



# Definition of Favourable Conservation Status for the Grey long-eared bat, *Plecotus austriacus*

Defining Favourable Conservation Status Project

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# Acknowledgements

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# About the DFCS project

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Natural England's Defining Favourable Conservation Status (DFCS) project is defining the minimum threshold at which habitats and species in England can be considered to be thriving. Our FCS definitions are based on ecological evidence and the expertise of specialists.

We are doing this so we can say what good looks like and to set our aspiration for species and habitats in England, which will inform decision making and actions to achieve and sustain thriving wildlife.

We are publishing FCS definitions so that you, our partners and decision-makers can do your bit for nature, better.

As we publish more of our work, the format of our definitions may evolve, however the content will remain largely the same.

This definition has been prepared using current data and evidence. It represents Natural England's view of FCS based on the best available information at the time of production.

# Introduction

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This document sets out Natural England's view on the contribution England needs to make to achieve Favourable Conservation Status (FCS) for **Grey long-eared bat, *Plecotus austriacus***.

The England contribution is defined in terms of three parameters: the natural range and distribution of the species; population of the species; extent of habitat necessary for long-term maintenance of populations.

Section 2 provides the summary definition of the England contribution to FCS. Sections 3 – 6 describe the evidence considered when defining FCS for each of the three parameters. Annex 1 lists the references and Annex 2 sets out the UK and England position in the 3<sup>rd</sup> Habitats Directive report.

This document does not include any action planning, or describe actions, to achieve or maintain FCS. These will be presented separately, for example within restoration strategies.

*Defining Favourable Conservation Status in England* describes the Natural England approach to defining the England contribution and lists the key information sources used to produce this definition.

# Summary FCS Definition

## 2. England contribution to FCS

The grey long-eared bat is restricted to Europe, its distribution extending from the north Mediterranean coast in the south to southern England, Germany and Poland in the north (Spitzenberger and others 2006). The species is of Least Concern at both a global and a European scale ([www.icun.org](http://www.icun.org)) but in England, at the edge of its range, the species is rare and currently only found in Devon, Dorset, Somerset, Hampshire, Isle of Wight and Sussex (Razgour and others 2013b). It is assessed as Endangered at a GB scale. The species in England contains two subpopulations, both genetically distinct from the mainland European populations, making its persistence in England valuable for the genetic diversity of the species (Razgour and others 2013a, Razgour and others 2014).

### Range

The grey long-eared bat occupies 73 10 km squares in England equating to an occupied range of 7250 km<sup>2</sup> (Matthews and others 2018). The current range is consistent with limited historic records and the species' climatic niche, and is deemed favourable.

### Population

Just 10 grey long-eared bat maternity colonies are known from England (Mathews and others 2018) and inbreeding could become a threat to the species in this country (Razgour and others 2014). Harris (1995) estimated a pre-breeding population of approximately 1,000 individuals, however these estimates were scored as being very subjective and were based on expert opinion only (Matthews and others 2018). Razgour and others (2014) calculated an effective population size of 82 in England (confidence interval 63-112). The effective population is thought to be ten times smaller than the actual population size (Frankham and others 2010), which would give a population of 820 individuals (confidence intervals 630-1120). We estimate that the favourable population is approximately 10,000 individuals to prevent inbreeding in the long term. This would mean that 250 maternity colonies of at least 20 breeding females is the favourable population size. In the short term 13 colonies of median size 20 breeding females are required to prevent inbreeding. These numbers are very speculative but can be updated in the light of future research.

### Habitat for the species

The habitat required to maintain populations of the grey-long eared bat in England is a combination of the habitat required for roosting, including maternity roosts, and foraging. The current number of potential roosting sites is unknown but the number is likely to have declined due to renovation of houses and the exclusion of bats (Stebbins 1995). However, roost availability is not thought to be a limiting factor for the species: they have similar requirements to the brown long-eared bat, which occurs at a density of 0.03 roosts per km<sup>2</sup> in Britain (Entwistle and others 2000). The current area of unimproved grassland available for foraging within the species range is 794 km<sup>2</sup> (see Section 6.3 for more details). Given that the amount of available habitat is declining (Fuller 1987, Vickery and others 2001), this area is deemed unfavourable. An increase of approximately 10% in the area of unimproved grasslands is necessary to achieve favourable status for the species and would give 875 km<sup>2</sup> of foraging habitat. It is important that unimproved grassland is also present between

colonies, as well as close to them, to increase connectivity between populations. These figures are based on satellite data and speculative calculations and further research is needed.

**Note:** This FCS definition is based on little data, and includes some speculative calculations, therefore the definition should be treated as having a Low confidence level.

**Current situation:** Based on the information within this document, grey long-eared bat is favourable in terms of range but unfavourable in terms of numbers and supporting foraging habitat. The number of roosts is not thought to be limiting. Please note, this assessment is not based on focussed or comprehensive assessment and monitoring.

**Sources:** *Fuller 1987; Stebbings 1995; Harris and others 1995; Entwistle and others 2000; Vickery and others 2001; Spitzenberger and others 2006; Juste 2008; JNCC 2013; Razgour 2012; Razgour and others 2013a; Razgour and others 2014; Mathews and others 2018.*

# Species definition and ecosystem context

## 3.1 Species definition

S1329 Grey long-eared bat (*Plecotus austriacus*)

**Sources:** Corbet 1964; Spitzenberger and others 2006.

## 3.2 Threat status

### Red list status

An assessment of the threat of extinction.

- **Global:** Least concern *Source:* The IUCN Red List of Threatened Species 2008
- **European:** Least concern *Source:* European Red List, IUCN
- **GB:** Endangered *Source:* Mathews and others 2018.

## 3.3 Habitat for the species definition

The habitat required to maintain populations of the grey-long eared bat in England is a combination of the habitat required for roosting, including maternity roosts, temporary roosts and hibernation sites, and that required for foraging.

### Roost requirements

Grey long-eared bats tend to roost close to human habitation in the roof spaces of buildings such as churches, barns and farm buildings (Swift 1998). All maternity roosts in England are in the loft spaces of residential buildings. Maternity roosts tend to be in old/traditional buildings with a large loft space with a roof lining constructed of wood or bitumastic underfelt (Razgour and others 2013b). In the UK and Channel Isles, roof floor sizes of maternity roosts range from 104 square metres to over 220 square metres with a maximum roof height of at least 2.5 m (Razgour and others 2013b). Temporary roosts are frequently found in open-fronted buildings with smaller roof spaces, although still large enough to permit free flight (Razgour and others 2013b). The minimum maternity roost temperature recorded during the summer months in England was 7.8°C on the Isle of Wight in May, the seasonal average was 20.1 (±1.7)°C (Razgour and others 2013b).

Studies on grey long-eared bat hibernation sites in England are lacking. At one site in Dorset, bats spent the winter in warmer areas of the summer roost, such as near hot water pipes (Razgour and others 2013b). In Europe, grey long-eared bats hibernate in cellars, lofts, mines, quarries, caves and rock crevices (Dietz and others 2009; Horáček 1975; Swift 1998). In Europe, hibernation sites are usually less than 30 km from summer roosts, but can be anything between 5 and 61 km away



(Hutterer 2005). In Europe the temperature of winter roosts ranged from 2-7 °C and in Dorset, England averaged 12 °C (Razgour and others 2013b).

### **Foraging habitat requirements**

The grey long-eared bat feeds on moths (Lepidoptera) with noctuid moths (Noctuidae) making up approximately two-thirds of their diet (Razgour and others 2011a). In England, the remainder is made up of flies (Diptera), particularly craneflies such as *Tipula oleracea* (Razgour and others 2011a).

Razgour and others (2011b) studied the foraging behaviour of 20 bats from two maternity colonies in Devon and the Isle of Wight in 2009 and 2010, and Whitby followed eight bats in West Sussex in 2002 (Razgour and others 2013b). These studies (summarised in Razgour and others 2013b) found a mean home range size of  $4.6 \pm 3$  km<sup>2</sup>. The colony home range varied between the three maternity roost locations (from 17.4 to 37.2 km<sup>2</sup>), potentially due to differences in resource availability and the number of bats radio tracked at each site. Bats travelled up to 5 km to foraging areas from the maternity roost with several different foraging areas visited each night. Half of all core foraging areas were more than 2 km away. The bats selected unimproved grassland, riparian vegetation and broadleaved woodland and avoided arable fields and coniferous woodland. The preference for foraging in unimproved grasslands is likely to relate to the availability of Lepidoptera and other invertebrates in this habitat.

**Sources:** Horáček 1975; Swift 1998; Hutterer 2005; Dietz and others 2009; Razgour and others 2011a; Razgour and others 2011b; Razgour and others 2013b.

**Confidence:** Moderate

## **3.4 Ecosystem context**

The grey long-eared bat is restricted to Europe, its range extending from the north Mediterranean coast in the south to southern England, Germany and Poland in the north (Spitzenberger and others 2006) with one recent record from Wales (Barlow & Briggs 2012).

Genetic analyses conducted on populations of the grey long-eared bat across Europe found that there are seven genetic subpopulations (Razgour and others 2013a; Razgour and others 2014) with those in England and the Channel Islands distinct from other European populations. Within England there are two genetic subpopulations: west Devon, and the remaining populations (Razgour and others 2013a; Razgour and others 2014). Therefore, England contributes to the genetic variation of the species internationally.

**Sources:** Spitzenberger and others 2006; IUCN 2008; Barlow & Briggs 2012; Razgour and others 2013a; Razgour and others 2014.

**Confidence:** Moderate

# Natural range and distribution

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## 4.1 Metric

Occupied 10 km squares is recommended as the metric for defining the favourable distribution of the grey long-eared bat within its natural range in England. Occupied relates to confirmed presence records for the species within the 10 km square.

# Evidence

## 4.2 Historical range

Data on the historic range of the grey long-eared bat in England is lacking. Ecological modelling shows that the required climatic conditions for the species in England (low summer precipitation ranging from 150 to 180 mm and high January temperatures above 6.5°C) reflect the currently known range (Razgour and others 2011b; Razgour and others 2013a) suggesting that, as the bat is at the edge of its range in England, it is likely that the species has always occupied a similar range in this country (Harris and others 1995).

Records analysed for the Second Report by the United Kingdom under Article 17 (JNCC 2007) showed a historical range (1900-2006), of 14,207 km<sup>2</sup>. The Third Article 17 report (JNCC 2013) gives a range of 14,303 km<sup>2</sup>, a +0.7% increase, which is likely due to an increase in records rather than an increase in actual range. These figures suggest that the range has historically remained stable.

Distribution across the range may have changed in the past two decades; at least two maternity colonies have been lost for unknown reasons in Sussex and Dorset (Razgour 2012).

**Sources:** *Harris and others 1995; JNCC 2007; Razgour and others 2011b; Razgour 2012; Razgour and others 2013a; JNCC 2013; Razgour and others 2014.*

**Confidence:** *Poor*

## 4.2 Current range

In England the grey long-eared bat is currently thought to be present in Devon, Dorset, Somerset, Hampshire, Isle of Wight and Sussex (Razgour and others 2013b). The grey long-eared bat has been recorded in 73 10 km squares since 1995 equating to an occupied range of 7250 km<sup>2</sup> (Mathews and others 2018). See Figure 1 Annex 2.

A potential source of error in this range estimation is that the species may be under-recorded, especially given the difficulty of differentiating the species from the common and widespread brown long-eared bat (*Plecotus auritus*) (Mathews and others 2018). This source of error may decrease in future due to the development of DNA analysis as a tool to identify bat species from their droppings (Barlow & Briggs 2012). For example, in June 2012 grey long-eared bat droppings were identified in a building in Pembrokeshire through DNA analysis (Barlow & Briggs 2012). However, thus far, increased survey effort using DNA analysis suggests that under-recording is unlikely be a significant issue: analysis of droppings from 44 roosts across the bat's known range resulted in a positive result for grey long-eared bat at one previously unidentified roost (Barlow & Briggs 2012).

**Sources:** *Barlow & Briggs 2012; Razgour 2012; Razgour and others 2013b; Mathews and others 2018.*

**Confidence:** *Low*

### 4.3 Range required for future maintenance of populations and diversity

The range of the grey long-eared bat in England is limited by low winter temperatures, high summer rainfall and the availability of grasslands (Razgour and others 2011b). If these variables remain stable, then the current occupied range of at least 7250 km<sup>2</sup> ought to be maintained.

Models that take into account future changes in climate predict that the climatic niche for the grey long-eared bat in England will increase in the next 100 years, thus there is potential for increases in the species range northwards in England (Razgour and others 2013a). However, English populations may not be adapted to warm and dry conditions experienced by the species in the Mediterranean and therefore the species may decline within the current range (Razgour and others 2017).

**Sources:** Razgour and others 2011b; Razgour and others 2013a; Razgour and others 2017.

**Confidence:** Moderate

### 4.4 Potential for restoration of the natural range

As the current range is limited by climatic factors, and is thought to have been historically stable, the current range is regarded as the Favourable Range.

As a result of climate change there is potential for the species range to extend beyond what is now considered as favourable (Razgour and others 2013a). Additionally, the species may begin to experience unfavourable climatic conditions in the current range (Razgour and others 2017). One of the current limitations to the species range is the availability of unimproved grasslands (Razgour and others 2011b) and therefore, in order for range expansion in England to be feasible suitable habitat must be available in the new range, i.e. unimproved lowland grassland, riparian habitat and woodland edge for foraging and suitable roost sites. Additionally there must be sufficient connectivity between new potential colonisation sites and existing populations, for example suitable hedgerows, field margins and edge habitats (Razgour and others 2013b). These landscape-scale habitat improvements are technically feasible. The maintenance of a mosaic of natural habitats with good connectivity at the landscape scale will also be beneficial to many other species in England.

**Sources:** Razgour and others 2011a; Razgour and others 2013a; Razgour and others 2013b; Razgour and others 2017.

**Confidence:** Moderate

# Conclusion

## 4.5 Favourable range

It is deemed that the current occupied range of 7250 km<sup>2</sup> (73 x occupied 10km squares) is favourable in England. This may change under future climate change scenarios.

### Recommendations for monitoring and evaluation

Distribution should be assessed by regular monitoring of maternity colonies. Genetic analysis of droppings to confirm species identification should also be used to better distinguish this species from the commoner and closely related brown long-eared bat.

## 4.6 Comparison with situation in 1994

The current and favourable range includes records from as far back as 1995. There is no evidence that the range has changed since 1994.

# Population

## 5.1 Population metric

Number of maternity colonies, this is the most accurate metric we have concerning the species and is the most quoted metric in the literature.

## 5.2 Historical populations

The historical population size of the grey long-eared bat is unknown. There is some evidence for a decline in the number of maternity roosts, with the loss of two maternity colonies recorded in Sussex and Dorset in the past few decades (Razgour 2012). The reason for this loss is unknown. Additionally, modelling of demographic history using genetic analysis indicates that the effective English population, the number of individuals to breed successfully and contribute to the genetics of the population, has been in recent decline and may have previously been 30 times larger than the current population size (Razgour and others 2013a).

Winter temperature may be responsible for reducing colony size. Stebbings (1970) documented the decline in the number of grey long-eared bats in one roost in the early 1960s; the number of grey long-eared bats fell from 22 to four individuals in three years, coinciding with the coldest and longest winter for 100 years. Habitat loss and degradation may also be responsible for a decline; there has been a reduction in roost availability in buildings due to renovation and exclusion of bats from buildings by humans (Stebbing 1995) and a loss of unimproved grassland, a key foraging habitat of the bat, due to intensification of farming in the past 100 years (Fuller 1987; Vickery and others 2001). There has also been a decline in habitat heterogeneity on farmland such as removal of hedgerows and the loss of woodland edge habitat (Robinson & Sutherland 2002; Stoate and others 2001). Furthermore, there has also been a decline in moth populations in southern England (Conrad and others 2006).

**Sources:** Stebbings 1970; Fuller 1987; Stebbings 1995; Stoate and others 2001; Vickery and others 2001; Robinson & Sutherland 2002; Conrad and others 2006; Razgour 2012; Razgour and others 2013a.

**Confidence:** Low

## 5.3 Current population

Just ten maternity colonies are known in the UK (Mathews and others 2018) and a robust estimate of the total number of individuals occupying them is unknown. See Figure 2, Annex 2 for location of maternity colonies.

Harris and others (1995) gave a pre-breeding estimate of 1000 individuals based on expert opinion. Razgour and others (2014) analysed genetic samples from across the species range to calculate an effective population size of 82 in England (confidence intervals 63-112). For mammals generally, the effective population is thought to be ten times smaller than the actual population size (Frankham and others 2010), which would give a population size of 820 individuals (confidence intervals 630-1120). For grey long-eared Mathews and others (2018) however suggest that the population may be lower given that most adult females were observed to breed each year and so it

is unclear whether the population is in equilibrium. Also the genetic analysis includes contribution from migrants. They calculate that there is a median of 20 bats for each of the ten known maternity colonies in England giving a pre-breeding female population of 200 or a total population of 400 adults.

**Sources:** *Harris and others 1995; Frankham and others 2010; Razgour 2012; Razgour and others 2014; Mathews and others 2018.*

**Confidence:** *Low*

#### 5.4 Population required for future maintenance of populations and diversity

The low number of maternity roosts and the low number of individuals in them (ranging from seven to 34 adults (Mathews and others 2018)), indicates that the population is small and so vulnerable to the effects of inbreeding and stochastic events (Razgour and others 2014). An effective population size of 50 is thought to be needed to prevent inbreeding of a species in the short term and an effective population size of 1000 is needed to prevent the accumulation of deleterious alleles in the long term (Frankham and others 2010). The actual population required is thought to be ten times that of the effective population size (Frankham and others 2010). Therefore, molecular studies indicate that in the long term the population of grey long-eared bats in England is not large enough to survive. However, the population is not closed and there may be gene flow from Europe (Razgour and others 2013a, Razgour and others 2014). We expect migration rates from the EU population to increase under future climate change because suitable conditions for this species will shift north-westwards. As the population size grows, the proportion of individuals with EU ancestry will not necessarily grow in the same manner to maintain the same proportion of the population, because the number of individuals migrating into the UK population will not necessarily increase. (Razgour, pers. com, 2019). Therefore this cannot be used to give exact estimates.

Using the above estimates of the population sizes needed to prevent inbreeding, and assuming the actual population needed is ten times that of the effective population (Frankham and others 2010), a population of 10,000 grey long-eared bats would be required in the long term in England. If we estimate that half of the population is female, this would give a population of 5,000 female bats. Using a median of 20 female bats per maternity colony, we can estimate that 250 maternity colonies are required in England for future maintenance of the species. If we make this calculation on the estimated population size needed to avoid inbreeding in the short term then 500 adult bats would be needed, giving 250 pre-breeding females and 13 maternity roosts.

It is suggested that 250 maternity colonies of median size 20 breeding females (or at least 20 breeding females) is the favourable population size. These figures are very speculative and need to be updated in the light of future research.

Note that there would also need to be good connectivity between these colonies otherwise inbreeding could also occur within the colonies.

**Sources:** *Harris and others 1995; Frankham and others 2010; JNCC 2013; Razgour and others 2013a; Razgour and others 2014; Mathews and others 2018.*

**Confidence:** *Low*

## 5.5 Potential for restoration of populations

An increase in the number of maternity roosts would require a reversal in the loss of unimproved lowland grassland, as well as an increase in the area and quality of a mosaic of other foraging habitats such as riparian habitats and broadleaved woodland. Additionally, existing and potential roosts should be protected from development. The connectivity of habitat on a landscape scale would need to be improved to allow gene flow between maternity colonies, for example through the restoration of hedgerows, field margins and edge habitats.

As discussed above, as a result of climate change there is potential for the species' range to expand to the north and west (Razgour and others 2013a). A range expansion could result in an increase in the number of maternity roosts. However, as stated above, in order for range expansion in England to be feasible suitable habitat must be available surrounding the current populations and connectivity to colonisation sites would be required. Increase in the population size in England may be important for maintaining numbers of the species internationally in the future.

However, (Razgour and others 2017) note that the English populations of grey long-eared bat are not adapted to the warm and dry conditions experienced by populations in their southern range i.e. Spain. As a result, under the more extreme scenarios of future climate change, the bats may struggle to survive in some parts of the current range of the species in southern England. This highlights the importance of habitat restoration both within and north of the current range and facilitation of range expansion through increased habitat connectivity.

The maintenance of a mosaic of natural habitats with good connectivity at the landscape scale will also be beneficial to many other species in England.

**Sources:** Razgour and others 2013a; Razgour and others 2017.

**Confidence:** Moderate



# Conclusion

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## **5.6 Favourable population**

The favourable population size is estimated as 250 maternity colonies of at least 20 breeding females. Plus 13 maternity colonies of this size are needed in the short term to prevent inbreeding. These figures are preliminary recommendations. Monitoring of maternity colonies needs to continue, with the use of genetic analysis of droppings to confirm species identification.

## **5.7 Comparison with situation 1994**

The favourable population is larger than in 1994.

# Habitat for the species

## 6.1 Metric

### Roost requirements

Number of roosts per km<sup>2</sup>.

### Foraging habitat requirements

Square kilometres of foraging habitat, this metric has been used in Article 17 reporting.

## 6.2 Historical area

### Roost requirements

The historical number of roosts available to the grey long-eared bat is unknown. As discussed for population metrics, there may have been a reduction in roost availability in buildings due to renovation and exclusion of bats from building by humans (Stebbing 1995).

### Foraging habitat requirements

The historical area of suitable foraging habitat available for the species is also unknown. The area of foraging habitat, i.e. unimproved grassland, has decreased due to intensification of farming in the past 100 years (Fuller 1987, Vickery and others 2001). There has also been a decline in habitat heterogeneity on farmland such as removal of hedgerows and the loss of woodland edge habitat (Robinson & Sutherland 2002; Stoate and others 2001).

**Sources:** Fuller 1987; Stebbing 1995; Stoate and others 2001; Vickery and others 2001; Robinson & Sutherland 2002.

**Confidence:** Low

## 6.3 Current area

### Roosting requirements

The current number of suitable buildings needed for roosts for the species is unknown. It is likely that roosts suitable for the brown long-eared bat are also suitable for the grey long-eared bat. It is estimated that there are 0.03 brown long-eared bat roosts per km<sup>2</sup> in Britain (Entwistle and others 2000; Matthews and others 2018). Although brown long-eared bats may differ in habitats required close to the roost (Entwistle and others 1996; Moussy 2011), there must be far greater than 10 suitable buildings for grey long-eared bat maternity roosts. It is therefore unlikely that roost availability is a limiting factor for this species.

### Foraging habitat requirements

The third Article 17 report (JNCC 2013) gave a suitable habitat area for the grey long-eared bat of 4900 km<sup>2</sup>, including foraging habitat and roost sites. This estimate was based on expert opinion and was calculated by simply including the foraging area around the records of the species. The

area of suitable habitat was recorded as unknown in the previous (2007) report. The quality of the habitat is recorded as unknown in both reports. Razgour and others (2011b) produced a habitat suitability map for the species based on climatic factors and radio-tracking data. The area of the country estimated to be favourable for the bat was 10,900 km<sup>2</sup>.

Statistics derived from the 2015 Centre for Ecology and Hydrology Land Cover Map give a figure of 6113 km<sup>2</sup> of unimproved grassland in England (including acid grassland, calcareous grassland and neutral grassland). The area of unimproved grassland in the counties the grey long-eared bat is currently present in is 794 km<sup>2</sup> (Rowland 2017) These figures are based on satellite data and cannot be used to accurately indicate change between earlier versions of the mapping produced in 1990, 2000 and 2007. The quality of this habitat is unknown but it is thought that the value of grasslands for conservation may be overestimated with grassland of particular species interest representing just 1-2% of lowland grassland in England and Wales (Blackstock and others 1999). The survey data used in Blackstock and others (1999) is patchy and again estimates should be treated with caution.

Razgour also produced a landscape connectivity map estimating the potential movement density between known roosts given the cost of crossing areas without suitable foraging habitat (Razgour, personal communication, 2017, Annex 2 Figure 3). Movement density indicates the potential capacity for movement through the landscape ranging from high indicating high connectivity to low indicating limited movement. Figures obtained from the map suggest that there is 3241 km<sup>2</sup> of higher potential movement density between the roosts in southern England and 45,376 km<sup>2</sup> of lower potential movement connectivity, suggesting poor connectivity between colonies.

**Sources:** *Entwistle and others 1996; Blackstock and others 1999; Entwistle and others 2000; Moussy 2011; Razgour and others 2011b; JNCC 2013; Rowland 2017.*

**Confidence:** *Low*

## 6.4 Area required for future maintenance of populations and diversity

### Roosting requirements

Given that roost availability is not the main limiting factor, an increase in roosts suitable for the grey long-eared bat is not suggested here and the current availability of roosts is deemed favourable (at least 0.03 roosts per km<sup>2</sup> based on brown long-eared bat roost density). However, existing known roosts should be protected. The habitat adjacent to the buildings that the species roosts in may be more important and this, along with connecting habitat between roosts and between roosts and foraging areas, should be increased in both area and quality (see below).

### Foraging habitat requirements

Given that the area of foraging habitat is declining, the area required to maintain future populations is greater than the current area available. The actual area needed is unknown. However, an increase in the approximately 794 km<sup>2</sup> of unimproved grassland in the occupied counties is necessary to support the favourable population.

A simple analysis of the extent of unimproved grassland on the Priority Habitat Inventory within 5 km of eight maternity roosts shows that on average a roost has access to 93 ha of unimproved grassland. However, the figures for individual roosts are highly variable (2.8 – 277.8 ha) The current extent of unimproved grassland between 5 and 55 km of the existing maternity roosts is

slightly over 22,000 ha. Taking the average requirement of 93 ha an additional 240 maternity colonies would require 22,320 ha of unimproved grassland. Therefore to support the achievement of the favourable population an increase in the extent of unimproved grassland is required.

A ten percent increase, giving approximately 875 km<sup>2</sup> of this key foraging habitat is proposed as the level to support the favourable population. This is slightly above the increase suggested above to take account of the large variation in the base figures. Note that this figure is arbitrary and speculative and is therefore pending further research. As suggested by the habitat connectivity mapping, it is important that unimproved grassland is also present between colonies, as well as close to them, to act as movement corridors.

As discussed above, if climatic modelling is correct there is potential for the range to expand to the north and west. Range expansion would have to be facilitated by roost availability and foraging habitat availability and therefore the habitat area required to support the species may increase in the future. Any increases in habitat availability and connectivity for the species would be initially most important in the counties bordering the current range.

**Sources:** *Entwistle and others 1996; Blackstock and others 1999; Entwistle and others 2000; Moussy 2011; Razgour and others 2011b; JNCC 2013; Rowland 2017.*

**Confidence:** *Low*

## 6.5 Potential for habitat restoration

### Roosting requirements

Genetic analysis of droppings to confirm species identification should be implemented to discover new roosts where the species has previously not been distinguished from the brown long-eared bat so that the roosts can be offered suitable protection.

### Foraging habitat requirements

As discussed above, restoring a favourable area of foraging habitat for this species would entail reversing the loss of unimproved lowland grassland, increasing the area of other semi-natural foraging areas such as riparian habitats and broadleaved woodland and improving habitat connectivity, for example through increasing or restoring hedgerows and field margins. These habitat improvements should be carried out within the current range and also further north and west to prepare for changes in range due to climate change. Carrying out restoration of this nature at a landscape scale will also be critical for any future range expansion (Razgour and others 2013b) and connectivity between subpopulations. These landscape scale habitat improvements are technically feasible through the implementation of agri-environment schemes, working with developers and through protected sites work. The maintenance of a mosaic of natural habitats with good connectivity at the landscape scale will also be beneficial to many other species in England.

**Sources:** *Razgour and others 2013b.*

**Confidence:** *Moderate*

# Conclusion

## 6.6 Favourable supporting habitat

### Roosting requirements

0.03 available roosts per km<sup>2</sup>.

### Foraging habitat requirements

An increase of unimproved grassland and connecting habitat by 10% to give 875 km<sup>2</sup> of unimproved grassland within the species range. Note that these figures are based on satellite data and speculative calculations and further study is required.

# Annex 1: References

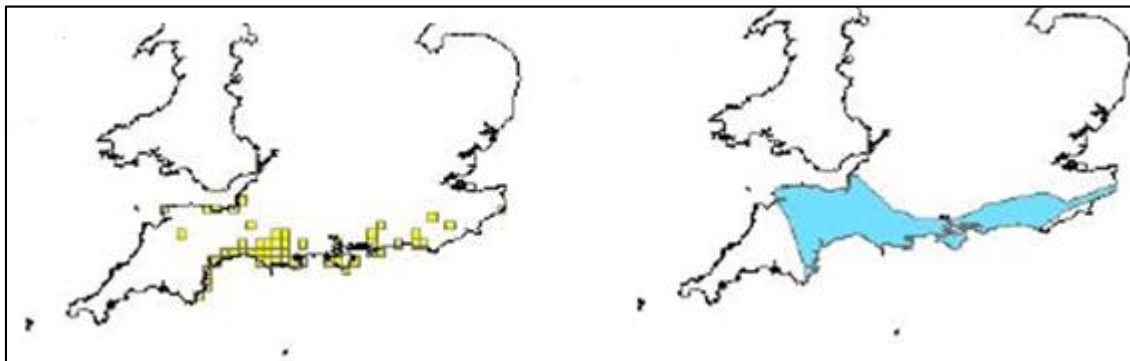
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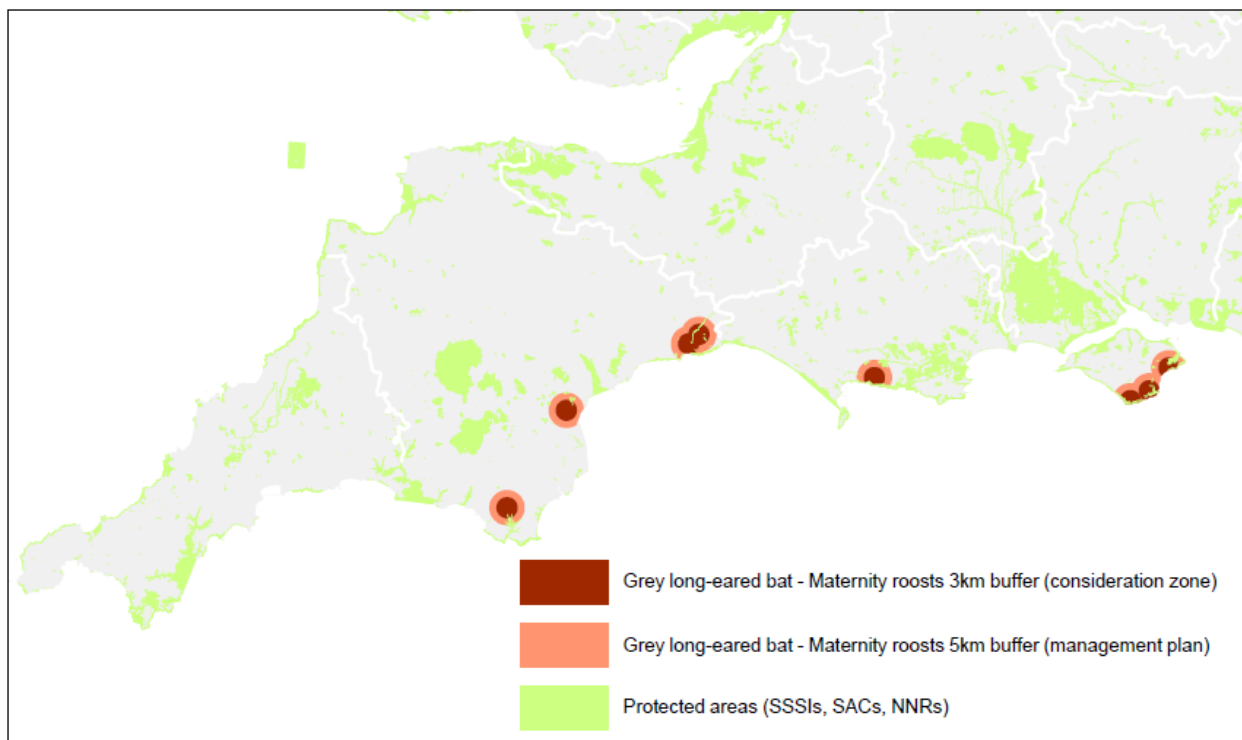
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# Annex 2: Maps

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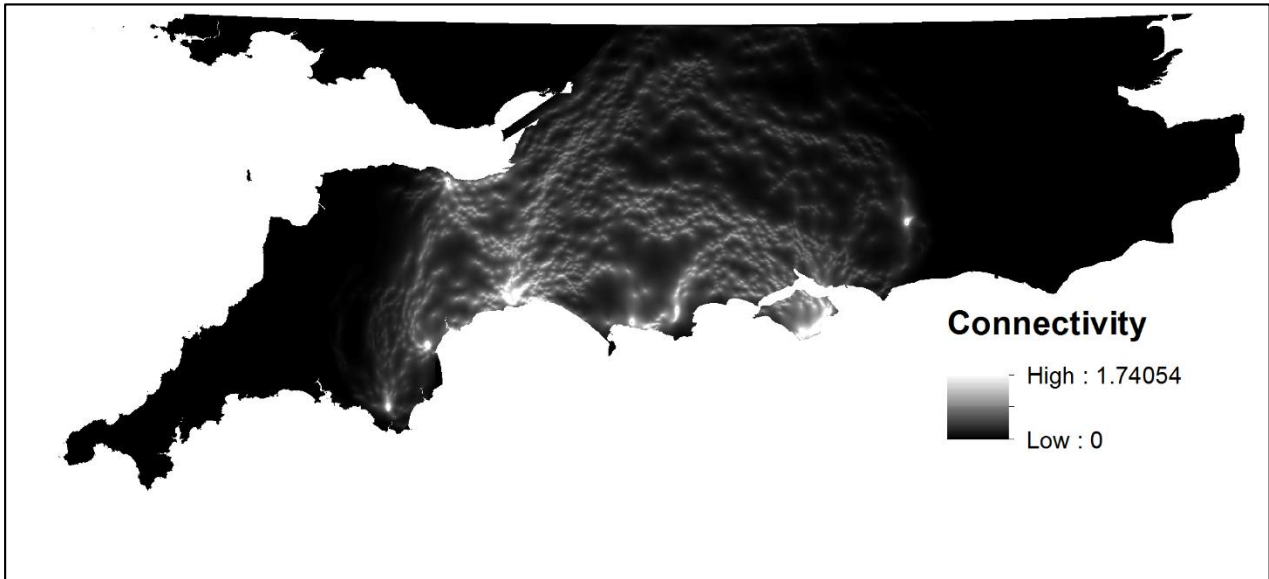


**Figure 1:** Left: Records of the grey long-eared bat from 1981-2012 (JNCC 2013). Right: The current range of the grey long-eared bat, calculated with an alpha value of 45 km (JNCC 2013)



**Figure 2:** The current location of maternity roosts in England (Bat Conservation Trust). Note this does not show two new roosts recorded in Devon





**Figure 3:** Estimations of potential movement density between known roosts given the cost of crossing areas without suitable foraging habitat (Unpublished data provided by O.Razgour 2017).

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## Cover image

Grey long-eared bat in flight  
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