of a single invertebrate (white-clawed crayfish *Austropotamobius pallipes*). All of these are generalist wetland species.

6.154 Figure 30 shows the distribution of species particularly associated with the different regions. It highlights three regions with the greatest number of UK BAP species associated with lakes – East of England (Broads), North West (Lakes District) and South West (Slapton Ley), although other regions such as the West Midlands (Meres and Mosses) hold a number of restricted species.

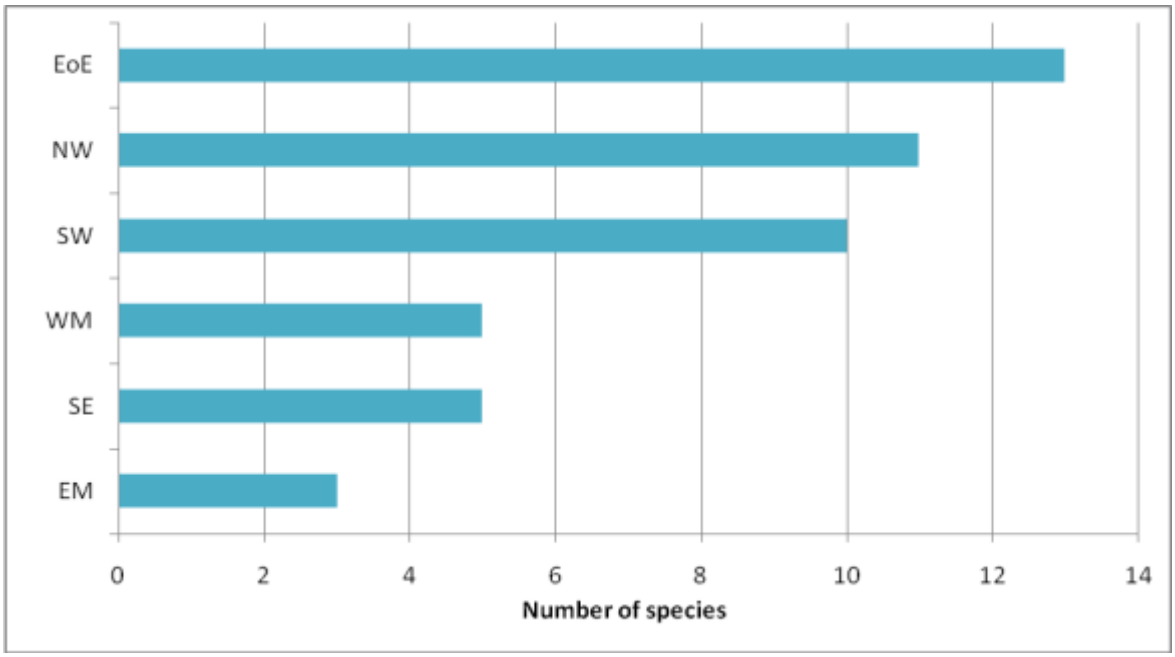

Figure 30 Regional distribution of UK BAP species associated with lakes

Habitat / niche requirements

6.155 Figure 31 displays the proportion of species in the different restriction classes which are dependent on specific habitat attributes.

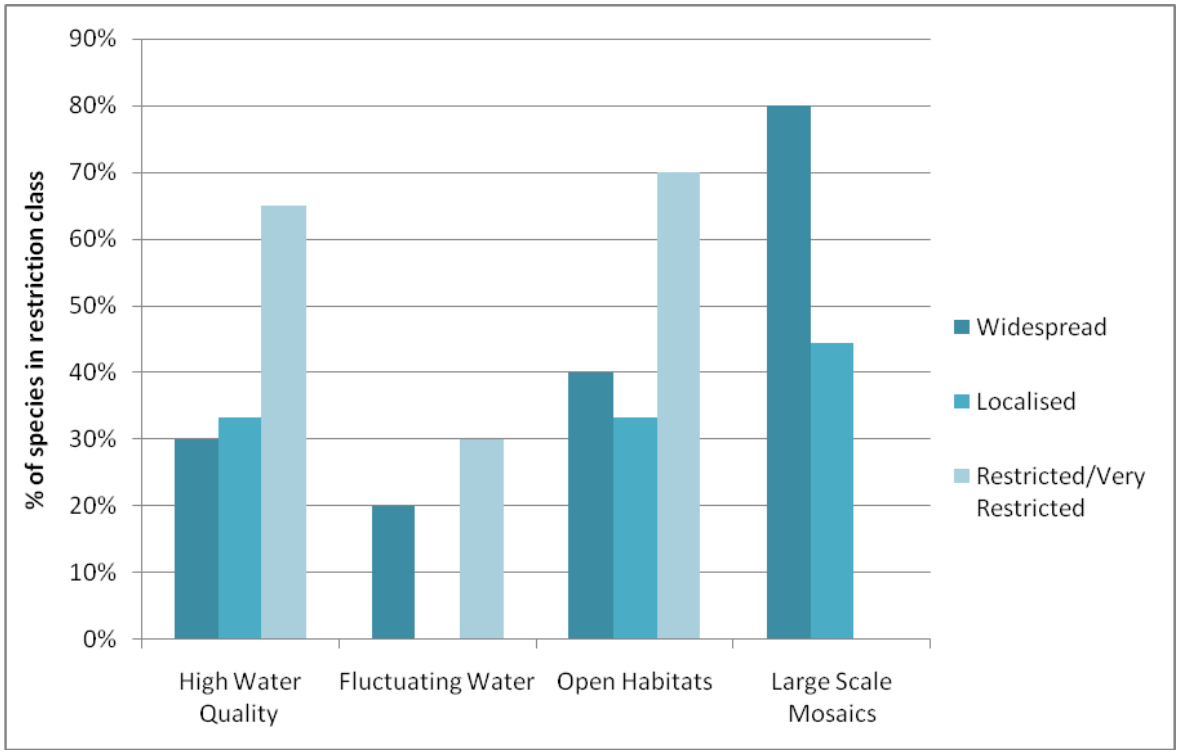

Figure 31 Proportion of UK BAP lake species requiring particular habitat attributes in each restriction class

6.156 This shows that restricted and very restricted species have a strong association with:

- **High water quality** (for example, starry stonewort *Nitellopsis obtuse*, holly-leaved naiad *Najas marina*, round-leaved Bryum *Bryum cyclophyllum*, tubular water-dropwort *Oenanthe fistulosa*);
  Open, unshaded conditions (for example, ribbon-leaved water-plantain *Alisma gramineum*, narrow small-reed *Calamagrostis stricta*, zircon reed beetle *Donacia aquatic*); and, to a lesser extent
- **Fluctuating water levels** and thus **drawdown zones** with **bare mud** (for example, strapwort *Corrigiola litoralis*,). Note that species requiring seasonal water fluctuations may not tolerate man-made fluctuations at inappropriate times of the year.

6.157 Connectivity with **larger scale mosaics** of wetland and other habitats is a requirement for a much greater proportion of widespread and localised species. All of these are highly mobile vertebrates (mainly fish and mammals), many of which use lakes for foraging and resting. These species are less affected by issues of water quality and small-scale niche requirements.

Summary

6.158 The data above suggests that although increasing connectivity and lake extent/abundance will benefit the more widespread vertebrate species, these improvements alone will not cater for many of the more localised or restricted UK BAP species. Rather, these improvements should go hand-in-hand with improvements to habitat quality. As a broad guideline, three critical factors affecting UK BAP species are:

- Unshaded lake edges. Trees and scrub will out-compete fringing and emergent herbaceous vegetation or make muddy banks unsuitable for invertebrates. This is important because the

great majority of plants and invertebrates use the fringes of water bodies and are very rarely found in the deeper, open water at the lake's centre.

- Seasonal fluctuations leading to the formation of mud, sand or shingle drawdown zones are an important habitat for many species. These species are generally active in the spring and summer, so factors that interrupt/alter the natural hydrology/fluctuations (for example, incompatible reservoir management) can be very detrimental.
- Water quality and nutrient status. Eutrophication, leading to a high nutrient status and associated consequences (for example, algal cover and competition), is a major cause of concern for many of the more restricted UK BAP species, which cannot tolerate such conditions.

6.159 These three factors can all be managed and should be key requirements in landscape designs if these restricted species are to benefit.

6.160 There are a number of species which require more specific habitat attributes related to factors such as water chemistry (for example, base-rich conditions), temperature and lake depth. For these species, appropriate habitat management should be targeted at those sites where they are still present.

Ponds

6.161 There are 77 UK BAP species associated with ponds of which 57 are restricted to them. These species are often found in ponds and other small water bodies, for example ditches particularly within grazing marshes.

Table 36 Species numbers across different taxonomic groups - ponds

Taxonomic group	No. of species
Fungi	1
Bryophytes	6
Stoneworts	8
Vascular plants	26
Invertebrates	22
Fish	1
Amphibian	4
Reptile	1
Birds	1
Mammals	7

Table 37 Species numbers across different restriction classes - ponds

Restriction class	No. of species
Widespread	10
Localised	16
Restricted	15
Very restricted	36

6.162 Species associated with ponds include widespread wetland generalists, such as the water vole *Arvicola terrestris*, otter *Lutra lutra* and white-clawed crayfish *Austrapotamobius pallipes*, widespread pond species, such as the common toad *Bufo Bufo* and great crested newt *Triturus cristatus* and a number of very restricted pond specialists including Norfolk bladder-moss *Physcomitrium eurystomum*, tadpole shrimp *Triops cancriformis* and fen raft spider *Dolomedes plantarius*.

6.163 Figure 32 shows the relationship between the numbers of species in each taxonomic group associated with the different restriction classes. The majority of widespread species are vertebrates (mostly mammals and amphibians/reptiles), whereas the restricted and very restricted species are mainly plants and invertebrates.

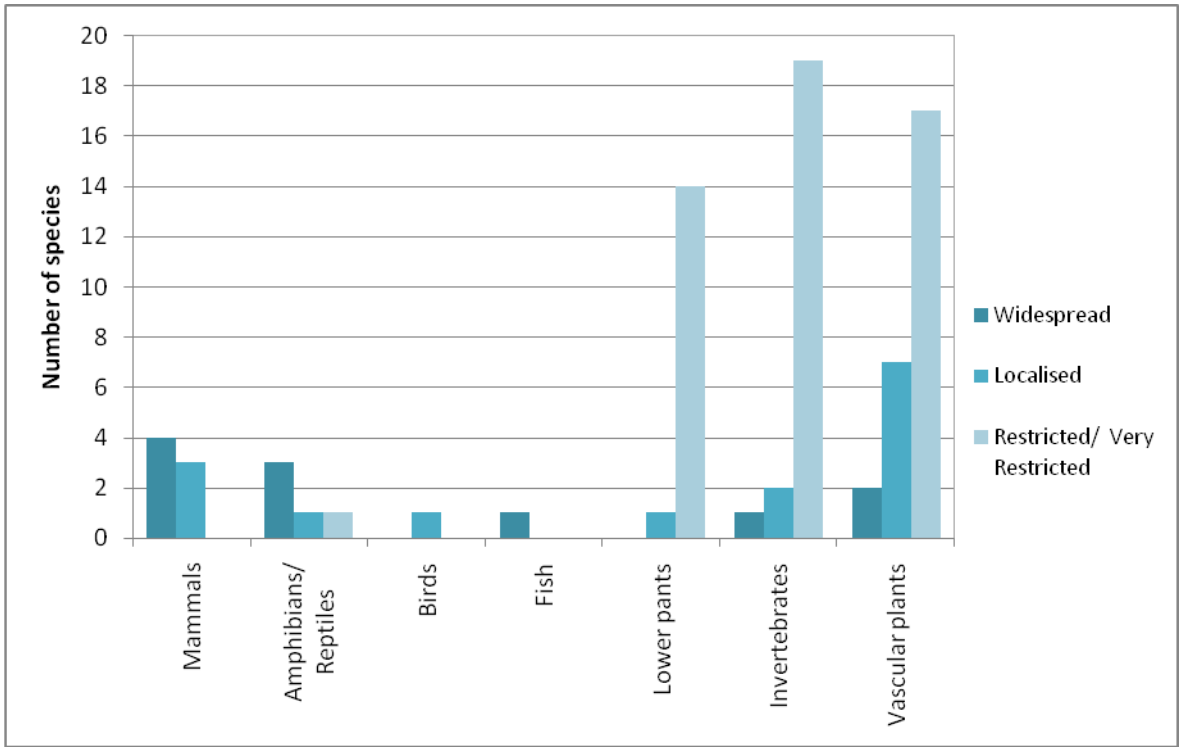

Figure 32 Relationship between taxonomic group and restriction class of UK BAP species associated with ponds

6.164 Figure 33 shows the regional association of UK BAP species associated with ponds. The South East, South West and the East of England are particularly important for species associated with this priority habitat.

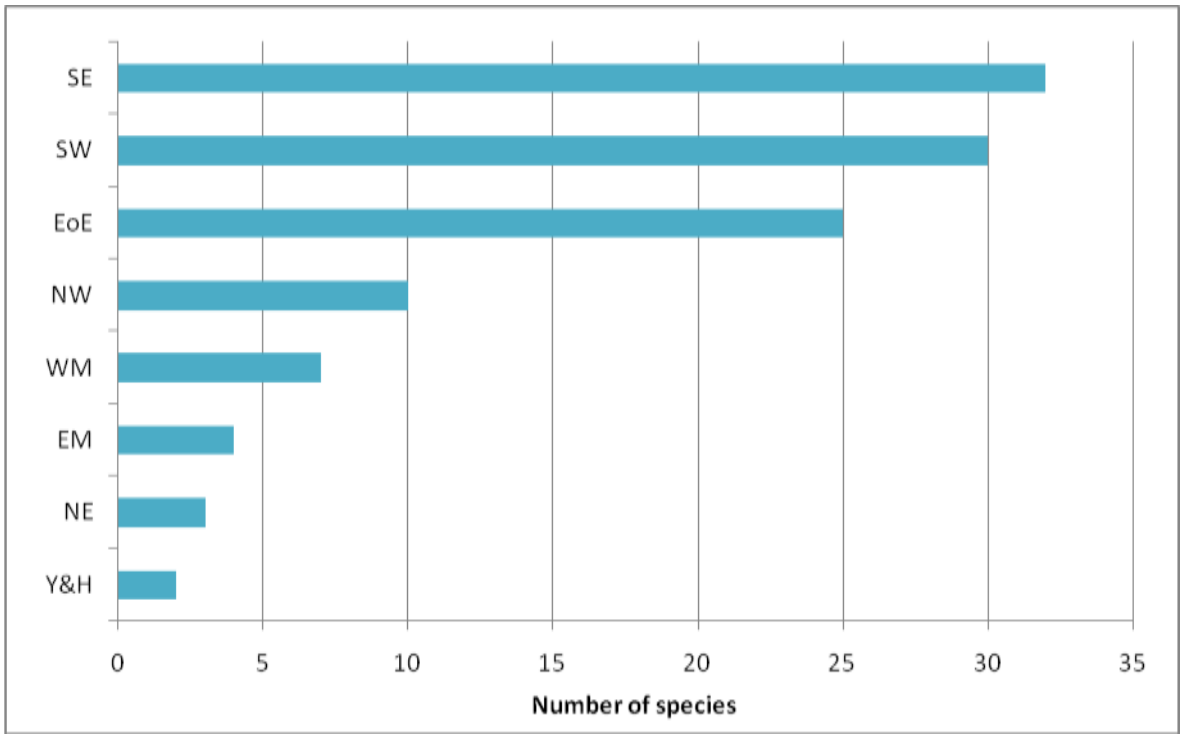

Figure 33 Regional distribution of UK BAP species associated with ponds

Habitat / niche requirements

6.165 Figure 34 shows the main habitat zones utilised by UK BAP species. For this analysis only the critical habitat zone has been included (as an example, water beetles also utilise terrestrial habitats but this is probably less critical than their dependence on aquatic habitats).

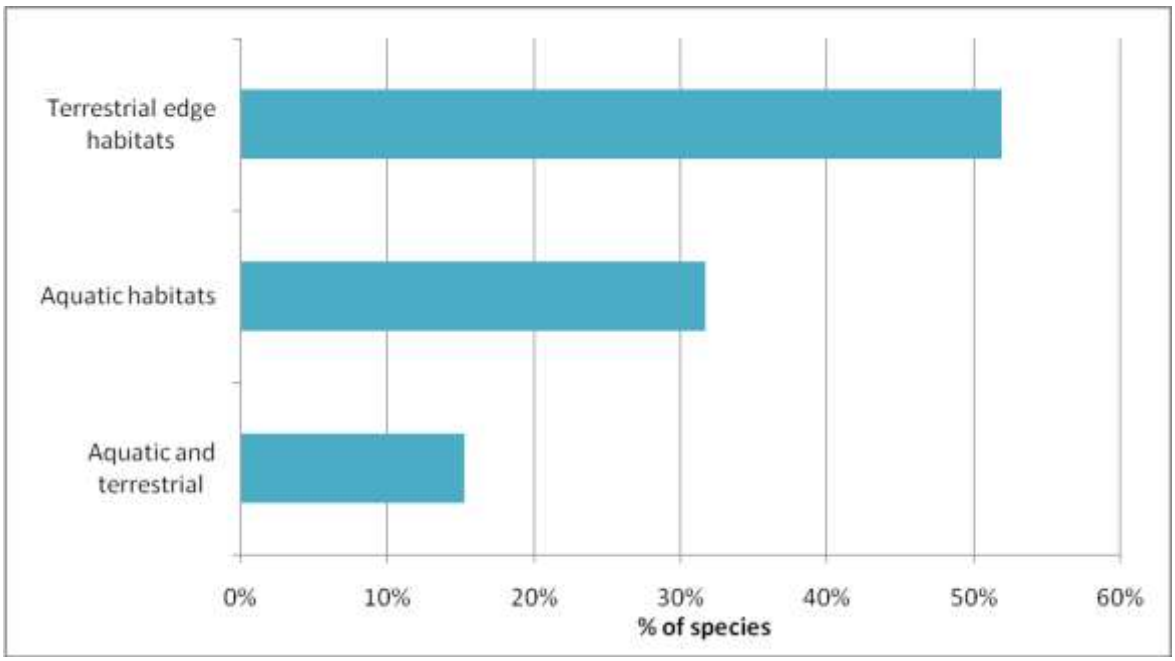

Figure 34 Habitat zones used by UK BAP species associated with ponds

6.166 This analysis shows that more species are reliant on the surrounding habitat than those purely associated with aquatic habitats (31%). Also:

- Seventy-five percent of the purely aquatic species are also reliant on **high water quality** (for example, stoneworts *Chara* spp., spangled diving beetle *Graphoderus zonatus*); and

- Sevety-nine percent of the species utilising only terrestrial habitats require **seasonal drawdown** zones associated with fluctuating water levels (mostly bare mud/sand and associated microhabitats). It should be noted that species dependent on fluctuating water levels (for example, petalwort *Petalophyllum ralfsii*, creeping marshwort *Apium repens*) are seasonal and would not tolerate man-made fluctuations at inappropriate times of the year.

6.167 Figure 35 displays the proportion of species in different distribution classes utilising different niche/resource requirements.

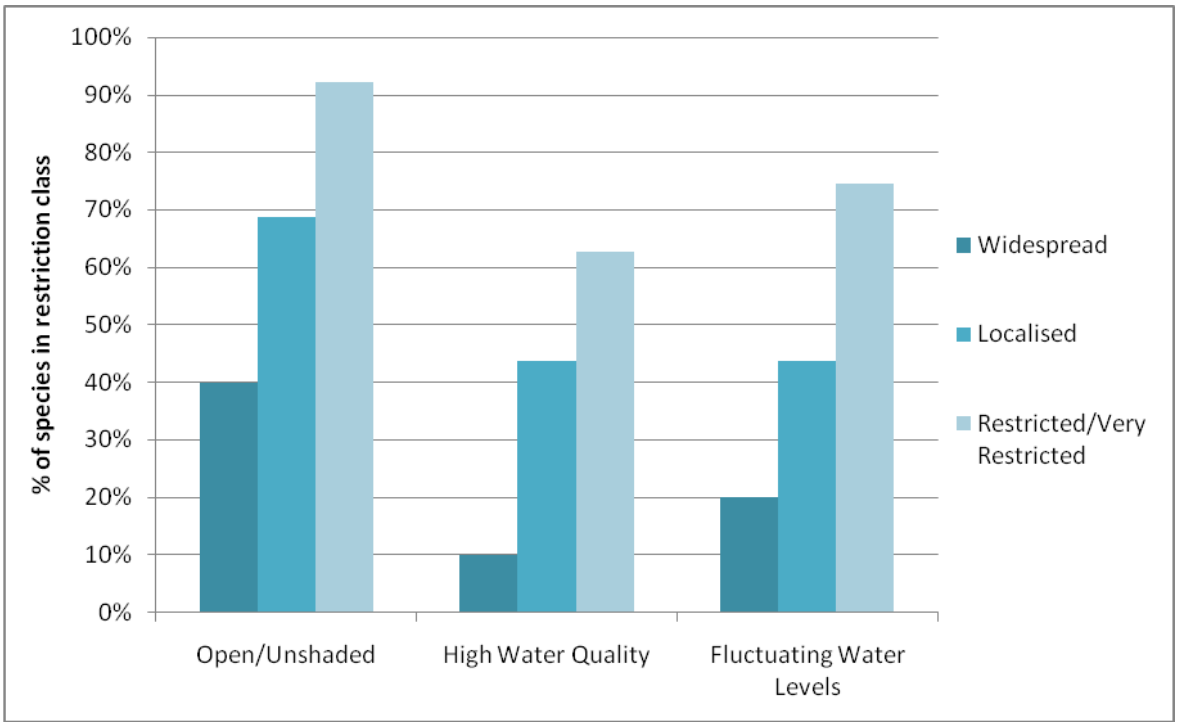

Figure 35 Proportion of UK BAP Pond species requiring particular habitat attributes in each restriction class

6.168 This shows that the requirements for **open/unshaded conditions**, **high water quality** and **fluctuating water levels** are particularly associated with the more localised and restricted species such as toothed threadwort *Cephaloziella dentata*, starfruit *Damasonium alisma*, oxbow diving beetle *Hydroporus rufifrons* and mud pond snail *Omphiscola glabra*.

6.169 Further analysis of these data shows that all but two of the widespread species (tubular water-dropwort *Oenanthe fistulosa* and marsh stitchwort *Stellaria palustris*) are reliant on **large scale mosaics** rather than any particular niche or resource requirement. They consist almost entirely of mammals and amphibians (for example, water vole, common toad).

Summary

6.170 Perhaps the most surprising result from this analysis is the identification of seasonally fluctuating water levels as being important for such a high proportion (53%) of UK BAP species associated with ponds. The concept that wet bare mud is of such high importance is perhaps not widely accepted within the Biodiversity community and its benefits (along with the importance of bare ground in fully terrestrial systems) should be strongly advocated.

6.171 Ponds are naturally ephemeral; any given pond will undergo vegetation succession until all open water is lost. This should not necessarily be seen as a bad thing as long as replacement ponds are created.

6.172 Taking all of this into account, ‘pondscapes’ should be identified as being areas with high densities of ponds and other wetland habitats. These should be:

- Dynamic, by allowing ponds to develop and facilitating the creation of new ones (naturally or otherwise);
- Fed only by catchments with high water quality; and
- Shallow and variable in profile, rather than bowl-shaped depressions in the ground.

Rivers habitat requirements

6.173 The rivers priority habitat includes a very wide range of river types, encompassing all natural and near-natural (i.e. with features and processes that resemble those in 'natural' systems) running waters in England. These range from tiny headwater streams to large lowland rivers with extensive floodplains.

6.174 Seventy-six UK BAP species are associated with river habitats, although two of these are considered extinct. One overall analysis of all species associated with rivers was undertaken. This gives an indication of what niches and habitats are required for UK BAP species in rivers generally.

Table 38 Distribution of species across the different priority habitats - Rivers

Priority habitat	No. of associated UK BAP species
Rivers	76
Chalk rivers	14
Active shingle rivers	20

6.175 A further analysis was undertaken to identify species associated with the following river sub-types and features identified as being of particular national priority for conservation:

- **Chalk rivers** - a restricted sub-type including 35 rivers in the South and East of England. Fourteen species are associated with chalk rivers, of which only three have a strong association: southern damselfly *Coenagrion mercuriale*, Thames rams-horn snail *Gyraulus acronicus* and the fine-lined pea mussel *Pisidium tenuilineatum*.
- **Exposed Riverine Sediments (ERS)**, a feature of **active shingle rivers** and other rivers with predominantly sandy sediments. Twenty species are associated with active shingle rivers, of which 8 species are found on exposed riverine sediments (for example, the beetles - *Meotica anglica*, *Hydrochus nitidicollis*, *Bembidion testaceum*).

6.176 A breakdown of the taxonomic groupings of these species associated with rivers is given below.

Table 39 Species numbers across different taxonomic groups - Rivers

Taxonomic group	No. of species
Mammals	8
Fish	11
Reptiles	1
Vascular plants	11
Lower plants	12
Invertebrates	33

Table 40 Species numbers across different restriction classes - Rivers

Restriction class	No. of species
Widespread	17
Localised	17
Restricted	10
Very restricted	29
Extinct or occasional visitor	3

6.177 Of the 72 extant species associated with rivers roughly half are restricted or very restricted. Figure 36 shows the association between restriction class and taxonomic group.

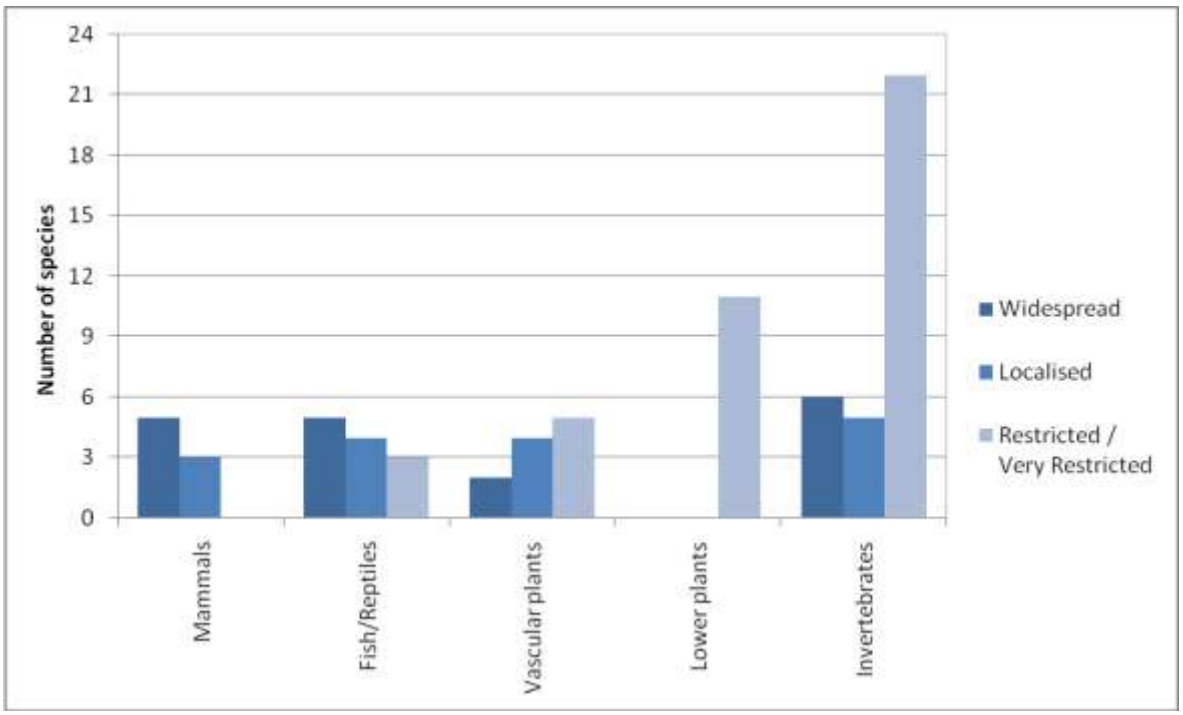

Figure 36 Relationship between taxonomic group and restriction class of UK BAP species associated with rivers

6.178 This shows that the distribution of the taxonomic groups across the restriction classes follows a pattern similar to most other semi-natural habitats: a large number of very restricted invertebrates and lower plants occurring alongside a smaller number of widespread vertebrates (including, in this case, a high proportion of fish species). The mammals include a number of bat species which feed over rivers as well as a range of other habitats.

6.179 Figure 37 shows the important regions for river species.

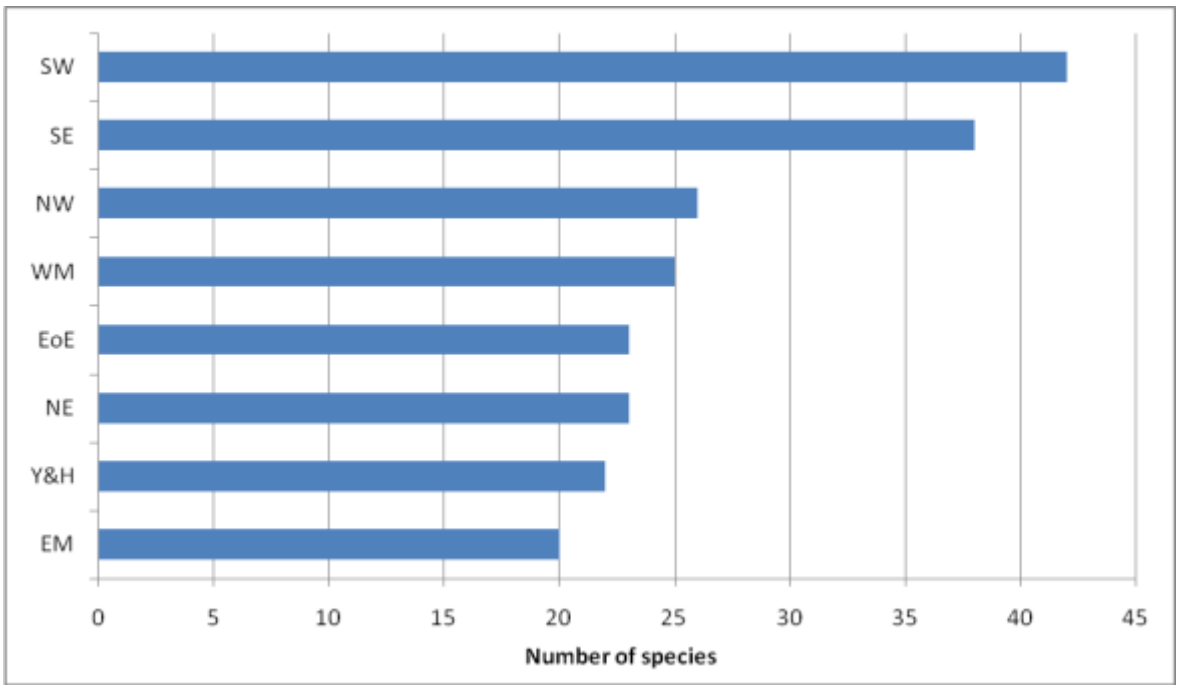

Figure 37 Regional distribution of UK BAP species associated with rivers

6.180 This shows that the South West and South East regions are of particular importance for the greatest number of UK BAP species. This due to the association of a number of very restricted invertebrates and plants with rivers in these regions, and for pelagic fish species that utilise the warms seas, estuaries and the rivers in southern England.

Habitat / niche requirements

6.181 There are two broad groups of river species, those occurring in the **river channel** itself (in-channel) and those found in **associated floodplain habitats** (non-channel).

6.182 Of the 76 species associated with rivers around 41 are restricted to in-channel habitats and 35 associated with non-channel habitats. The division between these groups is not absolute and some occur in both zones, using similar habitats in both rivers and the adjacent floodplain wetlands (see Figure 38).

6.183 The **river channel** group includes:

- Aquatic species (for example, fine-lined pea mussel *Pisidium tenuilineatum*, various fish); and
- Terrestrial species of exposed riverine sediments (for example, the beetle *Bembidion testaceum*).

6.184 The **associated floodplain** species are those that do not occur in the river channel but instead are associated with river bank and floodplain habitats or feed over the water surface. These include:

- Species that utilise both rivers and other wetlands (for example, tubular water-dropwort *Oenanthe fistulosa* which lives on the edges of rivers and ponds);
- Species that hunt over rivers (for example, bats); and
- Species found almost exclusively on river banks or floodplains and are inextricably linked to riverine processes, although they are not necessarily in-channel species (for example, the Tansy beetle *Chrysolina graminis* which feeds on Tansy *Tanacetum vulgare* growing along river banks).

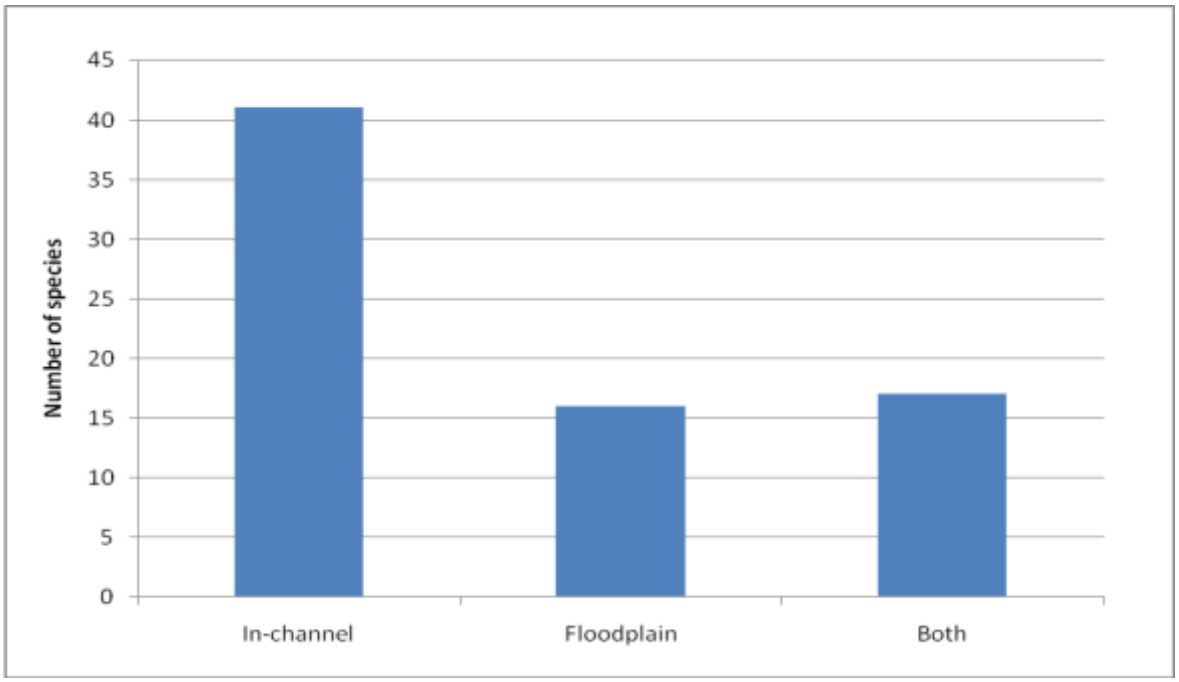

Figure 38 Number and percentage of species associated with in-channel and associated river floodplain habitats

6.185 Figure 39 shows the habitat / niche requirements of UK BAP species associated with rivers.

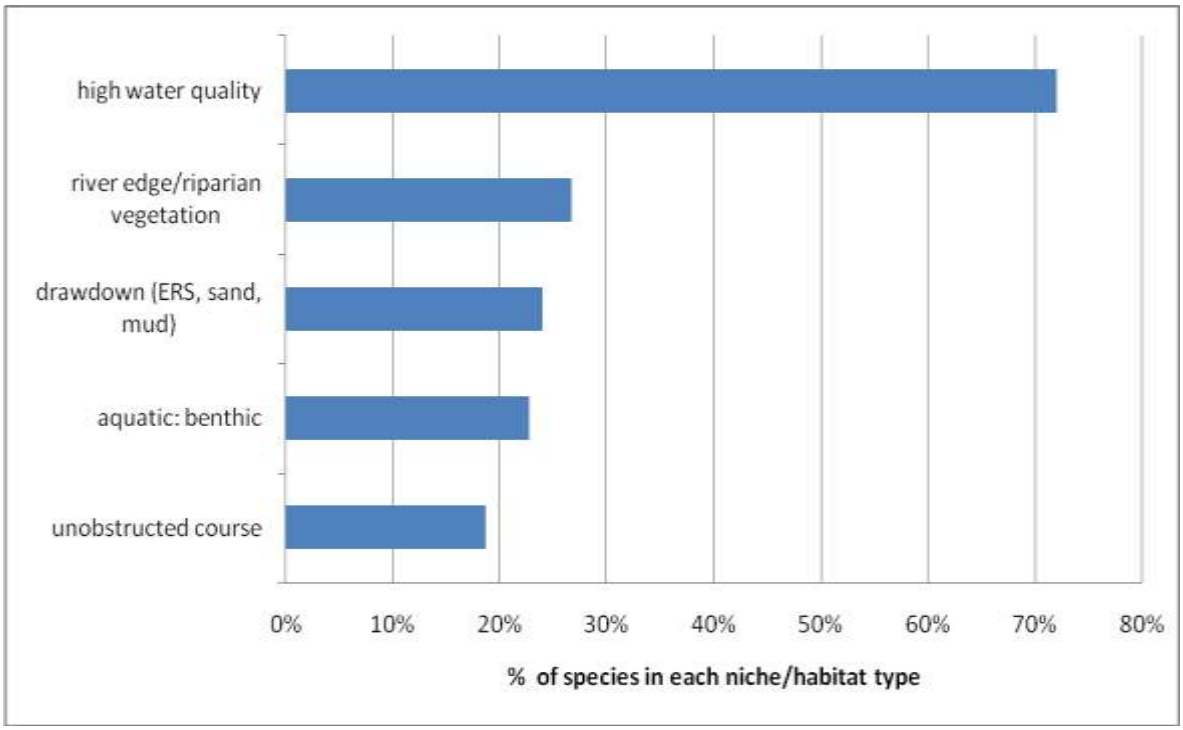

Figure 39 Habitat/niche requirements of UK BAP species associated with rivers

6.186 Analysis of habitat/niche requirements of river species shows that:

- Over 70% of species require **high water quality** (related to important factors such as high oxygen levels, un-silted gravel beds, abundance of prey);
- Twenty-seven percent of species are associated with **marginal and riparian vegetation** (related to the provision of overhead cover, shelter, shaded condition, food for juveniles etc.) which supports a range of river processes, as well as acting as habitat in its own right;

- Twenty-four percent of species are associated with **drawdown zones** and **exposed riverine sediments** along the river (sand banks, river shingle, mud) or in the floodplain (at the edges of oxbow lakes);
- Twenty-three percent of species live on the river bed. These **aquatic benthic species** require specific flow rates and, almost invariably, high water quality - specifically these species have a very low tolerance of organic pollution;
- Nineteen percent of species are highly **mobile pelagic animals** (mostly fish) that need complete river systems that are **unobstructed** and contain varied habitat niches, such as backwaters, gravel beds, riffles and pools for spawning; and
- Twelve percent of species require in-channel **coarse woody debris** (helps provide shelter and food and suitable conditions for larval development, spawning and nursery sites, refuges etc). Many more species also indirectly benefit from woody debris as part of their life cycle (for example, it helps species such as mayflies, caddis and stoneflies to emerge from the larval to adult stage).

6.187 A further analysis was undertaken of the habitat requirements of river species by splitting them into in-channel species and associated river-floodplain species (see Figure 40).

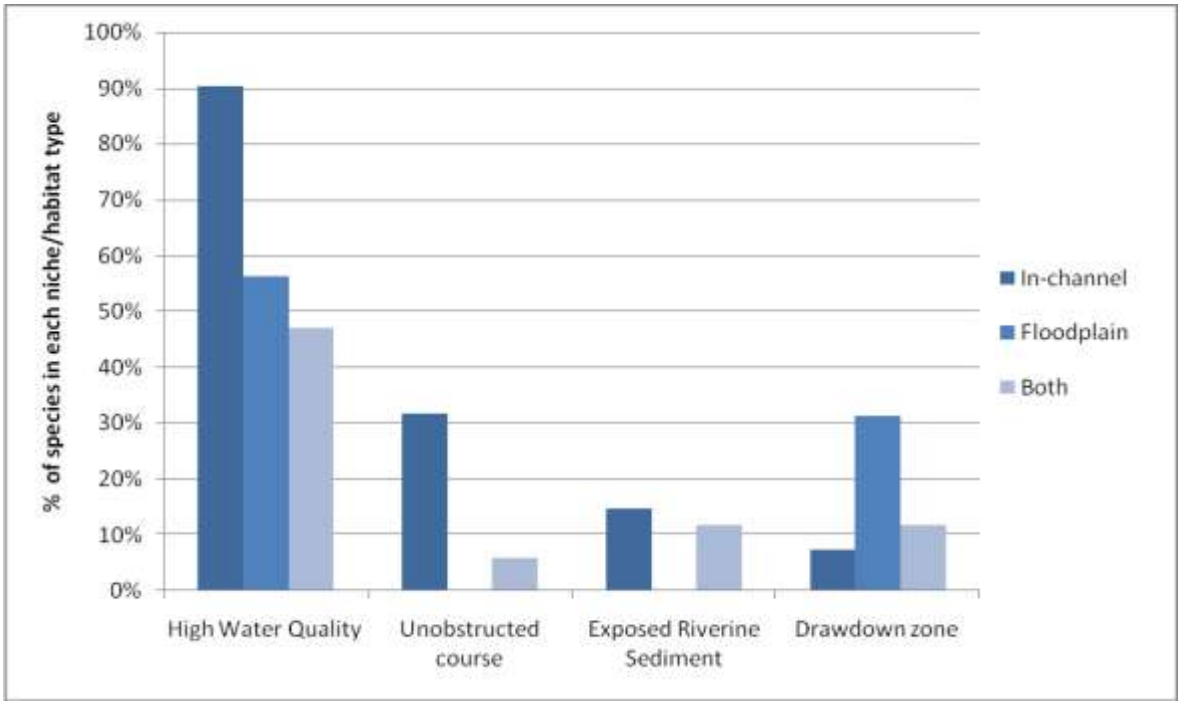

Figure 40 Habitat/niche requirements of in-channel and associated floodplain species

6.188 As would be expected, a higher proportion of in-channel species require high water quality, unobstructed courses and exposed riverine sediments. Both in-channel and floodplain species utilise drawdown zones. As an example, invertebrate species often use both the drawdown zone of rivers and the adjacent floodplain wetlands.

6.189 Flow rate was also analysed as it strongly affects available habitats (see Figure 41). This analyses of those species for which a flow rate preference is known clearly shows that a high proportion of restricted or very restricted species are associated with fast flowing rivers. Conversely, a greater proportion of widespread and localised species can tolerate a range of flow rates (i.e. variable). These, apart from the otter *Lutra lutra* and white-clawed crayfish *Austropotamobius pallipes* are all fish species.

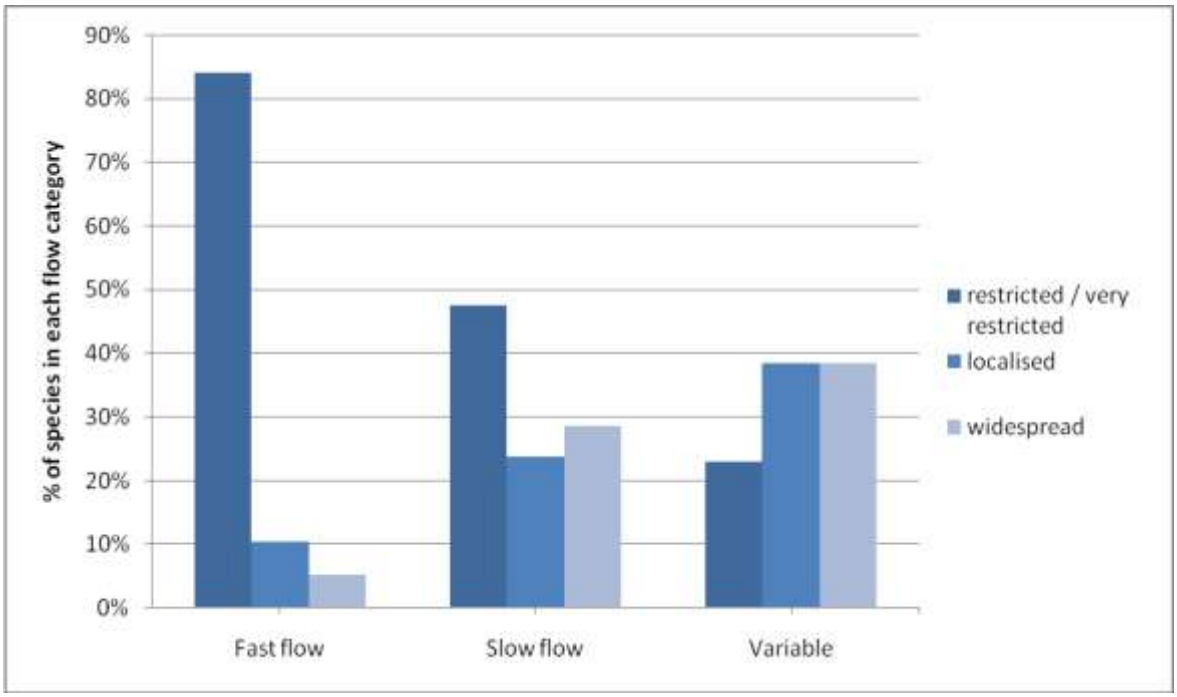

Figure 41 Association of species in different restriction classes with river flow rate

Summary

6.190 Individual rivers show great variation in their character from source to sea as they increase in size (width, depth and flow), decline in gradient and collect increasing amounts of nutrients and fine sediment. This provides a range of environmental conditions suited to different plants and animals.

6.191 Four critical factors have been identified for UK BAP species associated with English rivers:

- **High water quality**. This is required by most of the in-channel species (for example, fish and both fully aquatic and river edge invertebrates) and many associated floodplain species (for example, mud pond snail *Omphiscola glabra*, true fox-sedge *Carex vulpina*). 'High water quality' is necessary for all species affected by nutrient enrichment, siltation and toxic pollution. For many species, the link to high water quality is not direct (for example otters require a reasonable water quality for fish to be present; *Bembidion testaceum* requires a high water quality so its habitat, river shingle, does not silt up or become smothered with plant growth).
- **Drawdown zones** are of particular importance for species associated with exposed riverine sediments in fast-flowing rivers (for example, southern silver stiletto-fly *Cliorismia rustica*, shingle rove beetle *Meotica anglica*). Naturally fluctuating water levels are critical for maintaining these habitats.
- **Unobstructed natural river systems** with a wide range of natural habitats. Not only do such conditions benefit migratory species such as salmon *Salmo salar*, river lamprey *Lampetra fluviatilis*, and the otter *Lutra lutra*, they also benefit associated floodplain species (for example, through their functional importance to standing waters and many other wetlands).
- **Riparian vegetation** is an integral part of a river system, supporting a range of river processes, as well as acting as habitat in its own right. This is important in providing overhead cover and invertebrate prey for fish (for example, brown trout *Salmo trutta*, salmon) and other species; maintaining the integrity of the banks and reducing erosion. Ultimately it is also a source of woody debris and contributes to overall river diversity.

6.192 Most riverine habitats are strongly influenced by flow regime: emergent vegetation develops in slow-flowing rivers and exposed riverine sediments are a feature of fast-flowing rivers. In many instances it is necessary for flow rates to be as ‘natural’ as possible. For example, species living on drawdown zones do so at particular times of the year (usually spring and summer) and then require major flooding events in the autumn and winter to prevent plant succession smothering their habitats. Pulses of water or periods of low flow at other times will have detrimental effects on such species.

6.193 For rivers to properly incorporate the requirements of species, the factors outlined above need to be taken onto consideration when planning and undertaking river management and/or restoration projects. This will often require the reversal of anthropomorphic effects which alter water quality, flow and the river’s physical character. It should be noted that this analysis has not taken into account biological stress generated by fish-stocking and non-native invasive species.

6.194 As the majority of our rivers are already in a state of being heavily modified by us, the emphasis of any plan to integrate species needs should be on whole river restoration and subsequent monitoring rather than any species-specific action.

6.195 The importance of natural processes and structure should be recognised by the Rivers BIG as being critical for river ecosystems to adapt to climate change in the future. An approach based on natural processes should be adopted to the delivery of ecosystem services such as flood risk management.

6.196 The focus of the Rivers BIG must be on the river habitat, seeking to ensure that suitable conditions are secured for whole characteristic biological communities to thrive, including BAP priority species to the extent that these are characteristic of the habitat under conditions of high environmental quality.

6.197 The Lakes and Ponds, Wetlands and Rivers BIG categories should not be considered in isolation. Each one shares traits and characteristics and, as such, each shares a number of species. As well as sharing many similar traits, they often grade into one another - a valley will contain a floodplain, water bodies and flowing water, all of which comprise a wetland complex consisting of a number of priority habitats in the different BIGs.

Wetland habitat requirements

6.198 A total of 119 UK BAP species are associated with the Wetland BIG. As well as those species which are restricted to wetlands, this total includes animals which, although benefitting from these habitats (for example, for foraging), are not necessarily reliant on them.

6.199 The wetland category includes the following priority BAP habitats:

Table 41 Distribution of species across the different priority habitats - Wetland

Priority habitat	No. of associated UK BAP species
Lowland fen	75
Lowland raised bog	23
Reedbed	22
Coastal and floodplain grazing marsh	47

6.200 Breakdowns of the taxonomic groupings and restriction classes of the 119 species associated with wetlands are given below. Invertebrate species make up by far the greatest proportion, with relatively few lower plants and fungi. There is a relatively high number of restricted and very restricted species (56% of the total).

Table 42 Species numbers across different taxonomic groups - Wetland

Taxonomic group	No. of species
Fungi	3
Stoneworts	4
Bryophytes	6
Invertebrates	53
Vascular plants	22
Fish	1
Amphibians/reptiles	5
Birds	18
Mammals	7

Table 43 Species numbers across different restriction classes - Wetland

Restriction class	No. of species
Widespread	29
Localised	23
Restricted	18
Very restricted	49

Overall summary

6.201 Many of those species not dependent solely on wetlands require large scale mosaics of both priority and non-priority habitats including grazing marsh, wet woodlands and open water.

6.202 Structural diversity within open habitats (such as scrub, bare mud, flower-rich areas), water quality and hydrological regimes are all important for wetland specialists, many of which tend to operate at a much smaller scale than the more generalist species.

6.203 More species are associated with the lowland fen priority habitat than other priority habitats within the Wetland BIG. These species are characterised by their requirement for open habitats, permanent water levels and nutrient-poor conditions. Additionally, there is a significant number of 'fen' species (eight) that require fluctuating water levels; these may require specific management at certain sites resulting in at least some water fluctuation.

6.204 Species associated with lowland raised bog can be split into two groups: generalists that require structural diversity in the form of scrub or woodland and specialists that thrive in open, nutrient-poor wetlands with very stable water levels. Both types of species can be catered for by promoting core areas of high quality wetland buffered by fringing areas of more structurally diverse habitat.

6.205 Reedbeds support the fewest species of which many are generalists found in various wetland (and non-wetland) habitats.

6.206 The common niche requirements of grazing marsh species were the most difficult to define as this priority habitat represents a land-use rather than a distinct habitat.

6.207 The three BIG habitat categories of Lakes and Ponds, Wetlands and Rivers should not be considered in isolation. Each one shares traits and characteristics and, as such, each shares a number of species. As well as showing many similar traits, they often grade into one another - a valley will contain a floodplain, water bodies and flowing water, all of which comprise a wetland complex consisting of a number of priority habitats in different BIGs.

6.208 Rivers, in particular, will have a profound effect on other habitat types including the formation of fens, oxbow lakes and temporary water bodies. It is therefore particularly important that the Rivers BIG recognises this and acts as a custodian for all associated habitats.

Lowland fen

6.209 Seventy-five species are associated with lowland fen, with a large proportion of these being restricted or very restricted in range. Of these, 28 species are considered to be restricted to fen habitats.

Table 44 Species numbers across different taxonomic groups - lowland fen

Taxonomic group	No. of species
Fungi	3
Bryophytes	1
Stoneworts	4
Vascular plants	13
Invertebrates	41
Fish	1
Amphibians/reptiles	4
Birds	3
Mammals	5

Table 45 Species numbers across different restriction classes - lowland fen

Restriction class	No. of species
Widespread	17
Localised	12
Restricted	10
Very restricted	36

6.210 Figure 42 shows the association between numbers of species in each taxonomic group with the restriction classes.

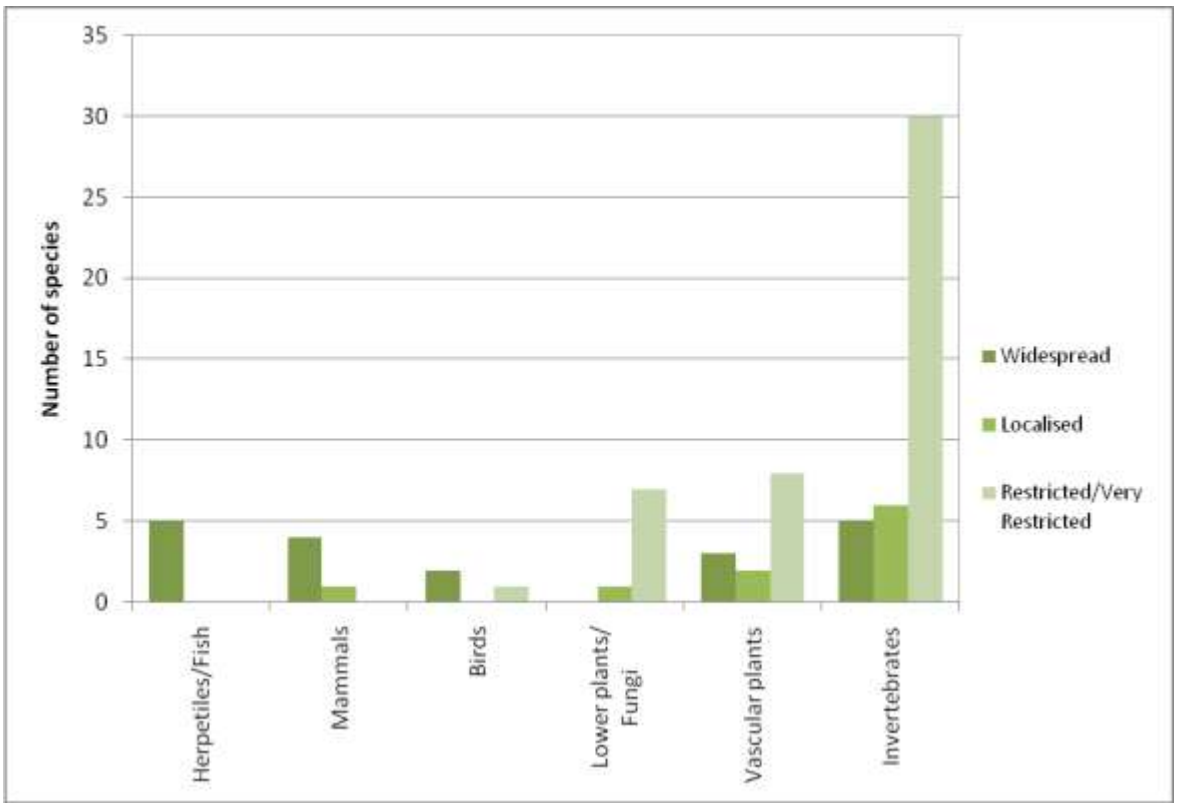

Figure 42 Relationship between taxonomic group and restriction class for UK BAP species associated with lowland fen

6.211 Forty-one species of invertebrates are associated with lowland fens and of these 73% are in the restricted and very restricted classes. All but one of the eight lower plants/fungi are also restricted or very restricted.

6.212 Figure 43 shows regional association of lowland fen species.

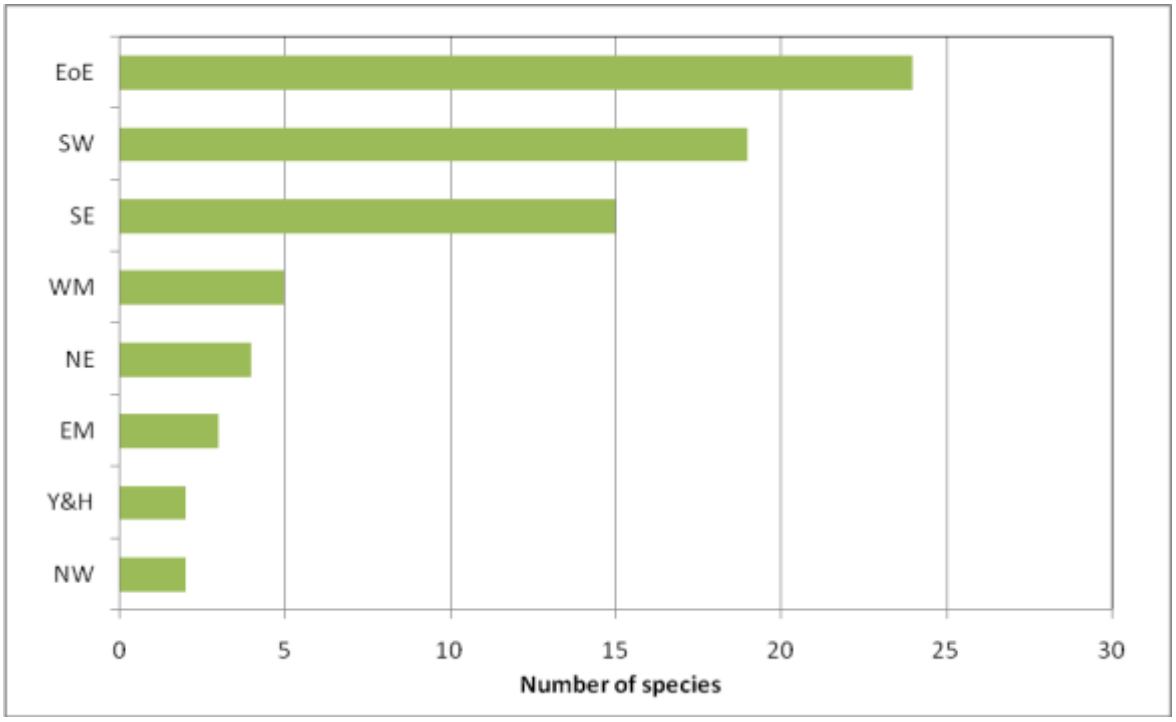

Figure 43 Regional distribution of UK BAP species associated with lowland fen

6.213 This highlights which regions have been flagged as important for a given UK BAP species. The East of England and the southern regions have the greatest number of lowland fen BAP species.

Habitat / niche requirements

6.214 Figure 44 shows some requirements of species within restriction classes.

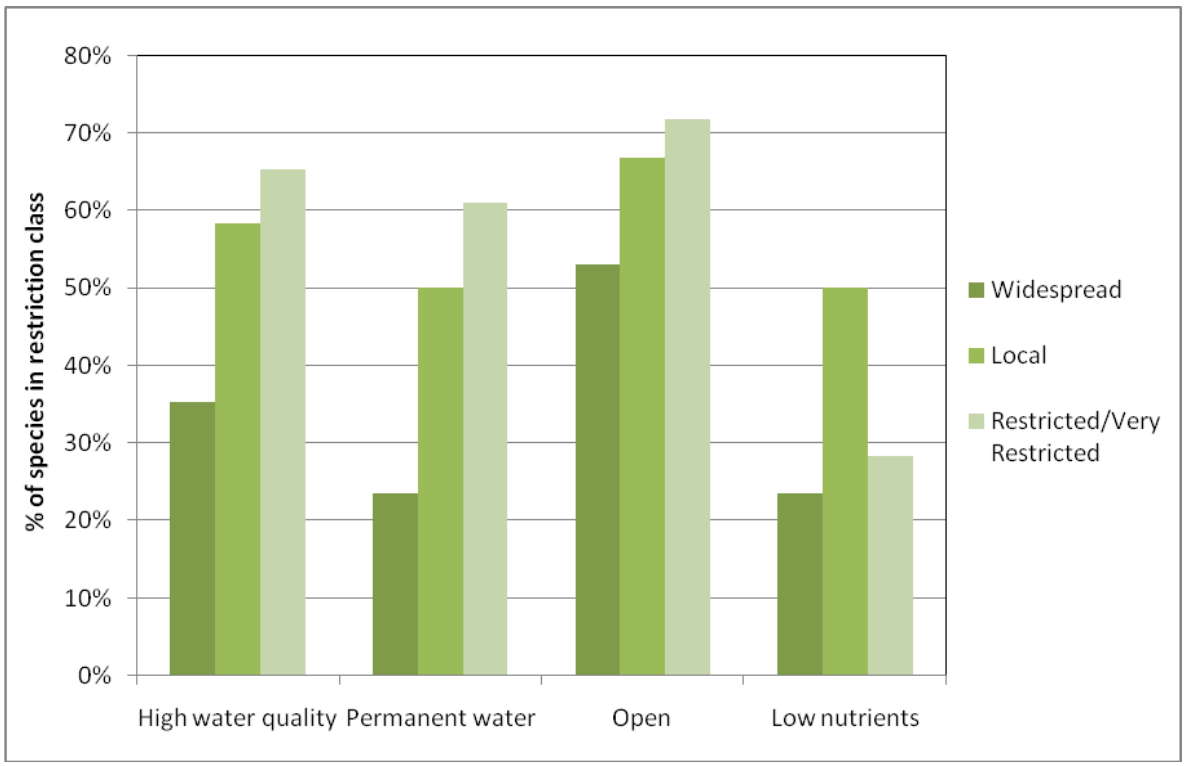

Figure 44 Proportion of UK BAP lowland fen species in restriction classes requiring particular habitat attributes

6.215 The requirements for **high water quality**, a **permanently high water table** and **open** (not shaded by vegetation) conditions are associated with the more **restricted species** such as the fungus *Bovista paludosa*, the fen raft spider *Dolomedes plantarius* and fen wood rush *Luzula pallidula*. Note that although many species require **stable water levels**, there are a number of fen species such as the mud pond snail *Omphiscola glabra*, tubular water-dropwort *Oenanthe fistulosa* and the ground beetle *Agonum scitulum* which require **fluctuating water levels**.

6.216 The requirement for **low nutrients** is less strongly associated with restricted species.

6.217 Figure 45 separates the generalist species from those species which are largely restricted to lowland fens species and highlights their resource / niche requirements.

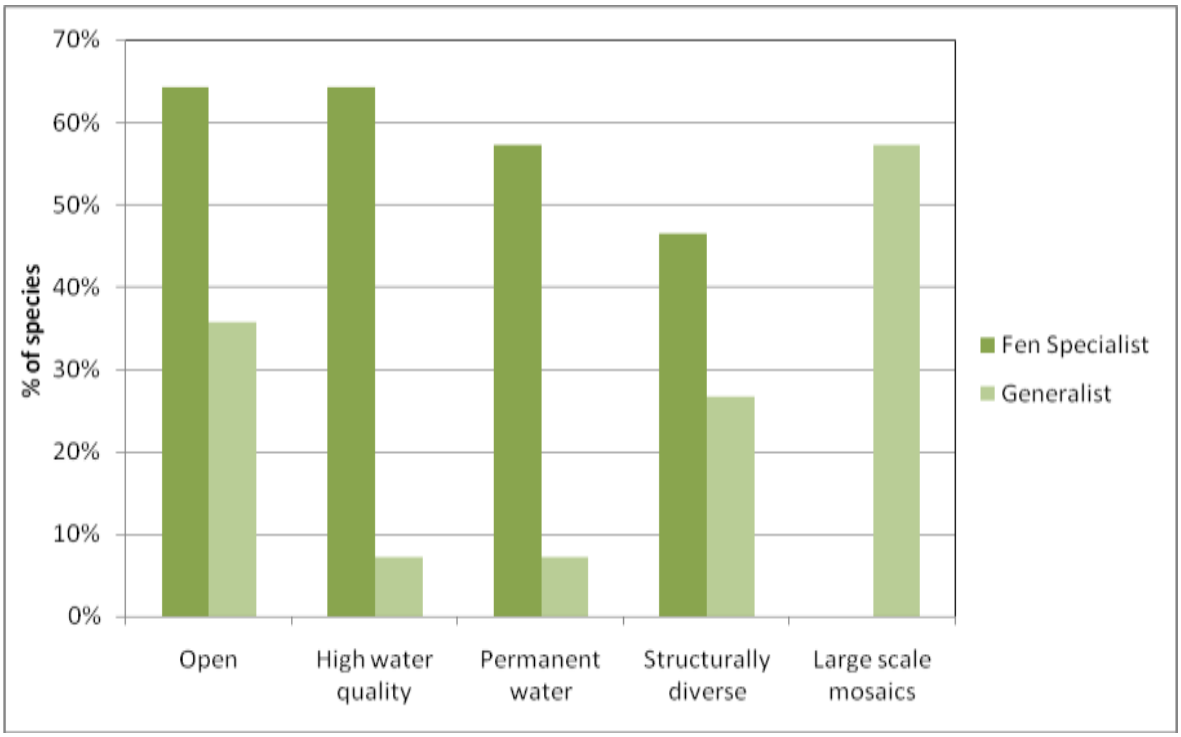

Figure 45 Habitat/niche requirements of lowland fen specialist and generalist UK BAP species

6.218 **Many generalists** such as the common toad *Bufo bufo,* grass snake *Natrix natrix* and foraging bats are typified by their need for **large wetland mosaics** (including wet woodland, scrub, open water bodies, fen and edge habitat). In contrast, **fen specialists** require **high water quality**, **stable water levels** and **smaller scale mosaics** with **structurally diverse vegetation**.

6.219 Although a further inspection of other resources does not indicate any strong relationships, there appears to be a general requirement for some form of **structural variation** within the herb layer in the form of:

- **tussocks** (for example, veilwort *Pallavicinia lyellii*, marsh fritillary, large marsh grasshopper *Stethophyma grossum*);
- **flower-rich patches** (for example, the bog hoverfly *Eristalis cryptarum*, small pearl-bordered fritillary *Boloria selene*); and
- areas of **bare mud** or other bare substrates (for example, *Agonum scitulum*, fen wood rush).

6.220 As with other habitats this suggests that structural diversity is important for many species. This diversity may develop naturally if the three main requirements of open habitats, high water quality and stable water levels are met.

Summary

6.221 More species are associated with the Lowland Fen priority habitat than any other priority habitat within the Wetland BIG category. Fens are, by their nature, very variable in character. They range from nutrient-rich systems on river edges (such as reedbeds) to nutrient-poor basin mires fed mainly by rainfall and dominated by *Sphagnum* mosses. As such, species requirements within fens are very variable. Despite this, several resource requirements can be identified for a large proportion of the more specialist species:

- High water quality.
- Open habitats (not covered by trees).
- Permanently high water levels (although those species needing fluctuating water levels may require special management at certain sites, for example some fluctuation at the fen's edge).

6.222 Structural diversity in the form of tussocks, flower rich patches and bare substrates is also important for many species.

6.223 In order to support the more generalist species, Lowland Fens should include elements of scrub or woodland edge habitat. Generalist species will benefit most from open fen situations within a larger scale mosaic of semi-natural habitats such as wet woodland, open water and purple moor-grass and rush pasture.

Lowland raised bog

6.224 Twenty-three species are associated with lowland raised bog, of which twelve are restricted to this habitat.

Table 46 Species numbers across different taxonomic groups - lowland raised bog

Taxonomic group	No. of species
Bryophytes	4
Invertebrates	9
Reptiles	3
Birds	3
Mammals	4

Table 47 Species numbers across different restriction classes - lowland raised bog

Restriction class	No. of species
Widespread	11
Localised	3
Restricted	1
Very restricted	8

6.225 Apart from two spiders, all the widespread species associated with this priority habitat are vertebrates not restricted to lowland bogs. The other three restriction classes are dominated by invertebrates and lower plants, all of which are confined to low input wetlands such as lowland bogs and poor fens.

6.226 Figure 46 shows that species of lowland raised bogs are scattered throughout most regions. Note that there are no intact raised bogs in the South East and South West and they appear in the regional distribution because some species occur in similar habitats such as valley mires.

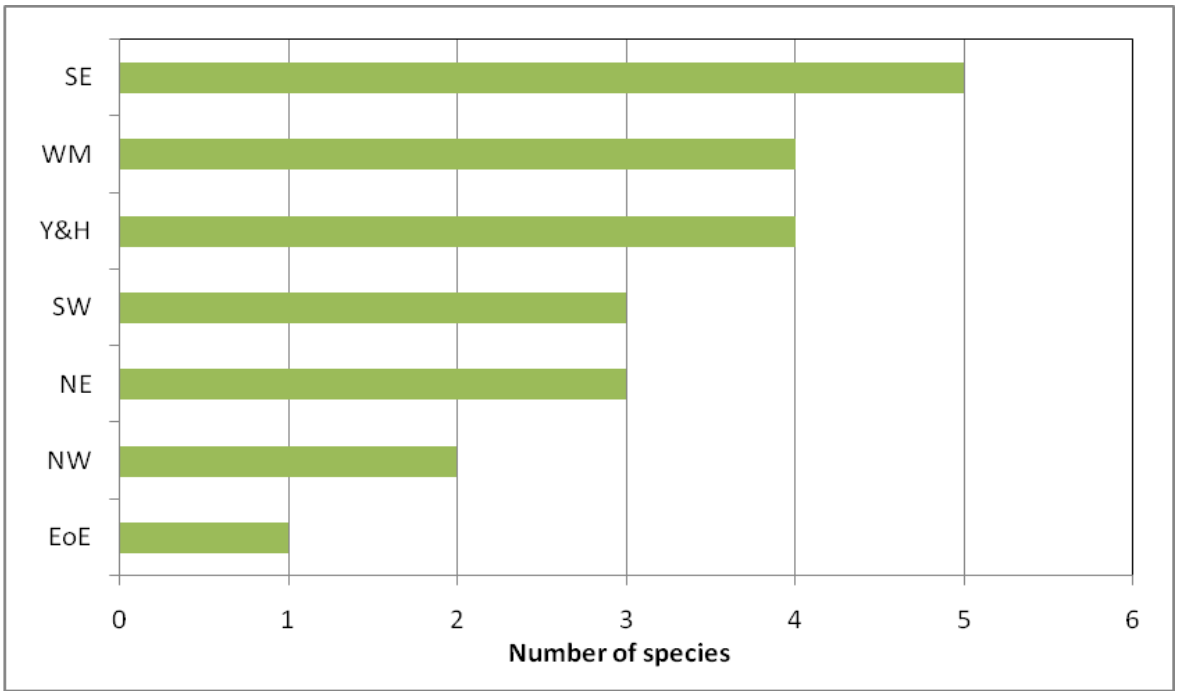

Figure 46 Regional distribution of UK BAP species associated with lowland raised bog

Habitat / niche requirements

6.227 Figure 47 divides the species occurring on lowland bogs into those restricted to bog habitats and the more generalist species that exploit bogs as part of a wider complex of wetland habitats.

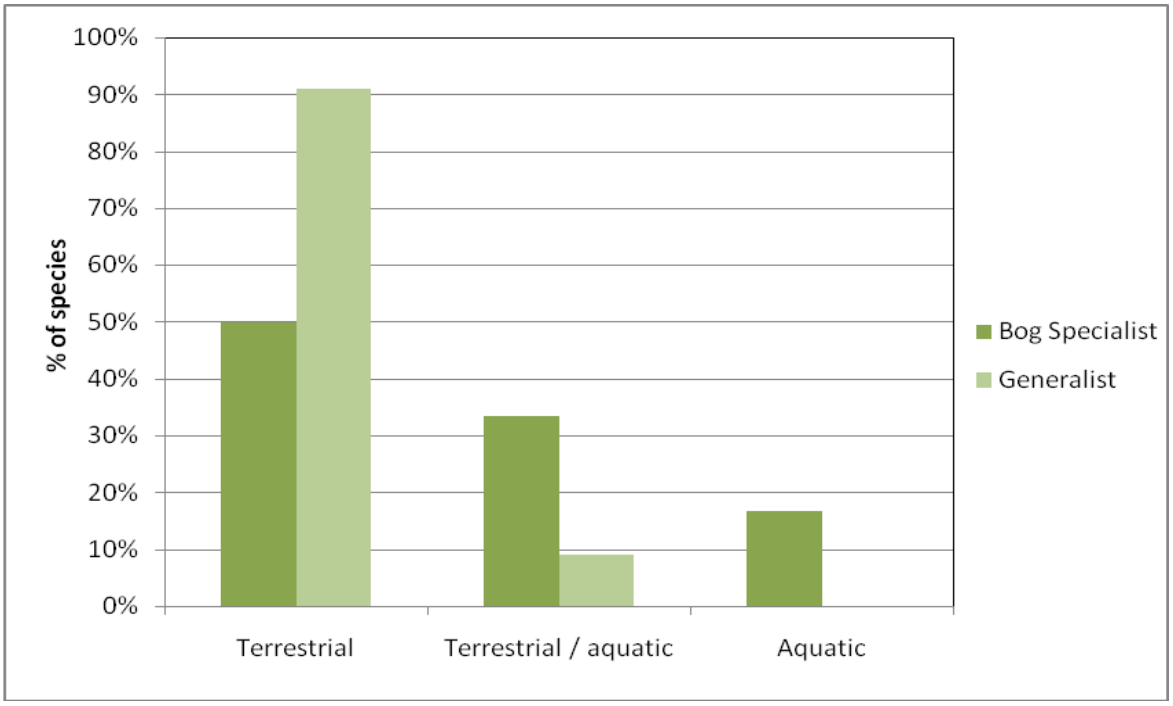

Figure 47 Association of lowland raised bog specialist and generalist UK BAP species with terrestrial and aquatic habitat zones

6.228 The majority of generalist species are entirely terrestrial, whereas a greater proportion bog specialists require aquatic habitat for at least part of their life cycle. Aquatic habitats are critical for at least two species: the flies *Hagenella clathrata* and *Phaonia jaroschewsii.*

6.229 Figure 48 further explores the difference in requirements between bog specialists and generalists.

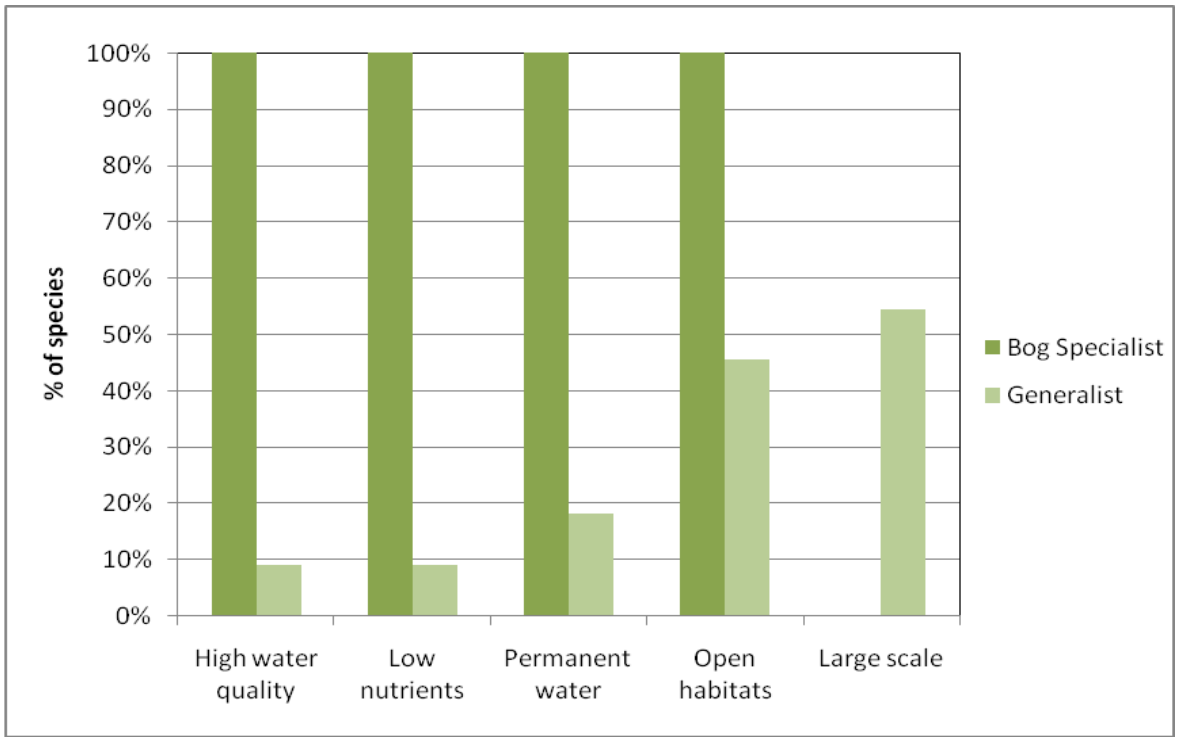

Figure 48 Habitat/niche requirements of UK BAP specialist and generalist species associated with lowland raised bogs

6.230 This analyses shows that all **bog specialists** are dependent on the **wettest, most high quality areas of the bog**, which are **unshaded**, **nutrient-poor** and have **stable water levels**. Conversely, the majority of **generalist species** such as the grass snake *Natrix natrix*, nightjar *Caprimulgus europaeus* and soprano pipistrelle *Pipistrellus pygmaeus* have no particular association with these attributes, though a significant number require **open conditions, larger scale wetland mosaics** and **transitions to other non-wetland habitats** (such as fringing scrub and woodland).

6.231 Some **specialists** have more precise requirements such as **small-scale vegetation mosaics**, **bare ground or peat** and **wet moss lawns** (for example, the beetle *Bembidion humerale* and the money spider *Erigon welchi*).

Summary

6.232 The species associated with Lowland Raised Bog habitats can be split into two distinct types:

- Those using the drier bog periphery, often in association with fringing habitats, such as woodland edge, scrub etc; and
- Those using the mire expanse (where water quality and stability are highest) which are best kept open and defined by their small-scale mosaics. It must be noted that these specialists are, for the most, equally at home on other peat habitats as they are on raised bogs as the microhabitats found in both habitats can be similar (i.e. *Sphagnum* lawns and peaty pools).

6.233 Lowland raised bog management should seek to restore an open *Sphagnum*-dominated mire expanse with a zone of fen and wet woodland where mineral-rich water enters the site. In common with lowland fens, the greatest benefit to generalist species will be found where the bog is part of a wider mosaic of semi-natural habitat.

Reedbeds

6.234 With only twenty-two species (all invertebrates and vertebrates), reedbeds support fewer UK BAP species than any other wetland priority habitat. Of these, only three species are restricted to reeds or have a requirement for reed: the moths *Archanara neurica* and *Chortodes brevilinea* and the bittern *Botaurus stellaris*.

Table 48 Species numbers across different taxonomic groups - reedbeds

Taxonomic group	No. of species
Invertebrates	7
Reptiles	1
Birds	8
Mammals	6

Table 49 Species numbers across different restriction classes - reedbeds

Restriction class	No. of species
Widespread	10
Localised	5
Restricted	4
Very restricted	3

6.235 Figure 49 shows that the East of England, the South East and the South West are particularly important for these species, closely reflecting the distribution of the habitat itself.

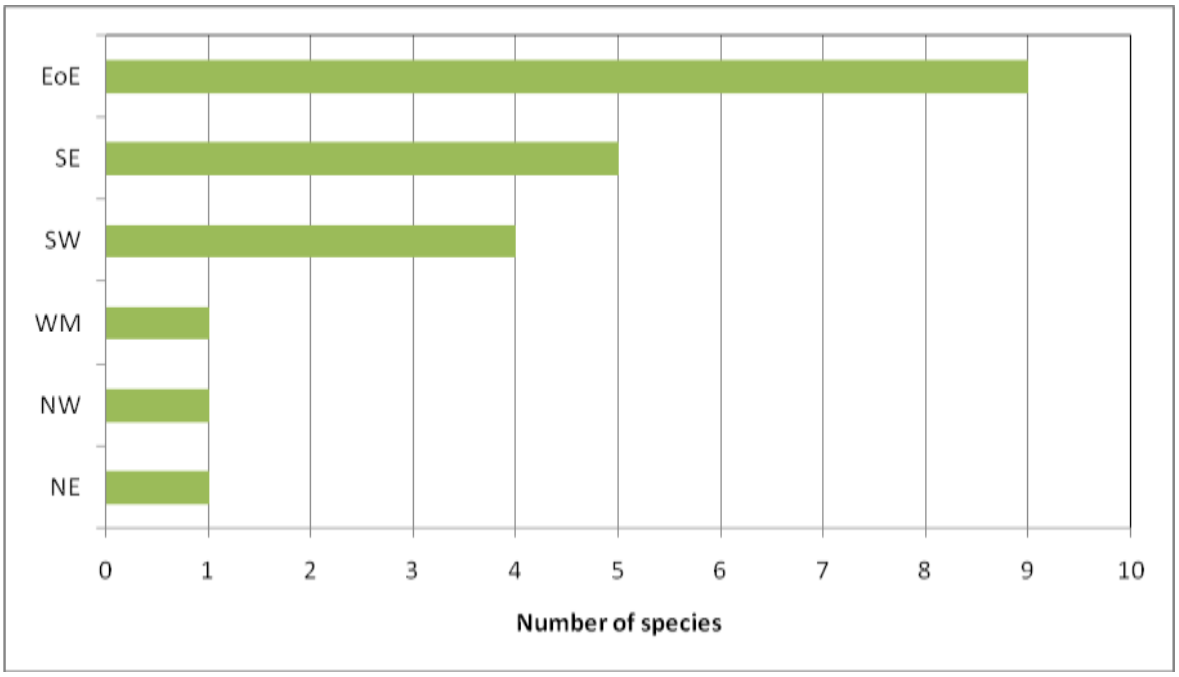

Figure 49 Regional distribution of UK BAP species associated with reedbeds

6.236 Figure 50 shows that the mammals and birds exploiting reedbeds are largely widespread, whereas a greater number of restricted and very restricted species are invertebrates.

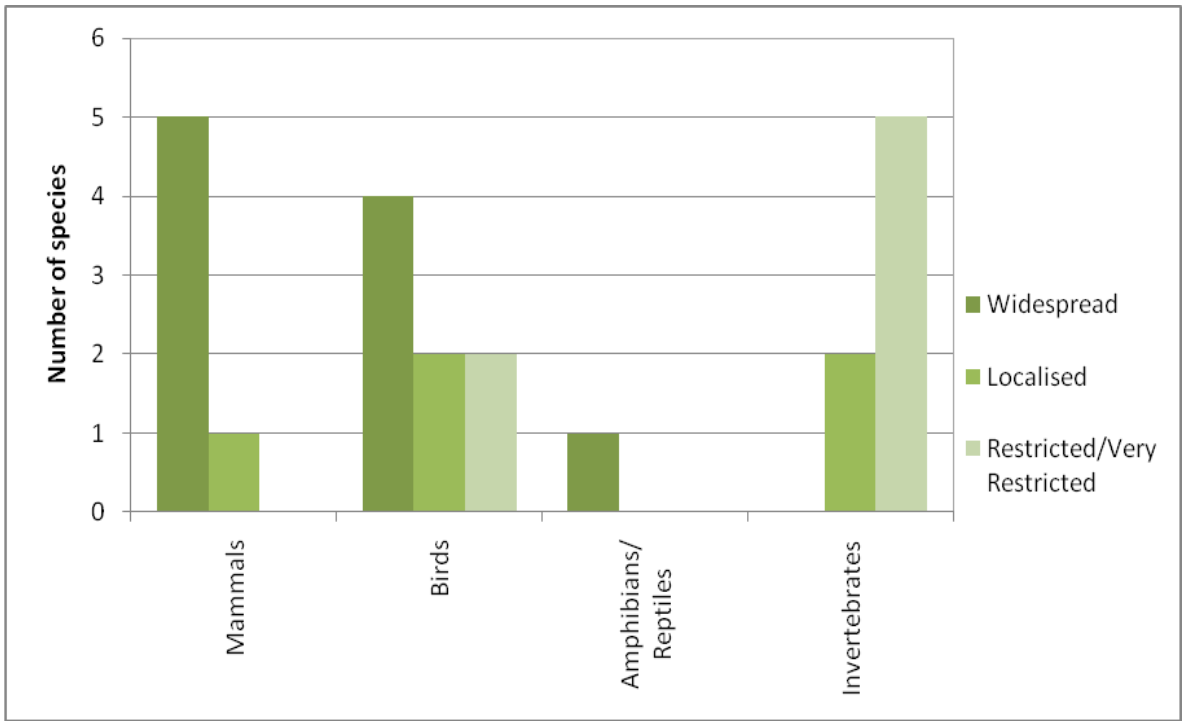

Figure 50 Relationship between taxonomic group and restriction class for UK BAP species associated with reedbeds

Habitat / niche requirements

6.237 The majority (72%) of the Reedbed UK BAP species are terrestrial. These include some very generalist species, such as bats and water voles *Arvicola terrestris*, and a few specialists, including the bittern.

6.238 Figure 51 identifies the niche/resource requirements of invertebrates and vertebrates associated with reedbeds.

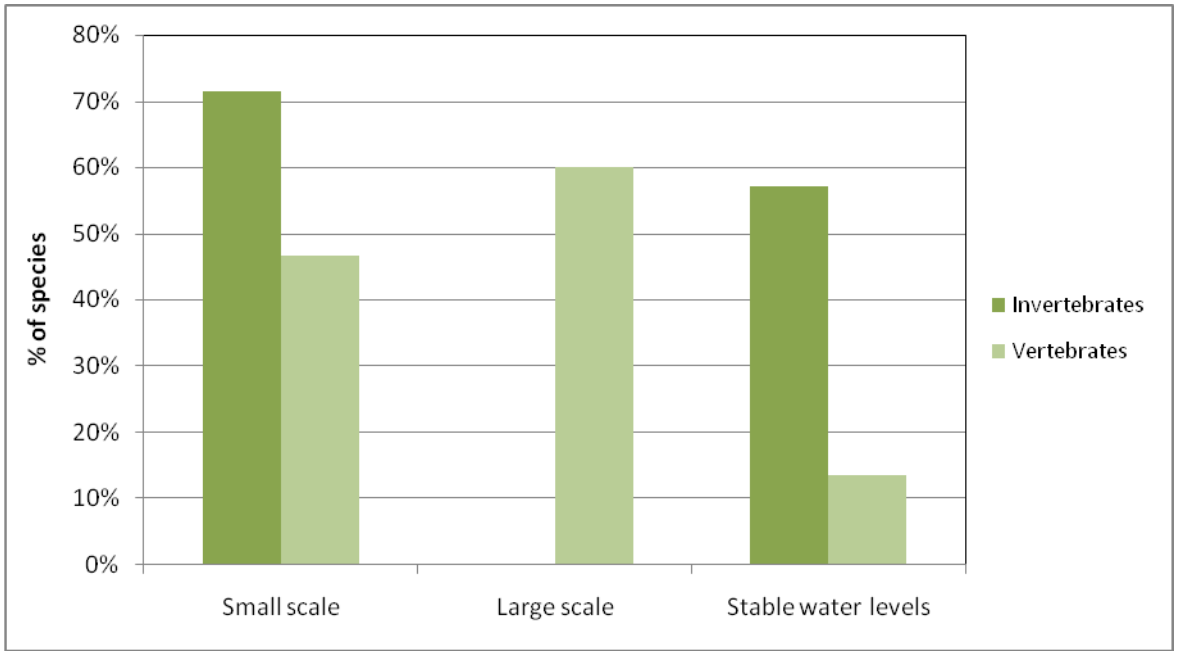

Figure 51 Habitat/niche requirements of invertebrate and vertebrate UK BAP species associated with reedbeds

6.239 Most invertebrates require **small scale mosaics** and **structurally diverse vegetation**, such as **matrices of ponds** (for example, the bug *Hydrometra gracilenta*) or **bare ground/herb-rich vegetation** within reedbeds (for example, the mason wasp *Odynerus simillimus*). Some vertebrates also require within-reedbed structural variation (for example, reed bunting *Emberiza schoeniclus*), while 60% require **larger scale mosaics** of wetlands and other habitats (for example, hen harrier *Circus cyaneus* and otter *Lutra lutra*). Invertebrate species such as *Hydrometra gracilenta* and the Norfolk Hawker *Aeshna isosceles* are particularly associated with **stable water levels**.

Summary

6.240 Reedbeds are nutrient-rich species-poor fens. One of the highest priority species associated with them is the bittern, although several other UK BAP species are at least partially dependent on them.

6.241 Reedbeds are beneficial to the greatest number of species when they include structural diversity (for example, pools and water edges for the invertebrates and birds, rotting leaf-litter for grass snakes *Natrix natrix*).

6.242 Unlike other wetland habitats, there seems to be little association between UK BAP species and high water quality or particular hydrological regimes.

Coastal floodplain and grazing marsh

6.243 A total of 47 species are associated with this habitat, consisting largely of vascular plants, invertebrates and vertebrates. There are relatively few restricted or very restricted species associated with this habitat.

Table 50 Species numbers across different taxonomic groups - coastal floodplain and grazing marsh

Taxonomic group	No. of species
Stoneworts	3
Vascular plants	12
Invertebrates	10
Fish	1
Amphibians/reptiles	3
Birds	12
Mammals	6

Table 51 Species numbers across different restriction classes - coastal floodplain and grazing marsh

Restriction class	No. of species
Widespread	18
Localised	13
Restricted	7
Very restricted	9

6.244 Figure 52 shows the degree of range restriction for each taxonomic group. The habitat supports many widespread birds and mammals and more restricted vascular plant and invertebrate species.

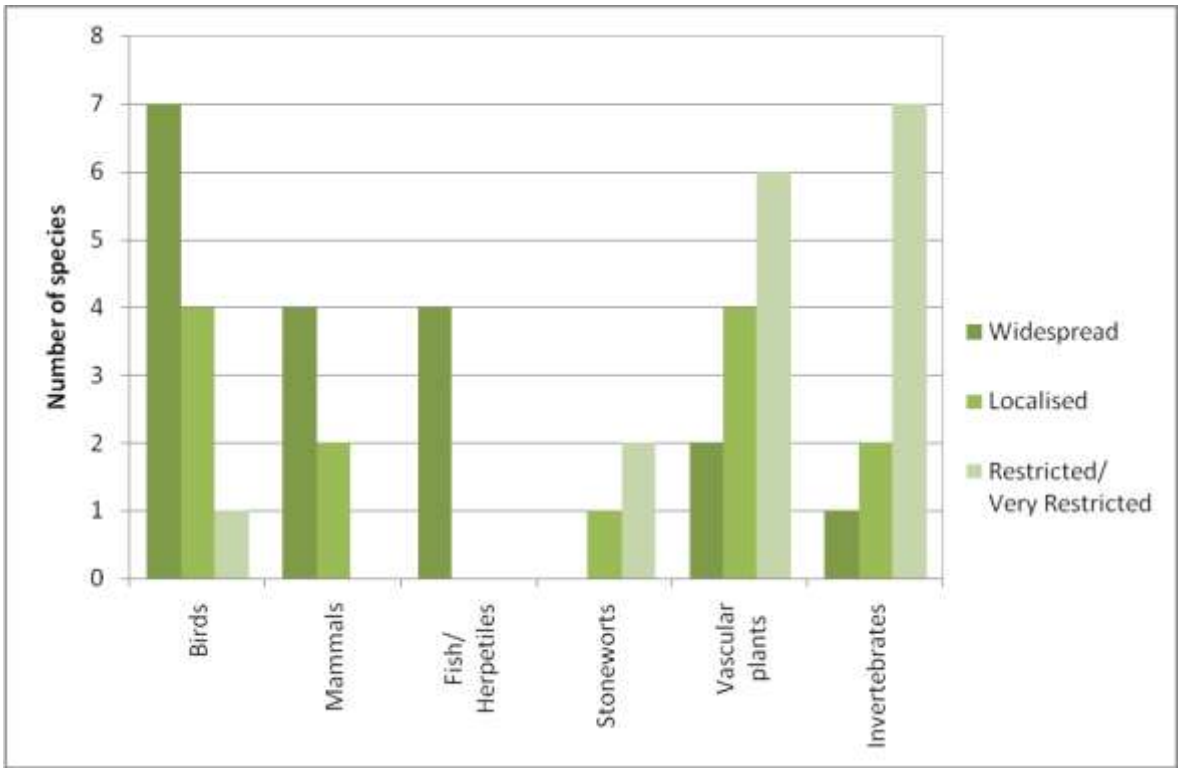

Figure 52 Relationship between taxonomic group and restriction class for UK BAP species associated with grazing marsh

6.245 Figure 53 shows the regional distribution of UK BAP species associated with grazing marshes.

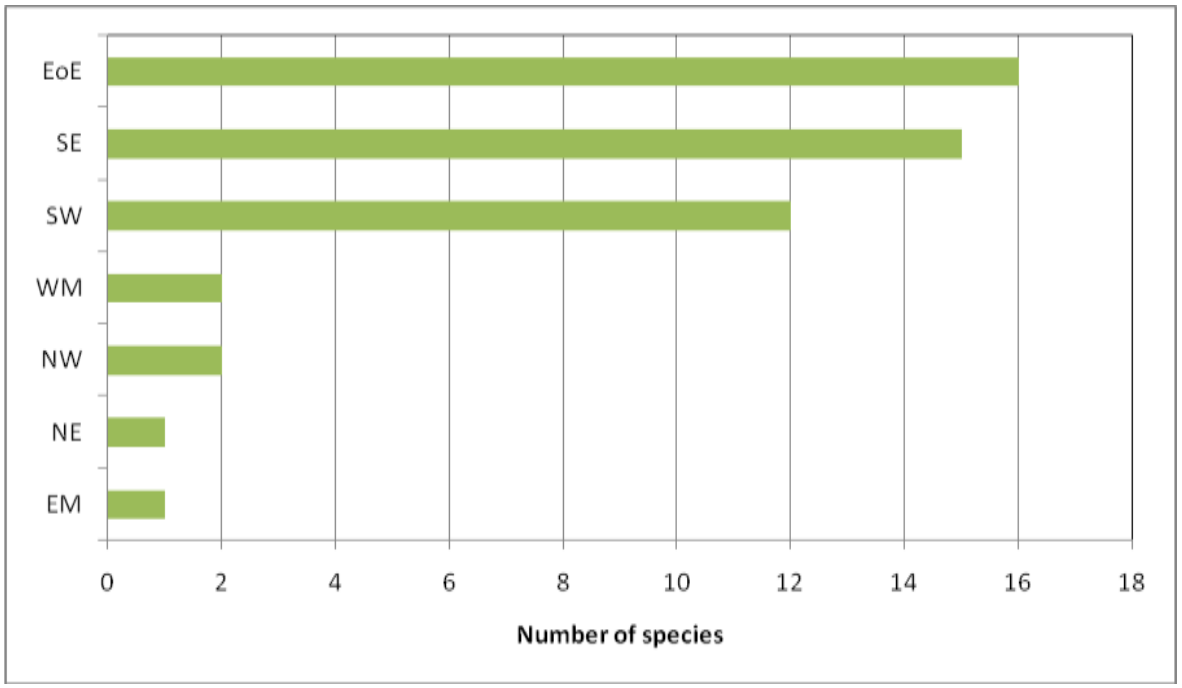

Figure 53 Regional distribution of UK BAP species associated with grazing marsh

6.246 This shows that species are strongly associated with three regions: the South West, South East and East of England. This closely mirrors the distribution of grazing marsh in England.

Habitat / niche requirements

6.247 Figure 54 shows the proportion of grazing marsh species associated with aquatic habitats (i.e. ditches) and terrestrial habitats (grassland), or both.

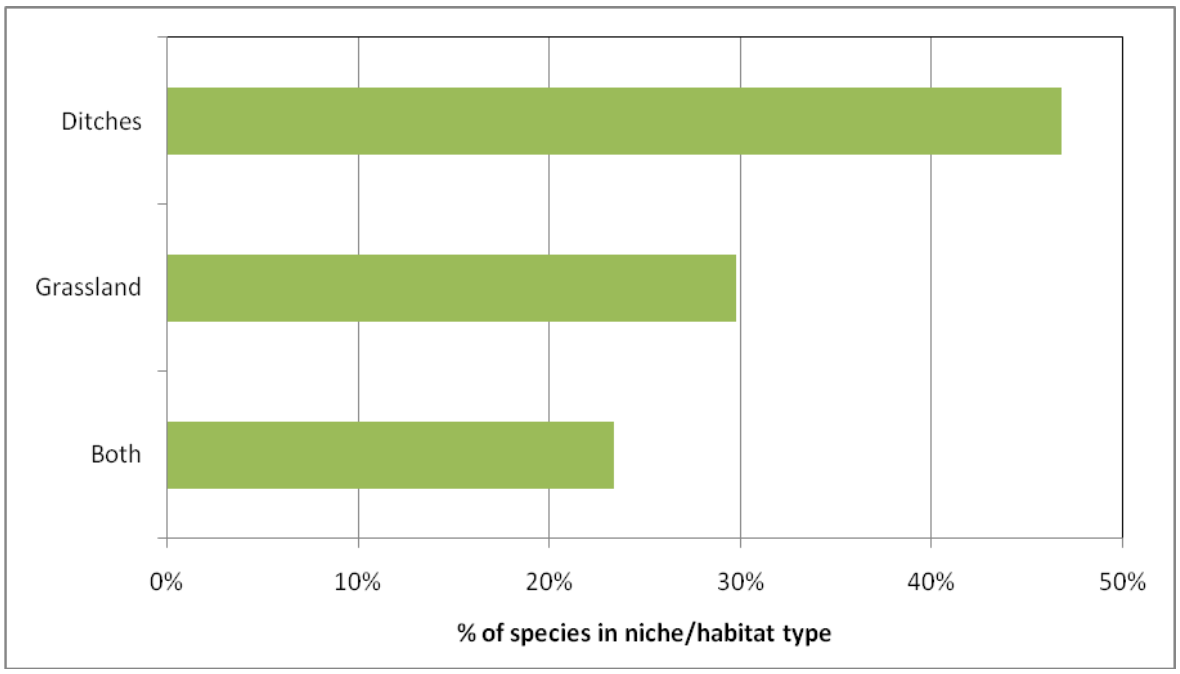

Figure 54 Association of UK BAP grazing marsh species with different zones

6.248 This shows that a greater proportion of species are associated, partially or wholly, with the **ditches**. Figure 55 further explores the association of species in the different restriction classes with these different grazing marsh zones.

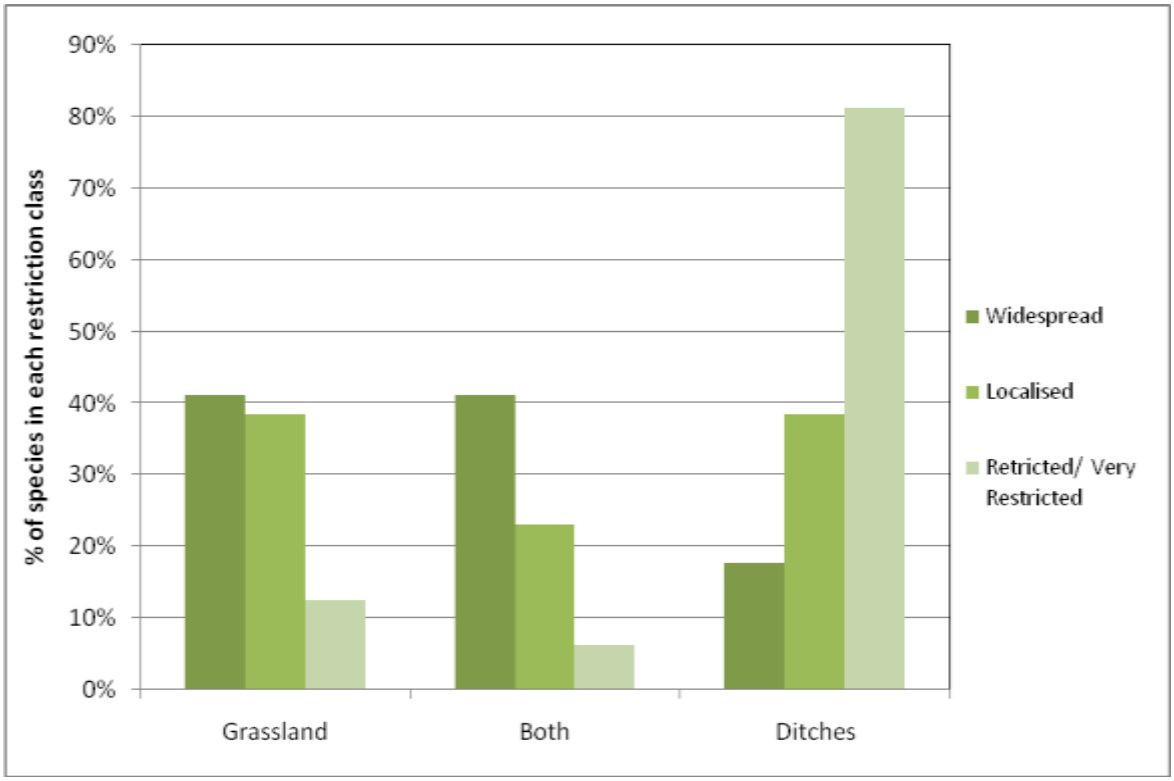

Figure 55 Proportion of UK BAP grazing marsh species in restriction classes associated with different zones

6.249 Grassland habitats support the most widespread and localised species. These are nearly all birds which feed, roost and nest on the grazing marshes, including such species as Dark-bellied brent goose *Branta bernicla bernicla*, curlew *Numenius arquata* and skylark *Alauda arvensis*. Their requirements are similar to that of other grassland species (see Lowland Farmland) and have thus been excluded from the rest of this analysis.

6.250 Conversely, those species at least partially dependent on ditches include a higher proportion of the restricted and very restricted species, such as sharp-leaved pondweed *Potamogeton acutifolius* and the shining ram's-horn snail *Segmentina nitida*.

6.251 Figure 56 shows the niche/resource requirements of those species entirely dependent on ditches.

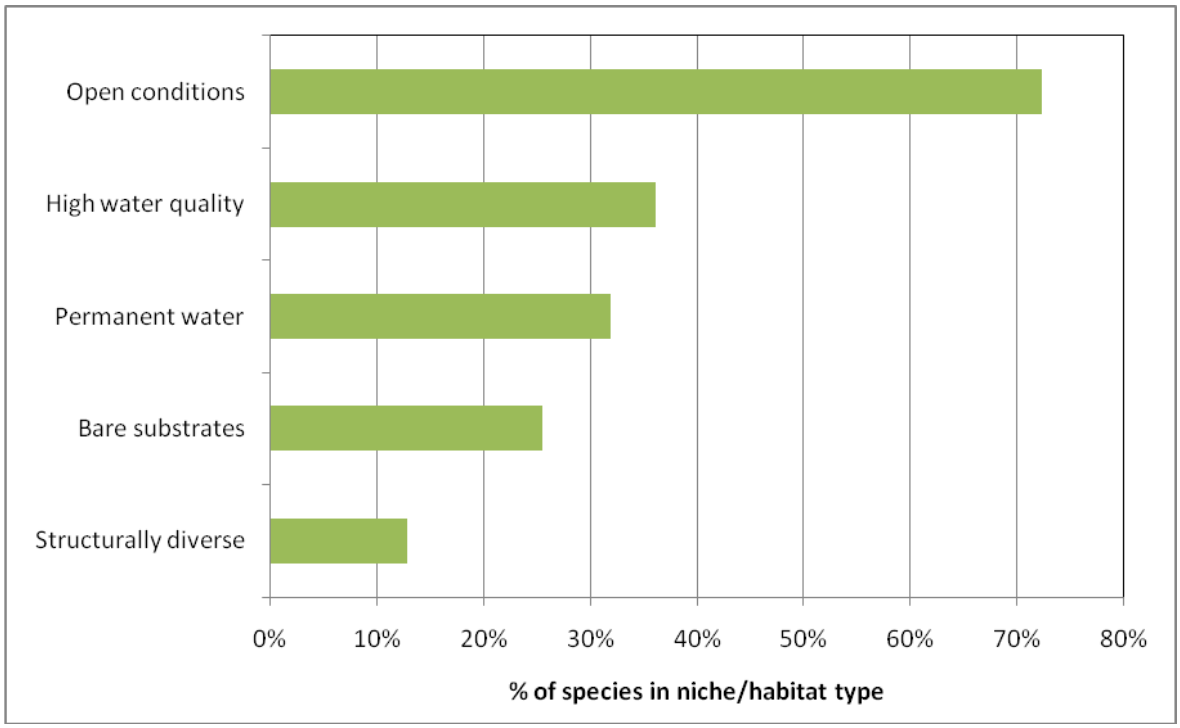

Figure 56 Habitat/niche requirements of UK BAP species associated with grazing marsh ditches

6.252 **Stable water levels**, **high water quality** and **open, unshaded conditions** are required by a large proportion of species, including the stoneworts *Chara* sp, Southern Damselfly *Coenagrion mercuriale* and the large-mouthed valve snail *Valvata macrostoma*. **Bare substrates** (both submerged and along the ditch edge) and a **varied structure of aquatic, emergent and terrestrial vegetation** are also important for some species (for example, cut-grass *Leersia oryzoides* which requires bare mud and the beetle *Bagous nodulosus* which require structurally diverse and species-rich vegetation).

Summary

6.253 Coastal and Floodplain Grazing Marsh is a land use-rather than a distinct habitat and is therefore difficult to assess due to its highly variable character. The species that are found within the ditches include both those of lowland wetlands (mainly fens) and those of ponds, whereas the in-field species are primarily associated with terrestrial grasslands.

6.254 Those species associated with ponds tend to use grazing marsh ditches in early succession (often having been recently dredged). These lack vegetation and, if the fields are grazed, have low-lying shelves which provide shallow water and a drawdown zone very similar to ponds.

6.255 Species associated with fens tend to use ditches with more established, late-successional vegetation (equivalent to 'linear fens'). The more restricted species are also dependant on high water quality.

6.256 Grazing marsh management should seek to maximise ditches in varying states of succession from completely open to fully vegetated. Some should therefore be on long-rotational management to encourage the development of late successional habitats.

Coastal habitat requirements

6.257 A total of 166 UK BAP species are associated with coastal priority habitats. The extent and distribution of these habitats varies considerably and the more extensive habitats (saltmarsh and mudflats) support relatively few UK BAP species.

Table 52 Distribution of species across the different priority habitats - Coastal

Priority habitat	No. of associated UK BAP species
Coastal sand dunes	72
Maritime cliffs and slopes	61
Coastal saltmarsh	29
Coastal vegetated shingle	15
Saline lagoons	12
Intertidal mudflats	3

6.258 Tables showing the distribution of species across the taxonomic groupings and restriction classes are shown below. Note that this analysis only includes a selection of UK BAP marine invertebrates (i.e. those associated with coastal priority habitats rather than purely marine habitats).

Table 53 Species numbers across different taxonomic groups - Coastal

Taxonomic group	No. of species
Fungi	6
Lichens	8
Stoneworts	2
Bryophytes	13
Marine invertebrates	7
Terrestrial invertebrates	73
Vascular plants	37
Amphibians/reptiles	6
Birds	14

Table 54 Species numbers across different restriction classes - Coastal

Restriction class	No. of species
Widespread	21
Localised	50
Restricted	17
Very restricted	77
Extinct	1

6.259 Coastal UK BAP species are dominated by terrestrial invertebrates and vascular plants. A relatively high proportion of these species are very restricted.

Overall summary

6.260 Many species found in coastal habitats are also present in other habitats, in particular lowland heathland and grasslands, which share important habitat features such as shelter and warm microclimates. Whereas these latter habitats require direct human intervention to generate essential structural variation, many coastal habitats benefit from natural disturbance resulting from dynamic coastal process influenced by wind and sea erosion (although these are often heavily modified by artificial coast defences). These processes are important for generating structural diversity at both small and large scales.

6.261 Important habitat attributes particularly associated with the coast and shared by many coastal UK BAP species include:

- extensive, open areas suitable for foraging birds (geese and waders);
- bare substrates (mud, boulder clay), often in small scale mosaics with vegetation; and
- seasonal pools in sand dune slacks.

6.262 It is important to note that although many coastal habitats require natural processes to create dynamic systems with good structural diversity, man-made disturbance caused by trampling and coastal flood defence works can be very damaging.

Saline lagoons

6.263 Of the twelve species associated with saline lagoons, two are widespread bird species (black-tailed godwit *Limosa limosa* and lapwing *Vanellus vanellus*) associated with a number of other habitats. As these bird species generally have different habitat requirements to the other lagoon species (extensive, open habitats and abundant invertebrate prey) they have been excluded from the analysis below.

Table 55 Species numbers across different taxonomic groups - lagoons

Taxonomic group	No. of species
Stoneworts	1
Marine invertebrates	5
Terrestrial invertebrates	4
Birds	2

Table 56 Species numbers across different restriction classes - lagoons

Restriction class	No. of species
Widespread	2
Localised	3
Restricted	1
Very restricted	6

Habitat / niche requirements

6.264 Figure 57 represents the available data on habitat requirements for saline lagoon species.

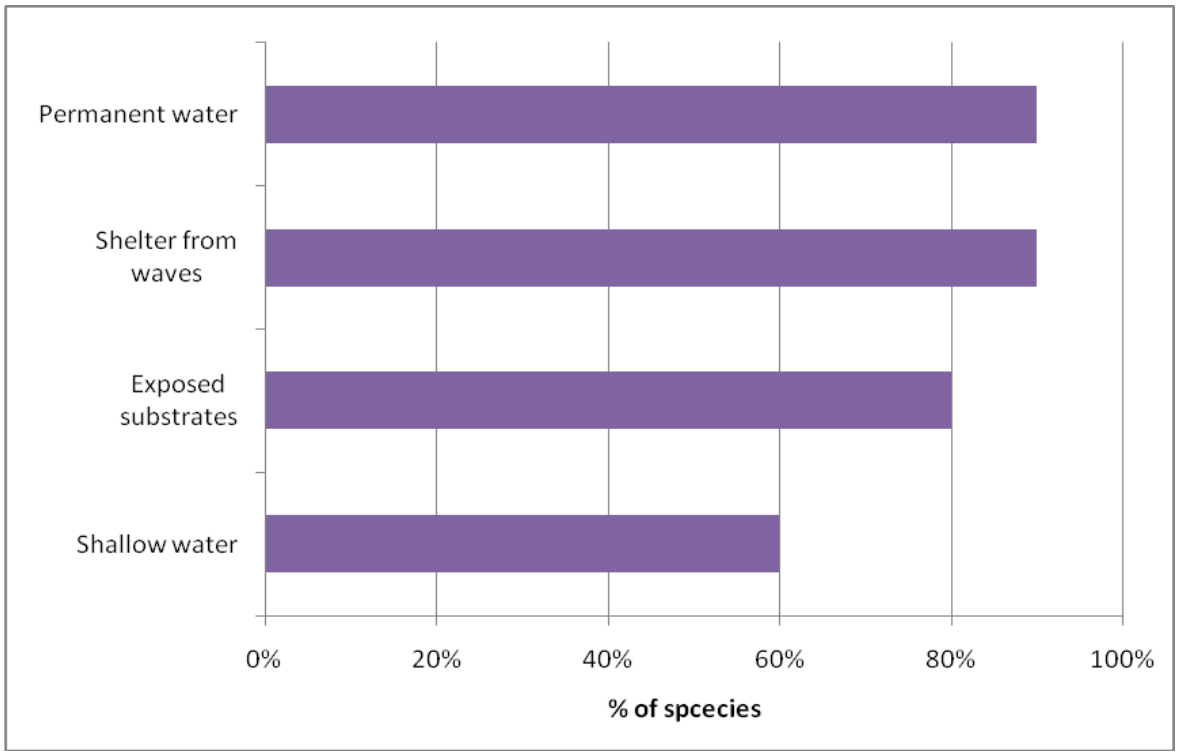

Figure 57 Habitat/niche requirements of UK BAP species associated with saline lagoons

6.265 Habitat requirements common to many species are:

- **shelter from wave action** (for example, the stonewort *Lamprothamnium papulosum* and the crustacean *Gammarus insensibilis*);
- the presence of **water all year around** (for example, the marine worm *Armandia cirrhosa* and the marine mollusc *Tenellia adspersa*);
- **exposed substrates** (usually mud) (for example, the beetle *Anisodactylus poeciloides* and the mollusc *Heleobia stagnorum*); and
- **shallow water** (less than 1m) which is required by at least six species, including the cnidarians *Edwardsia ivelli* and *Pachycordyle navis*.

6.266 **Salinity** requirements vary considerably between species. Unlike true freshwater aquatic or marine species, many can tolerate extreme variations in salinity.

Summary

6.267 Processes such as tidal inundation, high evapo-transpiration rates, rainfall and freshwater flooding mean that, by nature, lagoons exhibit extreme variation in water level and salinity. Many are man-made and can be quite large whereas others are very shallow, often of small size and ephemeral in nature. Detecting trends for this habitat is therefore difficult.

6.268 Shallow water in small pools warms more rapidly than water in larger pools and lakes. This may be an important factor influencing the presence of some of the BAP species. Shallow water in larger lagoons may not be so well utilised (as it will be colder). This suggests that mosaics of small, ephemeral ponds will have a particular significance for these warmth-loving species.

Coastal vegetated shingle

6.269 Fifteen UK BAP species associated with coastal vegetated shingle are identified. These are dominated by vascular plants and invertebrates. A relatively high proportion (57%) of shingle species is very restricted.

Table 57 Species numbers across different taxonomic groups - coastal vegetated shingle

Taxonomic group	No. of species
Vascular plants	5
Terrestrial invertebrates	8
Birds	2

Table 58 Species numbers across different restriction classes - coastal vegetated shingle

Restriction class	No. of species
Widespread	3
Localised	2
Restricted	1
Very restricted	8
Extinct	1

6.270 Figure 58 show the regional occurrence of species associated with shingle habitats.

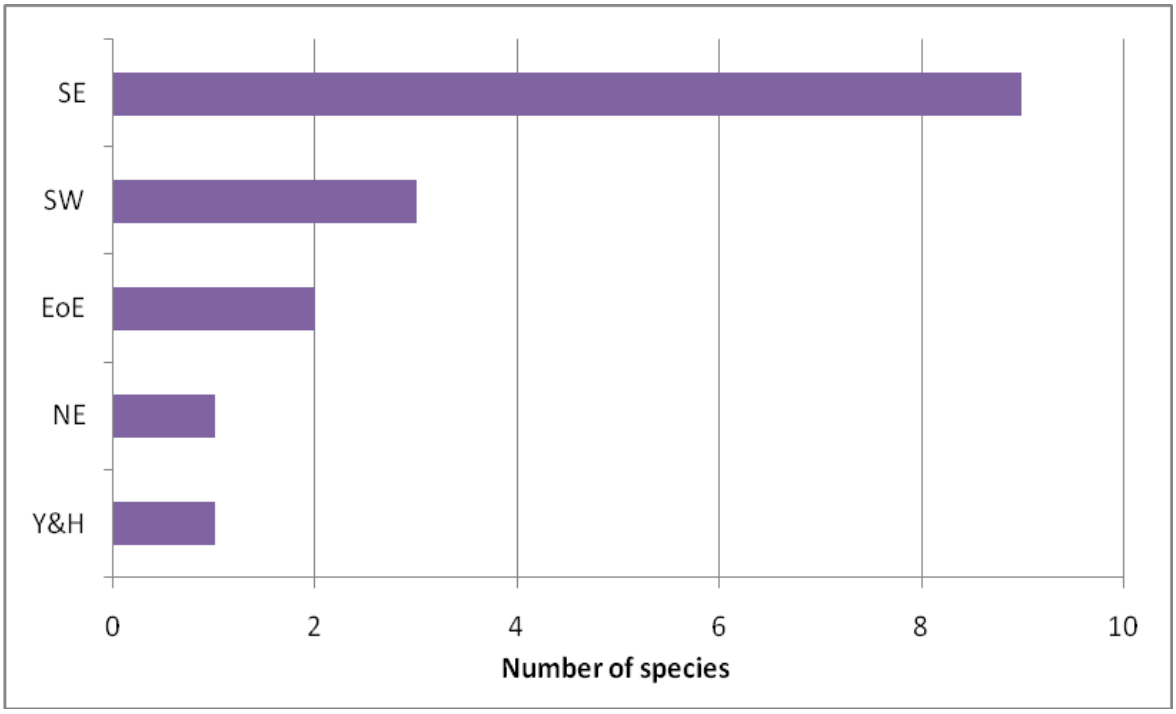

Figure 58 Regional distribution of UK BAP species associated with coastal vegetated shingle

6.271 The South East is of particular importance for shingle species as this region contains a large proportion of the habitat's extent; other regions have only 1 to 3 species particularly associated with them.

Habitat / niche requirements

6.272 Figure 59 highlights the niche/resource requirements for UK BAP species associated with coastal vegetated shingle.

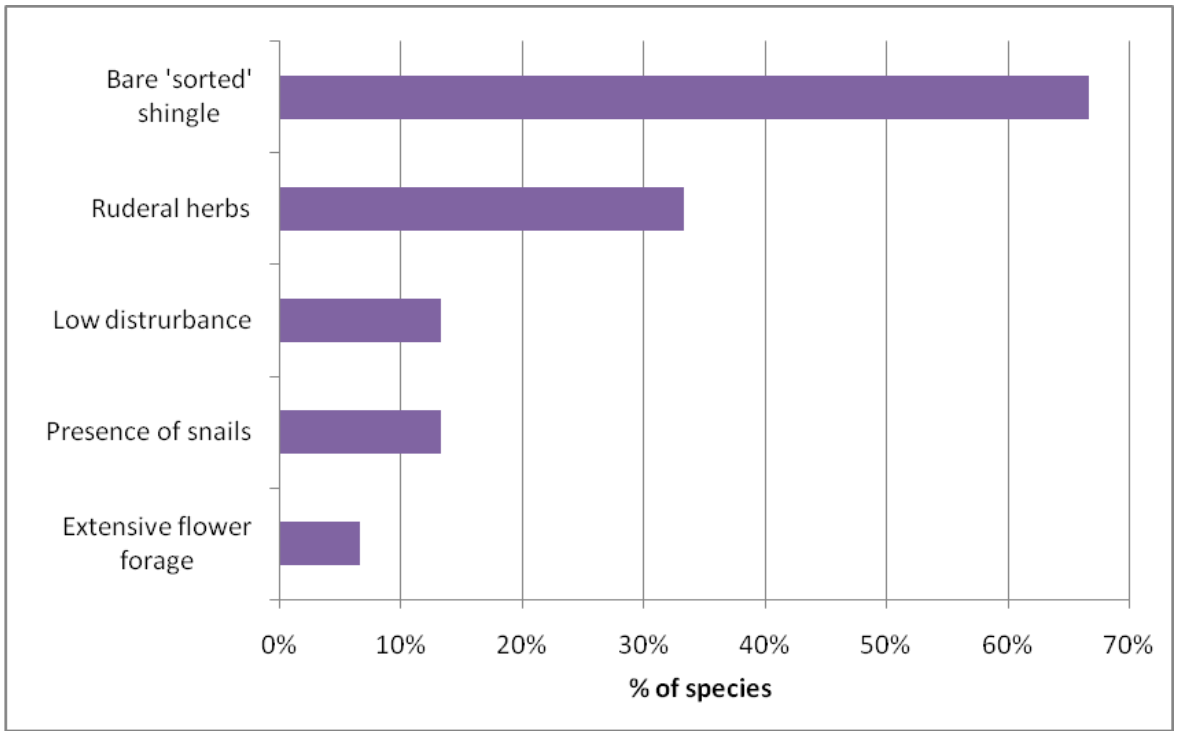

Figure 59 Habitat/niche requirements of UK BAP species associated with coastal vegetated shingle

6.273 A large proportion of species are reliant on **exposed, sorted shingle**, including least lettuce *Lactuca saligna*, annual knawel *Scleranthus annuus*, the ant *Temnothorax interruptus* and the jumping spider *Pseudeuophrys obsoleta*. Some, such as the bumble-bee *Bombus subterraneus* and Sussex Emerald *Thalera fimbrialis*, also require nearby vegetation for **flower forage** (nectar and pollen), **food plants** (grazing) or **shelter**. This vegetation may be in the form of ruderal plants associated with shingle or adjacent areas of flower-rich forage.

6.274 The two bird species, roseate tern *Sterna dougallii* and herring gull *Larus argentatus argentatus* have separate requirements, including **open, unrestricted views** and **low levels of disturbance** (i.e. by people and dogs).

Summary

6.275 Near-shore vegetated shingle is a highly disturbed habitat, inhospitable to many plant species and kept open by wave action and storms. Away from the shore, the physical structure of the pebble matrix largely prevents the development of a closed canopy of vegetation. Some sites with extensive areas of shingle can support a wider range of habitats, which range from pioneer communities through to wetland and scrub.

6.276 The timing and type of disturbance is critical. Sorted shingle is a prime requirement for both plants and invertebrates. Activities that mixes this shingle at inappropriate times (such as trampling in the spring and summer) is very damaging as it destroys interstitial spaces and microhabitats for seed dispersal and invertebrate shelter and nests. Thus, although natural disturbance, in the form of storms and wave action, is critical to shingle communities, trampling and disturbance is highly damaging and should be kept to a minimum.

Coastal sand dunes

6.277 Seventy-two UK BAP species (including one currently considered extinct) are identified as being associated with coastal sand dunes. A large number of these are also associated with other habitats (such as heathland, grassland and pools).

Table 59 Species numbers across different taxonomic groups - sand dunes

Taxonomic group	No. of species
Fungi	6
Stoneworts	1
Bryophytes	5
Vascular plants	20
Terrestrial invertebrates	29
Amphibians/reptiles	6
Birds	5

Table 60 Species numbers across different restriction classes - sand dunes

Restriction class	No. of species
Widespread	11
Localised	21
Restricted	7
Very restricted	32

6.278 Figure 60 shows the association between the number of species in each taxonomic group with the restriction class.

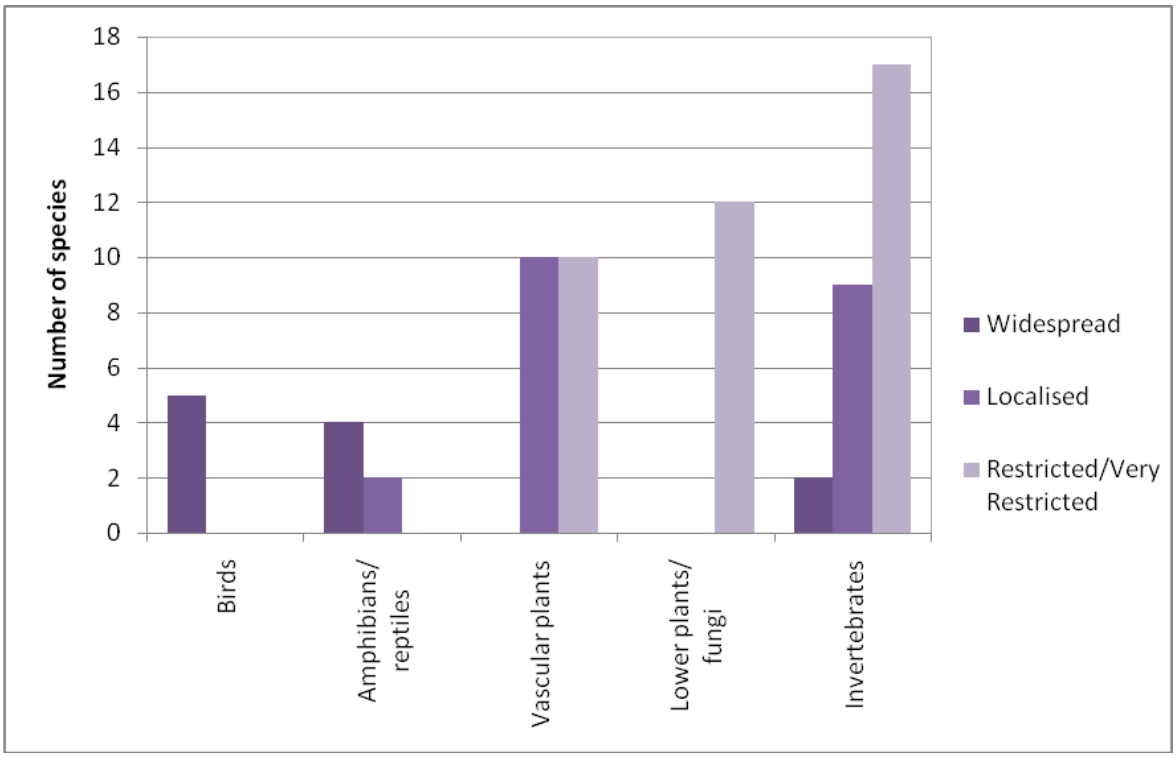

Figure 60 Relationship between taxonomic group and restriction class for UK BAP species associated with sand dunes

6.279 Species associated with sand dunes are dominated by vascular plants and invertebrates. Many of these are restricted or very restricted, whereas the vertebrate species are generally widespread.

6.280 Figure 61 shows the regional distribution of species associated with sand dunes.

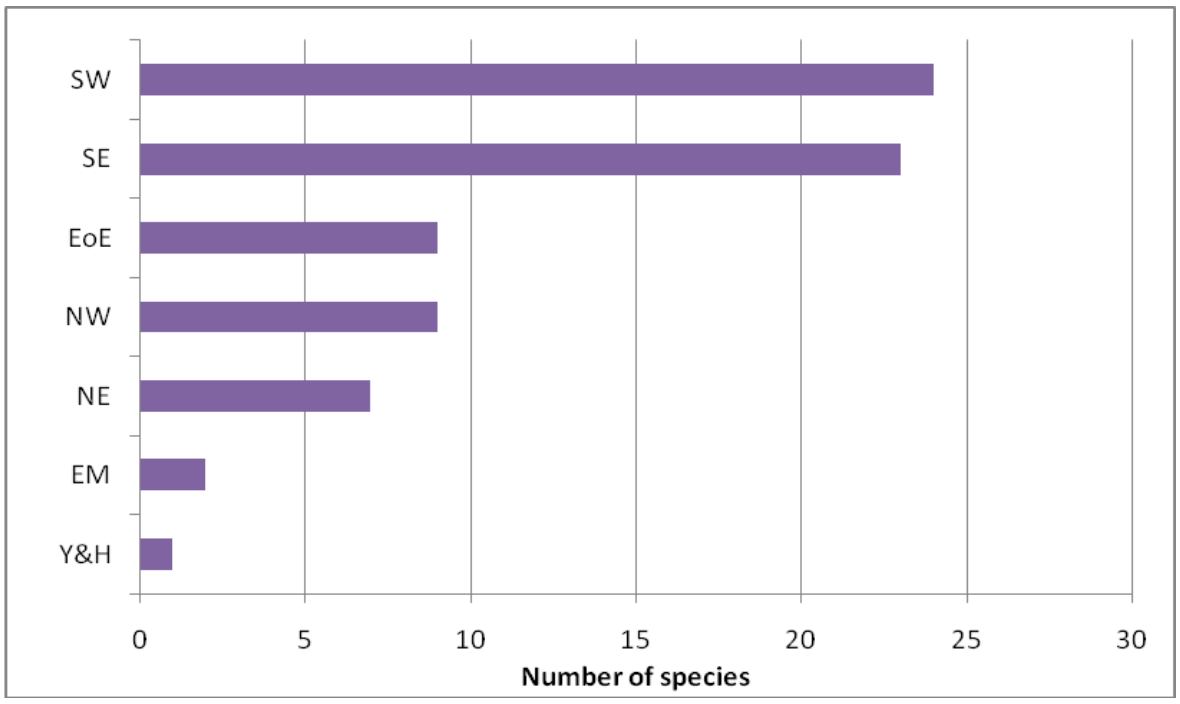

Figure 61 Regional distribution of UK BAP species associated with sand dunes

6.281 The South West and South East regions support by far the greatest number of UK BAP species associated with sand dunes.

Habitat / niche requirements

6.282 Figure 62 shows the niche requirements for dune-associated species.

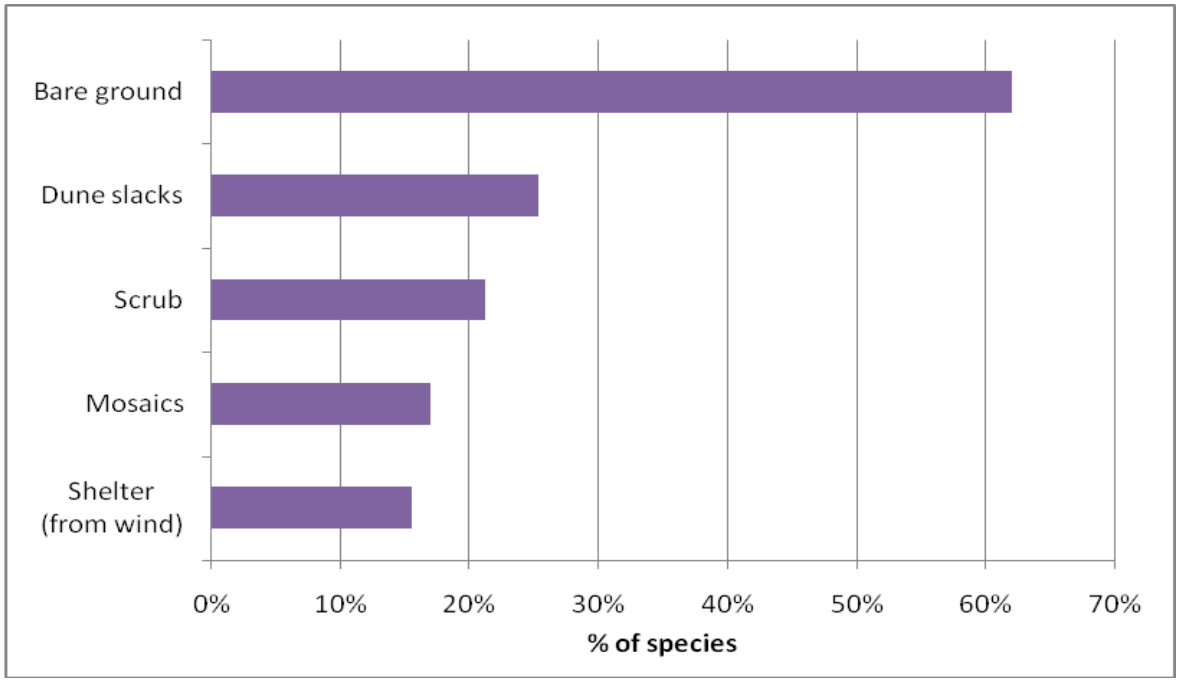

Figure 62 Habitat/niche requirements of UK BAP species associated with sand dunes

6.283 This shows that over 60% of all species are associated with **early successional habitats** (i.e. **bare ground and/or ruderal plants**). This includes very restricted species such as the earthstars *Geastrum elegans* and *G. minimum*, the dune gentian *Gentianella uliginosa* and the beetle *Harpalus honestus,* as well as the widespread Grayling *Hipparchia semele* and grey partridge *Perdix perdix*.

6.284 Other less common associations include:

- **Seasonally fluctuating water** in the form of **dune slacks**, required by species such as water germander *Teucrium scordium*, sandbowl snail *Quickella arenaria* and the natterjack toad *Epidalea calamita*;
- **Scrub**, either as a **foodplant** (for example, the moth *Stigmella zelleriella*), for associated **microclimatic conditions** such a raised humidity (for example, Lindisfarne helleborine *Epipactis sancta* associated with creeping willow *Salix repens*) or for nesting (for example, linnet Carduelis cannabina);
- **Small scale mosaics** of bare ground and vegetation (for example, the moth *Scythris siccella* and common lizard *Zootoca vivipara*); and
- **Shelter** from the wind provided by dune topography and scrub (for example, northern dune tiger beetle *Cicindela hybrida* and dingy skipper *Erynnis tages*).

Summary

6.285 Sand dunes are highly dynamic habitats where disturbance (by wind or trampling) produces mosaics of bare sand within a varied topography. Unlike shingle, sand dunes quickly recover from episodes of trampling as wind-blown sand rapidly reshapes the habitat.

6.286 Most species of sand dunes are not restricted to them. The nature of the free-draining soils, exposed, bare sand and sheltered bays created by the dunes produce very hot micro-climates. Warmth-loving species, many on the edge of their range, can take advantage of this and many of these species are also found on heathlands and sheltered grasslands.

6.287 Dune slacks where seasonally wet pools develop and dry in the summer are also significant and particular attention should be paid to these features as important resources within sand dunes.

Maritime cliffs and slopes

6.288 There are a total of 61 UK BAP species associated with maritime cliffs and slopes. A large number of these can also be found in heathlands, grassland and woodland clearings.

Table 61 Species numbers across different taxonomic groups - maritime cliffs and slopes

Taxonomic group	No. of species
Lichens	8
Bryophytes	7
Vascular plants	9
Terrestrial invertebrates	34
Amphibians/reptiles	2
Birds	1

Table 62 Species numbers across different restriction classes - maritime cliffs and slopes

Restriction class	No. of species
Widespread	8
Localised	14
Restricted	8
Very restricted	31

6.289 Figure 63 shows the association between the number of species in each taxonomic group with the restriction class.

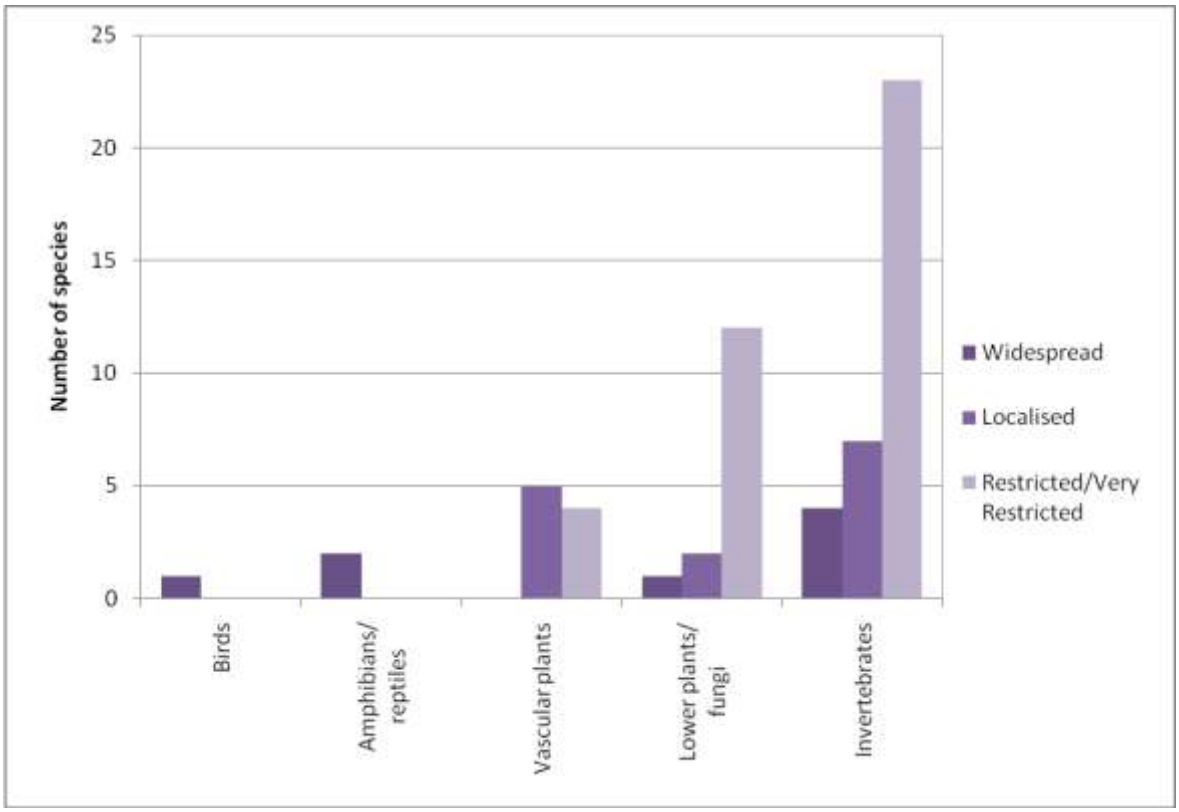

Figure 63 Relationship between taxonomic group and restriction class for UK BAP species associated with maritime cliffs

6.290 The UK BAP species are dominated by invertebrates and over half of are restricted or very restricted.

6.291 Figure 64 shows the distribution of these species across the regions.

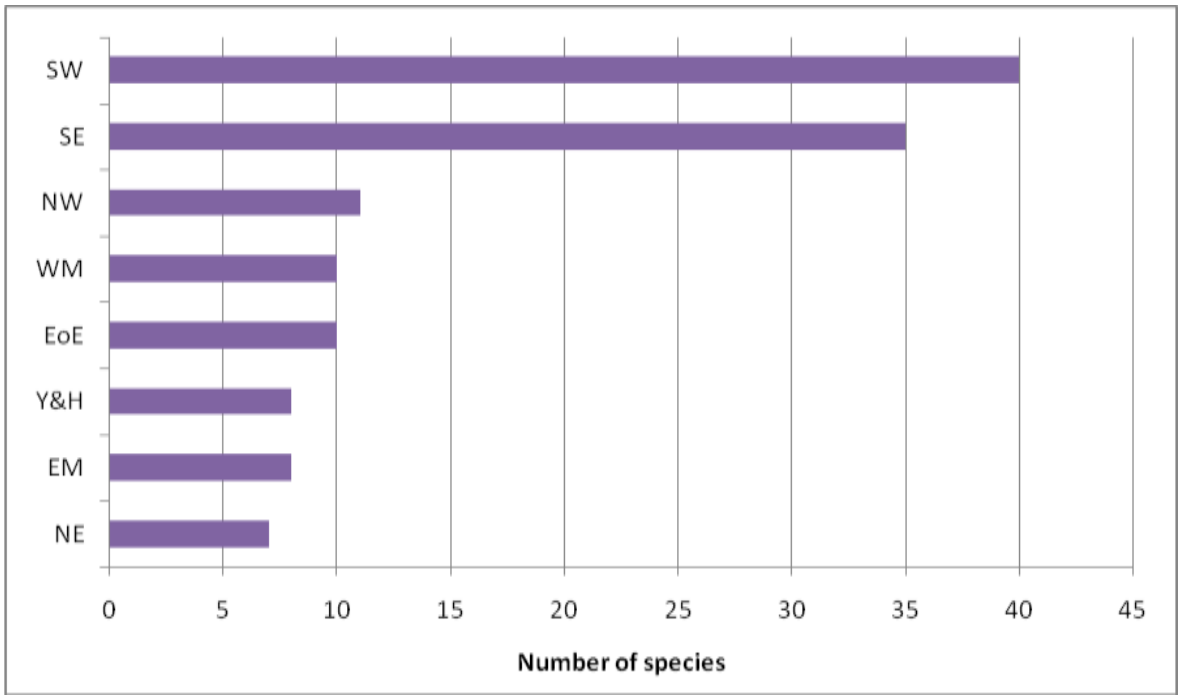

Figure 64 Regional distribution of UK BAP species associated with maritime cliffs and slopes

6.292 Most UK BAP cliff species are found in the South East and South West. This is perhaps a factor of climate and shelter. Many of these species are on the edge of their range, being far more common (in other habitats) in Europe.

Habitat / niche requirements

6.293 Figure 65 shows the most frequent maritime cliff habitat associations of the UK BAP species.

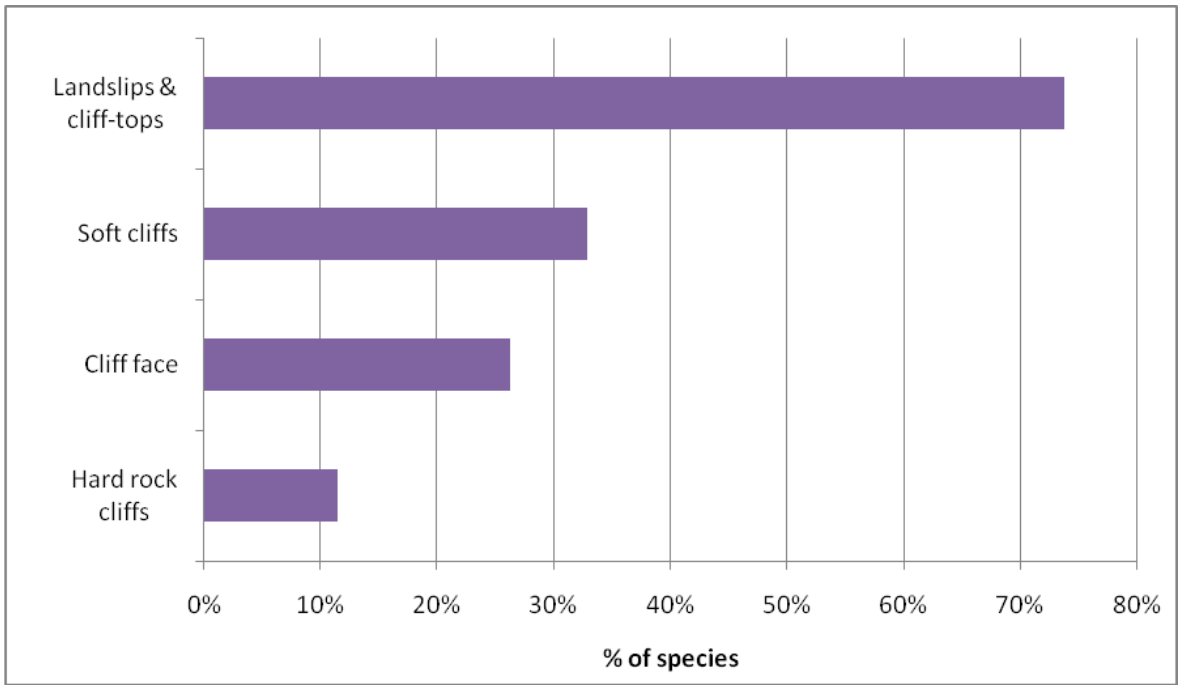

Figure 65 Habitat/niche requirements of UK BAP species associated with maritime cliffs and slopes

6.294 This analysis shows that the majority of all cliff species are associated with **landslips** and the **cliff-tops** rather than the open cliff face. This includes a wide range of taxonomic groups such as bryophytes (for example, blackwort *Southbya nigrella*), vascular plants (purple ramping-fumitory *Fumaria purpurea*), invertebrates (for example, Lulworth skipper *Thymelicus acteon*) and vertebrates (common lizard *Zootoca vivipara*).

6.295 Of the 48 species with a requirement for **bare habitats**, 42% (20 species) are particularly associated with **soft cliffs** (for example, boulder clay). These species are almost entirely invertebrates such as the violet oil-beetle *Meloe violaceus* and the mason wasp *Odynerus melanocephalus*. Only 7 species are associated with **hard rock cliffs** (for example, chalk, limestone, sandstone). All species associated with hard rocks are found on the cliff face, including the lichen *Acarospora subrufula*, the moss *Tortula cuneifolia* and snail *Truncatellina cylindrica*.

6.296 Further analysis of the requirements of species associated with the different habitat zones were carried out and the results are presented in Figures 66 and 67.

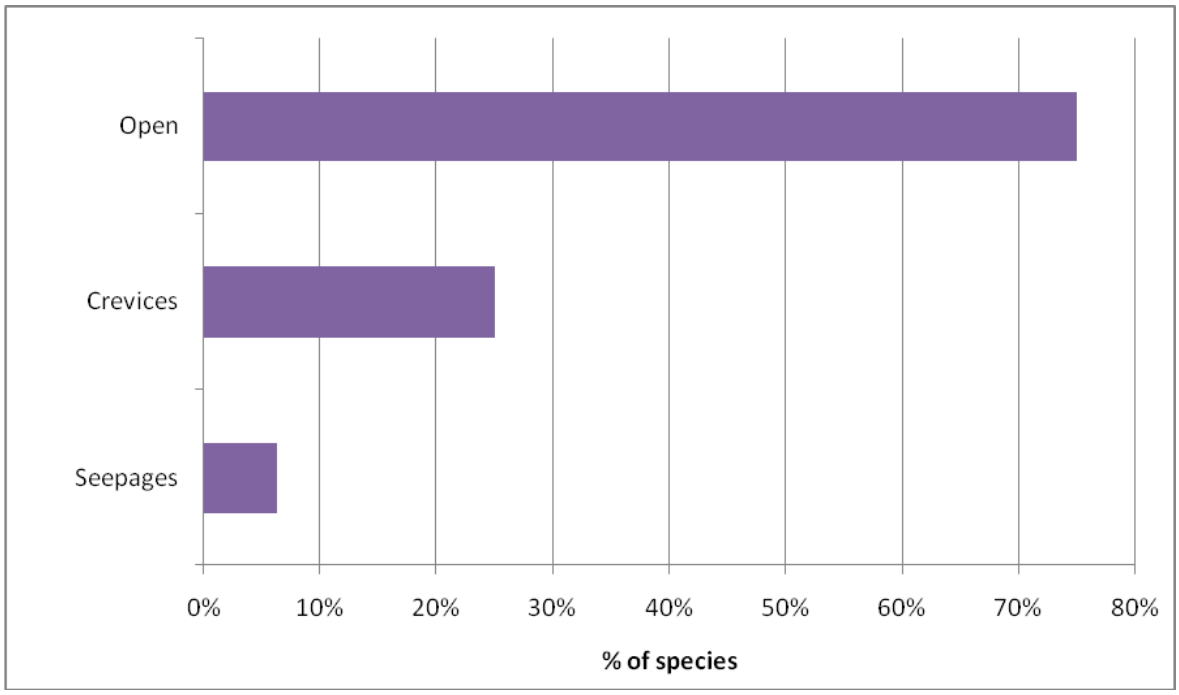

Figure 66 Habitat/niche requirements of UK BAP species associated with the cliff face

6.297 This analysis show that 75% of species (mostly lower and vascular plants such as *Bryum gemmiparum* and wild asparagus *Asparagus prostratus* respectively) utilising the **cliff-face** are associated with **open, unshaded conditions**, with only 25% of species (for example, the lichen *Toninia sedifolia*) found in **crevices**.

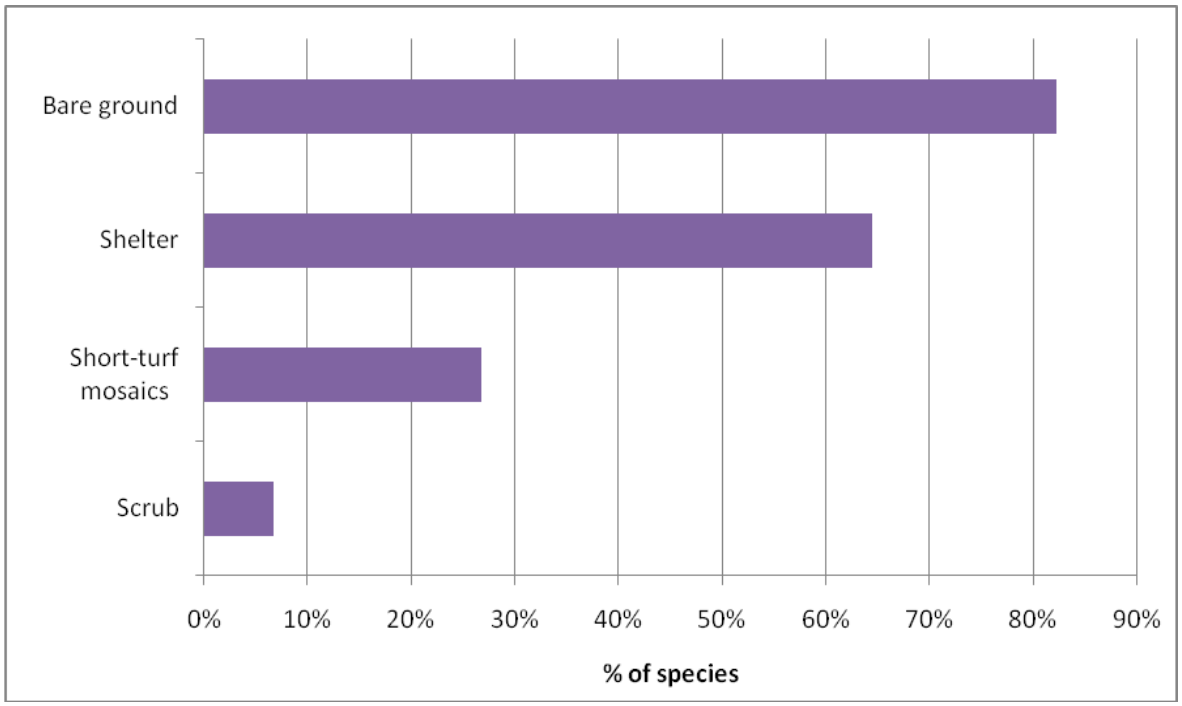

Figure 67 Habitat/niche requirements of UK BAP species associated with landslips and cliff-tops

6.298 Of those species associated with **landslips and cliff-tops**, 82% (mainly invertebrates such as the mining bee *Lasioglossum angusticeps* and the Glanville fritillary *Melitaea cinxia*) require **bare ground** and 64% (again, nearly all invertebrates, including the click-beetle *Anostirus castaneus* and the cuckoo bee *Nomada errans*) require **sheltered** conditions which generate a **warm microclimate**.

6.299 Less significant requirements include **mosaics** of bare ground with short-sward vegetation and scrub (for example, chalk carpet *Scotopteryx bipunctaria* and the common lizard).

6.300 **Cliff face** species tend to be cliff 'specialists', which live on **exposed rock or within crevices**. Conversely, **landslip and cliff top species** are often associated with **heathland and/or grassland habitats** and have similar requirements to species associated with those habitats.

Summary

6.301 Soft rock cliffs are characterised by episodic slumping followed by natural re-vegetation. This natural dynamism requires no intervention.

6.302 Many of the species present on landslips and cliff tops are reliant on shelter. This is often provided by the cliff structure and perhaps explains why less scrub association is seen for this priority habitat than in others (because the shelter is provided by the topography rather than the scrub).

6.303 Although there are some specialist cliff top species, many more have a general requirement for mosaics of bare ground and herb-rich vegetation (nectar, food plants etc) associated with other habitats (for example, grassland, heathland).

Intertidal mudflats

6.304 There are only three UK BAP Species associated with mudflats: the localised dark-bellied brent goose *Branta bernicla bernicla*, the widespread curlew *Numenius arquata* and the very restricted triangular club-rush *Schoenoplectus triqueter.* The bird species require **extensive mudflats** for feeding on eel-grass/algae or invertebrates. The club-rush is found on **mudbanks** in estuaries and along tidal rivers in the South West.

6.305 Note that this analysis does not include marine species and thus appears less well represented than some of the other habitats in this report. It also represents a valuable habitat for many non-BAP species, particularly bird species occurring in internationally important numbers, often in locations designated as Special Protection Areas.

Coastal saltmarsh

6.306 Twenty-nine species UK BAP species are associated with coastal saltmarsh. These are dominated by vascular plants, invertebrates and birds and the majority are widespread or localised.

Table 63 Species numbers across different taxonomic groups - saltmarsh

Taxonomic group	No. of species
Bryophytes	2
Vascular plants	6
Terrestrial invertebrates	11
Amphibians/reptiles	1
Birds	9

Table 64 Species numbers across different restriction classes - saltmarsh

Restriction class	No. of species
Widespread	4
Localised	16
Restricted	2
Very restricted	7

6.307 Their distribution at the regional level is shown in Figure 68.

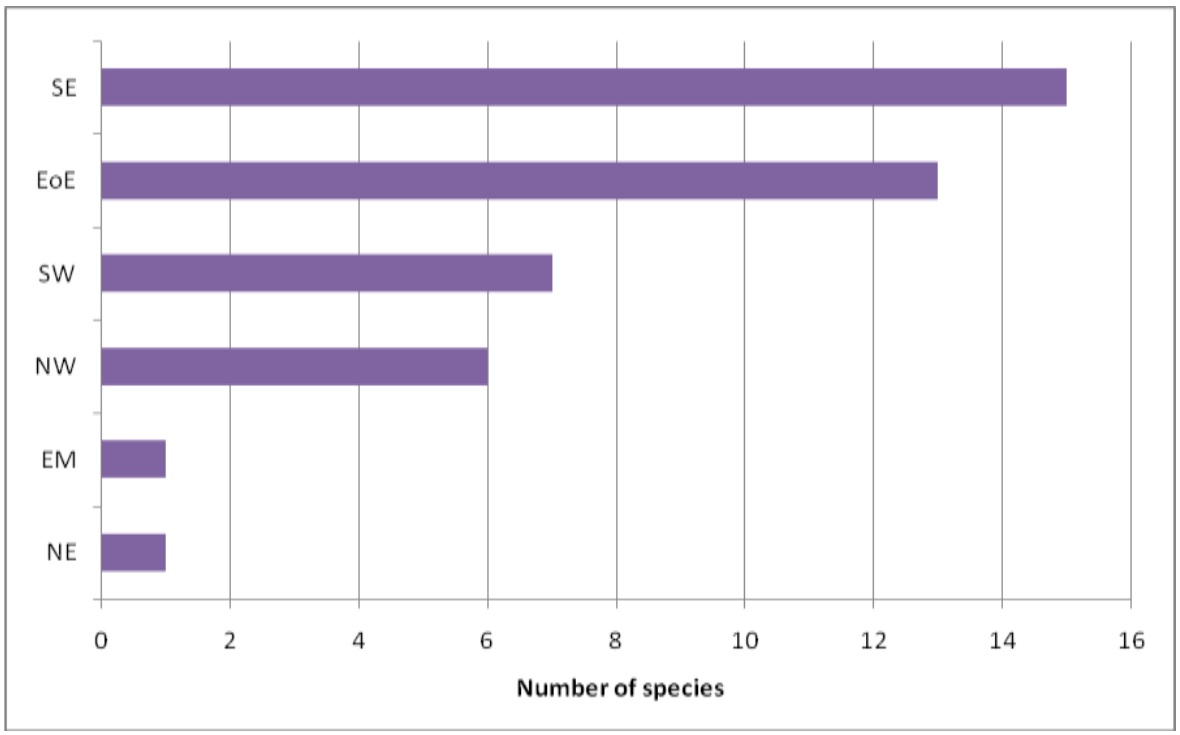

Figure 68 Regional distribution of UK BAP species associated with saltmarsh

6.308 The distribution of UK BAP species associated with saltmarsh broadly represents the distribution of the habitat itself, with the greatest number found in the South East and East of England.

Habitat / niche requirements

6.309 The distribution of the saltmarsh species in different habitat zones is shown in Figure 69.

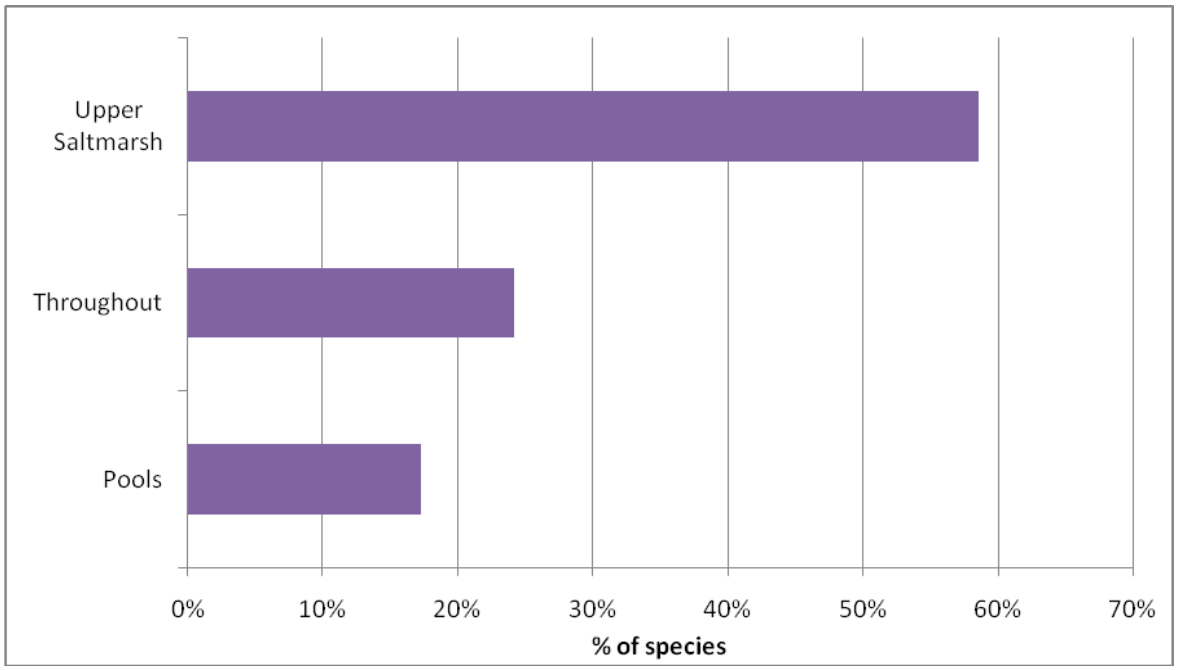

Figure 69 Distribution of UK BAP species within different saltmarsh habitat zones

6.310 This shows that almost 60% of all saltmarsh species are associated with the **upper saltmarsh zone** (i.e. the zone that receives the fewest tidal inundations annually), including small cord-grass *Spartina maritima*, slender hare's-ear *Bupleurum tenuissimum* and the wolf spider *Arctosa fulvolineata*. Those species more generally distributed across the entire marsh are all birds, such as dark-bellied brent goose *Branta bernicla bernicla* and twite *Carduelis flavirostris*.

6.311 A small number of species are associated with **pools**, including three invertebrates: the beetles *Anisodactylus poeciloides* and *Pogonus luridipennis* and the bug *Saldula setulosa*. The habitat/niche requirements of saltmarsh species are further explored in Figure 70.

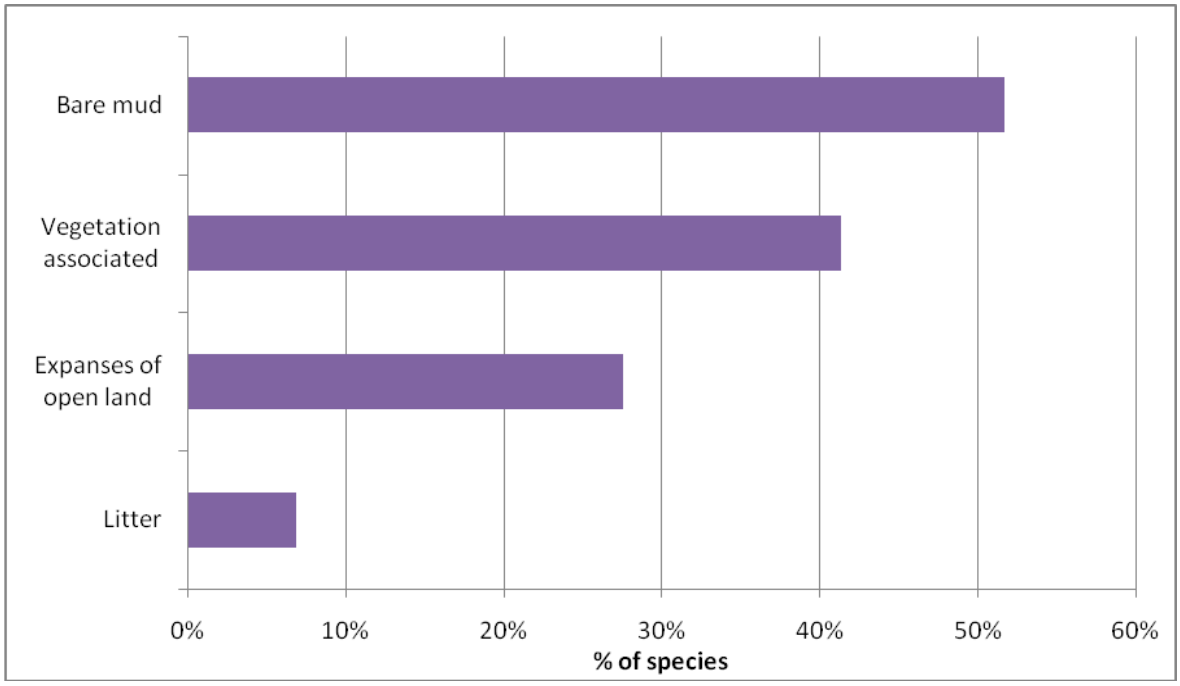

Figure 70 Habitat/niche requirements of UK BAP species associated with saltmarsh

6.312 Half of all species require some **bare mud** (along creeks for example), including small cord-grass, the beetle *Anisodactylus poeciloides* and black-tailed godwit *Limosa limosa*. Expanses of **open, undisturbed land** with **extensive view-lines** are also important for bird species.

Summary

6.313 Two main elements are apparent for UK BAP species associated with saltmarsh:

- Large expanses of open saltmarsh are very important for feeding and roosting birds.
- Bare mud located in the upper, less saline parts of the marsh, which is the critical zone for the majority of other species (mostly invertebrates and vascular plants).

6.314 Although it was not evident in the data, it is highly likely that invertebrate species which utilise bare mud are doing so within a matrix of vegetation as this increases shelter.

6.315 The evidence suggests that saltmarsh does not require man-made intervention. Instead, dynamic mosaics of bare ground, litter and vegetation are maintained by tidal activity.

6.316 As a result of coastal squeeze (where man-made flood defences prevent the landward migration of intertidal habitats in response to sea level rise), upper saltmarsh and transitions to freshwater wetlands or terrestrial habitats are now relatively scarce habitats and many upper saltmarsh specialists are now often restricted to sea walls and other man-made habitats. Wherever possible the creation of upper saltmarsh should be facilitated by, for example, managed realignments of flood defences which restore natural tidal processes and reduce coastal squeeze.

Brownfield habitat requirements

6.317 Brownfield habitat is best defined in terms of structure and growth forms, rather than through specific vegetation communities. It comprises mosaics of bare ground with, typically, very early pioneer communities on skeletal substrates; more established open grasslands, usually dominated by fine-leaved grasses with many herbs and areas of bare ground, scrub and patches of other habitats such as heathland, swamp, ephemeral pools and inundation grasslands. High quality examples may be characterised as "unmanaged flower-rich grasslands with sparsely-vegetated areas developed over many years on [edaphically-] poor substrates" (Harvey, 2000).

6.318 There are a total of 108 species associated with Brownfield Habitats. It contains a large proportion of widespread and localised species when compared with other more semi-natural priority habitats.

Table 65 Species numbers across different taxonomic groups - Brownfield

Taxonomic group	No. of species
Fungi	2
Lichens	4
Bryophytes	15
Stoneworts	1
Vascular plants	21
Invertebrates	38
Amphibians/reptiles	6
Birds	12
Mammals	9

Table 66 Species numbers across different restriction classes - Brownfield

Restriction class	No. of species
Widespread	36
Localised	35
Restricted	11
Very restricted	26

6.319 Figure 71 shows the association between restriction class and taxonomic group. As with a number of other priority habitats, invertebrates and lower plants contain more species overall, but many of these have a very restricted distribution.

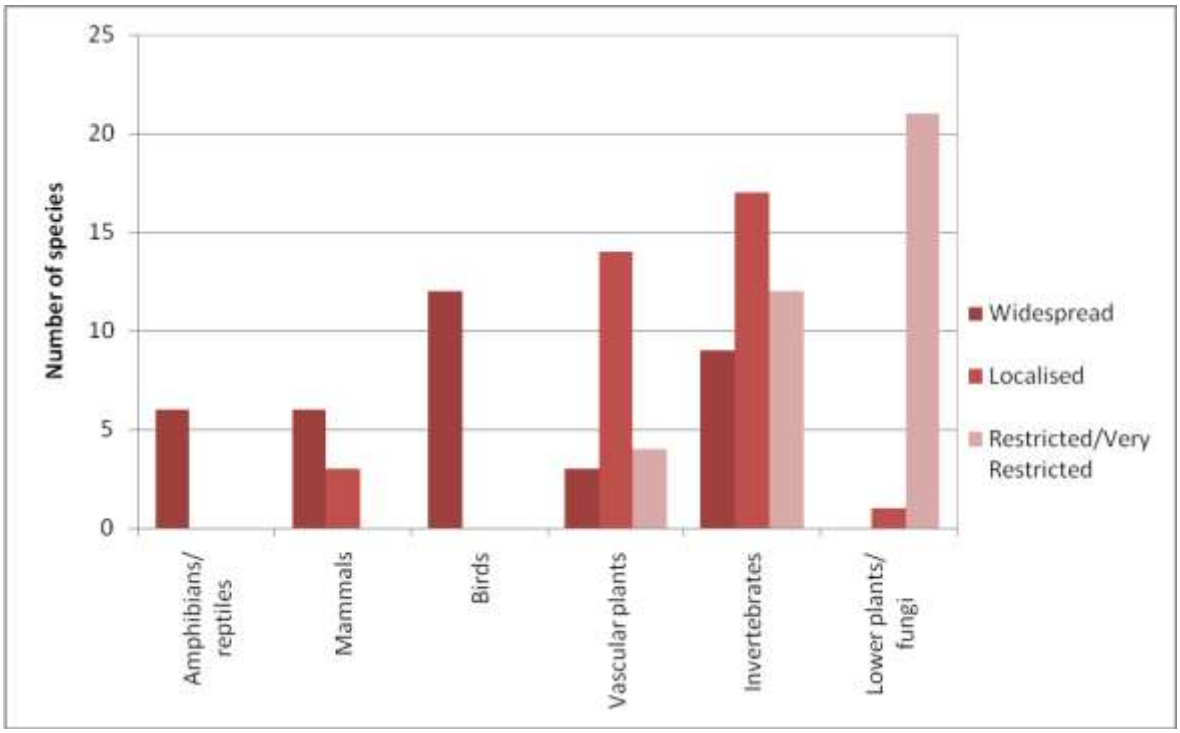

Figure 71 Relationship between taxonomic group and restriction class of UK BAP species associated with brownfield habitat

6.320 Figure 72 represents important regions identified for brownfield species. The majority of species are associated with southern regions of England (South West and South East). The East of England also figures strongly whereas the midlands and north of England contain far fewer species primarily associated with them. The distribution of brownfield species may largely reflect both climatic and geographic factors. For example, many species are found in areas of low rainfall and with periods of summer drought such as in the East of England or in areas where exposures of chalk/limestone, sands and gravels that have been extensively quarried such as in the South East. These areas are often favoured by thermophilic species (for example, invertebrates) often at the edge of their range in southern England.

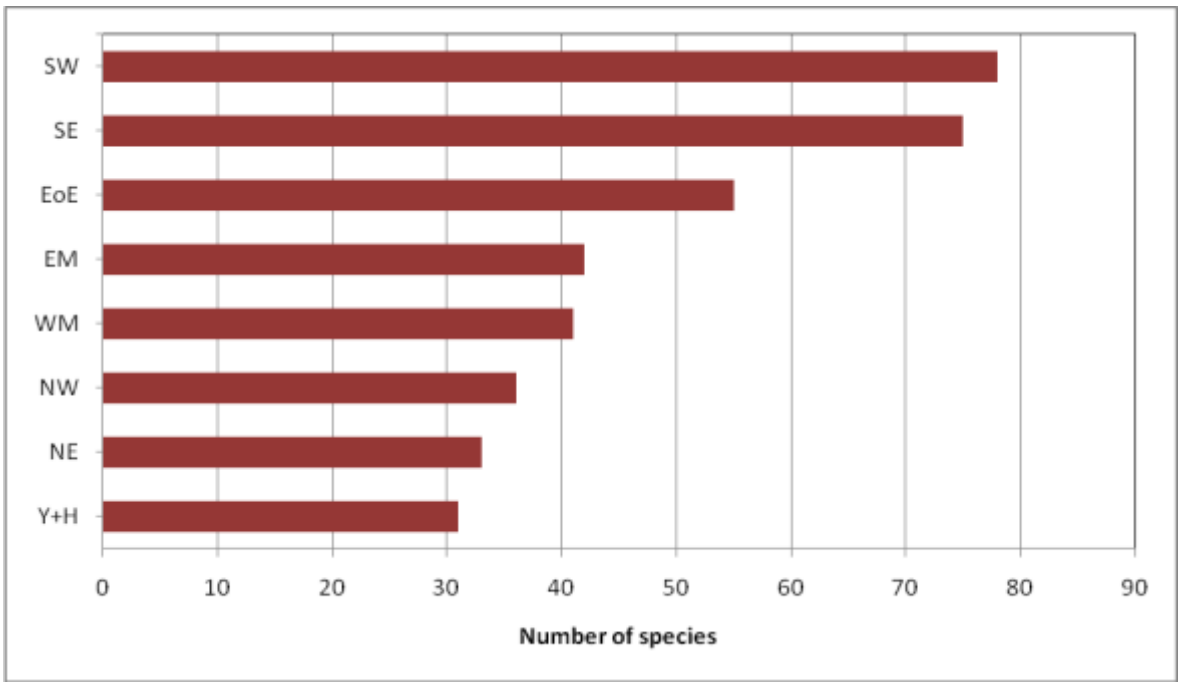

Figure 72 Regional distribution of UK BAP species associated with brownfield habitat

Habitat / niche requirements

6.321 Figure 73 shows the niche/habitat requirements for UK BAP species associated with brownfield habitats.

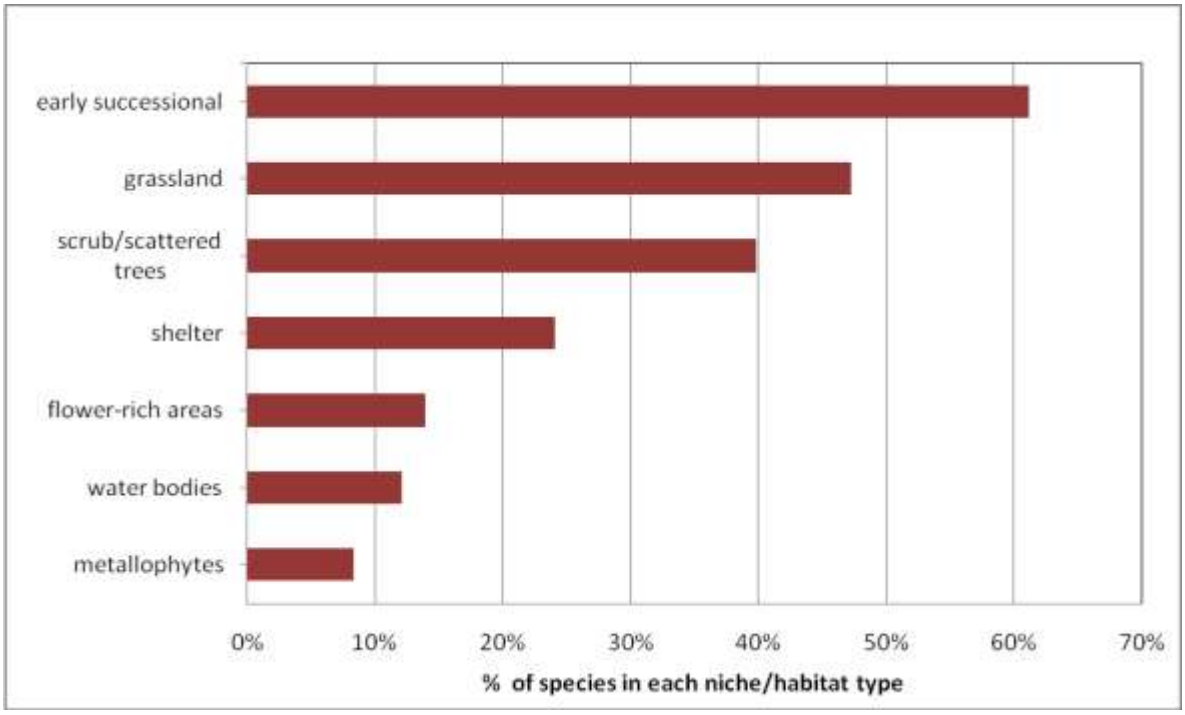

Figure 73 Habitat/niche requirements of UK BAP species associated with brownfield habitats

6.322 A large proportion of species are dependent on **early successional habitats**, principally bare ground, exposed rock and ruderal plant communities. A small number of lower plants are classed as **metallophytes**, requiring ore-rich deposits of certain metals. For example, entire threadwort *Cephaloziella calyculata*, greater copperwort *C. nicholsonii* and copper lecidea *Lecidea inops* all require copper-rich substrates.

6.323 Around a half of all species require **grassland niches,** such as flower-rich resources, particular grassland plant species or structure in the form of open, short, tall/tussocks and combinations of sward types (see Figure 74). Of these around a quarter can be identified as requiring **flower-rich foraging areas**. For example, bumblebees such as the shrill carder bee *Bombus sylvarum* and brown-banded carder-bee *B. Humilis* which require large scale flower-rich areas, with resource present from spring to late summer.

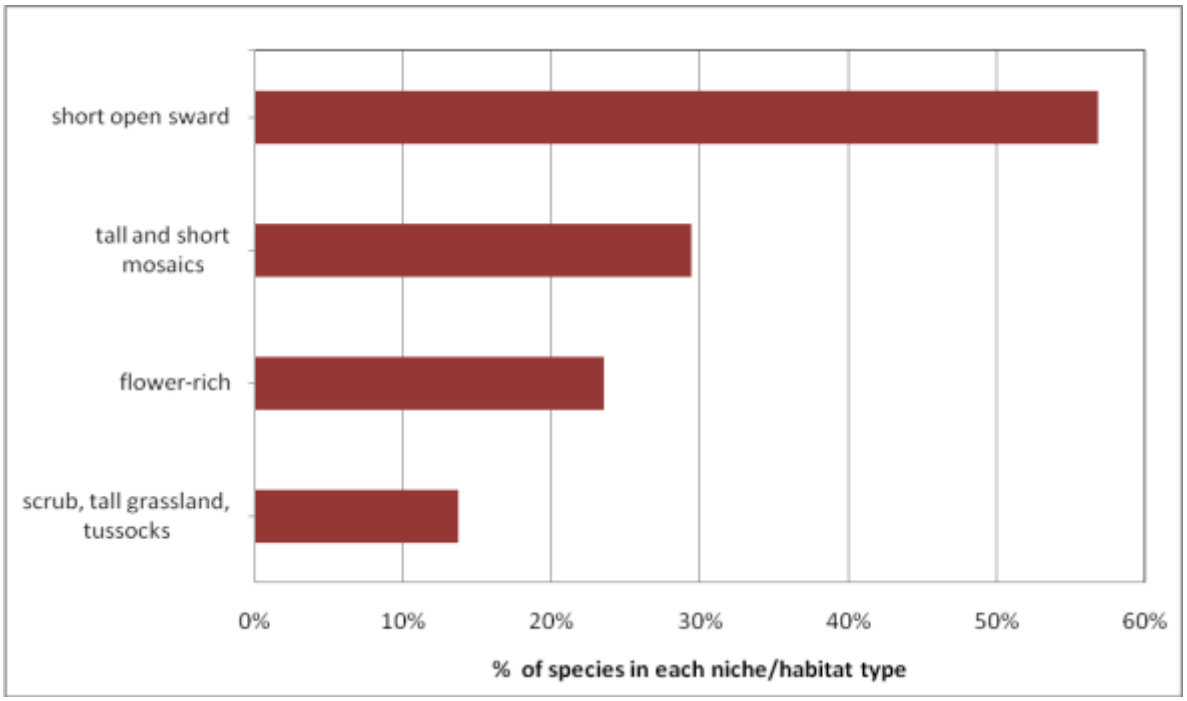

Figure 74 Habitat/niche requirements of UK BAP brownfield species associated with grasslands

6.324 For many species require some form of **shelter** such as from scrub/trees and other topographical features (pits, cliffs and banks). Of the species requiring shelter in brownfield habitats around 50% require **scrub** indicating the importance of structural features. For example, butterfly species (dingy skipper *Erynnis tages*, grizzled skipper *Pyrgus malvae*, small blue *Cupido minimus*) and reptiles (common lizard *Lacerta vivipara*, slow worm *Anguis fragilis* and adder *Vipera berus*).

6.325 A small number of species are associated with **water bodies**. For example, temporary water or seasonal wetlands (lapwing *Vanellus vanellus*, pillwort *Pilularia globulifera* and the large-celled flapwort *Lophozia capitata*; permanent lakes and ponds (great crested newts *Triturus cristatus*, grass snake *Natrix natrix*, herring gull *Larus argentatus*, bearded stonewort *Chara canescens* and wet areas / seepages (song thrush *Turdus philomelos*, reed bunting *Emberiza schoeniclus*, western rustwort *Marsupella profunda*).

6.326 **Underlying geology** such as calcareous/acidic substrates or sandy/clayey soils and **hydrology** (free-draining or wet soils) also plays an important role in determining species composition of brownfield sites. For example, 25% of species are found on limestone or calcareous rocks/soils (small blue and northern brown argus butterflies, man orchid *Acerus anthropophorum*, Cotswold pennycress *Thlaspi perfoliatum*, pasqueflower *Pulsatilla vulgaris*, blackwort *Southbya nigrella* and chalk threadwort *Cephaloziella baumgartneri*).

6.327 Species were further divided by their restriction class and then analysed by their niche requirements (see Figure 75). There are some clear trends expressed:

- A greater proportion of localised and restricted/very restricted species are associated with early successional habitats (86% of restricted/very restricted species compared with 36% of widespread species).
- The opposite trend can be detected for the number of species requiring grassland and scrub; it is more important for widespread UK BAP species than it is for restricted ones. This reflects that for these species, there is a requirement for landscape scale mosaics of different habitats. For example, bats require good vegetation linkages (such as scrub and hedgerows) for commuting between roosts and foraging grounds (woodland, grasslands and open water habitats).

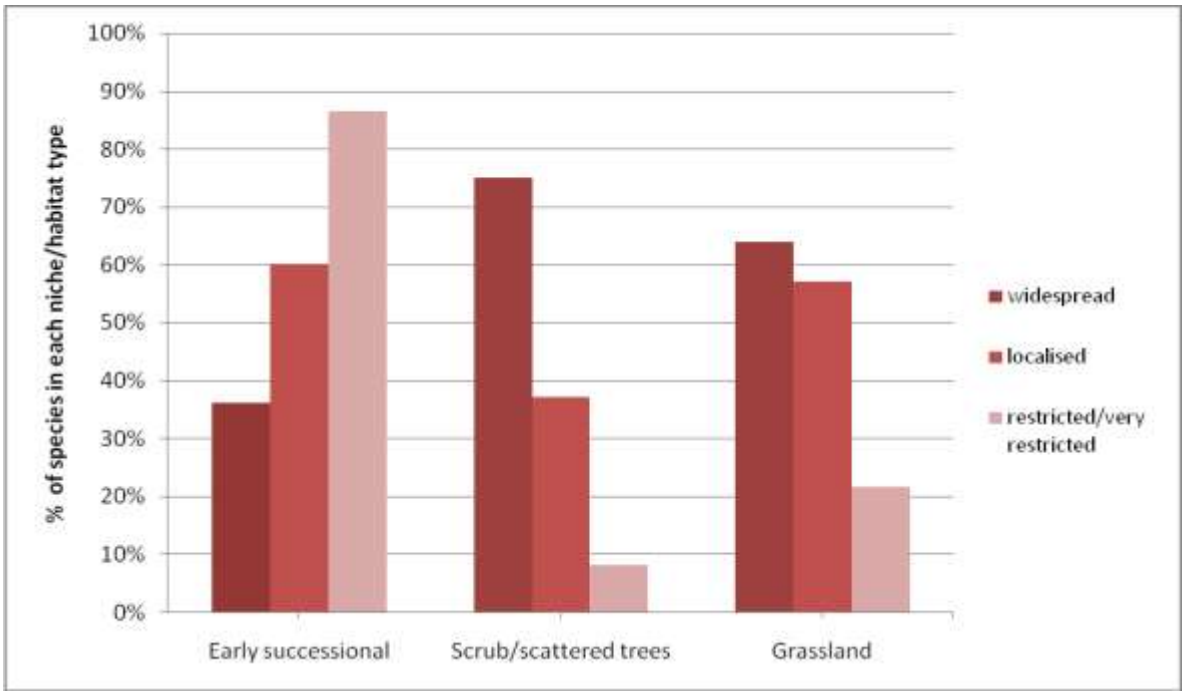

Figure 75 The relationship between habitat/niche requirement and restriction class of UK BAP species associated with brownfield habitats

Summary

6.328 The pooled requirements for brownfield species bare most resemblance to grassland priority habitats. Therefore a lot of this summary is very similar to grasslands outlined under lowland farmland. There is also considerable resemblance to heathlands although the requirement for shelter varied considerably with heathlands species being much more dependent on shelter (61% as opposed to 24%).

6.329 Brownfield habitat is dominated by similar species to grasslands, with birds and mammals operating at a large scale where available forage is plentiful; whereas invertebrates and plants operate at a small scale, requiring bare ground and flower-rich resources in herb-rich, open swards.

6.330 The main difference seems to lie in the number of species associated with the various successional states.

Table 67 Percentage number of species associated with different successional states by habitat type

% of species	Early successional	Grassland	Scrub/scattered trees
Brownfield	61%	47%	40%
Grassland	43%	59%	31%
Heathland	55%	38%	29%

6.331 Habitat structure is obviously critical; the presence of bare ground and ruderal habitats in particular play a vital role in determining species composition. As early successional habitat is important for over 60% of the species, small scale dynamics that help vary sward structure should be seen as an imperative for site management. Where this form of 'natural' disturbance is missing then man-made disturbance should be a strong option for site management.

6.332 Particular resources are also important to the animals that utilise grasslands. The presence of flowers (nectar and pollen) throughout the spring and summer is critical for 14% of species. Therefore, managing sites by wholesale mowing and/or intensive periods of grazing over the whole site will not be suitable to many species.

6.333 As with grasslands and heathland, brownfield sites require dynamic processes and short periods of stability to produce resources and niches for species; scrub matrices; bare ground and the presence of flowers and tall herbs.

6.334 The vegetation types of brownfield sites vary greatly in response to the range of geological textures (clays to gravels) and acidities (alkaline to acid) and in their various combinations. There are further contrasts between mature vegetation and newer vegetation forming on disturbed ground. The result is that many sites are characterised by an extensive mosaic of habitats favouring thermophilic and dry grassland/heathland species, (often at the edge of their range in southern England).

6.335 Species most reliant on brownfield sites require habitats that are:

- nutrient poor;
- have varied vegetation structure, all year round;
- have varied topographic structure (for example, wet and dry areas close together);
- have bare ground (including sandy, chalky, clay and gravelly);
- have an abundance of flowering plants; and
- have periodic low levels of disturbance.

Woodland habitat requirements

6.336 There are a total of 256 species associated with the Woodland Habitats in England. All of these have been associated with one or more of the priority woodland habitats. One overall broad analysis of all species associated with woodland was undertaken. This gave an overall indication of what niches and habitats are required for UK BAP priority species in woodlands generally.

6.337 Further analyses of species falling into a 'general woodland' category was undertaken, along with separate analysis to identify species associated with the following sub-types: wood-pasture and parkland (veteran trees), wet woodland and lowland beech woodland (as these were judged to be the most likely to have assemblages that might require different conditions to the general assessment).

Table 68 Distribution of species across the different priority habitats - Woodland

Woodland habitat	No. of associated UK BAP species
'General woodland' species incorporating: Lowland mixed deciduous Lowland beech and yew Upland oakwood Upland mixed ashwoods Wet woodland	169
Wood-pasture and parkland (veteran trees)	105
Wet woodland	36
Lowland beech woodland	55

6.338 A breakdown of the taxonomic groupings of the 257 species associated with woodland is given below. Woodlands contain a very high number of lower plants (fungi, lichens and bryophytes) and invertebrates when compared to others priority habitats. A high proportion of these are either in the restricted or very restricted category, with nearly forty-five percent found in five or less sites in England.

Table 69 Species numbers across different taxonomic groups - Woodland

Taxonomic group	No. of species
Fungi	42
Lichens	58
Bryophytes	12
Invertebrates	79
Vascular plants	25
Birds	21
Amphibians/reptiles	6
Mammals	13

Table 70 Species numbers across different restriction classes - Woodland

Restriction class	No. of species
Widespread	51
Localised	51
Restricted	41
Very restricted	112
Unknown, probably very restricted or extinct	1

6.339 The degree of restriction varies greatly between the different groups, as shown in Figure 76. The lower plants (especially fungi and lichens) and invertebrate groups contain a particularly high proportion of restricted and very restricted species.

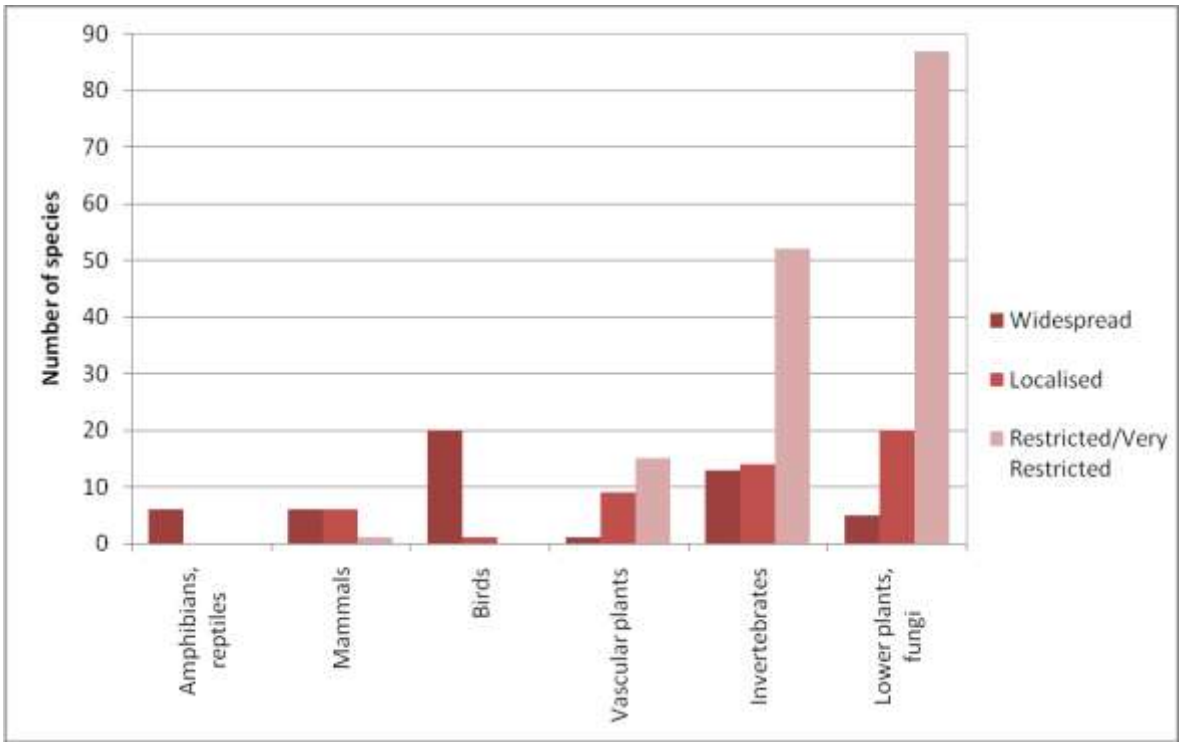

Figure 76 Relationship between taxonomic group and restriction class of UK BAP species associated with woodland habitats

6.340 Figure 77 shows that most BAP species are associated with woodland in the south of England, particularly in the South East. This is probably due both to climactic factors and the amount of available habitat (the South East has the highest proportion of lowland woodland in England). The South West ranks second highest. A number of species particular to this region are associated with the relatively warm, wet climate, in particular epiphytic lichens growing on tree trunks and limbs.

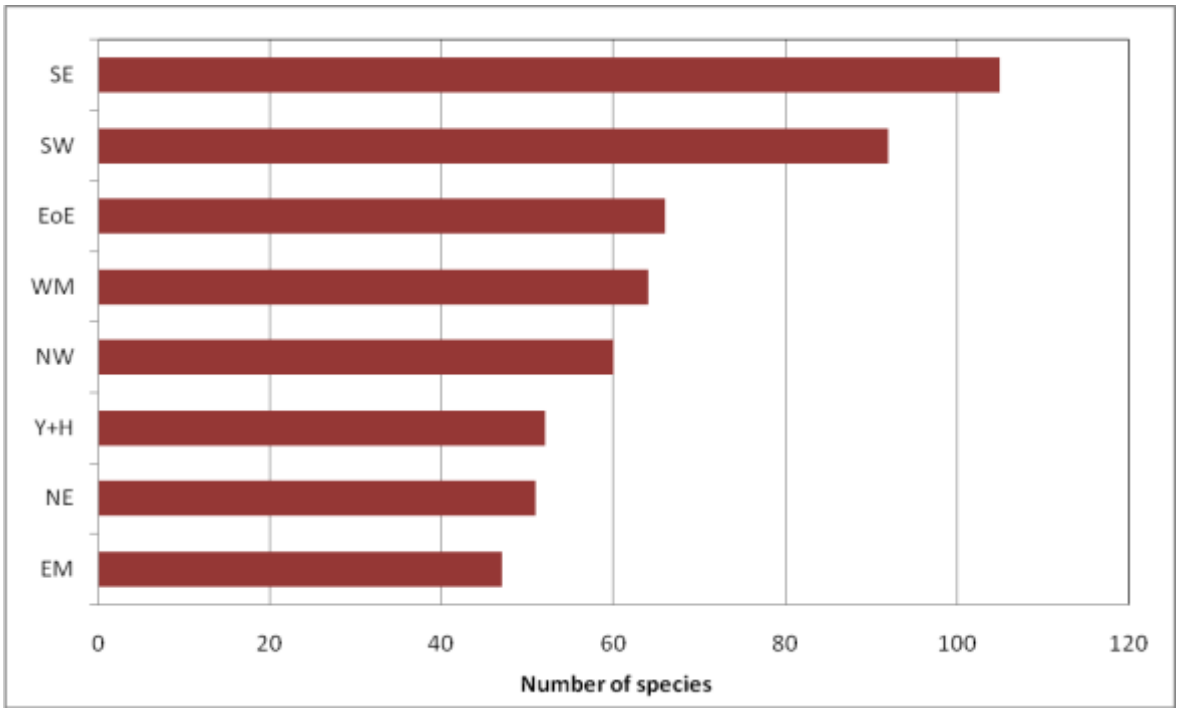

Figure 77 Regional distribution of UK BAP species associated with woodlands

Habitat / niche requirements

6.341 Figure 78 shows the niche/habitat requirements for UK BAP species associated with all woodlands. Analysis shows that:

- Forty-one percent of species are associated with **veteran trees** within wood-pasture and parkland; that is, large open-grown trees with spreading crowns and considerable structural variability (see analysis on wood-pasture and parkland);
- Forty percent of species are dependent on **glades, rides and edges**; sheltered grassy and heathland habitats which grade into woodland;
- Twenty-three percent of species require **closed-canopy** woodland. All of these live under the canopy, in the relative high shade and humidity, as opposed to on the top of the canopy (a habitat for which we have very little information);
- Twenty-eight percent of species are associated with **scrub mosaics**; scrub-herb interfaces on the edges of woodland, glades and rides; and
- Eight percent of species require areas of **clear-fell and coppice**. These tend to require bare ground and regenerating scrubby habitats in sheltered locations.

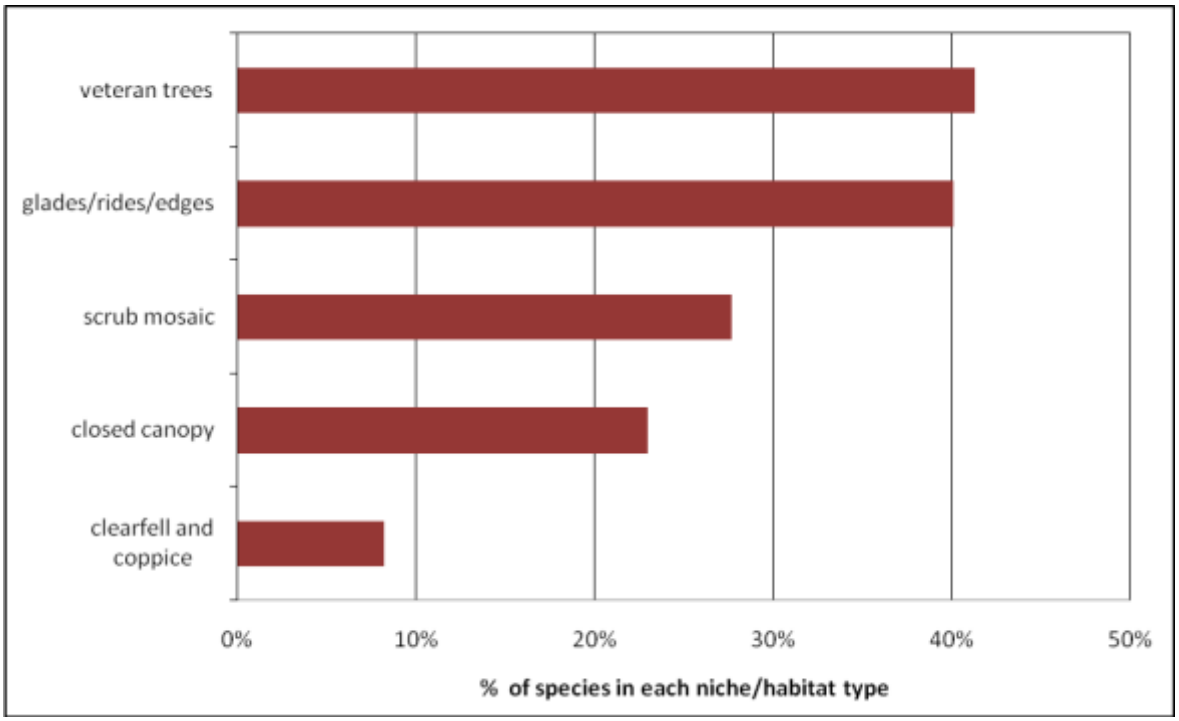

Figure 78 Habitat/niche requirements of UK BAP species associated with woodlands

General woodland

6.342 A total of 169 species are associated with the general woodland category. Around two-thirds of species are associated with glades, rides and woodland edge habitats and the remainder with closed canopy woodland. Analysis was undertaken separately for glades and rides and closed canopy woodland.

6.343 A total of 103 species are associated with glades, rides and woodland edge habitats. The majority of these species consist of invertebrates, vascular plants and vertebrates. Fifty-eight percent of species are either local or widespread (for example, birds, mammals, butterflies).

6.344 Figure 79 investigates what species require in woodland glades, rides and edge habitats. This analysis shows that:

- Majority (93%) of species within this niche depend on a **complex woody structure** of trees and shrubs (for example, low hanging boughs, dead wood, twigs and leaves), including wood edge where woodland grades into open scrub and grassland;
- Around a half of species are **ground-dwelling (or nesting)**; they are not utilising the trees and scrub for food or forage. It is more likely that they use this niche for shelter;
- A third of species are operating at a **larger-scale or even landscape-scale mosaic** level, requiring a mixture of trees, scrub and other open habitats. The majority of species in this category are birds and mammals;
- **Grassland and herbaceous plants** are important for 34% of species; utilised for foraging, nesting and overwintering;
- Fifty-two of all species require **sheltered** situations. This represents habitats open to direct sunlight and protected from wind by topography or vegetation; often found in bays of scrub or against a woodland edge; and
- Structural diversity created through different stages of **coppicing or clear fell** (for example, young to mature stands) is beneficial for 21 species such as the dormouse *Muscardinus avellanarius* and common fan-foot *Pechipogo strigilata.* Many of these species respond positively to the vigorous scrub regeneration that often grows after such events.

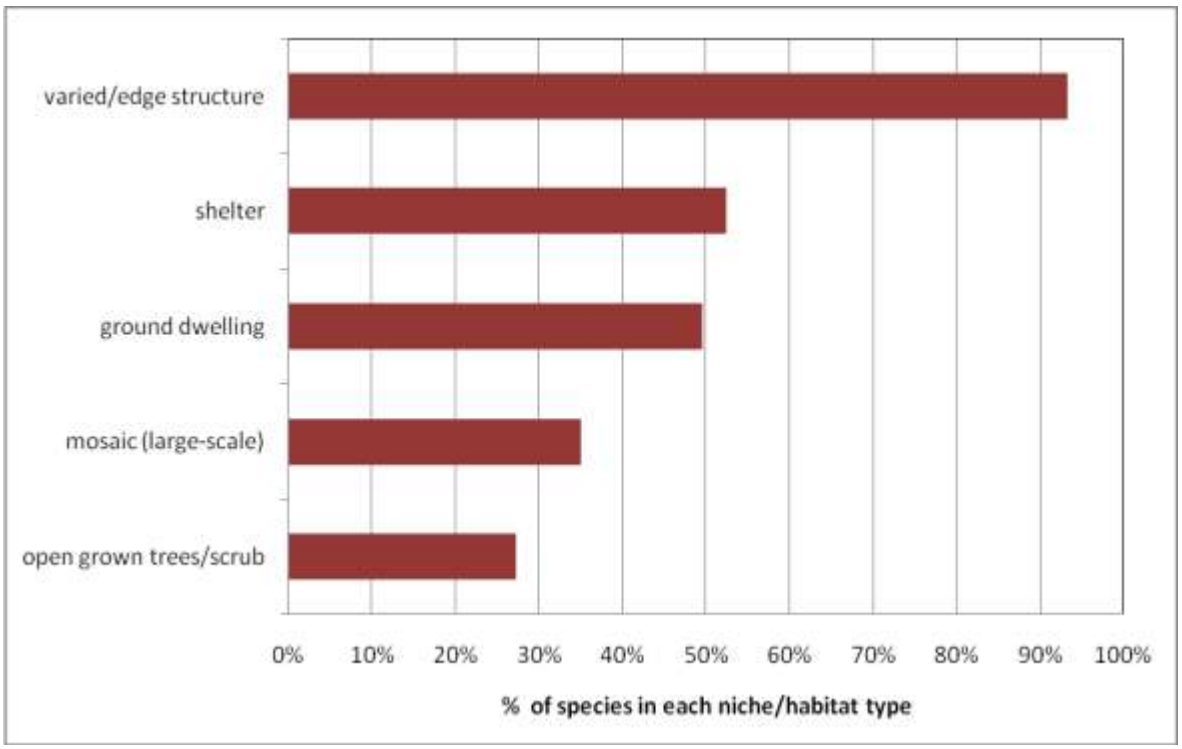

Figure 79 Habitat/niche requirements of UK BAP species associated with glades, rides and woodland edges

6.345 A total of 59 species are associated with **closed canopy** woodland. The majority of these species consist of invertebrates, fungi and lower plants. More than two-thirds of these species are very restricted or restricted in their distribution.

6.346 Figure 80 investigates what species require in closed canopy woodland. Analysis shows that:

- Seventy-one of the species associate with the **soil, litter and short, open vegetation** rather than the canopy or under-storey;
- Seventy-three percent of species have specific **humidity requirements**. Some only tolerate high humidity and can only be found where this is kept constantly high (for example, next to streams). Of all woodland species that require humidity 80% are associated with closed canopy woodland showing the importance of this habitat niche for some taxonomic groups (for example, fungi, bryophytes);
- Twenty-seven percent of species are associated with **tree trunks/branches** such as epiphytic lichens and bryophytes; **tree roots and bases** (for example, veilwort *Pallavicinia lyellii*, the money spider *Monocephalus castaneipes*) and the **tree canopy** (for example, the goat moth *Cossus cossus*, wood warbler *Phylloscopus sibilatrix* and red squirrel *Sciurus vulgaris*); and
- Fourteen percent of species are associated with **standing or fallen dead wood** (for example, willow gloves *Hypocreopsis lichenoides*, mulberry brain *Tremella moriformis*, scarce yellow splinter *Lipsothrix nigristigma*).

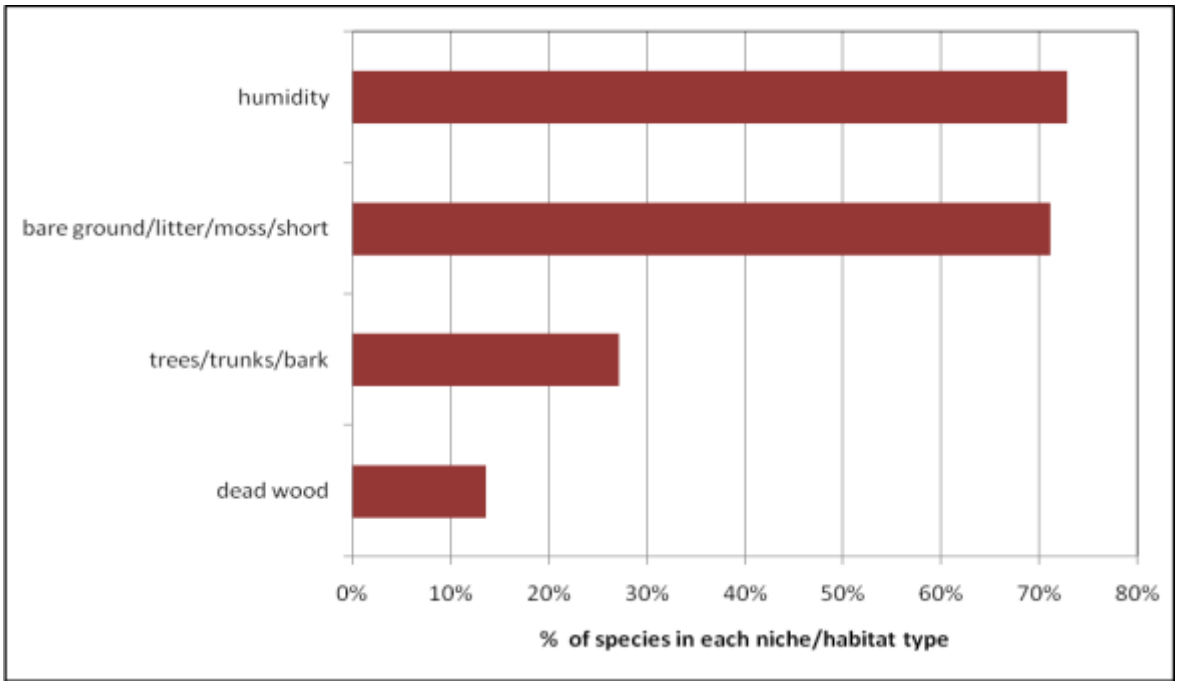

Figure 80 Habitat/niche requirements of UK BAP species associated with closed canopy woodland

Overall summary

6.347 Woodlands are often structurally complex habitats used by a large number and range of species. Although some species require larger-scale mosaics, these are outnumbered by a great number of lower plants, fungi and invertebrates dependent on microhabitats. Many of the species in this latter group occur in less than five sites in England.

6.348 Figure 81 shows the relationship between the restriction class of UK BAP species and the three largest niche/habitat requirements: veteran trees, glades and rides, closed canopy woodland. These have been plotted against total number of species. Widespread and localised species have been pooled. The results suggest that, for the pooled species, glades and rides are just as important as veteran trees.

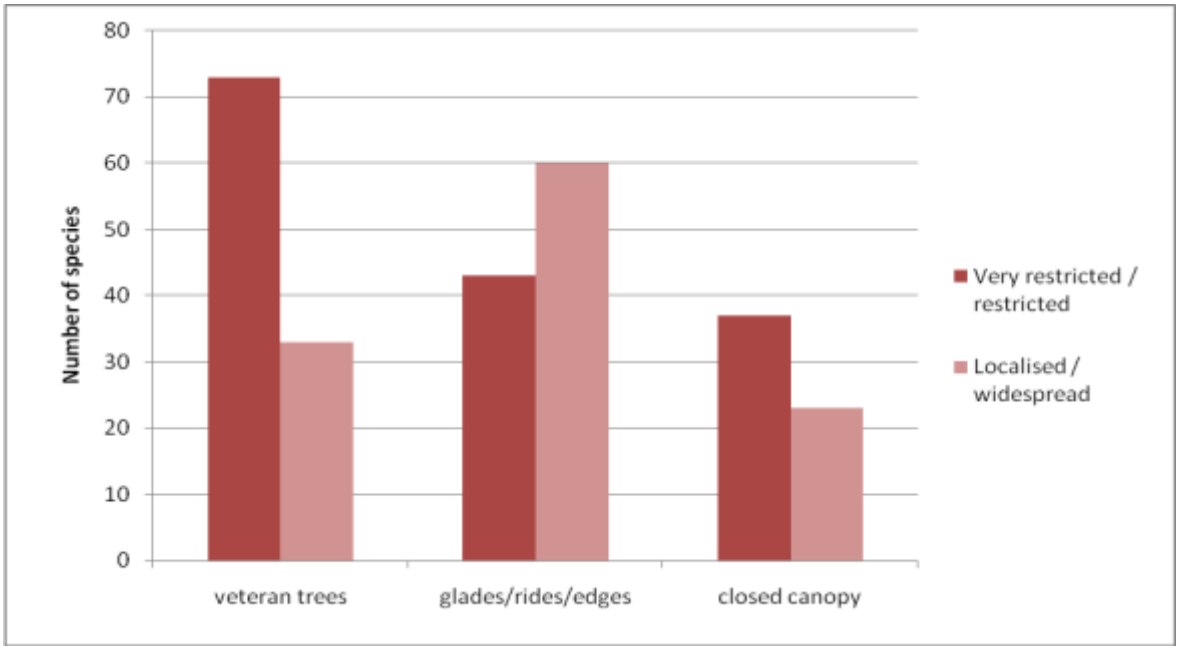

Figure 81 The relationship between habitat/niche requirement and restriction class of UK BAP species associated with woodlands

6.349 As with most other habitats, **structural variation** was identified as very beneficial. The main difference from other habitats was the identification of two kinds of important processes:

1) One operating on a **short rotational basis** (measured in years) including glade or coppice management and ride management.
2) A second operating over a **large time scale** (tens of decades) that gives rise to structural variation of the trees themselves as they grow, mature and become ancient.

6.350 Keeping this in mind, there needs to be long-term thinking when planning woodlands for maximum biodiversity, in particular where veteran trees have been identified as being an important component of the landscape.

6.351 UK BAP species require a variety of **different structural states** within woodlands. The evidence suggest that structural states of particular importance are:

- **Veteran trees** with good, spreading structure and abundant dead wood;
- **Sheltered glades and rides** where woodland habitats interweave with heathland, grassland and wetlands; and
- **Closed canopy woodland** where the humidity levels are high.

6.352 To generate this structure, woodlands require both long-term management geared towards conserving veteran trees as well as short dynamic systems to create, promote well-structured glades and rides.

Wood-pasture and parkland (veteran trees)

6.353 Wood-pasture and parklands are characterised by mature or ancient trees, which may have been managed by pollarding, within grazed grassland or heathland. Of the 105 species associated with this habitat 95% have some requirements for veteran trees. The majority of these species consist of invertebrates, fungi and lower plants.

6.354 Most of the restricted and very restricted species are lichens and invertebrates (42 and 20 species respectively) having a strong association with veteran trees. Widespread species are dominated by vertebrate species (birds and mammals) that operate at a large scale, often utilising adjacent habitats such as hedgerows, grasslands and woodlands.

Table 71 Species numbers across different taxonomic groups - wood pasture and parkland (veteran trees)

Taxonomic group	No. of species
Fungi	10
Lichens/bryophytes	58
Invertebrates	23
Vascular plants	0
Birds	7
Amphibians/reptiles	0
Mammals	7

Table 72 Species numbers across different restriction classes - wood pasture and parkland (veteran trees)

Restriction class	No. of species
Widespread	13
Localised	20
Restricted	19
Very restricted	52
Unknown, probably very restricted or extinct	1

Habitat / niche requirements

6.355 A variety of niches are identified for UK BAP species associated with veteran trees (see Figure 82). Analysis shows that:

- Wood-pasture and parkland trees tend to be more widely spaced, and hence better lit, than those in more closed woodlands where only the canopy and the woodland edge trees are well lit. Over a half of species are **epiphytic** (lichens and bryophytes) growing in **well-lit situations** on bark, trunks and branches of trees (for example, golden hair-lichen *Teloschistes flavicans,* tree catapyrenium *Catapyrenium psoromoides*). Consequently parkland trees can, (other factors being taken into consideration), support a rich epiphytic flora than those within closed woodlands although they may experience a rather drier microclimate, thereby restricting the growth of some species;
- Thirty percent of species require **open grown trees** (trees that have had an unimpeded growth). This leads to large specimens with spreading crowns and boughs that are exposed to the sunlight. As such, they tend to have a larger capacity for resources such as crevices and heart rot. These species consist mainly of lichens, rare invertebrates (for example, saproxylic beetles: violet click beetle *Limoniscus violaceus*, variable chafer *Gnorimus variabilis*) and mycorrhizal fungi requiring warm soils in more open conditions (for example, Royal bolete *Boletus regius*, the pretender *Boletus pseudoregius*);
- Twenty-three percent of species are dependent on **small cavities** and properties of the **tree's bark**, such as its micro-topography (for example, crevices, loose bark, fissures, rain/wound tracks). For example, bats require cracks and crevices for roosting and lichens are often located in areas with rain tracks and wound seepages;
- Only 9% of species depend on **large hollows or cavities** such as the knothole moss *Zygodon forsteri* which requires water filled cavities and the midas tree-weaver *Midia midas* which is found in old tree hollows; and
- Dead wood is an essential component of woodland ecosystems. This includes standing trees, dead branches, stems and snags on living trees and fallen branches and stumps. Twenty-one species have a specific requirement for **decayed or decaying wood** particularly associated with veteran trees (for example, saproxylic invertebrates) (see Figure 83).

6.356 Further analysis shows that:

- Seven species of saproxylic beetles are dependent on open grown veteran trees with soft red rotten **heartrot** such as the larvae of the violet click beetle *Limoniscus violaceus*, variable chafer *Gnorimus variabilis* and the bearded false darkling beetle *Melandrya barbata*;
- Two species of hoverfly require decayed wood in **wet rot holes** (for example, the golden hoverfly *Callicera spinolae*, Western wood-vase hoverfly *Myolepta potens*);
- Five species of **saprophytic fungi** contribute to the decay of dead heartwood in older trees (for example, oak polypore *Piptoporus quercinus*, bearded tooth *Hericium erinaceus*); and

- Eight species are associated with **standing or fallen dead** wood such as the lesser spotted woodpecker *Dendrocopos minor*, the spotty sap fly *Amiota variegate* and the ground beetle *Philorhizus quadrisignatus*. Four species are associated with tree stumps and fallen dead wood (for example, stag beetle *Lucanus cervus*, giant wood-gnat *Neoempheria lineola*).

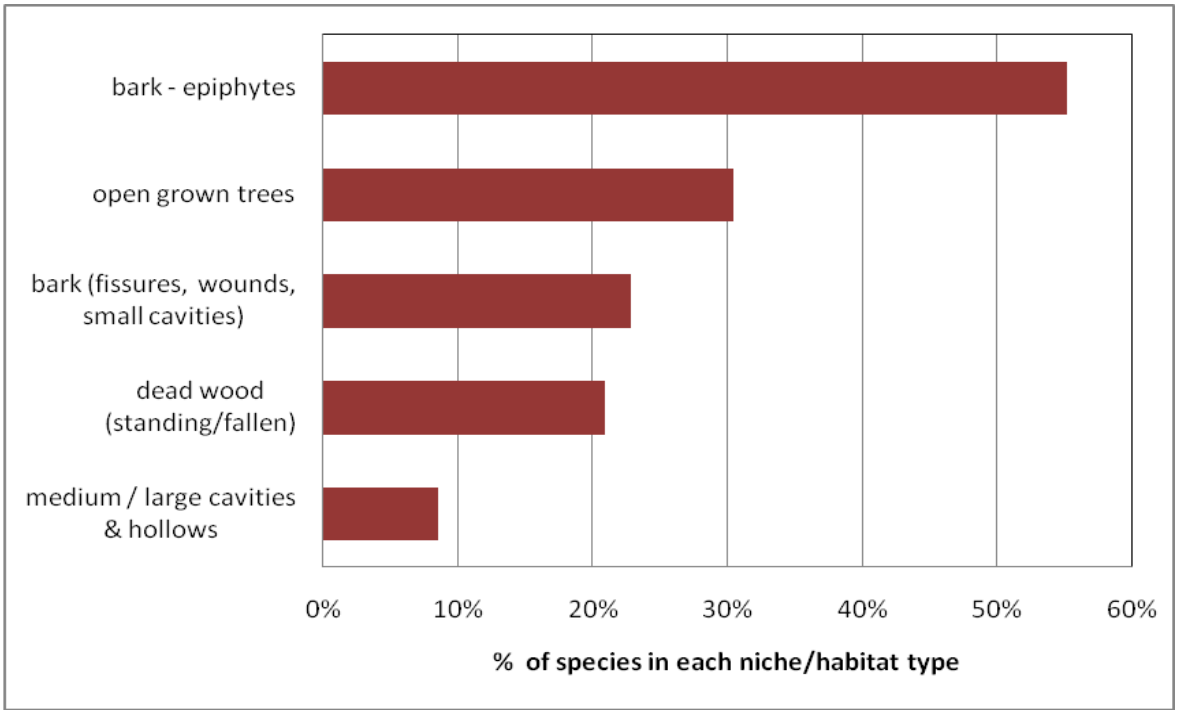

Figure 82 Habitat/niche requirements of UK BAP species associated with veteran trees

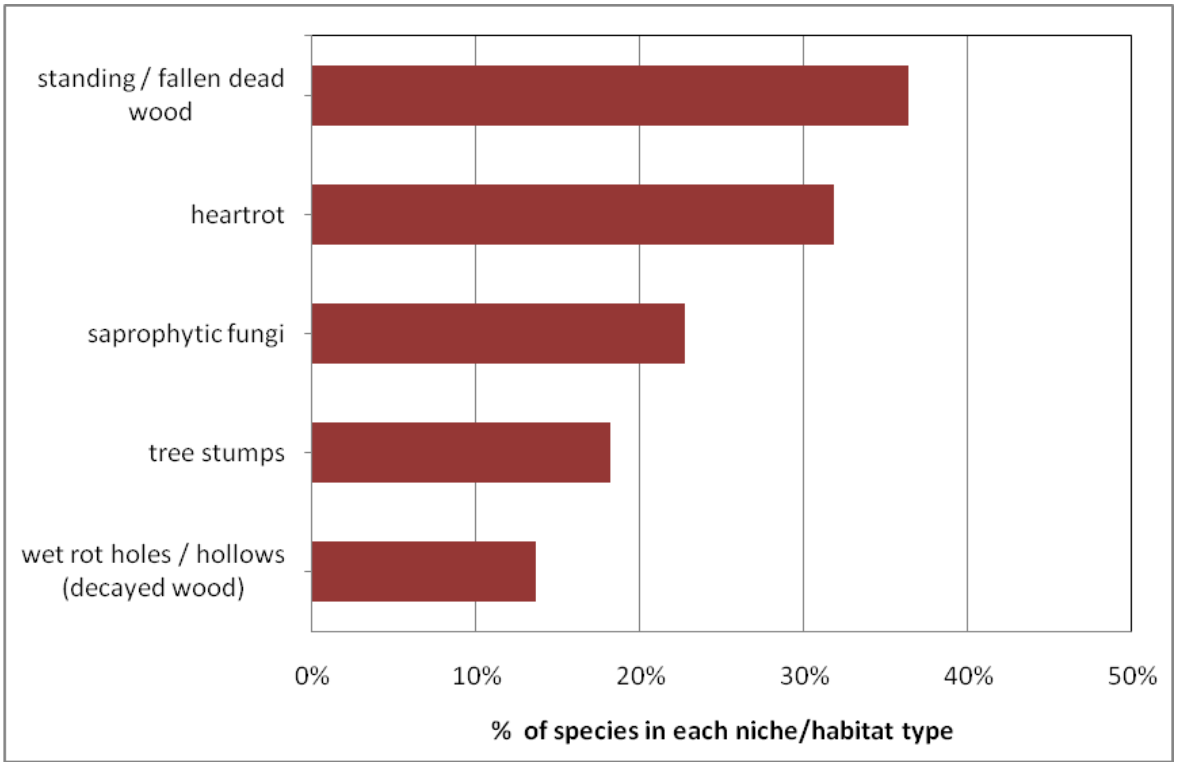

Figure 83 Habitat/niche requirements of dead wood species associated with veteran trees

Summary

6.357 Large mature trees are of high importance for a large number of species. This is not surprising since these trees are generally the feature that distinguishes this habitat from other woodland. These support different species (for example, invertebrates and lichens) from those growing in closed canopy woodland. Continued management carried out on the trees is thus necessary to ensure that there is a continuum of trees standing in the open, especially mature and ancient trees.

6.358 The importance of decay is clear, but many species do not appear to depend on very large cavities. Thus it supports the importance of large, open grown trees, even if they are not fully 'ancient'. Dead wood of all ages, both standing and fallen should be retained. Continuity of supply of dead wood in all conditions and situations is important for many rare saproxylic species which require very specific conditions.

6.359 Open areas are also an essential part of this habitat, providing sunny sheltered places for flowering plant and scrub which produce the nectar and pollen for adult invertebrates whose larvae develop in dead wood. Continued management of this habitat such as low-level grazing and rotational cutting will ensure the habitat is maintained in a reasonably open state.

6.360 Wood-pasture and parklands, like woodlands, are dynamic habitats and the habitat they provide for groups such as saproxylic invertebrates will change with the demography of trees in a particular site. Continuity of habitat for long-term conservation requires trees at all stages of growth, either within one wood-pasture/parkland site or a series of wood-pasture/parklands in a landscape.

6.361 The wildlife of wood-pasture and parkland sites depends on the mosaic of habitats they encompass, including veteran trees, scrub, hedgerows, grassland and heathland habitats, fallen dead wood and associated features such as lakes, ponds and streams.

Wet woodland

6.362 Wet woodlands occur on poorly-drained or seasonally wet soils, with alder, birch and willows usually dominant. Frequently found in a mosaic with other habitats (for example, oakwoods or fens).

6.363 There are 36 species associated with wet woodland. These consist of a mixture of lower plants, invertebrates, vascular plants and vertebrates.

Table 73 Species numbers across different taxonomic groups - wet woodland

Taxonomic group	No. of species
Fungi	3
Lichens/bryophytes	3
Vascular plants	0
Invertebrates	12
Birds	7
Amphibians/reptiles	3
Mammals	8

Table 74 Species numbers across different restriction classes - wet woodland

Restriction class	No. of species
Widespread	16
Localised	8
Restricted	5
Very restricted	7

6.364 Around a half of these species are restricted woodland specialist and the remainder are widespread generalist being found in a range of habitat types (see Figure 84). These consist of birds, bats, amphibians and reptiles.

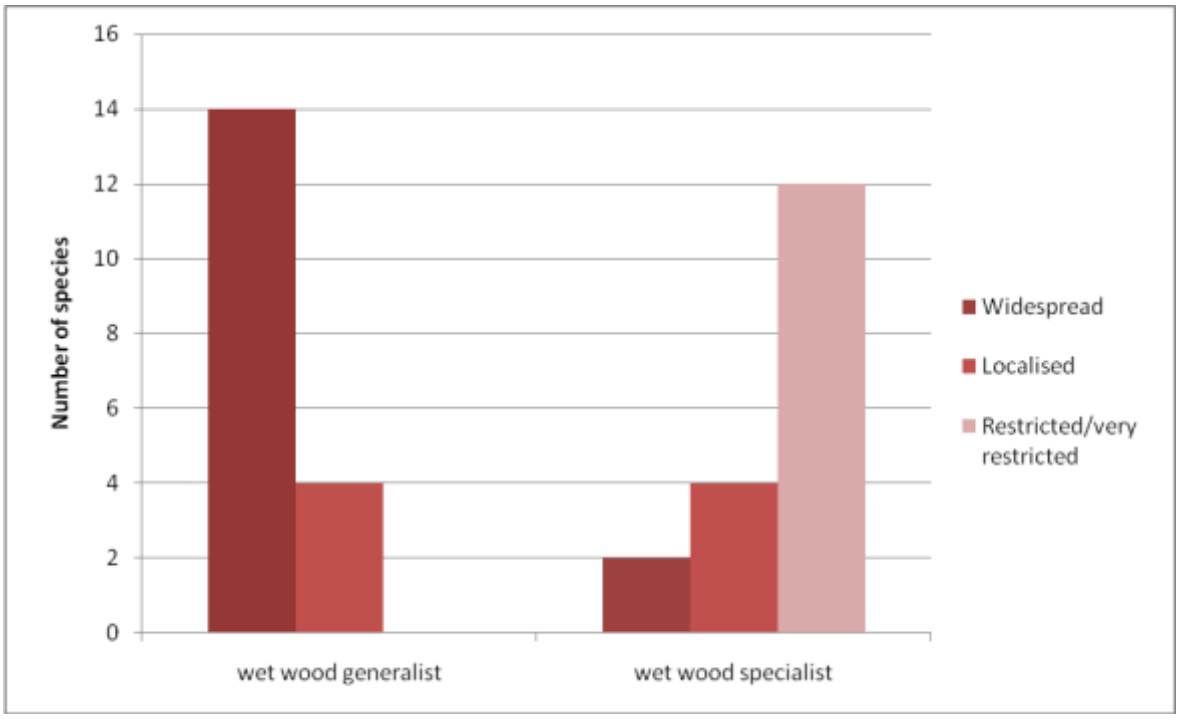

Figure 84 Relationship between wet woodland specialist / generalist species and restriction class

Habitat / niche requirements

6.365 Figure 85 shows the niche/habitat requirements for UK BAP species associated with wet woodlands.

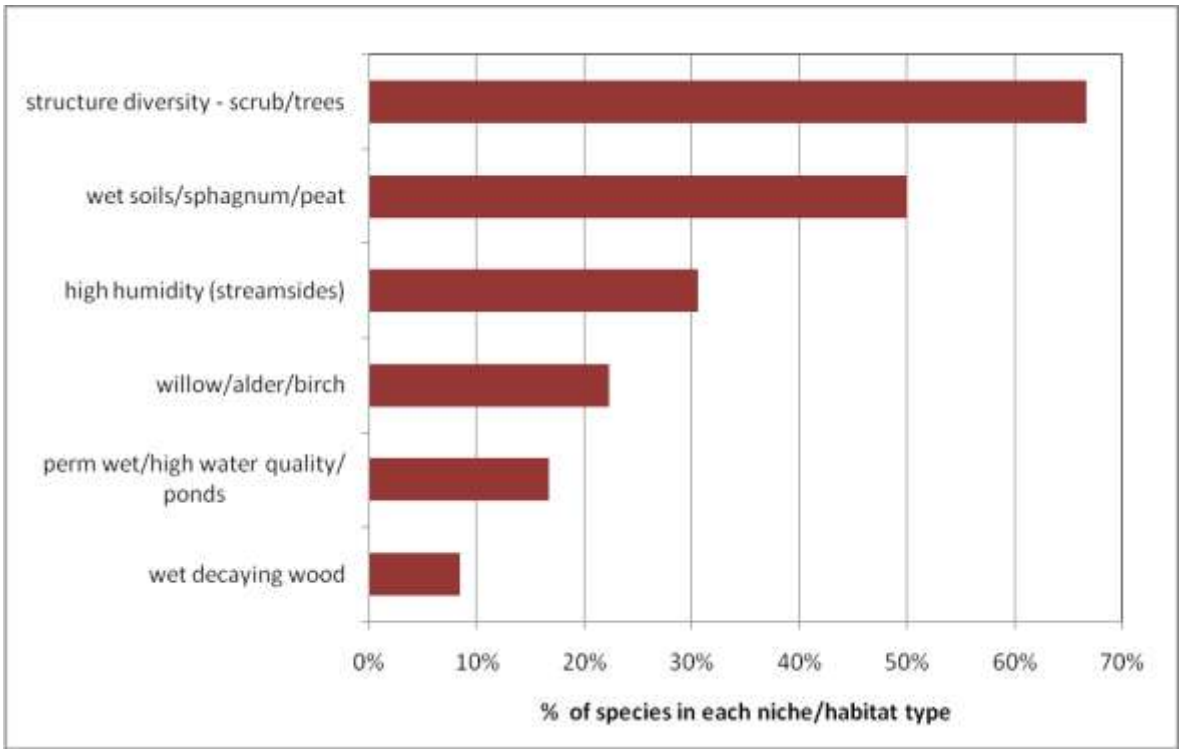

Figure 85 Habitat/niche requirements of UK BAP species associated with wet woodland

6.366 This analyses shows that:

- Sixty-seven percent of species require some form of **structural diversity** such as varied tree (canopy) or ground structure and scrub mosaics;
- Over half of the species require **wet soils** (for example, the netted carpet moth *Eustroma reticulatum*, willow tit *Parus montanus kleinschimdti*, scarce turf-moss *Rhytidiadelphus subpinnatus*);
- Thirty-one percent of species require **high humidity** levels such as found near streams (for example, long-leaved flapwort *Jungermannia leiantha*, veilwort *Pallavicinia lyellii*, fragile amanita *Amanita friabilis*); and
- Twenty-two percent of species are associated with **alder/willow/birch** trees (for example, sallow guest weevil *Melanapion minimum*, alder flea weevil *Orchestes testaceus*, fragile amanita *Amanita friabilis*).

Lowland beech woodland

6.367 Lowland beech woodland includes a variety of vegetation types reflecting soil and topographical differences. The canopy can include mixtures of beech *Fagus sylvatica*, ash *Fraxinus excelsior*, sycamore *Acer pseudoplatanus*, yew *Taxus baccata* and whitebeam *Sorbus aria*. There are 55 species specifically associated with lowland beech woodland. These consist of a mixture of lower plants, invertebrates, vascular plants and vertebrates.

6.368 Around three quarters of these species are restricted or localised beech specialist (41 species) and the remainder are widespread generalist (for example, bats and birds) being found in a range of habitat types (see Figure 86).

6.369 The majority of the beech specialists are associated with southern regions of England (in particular the South East). This is to be expected as this region has the bulk of this habitat type.

Table 75 Species numbers across different taxonomic groups - lowland beech woodland

Taxonomic group	No. of species
Fungi	16
Lichens/bryophytes	7
Invertebrates	10
Vascular plants	9
Birds	6
Amphibians/reptiles	0
Mammals	7

Table 76 Species numbers across different restriction classes - lowland beech woodland

Restriction class	No. of species
Widespread	14
Localised	16
Restricted	8
Very restricted	17

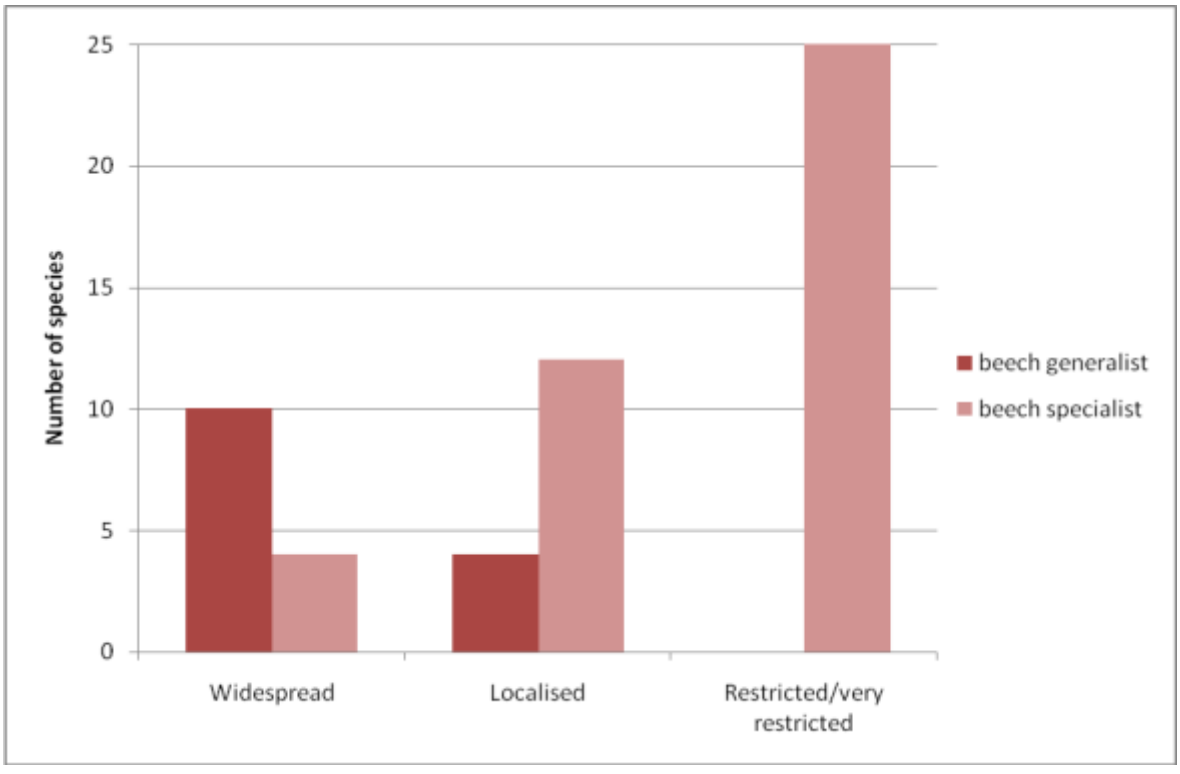

Figure 86 Relationship between beech woodland specialist / generalist species and restriction class

Habitat / niche requirements

6.370 Figure 87 shows the niche/habitat requirements for lowland beech woodland specialist species. Analysis shows that:

- Forty-nine percent of species are associated with **closed canopy woodland** (shade tolerant);
- Fifty-six percent of these species are associated with the **soil, litter and short, open vegetation** rather than the canopy or under-storey;
- Six species are particularly associated with **beech leaf litter** itself such the boring millipede *Polyzonium germanicum*, yellow bird`s-nest *Monotropa hypopitys* and violet crowncup *Sarcosphaera coronaria*;
- Around 40% of species require **high humidity** levels associated with closed canopy woodland;
- Forty-one percent of species are associated with open grown **veteran trees** requiring more specialist niche habitats (for example, dead wood, fissures, hollows/cavities); the knothole moss *Zygodon forsteri* requires the continued presence of mature beech trees with water-filled cavities; and
- Twenty-seven percent of species are associated with the **free-draining** calcareous nature of the substrate.

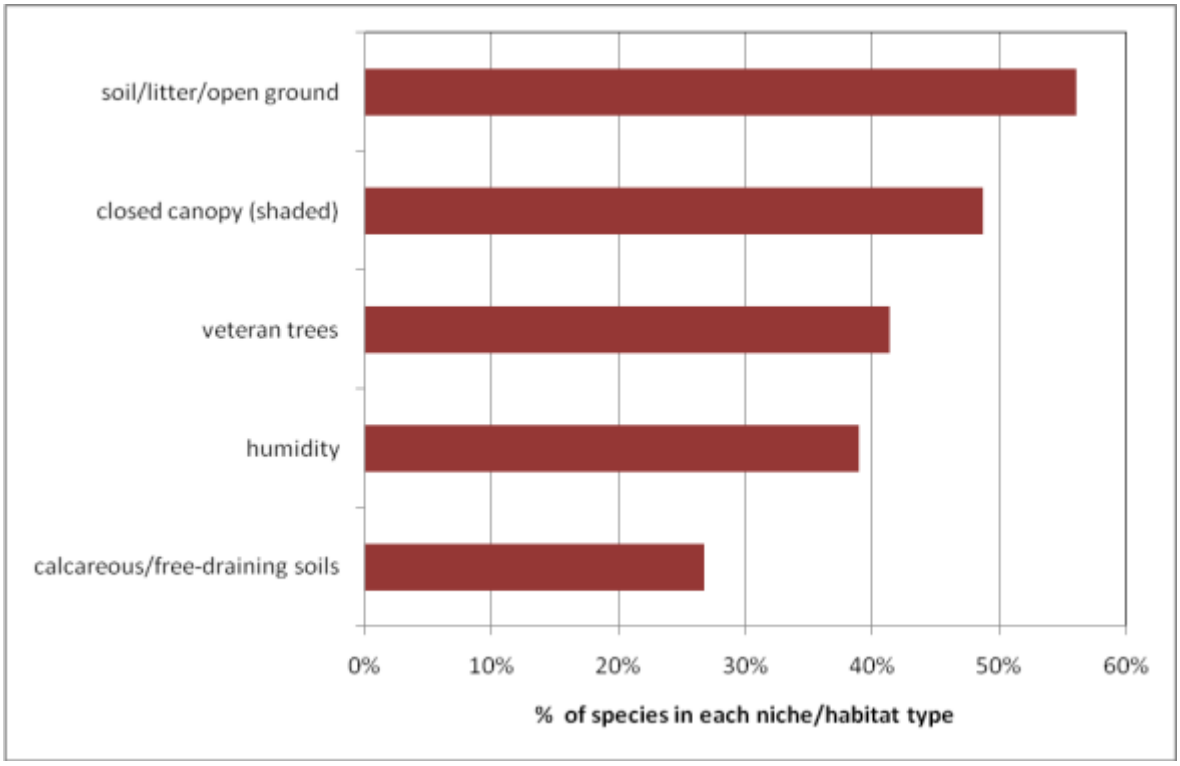

Figure 87 Habitat/niche requirements of UK BAP species associated with lowland beech woodland

7 Glossary of terms

Table 77 Glossary of terms

Term	Description
Bare ground	Bare, loosely friable soils (often sand or chalk) on freely draining soils where repeated disturbance removes vegetation to create areas of bare and sparsely vegetated ground. Suitable sources of disturbance include landslips, wind and salt blast on sea cliffs, sand accretion on sand dunes and small-scale poaching by grazing animals. The juxtaposition of disturbed areas of bare ground with other structural types of vegetation is often important. Bare ground includes pebbles, exposed rock and even small carpets of lichen and moss. It also invariably includes a scatter of early colonisers many of which are food plants or provide other critical resources such as nectar and pollen. Its nature is also important; soil that is overly compacted or churned is not as well utilised as loosely friable soil.
Bare mud (saltmarsh)	Exposed estuarine silt and mud formed by dynamic coastal process such as deposition and scouring. A critical zone for many species is the bare mud located in the upper, less saline parts of the marsh that receive less frequent inundation.
Benthic species	Aquatic benthic species living on the river bed. These species often require specific flow rates and high water quality and many have a very low tolerance to organic pollution.
Drawdown zone	Water levels fall naturally between winter and summer creating a “drawdown zone” (small beaches of mud or other exposed substrates with little vegetation) which is valuable for many species and a germination area for many wetland plants.
Early successional habitat	See bare ground. A useful term suggesting a process of succession which requires active intervention if this habitat is to be retained.
Exposed Riverine Sediments (ERS)	This represents the shoals, bars and spits present in river channels which are periodically exposed during periods of normal or lower than average flow. The sediments range in size from cobbles and boulders to silt and sand. The character, shape, size, location and sediment composition varies greatly, providing very significant habitat diversity.
Fast flow (river)	Stretches of rivers and streams where disturbance, due to the velocity of flow during spates, scours sediment to reveal bedrock or boulders and deposits fresh sediment elsewhere. The exact timing of these events is essentially unpredictable, but they exhibit a strong seasonal pattern peaking in the winter.
Floodplain	The part of a river valley that is made of unconsolidated, river-borne sediment and that is periodically flooded. Floodplain species are found almost exclusively on river banks or floodplains and are inextricably linked to riverine process, in particular periodic flooding (for example, *Chrysolina graminis* that feeds on Tansy growing along river banks).

Table continued...

Term	Description
Glades and rides	A term used to describe structural variation in woodland. Whereas wood-edge refers to the ecotone between woodland blocks and other land uses, glades and rides refers to structural variation within the woodland (although they have similar structural characteristics).
Herb-rich / structurally complex	Often referring to swards and dwarf-shrub communities where the diversity of species and the nature of management results in a complex architecture including tussocks and sheltered bays within a matrix of vegetation. Species utilising this habitat are often invertebrates whose requirements (such as humidity, condition of foodplant, etc.) are best met through proliferation of an herb-rich matrix. For saltmarsh it tends to refer to herbs, low shrubs and other vegetation that has not been grazed or otherwise compromised by inappropriate activity that denudes the vegetation and/or destroys its structural complexity. Grasslands should include components of scrub and bare ground. Both the flowers (producing nectar and pollen) and the structural component (for example, tussocks) are utilised and many species require these resources to be present all or most of the year around. This type of grassland is extensively managed and, wherever possible, flower-rich throughout the spring and summer.
High water quality (HWQ)	An inclusive term, HWQ is essential for those species intolerant of nutrient enrichment, siltation and toxic pollution. HWQ affects many aquatic habitat attributes including oxygen levels, siltation and the abundance and diversity of prey which, for some species, are of more direct importance than the water quality itself (for example, otters require a reasonable water quality for fish to be present and *Bembidion testaceum* requires a high water quality so its habitat, river shingle, does not silt up or become smothered with plant growth).
Humidity	Many species have specific humidity requirements. Some need conditions of constant high humidity (for example, woodland species associated with crevices in tree trunks or under leaf litter).
Large scale mosaics	This refers to the juxtaposition of different habitats at the landscape scale, such as hedgerows and woodlands adjacent to open grassland habitats or a complex of wetland habitats such as open water, reedbed and Carr. Such mosaics are required largely by highly mobile terrestrial species such as bats which breed or roost in adjacent woodlands and feed over surrounding hedgerows or wetlands. Such mosaics often include both priority and non-priority habitats.
Litter	An accumulation of dead plant remains on the soil surface. Woodland - leaf litter and dead wood in the form of branches and twigs. Woodland leaf litter can be very deep. Grasslands and heathlands - mainly consisting of leaf and plant litter covering some or all of the ground. Grass litter can accumulate in mats often forming humid microclimates. Saltmarsh - organic litter mostly consisting of small pieces of plant litter although occasional wood and other flotsam are included. These often forms bands of material along the high tide mark or are found trapped against saltmarsh vegetation and large debris. Wetlands - nutrient rich wetlands can accumulate large quantities of litter. Reedbeds and fringing plants can form layers of plant litter many centimetres deep.

Table continued...

Term	Description
Lower saltmarsh	Lower saltmarsh is submerged by tides greater than 360 times a year. Referred to as 'submergence marshes' they extend up to mean high water mark (MHWM) are never exposed continuously for more than nine days and are submerged daily in daylight for more than 1-2 hours.
Metallophyte	A plant that can tolerate high levels of heavy metals such as lead.
Mire	Wet land saturated with water, such as a bog, marsh or fen.
Open (habitat)	Habitats characterised by short vegetation where tree cover and scrub is at a minimum. This can include both wet and dry habitats. Wetlands are often dominated by open water and fringing vegetation whereas open terrestrial habitats tend to be dominated by grass and dwarf shrub.
Open grown trees	Mature and veteran trees that have had an unimpeded growth. This leads to large specimens with spreading crowns and boughs that are exposed to the sunlight. As such, they tend to have a larger capacity for valuable resources such as crevices and heart rot.
Shaded (terrestrial and fringing habitat)	Referring to scrub and tree growth that leads to deep shade which suppresses and inhibits plant growth, increases humidity and often reduces temperature and fluctuations in temperature.
Pelagic	Organisms that inhabit the open ocean (as part of their life cycle).
Ruderal plants	A plant that is associated with disturbed ground where there is generally little stress (i.e. no deficiency of nutrients, light or competition from other species). Such species are characterised by rapid growth and early reproduction and the formation of soil seed banks.
Scree	An accumulation of coarse rock debris that rests against the base of an inland cliff, produced by the weathering and release of fragments from the cliff face.
Scrub	Vegetation dominated by low, woody plants which typically forms an intermediate community between grass or heath and high forest. Scrub that is structurally rich, containing gaps and different-sized shrubs is of much greater value than scrub forming large, homogenous blocks. The presence of occasional trees is beneficial as they provide further structural diversity. Species utilise scrub for many reasons including shelter, feeding, roosting and nesting.
Seasonal inundation	Areas of land covered by water in the autumn and winter months, receding throughout the spring and summer. See also temporary water.
Shelter	This represents habitats open to direct sunlight but protected from excess wind by topography or vegetation. Species requiring shelter are often found in bays of scrub or against a woodland edge, cliff face or sloping ground.
Slow flow	Stretches of rivers, streams and spring-fed seepages where water action removes or retards vegetation, disturbs sediment and deposits fresh sand and silt. As opposed to fast flowing rivers, many tend to be fringed by emergent vegetation and can contain floating and aquatic vegetation. Similar types of habitat also occurs in association with large lakes, whose marginal areas are disturbed by wave action, seepages on soft-rock cliffs, which are disturbed by landslips, and artificially disturbed sites such as sand pits and gravel pits in the early stages of ecological succession.

Table continued...

Term	Description
Sorted shingle	Shingle which is naturally sorted or graded by natural process such and river currents and wave action. For shingle (both coastal and riverine) the timing and type of disturbance is critical. Sorted shingle is a prime requirement for both plants and invertebrates. An activity that mixes this shingle at inappropriate times (such as trampling in the spring and summer) is very damaging; it destroys interstitial spaces and microhabitats required by germinating seeds and invertebrates. Sorted shingle along rivers is also often graded, with finer graded shingles dominating the downstream portion of any given bar. Different communities are found within the different grades of shingle and mixing/disturbing them can be very deleterious.
Stable (water) levels (permanent water)	Species who require the permanent presence of water at a relatively high, stable level. This includes aquatic and edge species which require permanently waterlogged soils. Many fenland species fit into this category.
Sward	The mixture of grasses and other plants covering the ground in a meadow, pasture, dune or similar. Tall sward - one that includes inflorescences of both grasses and herbs for all or most of the year (utilised for foraging, nesting and overwintering). Short sward - carpet-like growth of grass and herbs that can be tightly packed but is never more than few centimetres high. Open sward - sward of variable length but with frequent tiny patches of bare ground (for example, such as on a limestone grassland with very thin soils and rocky outcrops).
Temporary water	Areas of land inundated by water in the winter and early spring which dry in the summer. These can be seasonal ponds and puddles (including wheel ruts on track-ways), the edges of larger water bodies or just patches of ground where ponding occurs. Species may either utilise the temporary nature of the water (for example, free from vegetation and predators) or the drawdown zone (small beaches of mud with little vegetation) or both. Also referred to in the reports as fluctuating water levels, seasonal inundation and temporary pools. These habitats are most often associated with dune slacks and floodplains.
Trophic state	A level in the food or energy chain within a system, for example producers (plants), primary consumers (herbivores) and secondary consumers (carnivores).
Unimproved	Farmland soils which have not been agriculturally improved by inorganic and/or organic fertilisers. They invariably support greater species richness and diversity.
Unobstructed course (river)	Complete river systems (from source to sea) that are unobstructed by weirs and other artificial barriers) and contain varied habitat niches, such as backwaters.
Upper saltmarsh	Upper saltmarsh is submerged less than 360 times a year. Such ‘emergence marshes’ occur above the mean high water mark (MHWM), have a minimum of 10-days continuous exposure and less than an hour’s daily daylight submergence. They include the transition zone (brackish marsh) where vegetation is intermediate between the upper saltmarsh and adjoining non-halophytic areas. This zone is influenced by salt spray but is only occasionally covered by tidal surges during extreme storm events.

Table continued...

Term	Description
Well drained	Porous soils and rock, such as sand and chalk, where water drains away quickly (as opposed to non-porous soils, such as clay).
Wood edge	Well structured tree-scrub-herb interfaces on the edges of woodland, glades and rides.

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Appendix 1 Biodiversity Integration Groups

Table A Biodiversity Integration Groups

England Biodiversity Strategy (EBS) Work Stream	Biodiversity Integration Group (BIG)	Priority habitats included	Chair of Biodiversity Integration Group
Agriculture	**Lowland farmland**	Arable field margins Calaminarian grasslands (lowland types) Hedgerows Lowland calcareous grassland Lowland dry acid grassland Lowland meadows Lowland heathland Purple moor-grass and rush pastures Traditional orchards	Natural England
	Upland	Blanket bog Calaminarian grasslands (upland types) Inland rock outcrop and scree habitats Limestone pavement Mountain heaths and willow scrub Upland calcareous grassland Upland flushes, fens and swamps Upland hay meadows Upland heathland	Natural England

Table continued...

England Biodiversity Strategy (EBS) Work Stream	Biodiversity Integration Group (BIG)	Priority habitats included	Chair of Biodiversity Integration Group
Water and wetlands	**Lakes and ponds**	Aquifer-fed naturally fluctuating water bodies Eutrophic standing waters Mesotropic lakes Oligotrophic and dystrophic lakes Ponds	Environment Agency
	Rivers	Rivers Chalk rivers	Environment Agency
	Wetland	Coastal and floodplain grazing marsh Lowland fens Lowland raised bog Reedbeds	Natural England
Coastal	**Coastal**	Coastal saltmarsh Coastal sand dunes Coastal vegetated shingle Intertidal mudflats Maritime cliff and slopes Saline lagoons	Natural England
Marine	**Marine**	16 marine habitats	Natural England
Towns, cities and development	**Urban and brownfield**	Open mosaic habitats on previously developed land	Town, Cities and Development EBS Work Stream Group
Woodlands and forestry	**Woodland**	Lowland beech and yew woodland Lowland mixed deciduous woodland Upland mixed ashwoods Upland oakwood Wet woodland Wood-pasture and parkland	Forestry Commission

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