ENGLISH NATURE

English Nature, the Rural Development Service and the Countryside Agency. Working in partnership to conserve and enhance our landscapes and natural environment, to promote countryside access and recreation as well as public well-being, now and for future generations.

This is one of a range of publications published by:
External Relations Team
English Nature
Northminster House
Peterborough PE1 1UA

www.english-nature.org.uk

© English Nature 2006

Printed on Evolution Satin, 75% recycled post-consumer waste paper, elemental chlorine free.

ISBN 1 85716 219 6

Catalogue code IN2.9

Designed and printed by statusdesign.co.uk, 2.5M.

Front cover photographs:
Top left: Severn Valley cycle route.
C. Turtle
Middle left: Dormouse nest tube.
P. Morris
Bottom left: Hazel nut opened by dormouse.
J. Norton
Main: Dormouse in hazel. P. Morris

ENGLISH NATURE

The dormouse conservation handbook

second edition

working towards *Natural England*
for people, places and nature

The dormouse conservation handbook
Second edition

by
Paul Bright, Pat Morris and Tony Mitchell-Jones

Illustrated by Sarah Wroot

Contents

	Foreword and acknowledgements	**5**
1	**Introduction: dormice and issues they raise**	**9**
1.1	General introduction	9
1.2	Organisational framework and support	10
2	**Introduction to dormouse ecology**	**11**
2.1	Understanding dormouse habitats and ecology	11
2.2	Dormice in other habitats	17
2.3	Problems with small population size	18
3	**Finding signs of dormice and monitoring numbers**	**21**
3.1	Predicting the presence of dormice	21
3.2	Finding evidence of dormice	21
3.3	Dormouse surveys – good practice recommendations	27
3.4	Monitoring	28
3.5	Marking dormice and taking samples	30
3.6	Estimating population density	30
4	**Habitat management**	**31**
4.1	Managing woods for dormice	31
4.2	The objectives of woodland management for dormice	31
4.3	'Conservation Woodlands'	31
4.4	Coppicing for dormouse conservation	34
4.5	Managing 'Forestry' woodlands where dormice are present.	35
4.6	Management of Plantations on Ancient Woodland Sites (PAWS)	38
4.7	Managing problems caused by deer and stock browsing	40
4.8	Squirrels	41
4.9	Hedges and their management	42
4.10	Support for habitat management	43
5	**Development and mitigation**	**45**
5.1	Legal background and licensing	45
5.2	When is a licence required?	45
5.3	Possible impacts from development	46
5.4	Predicting likely impacts	46
5.5	Roles and responsibilities	46
5.6	Planning mitigation and compensation	47
5.7	Mitigation and compensation methods	48
5.8	Nest boxes	52
5.9	Hibernating dormice	52
6	**Legislation, legal status & licensing**	**53**
6.1	Relevant direct legislation	53
6.2	Interpretation and enforcement	53
6.3	Exceptions and licences	54
6.4	Incidental protection	54
6.5	Planning policy	55

Contents

continued

7	**Captive breeding and reintroduction to the wild**	**57**
7.1	Captive breeding	57
7.2	Reintroductions and translocations	57
7.3	Progress so far	60
8	**The National Dormouse Monitoring Programme**	**61**
8.1	Monitoring Dormice at National and Regional Level	61
8.2	Other recording schemes	62
9	**Conservation achievements and priorities**	**63**
9.1	The UK Biodiversity Action Plan	63
9.2	Progress with the national action plan	63
9.3	Priorities for the next decade	64
10	**Organisations & contacts**	**65**
10.1	English Nature	65
10.2	The Department for Environment, Food and Rural Affairs	65
10.3	Office of the Deputy Prime Minister	65
10.4	Local Planning Authorities	66
10.5	Developers and environmental consultants	66
10.6	The Forestry Commission	66
10.7	County Wildlife Trusts	67
10.8	People's Trust for Endangered Species and the Mammals Trust UK	67
10.9	Local Biological Records Centres and the NBN	67
10.10	The Mammal Society	68
10.11	Common Dormouse Captive Breeders Group (CDCBG)	68
10.12	Other organisations	68
11	**Case studies in development and forestry**	**69**
11.1	Developing National Cycle Route 45 in The Severn Valley, Shropshire	69
11.2	Reconstructing a road junction	70
12	**References**	**71**
	Nest box suppliers	**73**

Foreword and acknowledgements

This considerably expanded second edition of the *Dormouse Conservation Handbook* draws together much information on the species that has been gathered since the first edition was published in 1996. In particular, the introduction of a licensing system for European protected species has highlighted the need for guidance on mitigating the impact of development or other operations on dormouse populations. Mitigation studies are still developing, but we have included, wherever possible, good practice guidance that should help determine appropriate levels of survey and mitigation in a variety of circumstances. Examples of successful mitigation are still relatively rare and we would welcome further case studies as they become available.

The authors wish to express their gratitude to the many hundreds of volunteers who have helped with the study and monitoring of dormouse populations over the past two decades. We also acknowledge the valuable and extensive input from the Common Dormouse Captive Breeders Group, a number of ecological consultants, and from representatives of organisations that have been directly involved in dormouse conservation, survey and mitigation work. A workshop attended by Nida Al-Fulaij, Neil Bemment, Caitriona Carlin, Paul Chanin, Warren Cresswell, Fred Currie, Valerie Keeble, Roger Trout, Cathy Turtle and Michael Woods was very helpful in clarifying many issues and identifying good practice. We are particularly grateful to Roger Trout of Forest Research for his very considerable input to the chapter on Habitat Management.

This handbook is endorsed by the Dormouse Focus Group (BAP group) as a contribution to the delivery of the Biodiversity Action Plan for the dormouse.

In October 2006, English Nature, Defra's Rural Development Service and the Landscape. Access and Recreation Division of the Countryside Agency will come together to form a new agency, Natural England. Functions currently provided by RDS or English Nature, such as species advice and licensing, will then be provided by the new agency.

Paul Bright
Pat Morris
Tony Mitchell-Jones
January 2006

Key messages

- There is only one native species of dormouse in Britain, whose basic biology is very different from that of ordinary 'mice'.

- Dormice are protected by law because their numbers and distributional range have declined by at least half during the past 100 years. This decline still continues in some regions.

- Dormice are important because they are a 'flagship species'; where dormice occur, the habitat is usually very suitable for a wide range of other species too. They are also important as 'bioindicators' as they are particularly sensitive to habitat and population fragmentation, so their presence is an indication of habitat integrity and sustainable populations of other sensitive species.

- Dormice normally occur in highly diverse deciduous woodland. They are also frequently found in species-rich hedgerows and scrub and they also occur in habitats such as gardens and conifer plantations.

- Dormice hibernate on or under the ground from about October until March or April. They are thus affected by ground disturbance in winter and early spring.

- Dormice are vulnerable to woodland and hedgerow management operations. In many areas, deer or livestock are also a major problem, compromising regeneration and reducing shrub layer extent and diversity.

- The potential presence of dormice should be considered when development, habitat management or land-use change is planned that affects any type of woodland, hedgerow or scrub. A survey should be carried out at the earliest possible opportunity as mitigation measures may depend on the season and may not be easily accommodated into works timetables later. As the dormouse is a European protected species, a licence may be required to permit activities that would otherwise be illegal.

- English Nature strongly advises developers to seek the services of a professional environmental consultant with appropriate experience when contemplating a development proposal that might affect dormice, or potential dormouse habitat.

- When considering applications for planning permission, planning authorities should take account of the presence of dormice and other protected species. They may refuse applications where a development will have adverse effects on protected fauna or flora, or if a suitable survey to assess the impact of a development on protected species has not been carried out. Local authorities should request applicants to instigate such a survey before determination rather than adding it afterwards as a condition of approval.

- If disturbance to dormouse habitat cannot be avoided, mitigation to reduce or compensate for this disturbance is likely to be a condition of planning approval and must be proportionate to the probable impact of the development. Similar conditions are likely to apply to a licence.

- Mitigation and subsequent woodland management may have to be carefully timed to protect dormice. Restoration of habitat continuity is particularly important and should sometimes include land that lies outside the area directly affected by operations. Sometimes a considerable period of time may be necessary to carry out this work, particularly where planting is required that may not mature for several years. Arranging to monitor the effects of mitigation and woodland management is highly desirable, and often a requirement of planning permission

- Mitigation may involve the translocation of dormice, but this should be considered a 'last resort' option because it is disruptive to natural populations and suitable sites for releasing animals may not be available locally. Moreover, establishing translocated dormice populations is a complex and expensive operation that requires specialist supervision.

- Protected species legislation applies independently of planning permission. Licences may be necessary for operations that do not require planning permission but do affect dormice.

- This document gives generic advice on woodland management, the assessment of development impacts and the creation of mitigation plans. It does not give a comprehensive explanation of current legislation, and readers may wish to seek their own legal advice.

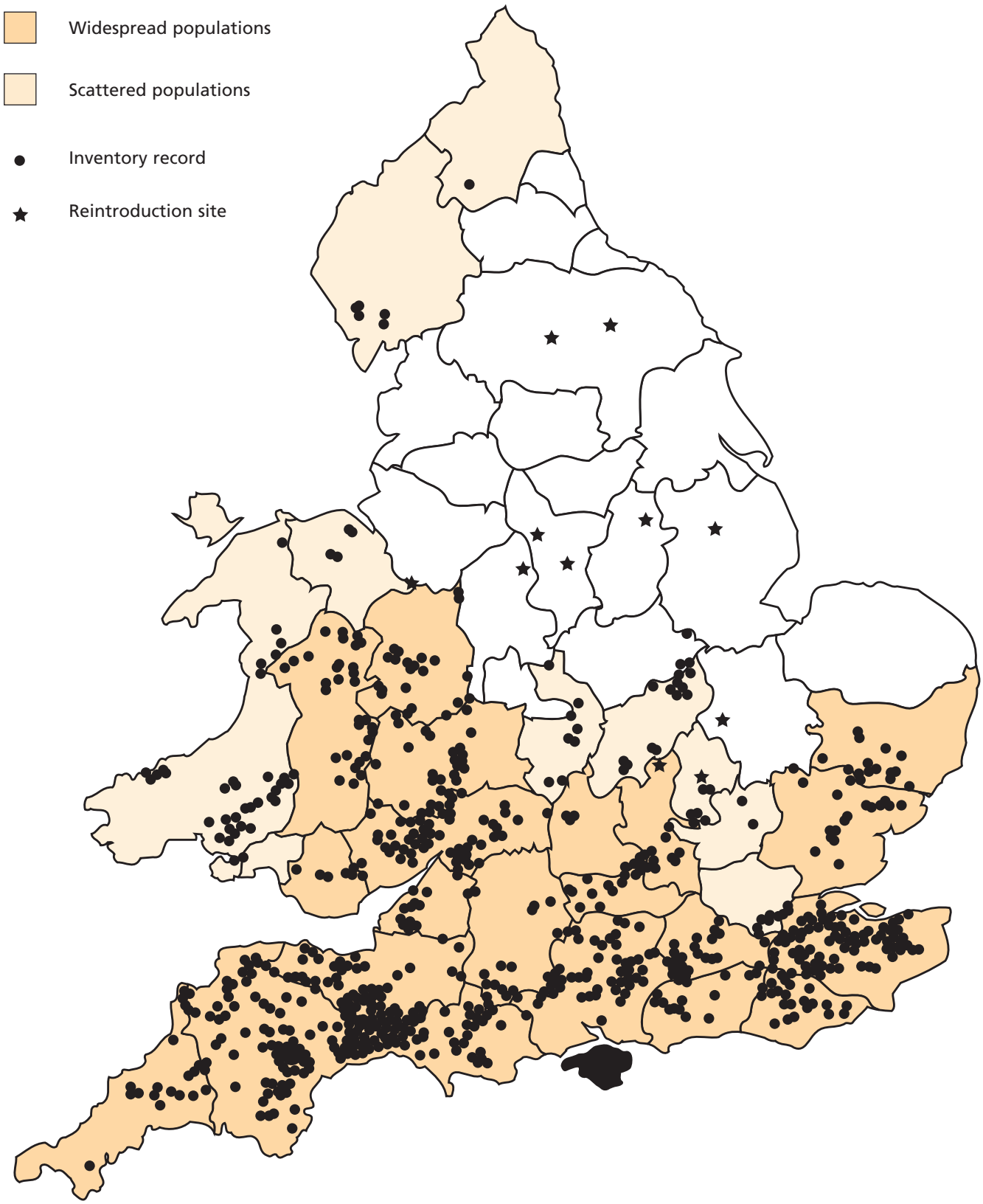


Figure 1 Dormouse distribution. Originally dormice were widespread over most of England and Wales, but they are now found only in the shaded areas. Circles show records from the national dormouse inventory, collected since 1990. Stars show sites of reintroductions carried out as part of the Biodiversity Action Plan. This map can help to predict the likelihood of finding dormice in an area.

1 Introduction: dormice and issues they raise

1.1 General introduction

Dormice form a distinctive family of rodents (the Gliridae), which are found widely across Europe and Africa, with one species in Japan. They are not common anywhere, and by international agreement they are protected throughout Europe (the Japanese species has even been designated a protected 'National Icon'). Two species occur in Britain, the edible dormouse *Glis glis*, a squirrel-sized, non-native species that has become a minor pest since its introduction in 1902, and the hazel dormouse *Muscardinus avellanarius* – the subject of this manual.

The hazel dormouse is a distinctive native British mammal that is infrequently seen owing to its rarity and nocturnal habits. It is rarely caught in traps or by predators such as cats and owls, so it is easily overlooked even where present. Moreover, it spends most of its active time high off the ground and passes at least a third of the year in profound hibernation, again making it unlikely to be seen by the casual observer. Nevertheless, the dormouse is widely known from its appealing photographs and its occurrence in children's story books (notably *Alice's Adventures in Wonderland*). Formerly it was also found by woodland workers during coppicing and hedge laying operations, who would often take these attractive animals home to show to their children. The dormouse is therefore a familiar species, despite being rarely encountered in the wild. Like the dolphin, it has the advantage of being an attractive animal with no 'negative' aspects to its lifestyle.

Over the last 100 years, the hazel dormouse has declined in both numbers and distribution. Recent surveys suggest that it has become extinct in about half its former distributional range, including six counties where it was reported to be present by Rope (1885). There are now fewer than ten known sites north of a line between the Wirral and the Wash (including recent reintroductions), and dormice are entirely absent from Scotland. The most northerly location is near Hexham in Northumberland, with at least three more sites in Cumbria. Dormice are now either absent or very thinly distributed in most midland and many southern counties. In Wales dormice have been found in a few widely separated areas in every county except Anglesey (Jermyn, Messenger & Birks 2001). Although it is still uncommon, the dormouse appears to be relatively widespread in southern English counties but, because of its specialised habitat requirements, it is never as numerous as woodland rodents such as the wood mouse *Apodemus sylvaticus* and bank vole *Clethrionomys glareolus*. Even in counties where it is widespread, the dormouse has a very patchy distribution. It is particularly associated with deciduous woodland, but also occurs widely in species-rich hedgerows and scrub and sometimes in other woody habitats. The total adult population is now thought to number about 45,000 (Battersby 2005), distributed among a variety of widely fragmented sites.

Hazel dormice are sensitive to weather and climate, both directly and indirectly, through their specialised feeding requirements. They are particularly affected by habitat deterioration and fragmentation and also by inappropriate habitat management. For these reasons, they are highly vulnerable to local extinction. They are consequently good bioindicators of animal and plant diversity: where dormice are present, so are many other less sensitive species. The successful maintenance of viable dormouse populations is a significant indicator of an integrated and well-managed countryside. Their continued presence is therefore highly desirable.

Dormice have full legal protection, and their presence must be taken into account when habitat changes are likely as a result of development or changes in woodland management.

This publication is intended to be a practical guide for specialists. Its purpose is:

1 To provide guidance for woodland managers and others wishing to promote dormouse conservation by active management of suitable sites and habitats.

2 To provide guidance for developers, foresters and other land managers, whose activities may impinge on dormouse habitats.

3 To provide a range of specialised references and contact points for those who wish to know more.

1.2 Organisational framework and support

In the context of dormouse conservation management and the licensing of activities likely to affect this species, the key statutory organisations are English Nature, the Countryside Council for Wales (CCW), the Forestry Commission, relevant sections of Defra (and the Welsh Assembly Government) and Local Authorities, particularly their planning departments. However, dormice also receive considerable support from non-governmental organisations, many of which are engaged in dormouse survey, conservation and monitoring activities. Considerable scope exists for fruitful co-operation with these bodies, perhaps avoiding unnecessary duplication of effort and actively advancing the conservation of dormice. Further details of organisations involved in dormouse conservation are given in Chapter 10, and details of legal protection in Chapter 6.

2 Introduction to dormouse ecology

2.1 Understanding dormouse habitats and ecology

Although traditionally associated with hazel, dormice actually occur in a wide variety of woody habitats, ranging from ancient semi-natural woodlands with hazel coppice and standard oaks, to species-rich scrub. They are also increasingly reported living in hedgerows, areas of plantation conifers and rural gardens. They may even be found occasionally in heathland Culm grassland and other habitats where these occur close to woodland. Some of these sites may well comprise sub-optimal habitat, with low densities of dormice present, but others often harbour significant numbers. Their absence should not be assumed simply on the basis of a 'non-typical' habitat.

In order to understand the potential effects of management or development work on dormice and to help plan effective management or mitigation measures, it is essential to understand the ecology of these animals. It is not possible to offer 'one size fits all' prescriptions for action in every circumstance. Instead, by understanding the principles underlying dormouse ecology, and the reasons why they have become nationally rare, it should be possible to adjust proposals to fit local situations. English Nature and Planning Authority staff may also find this approach helpful. Specialist consultants should gain deeper insights through their own fieldwork or by attending suitable training sessions (organised by The People's Trust for Endangered Species and/or The Mammal Society). However, this section is not intended to be a comprehensive review of dormouse biology and sources of more detailed information are listed in the bibliography (Chapter 12).

Only part of the 1.3 million ha of woodland in England and Wales is currently known to have dormice and some (for example, wet carr or woods at high altitude) are very unlikely to be suitable. Coppice woodland is generally perceived as potentially optimal for dormice but represents only 20,000 ha of the 700,000 ha of ancient or semi-ancient woodlands. A further 160,000 ha of ancient woodland was converted during the 20th century to plantations of conifer (50 per cent), broadleaf (28 per cent), or mixed woodland (22 per cent). Plantations that are not recorded as ancient woodland sites make up another 300,000 ha, and consist mostly of conifers. Dormice can inhabit Plantations on Ancient Woodland Sites (PAWS) and also new plantations, even quite small ones, especially if they are strongly linked to other suitable habitat including scrub, bramble or gorse.

The dormouse is a nocturnal animal that lives mainly in deciduous woodland and scrub, where it feeds among the branches of trees and shrubs. Except for hibernation, it rarely descends to the ground and is reluctant to cross open spaces, perhaps because of the danger posed by owls and other predators. It feeds on a wide variety of arboreal foods (Richards and others 1984), including flowers (nectar and pollen), fruits (berries and nuts) and some insects (especially aphids and caterpillars). They will also eat buds and young leaves, but cannot efficiently digest large amounts of mature leaves as they lack a caecum in their digestive system. In the autumn there is abundant food in the form of berries and nuts, but these are not generally ripe before about August. So, in the early summer, the dormouse must move from one tree species to another as the different flowers become available. When these are over, but fruits are not ready, there is a period of potential food shortage. At this time, insects may become important in the diet, but insects (particularly aphids and caterpillars) are also consumed at other times. It follows that a high degree of diversity among tree and shrub species is desirable in order to ensure that an unbroken sequence of foods is available throughout the summer. Certain tree species are particularly valuable as providers of food at different times of year (see Table 1). Hazel appears to be an important provider of insects, and its nuts form the main food used to fatten up for hibernation. Where hazel is scarce or absent smaller fruit seeds, such as those from hornbeam or blackthorn sloes (Eden & Eden 2003) may suffice, but offer less food in exchange for the gnawing needed to open them.

Table 1 Trees and shrubs of value to dormice

Hazel	Where present, this is the principal source of food (nuts) for fattening up prior to hibernation. Hazel also supports many insects, including caterpillars, which are potential dormouse food. Hazel forms a continuous understorey of sprawling poles, easy for arboreal activity and is a very valuable (but not essential) species for the dormouse.
Oak	An important source of insect food (including caterpillars). Dormice also eat oak flowers, but acorns are of little value.
Honeysuckle	The plant's finely shredded bark is the preferred nesting material used by dormice. Honeysuckle flowers also provide food at a time when few other things are available, with berries later. The climbing strands also offer convenient routes into the trees and provide dense shelter in which to nest.
Bramble	Its flowers and fruits are very important dormouse foods and tend to be available for a long period (especially where the site has slopes which vary the amounts of sunlight on the shrubs) and the thorns provide good protection for nests. Bramble often flowers late, when many other species are over and dormice also eat the berries and seeds in autumn. Dormice seem to thrive where blackberries are abundant, even in the absence of hazel. Bramble is best if scattered among hazels and trees.
Sycamore	A valuable source of insect food and pollen. A useful tree: dormice can survive in habitats with many sycamores. However, sycamores cast a dense shade which reduces the understorey. Thus sycamores should be kept few and scattered, perhaps coppiced to prevent seeding and to reduce the extent of shading.
Ash	Ripening seeds ('keys') are eaten whilst they are still on the tree, but ash supports few food insects. The canopy does not cast a dense shade, but generally ash woodlands are not good habitat.
Wayfaring tree	Fruits in late summer when little else may be available. Dormice eat the seeds and probably also the flowers.
Yew	The fruits are a favoured food and dormice will make special excursions to reach them, but the seeds are not eaten.
Hornbeam	Seeds are small and hard, but dormice eat them. The advantage is that they are too small to be attractive to squirrels, so they may form an alternative food where squirrels have taken most of the hazel nuts. Fruiting is erratic.
Broom	Flowers are eaten in early summer.
Sallow	Unripe seeds are eaten from the flowers in early summer. Sallow also supports many insects.
Birch	The catkins are over too early in the year to be much use to dormice, but they can eat the seeds. These are too small to attract squirrels and may provide support where squirrels compete for hazel nuts.
Sweet chestnut	Chestnuts are an excellent food source and dormice may also eat the flowers.
Blackthorn	Fruits (kernels) are eaten but the flowers come too early in the year. Dense blackthorn thickets tend to be avoided where alternative shrubs are available.
Hawthorn	Flowers are an important food in the spring. The fruits are eaten occasionally.
Conifers	Little is known about the use made of these trees by dormice, but they often support many aphids and caterpillars – potential dormouse food. The trees may also provide shelter from the wind and rain in exposed sites.
Other species such as cherry, crab apple, holly, ivy.	Little is known about the value of these trees to dormice, but it is likely that they will eat the pollen (stamens) and perhaps fruits. Ivy is a useful source of food insects and its evergreen tangles among tree branches are often used for summer nesting sites.

In addition to hazel, oak, bramble and honeysuckle are especially valuable food sources, but dormice can survive without at least one of them if an appropriate substitute is available. Most good dormouse sites will have most of these species, but the absence of any, or even all, of them is not evidence that dormice are also absent. Nevertheless, the association between dormice and hazel is particularly strong and is recognised by the animal's Latin name '*avellanarius*', which means 'hazel'. The majority of dormouse sites include hazel, but this does not mean that dormice occur only where it is present. On the contrary, they can sometimes be found living among other woody species, even conifers. They also occur in species-poor habitats such as areas of secondary growth dominated by sycamore. However these sites often constitute sub-optimal conditions in which the population is likely to have arrived relatively recently and may not be secure in the long term as the habitat matures. The occurrence of dormice in such sites, and even occasionally in gardens, should not imply that these are core habitats, nor distract from the need for appropriate conservation management elsewhere.

Dormice do not normally travel far from their nest (usually less than 70 m), so the different trees and shrubs necessary to maintain a sequence of foods through the seasons must be present within a small area. This implies that a very mixed habitat is desirable. Dormice are highly arboreal, so it is also important that the animals should be able to move easily from tree to tree without coming to the ground, and that they should be able to climb between the understorey and canopy without difficulty. A continuous shrub layer is ideal, especially where there are a few larger canopy trees. It is essential that the tree canopy does not cast too much shade. Heavy shading means the understorey will fail to fruit vigorously and may even be suppressed, reducing or removing key sources of dormouse food. As a rule of thumb, if visibility in high summer at eye level is more than about 20 m, the shrub layer is likely to be thinning out, and deteriorating as dormouse habitat. Conversely, the best woodland habitats are usually in dense understorey thickets (where visibility is severely restricted), especially those incorporating hazel. Dense thickets offer three-dimensional arboreal routes through the habitat, providing access to the tree canopy and a vital alternative to activity on the ground. Scrub and sprawling hedgerows often meet these criteria and benefit from full exposure to sunshine, maximising potential dormouse food and often supporting substantial populations.

Thus it is important that the physical structure of the habitat is appropriate as well as providing a sufficient variety of woody plants to supply a succession of foods as each becomes seasonally available. Although tall, shaded spindly growth can sometimes support dormice, it is a poor habitat for them compared to an open tree canopy over well-lit dense shrubs which is ideal. The best canopy trees are oaks, with hazel and bramble providing the best understorey so long as shading is not heavy enough to compromise their fruiting. Radio tracking studies suggest that in northern sites, the vegetation is less productive, forcing the dormice to enlarge their home range in order to obtain sufficient food. This uses up more energy and adds to the problems they face from inclement weather conditions and lower ambient temperatures.

Although they may weave their own nests (up to the size of a grapefruit) in bushes and shrubs, dormice prefer to use more robust resting places such as hollow tree branches, squirrel dreys and old bird nests. Tree hollows tend to be scarce in British woodlands particularly in coppice, in young plantations and in the vigorous undergrowth that provides the best feeding areas for dormice. Hence there is a need for older trees and shrubs with hollows and rotten branches to be available. Hollow tree stumps and coppice stools may also be used as hibernation sites. Nest boxes are a particularly attractive substitute for natural tree holes and, where boxes are provided, a high proportion of the dormouse population may use them. Provision of nest boxes can increase the local population density, suggesting that the availability of nest holes may be one of the factors that limit dormouse numbers. However, nest boxes are not normally used for hibernation.

Summer dormouse nests have also been found in bat boxes and bird nest boxes. Where such boxes are provided for the conservation of rare bird and bat species, it would be advisable to either increase the number of boxes to ensure that there is a surplus or put out dormouse nest boxes as well.

Dormice have a patchy distribution, even within the same woodland. This may be associated with patchiness in food supplies, but might also be a result of social or territorial behaviour. Male dormice are territorial in the breeding period (May to September) and may attack each other, so the population tends to be spread thinly. Even the best habitats may not support more than about four adult males per hectare. Females give birth to (usually) four or five young, from early June until September (but mainly in July or August). The young remain with their mother for up to two months, delaying her production of a second litter. If young are born too late in the summer they may be unable to reach a viable weight of 15g by late October before hibernation is forced upon them.

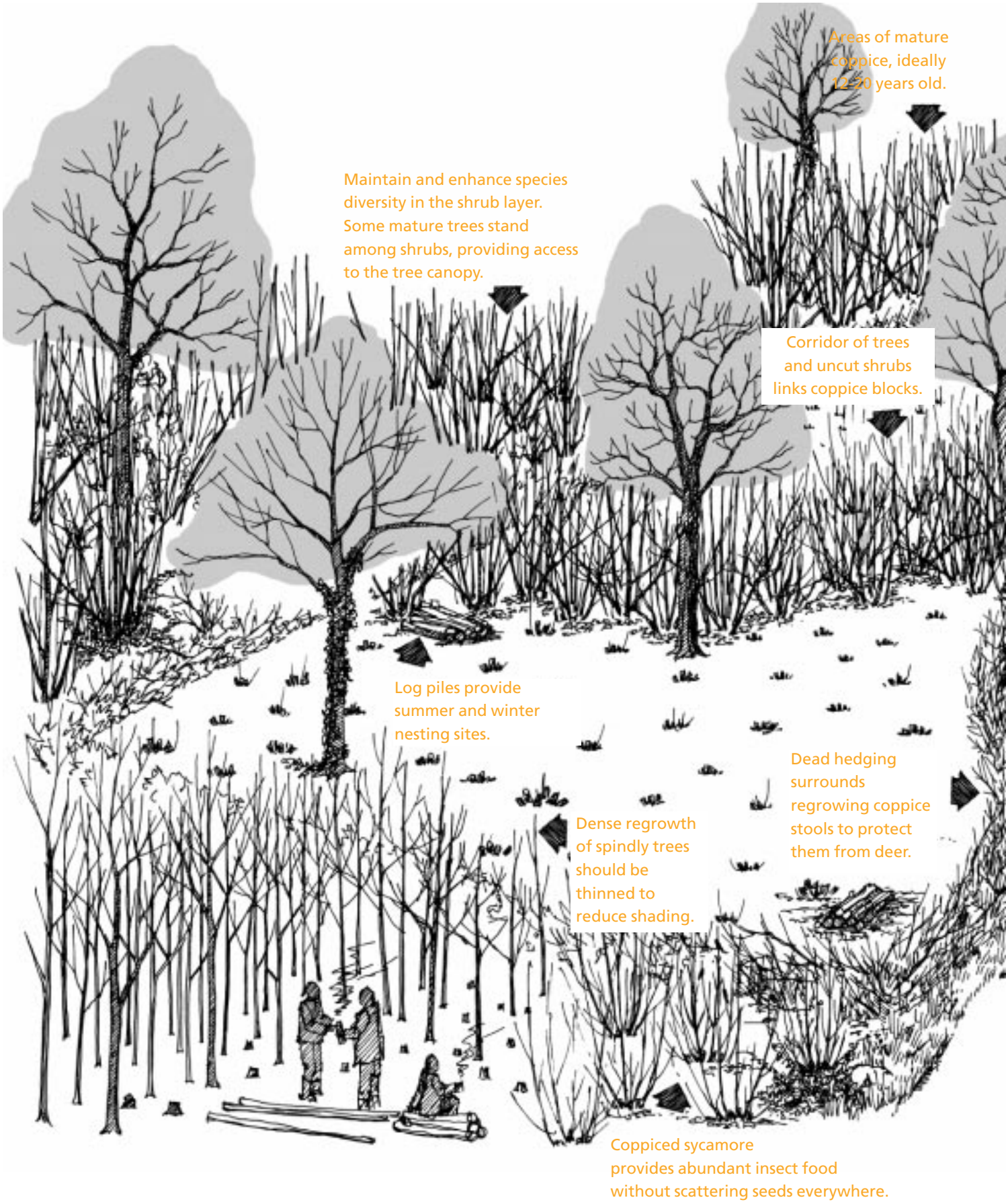
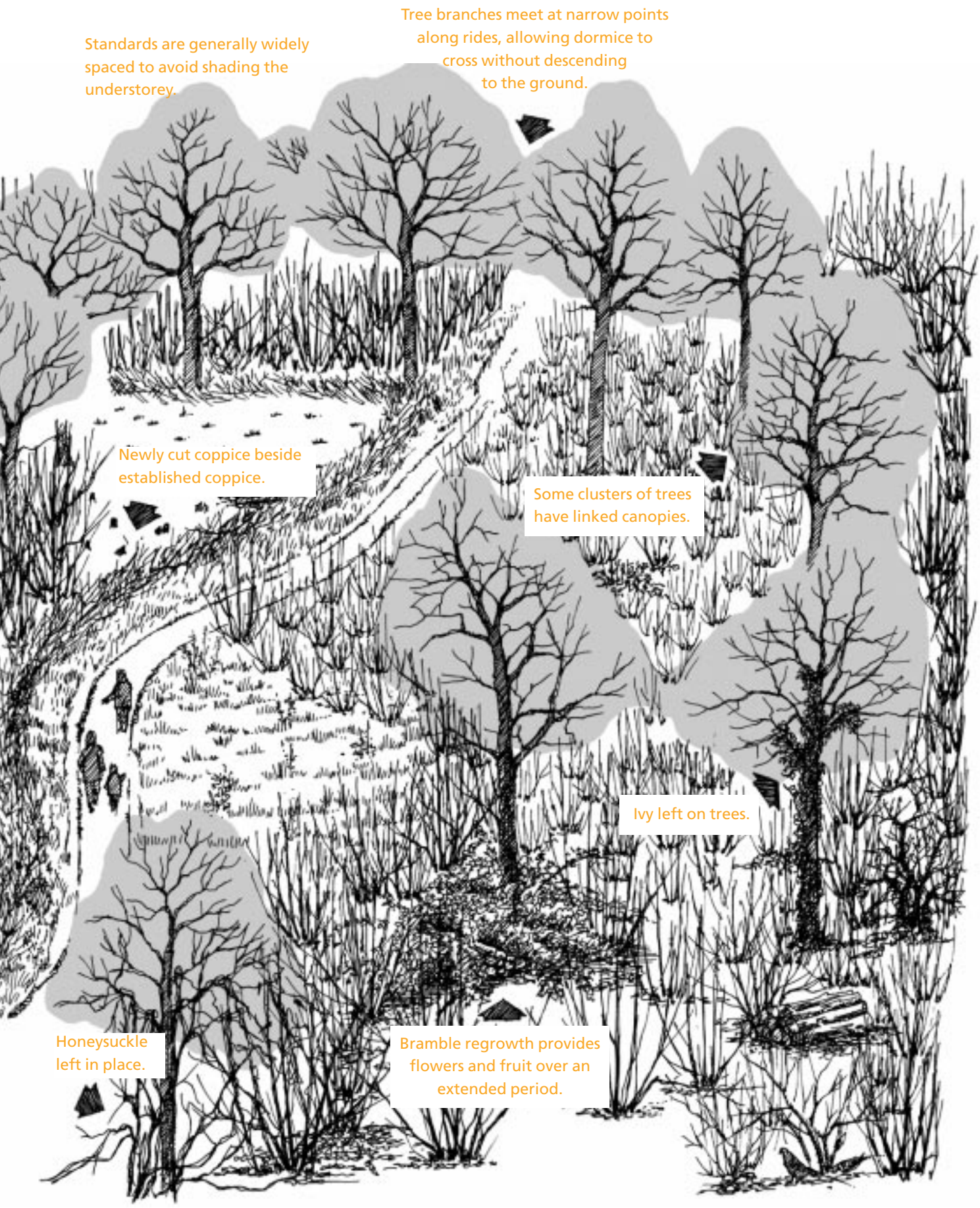


Figure 2 Features of good dormouse habitat management. The best habitat for dormice is in actively coppiced ancient woodland that maintains a rich herb and shrub layer below an open canopy.


Standards are generally widely spaced to avoid shading the understorey.
Tree branches meet at narrow points along rides, allowing dormice to cross without descending to the ground.
Newly cut coppice beside established coppice.
Some clusters of trees have linked canopies.
Ivy left on trees.
Honeysuckle left in place.
Bramble regrowth provides flowers and fruit over an extended period.

It is unlikely that such small juveniles will survive the winter, having run out of fat reserves before effective feeding becomes possible again in the spring. Thus, although some females may breed twice in a season, it is unlikely that they will raise more than one litter per year. The age of the young – in days – may be estimated by taking their mean weight (up to 8 g), subtracting 1 and dividing by 0.16 (see Chapter 8). Sometimes females may aggregate their families into a crèche, with up to nine young present at once. Individual males may share the same nest box with the same female in two successive years, implying a long-term pair bond and perhaps more complex social behaviour than is normal for small rodents.

During the winter, when little food is available, dormice save energy by going into hibernation. Having spent all the summer in trees and shrubs, they now descend to the ground and stay there all winter. A small tightly woven nest is made and the animals usually spend the winter there alone. They hibernate under logs, under moss and leaves or among the dead leaves at the base of coppice stools and thick hedges. Dormice choose a moist place to hibernate, where the temperature will remain cool and stable and the humidity high. Cool conditions are vital as metabolic processes are slowed at lower temperatures and fat reserves will then last longer. Damp conditions are also necessary because water vapour is lost during the animal's breathing. Hibernating in a moist place will ensure the animals do not desiccate during the winter, as they do not wake up and drink regularly.

Hibernation begins when the nights become cool in the autumn and there is little food left in the trees, generally around the time of the first frosts. Larger dormice (weighing up to 40 g) appear to enter hibernation earlier, while smaller animals continue to feed until later in the autumn. These may remain active until December in mild years, especially in the south of England. Once in hibernation dormice do not usually leave their nests until the following spring (other hibernators such as bats and hedgehogs often move about and feed during the winter months). Dormice do not normally hibernate successfully in nest boxes because the temperature inside is too variable.

During cool or wet periods in summer, dormice may spend several hours a day in a state of torpor. In early summer, more than nine hours per day may be spent in torpor, although by autumn the average time is less than half an hour. The animals become moribund and inactive as the body cools, with their normal temperature (similar to our own) falling to little above that of their surroundings. The torpid animal is tightly rolled up with the tail curled over its belly and face. Torpor economises on energy expenditure, but at the cost of delaying breeding, often until long after other woodland mammals have already raised young. Early in the season, dormice may go torpid in flimsy nests, from which they are easily dislodged by the wind. It is not uncommon to find a torpid animal lying on the ground in the open, on a footpath for example. In such cases the animal is best moved to nearby shelter and allowed to wake up and look after itself.

Dormice are highly sensitive to the weather and on cold nights will abandon their nocturnal feeding early. A 5 °C fall in air temperature may result in feeding activity being curtailed by an hour or more. In addition, dormouse fur is very fine and poorly suited to throwing off water droplets, so rain and drizzle are a danger to these animals, whereas mice and voles, with a different fur structure, are better adapted to cope. In the autumn, when nights are cold (below 9 °C

Figure 3 Hibernation nest. After being arboreal all summer, dormice retreat to the ground to hibernate. They weave a tight ball of grass or other fibrous material and pass the entire winter hibernating in the same place. Hibernation sites are chosen that are cool and moist, such as under moss or leaf litter, in coppice stools or under brushwood.

at midnight), dormice will often compensate for reduced nocturnal activity by coming out during the day. The unpredictable British climate thus affects dormice directly, but it also has indirect effects through their food supply. Warm sunshine stimulates the flow of nectar, helps to ripen fruits and speeds the growth of insects, all providing richer food supplies. Conversely, cool, cloudy conditions retard the production of dormouse food. In some years the majority of summer days may be dominated by cool, wet 'westerly' weather conditions, probably affecting the ability of female dormice to raise their young and also reducing the viability of independent juveniles. This may limit their success, especially in northern areas at the edges of their natural distribution, on higher ground and in more exposed sites. In such places good habitat management becomes even more important.

It is likely that a succession of bad years, with inclement weather and poor breeding success, has created a series of historical bottlenecks in the dormouse population. This would be particularly dangerous for small isolated groups of animals, whose numbers may then be reduced to a non-viable level, resulting in local extinction. This is likely to have happened more often in the north of England than the south (where weather conditions are generally more favourable), and it is in the north that the greatest contraction in dormouse distribution has occurred and where dormice are still declining. The same principles apply in microcosm to hilly sites. Habitats on south facing slopes are likely to be better for dormice than those with a shaded, northerly aspect. Narrow valleys, particularly with a north-south orientation where daily exposure to direct sunshine is brief, are likely to be inferior habitats compared to more gentle slopes. However, a varied local microtopography may be advantageous because the diversity of conditions and variation in exposure to sunshine will result in extended fruiting and flowering seasons, providing dormice with more feeding options.

2.2 Dormice in other habitats

The best conditions for dormice are to be found in extensive ancient semi-natural woodland, where there has been time for shrub species diversity to develop, and where coppicing of hazel is carried out on a long rotation. This appears to constitute the species' core habitat, especially where shrubs flourish in clearings and around woodland edges. However, this does **not** mean that dormice occur nowhere else, nor does it imply that other habitats are necessarily poor. Indeed, some types of scrub, young plantation and hedgerow offer excellent conditions, partly because they are unshaded and highly productive. Such sites may temporarily even have more dormice than an equivalent area of ancient semi-natural woodland. Occasionally dormice are found in gorse scrub, heathland and even in alder trees among reeds. They have also been found in gardens among honeysuckle or hibernating in clumps of pampas grass. However, these unusual occurrences should not distract from focussing on what is normal. At the same time, the exceptions indicate a need to be aware that dormice do occur in a wide variety of sites and the need for survey and consideration should not be overlooked simply because the habitat comprises something other than ancient semi-natural woodland. Moreover, the occurrence of dormice in 'non-typical' habitats may indicate the presence of a thriving population of these animals in adjacent areas.

2.2.1 Scrub

In some areas dormice can be found flourishing in scrub (Eden & Eden 1999), but such habitats tend to be relatively ephemeral (being succeeded by high trees in time). Scrub also often develops as a successional advance on previously open ground when, for example, grazing ceases. Where such sites are isolated by open ground, they are less likely to become colonised by dormice, irrespective of their habitat quality. Moreover, where succession takes place on open ground, the trees or shrubs tend to be of similar age and grow at high density. For some years, this may form good dormouse habitat, but in time, competition for light and space among the shrubs and saplings often results in tall, spindly growth. After about 10 to 15 years, this may begin to offer poor potential for dormice and the dense shade cast by the taller trees may reduce the viability of the understorey. Nevertheless, scrub can provide excellent conditions for dormice.

2.2.2 Conifers and plantations

Despite the importance of shrub diversity and abundant sunlight, dormice are sometimes discovered (frequently so in some areas) in the relatively uniform conditions of plantations, particularly where these constitute Plantations on Ancient Woodland Sites (PAWS). Surveys indicate that dormice may occur in up to 85 per cent of PAWS that have hazel present. Often the dormice occur where conifers have been planted into existing deciduous woodland or scrub and they may be persisting despite increased shading as the conifers grow. Plantations that are at the scrubby pre-thicket stage or have not been 'cleaned' (that is, broadleaves removed during thinning) probably have a much higher chance of having dormouse populations. However, some sites appear to support dormice in the virtual absence of deciduous trees and shrubs. It is difficult to see how they manage, but certain softwood species may well support sufficient insects (aphids and caterpillars for example) to sustain a small dormouse population in the absence of more conventional food. It is also possible that dormice can make use of sap as a food source in such habitats.

It is important not to assume that dormice will be absent from plantations and conifer-dominated habitats (especially where some deciduous species are present). Nevertheless, nationwide, their presence is unusual and is especially unlikely in upland conifer plantations. It is current policy for conifers to be removed from many ancient woodland sites and the possibility that dormice may be present should not be overlooked. Suggestions for appropriate survey and management are described later.

2.2.3 Hedgerows

Dormice also live permanently in some hedgerows which provide a continuity of foods throughout the active season. If they are unshaded, hedgerow shrubs often fruit well and thus offer abundant food for dormice. Hedges are also important dispersal routes, a vital lifeline linking dormouse populations in small copses. The best hedges are those with a high shrub diversity, a feature of ancient hedgerows, although some recent hedges may also be very diverse. Hedges need to be cut regularly if they are to remain tight and stock-proof, but cutting every year drastically reduces the availability of flowers and fruits (for example hawthorn) that are borne on new wood. Even cutting at 5-year intervals may remove most of the fruiting hazel. However, unmanaged hedges become outgrown and often develop gaps, reducing their value as dispersal routes. Probably the best compromise is to cut only short sections of hedge at a time, or perhaps alternate sides of the hedge at 3 to 5 year intervals (though this may not be practical in many circumstances).

2.3 Problems with small population size

Dormice live at low numbers, even in the best habitats. In early summer there are typically only 3 to 5 (but sometimes up to 10) adults per ha in deciduous and conifer habitats. The National Dormouse Monitoring Programme suggests an average of between 1.75 and 2.5 adults per ha based on 83 sites in various habitats, with the lowest densities in the north of England (1993 to 2000 inclusive; Bright & Sanderson, pers. comm.). Across the country, including sub-optimal habitats, the average population density is only about 2.2 per ha. Thus small woods will contain few dormice, perhaps not enough to constitute a viable population unless the site is connected to a larger area of habitat.

Table 2 Small mammal population densities (pre-breeding numbers of adults per ha). Autumn densities may be several times higher.

Species	Habitat	Mean spring density (individuals per ha)	Source
Dormouse *Muscardinus avellanarius*	Optimal habitat (diverse deciduous woodland with abundant scrub and vigorous understorey)	4 to 10 adults	Bright, pers. comm.
Dormouse	Oak dominated woodland, with hazel	2 adults, increased by 48 per cent by appropriate management	Bright & Sanderson, pers. comm.
Dormouse	Scrub	unknown	
Dormouse	Conifer woodland	1 to 3 adults	Trout, pers. comm.
Dormouse	Hedgerow	1.3 adults	Bright & MacPherson, 2002
Wood mouse (*Apodemus sylvaticus*)	Deciduous woodland	40 plus	Corbet & Harris, 1991
Bank vole (*Clethrionomys glareolus*)	Woodland	Up to 130	Corbet & Harris, 1991

Nobody knows how few is too few, but clearly a 'population' of less than about 20 animals, only half of them females, is very vulnerable to chance extinction as a result of accidents, inbreeding or poor breeding success. Small woods of less than 20 ha often provide excellent habitat (because of lack of shading and large areas of shrubby edge habitat), but if they are not linked to other sites nearby they probably contain too few dormice to sustain a permanently secure population. Even with good habitat, surveys show that woods smaller than 20 ha are less likely to contain dormice than larger sites, unless they are linked to other areas of suitable habitat. Fragmentation of large sites is therefore damaging and it is important that if small patches of woodland are created as a result of development projects or road construction, for example, then remnant woodlands should be linked by woodland strips or hedgerows to facilitate dispersal and effectively increase the continuous population of dormice. Isolated woods, even quite large ones, are likely to lose their dormice in time. Species-rich hedgerows offer good habitat and may be an essential means of dispersal between woodland sites, reducing the isolation effect of small woods, as well as providing suitable habitat for permanent occupation. However, dormice will cross open ground occasionally, so it should not be assumed that small sites lack dormice simply because they are isolated.

Table 3 Major threats to dormice.

1	Decline in coppice management	Ultimately results in heavy shading, suppression of regrowth and death of the understorey where the dormouse obtains most of its food at certain times of the year.
2	Heavy shading and lack of thinning	Canopy trees compete for the light, suppress the understorey and create a dark woodland with tall spindly trees and little dormouse food; generally an unsuitable habitat for dormice.
3	Loss of woodland habitat	Many areas of diverse ancient woodland have been felled and replaced by farmland, roads and urban developments. Replanted woodland has fewer tree and shrub species present, and these trees and shrubs will be of a similar age. Planted conifers sometimes support dormice.
4	Habitat fragmentation and consequent isolation woods	Large areas of woodland have been progressively dissected into smaller and smaller copses, by roads and other developments. These woodland fragments often contain too few dormice to be considered viable populations. The remaining habitat is left in isolated blocks, often with no woodland or hedgerow connections that would allow the dispersal and exchange of animals between local populations. Populations of dormice in isolated sites are likely to suffer from inbreeding in the long term.
5	Loss of species-rich, infrequently-cut hedgerows	Destroys habitat suitable for permanent occupancy. Removes important food-producing dispersal corridors between woodland sites.
6	Deer and squirrels	Browsing by deer (and domestic stock) damages shrubs that provide dormouse food. In extreme cases suppression of woody regeneration results, leading to the elimination of dormice. Squirrels compete for food, but how seriously this affects dormice is not known.
7	Climate change and unpredictable weather	Variable and unsuitable weather reduces breeding success and survival, making extinction more likely if other factors are less than ideal. This is likely to be a particularly sensitive problem in northern counties, at sites with higher elevations and in exposed sites. Bad weather, leading to poor breeding success seriously threatens small isolated populations. Three bad years in a row may be sufficient to cause local extinction. The effects of future climate changes are difficult to predict.

3 Finding signs of dormice and monitoring numbers

3.1 Predicting the presence of dormice

For sites within the distribution range of the dormouse, the only certain way of determining their presence is by survey, using the methods described below. Dormice have been found in small woods (even down to 2 ha where other suitable habitat is adjacent) and in woodland traditionally considered as unsuitable, for example conifer plantations on new sites. These populations should be encouraged, especially on the fringes of the UK dormouse range. In some areas, dormouse survival is apparently dependent on conifers in the absence of other woodland. Dormice could potentially occur in any woodland area, but certain factors affect that likelihood. This simple guidance is important both for sites with primarily timber-growing objectives (where normal cost-effective forestry operations will necessarily be carried out) and for sites with primarily wildlife conservation objectives. In the absence of an existing survey, a preliminary judgement based on the information in Table 4, supplemented by local knowledge, may be made. Dormice may be found in woods with several poor characters or are regularly moving in from an adjacent good habitat. If dormice are known to be present in all, or part, of a contiguous habitat, they are also likely to be present in neighbouring areas of connected woodland, scrub etc. (even where these appear to be suboptimal habitat).

3.2 Finding evidence of dormice

The presence of dormice should be assumed in any areas of woody habitat (including plantations, hedgerow and scrub) within their range (see Figure 1), particularly in the south of England.

Where development or land-use change is proposed, only in very limited circumstances will it be acceptable to submit mitigation plans based on little or no survey work. An example would be where the habitat is both clearly inappropriate and where the development's impact is likely to be negligible. Surveys should normally be undertaken to detect actual presence or demonstrate likely absence. No area of woodland should be presumed to lack dormice, except very small unsuitable copses of less than 10 ha in extent which have poor habitat **and** are separated by at least 500 m from the nearest suitable habitat. However, since dormice are known to occur in some types of amenity woodland, conifer plantations and scrub, as well as deciduous forest, **the survey process should not be eliminated solely on the grounds that the habitat is 'unsuitable'**.

Where local surveys are undertaken in order to find new localities, enquiries among cat owners, farm workers and through the local newspaper may elicit useful information. Pictures of dormice should be used in order to avoid following up reports based on mistaken identification. Owl pellets rarely contain dormouse remains (less than 1 per cent of all owl prey items in Britain), but skulls can be easily identified as the teeth have distinctive transverse ridges, not knobbly surfaces as in mice, or bold zigzag patterns as in voles. Dormice also have four cheek teeth, not three as in mice and voles. Where specific sites need to be surveyed, suitable methods should be employed.

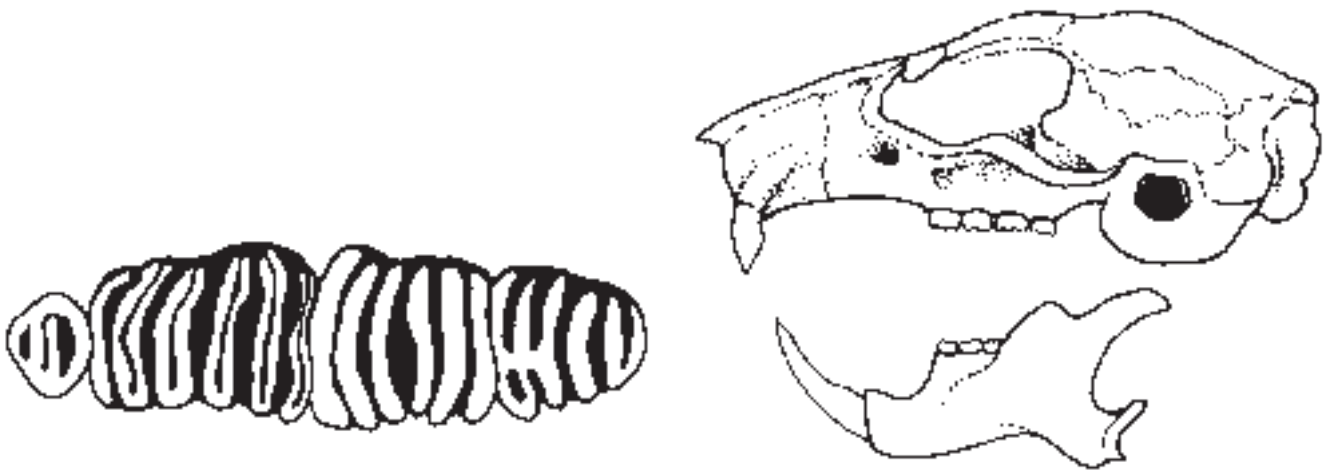
3.2.1 Traps and baiting points

Dormice do not normally enter small mammal traps (for example, Longworth traps), even where these are set in trees. American Sherman traps, baited with apple, are more successful (but expensive) and wire mesh cage traps are better still (Morris & Whitbread 1986). Traps can also be made from plastic rainwater pipe (details from the Vincent Wildlife Trust). However, traps must be visited at least once every day (unlike nest boxes or nest tubes). Trapping is both time consuming and relatively unproductive, as dormice live at low population densities. It is therefore an inefficient survey tool and not recommended. Trapping requires a licence from the appropriate authority (English Nature or the Countryside Council for Wales).

Table 4 Factors affecting the probability of dormice being present on a woodland site within their known range. This includes ancient woodland sites, Planted Ancient Woodland Sites (PAWS) and modern broadleaved or conifer plantations

Increased probability	• Large woods: area over 50 ha – very likely; at least 20 ha – likely; between 2 and 20 ha – possible. • Adjacent to ancient woodland or PAWS (including conifer), scrub or early successional stage woodland, including conifer. • Wide range of broadleaved species present, including some fruiting, either in patches, scattered or at the edge. • Wide range of ages of trees. • Species-rich shrub layer, especially with hazel, honeysuckle or bramble. • Species-rich edge strip or ride sides. • Thick, wide hedgerow connections to nearby suitable woodland. • Contains hazel or sweet chestnut coppice – ideally managed in small coupes. • No thinning history (for conifers).
Decreased probability	• Small wood, especially if mostly conifer. • Old conifer plantation subject to multiple thinning. • Isolated from other woodland or adjacent only to older conifer plantation already subjected to multiple thinning. • Little or no shrub understorey. • No fruiting broadleaved trees. • High local deer population suppressing most regeneration. • Presence of cattle, sheep or pigs. • Seasonally waterlogged ground. • Derelict coppice or clear-felled in very large coupes (that is, blocks of woodland) relative to the woodland area. • Site more than 300m above sea level.

Figure 4 Dormouse skull and teeth. Dormice have a typical rodent skull with four molar teeth. The transverse ridges are distinctive.



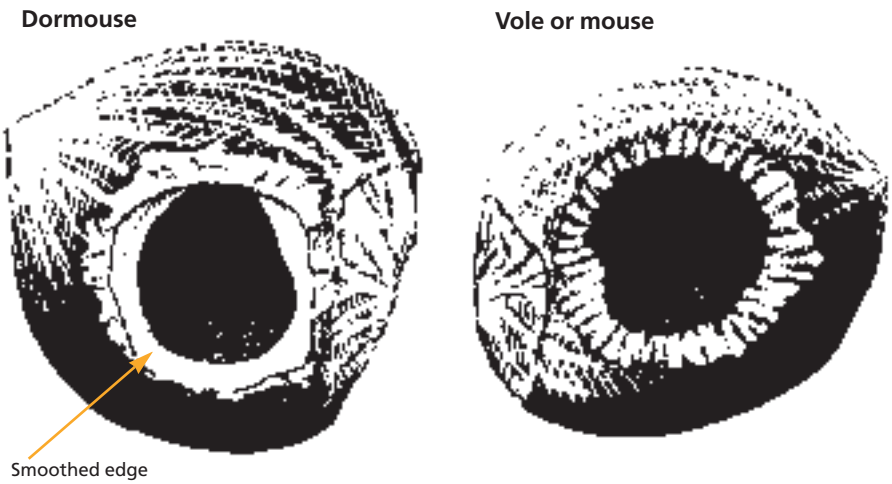


Figure 5 Gnawed hazel nuts. Dormice leave a smooth round hole with few toothmarks on the surface. Mice and voles may also leave a round hole, but with transverse toothmarks on the cut edge.

Baiting points can be set up (for example, in cardboard milk cartons fixed to trees and supplied with pieces of apple). Dormice may feed here and leave distinctive droppings which are usually larger and more crinkly than those of other small rodents. The problem is that positive identification of faecal pellets requires experience and is not fully reliable. Milk cartons are not very durable and the apple bait needs frequent renewal. This survey method is not recommended.

3.2.2 Gnawed hazel nuts

The best way to establish dormouse presence at a site is to look for gnawed hazel nuts (see illustration for diagnostic features). Although this is obviously impractical where hazel is absent, it is worth searching any adjacent areas with hazel to see if dormice are nearby and thus likely also to be present on the site under investigation. Several species of rodents open hazel nuts, but only the dormouse leaves a smooth round opening. Dormouse tooth marks will be found around the rim of the hole, smoothing it out, with a few tooth marks on the nut surface. There are no transverse tooth marks across the rim of the nut shell. Dormouse tooth marks may be visible to the naked eye, but use of a magnifying glass is recommended. Mice and voles also gnaw holes in nuts, but these are generally irregular in shape and have a different pattern of surrounding tooth marks. However, most hazel nuts are opened by squirrels which shatter them and leave a sharp, jagged and irregular opening to the nut. Squirrels will also split nuts in half or slice off portions of the shell, leaving a large (usually oval) hole. Small round holes (only 2 mm diameter) are the work of weevils burrowing out. Nuthatches and other birds may peck holes in nuts, but they are irregular in shape and often splintered at the edges, not smooth. Where whole slices of nut shell have been removed, tiny pores (like pin pricks) are often visible in the cut edges. This is clear evidence that the nut was not opened by the gnawing action of small rodent teeth, which tends to obliterate these minute pores.

Dormice gnaw nuts up in the canopy, dropping shells to the ground below. Their nuts will therefore tend to be scattered and more often found below the hazel canopy rather than close to the base of a tree or shrub. Mice and voles often collect nuts into caches, dormice do not. Casual searching for nuts is often sufficient, but a systematic search makes it easier to be confident that an absence of shells is due to absence of the animals rather than accidental failure to find the characteristically gnawed nuts.

To conduct a systematic search select an area of heavily fruiting hazel and search a square of ground measuring 10 m x 10 m for 20 minutes. If no dormouse nuts are found, repeat the process in another part of the site. There is an 80 per cent probability that, if dormice are present, the characteristically gnawed nuts will be found by the time three such squares have been searched (Bright, Mitchell & Morris 1994). If five squares fail to yield dormouse nuts, it is about 90 per cent certain that dormice are not present, although this is still not proof of absence from the site, especially in the north where dormice are particularly sparse. Heavy nut consumption by squirrels can result in ‘false negatives’, so where relatively few nuts (less than 100) are found that have been opened by species other than squirrels – and none have yet been found opened by dormice – it is appropriate to increase survey effort by searching up to a further five squares.

An alternative way of achieving an adequate sampling intensity (W. Cresswell, pers. comm.), is to collect 100 hazel nuts that have been opened by small rodents (voles and mice, but avoiding caches made by these species and also ignoring nuts opened by squirrels). If this sample contains no nuts that have been opened by dormice it is highly probably that dormice are not present.

Fresh hazel nuts show tooth marks much more clearly than older ones. It is thus best to carry out nut searches from about mid-August (when the nuts first accumulate on the ground), and preferably before Christmas. Hazel nuts will persist on the forest floor for over a year, but gradually decay so that tooth marks become progressively less distinct and it is harder to decide which species gnawed the nut.

Searches carried out after about Easter may need increased search effort to be effective, owing to the increasing proportions of nuts in which the characteristic tooth marks cannot be recognised with confidence.

Sometimes there is too little heavily-fruiting hazel to conduct the kind of surveys described above In these cases it is appropriate to check other locations more suitable for nut searches that are connected to the site by features along which dormice would be expected to move (for example, hedgerows). Should these prove to harbour dormice, then a precautionary approach should be taken to the site being investigated. This approach has particular merit when dealing with linear development schemes such as pipelines or new roads, which may affect large numbers of features such as hedgerows, patches of scrub and belts of woodland, all of which could be used by dormice and are difficult to sample by nut searches.

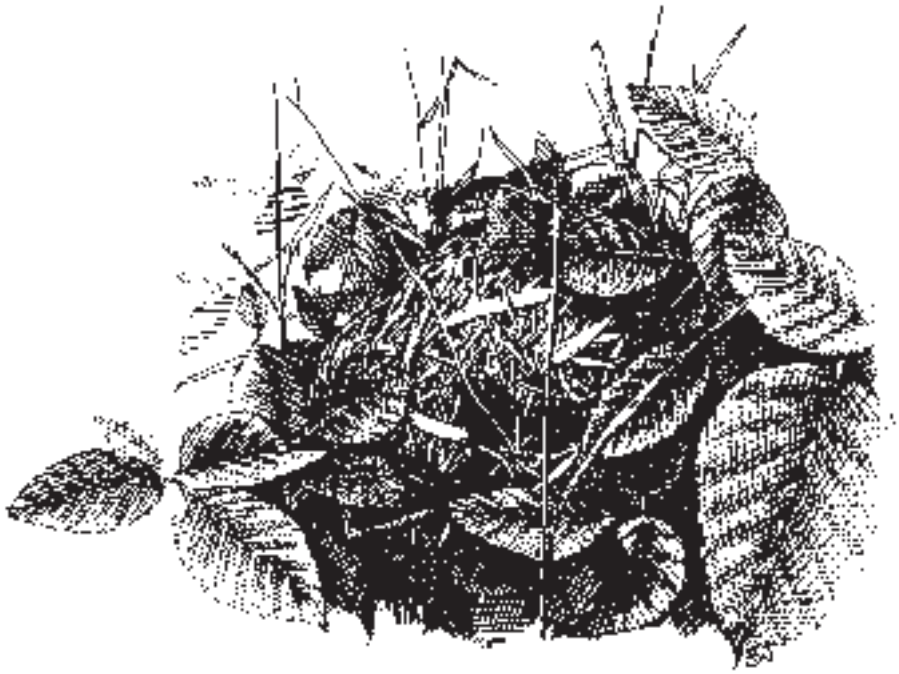
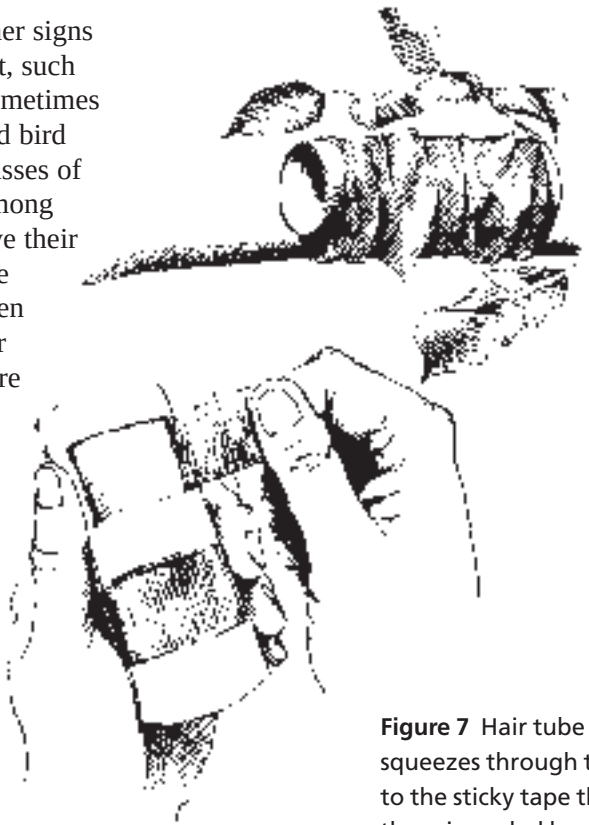


Figure 6 Summer nest. These are sometimes built in low brambles or other shrubs. They are about the size of a grapefruit, have no obvious entrance hole and usually have a covering of leaves over the woven honeysuckle core.

3.2.3 Nests

Where hazel is absent, other signs of dormice must be sought, such as nests. Dormice may sometimes be discovered asleep in old bird nests, tangles of ivy or masses of conifer needles trapped among branches. They also weave their own nests. Typically these are grapefruit-size and often found in brambles or other low-growing shrubs and are most likely to be found in the autumn. Dormouse nests are woven from strips of honeysuckle bark, or similar material, and frequently have whole leaves incorporated into the outer layers. These are often collected fresh and are either green or faded to grey. The nests are spherical and lack an obvious entrance hole. This distinguishes them from a wren's nest or harvest mouse nest, both of which have a distinct entrance hole and are normally made mainly of shredded grass. Harvest mouse nests incorporate the shredded leaves of the grass stems to which they are attached and are tennis-ball size. Unlike dormouse nests they do not usually incorporate tree leaves. Searching for nests is time consuming and often unsuccessful – even where dormice are known to be present – as they mainly use other places to rest (for example, tree holes) and do not often construct nests of their own. Thus, failure to find woven nests should not be used as evidence of absence.



3.2.4 Hair tubes

Hair tubes are simple to use and cheaper than nest boxes (see below). They can be made from plastic sink-outlet pipe approximately 3 to 4 cm diameter. Two 25 mm square openings must be cut in the 'roof' with a saw and chisel, then adhesive tape stretched across each opening with the sticky surface facing inwards. The tubes, baited with jam or peanut butter, are then fixed to horizontal branches using string, cable ties or sticky tape.

As the dormice (or other small mammals) squeeze through the

Figure 7 Hair tube taped to a branch. When an animal squeezes through the baited tube it leaves hairs attached to the sticky tape that covers the holes in the roof. One of these is peeled back to show the hairs attached.

tube to get at the bait, they leave hairs stuck to the sticky tape. After a few days, the tapes can be collected. Hair samples may be acquired from mice, voles and shrews, not just dormice, and a microscope is needed to tell them apart. This is not difficult, with practice, and will be made easier by having comparative samples mounted on glass microscope slides. Dormouse hairs tend to be very fine, much thinner than mice or voles. Under the microscope each hair has a 'uniserate' medulla (inner portion) that looks like a ladder of single blocks. Shrew hairs look similar but are darker and thicker. Mouse and vole hairs have a multiserate medulla, with several adjacent rows of blocks up the middle of each hair (See Figure 8).

The success rate of hair tubes is low. Fewer than 10 per cent of tubes may catch dormouse hairs, even where the animal is abundant. Their advantage is that they may yield results within a week, whereas nest boxes need to be put up and left, often for months, before they are found and used by dormice. Hair tubes are also easier to set up among the branches of dense shrubs and tightly trimmed hedges. They are also cheap, so large numbers can be put out, increasing the probability that dormice will be detected. Because of their low success rate, hair tubes should be used in large numbers. A density of at least twice that for nest boxes is recommended (see below). Their relative inefficiency suggests that this is not a good survey method and absence of hairs in the tubes cannot be accepted as evidence that dormice are not present

3.2.5 Nest boxes

Wooden nest boxes, similar to bird boxes, but with the entrance hole facing the tree, are readily used by dormice and offer a means of detecting the animals in the absence of gnawed hazel nuts. They are also an important conservation tool and evidently boost the local dormouse population density (Morris and others 1990). Those put up near honeysuckle are more likely to be occupied.

Although nest boxes will reveal the presence of dormice, they are often not used immediately. Sometimes they remain empty for several years. Often the first signs will be nests rather than the animals themselves. Dormouse nests are woven with a 'roof' (even inside a nest box), and they frequently incorporate green leaves collected from the tree canopy above. These tend to fade to a greyish colour as they dry out, distinctly different from dark brown dead leaves collected from the ground by other species.

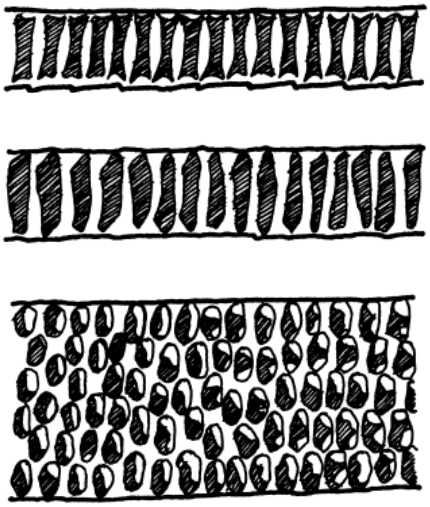


Figure 8 Small mammal guard hairs. Shrew hairs (top) are uniserate with distinctly rectangular cells. The hair is black and very fine. Dormouse hairs (centre) are also uniserate, but with more rounded cells. The hairs are fine and sandy coloured. Mouse and vole hairs (bottom) are thicker and have a multiserate medulla.

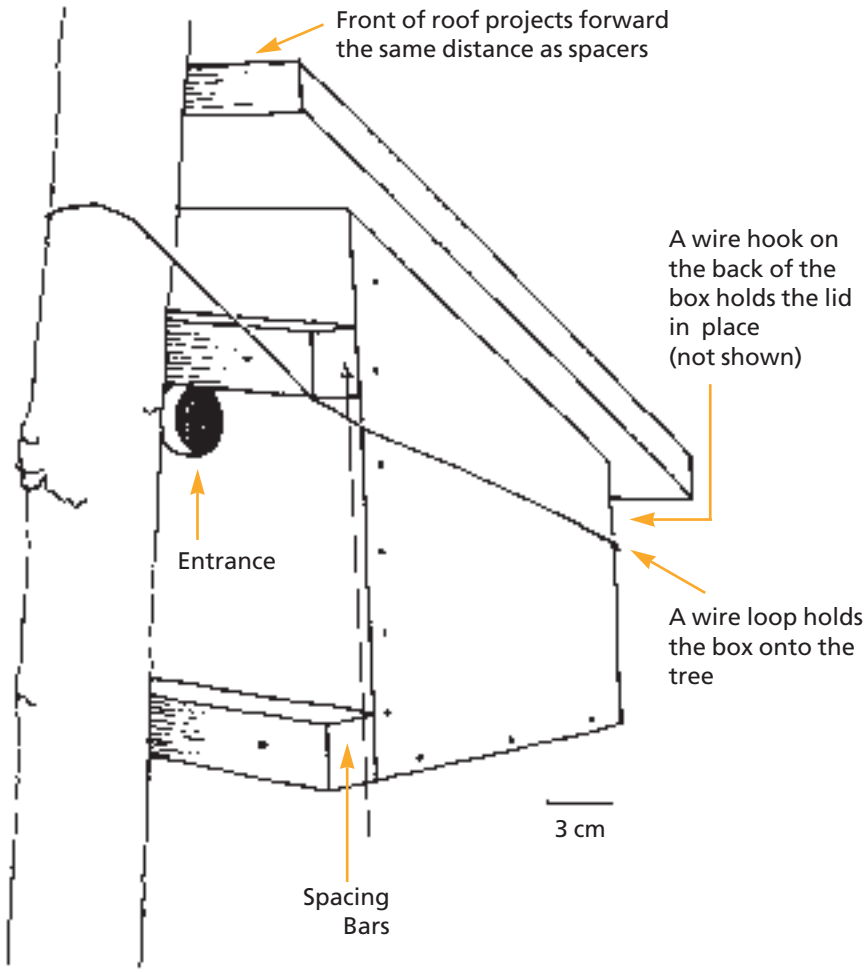


Figure 9 Nest box. Dormouse boxes are like bird boxes, but with the entrance facing the supporting tree or branch. Spacing bars above and below the entrance allow easy access to the entrance hole, which is about 35mm in diameter. The dimensions of the box are not critical. Boxes should be attached using a wire sling, making it easy to take them down for inspection.

Wood mice (and yellow-necked mice) will also make nests in the boxes, but these are not woven and have no 'roof'. When fresh, the nests of mice comprise a loose mass of dead brown leaves that becomes reduced to an untidy carpet of brown leaf fragments in the bottom of the nest box. Birds (mostly great and blue tits) also use nest boxes and make a dish-like nest with no top. Their nests are usually composed mostly of moss, hair and feathers, materials that the dormouse rarely uses. Invertebrates may use the nest boxes too, including slugs, moths, bumblebees, woodlice and, occasionally, hornets.

Nest boxes need to be used in large batches to be an effective survey method. Fifty or more boxes are recommended, and they should be put up in a grid, spaced about 20 m apart. A single line along the edge of a wood may achieve a higher occupancy rate (due to better quality edge habitat), but cannot give a reliable population density estimate. Similarly, putting clusters of boxes in 'good places' will enhance occupancy rates and increase the probability of detecting the presence of dormice, but reduce the potential for scientifically valid comparisons between sites. Since they are expensive, nest boxes should be considered mainly as a means of population monitoring rather than as a survey tool. Further advice on nest boxes can be found in section 3.4.

Inspecting nest boxes (and nest tubes) requires a licence from English Nature or the Countryside Council for Wales in areas where dormice are already known to be present. If boxes or tubes are put out speculatively to detect presence, this in itself does not require a licence, but a licence is essential once the first dormouse has been found.

3.2.6 Nest tubes

Nest tubes are an inexpensive means of detecting dormice in habitats where nut searches are unlikely to be effective. Nest tubes were first designed for use (in a larger form) with edible dormice, which found them as attractive as much more expensive wooden nest boxes (Morris & Temple 1998). Hazel dormice will readily use a smaller version, occasionally for breeding as well as daytime shelter. The smaller tubes are made from stiff double-walled black plastic sheet, 5 x 5 cm in cross section and 25 cm long. A small plywood tray is placed inside, projecting 5 cm beyond the tube's entrance to allow the animals' easy access. The opposite end of the tube is sealed with a wooden block mounted on the tray. Tubes can be made easily but are also available for purchase from The Mammal Society. They can be suspended by wire or tape, fixed firmly underneath horizontal limbs, where they resemble a hollow branch. The tubes can be emptied without removing them by placing a plastic bag over the closed end and pushing in the wooden tray from the open end of the tube. This will usually dislodge any occupant or nest.

Being relatively inexpensive, more nest tubes can be put out than wooden nest boxes, enhancing the probability of detecting scarce dormice. They are also lighter to carry and their slimmer shape makes them easier to position in dense hedgerow shrubs. Their disadvantage is that they probably will not last longer than a few years, whereas nest boxes made from outdoor plywood may survive for a decade or more.

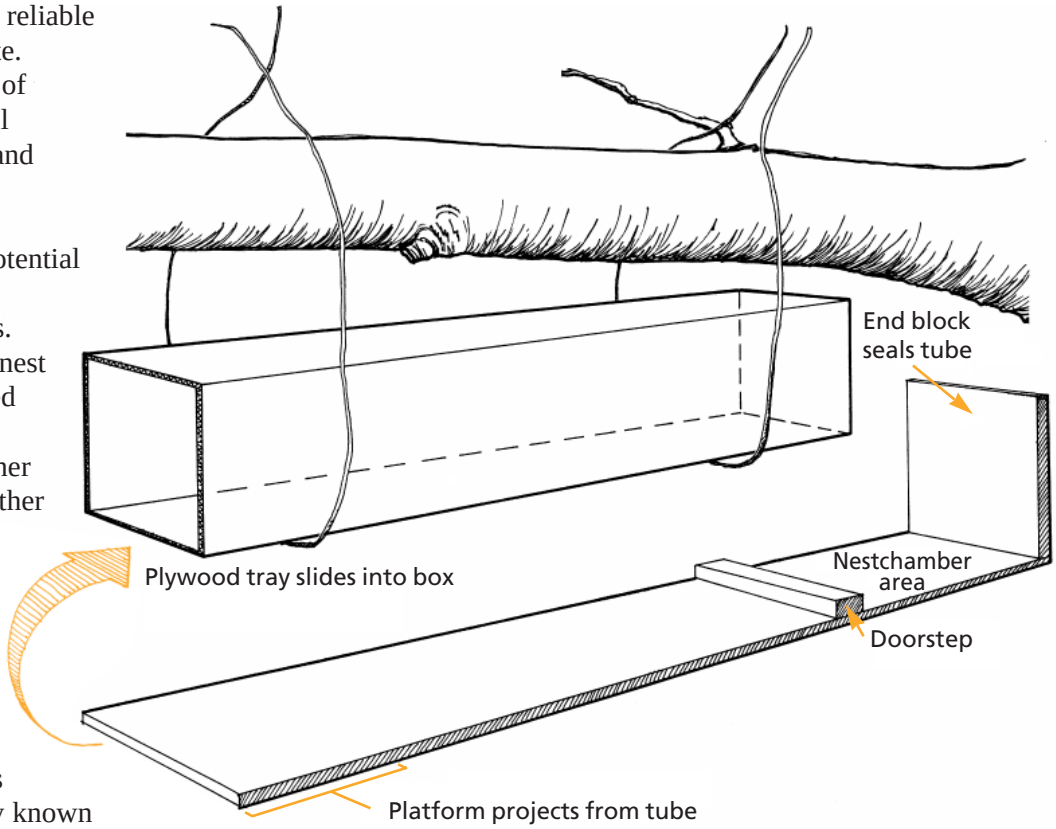


Figure 10 Nest tube. The tube is tied tightly to the underside of a suitable branch with wire. The plywood tray, with attached end stop, slides into the outer tube. Tubes are readily adopted as nest sites by dormice, providing a relatively cheap and easy way of detecting their presence.

Being small, they are also less suitable than nest boxes for breeding purposes. Nest tubes should therefore be considered as an excellent tool for surveys, but not for long-term population monitoring.

For survey work, small numbers of tubes are likely to miss dormice, even where they are known to be present. It is recommended that at least 50 tubes be used to sample a site, spaced at about 20 m intervals (Chanin & Woods 2003). They should also be left in place for several months. Nest tubes are most frequently occupied in May and August/September. Timing their deployment is therefore important. Setting them out in April may get early results, while setting them out in June may be less immediately successful. It is best to leave them out for the entire season, from March onwards, for checking in November. In one survey in South Western England sampling for only three months (July, August and September) detected half the number of new nests and resulted in a third of the sightings compared to a similar survey made in a full season (Chanin & Woods 2003). See Table 5.

It is possible to set out 100 nest tubes in a single day, provided that their siting has been pre-determined and they do not need to be carried far. Checking should take place at monthly or bi-monthly intervals, and under good conditions 150 tubes could be checked in one day. The tubes should be inspected for the presence of dormice and also for signs of recently constructed dormouse nests. A long-handled mirror may be helpful in prickly hedges. Numbering the tubes and setting them out in order at regular spacing makes this survey method much easier. Data recording can also be simplified (for example, by having pre-prepared data sheets with numbered grids or lines to note the contents of each tube).

Using 50 nest tubes as a standard and Table 5 as an index of the 'value' of different months for surveying, a score can be devised as an indicator of the thoroughness of a survey. Thus, 50 tubes left out for the whole season scores 25 (the sum of the indices for all 8 months), but 25 tubes left out in April and May scores only 2.5 (1 + 4, divided by 2 because only half as many tubes are used). This search effort may sometimes be enough to detect dormice, but assumed absence should not be based on a search effort score of less than 20. This would be obtained by using 50 tubes from June to November inclusive (Chanin & Woods 2003).

Table 5 Index of probability of finding dormice present in nest tubes in any one month

Month	Index of probability
April	1
May	4
June	2
July	2
August	5
September	7
October	2
November	2

3.3 Dormouse surveys – good practice recommendations

Although it is virtually impossible to prove that dormice are absent from any area of appropriate habitat within their natural range, an adequate survey will give confidence that any significant populations have been detected. For environmental assessment or development sites, survey proposals should be based on the recommendations in Table 6. The following is a recommended approach to a survey:

1 Check whether the site falls within or close to the known range of the dormouse (see Figure 1).

2 Check for the existence of dormouse records with the local biological records centre or on the National Biodiversity Network (NBN) www.searchnbn.net.

3 Check with the site owner to see if they know whether dormice are present.

4 If the presence of dormice is possible, carry out a survey using a recommended method at an appropriate intensity.

5 If dormice are found, submit data to the local biological records centre.

Finding dormice in conifer plantations

Sites may be pure conifer or include a wide diversity of habitat, including broadleaved perimeters or mixed-species plantings or isolated remnants of a previous broadleaved component within, around or adjacent the plantation.

- If hazel is present it should be inspected for gnawed hazelnuts by the normal survey method.
- Within a conifer Planted Ancient Woodland Site (PAWS), locations near glades – where shrubs are associated with a thin canopy – or where there are contiguous broadleaved edges or internal groups are the most likely sites. Analysis of the habitat components near 1000 nest boxes (from 20 conifer sites) shows that presence of dormice in boxes was closely related to the presence and amount of the shrub layer.

Finding evidence of dormice where no hazel exists may take months or even several years and requires the erection of nest tubes or nest boxes. To determine presence, choose the most likely locations. It may be appropriate to look where PAWS is adjacent to other suitable habitat. If dormice are found nearby in adjacent woodland or scrub, they are likely also to be in, or at least using, the plantation. Include nearby young scrubby plantations and other succession habitats containing bramble/gorse/bracken/old-heather and hedges.

3.4 Monitoring

Nest boxes are readily used by dormice and provide the only practical means of monitoring dormouse populations.

A suitable nest box design is shown in Figure 9. The exact size is not critical. The boxes are best made from marine ply or another rot-resistant wood. Make holes in the floor of the boxes to allow drainage. Cheaper boxes can be made using softwoods, though these will often deteriorate rapidly. A life of three to five years is normal for cheap boxes, whereas boxes made using more resistant woods will last five to 10 years. Cheaper temporary boxes are suitable for site surveys, but longevity is important where population monitoring is the objective. The wood **must not** be treated with oily or odorous preservatives. County Wildlife Trusts, bat groups and the RSPB may know where to contact local nest box manufacturers. Sponsorship may be obtained for individual nest boxes or whole sets. Boxes can be put up at any time of year, but ideally should be in place by May to allow use in the summer. In some areas, the first ones may be occupied within a month of being put up, in other places occupation may not occur until the second year. If three summers pass without use by dormice, then the animals are probably not present or the boxes have been badly sited.

Table 6 Survey methods and good practice

Choice	Method	Recommendations
1	Search for gnawed hazel nuts	Most efficient method. Gives quick results, but only where hazel is present. Most useful over winter. Search at least five 10 m x 10 m quadrats; more if squirrels have opened most of the nuts (see Section 3.2.2).
2	Nest tubes	Good method, especially where hazel absent. Only useful March–November. Likely to take several months at least. Use a search effort score of 20 or more (see Section 3.2.6).
3	Nest boxes	As for nest tubes, but much more expensive and better suited to long-term monitoring. Use a search effort score of 20 or more (see Section 3.2.5).
4	Hair tubes	Cheap; limited to summer months; requires hair identification skills. Low 'hit rate'. Very difficult to quantify search effort. Not recommended.
5	Nest searches	Not recommended as a survey method, but nests may well be found when clearance is in progress.
6	Trapping	Labour intensive. Needs a licence. Low 'hit rate'. Not recommended.

Figure 11 Sexing dormice. This can be more difficult than for other small rodents, particularly with young dormice. The difference to look for is the distance between the anus and genital papilla (penis/vagina) which is longer in males than females. In males, the testes may be apparent in the breeding season, but they are not very prominent.

It is recommended to clean out all nests at the beginning of each summer. Remove bird nests as soon as the chicks have fledged to reduce the risk of infestation with mites. Wet nests and damp material from the previous year should also be removed as they may harbour nematode parasites and also hasten decay of the box. Only fresh, dry dormouse nests should be left in the nest boxes. Dilapidated boxes should be repaired or replaced before the dormouse season begins about March or April. It may be helpful to mark paths with tags to make the boxes easier to find.

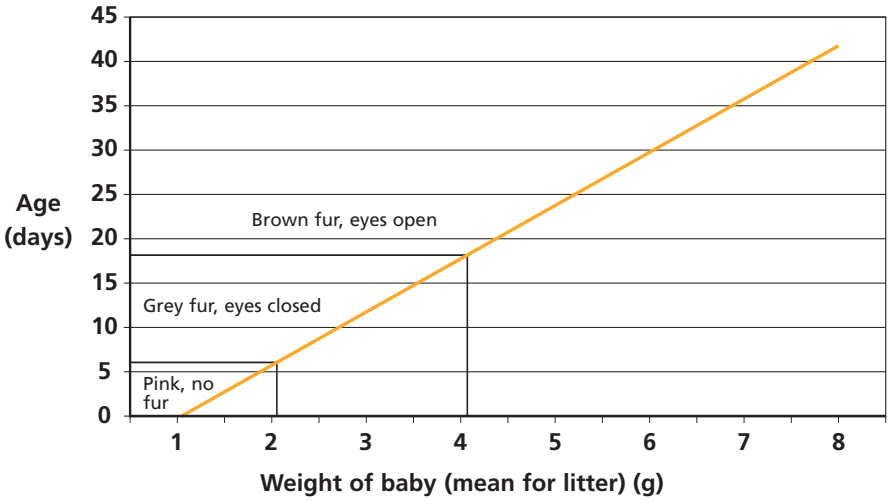
When checking nest boxes, use a small rag or plastic bag to plug the entrance hole or cover it with one hand, then open the lid cautiously. If there is a nest inside, close the lid, lift the box down and open it inside a large plastic bag. Any dormice found should be sexed and weighed. Unlike other small rodents, dormice rarely bite and so can be handled between palm and fingers, rather than by the scruff of the neck. **Take particular care not to handle them by the tail**, as the skin is easily stripped off and does not regrow.

For long-term monitoring, fifty or more boxes are recommended. Where estimates of population density (numbers of animals per hectare) are required, they should be put up in a grid spaced about 20 m apart, giving a density of 30 boxes per hectare. The boxes should be numbered sequentially with weatherproof ink to help locate them and to permit accurate record keeping. Numbering the boxes before they are put up, then setting them out in order, is more efficient that putting them up first then trying to find them to number them. Putting boxes out in more-or-less straight lines and standard intervals also makes it easier trying to find them again. It is a good idea to make a map, showing where each numbered box is located and what tree type it is in. The most convenient height for nest boxes is about 1.5 to 2 m off the ground. Higher boxes may be more secure from vandalism or other interference, but are no more likely to be used by dormice.

The boxes should be sited in hazel or other shrubs and young trees that are linked to the adjacent understorey. Avoid isolated trees or bushes. Attach each box to a stout branch, suspended in a loop of wire so it can be easily lifted down and emptied into a large plastic bag. Garden wire or galvanised strand will do, but plastic covered single core copper wire is best as it is slightly elastic and easier to manipulate. Avoid having the entrance hole pointing upwards as this allows rain to get inside. The entrance hole should face the tree, facilitating access by dormice and making it more difficult for unintended occupants to enter. It does not matter which compass direction the box faces.

Check nest boxes at least twice a year (May and October) to record any animals present. However monthly checks will provide more and better quality information, particularly on breeding. Studies have shown that monthly visits do not disturb the animals unduly, but more frequent visits are not recommended. Any new (pink) nestlings present in a nest box should be counted and left undisturbed. If necessary, they can be weighed as a batch and the average nestling weight calculated. Nestling weights can be used to estimate their approximate age (see Figure 12). Unlike some mammals, dormice do not eat or desert their young, provided that disturbance is not excessive. Nevertheless, you should avoid disturbing young families unless detailed studies are being made of breeding biology.

Figure 12 Predicting age from weight for babies. The age of the young in days may be roughly estimated by taking their mean weight (up to 8g), subtract 1 and divide by 0.16.



Inspecting nest boxes requires a licence from English Nature or the Countryside Council for Wales (CCW) where dormice are known to be present. All data from schemes using 50 or more nest boxes should be submitted to the National Dormouse Monitoring Programme, administered by the People's Trust for Endangered Species.

3.5 Marking dormice and taking samples

If dormice are marked individually, it will enable their numbers to be estimated more accurately. It will also provide information on how far the animals move, which nest boxes they use and which animals share accommodation. Temporary marking will suffice for making rough estimates of numbers, but long-term marking is needed for more detailed studies. However, permanent marking is usually more expensive and intrusive so dormice should not be marked permanently unless the intention is to continue to study them for several years. **Marking dormice requires a specific extension to the standard survey licence.**

Dormice may be marked temporarily by fur clipping, provided this is allowed for on the appropriate English Nature or CCW licence. Clipped fur will often remain visible for many months and does not need a Home Office animal experimentation licence. Collection of blood samples or pieces of skin for DNA analysis will require a licence from the Home Office.

More permanent marking, using ear tattoos is feasible, but requires training and special equipment. Toe clipping is illegal and inappropriate. Passive Implanted Transponder (PIT) tags may be used for marking small mammals. These are tiny microchips that can be injected under the skin and read like a supermarket bar code. PIT tags are an excellent method of identifying an animal throughout its lifetime. However, they are expensive (around £4 to £5 each) with electronic tag-readers costing over £100. Standard PIT tags, as used on dogs and cats, are about 13 mm long, but are too large for dormice. A smaller, more suitable PIT tag (8 mm x 2 mm) is available from Pet-ID UK Limited. These tags are now used routinely on captive-bred dormice, with no reports of problems in animals weighing more than 12 g. Tags can be inserted under the skin, either of the abdomen or between the shoulder blades, but their use requires special training and must be specifically allowed for on any licence that allows the handling of dormice.

Taking samples of external parasites does not need further licensing, but dormice rarely carry fleas or ticks.

3.6 Estimating population density

Dormouse density can be estimated using mark-recapture techniques, normally based on captures in nest boxes. However, this is a time-consuming activity and unnecessary for most purposes other than research. A rough estimate of minimum pre-breeding density can be made by using the number of dormice found in boxes in May divided by the area (in ha) covered by the nest box scheme. Other survey techniques, such as nut searches or nest tubes are intended to detect the presence of dormice and do not permit an estimation of density unless detailed work to calibrate the method has been carried out. For most purposes, it is adequate to use the average density figures given in Table 2.

4 Habitat management

With Roger Trout, Forest Research

4.1 Managing woods for dormice

Sites with dormice will generally fall into two broad categories: those where wildlife conservation is a priority for management, and those where economic forestry is the main concern. For convenience, these types of woodland – with their differing priorities – are referred to here as 'Conservation Woodlands' and 'Forestry Woodlands'.

There are many general actions associated with woodland management that would benefit dormice. The degree to which these are followed is influenced by whether the site is a conservation wood managed for dormice, or whether other objectives are of equal or overriding importance. Definitive scientific evidence underpinning guidance is more available for coppice woodland than other broadleaved woods. Research on dormice in conifer habitats is recent and ongoing.

Whereas there are obvious concerns about dormouse conservation in the face of development projects (see Chapter 5), where planned activities directly affect dormouse habitat, it is also true that dormice can be affected by a lack of activity. The reduction in woodland management operations, particularly cessation of coppicing, resulted in extensive habitat degradation during the 20th century. In many cases, mitigation in the face of proposed actions is not required, because the problem is the result of inaction, where nothing is being done at all. In these cases, restoration of derelict habitat – applying the principles outlined in this chapter – is the answer.

4.2 The objectives of woodland management for dormice

Dormice fare best where there is a high degree of species diversity among trees and shrubs and a fully three-dimensional physical structure, with plenty of links between woody vegetation at all levels. Conditions for dormice may therefore be improved by appropriate planting, coppicing, thinning or felling.

Where dormice are already present, the aim should be to maintain or create woodland with a high species diversity, a mosaic of age classes and a multi-storied canopy including plenty of links between different levels of the canopy and undergrowth. There should also be links – via suitable hedgerows and other scrubby habitats – across the whole woodland landscape. In planted areas, especially on coniferous woodland sites, the initial priority is the encouragement of diversity among broadleaved species, with a permanent increase in the shrub component. Standard uniform thinning operations may not achieve this, so alternatives should be considered. In recently planted woodlands and where growth results in a continuous dense canopy shading-out shrubs, keeping internal and external connectivity are important priorities. Each woodland will require individual management prescriptions and plans for conserving dormice. Some generic management decision processes may help in determining specific needs, as shown in Figure 13.

4.3 'Conservation Woodlands'

4.3.1 Woods with currently adequate diversity and form

Good habitat for dormice is often provided by what may be considered young growth stands: areas of scrub, early coppice regrowth, or young naturally regenerated broadleaved stands. Such early successional woodland is often species-rich, though this diversity declines once the canopy closes and reduces the light available to ground flora and shrubs. Soil types, exposure and rainfall strongly influence the final structural components of a forest but it is important to manage the woodland to provide a range of age and tree species. The ability to manage the browsing impact of deer (for example, by fencing), will often be important in delivering sustainable young regrowth woodland.

Management involves periodic removal, coppicing or killing of trees to limit the density of the canopy layer and maintain a well-lit understorey. Felling need not be undertaken uniformly or immediately and small group fellings (even of trees and shrubs only three to five metres high) at intervals throughout the stand should maintain the species richness if undertaken every five years or so. Small groups of any species, including conifers, should be left.

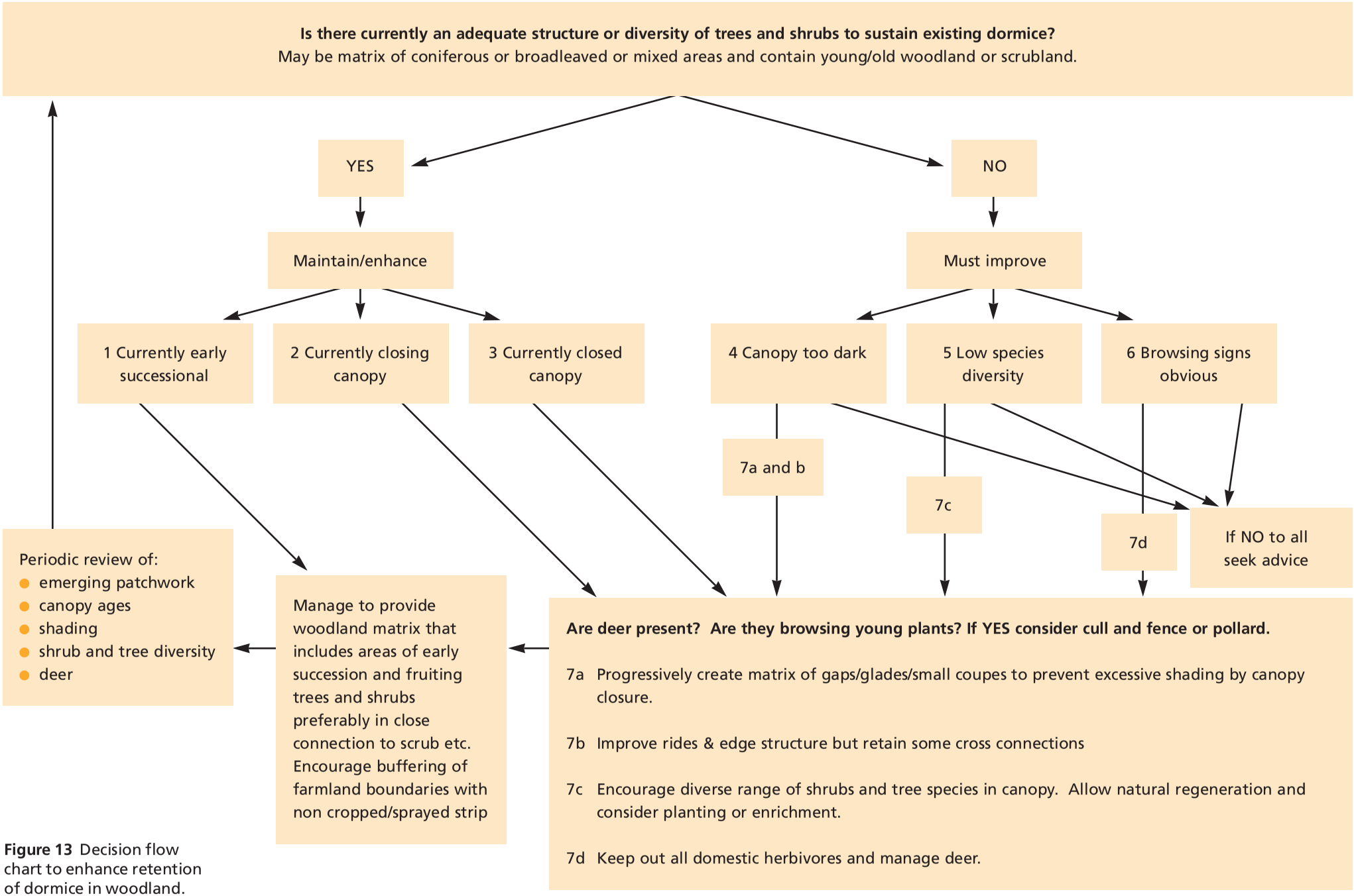


Figure 13 Decision flow chart to enhance retention of dormice in woodland.

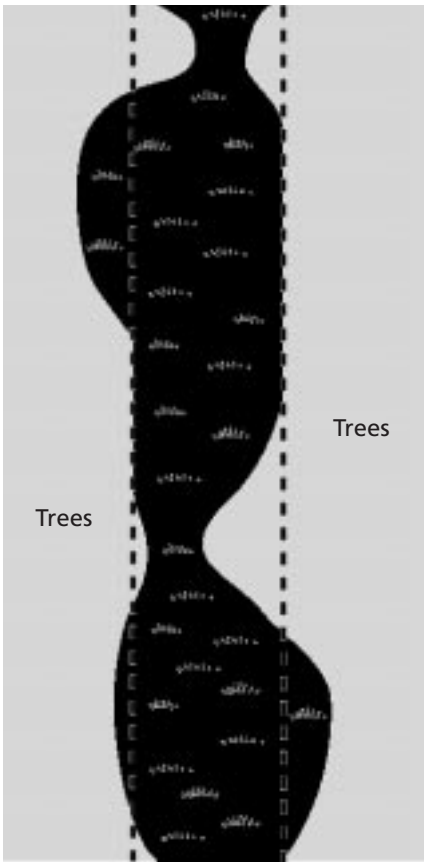


Figure 14 Ride with glades and constrictions. Wide open rides are an impediment to dormouse movements because they do not like to cross open ground. It is better to open up rides to form sheltered glades (for butterflies) but leave narrow constrictions every 70m or so, where the trees meet overhead and allow dormice to cross without descending to the ground.

Some sites may already have scattered conifers planted into otherwise deciduous habitat. Removing these may be aesthetically desirable, but individual evergreen trees (such as pines and spruce) may offer shelter from inclement weather and often support large populations of food insects, such as aphids. Evergreens in the form of rhododendron or laurel bushes should be removed as they offer nothing useful and their spread smothers other shrubs. Coppicing is a desirable option, at least for some tree species. Hand-felling to waste may be most appropriate as the use of harvesting machinery is usually expensive and harmful to wildlife.

Closed canopy woodland is shady and this restricts the development of small trees, seedlings and shrubs, leading to the reduction of shrub quality and regenerative growth. The activity needed to enhance a woodland's structure and its species diversity will depend on the amount of canopy shade. Shading will vary with species and density; for example larch, pine or ash allow more light through to the understorey than spruce, fir, sycamore or beech. The canopy layer should be thinned unevenly to prevent continuous dense shade over the understorey and to open up glades where shrubs can develop. Where deer browsing is controlled, this management should allow a vigorous understorey to develop. Some canopy trees should have their branches touching (to create arboreal pathways between them), but most should not. Some canopy trees in glades should be left with their branches touching the glade edge to create arboreal pathways.

Where rides have been opened out to create glades (for example, for the benefit of butterflies and ground flora), constrictions should be left every 70 m or so, where the trees meet overhead. This will enable dormice to cross the ride without needing to come to the ground. Where various conservation interests need to be accommodated a series of linked glades is probably the best compromise. This linking will also provide a secluded and supportive microenvironment for many invertebrates. Large open spaces and wide rides tend to alter the microclimate, increase wind speed and decrease accessibility, all negative factors for dormice and many other creatures.

Domestic stock (cattle, sheep and pigs) should be excluded from dormouse woods as their trampling and browsing damages the understorey. If this continues unchecked, regeneration is suppressed and the wood will develop the characteristics of parkland – isolated trees with little or no understorey. This is unsuitable habit for dormice, although they may survive there for a while.

How shady is too shady?

The best dormouse sites have a dense shrubby understorey. In this type of habitat it is difficult to see more than two or three metres in any direction unless you are standing on a footpath. If you can see 20 m or more, this is probably because the understorey has thinned as a result of shading. Such sites tend to become progressively less suitable for dormice.

Management of sycamore

The sycamore is a valuable tree because it supports a high biomass of insects (especially aphids), one of the best 'value-for-effort' foods available to the dormouse in early summer. Dormice also eat the pollen from sycamore flowers, and probably the ovules too. These flowers are often available slightly later than others used by dormice for food. However, sycamore also casts a dense shade, suppressing understorey development and the flowering of many plants of considerable conservation value. It is also very invasive, due to its airborne seeds, and elimination of sycamore is often a conservation priority.

Total eradication may not be in the best interests of dormice, but allowing sycamore to remain risks the loss of understorey plants. A compromise is to pollard or coppice the trees. They will then produce foliage but no seeds, and their low canopy will not result in dense shade.

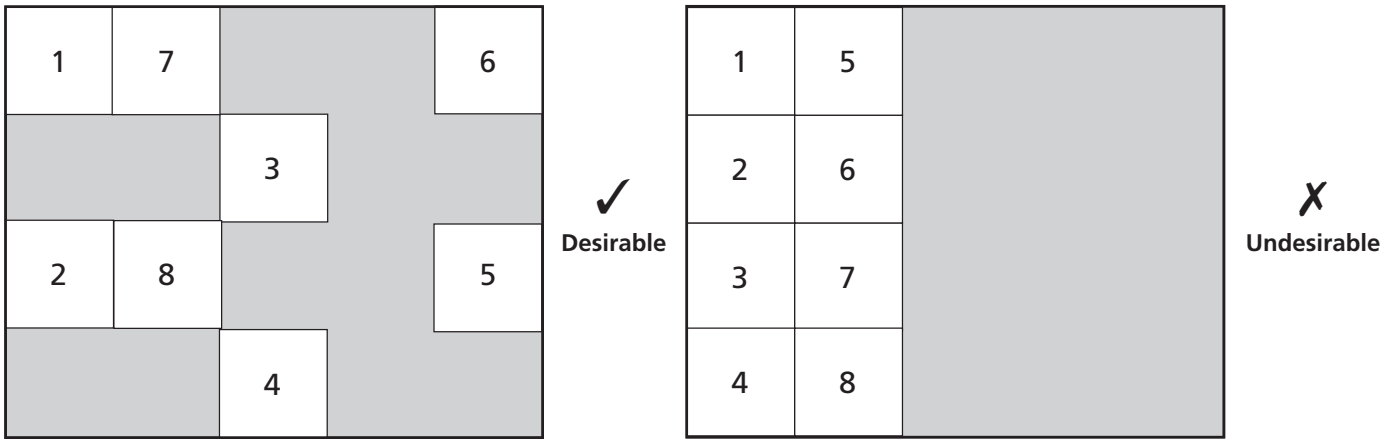


Figure 15 Example coppicing scheme. Cutting adjacent coupes in successive years results in large areas of hazel less than 7 years old, too young to be fruiting. It is better to cut patches in a sequence that encourages new coppice adjacent to old, permitting access to hazel crops and easy recolonisation by dormice.

Trampling also endangers dormice in winter when they are hibernating on the ground. Hibernating dormice are vulnerable to predation by pigs searching for mast (acorns, nuts etc) in the leaf litter. They should always be excluded from woods where dormouse conservation is a priority.

4.4 Coppicing for dormouse conservation

Coppicing (particularly of hazel, but also sweet chestnut) helps to create good habitat for dormice, but management of the canopy trees is also important (see above) as coppice stools will not regrow if they are in heavy shade. Coppicing results in a renewed understorey, supporting plenty of insects and creating a vigorous new growth of shrubs. Generally, hazel coppicing and coppice habitats are good for dormice and the progressive cessation of coppice management during the 20th century was probably an important factor in the decline of the species. However, coppicing must be managed carefully or it will speed the extinction of dormice rather than prevent it.

4.4.1 Length of coppice rotation

Hazel and chestnut coppicing promotes a rich ground flora and is ideal for certain species of butterflies. For the first two to three years after cutting, coppice often develops a thick growth of bramble between the stools. However, hazel does not usually fruit well before it is seven or more years old. The ideal cycle length for dormice is probably 15 to 20 years, which is different from commercial cropping and longer than desirable for many butterflies. After about 20 to 25 years, hazel in the south of England often starts to collapse and die back, although at some sites the hazel itself may still be suitable for dormice after 50 years. The management implication for small woods is to reduce the size of coupes (blocks of coppiced woodland) and to only cut coppice on a long cycle.

Attempting to create age diversity by cutting poles on a single coppice stool at different times (for example, half this year and half in five years time) may be helpful, but risks damage to the coppice stool which becomes susceptible to rot and disease unless all the poles are cut simultaneously.

4.4.2 Coupe size

Where deer are present, large coupe sizes are often recommended to minimise the impact of browsing. If deer are absent, it is better to cut only small areas of hazel at a time, or cut in strips. Ideally, coppice coupes should be small (less than 0.3 ha) and in total less than 10 per cent of the total woodland area in any one year. If larger blocks are cut, this may leave many canopy trees inaccessible by arboreal routes for several years, reducing the availability of important food resources to dormice until the coppice has regrown. Progressive annual coppicing over a small isolated woodland site should not be undertaken otherwise too much of the site will be rendered unsuitable for dormice at any one time. In a small isolated woodland, composed entirely of coppice or coppice with standard trees, the area of fruiting age hazel remaining in any one year should not be less than 10 ha. This can be achieved by refraining from coppicing every year and/or reducing the size of the cut area. Conservation managers must also be prepared to reduce the density of canopy trees above the new coppice growth and to prevent deer or stock from browsing it.

Standards (canopy trees) should be thinned, ideally to cover 25 to 30 per cent of the area. This represents about 10 large trees per hectare, perhaps more if some are grouped together; other patches could then have no standards at all. Standards should also be managed to diversify their age structure and diversity should be promoted, especially retaining characteristic

species such as hawthorn, service, maple and hornbeam. Unfortunately, conservation managers are often reluctant to thin canopy trees, leading to deterioration of the coppice underneath and the creation of even-aged standard trees.

4.4.3 Distribution of coupes

To benefit dormice, avoid coppicing coupes next to previously cut areas. This will ensure that new growth is alongside older shrubs, adding to the diversity of resources. Where coppicing takes place in adjacent blocks in successive years, the effect is to create a large area of relatively poor habitat for dormice that will not begin to improve until the hazels fruit at seven years old. By that time the dormouse population might have been reduced below a viable size. Where adjacent areas have to be cut at the same time, leave uncut strips (perhaps two coppice stools wide) between them. These will provide food and access routes for dormice and act as windbreaks, protecting new growth and its associated butterflies and other insects. Aim to create a very patchy environment, with different ages and shapes of shrubs. For the first two to three years after cutting, coppice often develops a thick growth of bramble. This is a valuable food source, especially if it is close to older trees and shrubs.

Extensive coppicing should not be undertaken right to the edge of a wood. Leave a fringe of older shrubs to help maintain the microclimate within the wood. This will be beneficial to invertebrates as well as dormice. However, this strip should not be more than 20 m wide in order to discourage deer from using it as a lying-up base from which to raid surrounding farmland. Edge habitat is often excellent for dormice as it receives more sunlight than the wood's interior. Its management should be undertaken with care and only small areas cut at a time. Do not fragment the connecting links with other woods along the woodland margin.

4.4.4 Timing

The optimum coppicing season for dormice is November to March, a period that allows dormice to fully exploit the nut crop before they hibernate. Earlier coppicing results in the premature removal of this crop and also disturbs late nests of young. Fortunately many woods are closed for the shooting season until Christmas, meaning coppicing usually starts in January. Burning or chipping material that has just been cut in winter is not a serious threat to dormice if kept to as few locations as practicable, but brushwood piles are best left as potential hibernation shelters for next year. Burning in summer should be avoided as torpid dormice may be sheltering in wood piles.

4.4.5 Restoration of derelict coppice

From the end of the 19th century, managing deciduous woodland to produce traditional wood products (charcoal, baskets, fencing, coppice poles etc) became steadily more uneconomic. Large areas of woodland were essentially abandoned, to be harvested only for timber at long intervals. After about 20 years, un-coppiced hazel starts to collapse, the larger individuals progressively shading out smaller ones. Any standard trees will continue to grow, shade the whole site and reduce the density of hazel. Many hazel poles die back through self-shading, and become rotten. Retaining a few very old hazels (which may fruit heavily) and a scattering of hollowed-out dead wood (within which dormice can shelter) will be beneficial, but extensive areas of 'derelict' coppice tend to support lower numbers of dormice.

Restoration of ancient woodland coppice is a long-term process (Harmer & Howe 2003) and improving the habitat for dormice means thinning the canopy trees and progressively, coppicing hazel. The density of hazel stools may need to be restored by planting or layering into open sunny gaps. For layering, one long young pole from an existing stool is bent over to ground level and pegged in place with the tips of its branches covered by soil. After a year or so, the branch tips will develop roots and eventually the pole can be severed from the original stool. This is probably a more efficient way of filling in gaps than planting afresh, although this may be necessary where large areas are lacking in hazel. Improving the habitat for dormice will often be aesthetically beneficial and also result in increased ground flora, more butterflies and other positive developments.

4.5 Managing 'Forestry' woodlands where dormice are present.

Many woodlands that support dormice also have other management considerations. This particularly applies to Planted Ancient Woodland Sites (PAWS) where dormice have survived into the present habitat. Dormice will also colonise new areas of woodland established for commercial or aesthetic reasons. Such areas often exhibit a low species diversity, contain single-age stands and have the trees planted very close together. Often the lack of diversity reflects the original planting, but also results from removal of unwanted species (for example, deliberately taking out deciduous species from a conifer crop). However, it is possible to manage such sites in ways that favour dormice, without compromising other objectives.

Standard rack (row) creation and uniform thinning treatments are aimed primarily at enhancing the quality of the next thinning of timber. It does not result in a thick regrowth of the shrub layer as the canopy closes again in a very few years. Creating gaps in it (see below) is a major departure from traditional practice, causing potentially conflicting management objectives, especially where plantations of conifers are involved

Modern (recently planted) broadleaf, conifer or mixed woodland at the pre-thicket stage has a strong shrub layer. This can on occasion overwhelm the planted trees, but is readily used by dormice, the population presumably being derived from an adjacent woodland, scrub or hedgerow habitat. Research has yet to be carried out on dormice in this habitat, but generic advice is to preserve links with any adjoining suitable habitat, be sensitive at the edge of a stand, ensure piecemeal thinning continues, enhance or

Good Practice: mitigation during planning and forestry management

Detailed advice may change as further evidence is obtained, but good practice for managing dormouse sites, within the other site objectives, aims to achieve three outcomes:

Retain connectivity, so dormice do not become isolated in small areas

- Avoid removing links along the perimeter belt of scrub, understorey or canopy trees when creating access or operational turn-round/storage areas.
- Do not completely isolate big broadleaf trees – crescent thinning is best, especially if this allows cross-rack connection.
- Retain or create connectivity across tracks and racks (rows) at 75 to 100 m intervals.
- Retain higher level branches crossing tracks for example, when clearing to lorry height in advance of operations.
- Favour retention of broadleaved species when thinning, especially the shrub layer in natural gaps etc. Pollard, rather than fell, small broadleaves if deer/rabbits are present.
- Reconstruct low level connections across racks using brash or tops, especially at perimeters or near cross tracks if aerial linkages have been lost during operations.
- As a last resort use the mechanical loader head to gently lodge trees from three rows back to create connecting bridges across racks at around 100 m intervals following timber extraction.

Retain and improve the shrub layer growth and regeneration

- Adapt brash treatment to site conditions and redistribute to create links.
- Scallop ride edges instead of cutting straight-line clearances when ride widening, to leave selected overhanging canopy trees that act as arboreal crossing points.
- Create glades along racks and opportunistically enlarge existing areas for regeneration.
- Consider ways to avoid the use of the same racks in subsequent thinning so as not to damage emerging shrubs.
- Do not drag felled trees along every row.

Minimise disturbance and killing of dormice during forestry operations

- Always seek to avoid large clearfells.
- Follow the timing advice given in this manual (see 4.5.3).
- Do not tidy or widen ride edges strictly parallel to the track.
- Cut the ride edges of the managed compartment in autumn to discourage hibernation there if timber has to be stacked at the ride side.
- Avoid stacking or restacking timber on roadsides between December and April (inclusive). If possible, stack logs on the ride side opposite to the managed compartment.

produce a shrubby understorey and maintain older trees (as outlined earlier). Maintaining or creating connections within the wood during forestry operations is critical, except when working in winter, when re-connections must be made before hibernation ends.

Uniform thinning does not allow sufficient time for a diverse growth to be produced. Creating gaps for scrub growth by felling trees to produce linked patches of clear ground may be the best compromise where various forestry and conservation interests need to be accommodated. This can be achieved at a small-scale (for example, in areas of around 25m^2) to create a mosaic of uneven age over several years. Group-felling of large well separated areas (up to 0.3 ha) within a larger block appears to be acceptable, but has the drawback of not fulfilling the professional forester's desire for promoting uniform timber growth in the uncut areas. Large-scale clearfells that completely remove dormouse habitat are generally unacceptable. Historically, some very large areas were cleared – often a strip over 200 m wide along a whole valley over a few years – and dormice survived in the remnant edge woodland, scrub and wide hedges to later reinvade the new woodland. These days, habitat isolation, fragmentation and a lack of scrubland and hedges mean that large-scale operations with fast modern machinery have to be carefully planned to ensure that adjacent areas of adequate size and diversity are reserved to act as a source of future dormouse populations.

4.5.1 Improving rides and edges

This habitat may be the easiest to deal with first when only limited resources are available but management must ensure that the continuous connection around the perimeter of an area of woodland is not broken. Consider managing the edge of the existing crop by small-scale thinning, coppicing (or pollarding, if deer are a problem). Where rides are to be opened out to create glades for the benefit of butterflies and ground flora or for aesthetic reasons, a wavy scalloped edge should be considered with constrictions every 70 m or so. Trees on either side of a ride should meet overhead at these constrictions allowing dormice to cross over without coming to the ground. Sympathetic ride widening is part of many management schemes designed to enhance biodiversity, as well as improve game shooting.

4.5.2 Clear felling

Clear felling has the potential to severely affect dormice as it results in the immediate and complete loss of resources. To encourage a continuing population, it is best to restrict the scale of operations in any one year (for example, on a similar scale to coppicing).

Where possible, only clearfell 0.5 to 5 ha units depending on the overall size of the woodland block. If there is suitable habitat adjacent to the cleared area, ensure that there are links to it on more than one side. If large-scale operations are planned, try to ensure that adjacent compensatory habitat is available, creating it beforehand if necessary. Felling, during the autumn, should then start in the centre of large stands and continue outwards,

Commercial hazel coppicing, energy coppice and sweet chestnut coppice

Dormice can occur in coppice other than hazel, but comparatively little is known of their ecology in such situations. Until further research is carried out, it is difficult to offer specific advice apart from the following observations

1. Nest boxes will be beneficial for the same reasons as in hazel coppice.
2. Cutting the coppice in summer will be destructive to nesting dormice and also deprive them of food resources. November to March would be better.
3. Short rotation cutting of hazel (less than 10 years) may be required for economic reasons, but is incompatible with the dormouse's need for hazel nuts in autumn. Similarly, short rotations of sweet chestnut will reduce food availability.
4. Large coupes will be harmful to dormice, as will cutting more than 25 per cent of a wood in one year.
5. Intensively managed coppice often develops towards a monoculture, reducing tree diversity (for example, by removal of unwanted species). This will not favour dormice.
6. Restoration of abandoned coppice, if carried out using heavy machinery, may be damaging to dormice, especially in winter when they are hibernating and unable to escape.
7. If they are large enough, non-intervention areas may allow dormice to survive. Such areas should be 10 to 20 per cent of the wood if possible.
8. Willow, alder and biomass fuel shrubs are often grown on wet ground that is relatively unsuitable for dormice and may therefore not cause conflicts of priorities to arise.

Good practice guidance – timing of operations

Traditional broadleaved coppice management (and thinning of standards) occurs in winter.

- In conifers (and broadleaf woodlands), operations that seriously physically disturb the whole canopy or forest floor such as large-scale machine felling and thinning should take place in September and early October when animals are mobile. In these cases mitigation must be immediate.
- 'Small footprint' operations (less than 5 ha) and those involving under 25 per cent of a wood containing largely suitable habitat, should take place between September and October or between December and March inclusive. This may include hand-felling and rackside timber stacking. Large machinery may be used for felling rows and small areas.
- Clearfelling large areas (for example, more than 5 ha, or over 25 per cent of a wood) should be done in the autumn. Large clearfells should be undertaken progressively over several years. Provisional guidance is that narrow strips may be undertaken in winter – wider strips during autumn – when the dormice are still active and capable of redistributing themselves.

progressively moving the animals towards this refuge. This will be more successful if the refuge is well-connected to the area to be felled rather than if the animals are forced to cross open ground. Strips of 75 m may be removed so long as uncrushed brash rows (providing access links to adjacent refuges) are constructed immediately or strips of connected trees are left uncut.

On some soils, clearing large areas results in a rich growth of bramble and other shrubs, but on others *Molinia* grass or bracken may take over and it may take many years for tree seedlings to become established.

4.5.3 Timing of operations

As indicated earlier, there is no 'good' time that avoids disturbance to dormice altogether, which is why attention to the scale of operations and possible mitigation measures are so important. Operations should, as far as possible, avoid periods of the year when dormice are particularly vulnerable – coincidentally the main bird breeding season. The two least detrimental periods for thinning in conifer woods includes August to September, the end of the main breeding period when the first young have left the nest and are mobile – but before animals need to feed-up to create their fat reserves for hibernation. Alternatively, except for large-scale operations, work could be undertaken during the hibernation period itself. Any dormouse nestlings that are disturbed in the autumn are generally too undeveloped to survive the oncoming winter and would be lost to the population anyway.

4.6 Management of Plantations on Ancient Woodland Sites (PAWS)

During the 20th century, many ancient woodland sites were planted up with conifers and some may have retained their dormice. Changes in national policies towards forestry management now encourage many of these sites to be diversified and brought back into a condition resembling their original state. The composition of PAWS is very variable. It is increasingly clear that many have dormouse populations, often on surprisingly small sites, and these need to be taken into account when deciding on an appropriate management regime. It is not known whether dormice live only near the edge of large single-species conifer compartments, or if they also inhabit the centre of large conifer blocks.

Doing nothing is not an option, either under normal conifer management or for PAWS restoration to broadleaved woodland, because the trees and most wildlife (including dormice) would suffer as the canopy thickened and shrub layer declined. The timing, form and scale of management are crucial to ensure dormouse survival. More detailed guidance is given in a Forestry Commission Information Note which is in preparation.

4.6.1 Normal and restoration management

For all conifer PAWS, the principles of management and restoration may appear similar but in practice may vary, principally in terms of scale. Standard uniform thinning favours the remaining crop but is less likely to result in shrub and tree regeneration than the creation of gaps and clearings. Restoration is usually a long-term process requiring several management operations over many years and there is no 'one-size-fits-all' option. It involves the re-establishment of a native woodland mixture by removing (over time or in one clearance) most of the introduced or exotic species, encouraging native plant species and enhancing any ecological processes that may have been compromised. Practical planning and methodology used for restoration will differ from site to site

reflecting local history and needs. The complete removal of conifers that normally occurs at the clearfelling stage may be brought forward if dormice are absent, but the edge of the plantation (to a depth of at least 50m) should be treated sensitively if there is any doubt.

4.6.2 Planning for management of PAWS

Before any operations take place, a planning phase should include:

- General consideration of potential dormouse populations.
- A simple site survey detailing the current conditions, previous species planted, past techniques employed to establish and to manage the crop, such as cleaning and thinning. Soil characteristics and the shading properties (light, moderate or severe) of the existing tree canopy should also be investigated. The presence, or not, of grazing or browsing mammals should be established.
- Identification of the likely restored woodland type. For example, the silvicultural regime that will be required according to site conditions, other local woods or national advisory systems.
- The listing of other objectives, opportunities, constraints, practical management, economic and landscape issues.

This will indicate the site potential and the nature of any restoration work (Thompson and others 2003).

Many PAWS woodland blocks are large and contain a range of adjoining stands often of differing species or ages in which dormice might live. Boundary belts, buffer zones and the timing of specific silvicultural works can vary across the different coupes within the wood, depending on the individual outcomes of the planning process. Alternatively PAWS may be a small component of the woodland area. Management and mitigation can thus be tailored to be sympathetic to dormice at the larger scale.

Whilst gradual restoration is the norm, there are important exceptions, such as areas of potential windblow or difficult access. Particular difficulties are associated with areas with dominant reseeding conifer species such as hemlock, or where the crop is at the final felling stage. Here, a more drastic single management operation may be necessary. In these situations advice should be sought from the Forestry Commission or English Nature.

4.6.3 Management operations: thinning and clear-felling PAWS

The management and mitigation of typical woodland operations in the presence of dormice has been referred to earlier and only additional information is provided below. Clear-felling in conifer PAWS has the potential to severely affect any dormice present. Felling all conifers adjacent to, or in, a broadleaved wood or coppice may suddenly remove a desirable seasonal resource such as food or nesting habitat. Large-scale removal in a plantation results in the temporary loss of resources within an already poor habitat. Either may reduce the dormouse population. The main way to ensure dormouse survival is to restrict the scale of operations in any one year to a scale similar to hazel coppicing, or to relatively narrow strips within a larger refuge habitat. Where possible, ensure that compensatory habitat is created (preferably during the planning phase) to ensure a refuge will be available.

For the final clearance of large areas, work should proceed over several years. First the centre of the block (around 5 ha) should be cleared, then the perimeter pushed back annually in a comb- or wedge-like pattern towards a previously prepared refuge habitat. Uncrushed brash strips should link the cut and uncut areas to provide sheltered access routes for dormice and other wildlife.

Good practice in relation to the management of PAWS

- Preferably create small glades, group fells and open rides whilst ensuring connectivity across and around the perimeter of the block.
- Use a patchwork approach, similar to the cycle of coppicing within a wood.
- Leave large and, where possible, small broadleaves and link these to unfelled areas.
- Leave any broadleaved habitat strips around the margins of conifer plantations and improve habitat connectivity.
- If occasional cross rack connections are not present, lodge trees from three rows back across the rack during the last extraction passage or ensure brash or tops are placed as wildlife access corridors at intervals of around 100 m.
- Consider enrichment by planting with native species used by dormice.

4.7 Managing problems caused by deer and stock browsing

Browsing suppresses regeneration and prevents the fruiting and flowering of shrubs. It is normally highly unsatisfactory for many reasons, not just dormouse conservation. Domestic stock (pigs, sheep and cattle) should always be excluded from woods that support dormice, particularly in winter.

Evidence of browsers can be seen in tightly nibbled twigs and coppice stools, small piles of spherical or oval black droppings and cloven-hoofed footprints in mud. In the absence of domestic stock, deer are likely to be the main animals involved and they are a widespread and increasing problem in woodlands throughout England and Wales. Where they occur in substantial numbers, the woodland floor may become devoid of many species and have few regenerating seedlings (or none at all). Often there is a lower 'browse line' visible on the trees in summer and the site begins to look open as the understorey is progressively removed or suppressed. Deer should be taken into account when planning woodland management as they may well prejudice the entire future woodland structure and composition. Fallow deer are a particular problem as they usually occur in groups, increasing their impact on small areas. Roe and muntjac deer tend to be more territorial, usually occurring as individuals or small family groups.

When patches of hazel are cut, the regrowth will be very attractive to deer. Their browsing may then severely retard growth of the hazel stools. Scattered coppicing may reduce this effect and will also create a better mosaic habitat for dormice. Cutting very large patches is said to reduce deer damage, but may eventually attract more of them! Also, large cut patches are unsuitable for dormice until the hazel has matured sufficiently to produce nuts.

Figure 16 Pollarded hazel. The poles are cut about 1.5m above the ground so that regrowth is out of reach of muntjac and perhaps other deer, which nibble off shoots as fast as they appear. Pollarded hazel grows quickly and may fruit earlier than conventional coppice.

If left unmanaged, deer will destroy large areas of understorey, reducing the food supplies for dormice, their nesting areas and their arboreal pathways. Habitat restoration may then take a long time, during which dormice could decline to extinction.

Three ways to prevent damage by deer:

1 Protecting individual shrubs or coppice stools

Individual tree guards, temporary fencing (plastic or light metal mesh or chestnut paling) or the permanent metal-mesh fencing of small areas or coupes may be appropriate. Some fence designs can be moved to another location later (Trout & Pepper 2005).

Fencing entire woods is standard practice against stock and an option against deer. It is also the easiest way to protect the shrubs and ground flora. 'Dead hedges' can be used to exclude deer by fencing off individual stools or groups of stools behind a wall of dead branches. Material cut when stools are coppiced can be used to form these barriers. This option is cheaper than buying fencing, but is very labour intensive and often not fully effective. Welded, galvanised metal fencing is now often used to exclude people from building sites, and similar panels may be installed in woodland areas to exclude deer. This fencing is highly effective, but unsightly and costly. Metal fencing lasts well and can be moved to another area as older growth becomes less vulnerable to deer. Chestnut paling can also be used to exclude deer from newly coppiced areas, but will probably be useful for only one cycle of coppicing, becoming too rotten to

move after about 5 years in position. Further suggestions for temporary and reusable fencing are given by Pepper (1999).

2 Pollarding instead of coppicing

Hazels can be pollarded about 1.5m above the ground, so that regrowth is mostly out of reach of deer (and rabbits). Pollarding results in shorter coppice poles, but this does not matter where the poles are not being harvested commercially. Pollarded hazels seem to fruit again sooner than those stools coppiced at ground level, helping to reduce the period when the cut hazels are providing little or no food for dormice. However, pollarding requires awkward and potentially dangerous actions at shoulder height using a chain saw or axe. Pollarded hazels also regrow into a form different from traditional coppice stools. This may be undesirable for aesthetic reasons, particularly in woods where public access and scenic considerations are paramount, although pollarding was a common and sustainable component of woodland management for many centuries. Pollarding hardwood trees up to 40 cm in diameter is often successful, except for beech and birch. Further advice can be found in Read (2000).

3 Deer culling

Deer numbers can be controlled by trained stalkers. Once their impact has been brought down to an acceptable level, deer management must be maintained to keep populations at a suitable density (typically under five per 100 ha). This is most effective if adjacent landowners plan deer management together, perhaps by forming a Deer Management Group. For advice and support contact The Deer Initiative, PO Box 2196, Wrexham, LL14 6YH. Tel: 0870 774 3677; info@thedeerinitiative.co.uk; www.thedeerinitiative.co.uk .

4.8 Squirrels

Squirrels compete with dormice for food supplies, especially hazel nuts. Evidence for this is provided by the Great Nut Hunt of 1993 (Bright, Morris & Mitchell-Jones 1996), in which over 170,000 gnawed hazel nuts were examined. The majority (about 90 per cent) were discarded in the field as having been eaten by squirrels, but 13,171 were submitted for further checking in the belief that they had been opened by dormice. Even these were, in fact, mostly also the work of squirrels (see Table 7). Grey squirrels are a particular problem because they commonly live at more than twice the population density of red squirrels, meaning that they eat more than twice as much potential dormouse food. Moreover, a squirrel may eat several nuts at a sitting, each one of which may represent a whole meal for a dormouse.

Removing squirrels may be desirable, but is probably not a cost-effective way of assisting dormice. However, in many areas squirrel control is already undertaken for other reasons. Where squirrels are shot or trapped, there is no hazard to dormice. Use of Warfarin-dispensing hoppers is now a widespread method of poisoning grey squirrels. However, although the hoppers are supposed to exclude non-target species, spillage of bait is common. This is unlikely to affect dormice as they do not normally eat wheat baits (as used in hoppers), cross open spaces, or feed on the ground. Hoppers should be inspected regularly to clear up any spillage but if they are properly supervised and placed near the ground, in open clearings, the risk to dormice is minimised. Nevertheless, once poison is put out, it is difficult to control what eats it.

Red squirrels also compete for essential dormouse foods but they are now rare or extinct over most of the range of the dormouse. Use of Warfarin dispensers is illegal in areas where red squirrels occur.

Table 7 Nuts identified by the public during the Great Nut Hunt of 1993 as having been gnawed by dormice. Of the 13,000 nuts submitted as opened by dormice, more than half had actually been opened by squirrels.

	Number of nuts	per cent
Opened by squirrel (and possibly some birds)	8,323	63.2
Opened by dormouse	1,352	10.3
Opened by wood mouse	1,190	9.0
Opened by bank vole	1,091	8.3
Unidentified, but not opened by dormouse	1,215	9.2
Total number submitted as 'dormouse nuts'	**13,171**	**100.0**

4.9 Hedges and their management

4.9.1 The importance of hedgerows

Hedgerows are of key importance for conservation in agricultural landscapes, both as habitat and as dispersal routes between patches of woodland. It is essential that hedgerow connections are maintained between dormouse sites, especially small ones, to allow exchange of animals between sites which ensures genetic mixing and avoids inbreeding. However, over the past 50 years, many hedges have been removed in pursuit of greater farming efficiency, especially in arable areas. In addition, changes in the management of hedgerows in the last few decades have had a profound negative impact on dormice. A survey in 2000 to 2001 of 59 hedgerow sites where dormice were present in the late 1970s found them absent from 64 per cent of sites, equivalent to a 70 per cent decrease over 25 years. Hedgerow management is now much more uniform and intensive (nearly all hedges on a farm are usually cut every year) and hand-trimming and laying has been replaced by the use of mechanical flails and cutters. Many of these intensively-managed sites no longer support dormice.

Dormice are often relatively numerous in hedgerow networks, so the removal of hedgerows and hostile management of those that remain has significantly reduced dormouse populations nationally. Loss of hedgerow dispersal corridors makes it likely that dormouse populations have become more isolated and metapopulation connectivity has broken down. A metapopulation is a network of populations in a landscape, linked by occasional movement of animals between them.

This is likely to precipitate dormouse extinctions in isolated woodlands as the small population fragments are vulnerable to poor breeding success or inbreeding.

Hedgerow shrub diversity is linked to dormouse abundance and dormice are indicators of ancient biologically diverse hedgerows. Loss of dormice from hedgerows is also of high conservation concern because the dormouse is a good indicator of biological diversity, which itself reflects the historical interest of the hedgerow. If the dormouse has gone, many other species will have been lost too. Hedgerows with fewer shrub species, especially those more recently planted in the midlands and East Anglia, are unlikely to support dormice. There are also regional differences, even where the habitats are suitable. For example, dormice were found to be less abundant in hedgerows in Carmarthenshire and most abundant in Sussex.

Hedgerows can provide a high quality habitat for dormice and population densities in hedgerows are similar to those for woodlands, sometimes reaching post-breeding densities of 30 per ha. Population density is strongly related to hedgerow height and shrub diversity. Densities of juvenile dormice are higher near to ancient woodland, implying that hedgerows

Hedgerow management good practice, for the benefit of dormice and hedgerow biodiversity

1 Except where road safety or access preclude it, hedgerows should be trimmed only every 3 years (or less frequently if possible) and maintained at a height of at least 3, and preferably 4, metres.

2 Ideally, about one third of hedgerows on a farm should be left to grow for 7 to 10 years.

3 It is important not to cut all hedgerows on a farm at once, so that some heavily fruiting hedgerows are always present. As a guide, we suggest cutting only 10 to 30 per cent in any one year.

4 In some places it may be feasible to cut only one side of the hedge, cutting the other a year or two later, thus not removing all the food sources at once and allowing some regrowth before further cutting takes place. If possible, flails should not be used to manage hedgerows.

5 Coppicing or, even better, laying should be used to manage hedgerows that become gappy or lack dense branches at their base. Fencing may be needed to prevent stock from causing damage before new growth has become established.

6 If hedgerow size needs to be reduced it is better to avoid cutting the top and to cut one side only.

7 When creating new hedgerows, or plugging gaps in existing ones, at least five and preferably seven different shrub/tree species should be planted. The best species to plant are hawthorn (for its flowers and berries) and hazel (nuts and insects); with a diversity of other species to offer flowers insects and fruits at different times (see Table 1). Bramble would make a valuable addition, but may arrive naturally.

8 Where new roads or other developments cut across hedges, the 'loose ends' should be linked up by suitable plantings. Mixtures of hawthorn and hazel are the preferred species where early results are needed.

9 Environmental Stewardship (in Wales, Tir Gofal) will support many of these measures (see below).

act as dispersal corridors, but dormice also breed in hedges and it is known that they establish permanent populations in many of them.

Hedgerow dormice feed on bramble, dog rose and hazel, but probably many other hedgerow shrub flowers and fruits too. Home ranges in hedgerows are longer than those in woodlands, but cover a much smaller area.

4.9.2 Hedgerow management

Hedgerows in arable landscapes and those with high hawthorn content tend to be cut most frequently. This is relevant because the abundance of berries increases from one to two years after hedgerow cutting and then slowly declines. Seed production in other species (for example, hazel) remains low until at least 6 years after cutting, before beginning to increase again. Frequent cutting of hedgerows, often every year, prevents the production of seeds and drastically reduces the number of flowers, nuts and berries available for dormice. Hedgerow cutting intervals need to be lengthened to avoid reduction in dormouse numbers.

Uncut hedgerows are more likely to be occupied by dormice, but can become straggly and cease to be stock-proof. A compromise management programme is therefore needed. It is recommended that most hedgerows should be cut at 3-year intervals, with some left to grow for at least 7 to 10 years. It is important that only a minority of hedgerows on a farm are cut in any one year. Cutting a hedgerow on its top has as much impact on dormouse density as cutting on both sides. Consideration should be given to hedge laying rather than cutting, especially as this will also help to prevent old hedges from becoming 'gappy'. Laying hedges to keep them stock-proof is a valuable alternative to installing wire fencing to close gaps, as flowering and fruiting can continue uninterrupted.

Where hedges are poorly maintained – especially where stock are allowed to browse or trample the hedge – large gaps may develop. These severely reduce the value of the hedge as a dispersal route for dormice and fragment the available patches of food. Radio tracking reveals that dormice will travel along hedges, but may turn back from gaps as narrow as 3 m. Even gateways could be a deterrent to free movement unless the gate is closed and the animals can cross the open space without descending to the ground. The larger the gap the greater the impediment to free movement, denying access to the food resources that lie beyond and reducing the extent to which the dormice can mix and interbreed. Gaps should be closed by planting and fencing-out stock and/or by laying existing shrubs. Such measures may also be desirable for reasons of animal husbandry and landscape considerations, and are also likely to benefit many other species that use hedges for shelter and as dispersal corridors.

4.10 Support for habitat management

4.10.1 Agri-environment schemes

Agri-environment schemes, currently known as Environmental Stewardship in England and Tir Gofal in Wales, can provide support for habitat management for dormice.

Environmental Stewardship has three elements:

- Entry Level Stewardship; open to all land managers.
- Organic Entry Level Stewardship; open to organic farmers.
- Higher Level Stewardship; discretionary and concentrates on more complex types of management.

Entry Level Stewardship (ELS) and **Organic Entry Level Stewardship** (OELS) include options for hedgerow management (EB1, EB2, OB1 and OB2) to maintain hedges at a height of at least 1.5 m, cut no more than once every 2 years; there is also an option for enhanced hedgerow management (EB3 and OB3) to maintain hedges at a height of at least 2 m, cut no more than once every 3 years, with no more than a third of the hedges cut each year. ELS and OELS also contain options for the maintenance of woodland fences and exclusion of livestock from woodland (EC3 and OC3); there is also an option for the management of woodland edges (EC4 and OC4) to encourage the woodland edge to grow out, requiring 2 m to be left uncultivated from the edge of the wood.

Higher Level Stewardship (HLS) contains an option for the maintenance of hedgerows of very high environmental value (HB12). This option will allow hedgerow management to be tailored to meet the specific requirements of a target species such as the dormouse. Where required, works such as planting up gaps or establishing new hedgerow trees may be funded by a Capital Works Plan. Support is also available for woodland management, as HLS contains options for the maintenance or restoration of small farm woodlands (HC7 and HC8), for example by rotational coppicing and livestock exclusion. New woodland may also be created (HC9 and HC10). Capital items such as planting new trees, fencing and the provision of dormouse nest boxes can be funded by a Capital Works Plan. There are also options for the maintenance, restoration or creation of successional areas and scrub (HC15, HC16 and HC17). Management can be tailored to provide ideal scrub conditions for specific target species, such as the dormouse, and may include livestock exclusion, allowing scrub to develop naturally, or managing the scrub by coppicing.

Further details of these options, and how to apply, can be found on Defra's website www.defra.gov.uk. Environmental Stewardship is managed by Defra's Rural Development Service (RDS); this will be replaced by a new agency, *Natural England*, in October 2006.

4.10.2 Woodland grants schemes

The Forestry Commission operates grant schemes for the stewardship and creation of woodlands in England and Wales. Details of grants are available from the Forestry Commission website at www.forestry.gov.uk.

5 Development and mitigation

5.1 Legal background and licensing

The dormouse is a European protected species. It is protected from deliberate killing, injury or disturbance and its breeding sites and resting places are absolutely protected with no requirement to show that their destruction was deliberate or reckless. Exactly what constitutes a breeding site or resting place for a dormouse has not been defined in case-law, but a narrow interpretation might include nests (summer or winter) currently in use or, perhaps, built or used during the current season. Because the dormouse is so embedded in its habitat and nests are difficult to find, a pragmatic approach is to treat any dormouse habitat as though it is protected and develop mitigation based on this assumption. This approach is also compliant with the duty to have regard to the conservation of biodiversity imposed on Government Departments by S74 of the Countryside and Rights of Way (CRoW) Act 2000.

If operations are proposed that would deliberately disturb, injure or kill dormice or destroy their breeding or resting places, protection against the possibility of legal proceedings can be obtained in two ways:

1 Ensure that the work meets the requirement of the defence that it was the incidental result of a lawful operation and could not reasonably have been avoided. Only a court can decide what is reasonable in any set of circumstances and readers may wish to seek their own legal advice as to the applicability of this defence. However, following the good practice guidance contained in this manual could help to demonstrate that reasonable steps had been taken to minimise any harm.

2 Obtain a licence from Defra (or the Welsh Assembly Government) to carry out the work. Licences can be issued where the work is for imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance to the environment. A licence cannot be granted unless there is no satisfactory alternative and the action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range. In England, licences are issued by Defra's Rural Development Service (RDS); this will be replaced by a new agency, Natural England, in October 2006.

In order to obtain a licence, it must be demonstrated by the applicant that all reasonable steps have been taken to minimise the impact of any disturbance, and that any damage will be adequately compensated. In practice, this means that a mitigation scheme will be required.

5.2 When is a licence required?

English Nature and Defra are frequently asked by consultants whether a Defra licence is required for a particular activity. Ultimately this is a decision to be made by the consultant and client. A licence permits an action that would otherwise be unlawful. To minimise the risk of illegal activities being undertaken, it is recommended that a licence is applied for if – on the basis of survey information and specialist knowledge – it is considered that:

- The site in question is demonstrably a breeding site or resting place for dormice.
- The proposed activity is reasonably likely to result in an offence being committed.

In addition, works can only be licensed when they meet the purpose and conditions set out in section 5.1(2) of this manual.

No licence is required if the proposed activity is unlikely to result in an offence. The advice given in this document should assist a consultant in arriving at a decision on this matter, though it must be recognised that determining whether a particular site is used as a breeding or resting place can be problematic. Note that if the proposed activity can be timed, organised and carried out to avoid committing offences, then no licence is required.

Examples of works that are likely to need a licence include:

- Clearance of woodland inhabited by dormice for development or road schemes.
- Removal of hedgerows inhabited by dormice for pipeline schemes or building works.

5.3 Possible impacts from development

Dormice may be threatened by destruction of their habitat, for example when woodland is cleared for development or conversion to other uses. Hedgerows may be removed as part of such developments or in the course of farm management. Radiotracking and surveys have demonstrated clearly the importance for dormice of linear features in the landscape, especially hedges. The loss of hedges, leaving remnant groups of dormice isolated in the landscape, can be very damaging. A typical example may be where a small copse is protected from development but is left isolated from larger areas of habitat and useful food resources. New roads and the widening of existing ones are also a threat, not just because of the destruction of dormouse habitat (for example, by removal of roadside hedges), but also because a new road is likely to be wider than the old. This constitutes a greater barrier to dispersal and will probably reduce movements between local populations. In the long term, this fragmentation of habitat and reduction of dispersal potential may be a greater danger than the more obvious threat posed by the destruction of a woodland site.

The long-term impact of increased human activity should also be considered when deciding on appropriate mitigation, particularly where high density housing is being built adjacent to habitat that previously was rarely visited by people.

Direct modifications to sites, including the felling of trees or scrub clearance, can have a significant impact on dormice. Even where trees and shrubs remain largely unaffected, or where work is done in winter, there may still be significant implications for hibernating dormice and the places where they overwinter.

Activities associated with development works are likely to lead to an increase in human presence at the site, extra noise and changes in the site layout and local environment. All these may have a detrimental effect on dormice, their needs for particular environmental conditions (such as specific temperature and humidity regimes), and a stable landscape that allows them to follow established routes to feed (see below). Sometimes it may be possible to lessen the impact, or measures may be taken to help the dormice through a difficult period.

5.4 Predicting likely impacts

The task of determining the impact of a proposed development is made easier by good survey information and detailed plans, showing pre-development and post-development site layout in relation to the places where evidence of dormice has been found. Sometimes called 'impact assessment', this is a critical phase of mitigation planning. This assessment can also help in considering alternative sites or alternative site layouts. For certain types of project, listed in schedules of the *Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999*, impact assessments are mandatory (Schedule 1) or discretionary (Schedule 2). Even when a statutory impact assessment is not required, Local Planning Authorities do have powers (for example, under the *Town and Country Planning (Applications) Regulations 1988)* to direct developers to provide any information the Authority may reasonably require to enable it to determine the application. The High Court has ruled (R. v. Cornwall County Council *ex parte* Jill Hardy, 22 September 2000) that for developments requiring an Environmental Impact Assessment (EIA), where there are grounds for believing that protected species may occur, environmental information (primarily survey results) has to be provided to the Local Planning Authority before determination. Initial surveys to determine the presence of protected species should not be a condition of the planning permission. It seems logical that these principles should also apply to non-EIA developments, since the guidance in the legal circular accompanying *Planning Policy Statement 9: Biodiversity and Geological Conservation* (PPS9) regarding protected species being a 'material consideration' is difficult, if not impossible, to implement where no survey information exists. Ideally, an impact assessment should inform the drawing up of detailed development plans, so that impacts can be avoided where possible. It is therefore important that a survey is undertaken as early as possible in the planning process.

It is desirable to consider direct and indirect impacts, both at the site level and in a wider perspective. The latter relates to the assessment of the overall importance of the site, and the broad context of the site should also form part of the impact assessment.

Timing should also be considered. If the site is part of a larger phased development, the potential consequences for the affected population(s) during later stages of the work also need to receive attention. For example, planting new habitat, only to have it destroyed during a later phase of development, does not constitute mitigation.

5.5 Roles and responsibilities

It is the responsibility of the organisation or individual wishing to carry out the development to make sure that they comply with the law. In practice, developers may wish to employ a specialist environmental consultant to carry out any survey, make

recommendations and, if necessary, apply for a licence. The statutory nature conservation organisations (English Nature or the Countryside Council for Wales) can provide general advice on protected species, advise Local Planning Authorities on specific planning issues and assist the licensing authority with the determination of licence applications. Further information about the roles of the organisations involved is given in Chapter 10.

5.6 Planning mitigation and compensation

5.6.1 Why mitigate?

Minimising the impact of development on dormice is fundamental to meeting the requirements of the licensing regime with its tests of **no reasonable alternative** and **imperative reasons of overriding public interest**.

The aim of the consultant and developer should be to achieve one of the following outcomes, in decreasing order of preference. Each of these scenarios should be designed to satisfy Regulation 44(3)(b) (see Section 6.1):

- **Most preferable.** Avoidance of impact; no negative impact on dormouse populations.
- **Minimisation of impact with on-site mitigation;** compensation by the improvement of existing nesting and feeding sites or the provision of new opportunities (such as nest boxes) within the site. Maintenance or reinstatement of hedges and tree lines linking wooded areas.
- **Minimisation of impact with off-site compensation;** where on-site mitigation is not possible, new habitats should be created nearby.
- **Least preferable.** In some situations, translocation of dormice may be needed.

The potential impacts of the development should be considered at the outset, so that, where possible, plans can be modified in order to achieve the preferred outcome listed above. This could entail the development of alternative sites, or the repositioning of structures to avoid impacts. Note that Defra licences to destroy breeding or resting places can only be obtained where there is no satisfactory alternative to that course of action. If impacts can be avoided completely the Habitats Regulations are not contravened and no licence is required.

5.6.2 Key principles of mitigation

Strictly speaking, there are two elements to the broader mitigation process:

- Mitigation – in the strict sense, refers to practices that reduce or avoid damage (for example, by changing the layout of a scheme, or altering the timing of work).
- Compensation – refers to work that offsets damage caused by a development (for example, by the creation of new habitat).

Both these elements need to be considered, the overall aim being to ensure that there will be no detriment to the conservation status of dormice. In practice, this means maintaining and, preferably, enhancing populations affected by development.

The following points should be considered when planning mitigation:

- **Mitigation should be proportionate.** The level of mitigation required depends on the size and type of impact, and the importance of the population affected. This is a complex site-specific issue. For example, a minor car park extension in an area of Kent where dormice are widespread would require less investment in mitigation than a major road driven through one of the few dormice sites in northern England.
- **Plans should be based on adequate knowledge.** Thorough surveys, site assessments and impact assessments are essential. The development plan should consider each predicted impact and suggest how it can be avoided, lessened and/or compensated for. The seasonal nature of dormouse activity may mean that survey work lasts for more than one year.
- **Mitigation should aim to address the characteristics picked up by the site assessment.** There should be minimal net loss of suitable habitat. Where significant impacts are predicted, compensation should offer more than has been lost. The reasoning behind this concept is that the acceptability of newly created habitat to dormice is not predictable. In addition, not all the new habitat may be immediately available due to the time it takes for planted shrubs and trees to bear fruits and flowers. Plans should aim to create similar habitat types (for example replace hazel coppice with hazel, not sweet chestnut) though it must be recognised that ancient woodland is irreplaceable. Compensation measures should ensure that the affected dormouse population can function as before. This may require attention to the environment around the development site, such as planting hedges to link adjacent habitats.
- **Preparing a site or appropriate replacement may require considerable time and effort.** For high impact schemes, additional land may need to be purchased, increasing the costs of compensation. Depending on circumstances, a long period of time may be needed to develop new plantings into suitable habitat for dormice.

- **The long-term security of the population should be assured.** Mitigation should aim to ensure that the population will be free from further disturbance, and will be subject to adequate management, maintenance and monitoring. Any proposals should be officially confirmed – ideally by a legal agreement or planning obligation – and not left as open-ended options.

- **Mitigation plans will be open to public scrutiny**. English Nature and Defra will make plans available to third parties on request wherever possible, as required by freedom of information legislation. If submitted as part of a planning application, plans will also be held on file by Local Planning Authorities and be available for public viewing.

- **Mitigation plans should address the impacts of all stages in phased developments.** Individual phases will normally be mitigated for individually, but there should be an overall plan that takes the impacts for the entire scheme into consideration.

Precautionary mitigation (that is, going ahead with mitigation before a proper survey has been undertaken) is not normally acceptable. An exception might be where there is good evidence to indicate that the site is of very low importance and there will be negligible impacts.

5.7 Mitigation and compensation methods

5.7.1 Introduction

This section gives advice on the methods commonly used for mitigation and compensation, paying particular attention to effort and timing. These are not the only methods that could be used, but they are generally effective and should be considered as good practice applicable to the majority of development schemes. As sites vary in their characteristics, and will have different impacts, the information presented here is generic rather than prescriptive; licence applicants may make a case for different techniques and levels of effort on a site-by-site basis.

It is the responsibility of the applicant (normally the consultant and their client) to make sure that any proposed mitigation meets other legal requirements.

5.7.2 Avoidance of disturbance, killing and injury

The Habitats Regulations and Wildlife & Countryside Act are constructed to give protection to individuals as well as breeding sites and resting places. This means that precautions must be taken to avoid the deliberate killing or injury of dormice, an action that is most unlikely to be permitted under the terms of a licence. Disturbance of dormice or destruction of their nests may be permitted under licence, but conditions are likely to apply.

Where habitat suitable for dormice would be unavoidably lost as a result of development, the extent of this loss will determine the appropriate course of action. Where habitat loss can be limited to a strip of woodland or scrub less than 50 m wide, or its equivalent, (less than the radius of a typical dormouse home range) and this strip remains linked to a larger continuous area of dormouse habitat, then displacement of the resident animals is the most appropriate option. This is also the most appropriate option where less than 100 m of hedgerow would be removed. Where greater areas (or lengths of hedgerow) need to be removed in any one location and in any one season, then translocation of the animals should be considered (see below).

5.7.3 Clearing dormice from a site prior to development

If an area of dormouse habitat needs to be cleared for development (for example, in a road widening operation), its type, size and position relative to other habitat are key issues in determining the most appropriate mitigation strategy. If the site is large or isolated, or perhaps only linked to one small hedge, then the dormice may have to be translocated, otherwise persuasion (see below) is the method of choice, provided that it does not result in more than doubling the spring population density in the remaining habitat.

Persuasion

If the land to be cleared forms part of a larger continuous area of dormouse habitat (a strip along the edge of a wood for example), then persuading the animals to leave by progressively clearing narrow strips of habitat is recommended. Each strip should be narrower than the radius of a typical home range for that habitat (an average of 50 m) encouraging the dormice to leave the area as the habitat becomes unsuitable. The dormice will then relocate of their own accord into the adjacent undisturbed habitat, especially if attractive features such as nest boxes are present there. However, deploying nest boxes between October and April will have no useful effect until the following summer as dormice do not normally use them during the winter.

Clearance in winter

This should remove sufficient vegetation to persuade dormice emerging from hibernation in April or May to move to more appropriate habitat nearby. Once emergence is complete, by the end of May, full clearance of the area can continue. Winter clearance should thus be planned as a two-stage process.

Trees and shrubs within the area in question should be cut down between November and March inclusive, to avoid both the bird nesting season and the majority of the period when dormice might be found in nests above ground. Clearance should be done by hand and in a sensitive

manner, to minimise the likelihood of disturbing or killing hibernating dormice. Similarly, the process of removing the cut material should, as far as possible, be designed to protect dormice hibernating on the ground. This can involve such techniques as:

- sacrificing a single 'haul-route', which has first been cleared by hand if necessary;
- using a long-reach mechanical grab and/or limiting the number of 'drag-lines' along which stems are removed; and/or
- directional felling to minimise the ground impact.

In some cases it is possible to leave felled stems until later in the year (brash should however be removed or chipped to avoid subsequent constraints associated with nesting birds). There will always be some parts of the site where hibernating dormice will be more at risk. In these situations, careful raking over of leaf litter and moss on the ground and the hand-clearance of log piles may help to find a few hibernating dormice before the machines move in. However, searching large areas is impractical.

In parallel with clearance operation, work should be undertaken within the retained woodland, hedgerow or scrub to increase its carrying capacity for dormice. This can include careful felling or coppicing work to increase the fruiting of selected understorey shrubs. Similar operations can also help form a new woodland 'edge' in situations where previously sheltered trees become exposed to wind-throw. Where there are few opportunities to improve adjacent areas for dormice, consideration should be given to advance planting of new areas nearby, or reducing the level of management in any adjacent hedgerows. The provision of nest-boxes can also be helpful.

Dormice emerging from hibernation in cleared areas will tend to move into the nearest retained vegetation. The coppiced stools in the cleared areas should then be dug up (usually in parallel with other earthworks), but this should be done no earlier than May of the following season. At this point consideration could be given to translocating some of this material to create new habitat, as explained below.

Even if quite small areas of habitat need to be cleared, the positions of these relative to other suitable habitat is a key issue. If parts of the site are so isolated that dormice hibernating there would not be able to reach areas of retained habitat, measures need to be taken to catch and remove these animals; either well in advance of clearance or from those fragments of habitat that remain following the coppicing works.

If larger areas of woodland are to be cleared for development, it may be necessary to repeat the above over more than one winter. Care should be taken to ensure that dormice displaced over one winter are not displaced again the next year.

Similar principles apply to hedge clearance, where clearance by hand or with hand-held machinery should avoid disturbance to the base of the hedge, where dormice may hibernate. Using heavy machinery to grub out hedges is likely to destroy dormice in their hibernacula.

Clearance in summer

Summer clearance is suitable for small areas of dormouse habitat (for example, less than 50 square metres of high quality woodland, larger areas of low quality habitat and short lengths of hedge). This may be done by taking out small amounts of vegetation on successive days at a time of year when the animals are active and able to respond immediately. Such clearance should be done by hand and should be combined with searches for nests. Clearance in May will avoid separating females from dependent young, but there may be a conflict here with nesting birds, at least up until about July. After early June, female dormice are likely to have young in their nests until about late September (depending on latitude and weather).

Whichever season is chosen for clearance, care should be taken to ensure that the number of animals displaced does not result in unnaturally high densities in the remaining woodland. As a rule of thumb, clearance of more than 10 per cent of any woodland (or woodland complex if well-connected) should be avoided. For example, a 10 ha wood may be capable of supporting a post-breeding population of 10 dormice per ha. Clearance of a single hectare (10 per cent) of this woodland over the winter might displace five dormice in the spring (allowing for 50 per cent mortality over the winter), resulting in a total population in the remaining 9 ha of 50 dormice or 5.5 per ha, well within the carrying capacity of the woodland.

Translocation

Where persuading dormice to relocate from a site is inappropriate, either because of the scale of the proposed operation or the lack of suitable adjacent habitat, the only remaining solution is to translocate the animals. This is the least favoured option because of the difficulty of catching all the animals and establishing them at an appropriate site elsewhere. Where a large area of dormouse habitat has to be removed in a single season, translocation is the only option, but a suitable recipient site must be identified in advance.

Persuasion – good practice summary

- For areas of up to one dormouse home range (approximately 1 to 1.5 ha of woodland or 300 m of hedge) clearance of bushy vegetation and tree felling in winter (November to March inclusive) is recommended as the least-damaging option. At this time, dormice will be hibernating in nests just below ground level and are vulnerable to crushing so every reasonable effort should be made to minimise disturbance to the ground. Clearance should therefore be planned as a two-stage operation, with removal of surface vegetation in winter followed by stump extraction and earth removal in the following summer.
- For smaller areas – including short lengths of hedgerow – clearance in summer is an acceptable alternative. Small amounts should be taken out each day to allow animals time to escape, and a search should be made for nests. The best times for this work are May and late September, when there is less likelihood of young being present in nests.
- Whichever method is used, care should be taken that the clearance does not result in an unnaturally high population density in the remaining area.

Guidance on translocation (and reintroduction) is given elsewhere in this manual, but it should be noted that translocation requires much preparatory work and finding suitable release sites can be difficult. Releasing translocated dormice into sites with existing populations is unlikely to be acceptable to the licensing authorities.

Dormice may be trapped for removal, but this requires large numbers of suitable traps as the animals live at low densities. The traps need to set off the ground and inspected twice a day, a labour intensive and costly process. A better method is to put up nest boxes at a density of at least 30 per ha. These should be in place well in advance of work at the site, preferably a year or more beforehand if possible. As a minimum, the nest boxes should be put up by early May and left in place until late October. The dormice should then use the boxes and be easily caught. Nest boxes should be left in place and inspected frequently until no more dormice appear in them. This will only be successful when the dormice are active (May to October) and it may take many weeks before the animals begin to use the nest boxes. Capture efficiency varies seasonally, and there is generally a dip in nest-box usage in June and July (see Table 5). Nest tubes may also be used for this purpose and there may be benefits in using a combination of tubes and boxes to maximise the number of dormice caught.

It is difficult to know when all the dormice are likely to have been caught, especially as others may move into the site during a removal operation. Table 2 gives an indication of the population density associated with different habitats, though these are spring pre-breeding densities. In late summer, good woodland habitat may have more than 10 individuals per ha and large hedgerows may have up to one adult pair per 300 m. Clearing a 50 m length of hedge where it adjoins other dormouse habitat may reduce recolonisation while removal operations are in progress.

5.7.4 Minimising and repairing habitat damage

So far as possible, removal of hedges should be avoided, as should the removal of large fruiting hazels and oaks. Removal of other species from a mixed woodland (for example, ash, holly, conifers) is unlikely to have significant effect except where their removal breaches access points and disrupts the continuity of dispersal routes. Planting hedges, particularly with a variety of shrubs, links up isolated copses and individual trees, thus helping the exchange between small dormouse populations and providing access to a wider range of food sources. This may be a valuable conservation option for new road construction, which often leaves small hedge and woodland fragments isolated from each other. Planting should begin as early as possible, preferably before other operations begin and not after clearance has been completed. This is to allow the new shrubs time to flower and fruit before the old habitat is removed. Planting bramble and other useful food plants is valuable if they fruit within the first year. Dormice cannot wait five years for hazel to mature!

Where heavy machinery is already on site, transplantation of vegetation (especially hazel stools) that would otherwise be uprooted and chipped or burnt can be a helpful and cost-effective measure.

Transplanting during the winter may achieve 100 per cent survival, even without watering, but after about May watering will be necessary or survival rates will be reduced. Shrubs moved in this way will fruit much earlier and more heavily than new saplings. In addition, transplanted shrubs will enhance arboreal connectivity, again at a much earlier stage, and particularly if combined with the 'dead-hedging' of cut material. If this is seen as a key aspect of a mitigation scheme, it should be done sensitively and with appropriate aftercare, in order to maximise the likelihood of survival and vigour of the transplanted material. Transplants may also reduce the visual impact of new developments. See Anderson & Groutage (2003) for guidance on habitat translocation.

Where strips of woodland edge are removed, or mature woodland is bisected, a 'wall' of high trees remains at the edge of the cleared area. In these cases it is better to

clear a few extra metres, then plant a fringe of species-rich shrubs. These will grow quickly, healing the visual scar and providing abundant food and shelter for dormice and other species.

Where possible shrubs and trees should be planted to fill in small gaps or to link habitats, in particular to link new plantings with existing areas of dormouse habitat. The Highways Act 1980, Section 253 allows for work to be carried out on third-party land for mitigation purposes, at least in respect of road developments. Again, such work should be started as soon as possible to allow time for maturation, and some landowners may be sympathetic to an early start in advance of the main operations.

5.7.5 Dormouse bridges and tunnels

Roads and other developments can cause significant incidental damage to populations of dormice by fragmenting habitats and creating barriers to natural movement. This is a particular problem for dormice because of their reluctance to cross open ground, but it is also an impediment to the dispersal of many other animals, for example reptiles, spiders and molluscs.

Habitat continuity and natural dispersal movements can be retained by building 'green bridges' to permit animals to cross roads and other newly-constructed barriers. For dormice, the cheapest form of overhead link is a pole or rope stretched between two substantial trees. Whilst this might be a feasible option within a wood (for example to temporarily bridge a narrow ride while arboreal links regrow) it is probably not applicable to larger scale situations. Although ropes have been suggested as a mitigation measure (Highways Agency 2001) there appears to be no published scientific evidence that dormice actually use them, but it remains a possibility. Ropes will be used (over short distances) by squirrels, and wooden structures (such as horizontal ladders) have been used elsewhere to assist monkeys to cross roads.
If ropes are to be tried for dormice, they should be taut and stabilised by lateral supporting ropes leading to adjacent habitats at 5 m intervals.
It is very unlikely that dormice will often venture more than a few metres on such an exposed structure, as radiotracking shows that they are normally only active within cover.

A cylindrical wire cage around the rope, made of welded mesh, might help to stabilise a structure and provide greater protection for dormice, while allowing them to get a better grip. A tubular cage-type structure, formed into a suspension bridge, might also offer a way forward and should be tested for use by dormice. It is likely that short bridges, whatever their construction, will be more likely to be used than longer ones and that attempting to bridge gaps of more than 100 m will be largely ineffective.

In Japan, a dormouse bridge has been built, based on a welded steel frame of the sort normally used for supporting road navigation boards. It is about 50 m long and there is clearance for large lorries to pass below. The bridge itself is about 1 m wide x 1.5 m high, and is encased in welded mesh to protect the animals. The floor is made of wooden boards along which lie a selection of branches cut from nearby trees. At each end, ropes and planted climbing vegetation link the bridge with the adjacent forests. The bridge was used within a few weeks by Japanese wood mice and within a year by Japanese dormice. The bridge was custom-made and expensive but a similar bridge might be constructed more cheaply, based on a standard overhead gantry used for highway signboards. Alternatively, suitable facilities might be built into existing gantries or as 'add-ons' to planned structures. Some structures of this type are currently being trialled in Britain, though their success has yet to be demonstrated.

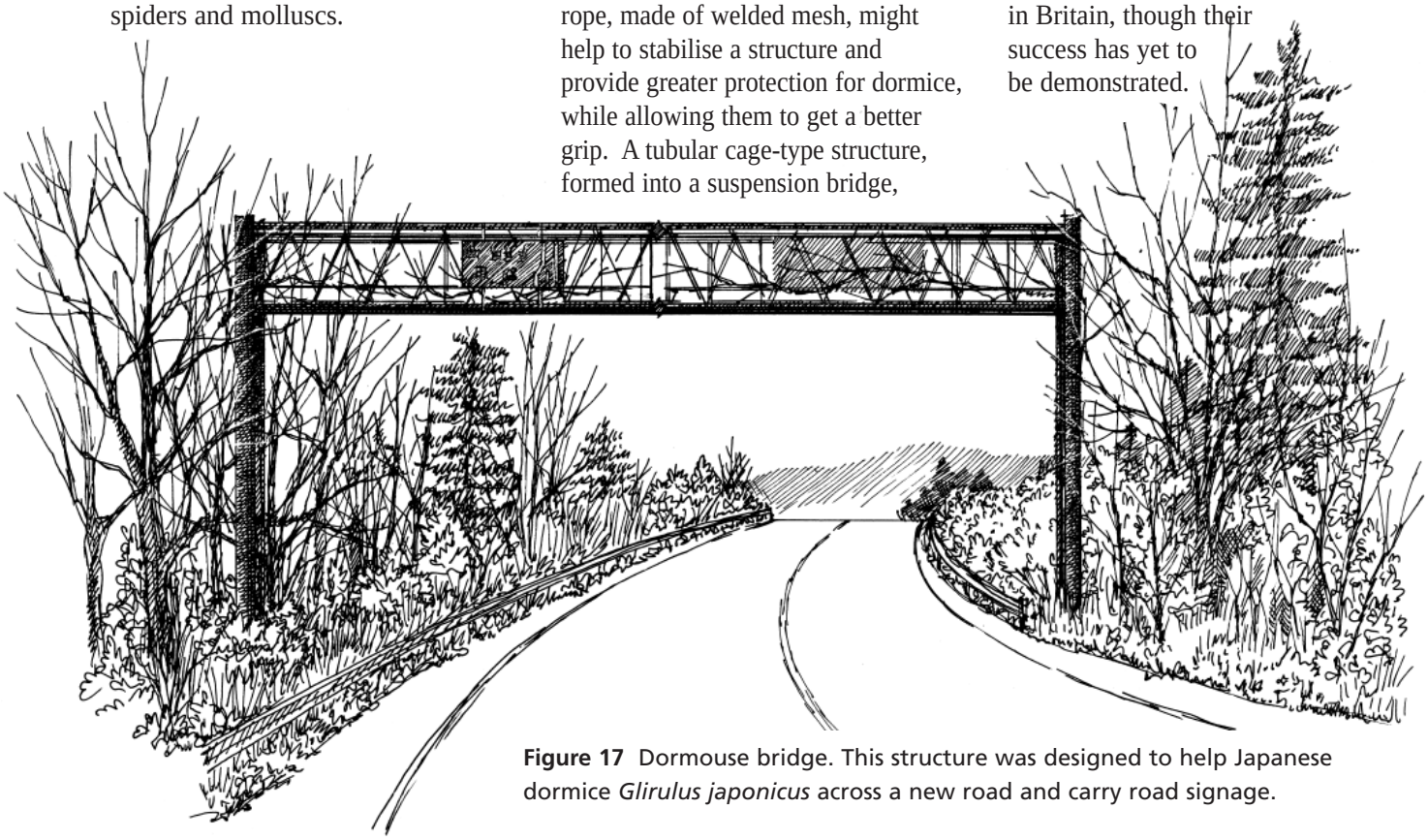


Figure 17 Dormouse bridge. This structure was designed to help Japanese dormice *Glirulus japonicus* across a new road and carry road signage.

In some parts of Europe, concrete 'green bridges' have been constructed with shrubs and other natural vegetation planted on top of them. In Germany, dormice have been shown to use such structures. However, much would depend on the nature of the shrub layer and how effectively it was integrated with the natural habitats at either end of the bridge. Some details and illustrations of habitat bridges are given in Iuell and others (2003), and one has been built over the Lamberhurst bypass (A21) in Kent and opened in 2005. Such bridges are expensive, but may benefit a variety of species, particularly those with low dispersal potential such as reptiles and invertebrates.

As an alternative to bridges, it may be possible to maintain habitat connectivity by planting shrubs in tunnels and culverts. This is only likely to be successful where the tunnel or culvert admits enough light enough to sustain plant growth. An example is shown on the cover, though the success of this form of mitigation is unknown.

5.8 Nest boxes

Provision of suitable nest boxes will help dormice adjust to newly created or modified habitats, particularly where new plantings mean a scarcity of natural tree hollows. Nest boxes appear to increase the 'carrying capacity' of the habitat, sometimes doubling the population density (Morris and others 1990). In addition, nest boxes benefit other species, including many invertebrates. Other mammals may also use them including bank voles, shrews and bats. Clearly provision of nest boxes is helpful in a broader sense than just dormouse conservation. However, this applies to boxes, not nest tubes. Plastic nest tubes are not adequate compensation for the loss of permanent nest sites.

5.9 Hibernating dormice

Sometimes hibernating dormice are disturbed accidentally during hedging, woodland management operations or site clearance. If possible, the animal should be quickly wrapped up in its nest and replaced, perhaps with a light covering of leaves, moss or twigs. If the site is to be destroyed or extensively trampled, transfer the nest and its occupant – with plenty of damp padding – to a more secure place within 100 m, on the ground (for example, tucked under the curve of a large log) or between the roots of a tree or bush. A large roof tile or suitably supported paving stone may be placed to cover the nest, protecting it from predators and helping to maintain moist and cool conditions. It is harmful for hibernators to be exposed to extreme frosts, but it is also damaging, and more common, to become too warm. This would be the case if the sun shone on a hibernation nest for an hour or so. The animal should only be removed as a last resort. If it is taken away, or caused to arouse fully, it should be kept in captivity and not returned to the site until the summer. On return it should be released within 100m of its origin. Dormice should not be released at a site unfamiliar to them without full support (see Chapter 7).

Reducing site damage: good practice guidance

In some cases, site destruction is unavoidable, but the damage may be reduced by:

- Limiting the use of heavy machinery for site clearance in winter, when dormice will be helpless in their hibernacula on the ground. They will be easily crushed, and in their inactive hibernating state, unable to help themselves.
- Carefully raking over leaf litter and moss on the ground in winter and clearing log piles by hand may find a few hibernating dormice.
- When clearing small sites, carrying out site activities in spring or late summer when the risk to dormice is reduced. Moreover, if clearance proceeds progressively from one edge of the site it may be possible to persuade the animals to move away into refuge areas over several days.
- Putting up nest boxes in refuge areas may entice at least some animals away from danger, but only in summer.
- Leaving mature oaks and other valuable trees wherever possible, and then using shrubs to link trees to each other and to areas of remnant woodland.
- Planting species-rich hedges to link isolated woodland remnants or reconnect remnants of damaged hedgerows. In the long term, this will allow the interchange of small mammals (including dormice), so reducing the dangerous effects of isolation.

6 Legislation, legal status & licensing

6.1 Relevant direct legislation

The hazel dormouse is a fully protected species under both United Kingdom and European law. It is also included in the UK Biodiversity Action Plan as a priority species.

The dormouse was given partial protection under the Wildlife and Countryside Act 1981. Schedule 5 of this Act was amended in 1988 making it a fully protected species. Protection is also afforded by Schedule 2 of the Conservation (Natural Habitats &c.) Regulations 1994, making the dormouse a European protected species. These two pieces of legislation operate in parallel, although there are some small differences in scope and wording.

The Wildlife and Countryside Act 1981 (WCA) transposes into UK law the Convention on the Conservation of European Wildlife and Natural Habitats (commonly referred to as the 'Bern Convention'). The 1981 Act has been amended several times, most recently by the Countryside and Rights of Way [CRoW] Act 2000, which added 'or recklessly' to S9(4)(a) and (b). Dormice are listed on Schedule 5 of the 1981 Act, and are therefore subject to the provisions of Section 9, which makes it an offence to:

- Intentionally kill, injure or take a dormouse [Section 9(1)].
- Possess or control any live or dead specimen or anything derived from a dormouse [S 9(2)] (unless it can be shown to have been legally acquired).
- Intentionally or recklessly damage, destroy or obstruct access to any structure or place used for shelter or protection by a dormouse [S 9(4)(a)].
- Intentionally or recklessly disturb a dormouse while it is occupying a structure or place which it uses for that purpose [S 9(4)(b)].

The Conservation (Natural Habitats &c.) Regulations (known as the Habitats Regulations) transpose into UK law Council Directive 92/43/EEC of 21st May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (often referred to as the 'Habitats [and Species] Directive.'). Dormice are listed on Annex IV ('European protected species') of the Directive meaning that member states are required to put in place a system of strict protection as outlined in Article 12; this is done through inclusion on Schedule 2 of the Regulations. Regulation 39 makes it an offence to:

- Deliberately capture or kill a dormouse [Regulation 39(1)(a)].
- Deliberately disturb a dormouse [R. 39(1)(b)].
- Damage or destroy a breeding site or resting place of a dormouse [R. 39(1)(d)].
- Keep, transport, sell or exchange, or offer for sale or exchange a live or dead dormouse or any part of a dormouse [R. 39(2)].

6.2 Interpretation and enforcement

As the legislation referred to above applies to a wide range of species, not just dormice, its provisions are generic in nature. For example, there are no detailed definitions of exactly what constitutes a 'resting place' for a dormouse, nor what has to be proved to establish that an act could not reasonably have been avoided. Were a breach of the law to be alleged, a court would have to decide whether an offence did in fact occur. Note that, under the 1994 Habitats Regulations, damaging or destroying a breeding site or resting place is an offence regardless of whether the act was deliberate or not. There are currently no legal precedents (that is, cases in the Crown Court or higher) that are helpful in interpreting what constitutes a place used for breeding and resting.

The Police are the main enforcement body for wildlife offences, and in some cases Local Authorities may also take action. Section 24(4) of the 1981 Act gives English Nature (or the CCW) the function of providing advice or assistance to the Police in respect of alleged offences. The maximum fine on conviction for offences under Section 9 and Regulation 39 currently stands at £5,000. The Countryside and Rights of Way (CRoW) Act 2000 amended the 1981 Act to allow for a custodial sentence of up to six months instead of, or in addition to, a fine. Penalties may be imposed in relation to each offence committed, so operations involving many animals or repeated offences can potentially accrue large fines. In addition, items which may constitute evidence of the commission of an offence may be seized and detained. The CRoW Act 2000 also amends the Police and Criminal Evidence Act 1984 to render Section 9 offences 'arrestable', giving the police significant additional powers.

6.3 Exceptions and licences

There are several exceptions (defences) to the provisions listed in section 6.1 above. For example, a disabled dormouse may be lawfully captured solely for the purpose of restoring it back to health for subsequent release, and 'mercy killing' of severely injured dormice is also permissible without a licence. Both the 1981 Act and the Habitats Regulations provide a defence to the offences listed in section 2.1 above in cases where "**the act was the incidental result of a lawful operation and could not reasonably have been avoided.**" [S. 10(3)(c) of the Wildlife and Countryside Act and Regulation 40 (3)(c) of the Habitats Regulations].

English Nature can issue licences to allow otherwise prohibited actions (such as catching and handling dormice) for scientific or educational purposes. This covers marking them, conservation work, photography or protecting zoological collections. Applications should be made to the Licensing Section, English Nature, Northminster House, Peterborough, PE1 1UA. Similar licences for work with dormice in Wales are available from the Countryside Council for Wales, Maes y Ffynnon, Penrhosgarnedd, Bangor, Gwynedd, LL57 2DW. There are no dormice in Scotland. Licence applications should be supported with evidence of competence in the activities for which a licence is required, such as previous attendance at a dormouse training course or working with a current licensee. A licence may be refused unless suitable knowledge and experience (especially of handling) can be demonstrated.

Licences in connection with public health or safety, prevention of the spread of disease or the prevention of serious damage to livestock, crops or other property are available from the Rural Development Service (RDS) of the Department for Environment, Food and Rural Affairs (Defra) or, in Wales, the Welsh Assembly Government. Since dormice do not carry serious diseases or do significant damage, it is unlikely that these provisions will apply. In addition, these authorities issue licences for the purposes of "**preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment.**"

In every case, a licence cannot be granted unless:

"**There is no satisfactory alternative**"; and

"**The action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range.**"

'Favourable conservation status' is defined in the Habitats and Species Directive (Article 1(i)). Conservation status is defined as "**the sum of the influences acting on the species concerned that may affect the long term distribution and abundance of its population within the territory.**" It is assessed as favourable when:

"**population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats**":

"**the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future**"; and

"**there is, or will probably continue to be, a sufficiently large habitat to maintain its populations on a long term basis.**"

Further information about the operation of this licensing regime as it relates to development is given in Chapter 5. Note that a new Agency, Natural England, will take over the licensing roles of English Nature and the Rural Development Service in October 2006.

This is only a general guide to the main provisions of the law. The Wildlife and Countryside Act 1981 and the Conservation (Natural Habitats &c.) Regulations 1994 should be consulted for further details.

6.4 Incidental protection

The dormouse is also incidentally protected by the Hedgerow Regulations 1997, which are intended to prevent removal of important hedgerows. The criteria for defining an important hedgerow include a record of the presence of any species protected by Schedule 5 of the Wildlife and Countryside Act within the 5 years before the passing of the Act (that is, the period from March 1992 to March 1997). Approval of the Local Authority is required before such a hedge is removed and there is an appeals process involving the Secretary of State. Environmental assessments are required (under European Directive 82/357/EEC, as amended), where proposals for new road developments and for improvement of existing roads are considered to have significant environmental effects. The Directive is enacted in the UK by the amended Highways (assessment of environmental effects) Regulations (1988), for motorways and trunk roads, and the Town & Country Planning (assessment of environmental effects) Regulations (1988), as amended, for local authority and private roads and associated works. Effectively, these regulations require that actual or potential presence of protected species be taken into account when major developments are planned. Surveys are required to confirm presence or likely absence of protected species. In the former case, mitigation measures must be implemented to compensate for the damage done to protected species, so as to avoid their local extinction as a consequence of the planned development.

The UK Government is a signatory to the Convention on Biological Diversity ('The Rio Convention') and consequently committed to conserving and enhancing biodiversity. This is given force by the Countryside and Rights of Way Act 2000 (Section 74), which imposes a duty on Ministers and Government departments to have regard to the purpose of conserving biological diversity when carrying out their functions and also to take appropriate steps to further the conservation of listed priority species.

6.5 Planning policy

Planning Policy Statement 9 (PPS 9): Biodiversity and Geological Conservation embodies the Government's commitment to conserving biodiversity through the planning system and states that the presence of a protected species is a 'material consideration' in assessing a development proposal. The guidance sets out policy as it relates to nature conservation in England and, although only advisory, it can be seen as providing guidance on good practice in the planning system. PPS9, which is accompanied by a legal circular and good practice guidelines, also offers guidance on the roles and responsibilities of Local Planning Authorities and statutory nature conservation organizations, with regard to development control affecting SSSIs and other designated sites. It is particularly relevant to Local Authority road schemes and associated developments such as service areas. The equivalent document in Wales is the Planning Guidance (Wales) Technical Advice Note (TAN) 5 – Nature Conservation and Planning.

7 Captive breeding and reintroduction to the wild

7.1 Captive breeding

Dormice are nocturnal animals with specialised requirements and should not be kept as pets. Taking them from the wild for this purpose is illegal. A specialist consortium of zoos and volunteers (the Common Dormouse Captive Breeders Group) maintains a captive population of dormice, based on dormice rescued from cats and animals taken (under licence) from the wild that would otherwise probably have died. The purpose of this captive population is to maintain the animals in sufficiently large numbers to supply dormice for reintroduction projects intended to supplement fragmented wild populations.

Rescued animals or those found by accident should be released if possible where they were found, or kept until further advice is obtained (from English Nature or the Common Dormouse Captive Breeders Group, c/o Paignton Zoo Environmental Park, Devon TQ4 7EU). Dormice taken into captivity temporarily for welfare reasons should be fed fresh food daily (apple, carrot, grapes) with nuts, biscuit and seeds provided in quantity. Fresh water must always be available. Adult males must be caged separately, but may be accompanied by one or more females. Each animal should have its own nest box, even if they choose to share the same one. Fresh hazel or other tree branches should be provided so the dormice do not lose their agility, reducing their success in the wild. Dormice should not be encouraged to become tame or they may be insufficiently wary of predators after release. Cages must allow plenty of vertical space for climbing and should ideally provide more than 0.75 cubic metres per animal. A deep tray in the floor of the cage should be filled with soil or peat, covered with moss. This will provide a place to hibernate. The soil should be kept damp by weekly spraying with water throughout the winter otherwise the hibernating dormice may become dehydrated. Hibernation is unlikely to be successful in a conservatory where the temperature may often be too warm in winter, causing disruptive arousals and faster depletion of fat reserves. It is better for dormice to be cool; even hard frosts are not a serious danger to them.

Juvenile dormice weighing less than 15 g in late October generally do not survive the winter. Their removal to captivity therefore does not significantly affect the wild population, but is illegal unless licensed by English Nature. Licences may be granted for approved conservation projects, but these need to be long-term and part of an integrated national programme for dormouse conservation.

7.2 Reintroductions and translocations

English Nature, in partnership with the Mammals Trust UK, is committed to re-establishing dormice in counties where they have become extinct. Extinction often resulted from past problems that have now ceased and extensive areas of potentially suitable habitat are available but lack dormice because they are unable to recolonise naturally. There is also a desire to reinforce populations in areas where dormouse sites are few and widely scattered as a result of habitat fragmentation. In such cases, filling in gaps between existing relict populations may help to conserve the species as a whole by reducing the isolation of surviving groups.

Sometimes there is a need to move dormice (for example, from a large development site or road widening scheme) and release them elsewhere. In such cases, it is strongly advised that, where translocation is likely to be needed, liaison with the Common Dormouse Captive Breeders Group and English Nature is likely to be mutually beneficial. Where translocation is needed to remove dormice from a development site, it is generally better to release animals into nearby suitable sites, or to areas where the habitat has been enhanced in advance (for example, by appropriate planting). Nest boxes should also be in place, preferably at a density of about 20 to 25 per ha.

Sites suitable for releasing dormice have the following features:

1 A diverse, unshaded and productive understorey, preferably dominated by hazel.

2 A variety of other supportive tree and shrub species (see Table 1).

3 At least 20 ha of suitable habitat, less only if the site is well connected to other woods.

4 At least 100 nest boxes in place, with appropriate monitoring arrangements.

5 A commitment to suitable site management in the future.

Selecting suitable sites for releases to take place is time consuming. Sites need to have more than 20 ha of suitable habitat, yet be currently free of dormice in order to avoid territorial conflicts and excessive pressure on food and nesting resources. The aim of releasing dormice must be to establish a viable population, not just 'let them go'. It is therefore important not to release dormice in circumstances where the majority will soon die. It is also potentially wasteful to 'reintroduce' dormice to sites where they are already present and may occur at a low density for natural reasons. Where dormice are already present resident males may kill released individuals, so checks should be made for evidence of dormice being present before plans proceed.

An essential part of preparatory work is to carry out a disease risk analysis, particularly to detect alien (non-native) parasites in the donor population. The introduction of alien parasites into the native population of dormice could cause an epidemic. At this stage it is also important to determine the potential effect of native dormice and their parasites on the reintroduced individuals' health. If the conservation benefits of a reintroduction are considered to outweigh the disease risks, and the reintroduction goes ahead, it is important to carry out a health surveillance of the reintroduced animals, before and after release, to safeguard their welfare. Disease risk analysis and health surveillance for the national reintroduction projects is carried out by the Zoological Society of London, Regents Park, London, NW1 4RY.

Release of small numbers of animals carries a disproportionate risk of failure. Translocations should therefore be based on releasing groups of 30 or more animals. Released animals should weigh at least 16 g, preferably more than 20 g, or they may have insufficient reserves to survive the first few days. Studies have shown that captive-bred animals have a lower survival potential when released into the wild. However, they still play a vital part in reintroductions, when properly managed. It is often difficult to obtain sufficient wild-caught dormice to form a viable release group. If small numbers of dormice are obtained (for example, as part of a rescue operation) it is better to contact the Captive Breeders Group and arrange for them to become part of a larger release group.

It is pointless to release dormice unless the habitat is suitable and large enough. It is also important that the cause of their original extinction has been removed and that a secure commitment has been obtained to ensure that future habitat management will favour dormice. Site preparation should include provision of at least 100 nest boxes. These will be needed not just to aid the dormice, but also to allow future monitoring of numbers and success.

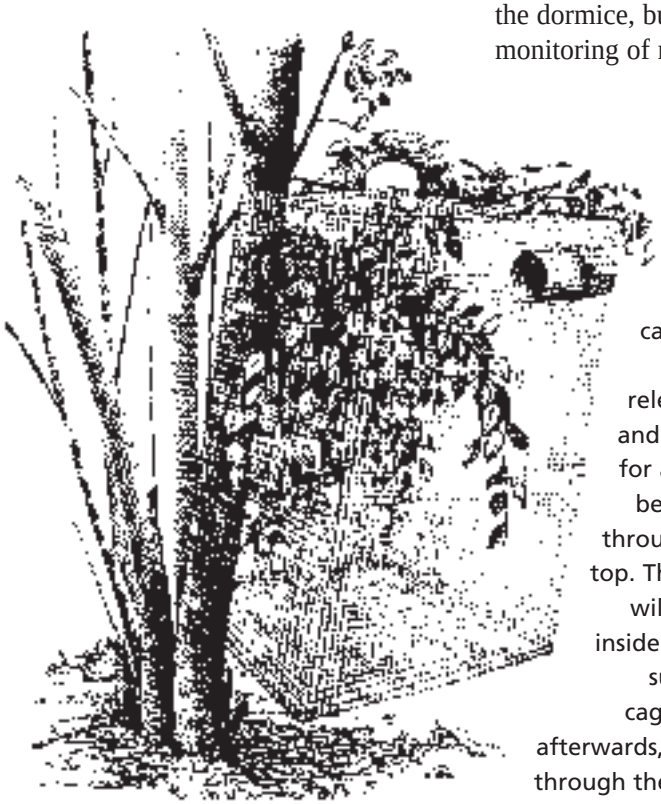


Figure 18 Pre-release cage attached to a tree. Dormice intended for release are installed here and acclimated to the site for about ten days before being allowed to escape through a small hole in the top. They can then return at will to use their nest box inside. Extra food should be supplied in the opened cage for at least a month afterwards, replenished regularly through the plastic access pipe at the side of the cage.

Release without provision for monitoring and proper habitat preparation is irresponsible.

Dormice have complex ecological requirements. Studies have shown that if they are simply let go, the majority will disperse and/or starve to death within a few days. They require support after release. For this reason, they should first be established in pre-release cages. This allows them to become accustomed to the site before release. Cages made from welded mesh should be attached to one of the poles of a mature hazel. Each should contain two or three nest boxes and plenty of fresh hazel branches to provide shelter and allow the animals to climb about. Ideally, each cage should contain a male and female pair of dormice that have been familiar with each other for several weeks, as they are more likely to stay together. It is also possible to use single dormice, a mother and litter of young, or one male with two females. Release cages containing adult males must be 100 m apart or fatal aggression may result when the animals are released. Cages with only females should be sited in-between male-only cages. Overall, the aim should be to release similar numbers of males and females.

The timing of releases is critical. If animals are let go late in the summer there will be plenty of food for them, but any offspring they produce will have too little time to fatten up for the oncoming winter. This is important because the production of a large number of young in the first year of reintroduction is critical to its success. Releases should therefore take place no later than early July. Animals should be introduced into the pre-release cages in mid-to late-June and kept there for at least 10 days to become accustomed to their new surroundings. They must be fed fresh fruit like apple daily, with a constant supply of biscuit, peanuts and sunflower seeds. If food is not eaten, the cage should be opened and the health of the animals checked. Releases should be made during fine weather, avoiding cold periods, by making a small opening (about 3 cm) in the cage roof. This will allow the dormice to come and go as they please. The aperture should be small enough (about 5 cm x 5 cm maximum) to exclude squirrels and birds that will otherwise raid the cages for food.

Food must be continuously available in the cages, with the fruit renewed daily, for at least 2 weeks. After that, the fruit may be slowly withdrawn. This supplementary food is important during the establishment period. It also helps maintain body condition in the females so that they can successfully produce and rear their young. Moreover, feeding helps to maintain a cohesive population; without it dispersal is likely, reducing the probability of breeding. It is very important that the new population should breed and build up its numbers as soon as possible. Once the natural fruit and nut crop is ripe (usually late August), all artificial feeding should cease in order to encourage the development of natural feeding habits.

By late August, the animals should be independent and their cages can be removed, leaving the nest box in place. All the nest boxes should be checked in September and October to count and weigh the dormice and to note numbers of young. After this they should be left alone until May the following year.

Checklist of things to resolve before releasing dormice

1 Are there dormice already present? If so, why are more being released?

2 Is the site big enough to support a viable population in the long term (that is, more than 20 ha).

3 Is the habitat and its management suitable? If so, why are dormice not present already?

4 Where are the dormice coming from; are there sufficient numbers?

5 Have relevant licences and permissions been obtained?

6 Are the necessary 100 plus nest boxes available, with people to put them up?

7 Are pre-release cages available and ready to put up?

8 Is there a team of people organised to ensure daily feeding at the crucial time?

9 Is there someone who will check the nest boxes regularly, now and in future?

10 Have English Nature or the Countryside Council for Wales, and the relevant County Wildlife Trust been informed?

11 Have arrangements been made (and licences obtained) for permanent marking, where long term monitoring of individuals is part of the project plan?

There should be monthly monitoring of the nest boxes to observe progress. Details of the release should be deposited with English Nature and the local Wildlife Trust. This is to ensure that future conservationists will know when and where the animals were introduced and also what happened to them. Such records are important, even in the case of failure, to aid future conservation management. At present, no licence is necessary to release dormice (although this may change in the future), but a licence is needed to check dormouse nest boxes.

Criteria of success

True success will only be achieved when the new dormouse colony is self-sustaining in the long term. Often the notional target is set of having a secure population still present in 100 years time, in the meantime other short term milestones should be passed:

Stage 1 Release should be accomplished by July, with animals returning to feed in their cages, even if they do not live in them all the time.

Stage 2 There should be young born at the new site, preferably by September of the first year.

Stage 3 At least some animals should still be alive after the first winter, present in the nest boxes in May of year 2.

Stage 4 The second summer should see the birth of second generation young (i.e. born to females who themselves were born at the site), but this will be difficult to demonstrate unless the original released animals had been permanently marked.

Stage 5 The third or fourth summer should see more adults present than were originally released (that is, survival should by now exceed losses).

7.3 Progress so far

To date, more than a dozen successful reintroductions have taken place (see Bright & Morris 2002, for a summary up until 2000). Several additional translocations have also taken place to mitigate the impact of development projects, especially road construction.

Successful reintroduction comprises two phases: establishment (when a population becomes self-sustaining) and spread (when population size and distribution increase sufficiently to escape the high probability of chance extinction to which small populations are vulnerable). Like the majority of species reintroductions, dormouse releases have taken place over small areas and involved a small founder population. Spread is therefore a vital component of successful translocation, ensuring that a viable population is established, capable of persisting over time. However, spread (of dormice or other mammal species) has rarely been measured following reintroductions or translocations.

An assessment of the success of the 11 dormouse reintroductions carried out between 1993 and 2002 has been made by Sanderson (2004). In order to measure dispersal, over 1000 dormouse nest tubes were set up around the six earliest reintroduction sites still supporting dormouse populations. Grids of nest tubes were placed at distances of 500 m, 1000 m and 1500 m from the sites of the original reintroductions. Checking for dormice in September and October 2002 revealed that most of the earlier reintroductions had resulted in both establishment and spread of the population.

The number of dormice living away from their release site was positively related to the size of the founder population: the more animals released, the better they had spread. Habitat connections with other woods and hedges were also important. Single large woods providing high quality habitat rather than smaller, connected ones, also encouraged rapid spread. Dormice were able to colonise connected woods, but spread occurred more slowly between woods than within woods.

It also seems that, although juveniles may colonise new sites quite readily, it takes some years before a permanent population, including adults, becomes established. Nevertheless, four of the original reintroductions had reached the spread phase in less than 10 years, and three had developed satellite sites nearby, with populations of more than five dormice per hectare.

Using VORTEX (population modelling software), and assuming a founder population of 30 animals, the probability of extinction within 100 years was less than 30 per cent in good habitat, but over 45 per cent in poorer habitat. This emphasises the vulnerability of single dormouse populations and highlights why they have often disappeared from small isolated sites. When catastrophes (such as temporary, but severe, reduction in breeding success) were included in the population model, the likelihood of extinction was almost 50 per cent, even in the best conditions. Population modelling also suggested that reintroductions are more likely to create a quickly spreading population if they have a large founder population, preferably more than 40 animals. However, larger numbers may be logistically impractical.

8 The National Dormouse Monitoring Programme

8.1 Monitoring Dormice at National and Regional Level

The National Dormouse Monitoring Programme (NDMP) collates data from more than 200 key sites in various parts of the country. The aim is to collect long-term data about abundance, annual variation in timing and success of breeding, and also population density in different habitats and geographical areas. A newsletter *The Dormouse Monitor* is distributed to participants. Recording forms are available and new sites qualify for addition to the scheme provided they have at least 50 nest boxes in place and someone willing to monitor them regularly. Submission of data to the NDMP is a standard condition of English Nature licences to inspect nest boxes. The NDMP is administered by the People's Trust for Endangered Species (PTES) and the Mammals Trust UK (MTUK); details are available from English Nature or the MTUK.

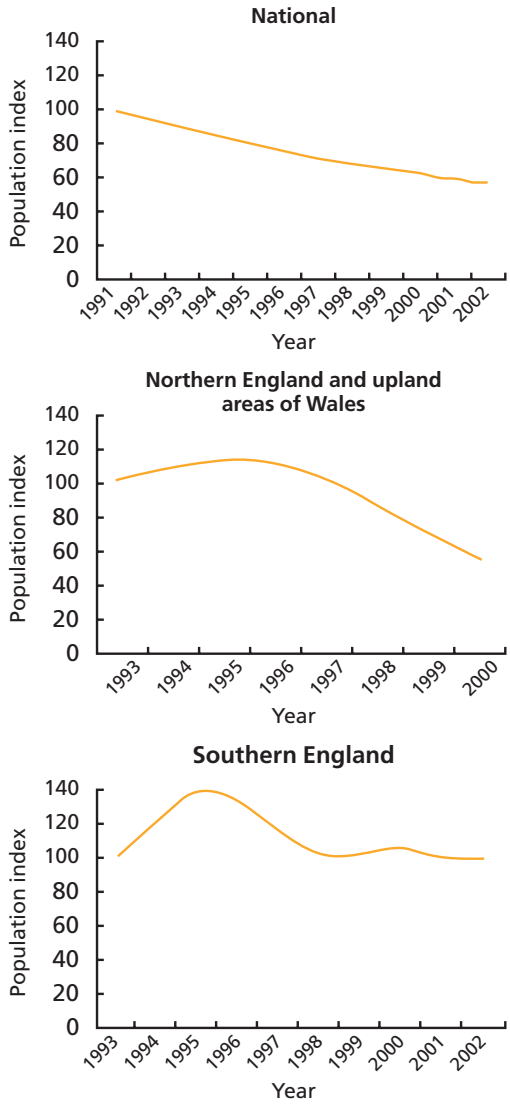


Figure 19 Population trends from the National Dormouse Monitoring Programme. The index of abundance shows changes since a 1993 baseline. There appears to have been a downward trend in the north of England and parts of Wales, but dormice seem to be holding their own in the south.

The year-by-year results of monitoring dormouse populations are reported to contributors via *The Dormouse Monitor*, circulated twice a year and also freely available on the MTUK and PTES websites. However, the number of dormice recorded in nest boxes fluctuates in response to factors such as the weather, so although short-term results may be very interesting, they do not necessarily indicate real long-term trends. Short-term variability can easily mask real changes and compromises attempts to substantiate statistically any trends that appear to be happening. Fortunately, we now have long sets of data from nearly 100 sites, allowing an analysis (by Fiona Sanderson) to assess whether the system works or not, and what might be learned as a consequence.

The key question is whether the NDMP can detect a population change of conservation significance, or whether more sites need to be added to the scheme to make it reliable. The 'red alert' decline figure used in bird monitoring in the UK is 50 per cent change over 25 years, equivalent to about 27 per cent over 10 years. It seems that, with 100 monitoring sites, the NDMP can easily detect a national

decline of about this level. We may need more sites in particular regions (especially in the north) to detect more localised changes, but the NDMP is effective enough to detect significant national trends.

The next question is whether there really has been any trend in dormouse abundance over the last few years. In fact, there have been major changes in abundance, but the trend differs in different parts of the country. Data from 83 NDMP sites suggest a national decline of about 19 per cent in dormouse abundance between 1991 and 2000 (Sanderson and Bright, in preparation). Populations in northern England have declined much more (by 40 per cent between 1993 and 2000), while in southern England the total population appears to be relatively stable.

Dormice are extremely sensitive to the weather, and as habitat specialists, they are also likely to be sensitive to changes in the quality of their habitat. The National Dormouse Monitoring Programme allows analysis of the likely effects of these environmental factors on dormouse abundance. Weather can affect populations in different ways at different times of year. Dormice need cold, dry winters to hibernate successfully and if temperatures rise suddenly in winter, they wake up, but risk starvation as there is no food available. However, in summer, dormice need warm, dry conditions, both to encourage fruiting and flowering of food plants, and to keep them awake and breeding instead of cold and torpid.

In fact the monitoring data confirms that weather affects dormice at most times of year. Dormouse numbers are higher in years following a cold, dry winter or warm spring. The number of young dormice born per female is higher in hot dry summers than at other times. However, warm springs and hot summers only benefit populations in woods that have food plants (such as oak trees), which support the large numbers of insects that provide food early in the breeding season. Hot spring and summer weather does not have the same impact at sites where dormice breed later in the year. This means that the same weather has different effects upon different populations. Unlike dormice in continental Europe, from Lithuania to Italy, British dormice usually only raise a single litter each year. Their breeding success is therefore very vulnerable to cold, wet weather occurring at peak breeding times, which can send them into torpor and also reduce the fruiting and flowering of their food plants. Studies at the University of East Anglia suggest that there is an ongoing increase in air temperature and winter rainfall in Britain, with a marked increase in north-west England. There is also an increase in spring days with high rainfall in all regions where dormice occur except parts of south-east England. This does not bode well for dormice and changes in weather patterns may explain the changes already seen in dormouse numbers, both regionally and over the past century.

Although summer weather seems to be getting hotter, the NDMP suggests that there is no significant increase in the numbers of dormice being born. At many sites, the number of juveniles born per female has actually declined since 1993. The decline may be due to decreased productivity, and the environmental factor causing it may be habitat quality. Dormice are sensitive to small changes in their habitat and there have been major changes in our woods that are likely to have been detrimental to dormouse conservation. For example, increased deer populations and the ingress of sheep into ancient woods leads to the browsing of some important food plants and the trampling of others. Changes in woodland management, such as coppicing, also impact on dormice. Targeted management could help to reverse these effects and conserve dormouse populations. Using NDMP data for a population modelling study showed that retaining a high proportion of mid-aged hazel coppice (between 6 and 25 years), and increasing the proportion of the site containing of mid-ages coppice from 10 per cent to 50 per cent could increase dormouse populations by over 50 per cent, but only in woods where the hazel had previously stopped fruiting abundantly. Where the existing hazel was still fruiting well, coppice management was related to a (possibly temporary) decrease in population size, perhaps because coppicing, however necessary, is a form of disturbance.

So dormouse populations are extremely sensitive to both climate and habitat quality and also to the interaction between them. They are therefore one of the species that we particularly need to monitor in a changing world.

8.2 Other recording schemes.

Most counties now have a wildlife data recording system as part of the National Biodiversity Network (NBN), usually based either with the local Wildlife Trust or the Local Authority. The aim is to collect locality data for plants and animals, so that their distribution is properly known. In addition, there is a Dormouse Site Inventory held by English Nature but available via the NBN (www.searchnbn.net). The purpose of this is to make it easier to decide where new surveys are needed and which sites are at risk when new developments are proposed. It is important that translocations and fresh surveys should input data to one or more of these systems to keep them up to date.

9 Conservation achievements and priorities

9.1 The UK Biodiversity Action Plan

The dormouse is a priority species in the UK Biodiversity Action Plan (UKBAP) and has an individual Species Action Plan. Joint Lead Partners for this plan are English Nature and The Wildlife Trusts. The plan's current targets are to maintain and enhance existing dormouse populations in all counties and to re-establish self-sustaining populations where they have been lost. Other dormouse action plans have been produced at local, county and regional scales, usually as part of the Local Biodiversity Action Plan (LBAP) process. Details of both the national species action plan and local action plans can be found at www.ukbap.org.uk

A major review of the UK BAP is being carried out in 2005-6. Although the targets for the dormouse will be more precisely defined, it seems likely that it will remain a priority species.

9.2 Progress with the national action plan

The national action plan, published in 1994, which built on conservation initiatives already in progress, identified a number of actions that would help to deliver the targets. Substantial progress has been made in delivering many of these over the past decade and the following paragraphs summarise progress to date on the most significant actions.

9.2.1 Site safeguard and management

A national inventory of dormouse sites has been produced, incorporating results from two 'Great Nut Hunt' surveys as well as many other recent records. These data are now available through the National Biodiversity Network (www.searchnbn.net). The first edition of this dormouse conservation handbook, published in 1996, gave management advice to landowners, which has been substantially expanded in this second edition. Research on dormice in hedgerows has provided clear guidance on appropriate management and this has now been incorporated into agri-environment schemes.

9.2.2 Species management and protection

The objective of reintroducing dormice to five counties and reinforcing populations in three more has been exceeded, with 14 reintroductions in 11 counties by 2005. Most dormice for these reintroductions have been supplied by the Common Dormouse Captive Breeders Group, which has developed considerable expertise in maintaining and breeding the species. A recent review of 11 of these reintroductions (Sanderson 2004) demonstrated a high degree of success.

9.2.3 Advisory

As well as producing the advisory handbook, numerous courses have been held for foresters, ecological consultants and conservation staff on dormouse conservation techniques.

9.2.4 Research and monitoring

A long-term programme of research has continued throughout the last two decades, with particular emphasis on understanding the needs of dormice in hedgerows and the impact of woodland restoration on dormouse populations. This research has been focused on supporting management advice and identifying areas where improvements to conservation actions could be made. Studies have also been undertaken to learn more about the ecology of dormice in conifer woodland, again with a view to providing practical management guidance, particularly in connection with clearance operations.

The use of 'green bridges' by dormice should be investigated with a view to providing advice on their likely effectiveness in relation to width of obstacles (such as roads) to be bridged.

The development of the National Dormouse Monitoring Programme, described in Chapter 8 has been a significant success, with 200 sites and 11,000 boxes now being monitored annually by volunteers. A recent review of this monitoring system confirmed that it could detect changes in the national dormouse population with adequate sensitivity to meet the requirements of the Tracking Mammals Partnership. This system, based on a national series of Key Sites, has been supplemented by two public-participation Great Nut Hunts, which have resulted in the discovery of many new sites for dormice.

9.2.5 Communications and publicity

Many of the actions described in the preceding paragraphs, most notably the two Great Nut Hunts, have resulted in the dormouse having a very high public profile, with extensive coverage in the Press. The first nut hunt gained more publicity for English Nature than any of its other contemporary projects and the reintroduction of dormice to Cheshire drew much attention to the Cheshire Wildlife Trust, even though the site was secret and could not be visited by the public. It has since been the focus of a broader approach to wildlife conservation in the vicinity, involving many partners. Nationally, the dormouse 'awareness' of landowners and planners has also increased.

9.3 Priorities for the next decade

- Maintain surveillance through the National Dormouse Monitoring Programme (NDMP); repeat the Great Nut Hunt at intervals.
- Improve and extend the national inventory of dormouse sites. Ensure availability of data through the National Biodiversity Network (NBN).
- Continue research on the ecology of dormice, particularly in the marginal uplands; deliver management advice.
- Undertake studies to understand the impact of weather and climate change.
- Review the future of the reintroduction programme and associated captive breeding schemes.
- Encourage population expansion from reintroduction sites; encourage and develop habitat linkages in the countryside.
- Encourage the targeting of grants to include dormouse habitat restoration and management.
- Publish information about dormice in conifers with appropriate actions to be taken.
- Improve management, mitigation and best practice advice in relation to development and forestry. Publish improved guidance as it becomes available.

10 Organisations & contacts

10.1 English Nature

English Nature is the government's statutory advisor on nature conservation. It has a wide range of functions including:

- Provision of advice to Local Planning Authorities on European protected species issues, including protected species policies and consultations on planning applications where dormice are thought to occur.
- Provision of general advice to developers, consultants and others on protected species.
- Issuing licences for scientific and educational work on dormice.
- Advising Defra over licences applied for under the Habitats Regulations.
- Provision of advice involving wildlife law enforcement.
- Statutory consultee over planning issues affecting Sites of Special Scientific Interest.
- Assisting with the delivery of Species Action Plans for priority species.

Contact
English Nature,
Northminster House,
Peterborough, PE1 1UA
Tel: 01733 455000
Website:
www.english-nature.org.uk

Note that services currently delivered by English Nature will be transferred to a new Agency, *Natural England*, in October 2006.

In Wales, the Countryside Council for Wales has a similar role.

Contact
Countryside Council for Wales,
Maes y Ffynnon, Penrhosgarnedd,
Bangor, Gwynedd, LL57 2DW
Tel: 0845 130 6229
Website:
www.ccw.gov.uk

10.2 The Department for Environment, Food and Rural Affairs

Defra has the following roles in connection with dormice:

- Assisting in the development of UK wildlife legislation.
- Responsible for ensuring that the UK Habitats & Species Directive is properly implemented.
- Determining licence applications for activities under Regulation 44(2)(e) of the 1994 Habitats Regulations and monitoring licence compliance. This service is provided by the RDS.
- Delivering Environmental Stewardship. This service is provided by the RDS.

Contact
European Wildlife Division,
Defra, Zone 1/08c, Temple Quay House, 2 The Square, Temple Quay,
Bristol, BS1 6EB
Tel: 0117 372 6170
Website:
www.defra.gov.uk/wildlife-countryside/ewd/index.htm

European Protected Species Licensing, Wildlife Administration Unit, RDS, Burghill Road, Bristol, BS10 6NJ
Tel: 0845 601 4523
Email: enquiries.southwest@defra.gsi.gov.uk

Note that services currently delivered by the Rural Development Service (RDS) will be transferred to a new Agency, *Natural England*, in October 2006.

In Wales, the Welsh Assembly Government (Countryside Division) has a similar role.

Contact
Welsh Assembly Government,
Countryside Division,
Cathays Park, Cardiff, CF10 3NQ
Tel: 029 2082 6780
Website:
www.countryside.wales.gov.uk

10.3 Office of the Deputy Prime Minister

The ODPM has the following roles in connection with dormice and development:

- Producing the Government's Planning Policy Statement (PPS) for Local Planning Authorities in respect of nature conservation and species protection (currently PPS9: Biodiversity and Geological Conservation, 2005).
- The Secretary of State at the Office of the Deputy Prime Minister determines planning appeals, applications which are 'called in', local inquiries and presides over Local Plan inquiries.

Contact
Policy Branch,
Planning Policies Division (PD1),
ODPM, 4/H4 Eland House,
Bressenden Place, London,
SW1E 5DU
Tel: 020 7944 3973
Website:
www.planning.odpm.gov.uk/

10.4 Local Planning Authorities

Local Planning Authorities have the following roles:

- Ensuring that protected species issues are taken into account when determining planning applications, as set out in PPS9. This may involve refusal, deferral, conditions or agreements.
- Ensuring that protected species issues are taken into account in preparation of Local Plans, UDPs, etc.
  This and the above point relate to Regulation 3(4) of the Conservation (Natural Habitats &c.) Regulations 1994, which require authorities to have regard to the conservation of European Protected Species.
- Raise awareness of protected species in their area and, in some cases, enforce wildlife legislation (S.25 of the Wildlife and Countryside Act 1981).
- Advising developers about statutory species protection provisions affecting an application site.
- Enforcement of planning obligations and Agreements.

Contact

Website 1:
www.direct.gov.uk/Dl1/Directories/LocalCouncils/fs/en
Website 2:
www.planningportal.gov.uk/england/genpub/en/

10.5 Developers and environmental consultants

Developers and their advisor(s) share responsibility for:

- Ensuring that they provide Local Planning Authorities with satisfactory and accurate assessments of application sites, including surveys for dormice if they are potentially present.
- Applying to Defra for a licence, should they judge one to be required.
- Providing an objective assessment of the potential impact of proposed development on dormouse populations.
- Where necessary, designing and implementing a mitigation scheme that meets planning and licensing requirements. Specifically, such plans will ensure, as far as possible, the long term future of any populations affected; such schemes should employ 'best practice'.
- Where necessary, negotiating with Local Planning Authorities a planning agreement (S106) or similar, to ensure continued support for affected dormouse populations. In many cases, monitoring of affected populations after completion of development.

Contact details for environmental consultants can be obtained from a number of sources, including their professional bodies and published directories. Two such directories are:

- The Environmental Data Services (ENDS) Environmental Consultancy Directory (www.endsdirectory.com/search/)
- The Institute of Ecologists and Environmental Managers (IEEM) Directory (www.ieem.co.uk).

10.6 The Forestry Commission

The Forestry Commission issues felling licences for felling timber but the landowner and timber feller are responsible for working within existing legislation relating to biodiversity.

Forestry Commission grants for woodland management are available, provided a commitment is made to acceptable environmental codes of practice as part of the scheme. Advice from the Forestry Commission must be sought to assess the need for an 'Environmental Assessment' where change of land use to, or from, woodland is involved. The Forestry Commission is not normally involved in matters concerned with building developments.

Contact

The Forestry Commission, Great Eastern House, Tenison Road, Cambridge, CB1 2DU
Tel: 01223 314546
Website: www.forestry.gov.uk
Email: nationaloffice.fce@forestry.gsi.gov.uk

10.7 County Wildlife Trusts

The Wildlife Trusts Partnership comprises a network of 47 autonomous county-based wildlife trusts whose primary concern is wildlife conservation within their own geographical area. The Wildlife Trusts are responsible for:

- Organising volunteer support for local wildlife conservation.
- Administering grant aid for wildlife support.
- Managing some local nature reserves and public open spaces.
- Providing assistance and advice on conservation and wildlife matters, within their capabilities and resources.
- Liaising with local authorities and local non-Governmental organisations (NGOs) to facilitate wildlife conservation.
- Joint Lead Partner (with English Nature) for the dormouse Biodiversity Action Plan.

Contact

The Wildlife Trusts, The Kiln, Waterside, Mather Road, Newark, Nottinghamshire, NG24 1WT
Tel: 0870 036 7711
Website: www.wildlifetrusts.org
Email: enquiry@wildlife-trusts.cix.co.uk

10.8 People's Trust for Endangered Species and the Mammals Trust UK

The People's Trust for Endangered Species (PTES) administers the National Dormouse Monitoring Programme and coordinates dormouse reintroduction projects. Mammals Trust UK (MTUK), a restricted fund of the PTES, provides grant aid for the conservation of British mammals.

Contact

PTES/MTUK, Cloisters House, 8 Battersea Park Rd, London, SW8 4BG.
Tel (PTES): 020 7498 4533
Website (PTES): www.ptes.org
Email (PTES): enquiries@ptes.org
Tel (MTUK): 020 7498 5262
Website (MTUK): www.mtuk.org
Email (MTUK): enquiries@mtuk.org

10.9 Local Biological Records Centres and the NBN

These often have useful information on where dormice might be found locally, and sites which are already known to harbour dormice. They can provide such details to consultants, developers and Local Planning Authorities. Similarly, some local natural history societies may collect location data and be able to provide a more detailed assessment of status; some may also be willing to assist with dormouse surveys in advance of planning applications.

Much of the information held by local records centres or English Nature is gradually being made available through the National Biodiversity Network (NBN) gateway. For example, the national dormouse inventory compiled by English Nature is now available in this way.

Contact

A list of local records centres can be found at: **Website:** www.nbn-nfbr.org.uk/nbn.php
The NBN gateway is at:
Website: www.searchnbn.net

10.10 The Mammal Society

The Mammal Society was involved with much of the original research on dormice, including the first survey, and this research continues, mainly through its local groups in the south-west. In addition to providing training for consultants and applicants for dormouse handling licences, The Society supplies nest tubes and has published a useful booklet on dormouse biology.

Contact

The Mammal Society, 2B Inworth St, London, SW11 3EP
Tel: 0207 350 2200
Website: www.mammal.org.uk
Email: enquiries@mammal.org.uk

10.11 Common Dormouse Captive Breeders Group (CDCBG)

The CDCBG coordinates the captive breeding programme that supplies animals for reintroductions. These are coordinated by the People's Trust for Endangered Species.

Contact

The Common Dormouse Captive Breeders Group, c/o Paignton Zoo Environmental Park
Totnes Road, Paignton, Devon, TQ4 7EU **Tel:** 01803 697500

10.12 Other organisations

Enforcement of most relevant legislation is carried out by the Police, and in most forces there is now a Wildlife Crime Officer (WCO) who will assist (see www.police.uk). A list of police WCOs is also available from the RSPB Investigations Section (Tel: 01767 680551).

11 Case studies in development and forestry

It is too early to measure the effectiveness of recent attempts to mitigate the impacts of development. Similarly it is too soon to see the effects of changes in forestry practice. Nevertheless, two case studies are described below; further studies are welcome.

11.1 Developing National Cycle Route 45 in The Severn Valley, Shropshire

Contributed by Cathy Turtle

Background

National Cycle Route number 45 is being built within woodlands and scrub along the Severn Valley between Bridgnorth and Bewdley. Surveys have confirmed dormice are present in the woodlands. There are two confirmed populations divided by an active steam railway and, more significantly, the River Severn. It was assumed that all potential habitats affected by the scheme could support dormice.

Description of works

The cycle route consists of a hardcore base with a geo-textile liner. Where the slopes are steep piling has been installed. The construction machinery required access from several areas that cross the railway line. In parallel to this, the bridge that joins Highley to Alveley needed to be replaced, requiring a large working area near the bridge and further access routes through the Severn Valley Country Park for more machinery.

Features of importance to dormice

The habitats of value affected by the cycle route include native broadleaved woodland, diverse scrub, including some bracken, and areas of recently planted native trees and shrubs within the country park. The railway verges are managed by small areas of coppicing over a long time period, which has created some excellent habitat.

The secondary woodland within the Severn Valley Country Park is young but has a continuous canopy cover. This woodland is only tentatively connected to the ancient woodland site, with dormice confirmed on the eastern side of the River Severn as the trees and shrubs are too immature to provide full cover at any level.

Project approach

Due to project timing, driven by funding, the clearance work had to start in July. The line of the route, soil storage and working areas were hand searched for both dormouse and bird nests. Where nests were found warning tape was installed to prevent disturbance until the birds had fledged. No dormouse nests were found but they would also have been left until the young had left the nest. The site was then 'strimmed' to the ground to prevent further nesting, and vegetation cleared to dissuade dormice from hibernating in the area. All potential shelter areas such as wood piles and debris were dismantled by hand and removed to locations off-route. Nest boxes were installed in woodland areas off route and nest tubes were put in place along the hedgerows and fences that connect areas of value for dormice.

Timetable & execution

Year 1	
July	Site clearance with hand-searching for nests prior to strimming
August	Further checks for birds prior to clearing remaining areas. Nest box and tube installation
October	Supervision of site clearance for bridge works on the eastern side of the river. Nest box and tube installation
December	Completion of cycle route
Year 2	
January	Start of bridge works
June & October	Monitoring of boxes and tubes
December	Bridge completion

Once work was completed, the soil storage and working areas were re-planted with species to favour dormice. Several hazel glades were created. These were planted within the even-aged secondary woodland in the Country Park to increase diversity.

Where machinery has broken the links in the canopy, branches will be tied together overhead in year 2 (see below) to bridge the route at several places along the access tracks.

Monitoring

The site will be monitored for one year after completion. This will hopefully confirm the continued presence of dormice within the area and increase our understanding of the two populations.

11.2 Reconstructing a road junction

Contributed by Paul Chanin

Background

The reconstruction of this road junction involved the realignment of 80 m of hedge, it being preferable to move, rather than replace, the hedgerow. The hedge was diverse, had a lot of mature hazel and was unmanaged. It was more than 4 m wide and high. A preliminary survey (looking for hazel nuts) showed that dormice were present in nearby hedges, although not in the one to be moved.

Project approach

- Install nest boxes in hedges on either side of the one to be moved.
- Carry out metre by metre search for nests within the hedge.
- 'Coppice' hedgerow shrubs (in summer).
- Move hedge during winter to maximise tree and shrub survival.

Results

This project was carried out before the need for licensing was introduced, so there was no requirement for a follow-up. Four years later the transplanted hedge is just beginning to recover as most shrubs and trees failed to survive the move. Another hedge on the other side of the road was moved as part of the same road scheme and survived much better, perhaps because it was not cut so close to the ground. Clearly botanical advice should be sought before attempting hedge translocations.

Lessons

- Dormice do breed in hedges.
- Nest boxes can be used as a means of encouraging dormice out of threatened habitat.
- You may still get some nests in the area to be destroyed and need to make sure that clearance is done with clear guidelines on what to look for.
- Dormouse nests are easier to find while clearing a hedge than by visual survey.
- Good guidance is required on hedge moving and other forms of mitigation.

Timetable & execution

April	Nest boxes installed
July	Dormouse nest found in one box
September	Four boxes found with nests. Two adult dormice present in one of these, five juveniles in another
October	Hedge surveyed from inside looking outwards (so that nests would be seen against the light) none found. Trees and shrubs coppiced following on-the-spot briefing of contractors on dormouse nests and how to recognise them. Two summer nests found during clearance, both very low to ground (c 30 cm) at the edge of the hedge growth, in bramble and small blackthorn. No dormice in either. One old hibernation nest found under small flat stone ca 2m from midline of hedge
Winter	Hedge moved

12 References

Anderson, P. & Groutage, P. 2003 *Habitat translocation – a best practice guide* (C600). Construction Industry Research and Information Association.

Battersby, J. (Ed.) & Tracking Mammals Partnership. 2005. *UK mammals: species status and population trends. First report by the Tracking Mammals Partnership.* JNCC/Tracking Mammals Partnership, Peterborough.

Bright, P.W. 2000. *Status and woodland requirements of the dormouse in Wales.* CCW Science Report 406. Bangor: Countryside Council for Wales.

Bright, P. & MacPherson, D. 2002. Hedgerow management, dormice and biodiversity. *English Nature Research Report* No. 454.

Bright, P. & Morris, P. 1989. *A practical guide to dormouse conservation.* Occasional Publication no.11. London: The Mammal Society.

Bright, P. & Morris, P. 1990. Habitat requirements of dormice (*Muscardinus avellanarius*) in relation to woodland management in Southwest England. *Biological Conservation.* 54: 307–326

Bright, P.W. & Morris, P.A. 1991. Ranging and nesting behaviour of the dormouse *Muscardinus avellanarius*, in diverse low-growing woodland. *Journal of Zoology*. 224 177–190

Bright, P.W. & Morris, P.A. 1992. Ranging and nesting behaviour of the dormouse (*Muscardinus avellanarius*) in coppice-with-standards woodland. *Journal of Zoology*. 226 589–600

Bright, P.W. & Morris, P.A. 1993. Foraging behaviour of dormice *Muscardinus avellanarius* in two contrasting habitats. *Journal of Zoology*. 69–85

Bright, P.W. & Morris, P.A. 1993. Conservation of the dormouse. *British Wildlife.* 4: 154–162

Bright, P.W. & Morris, P.A. 1994. Animal translocation for conservation: performance of dormice in relation to release methods, origin and season. *Journal of Applied Ecology.* 31: 699–708

Bright, P.W. & Morris, P.A. 1996. Why are dormice rare? A case study in conservation biology. *Mammal Review.* 26: 157–187

Bright, P. & Morris, P. 2002. Putting dormice back on the map. *British Wildlife.* 14: 91–100

Bright, P.W. & Morris, P.A. 2005. *The Dormouse.* London: The Mammal Society.

Bright, P.W., Mitchell, P. & Morris, P.A. 1994. Dormouse distribution: survey techniques, insular ecology and selection of sites for conservation. *Journal of Applied Ecology.* 31: 329–339

Bright, P.W., Morris, P.A. & Mitchell-Jones, A.J. 1996. A new survey of the dormouse *Muscardinus avellanarius* in Britain, 1993–4. *Mammal Review.* 26: 189–195

Bright, P.W., Morris, P.A. & Wiles, N.J. 1996. Effects of weather and season on the summer activity of dormice (*Muscardinus avellanarius*). *Journal of Zoology.* 238: 521–530

Chanin, P. & Woods, M. 2003. Surveying dormice using nest tubes. Results and experiences from the South West Dormouse Project. *English Nature Research Report* No. 524.

Corbet, G.B. & Harris, S. (Eds) 1991. *The handbook of British mammals.* Oxford: Blackwell.

Eden, S. & Eden, R. 1999. Dormice in Dorset – the importance of hedges and scrub. *British Wildlife.* 10: 185-189

Eden, S.M. & Eden, R.M.G. 2003. Further observations on dormice in Dorset. *Dorset Natural History and Archaeological Society Proceedings.* 125: 125-129

Harmer, R. & Howe, J. 2003. *The silviculture and management of coppice woodlands.* Edinburgh: Forestry Commission.

Highways Agency. 2001. *Design manual for roads and bridges. Vol. 10 Environmental design and management. Section 4, Nature conservation. Part 5, Nature conservation management advice in relation to dormice.* London: The Stationery Office.

HMSO. 1994. *The Conservation (Natural Habitats &c.) Regulations 1994.* HMSO, London.

Bekker, G.J. and others (Eds.) 2003. *Wildlife and traffic: A European handbook for identifying conflicts and designing solutions.* Utrecht: KNNV Publishers.

Jermyn, D.L., Messenger, J.E. & Birks, J.D.S. 2001. *The distribution of the hazel dormouse Muscardinus avellanarius in Wales.* Ledbury: The Vincent Wildlife Trust.

Morris, P. 2004. *Dormice.* Stowmarket: Whittet Books.

Morris P.A., Bright, P.W. & Woods, D. 1990. Use of nest boxes by the dormouse *Muscardinus avellanarius*. *Biological Conservation.* 51: 1–13.

Morris, P.A., Temple, R.K. 1998. 'Nest tubes'– a potential new method for controlling numbers of the edible dormouse (*Glis glis*) in plantations. *Quarterly Journal of Forestry.* 92(3) 201–205

Morris, P. & Whitbread, S. 1986. A method for trapping the dormouse *Muscardinus avellanarius*. *Journal of Zoology.* 210: 642–644.

Office of the Deputy Prime Minister. 2005. *Planning Policy Statement 9: Biodiversity and geological Conservation.* London: HMSO.

Pepper, H.W. 1999. *Recommendations for fallow, roe and muntjac deer fencing: new proposals for temporary and reusable fencing. Forestry Commission Practice Note 9.* Edinburgh: Forestry Commission.

Read, H. 2000. *Veteran trees, a guide to good management.* Peterborough: English Nature.

Richards, C.G.J., White, A.C., Hurrell, E. & Price, E.F.F. 1984. The food of the common Dormouse (*Muscardinus avellanarius*), in South Devon. *Mammal Review.* 14; 19–28.

Rope, G.T. 1885. On the range of the dormouse in England and Wales. *The Zoologist.* 9: 201–213.

Sanderson, F. 2004. *The population ecology and monitoring of the dormouse Muscardinus avellanarius.* University of London. PhD thesis.

Trout, R.C. & Pepper, H.W. 2005. *Forest Fencing.* Edinburgh: Forestry Commission.

Nest box suppliers

Dormouse nest tubes are available from The Mammal Society. Dormouse nest boxes are available from many sources. Some of the larger suppliers are listed below, but this list is certainly not exhaustive:

Kingslake Resources Ltd, Bolton Farm, Lyonshall, Kington, Herefordshire, HR5 3JY
Tel: 01544 340657
Website: www.nestbox.co.uk

Jamie Wood Ltd, 1 Green Street, Eastbourne, East Sussex, BN21 1QN
Tel: 01323 727291
Website: www.birdtables.com

Alana Ecology, The Old Primary School, Church Street, Bishop's Castle, Shropshire , SY9 5AE
Tel: 01588 630173
Website: www.alanaecology.com

CJ Wild Bird Foods Ltd, The Rea, Upton Magna, Shrewsbury, SY4 4UR
Freephone: 0800 7312820
Tel: 01743 709545
Website: www.birdfood.co.uk

Top: Dormouse-friendly underpass/P. Chanin
Middle left: Green bridge/P. Morris
Middle Right: Hazel nut opened by dormouse/J. Norton
Bottom: Dormouse nest-tube/P.Morris