Definition of Favourable Conservation Status for the Serotine, *Eptesicus serotinus*

Defining Favourable Conservation Status Project

Natural England and Bat Conservation Trust

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www.gov.uk/natural-england

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Executive summary

This document sets out Natural England's view on Favourable Conservation status for the **Serotine**, *Eptesicus serotinus,* in England.

Favourable Conservation Status is the minimum threshold at which we can be confident that the species is thriving in England and is expected to continue to thrive sustainably in the future.

This Definition has been produced following the Natural England approach to defining Favourable Conservation status described in the guidance document Defining Favourable Conservation Status in England.

Section 1 of this document describes the species covered by this Definition and its ecosystem context.

Section 2 specifies the units used to describe the three Favourable Conservation Status parameters. These are:

- Natural range and distribution (where the species occurs).
- Population (how many there are of the species).
- The extent and quality of habitat supporting the species' population.

Section 3 outlines the evidence considered when developing the Definition. This Definition is based on the best available evidence on the ecology of the **Serotine.** The evidence covers the current situation, historical changes and possible future changes.

Section 4 sets out the conclusions on the favourable values, that is the value for each of the three parameters when the species has achieved Favourable Conservation Status.

This document does not include any action planning, or describe actions, to achieve or maintain Favourable Conservation Status. These will be presented separately, for example within strategy documents.

Summary definition of Favourable Conservation Status

The Serotine is listed on the International Union for Conservation of Nature (IUCN) Red List as Least Concern globally and in Europe, and Vulnerable in Britain.

In England, the distribution of the Serotine is mostly restricted to the south of England, with occasional records in the midlands, Welsh borders and Merseyside. The range of the species is estimated to be 78,082 km^2 in England. This figure should be maintained for favourable status.

The population was estimated to be 117,000 individuals in 2018, though statistical confidence in this value is low due to limitations in the data (plausible interval = 6,250 – 356,000). It is accepted that the species likely suffered a decline in population as a result of habitat loss and anthropogenic impacts from at least the start of the 20th Century, although there are currently no data available to accurately quantify this. Therefore, the favourable value proposes a 10% increase to the population to give a favourable population of 129,000 individuals (plausible interval = 6,875 – 391,600) which has been rounded to the nearest 1000 to reflect the uncertainties in the data.

Serotines are edge and open area specialists and are often associated with pasture and parkland. They frequently commute along hedgerows, treelines and over pasture. This species has a relatively large foraging range, with average commutes of 6.5 km recorded in a pastoral region, and 8 km in a more arable region of southern England.

Within its estimated range of 78,082 $km^{2,}$, the distribution of the Serotine in England is estimated as 12,248 km^2. The area of supporting habitat for Serotine is considered to be equal to its distribution. In order to be deemed favourable, the area of habitat will need to be maintained at the current value of 12,248 km^2 as it is considered that this provides sufficient habitat to support the favourable population.

Table 1: Favourable Conservation Status parameters for the Serotine, with favourable values and confidence levels. © Natural England 2025; This table is published under the Non-Commercial Government Licence v2.0 for public sector information.

Favourable Conservation Status parameter	Favourable value	Confidence in the favourable value
Range and distribution	The current estimated geographical range (extent of occurrence), which is 78,082 km^2. The current distribution (area of occupancy), which is 12,248 km^2.	Low
Population	129,000 individuals (plausible interval = 6,875 – 391,600).	Low
Supporting habitat	Equal to the current distribution in England, which is 12,248 km^2.	Low

As of December 2025, comparison of the favourable values with the current values shows that the Serotine is not in Favourable Conservation Status. This conclusion is based solely on the information within this document and not on a formal assessment of status nor on focussed and/or comprehensive monitoring of status.

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About the Defining Favourable Conservation Status project

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

Through setting our ambition and aspiration for species and habitats, our Definitions will inform decision making and actions to achieve and sustain thriving wildlife.

Our Definitions will be embedded into delivery of the UK government’s Environmental Improvement Plan, through the Nature Recovery Network, biodiversity net gain and environmental land management schemes.

Conservation bodies will use them to inform their work, including management planning for the land they own. Businesses will have a clear understanding of how their work impacts nature recovery and how they can help contribute to achieving thriving nature.

By considering the evidence for Favourable Conservation Status, decisions will be more confident and strategic, with an understanding of their contribution to, or impact on, the national ambition.

1. Species definition and ecosystem context

1.1 Species definition

S1327 - Serotine *Eptesicus serotinus,* formerly *Eptesicus serotinus* (Cláudio and others 2023).

The species is also known by the following English common names: Big Brown Bat, or Silky Bat.

1.2 Species status

Red list status

An assessment of the risk of extinction.

Global: Least Concern - Source: Godlevska and others (2021).

European: Least Concern - Source: European Commission European Red List. IUCN

Britain: Vulnerable – Source: Mathews and Harrower (2020)

Conservation status

GB and England: Favourable - Source: Mathews and others (2018); Joint Nature Conservation Committee (2019).

1.3 Life cycle

Serotine breeding takes place between early autumn and winter. During the late spring and summer, females form maternity colonies (Mitchell-Jones 2004; Martinoli and others 2020). They give birth between May and August to a single pup and the period of births lasts on average 14 ± 6 days (Harbusch and Racey 2006; Lanza 2012). Adult females and young start to disperse after the first young are weaned at the beginning of August, and are last observed in maternity colonies in October (Harbusch and Racey 2006).

Serotines use different roosts over the course of the year, depending on the time of year, including pre- and post-breeding, maternity roosts during breeding and hibernation roosts during the winter months. Use is often based on prey availability or climatic variations. This means that a range of different roosts, including male roosts, are required to sustain a population over the year (Catto and others 1996; Harbusch 2003; Mitchell-Jones 2004; Harbusch and Racey 2006).

In hibernation roosts, the Serotine is tolerant to dry air and prefers temperatures of 5–11 °C in autumn and 0.5–6 °C in winter (Harmata 1969; Strelkov 1969). Prolonged torpor (slower metabolism) is used during winter months (usually between November and April), though this is normally repeatedly interrupted for brief periods during which the bats actively fly (Harmata 1962). After hibernation, bats move from these winter roosts to roosts with warmer temperatures.

1.4 Supporting habitat

The habitat required to maintain populations of the Serotine in England is a combination of the habitat required for roosting (Roost Requirements), that required for foraging and commuting (Foraging and Commuting Habitat Requirement), and that required for swarming (Swarming Requirements).

Roost Requirements

The specific type of roost site selected by Serotines is determined by several factors such as the temperature within the roost (Harbusch and Racey 2006), the proximity of the roost to suitable foraging areas (Robinson and Stebbings 1997), or other features of the landscape surrounding the roost such as cover and linear features (Verboom and Huitema 1997). As these requirements change over the course of the year, Serotines utilise different roosts (Catto and others 1996).

Serotines predominantly roost in buildings (Simon and others 2004) in small cavities or crevices with high access points such as gables (Bat Conservation Trust/BMT Cordah Limited 2005). Recorded hibernation sites include cavity walls, disused chimneys, and occasionally caves (Bat Conservation Trust /BMT Cordah Limited 2005). They are found very occasionally in trees and bat boxes, with most documented cases consisting of individuals, primarily males, using tree cavities or tree-mounted bat boxes (Heise 1983; Baagøe 2001; Bat Conservation Trust /BMT Cordah Limited 2005).

Maternity roosts are of particular importance. If bats are forced to move roosts, for example from roost loss due to renovation or development, this may disrupt social bonds, and place increased energy demands on individuals when finding new roosts and foraging sites. Genetic and isotope data suggest relatively strong summer segregation of different maternity social groups, even when they are geographically close (Moussy 2013). This implies that there are geographic and social constraints associated with finding new maternity roosts, in addition to the high energy costs (with resulting high local population impact) mentioned by Mitchell-Jones (2004).

Serotine maternity roosts are almost exclusively located in buildings, particularly residential houses constructed in the late 19th and early 20th Century which have high gables and a substantial roof-space offering diverse microclimates so that the bats can choose their location according to the temperature (Mathews and others 2018). Maternity colonies are thought to be almost entirely formed by adult females, usually consisting of 10-60 females (Catto and others 1996; Moussy and others 2015). Males roost separately, or in small groups (Catto 1993). Females have been reported to use multiple permanent roosts: this usually involves a principal roost used for most of the summer and several satellite roosts used for shorter periods (Catto and others 1996; Harbusch 2003; Harbusch and Racey 2006). Both sexes will return to the same sites annually (Catto and others 1996; Harbusch and Racey 2006). Roosts are located closer to woodland, water and pasture than would be expected by chance, the spatial scale at which this relationship is seen varies (Battersby 1999; Boughey and others 2011; Tink and others 2014).

Little information exists on the hibernation sites used by the species (Moussy 2013), and there are very few records of individuals in underground hibernacula. It is therefore presumed that most remain in roof spaces, disused chimneys and cavity walls where the temperature can reach a sufficiently low temperature for hibernation (Dietz and Keifer 2016). According to Lanza (2012), hibernating roosts are located mainly in caves, mines, tunnels, ceilings, cellars (with average temperatures around 2-4 ˚C), although this species may also occasionally roost in woodpiles or crevices in attics. In artificial caves in Poland, Smirnov and others (2008) found Serotines in a narrow vertical space between the wall and a detached rock piece, 1-2 m above the floor. Air temperatures ranged from 1 ˚C to 2.5 ˚C, with air humidity reaching 96%.

Temperature and relative humidity regimes within hibernation sites appear to be the most important factors in determining their use. However, the quality of the surrounding habitat is also key, as hibernating bats often wake to forage when the weather and temperature are suitable. Bat species, including the Serotine, return to the same site year after year (Harbusch and Racey 2006; Moussy and others 2015). Consequently, several different roosting sites and supporting foraging habitats are required to maintain the conservation status of the population (Mitchell-Jones 2004).

Foraging and Commuting Habitat Requirements

The Serotine is an edge and open-area specialist, often associated with pasture and parkland. With slow, highly manoeuvrable flight it can fly very close to the ground as well as among the canopies of trees, gleaning insects from vegetation with a predominant foraging strategy of aerial hawking (Baagøe 2001). It preys mainly on insect taxa associated with semi-open and open habitats such as meadows and pastures with tree groups, hedges or woodland edges [Coleoptera (beetles), including *Aphodius* spp. (dung beetles) and *Melonotha* spp. (cockchafers)], and on larger Lepidoptera (moths) (Robinson and Stebbings 1993; Vaughan 1997). Many Diptera (flies), including dung flies, and small prey items are also eaten, particularly early in the season (Catto and others 1994). In Germany, the diet of the Serotine is seasonally variable, with dietary richness increasing during the summer months as insect activity increases. Dietary analysis detected prey from 254 taxa, indicating a generalist diet (Tiede and others 2020).

Diet may be linked to variable habitat use, with habitat preferences changing according to prey availability and preferences. For example, Serotines have been found to spend over half their time in woodlands in May through July, while from August through the latter part of the year grazing land was favoured, as livestock are likely to provide an important foraging resource (Robinson and Stebbings 1997; Downs and Sanderson 2010).

Serotines commonly commute along hedgerows, treelines and over pasture, and Serotine activity increases with the density of linear elements in the landscape (Verboom and Huitema 1997). Serotines have a relatively large foraging range, with average commutes of 6.5 km recorded in a pastoral region (Catto and others 1996), and 8 km in a more arable region of southern England (Robinson and Stebbings 1997). Serotines can use up to 10 foraging sites per night and feed in groups in areas of high prey abundance (Catto and others 1996; Robinson and Stebbings 1997; Harbusch 2003).

Evidence suggests that habitat quality within a bat species' home range has a significant impact on the conservation status of the species. The size of an individual home range is related to the habitat quality and abundance of prey insects. Within this range there is a core sustenance zone, which is the area surrounding a communal bat roost within which habitat availability and quality have a significant influence on the resilience and conservation status of the colony using the roost. Serotines have been documented to spend around 90% of their foraging time at distances less than 2 km from the maternity roost (Godlevska and others 2021). In England, their core sustenance zone has been estimated to have a 4 km radius (Bat Conservation Trust 2020).

Neighbouring Serotine colonies are observed (via radio-tracking) to have overlapping home ranges (Robinson and Stebbings 1997). However, one colony was isolated and the core areas of other colonies only slightly overlapped, possibly opportunistically through the exploitation of temporary feeding sites. It therefore seems that foraging site territoriality occurs. It is also likely that Serotines display a range of foraging and roosting behaviours according to habitat and resource availability, intra- and inter-species competition, environmental conditions and metabolic or reproductive status (Moussy 2013).

Swarming Requirements

Bat autumn swarming behaviour is thought to serve primarily as a promiscuous mating system but may also be related to the localisation and assessment of hibernacula (van Schaik and others 2015). Little is known about Serotine swarming behaviour (Martinoli and others 2020), although swarming does seem to peak in August (van Schaik and others 2015; Tomlinson 2020). Cave swarming sites that are both coastal, and open and clutter-free around the entrance, may be particularly important for Serotines. If this is supported by further study then, given the role of swarming in gene dispersal and wider population health, ensuring these sites are safeguarded is vital (Tomlinson 2020).

1.5 Ecosystem context

Serotines occur across the Palearctic from Portugal eastwards to Central Asia and the Himalayas, extending north up to about 58 ºN in Sweden. In the Middle East, Serotines have been recorded in Syria, Israel and Lebanon. The species is known to range up to 1,440 m elevation in the Alps (Spitzenberger 2002) and 2,493 m in the Caucasus (Rakhmatulina 2005; Godlevska and others 2021).

Distribution in England is mainly restricted to the south of the country with occasional records in the Midlands, the Welsh Borders and Merseyside, suggesting that a range expansion may be occurring from satellite groups. However, with the current data limitations, this cannot be certain. The UK southern population exhibits a greater genetic diversity than that of continental Europe. Genetic data suggest a single population on the continent, while microsatellite markers have found three distinct populations in Britain, these are the south of England; east of England and the west, including the Isle of Wight (Moussy and others 2015). These groups showed low levels of mitochondrial diversity suggesting restricted gene flow between them (Smith and others 2011; Moussy and others 2015).

According to both ecological observations and molecular analyses, female Serotines are highly philopatric, returning to the same sites each year (Harbusch and Racey 2006). Gene flow is therefore likely to be mediated by male dispersal and probably by the use of mating or swarming sites (Moussy and others 2015; Tomlinson 2020; Collins 2023). Although dispersal may be limited, genetic evidence also suggests that there must be some gene flow across the English Channel (Moussy and others 2015).

2. Units

2.1 Natural range and distribution

The natural range of the Serotine in England comprises southern and central England (Artyushin and others 2018). Range, the term used here, is defined as the geographical area where the species is found, or geographical range. It is expressed in km^2 and was calculated from all records in the 1995-2016 population review by Mathews and others (2018), by using 20 km alpha-hull smoothing (Mathews and Harrower 2020). The range is also called the ‘extent of occurrence’.

The term distribution (also called ‘area of occupancy’) is used to define the way in which a species is spatially distributed within its range. For the Serotine, distribution is expressed in km^2 and based on the number of tetrads (2x2 km squares) in which records exist for the species, following IUCN guidelines (Mathews and Harrower 2020). It was computed from all records in the latest Mammal Society Mammal Atlas period (2000-2016) that fall within the range (Mathews and Harrower 2020).

2.2 Population

The population of the Serotine is estimated as the number of individuals based on pre-breeding colony sizes and maternity roost densities (Mathews and others 2018).

2.3 Habitat for the species

Foraging and commuting habitat is expressed in km^2, in line with Red Lists, Regulation 9A reporting and for range estimations. For the Serotine, the area of supporting habitat (foraging and commuting habitat) is unknown. Therefore, the distribution is used as a proxy for the supporting habitat for this species.

3. Evidence

All blocks of evidence are assigned one of three confidence levels (high, moderate, or low), based on the quality of the evidence, its applicability and the level of agreement.

The matrix in Figure 1 is used to assess the confidence level assigned to blocks of evidence. White = high confidence; light blue = moderate confidence and dark blue = low confidence.

Limited evidence Strong agreement	Medium evidence Strong agreement	Robust evidence Strong agreement
Limited evidence Medium agreement	Medium evidence Medium agreement	Robust evidence Medium agreement
Limited evidence Weak agreement	Medium evidence Weak agreement	Robust evidence Weak agreement

Figure 1 Matrix used to assign confidence to blocks of evidence © Mastrandrea and others 2010.

Quality of evidence is defined as follows:

- Robust evidence is that which has been reported in peer-reviewed literature, or other reputable literature, from well-designed experiments, surveys or inventories that shows signs of being applicable generally.
- Medium evidence is that reported from well-designed experiments, surveys or inventories but from only one or a small number of sites, with uncertainty over its more general applicability, or is correlational or circumstantial evidence.
- Limited evidence includes ‘expert opinion’, based on knowledge of ecological factors that plausibly suggest an effect, but there is no circumstantial or direct evidence available.

Agreement is defined as follows:

- Strong agreement is consensus across the literature and amongst those with expertise on the habitat or species.
- Medium agreement is common consensus across the literature and amongst experts but there are some differing papers or reports and/or some differences of opinion.

- Weak agreement is little consensus across the literature and amongst experts and, possibly, many different findings and/or opinions.

3.1 Current situation

Natural range and distribution

The range of the Serotine in England is 78,082 km^2 (Mathews and Harrower 2020). The species roosts mainly in buildings, and its droppings are distinctive. Therefore, despite being inconspicuous at its roost sites, it is nevertheless well-recorded compared with bat species that rely primarily on tree roosts (Mathews and others 2018). There is some evidence from bat workers, as well as from population genetics, of a westward expansion of the population, possibly corresponding with a decline in the east (Moussy and others 2015). However, caution should be applied when interpreting the data. The presence data used to derive the range include data from known roost locations and acoustic data derived from field surveys of bats in flight. There is some potential for confusion between the Serotine and other species of flying bat, including the Noctule *Nyctalus noctula* (Couzens and others 2017), Leisler's Bat *Nyctalus leisleri,* Barbastelle *Barbastella barbastellus* and *Myotis* spp*.* (Russ 2021).

Figure 2 outlines the current estimated range (Mathews and others 2018). The IUCN-compliant Red List Assessment for Britain's terrestrial mammals (Mathews & Harrower 2020) estimated the range in England as 78,082 km^2, and the distribution as 12,248 km^2.

Figure 2: The geographic range (also termed extent of occurrence) of the Serotine: 78,082 km^2 in England (Mathews and others 2018). © Fiona Mathews 2025. This map is published under the Open Government Licence v3.0 for public sector information.

Confidence: Low

Population

The population of the Serotine in England is estimated to be 117,000 (plausible interval = 6,250 – 356,000) (Mathews and others 2018). Plausible interval for the population estimate is extremely wide owing to limitations in survey data. In England, the 2024 National Bat Monitoring Programme (NBMP) population trend data from both the Field Survey and Roost Count show no significant trend in the smoothed survey index between 1999 and 2023. Between 2018 and 2023 the NBMP Field Survey index for England has increased (only just significant) and the Roost Count index for England has shown no significant change. The population of the Serotine in England is considered to have been stable in the long term (since 1999), while there is evidence to suggest it has increased in the short term (since 2018). However, this finding should be treated with caution, as Serotines are encountered relatively infrequently during surveys, resulting in increased variability in the data. Therefore, the level of uncertainty associated with these trends is large, making trends for this species difficult to detect (Bat Conservation Trust 2025).

The lack of data for key aspects of the species' ecology, such as colony sizes across habitat and geographical gradients and roost densities, in particular maternity roost data, have meant that the methodology used to produce the population figure is not sufficiently robust to provide a more accurate estimate (Mathews and others 2018).

The 2019 Article 17 report therefore advises that the lower and upper confidence intervals (in this case, approximated by the plausible intervals) should be treated as minimum and maximum estimates of the population size (Joint Nature Conservation Committee 2019).

Confidence: Low

Habitat for the species

In other Favourable Conservation Status Definitions, modelling has been used to determine favourable supporting habitat (Zeale and Natural England 2024). In the absence of such modelling for the Serotine, the distribution (km^2) was used as a proxy for supporting habitat. It was calculated using confirmed presence records, home and core range and habitat data by Mathews and Harrower (2020) in the IUCN-compliant Red List Assessment for Britain's terrestrial mammals as 12,248 km^2. However, the figure should be interpreted with caution, as confirmed roosts are often under recorded and data derived from volunteer bat worker visits may be variable. Additionally, a large majority of data derived from European Protected Species licence applications to Natural England are not included in population monitoring.

When determining habitat for the species, both roosting opportunities in buildings and the habitats to support foraging and commuting around them should be considered.

Roost Requirements

Mathews and others (2018) estimated a maternity roost density for typical habitat of 0.5 roosts/km^2 and 0.33 roosts/km^2 were observed in Sussex (Tink and others 2014). Densities of 0.04 roosts/km^2 and 0.12 roosts/km^2 for poor and good quality habitat were used as the lower and upper plausible limits (Mathews and others 2018). However, these figures remain largely uncertain, owing to a low number of roost records used to derive the data. The Serotine is still encountered relatively infrequently. The studies used to inform the estimates were all conducted within strongholds for the species and therefore likely to be higher than those expected elsewhere. In addition, further clarity is needed on occupancy and density trends across geographical gradients (Mathews and others 2018).

Foraging and Commuting Habitat Requirements

Serotines are considered to utilise a core sustenance zone around a roost of 4 km in radius (Bat Conservation Trust 2020) and prefer to roost close to woodland, water and pasture (Battersby 1999; Boughey and others 2011; Tink and others 2014). Not only physical habitat, but how it is used by the bats needs to be taken into consideration; for example, favoured insect prey (Martinoli and others 2020) and the association with other species, including livestock (Downs and Sanderson 2010). There is currently insufficient information on the percentage of potentially suitable habitat within the distribution. In these cases, 100% occupancy is assumed (Mathews and others 2018), leading to an overestimation of habitat availability and extent (Joint Nature Conservation Committee 2019).

Confidence: Low

3.2 Historical variation in the above parameters

Natural range and distribution

Across Europe, the Serotine is generally considered non-migratory, despite its capacity for strong flight and relatively large nightly movements. The range estimated by Mathews and others (2018), which is considerably larger than that shown in Arnold (1993), Harris and others (1995) and Robinson and Stebbings (1997), includes south-west England, the Midlands, the Welsh Borders and Merseyside. It is unclear how much this reflects a true range change rather than increased observer effort, and occupancy is thought to be low in some of these areas (Joint Nature Conservation Committee 2019). There are reports from experts of declining populations in the east of England, supported by some evidence from population genetics (Moussy and others 2015). Range was not estimated for England in the previous Article 17 report (Joint Nature Conservation Committee 2013), so cannot be used for comparison.

Confidence: Low

Population

There is insufficient evidence to provide a single value on the historical variation in population. A population estimate of 14,750 individuals was given in Harris and others (1995). However, this estimate was based on very limited information, extrapolating a figure from the known size of Common Pipistrelle *Pipistrellus pipistrellus* and/or *P. pygmaeus* colonies in relation to size of Serotine colonies, and was therefore graded as having very poor reliability (Joint Nature Conservation Committee 2019).

Between 1999 and 2023, the NBMP Serotine smoothed field survey index for England (Figure 3) remained stable: the increase of 26% (95% Confidence Interval: 28% to 124%) is not statistically significant (Bat Conservation Trust 2025).

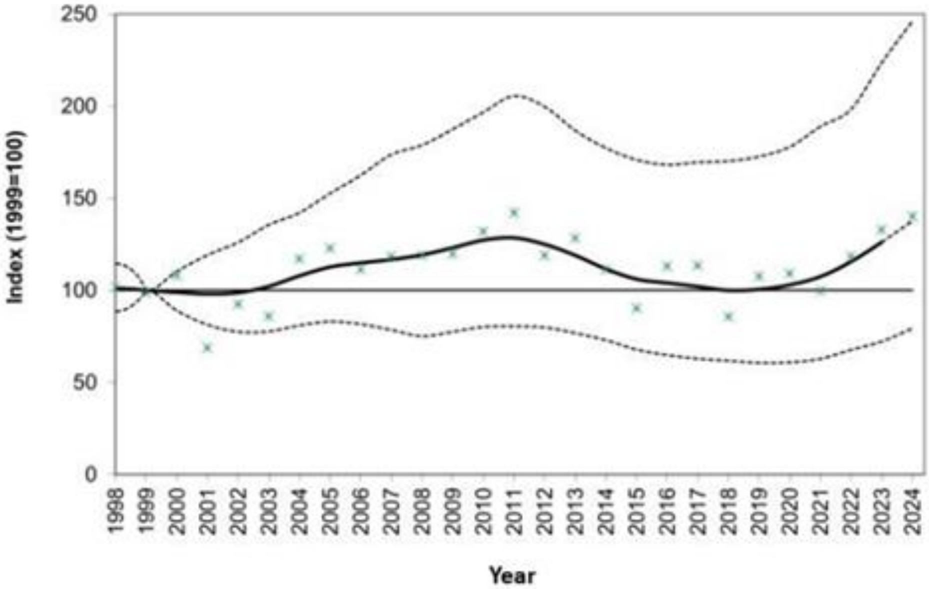

Figure 3: Smoothed Field Survey index for Serotine in England © Bat Conservation Trust 2025.

Between 1999 and 2023, the smoothed index trend for the NBMP England Roost Count (Figure 4) remained stable: the decrease of 4% (95% Confidence Interval: -28% to +36%) is not statistically significant. Sample sizes are relatively small, with an average of 35 sites per year contributing to the roost count trend analysis between 1999 and 2024 (Bat Conservation Trust 2025).

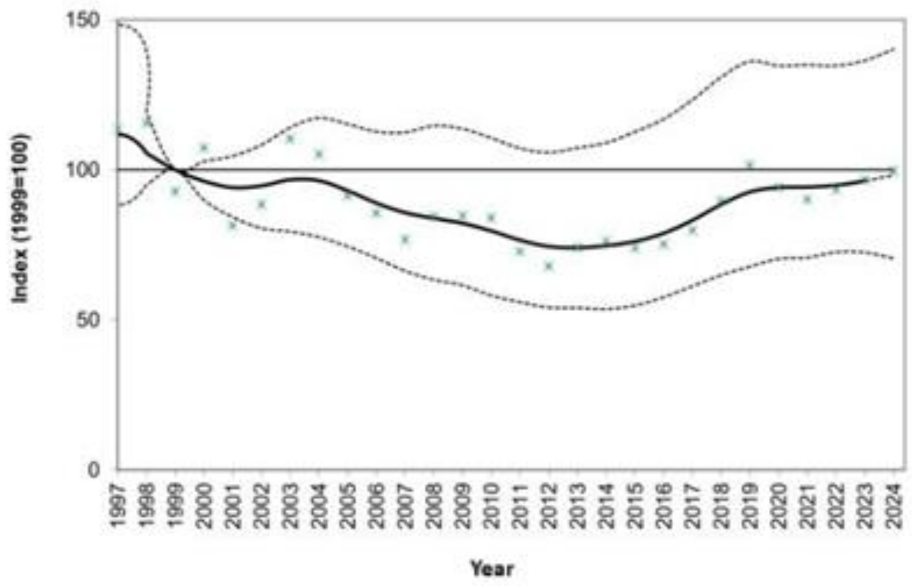

Figure 4: Roost Count index for Serotine in England © Bat Conservation Trust 2025.

With regard to the NBMP field survey, Serotines have a wide range of echolocation calls which can be easily confused with other bats (notably those belonging to the genera *Myotis*, *Nyctalus*, *Plecotus*, and *Barbastella*). This is particularly the case when detection is based on heterodyne bat detectors, which is the primary technique used in the NBMP field survey. The results should therefore be interpreted with caution and not outweigh the Roost Count data (Mathews and Harrower 2020).

There is a distinct lack of hard data on which to assess current population trends, making population monitoring or assessment difficult and unreliable (Mathews and Harrower 2020). Although there are no significant trends in Serotine populations, changes in agricultural practice and reductions in prey abundance, particularly in the east of England, may be expected to lead to a decline (Mathews and others 2018). The wide plausible interval reflects the small sample size. In order to gain a better indication of the current situation, it is possible to apply the IUCN Red Data List units of measure (a period of three generations) to the current trend. Over three generations, this has been calculated by the IUCN Red List as an inferred decline of 37% (Mathews & Harrower 2020).

It should be remembered that data from studies such as Harris and others (1995) and the NBMP reflect relatively recent changes in bat populations. There is a body of evidence documenting declines in abundance for a range of UK bat species (Harris and Yalden 2008; Haysom and others 2010), including significant historical declines in bat populations dating back to at least the start of the 20th Century, with some maternity colonies of Serotines reported to show dramatic declines since 1960 (Stebbings and Griffith 1986; Robinson and Stebbings 1997).

Confidence: Low

Habitat for the species

Roost Requirements

The historical number of roosts available to the Serotine is unknown. There may have been a reduction in roost availability in buildings due to renovation and exclusion of bats from buildings by humans (Mitchell-Jones 2004; Reason & Wray 2023).

Foraging and Commuting Habitat Requirements

There appears to be a range expansion. However, this may reflect increased survey effort rather than increased foraging and commuting habitat. Advances in survey methodology, equipment and analysis may have also contributed. The historical area of suitable foraging habitat for the Serotine remains unknown, although it can be assumed that the area of foraging habitat has decreased due to increased urbanisation and agricultural intensification over the past hundred years. There has been a decline in habitat heterogeneity on farmland through the loss of unimproved grassland or cattle pasture, degradation or reduction in accessibility to foraging areas, exposure to toxic compounds such as pesticides, and the decline of mixed farming (Robinson and Stebbings 1997; Stoate and others 2001; Robinson and Sutherland 2002; Boatman and others 2007). The potential consequences of the use of avermectins, pesticides frequently used in agriculture, warrants further research (McCracken 1993; Forbes 2021; Kumar 2023).

Confidence: Low

3.3 The future for the species and its conservation

Serotines are highly mobile, requiring a mosaic of habitats in order to sustain a resilient population. A number of factors may influence the future maintenance of their biological diversity and variation. The primary drivers of change (positive and negative) likely to affect the Favourable Conservation Status of the species at a national scale are the loss and degradation of habitat from development, habitat fragmentation and degradation from agriculture, renewable energy developments and climate change. These are discussed in greater detail below.

Loss and degradation of habitat from development

Roost Habitat

The legislative protection of bat roosts has succeeded in mitigating for the historical loss of roosts and habitats as a result of development to some extent, with population declines appearing to level out since 1999 (Bat Conservation Trust 2025). However, the destruction and damage of roosts as a result of development has the potential to remain one of the most severe drivers of population change. Increased economic factors continue to exert pressure on the legislative measures in place. Roost requirements change over the course of the season (Harbusch and Racey 2006) and serotines use different roosts over this period to meet their requirements. Female Serotines are highly faithful to their roosts and return to the same sites year on year (Catto and others 1996; Harbusch & Racey 2006); the breeding success of the species is therefore reliant on the availability and maintenance of their roosts. The legislative protection of roosts has been a vital element in seeing this species begin to halt its decline.

Potential Severity: High

Confidence: Moderate

Foraging and Commuting Habitat

Serotines may benefit from a less densely developed urban habitat mosaic that provides both roosting and foraging habitat in close proximity. Since the early 20th Century, urbanisation in England has increased significantly. Some studies have shown that the activity of bats, including Serotines, tends to be lower in high-density residential areas and city centres than in low-density areas and semi natural areas (Vaughan and others 1997; Gaisler and others 2006). Serotines predominantly roost in buildings in less densely developed urban habitat mosaics that provide both roosting and foraging habitat in close proximity. However, the benefits of a landscape matrix can be reduced owing to cumulative local factors (patch effects) (Angold and others 2006). This means that the maintenance of a population is not solely reliant on the protection of individual roosts, but the cumulative mosaic of foraging habitat that surround it and connect it to the wider habitat.

The presence of woodland, water, arable land, improved grassland (for grazing) and linear features may improve the chances of roost sites being selected by Serotines (Battersby 1999; Boughey and others 2011; Tink and others 2014). Though the spatial scale at which effects are seen varies, this supports evidence showing that the maintenance of habitat within the core sustenance zone surrounding roosts is an important factor in supporting a viable population (Bat Conservation Trust 2020). These core sustenance zones become harder to retain at higher urban density as the landscape matrix becomes less likely to support a viable population.

Potential Severity: Moderate

Confidence: Moderate

Habitat fragmentation and degradation from agriculture

Habitats on agricultural land can be separated into two broad categories: productive habitats such as grassland and arable habitats, and non-productive or non-crop habitats, such as hedgerows and woodland. Serotines use a variety of agricultural habitats (notably hay meadows and pasture), but they avoid intensively managed arable habitats for foraging (Robinson and Stebbings 1997).

Serotines are highly mobile and capable of dispersing if suitable areas of well-connected habitat are available. Serotines cross open areas, but rely on linear features as flight lines to commute (Verboom and Huitema 1997). A reduction in linear landscape features could decrease survival rates for local populations, particularly for maternity roosts. Altering established commuting routes through the removal of linear features could make commuting distances longer, or harder to navigate, increasing the energy expenditure used to commute to foraging sites and reducing prey availability (Russ and Montgomery 2002).

As well as hedgerow removal, there has been an increasing trend to manage hedgerows more intensively through cutting them shorter and narrower, further decreasing the available hedgerow habitat for wildlife (Newton 2004). Bates (2010) found that activity of Serotines was higher at large rather than small hedgerows on both organic and conventional farms. Hedgerows and tree lines can act as windbreaks, with airborne insects accumulating next to the barrier; higher insect prey abundance has been recorded alongside large hedgerows than alongside smaller ones (Bates 2010).

Within the last hundred years, agricultural landscapes have undergone massive changes, with a shift from a varied mosaic of semi-natural and productive habitats managed extensively, to landscapes dominated by intensively managed grass and arable habitats with a smaller proportion of non-crop habitat. Changes in soil cultivation may impact prey availability by increasing the mortality of the larval stages of prey such as Coleoptera and Diptera (Krooss and Schaefer 1998; Frouz 1999). Longer-lived larvae are often worst affected, and intensively managed habitats may have higher densities of small Coleoptera than areas with more extensive management practices (Blake and others 1996). This impacts bat species such as the Serotine that depend upon Coleoptera with long-lived larvae, such as cockchafers and dung beetles. Serotines may benefit from varying cultivation management at both a farm and landscape level to ensure continuous food supply over time (Defra 2005). Cattle-grazed pasture is recognised as an important habitat for Serotines preying upon *Aphodius* dung beetles (Downs and Sanderson 2010). Changes in the extent of cattle-grazed pasture may have a detrimental impact on the species, and Serotines could be adversely affected by endo-parasitic treatments for livestock, such as avermectins (McCracken 1993).

Potential Severity: Moderate

Confidence: Low

Renewable energy developments

The Serotine has been identified as one of the species particularly vulnerable to mortality at wind turbines in the UK (Rydell and others 2010; Mathews and others 2016), and have been recorded echolocating at altitudes of 30 m above ground (Collins and Jones 2009). Potential impacts of wind-farm operation include ultrasound emission, which can interfere with echolocation; a loss of foraging habitat if bats avoid the area surrounding operational turbines; the loss or alteration of flight corridors; and fatalities due to direct collision with rotors (Rodrigues and others 2008). The extent of the impact of wind turbines on Serotines, and the number of casualties, remains unclear owing to limitations in both data coverage and collection. Further investigation is required in order to identify methods to reduce adverse effects and prevent significant impacts on future populations; for example, detection dogs can be used to recover bat corpses during fatality searches (Arnett 2010). Studies into operational curtailment as a bat fatality reduction measure~~,~~ have shown that this method of mitigation reduced near-misses and rotor-disrupted flights of bats, and significantly reduced fatalities (Mathews and others 2016; Smallwood and Bell 2020). It remains unclear whether the scale of casualties in England is sufficient to affect populations of Serotines.

Potential Severity: Moderate

Confidence: Low

Climate change

Unfavourable weather conditions adversely affect foraging and breeding success, as well as winter survival rates, in bats. Increased temperatures in maternity roosts are correlated with less torpor in lactating females, earlier births and increased juvenile growth (Hoying and Kunz 1998). A study by Gaisler and others 2006 reported that Serotine foraging activity was positively correlated with temperature, suggesting potential benefits from warmer climates. However, when coupled with the more extreme weather events and wetter seasons, climate change could have an adverse effect owing to a reduction in prey availability (Jones and others 2009; Burns and others 2016). Warmer winters could mean that more energy is spent hibernating, with wetter springs potentially also resulting in less efficient foraging for bats and the risk of starvation (Sherwin and others 2012).

Serotines have been shown to have high juvenile fatality rates in the first few months of life, which makes this species particularly vulnerable to poor summer weather (Harbusch and Racey 2006; Chauvenet and others 2014). It is currently unclear how climate change will impact the Serotine population, but findings from genetic studies are likely to offer greater clarity in the coming years.

Potential Severity: High

Confidence: Low

3.4 Constraints to expansion or restoration

A notable constraint to expansion or restoration remains the lack of knowledge resulting from the current lack of reliable data for the species. This makes it difficult to determine the impact of pressures and to target remedial measures (for example, habitat management) effectively. However, while a greater understanding of the species is obtained, the pressures being exerted on the population should continue to be monitored and reviewed.

Theobald and others (1997) identified a difficulty in assessing the cumulative impacts of development on wildlife: while each individual change may make an apparently minor impact, a major impact may be exerted by many changes. Systematic reviews and monitoring would be required to provide sufficient information on the continued status of the Serotine population in order to ensure that the legislative protection remains effective and that the habitat quality and quantity around all roosts, including those in the built environment, are not damaged by future development (Simon and others 2004; Reason and Wray 2023) or by other management changes. More information is known on this topic for other bat species (Collins and others 2020).

Confidence: Low

4. Conclusions

4.1 Favourable range and distribution

The IUCN-compliant Red List Assessment for Britain’s terrestrial mammals (Mathews and Harrower 2020) estimated the current range for the Serotine in England as 78,082 km^2. The distribution in England is estimated as 12,248 km^2 (Mathews and Harrower 2020). It is considered that these figures reflect the favourable range and distribution for the species.

4.2 Favourable population

The population estimate for the Serotine is 117,000 individuals (plausible interval = 6,250 – 356,000).; Mathews and others 2018). The species is likely to have suffered a decline historically; however, there is a lack of robust data available on the scale of the decline. Therefore, a 10% increase of the current population estimate is proposed in order to achieve Favourable Conservation Status, producing a favourable population of 129,000 (to the nearest 1000) individuals (plausible interval = 6,875 – 391,600).

4.3 Favourable supporting habitat

The area of favourable supporting habitat for the Serotine is deemed to be equal to the distribution of the species in England (12,248 km^2, Mathews and Harrower 2020).

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