Definition of Favourable Conservation Status for Hazel or Common dormouse, *Muscardinus avellanarius*

Defining Favourable Conservation Status Project

Author: Kate Morris

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Contents

About the DFCS project

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

This document sets out Natural England's view on Favourable Conservation Status (FCS) for **Hazel or Common dormouse, *Muscardinus avellanarius*** (referred to as hazel dormouse from here on) in England. FCS is defined in terms of three parameters: the natural range and distribution of the species; population of the species; extent and quality of habitat necessary for long-term maintenance of populations.

Section 2 provides the summary definition of FCS in England. Sections 3 – 6 describe the evidence considered when defining FCS for each of the three parameters. Annex 1 lists the references.

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

The guidance document Defining Favourable Conservation Status in England describes the Natural England approach to defining FCS.

2. FCS in England

Hazel dormouse numbers in Britain declined during the 20th century and it is thought that their range has shrunk from a presence in 49 English counties in 1885 to 32 counties today (excluding six counties where reintroductions are currently active). Favourable Conservation Status will be achieved in England when hazel dormice re-occupy these 49 counties.

The current population of hazel dormice in England is estimated as 757,000 individuals (95% CL 298,000 - 2,110,000; Mathews and others 2018). The National Dormouse Monitoring Programme has shown a steady decline in its count index since its inception, with a 72% decline (95% CI = 62% to 79%) between 1993 and 2014 (Goodwin and others 2017) and the species is therefore classified as Vulnerable on the GB Red List for mammals (in prep). In order to achieve Favourable Conservation Status for this species in England metapopulations should be established in each of the 49 counties, the population should be at least 2,700,000 (reversing the decline demonstrated by the National Monitoring Programme) and the species should be assessed as Least Concern under regional IUCN Red List criteria.

The available habitat for hazel dormouse has been estimated as 764,000 ha (Mathews and others 2018). Given that the available habitat and hazel dormouse numbers are declining (Goodwin and others 2017; Mathews and others 2018) this habitat area is deemed to be unfavourable. Favourable Conservation Status in respect of habitat could be achieved by the proposed12 -13% increase in lowland mixed deciduous woodland (Natural England Lowland Mixed Deciduous Woodland FCS Definition in prep.) providing that the new woodlands are well-connected, have suitable vegetative and structural composition and are of appropriate size.

Sources: *Goodwin and others (2017); Mathews and others (2018)*

Species definition and ecosystem context

3.1 Species definition

S1341 Common dormouse, *Muscardinus avellanarius*

(also known as Hazel dormouse)

3.2 Threat status

Red list status

An assessment of the threat of extinction.

- Global: Least Concern *Source:* IUCN 2019. The IUCN Red List of Threatened Species. Version 2019-2. http://www.iucnredlist.org.
- European: Least Concern *Source:* Temple & Terry 2007
- GB and England: Vulnerable *Source:* A Review of the Population and Conservation status of British Mammals, Mathews and others (2018); Goodwin and others (2017)

3.3 Supporting habitats

Hazel dormice have traditionally been considered to be habitat specialists, but they are now seen as more adaptable (Juškaitis & Büchner 2013). They are primarily found in broadleaved woodland and have traditionally been associated with coppiced hazel (Bright & Morris 2006), but studies have shown that they occur in a range of habitats, including scrub, coniferous plantations and hedges (Chanin & Woods 2003) and that, in comparison to some other dormouse species, they are able to live in a broad diversity of habitats (Juškaitis & Büchner 2013).

The structure of hazel dormouse habitat is important, particularly the availability of arboreal pathways formed by sprawling coppice and climbing plants, such as honeysuckle or bramble. A well-developed understorey is an important habitat feature and the best developed understorey usually occurs along forest edges, within woodland glades, along forest tracks and rides, or in areas of coppice (Juškaitis & Büchner 2013; Juškaitis & Šiožinyté 2008). Less intensively managed hedgerows also offer suitable habitat, particularly those with a variety of woody shrub species. Hazel dormice may inhabit old hedgerows throughout the year, or use them seasonally to exploit autumn fruits and berries (Bright and others 2006).

The species exploits a wide range of high quality plant foods, such as flowers, buds, seeds and fruits, as well as invertebrates, and requires a diverse range of sources to provide a sequence of food types through the seasons. The omnivorous habit enables hazel dormice to occur in habitats where plant species diversity is low (e.g. coniferous plantations), but insect diversity or density is high (Juškaitis & Büchner 2013).

Sources: *Bright and others (2006), Chanin & Woods (2003), Juškaitis & Büchner (2013), Juškaitis & Šiožinyté (2008), Richards and others (1984)*

Confidence: *Moderate*

3.4 Ecosystem context

The hazel dormouse is endemic to Europe and northern Asia Minor (Turkey). In continental Europe, it is fairly widespread, although it is absent from Iberia, south-west France, northern parts of Fennoscandia and Russia. It is also absent from eastern Ukraine and southern Russia. Island populations occur in southern Britain (Isle of Wight) and on Corfu and Sicily. In the Alps it occurs up to 1,920 m (Spitzenberger 2002; Morris 1999; Rossolimo and others 2001; Hutterer and others 2016). In Britain, this species is at the north western edge of its global range and, other than one known population in Cumbria, natural populations are restricted to Wales and parts of the midlands and southern England (with reintroduced populations as far north as the Yorkshire Dales) (Mathews and others 2018).

Sources: *Combe and others (2016); Morris (1999); Rossolimo and others (2001); Spitzenberger (2002); Hutterer and others (2016); Mathews and others (2018)*

Natural range and distribution

4.1 Metric

Number of counties present in.

4.2 Historical range

Hazel dormouse numbers in Britain declined during the 20th century; it is thought that their range has shrunk from a presence in 49 English counties in 1885 to 32 counties today (excluding six counties where reintroductions are currently active), mostly in southern England, with the exception of isolated and reintroduced populations. The species reaches its northern limit in south Cumbria (Bright & Morris 1996; Wembridge and others 2016), where the population is isolated from others.

Records analysed for the Second Report by the United Kingdom under Article 17 (JNCC 2007) showed a recent range (1990-2006) of 77,731 km^2 throughout England and Wales. The most recent Article 17 report (JNCC 2013) gives a range of 86,885 km^2, but this is likely due to an increase in the availability of data rather than an increase in actual range (for example, dormice may have been found in habitats which may have previously been overlooked). The estimated range for Britain suggested by Mathews and others (2018) is lower, at 82,277 km^2, but this is likely due to changes in methodology as opposed to actual change. Both the most recent Article 17 report (JNCC 2013) and the revised Review of British Mammals (Mathews and others 2018) suggest that the range of this species in Britain is currently stable, despite historical range contraction and current ongoing declines in population size. Trends in both range and population size reflect monitored sites only and wider trends are unknown, but the National Dormouse Monitoring Programme currently provides the best available evidence on dormouse population trends (Goodwin and others 2017).

There are a number of factors that can influence range, occupancy and population. These are outlined below.

Loss and fragmentation of habitat – the loss of woodland cover since the early 20th century, post-war intensification of farming and the consequent removal of hedgerows have reduced the extent of available dormouse habitat. The fragmentation and isolation of remaining habitat is increasing and this is restricting movement between populations and decreasing the long-term viability of existing populations (Wembridge and others 2016; JNCC 2013; Bright and others 2006).

Changes in woodland and hedgerow management – traditional coppicing and selective felling are less commonly practiced than they were in the past. As a result, woodland is less structurally diverse, with fewer open spaces and less new growth of understorey that provides food and nesting sites for dormice. More intensive management of hedgerows is also having an impact on habitat availability and quality, as well as opportunities for dispersal (Wembridge and others 2016; JNCC, 2013; Bright and others 2006). High densities of deer, browsing by stock and lack of appropriate deer and stock management are also considered to be having an impact on

woodland understorey and dormouse habitat quality in many areas (Juškaitis & Büchner 2013; JNCC 2013; Newson and others 2011).

A changing climate and unpredictable weather – unfavourable weather conditions adversely affect foraging and breeding success, as well as winter survival rates. Hazel dormice hibernate during the winter months and undergo periods of torpor during the rest of the year. This sensitivity to weather conditions suggests climate change – with warmer, wetter seasons and more extreme weather events – is likely to adversely affect dormouse populations (Goodwin and others 2018; Wembridge and others 2016). Phenological changes caused by climate change, such as deviations in the fruiting or flowering time of plants, may affect the availability and abundance of food throughout the year, which would consequently have an impact on populations and their ability to accumulate sufficient fat reserves or access sufficient food post hibernation. Warmer winters may also affect hibernation, with increased periods of activity during months when food sources are limited and energy costs cannot be met by feeding. Changes in climate may also impact the timing of breeding and the birth of the first litter; potentially impacting on the number of litters a dormouse may have each year (Juskaitis & Büchner 2013; Bright & Morris 2005; Wembridge and others 2016).

Although weather has been shown to influence dormouse population ecology, it is not at all clear whether changes over the next few decades will be beneficial to dormice or detrimental. It is conceivable that the range of hazel dormice in the UK could expand northwards if suitable habitat was available, but also possible that it may further contract (Chanin 2014).

Sources: *JNCC (2007); JNCC (2013); Chanin (2014); Wembridge and others (2016); Mathews and others (2018); Bright & Morris (1996); Bright & Morris (2005); Bright and others (2006); Juskaitis & Büchner (2013); Newson and others (2011)*

Confidence: *Moderate*

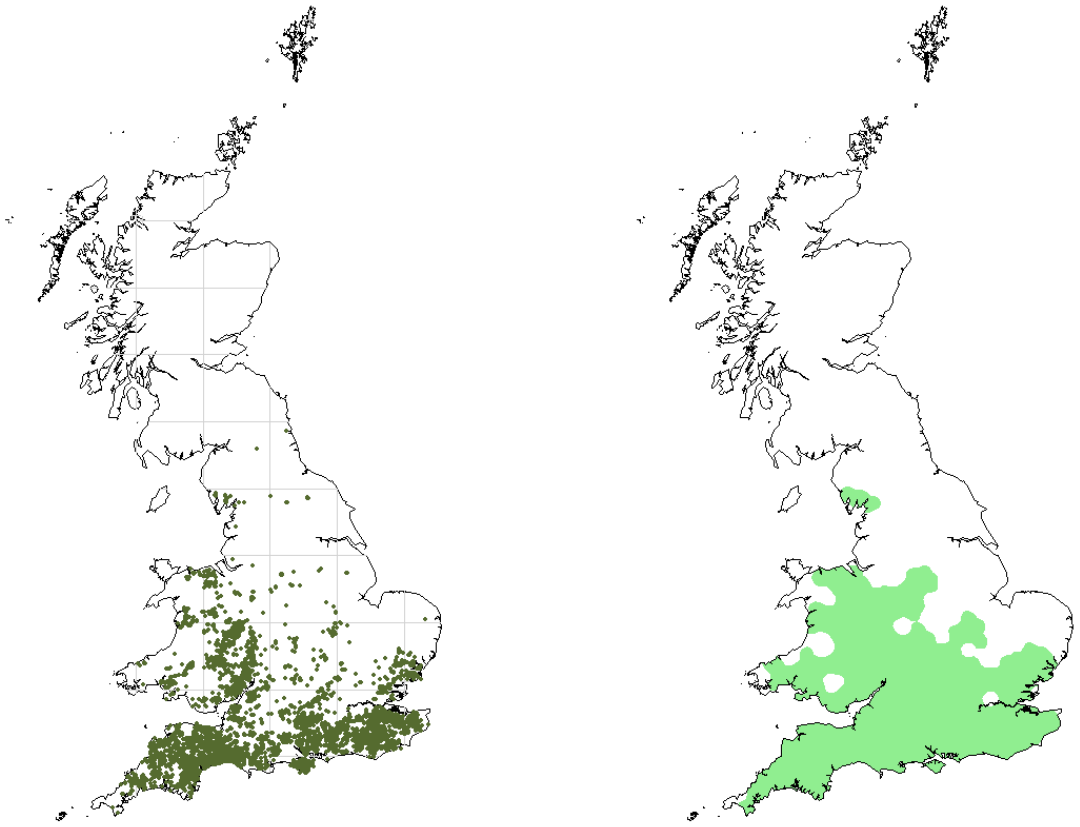
4.3 Current range

The hazel dormouse is currently thought to be present in 32 English counties, excluding reintroduced populations (Wembridge and others 2016). The reintroduction programme has reintroduced dormice to six counties where hazel dormice are no longer found naturally, as well as translocating them to some counties where there are existing natural populations. Many of these reintroduced populations are not sufficiently established, or are too isolated, to be considered as a contributor to the population range at present.

The current range of dormice in England is estimated to be 67,601 km², roughly 82% of the total British range of 82, 277 km² (Mathews and others 2018). These estimates are broadly similar to the most recent Article 17 report (JNCC 2013) and any slight differences are likely to be due to differences in methodology as opposed to actual change.

Information gathered on range is based on presence data, which is mainly collected through the National Dormouse Monitoring Programme and National Dormouse Database. A potential source of error with this range estimation is that hazel dormice living outside of these sites may be under-recorded, or in areas such as Cumbria where there is currently only one known population, there may be an over estimation of the area in which they are present.

Muscardinus avellanarius (Hazel Dormouse)



These maps show the range of dormice in Great Britain. Range is based on presence data collected between 1995 and 2016. The map on the left shows the 10 km² range and the map on the right shows the smoothed map which was created using alpha hull methodology. This method discounted areas that contain very isolated records, which includes areas with reintroduced populations (Mathews and others 2018).

Sources: Mathews and others (2018); Wembridge and others (2016); JNCC (2013)

Confidence: Moderate

4.4 Range required for future maintenance of populations and diversity

The most recent Article 17 report (JNCC 2013) gave a Favourable Reference Value (FRV) for range of 86,885 km² for Britain, which was equal to the estimated range at that time. This FRV was provided as it was thought to be an indication of the range when the Habitats Directive came into force in the UK in 1994 and it was thought to be large enough to support a viable population. Current range is thought to be stable (Mathews and others 2018; JNCC 2013) and the figures for range provided by Mathews and others (2018) are broadly similar to the most recent Article 17 report (82,277 km² in Britain and 67,601 km² in England). However, taking historical range loss into account, the species' range should be expanded in order to bring the species to FCS in England.

Range has decreased from hazel dormice being present in 49 counties in 1885, to being present in 32 (38, including additional counties where reintroductions have taken place and populations

are still establishing). Range within these historic counties is unknown, but restoring populations within these counties would improve the conservation status of dormice in England.

Sources: *JNCC (2013); Mathews and others (2018)*

Confidence: *Moderate*

4.5 Potential for restoration of the natural range

The natural range of hazel dormice in Britain has declined, from 49 English counties in 1885 to 32 counties today (Bright & Morris 1996; Wembridge and others 2016). Hazel dormice have been reintroduced into an additional six counties where natural populations have been lost, but they are not yet thought to be established in these counties as they are isolated populations and are present in small numbers.

The known natural range of hazel dormice has not changed markedly in recent years, other than in northern England where the population in Northumberland is thought to have been lost. However, it is now known that hazel dormice exploit a wider range of habitats than previously thought and are able to take advantage of a wider diversity of food sources. As further studies have taken place, the number and variety of places where hazel dormice have been recorded has increased (including scrub, coniferous plantations, coppice and hedgerows). The National Dormouse Database shows that during the period 1990 to 1993, dormice were recorded in 340 one kilometre squares and between 2000 and 2014 they were recorded in 1270 one kilometre squares (Chanin 2014). With this new information and increased recorder effort, it is possible that dormice may be found outside of the current known range.

Although the historic natural range of the hazel dormouse has shrunk in England, the dormouse reintroduction programme has been in place since 1993 and has enabled dormouse populations to return to six counties where natural populations had been lost, as well as reintroducing new populations within the current range. As of 2018, 28 reintroductions have taken place in 12 counties across England (Wembridge and others 2016; Chanin 2014). These reintroductions have had varying levels of success (see Chanin 2014 for detail on success criteria), but breeding and dispersal have occurred at many of the sites and improvements to the way in which the programme is carried out (for example, clustering of sites; improving genetic diversity within the captive breeding programme) ensure that the reintroductions continue to contribute to the restoration of the species' former range.

However, in order for the species' range to expand in England, suitable habitat must be available and, there must be sufficient connectivity between new and existing sites as, although dormice will cross open ground, arboreal routes are thought to be favoured (Juškaitis & Büchner 2013). Appropriate landscape-scale habitat improvements are technically feasible and might be encouraged through the implementation of agri-environment schemes, working with developers, through landscape-scale partnership projects and through protected sites work.

As discussed in 4.2, the impacts of climate change on the range of the hazel dormouse are unknown, but weather has been shown to influence hazel dormouse population ecology. It is not clear whether changes over the next few decades will be beneficial or detrimental to hazel dormice, but they may influence the potential for restoring the natural range of this species.

Sources: *Juškaitis & Büchner (2013); Bright & Morris (1996); Wembridge and others (2016); Chanin (2014); Goodwin and others (2018)*

Confidence: *Moderate*

4.6 Favourable range

It is deemed that the current occupied range of 32 counties is unfavourable in England.

Favourable range could be achieved by restoring hazel dormice to their former range of 49 English counties.

County	1885 status	2016 status	Reintroduction site
Kent	Common	Common	
East Sussex	Common	Common	
West Sussex	Common	Common	
Essex	Common	Present	
Hertfordshire	Common	Rare	
Surrey	Common	Common	
Hampshire	Common	Common	
Isle of Wight	Common	Common	
Wiltshire	Common	Present	
Dorset	Common	Common	
Somerset	Common	Common	
Devon	Common	Common	
Worcestershire	Common	Present	
Shropshire	Common	Present	
Cornwall	Common	Common	

Suffolk	Present	Present	Yes
Berkshire	Present	Present	
Gloucestershire	Present	Present	
Oxfordshire	Present	Present	
Buckinghamshire	Present	Rare	Yes
Northamptonshire	Present	Rare	Yes
Herefordshire	Present	Common	
East Yorkshire	Present	Absent	
Staffordshire	Present	Rare	Yes
Cheshire	Present	Rare	Yes
South Yorkshire	Present	Absent	
West Yorkshire	Present	Absent	
Greater Manchester	Present	Absent	
Merseyside	Present	Absent	
Lancashire	Present	Absent	
Cumbria	Present	Rare	
North Yorkshire	Present	Rare	Yes
City of Bristol	Present	Present	
South Gloucestershire	Present	Present	
North Somerset	Present	Present	
Bath and North East Somerset	Present	Present	

Greater London	Rare	Present	
Cambridgeshire	Rare	Rare	Yes
Bedfordshire	Rare	Rare	Yes
Warwickshire	Rare	Rare	
West Midlands	Rare	Rare	Yes
Lincolnshire	Rare	Rare	Yes
Nottinghamshire	Rare	Rare	Yes
Derbyshire	Rare	Rare/absent	Yes
Cleveland	Rare	Absent	
Durham	Rare	Absent	
Tyne and Wear	Rare	Absent	
Rutland	Rare	Absent	
Leicestershire	Rare	Absent	

This should be measured by continued monitoring of dormouse populations through the National Dormouse Monitoring Programme, as well as collecting additional records through the National Dormouse Database. These resources provide data on presence at sites, as well as from licence returns and ad hoc records, and allow for estimates of range to be calculated by assessing occupied hectads. However, there are still data gaps in our understanding of dormouse status.

Population

5.1 Population metric

Number of individuals.

5.2 Historical populations

The majority of current populations are in southern England, Wales and the Welsh borders, though there are remnant and reintroduced populations elsewhere. The northern limit in Britain for this species is now thought to be a single population in south Cumbria (Wembridge and others 2016). Even in the south of England, the populations are often patchily distributed.

In the second edition of the Dormouse Conservation Handbook, Bright and others (2006) stated that the species had become extinct in around half of its former range in the past hundred years and that the causes of this decline were believed to be mainly due to changes in land management practices, particularly the decline in coppicing, but also to habitat fragmentation and deterioration. They also considered climatic factors to be involved due to the species specialised feeding requirements.

The National Dormouse Monitoring Programme has monitored dormice since 1993. Counts of dormice in nest boxes are carried out at selected sites, providing an index of dormice with which to assess relative trends in population size. The monitoring programme has shown a steady decline in its count index since its inception, with a 72% decline (95% CI = 62% to 79%) between 1993 and 2014 (Goodwin and others 2017). Goodwin and others (2017) suggests that these declines in dormouse counts are a real trend and the apparent population decline cannot be ascribed to changes in monitoring.

Many of the issues that have affected historical populations also affect the range of this species and have been outlined in 4.2.

Sources: *Wembridge and others (2016); Bright and others (2006); Goodwin and others (2017)*

Confidence: *Moderate*

5.3 Current population

The current population of the hazel dormouse in England is estimated to be 757,000 (95% CL 298,000 - 2,110,000; Mathews and others 2018). This estimate was derived from population density estimates for each habitat type from a review of the literature between 1995 and 2015, as well as expert opinion. This population estimate differs from previous estimates (465,000 - Harris and others 1995; 37,500 - JNCC 2013) due to differences in methodology. For example, Harris and others (1995) assessed a narrower range of habitats and the estimated population densities were different. The current analysis includes all broadleaved woodland, rather than ancient woodland only, as well as hedgerows and coniferous woodland. However, 50% of available habitat was assumed to be occupied by Harris and others (1995), as opposed to 34% in the current analysis by Mathews and others (2018). Population size estimates are, therefore, unlikely to be directly comparable between the two time periods due to differences in methodology.

Mathews and others (2018) highlighted the need for further research to increase the reliability of population size estimates for this species. In particular, density estimates and occupancy data for coniferous woodland and further density estimates for broadleaved woodland and hedgerows.

Sources: *Mathews and others (2018); Harris and others (1995); JNCC (2013)*

Confidence: *Poor*

5.4 Population required for future maintenance of populations and diversity

The population required for future maintenance of populations and diversity is uncertain. The current population estimate has wide confidence limits, making it difficult to provide a realistic estimate for a favourable population. However, it is judged that favourable status should at least represent a reversal of the recent monitored 72% population decline.

The English population is currently assessed as Vulnerable under the GB Red List, based on population decline. There is agreement that the population is still declining and is likely to continue declining (Goodwin and others 2017). A reversal of the recent population decline would give a favourable population of 2,700,000 dormice based on the current population estimate.

Further research needs to be undertaken in order to better understand occupancy across different habitats where dormice are found (e.g. coniferous woodland, broadleaved woodland, hedgerows etc) and the constraints on population expansion (e.g. geographical boundaries, impact of climate etc). This information would allow for more robust population estimates to be established.

Sources: *JNCC (2013); Mathews and others (2018); Goodwin at el (2017)*

Confidence: *Poor*

5.5 Potential for restoration of populations

To maintain or increase the current populations in England there would need to be a reversal in the decline and fragmentation of important dormouse habitats, continued favourable improvements in habitat management and continued legislative protection.

The dormouse reintroduction programme has been in place since 1993 and has enabled dormouse populations to return to six counties where natural populations had been lost, as well as translocating dormice to counties where natural populations still exist (Bright & Morris 2002). As of 2018, 28 reintroductions have taken place in 12 counties across England (Wembridge and others 2016; Chanin 2014). These reintroductions have had varying levels of success, but breeding and dispersal has occurred at many of the sites and it is hoped that populations will continue to grow in these areas. Chanin (2014) outlines the criteria for assessing the success of a reintroduction, but at present 21 of these reintroductions have shown some level of success (short to long-term, depending on the length of time they have been established). Five of these sites have failed and

the remaining reintroductions are too recent to assess. Again, for this expansion to occur, the habitat needs to be well managed and well connected.

Recent studies have shown evidence of genetic divergence between common dormouse populations in continental Europe and those in the UK. These studies have also provided evidence to show regional genetic clustering of populations around the UK. This clustering could be explained by gross geographical features providing barriers to genetic exchange or local adaptation, but further study is needed (Combe and others 2016). Further work on dormouse genetics may improve our understanding of the success or failure of reintroductions.

The connectivity of habitats on a landscape scale should be considered, for example through the restoration of hedgerows and edge habitats. As already discussed, the impacts of climate change are unclear, but if it did enable range and population expansion then the habitat would need to be suitable and well connected. These landscape-scale habitat improvements are technically feasible through the implementation of agri-environment schemes, working with developers, through landscape-scale partnership projects 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: *Wembridge and others (2016); Bright & Morris (2002); Chanin (2014); Combe and others (2016)*

Confidence: *Moderate*

5.6 Favourable population

The current population estimate has wide confidence limits, making it difficult to provide a realistic estimate for a favourable population. However, the return of a sustainable metapopulation to each of the 49 counties known to have previously been occupied by dormice (see 4.6), and a reversal of the observed 72% population decline would be considered a favourable population.

In order for the hazel dormouse population to be considered favourable in England, the IUCN Red List status should be Least Concern and the population should be 2,700,000 individuals.

There are large evidence gaps regarding dormouse populations and a programme of further research needs to be conducted in order to provide a robust figure for favourable population size.

The population should continue to be measured through the National Dormouse Monitoring Programme, as well as collecting additional records (e.g. ensuring all records from developers are submitted, ad hoc records etc) through the National Dormouse Database.

Habitat for the species

6.1 Metric

Hectare

6.2 Historical area

The hazel dormouse has traditionally been considered to be a habitat specialist, but it is now seen as more adaptable (Juškaitis & Büchner 2013). They are primarily found in broadleaved woodland and have traditionally been associated with coppiced hazel (Bright and others 2006), but studies have shown that they occur in a range of habitats, including scrub, coniferous plantations and hedges (Chanin & Woods 2003) and that, in comparison to other dormouse species, they are able to live in a broad habitat spectrum (Juškaitis & Büchner 2013).

The loss of woodland cover and changes in woodland management (for example, reduction of coppicing; conversion to conifer plantations; an increased deer population) in the 20th Century may have led to a decrease in the availability of, as well as the structural complexity of, important habitats for dormice in Britain (Bright and others 2006; Mathews and others 2018; JNCC 2013; Newson and others 2011). The removal of hedgerows during post-war agricultural intensification also reduced the extent of available habitat, leaving remaining populations increasingly isolated and vulnerable (Wembridge and others 2016).

Conversely, new roadside habitats (the regular management of road verges helps to maintain species and structural diversity required for dormice), as well as improvements to remaining hedgerows and woodlands under appropriate management, may have increased available habitat in some areas in more recent years (Mathews and others 2018).

Sources: *Juškaitis & Büchner (2013); Bright and others (2006), Chanin & Woods (2003); Newson and others (2011); Wembridge and others (2016); JNCC (2013); Mathews and others (2018)*

Confidence: *Moderate*

6.3 Current area

Mathews and others (2018) estimate the area of suitable habitat in England as 764,000 ha.

Source: *Mathews and others (2018)*

Confidence: *Poor*

6.4 Area required for future maintenance of populations and diversity

With the information available, it is difficult to estimate the extent and quality of the habitat in England and the latest Article 17 report (JNCC 2013) stated that it is unknown whether the amount of habitat in the UK is sufficient to support a viable population of the species. However,

Mathews and others (2018) state that the 'available habitat' trend is declining. This assessment is based on the current trends, current drivers of change and potential future drivers of change.

The future area required to support the species in England is therefore uncertain. However, given that both the population and the available habitat are thought to be in decline (Mathews and others 2018), it is likely that 764,000 ha is insufficient to maintain the population.

Although there is uncertainty around the area of habitat required to support this species in England, we do know that connectivity of semi-natural habitats on a landscape scale should be considered, for example through the restoration of hedgerows and woodland edge habitats. We also know that woodlands of less than 20 ha which are poorly connected to other areas of suitable habitat are unlikely to support viable populations of dormice (Bright and others 2006). From studies undertaken using microchipping, we know that dormice are capable of dispersing up to 500 m, with some individuals travelling even further (Juškaitis & Büchner 2013). However, in order to achieve this level of dispersal, suitable areas of habitat need to be well connected.

As already discussed, the impacts of climate change are unclear, but if it did enable range and population expansion then the habitat would need to be suitable and well connected.

Further research needs to be undertaken in order to better understand occupancy across different habitats where dormice are found (for example, coniferous woodland, broadleaved woodland, hedgerows etc) and the limitations regarding population expansion (for example, geographical boundaries, impact of climate etc). This information would allow for more robust population estimates to be established and as a consequence, would enable us to quantify the area of habitats required to maintain the population. It would also be beneficial to revisit the work undertaken by Bright and others (2006) to further understand the area of habitat required to support a viable population of dormice as this knowledge of their ecology was based on a single study.

Sources: *JNCC (2013); Mathews and others (2018); Juškaitis & Büchner (2013)*

Confidence: *Poor*

6.5 Potential for habitat restoration

The known natural range of dormice has not changed markedly in recent years, other than in northern England where the population in Northumberland is thought to have been lost, although there has been continued habitat loss and degradation. It is now known that dormice exploit a wider range of habitats than previously thought and are able to take advantage of a wider diversity of food sources. As new methods of detecting the species have become available and further studies have taken place, the number and variety of places where they have been recorded has increased (Chanin 2014). However, most monitoring still takes place in more 'traditional' habitats and further research is needed to better understand populations using these other habitats.

For the species to be maintained in England, suitable habitat must be available and this habitat requires appropriate and ongoing management. There must also be sufficient connectivity between sites, for example suitable hedgerows and edge habitats (Juškaitis & Büchner 2013). These landscape-scale habitat improvements are technically feasible through the continued implementation of agri-environment schemes, working with developers, through landscape-scale

partnership projects (such as those associated with some of the dormouse reintroduction projects) 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.

The impacts of climate change on the range of the hazel dormouse are unknown, but unfavourable weather conditions adversely affect foraging and breeding success, as well as winter survival rates. Climate change may also have an impact on their success indirectly, by affecting their habitat (Wembridge and others 2016; Goodwin and others 2018). There are concerns about various impacts, including changes in habitat structure and composition, as well as phenological effects whereby the physiological adaptations of dormice which determine when they go into and emerge from hibernation may not synchronise with food supplies. It is also thought that the impact of climate on farming and land management practices may be influential (Mathews and others 2018).

The impacts of climate change on dormice may also be dependent upon habitat type. For example, in oak woodland dormice tend to breed in spring and early summer, when food is available, and they benefit from warm, dry summers, but in hazel woodlands autumn is more fruitful and dormice tend to breed later in the year. In this case, dormice benefit from cold, dry autumns, which provide prolonged periods of time for foraging (Wembridge and others 2016; Goodwin and others 2018).

Although weather has been shown to influence dormouse population ecology, it is not at all clear whether changes over the next few decades will be beneficial or detrimental to dormice. It is conceivable that the range of dormice in the UK could expand northwards if suitable habitat is available and well connected, but also possible that it may further contract (Chanin 2014).

Sources: *Juškaitis & Büchner (2013); Wembridge and others (2016); Chanin (2014); Goodwin and others (2018); Mathews and others (2018)*

Confidence: *Poor*

6.6 Favourable supporting habitat

The favourable area of supporting habitat for the hazel dormouse is unknown, but it is likely that it should be more than the current 764,000 ha. This should be measured by land cover data and uptake of agri-environment scheme options. Favourable supporting habitat should be achieved through encouraging mosaics of semi-natural habitat and not intensive conifer plantation, although existing plantations may form part of a wider habitat assemblage.

As previously discussed in 6.4, we know that connectivity of habitats and the size of each woodland is an important factor in supporting a viable population of dormice. We also know that dormice are capable of dispersing, but in order to achieve this suitable areas of habitat need to be well connected.

As mentioned in 5.2, the impacts of climate change are unclear, but it is likely to affect dormouse populations. The available habitat needs to be of good quality, robust and well connected, with high species and structural diversity.

Further research needs to be undertaken in order to better understand occupancy across different habitats where dormice are found (e.g. coniferous woodland, broadleaved woodland, hedgerows etc) and the limitations regarding population expansion (e.g. geographical boundaries, impact of climate etc). It has been suggested that a 12-13% increase in lowland mixed deciduous woodland (Natural England, in prep) would be appropriate to achieve a favourable status for that particular habitat type and it may be that this would also be appropriate for dormice, assuming those areas were well connected, had suitable vegetative and structural composition and were of an appropriate size. However, dormice do not just use deciduous woodland and we need more information on occupancy within all of these habitats before any robust estimates can be calculated.

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Hazel/Common Dormouse, *Muscardinus avellanarius*
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