



Hazel dormouse © Hattie Spray

Small mammals

Small mammals are an important part of the food chain and all species make use of farmland to a greater or lesser extent. Cover in the form of mature hedgerows, tussocky margins and patches of scrub or woodland will help provide small mammals with plentiful food supplies of seeds and invertebrates, undisturbed nesting sites and a refuge from farming operations such as ploughing and harvest. If hedgerows link patches of woodland or scrub this helps small mammals move across farmed landscapes.

Key points

- Wide hedgerows, infrequently cut, will benefit small mammals
- Grassy field margins and ditches provide food and cover
- Hedgerows and margins linking areas of woodland are especially valuable
- Reducing pesticides within the crop, as in conservation headlands, helps small mammals

Small mammals



The arable wood mouse is the most common small mammal on farmland
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Farmland is used by all of Britain's small mammals (mice, dormice, voles and shrews), to a greater or lesser extent. The most common small mammal on farmland is the wood mouse, followed by field voles and bank voles. Small mammals play an important part in farmland ecosystems, being midway in the food chain. Common and pygmy shrews feed entirely on invertebrates (particularly earthworms), voles are herbivorous, and wood mice and harvest mice live on a mixed diet of plant material and insects; small mammals themselves are preyed upon by birds such as barn owls and larger mammals such as weasels.

Habitat management



©Rob Wolton, Hedgelink
The hazel dormouse (above) needs mature hedgerows and species-rich woodland for foraging and building nests (below)

All small mammals require an adequate supply of food, suitable habitat for nesting, cover from predators and refuge from farming operations. In general, management which increases plant and invertebrate food, creates opportunities for nest sites and cover from predators, and links habitats for colonisation and dispersal, will help small mammal populations on farmland. Different species use different habitats and this also varies throughout the year, so increasing overall habitat diversity within a farm will be beneficial to small mammals.

Hedgerows

Hedgerows support a rich community of small mammals, including rarer species such as dormice, and more common species such as bank voles and harvest mice (Box 27). Even the adaptable wood mouse, the only small mammal that can live in arable crops year round, makes good use of hedgerows. Recent work has shown that hedges with more trees support more wood mice and that thicker hedgerows have higher numbers of small mammals. Overly intensive hedgerow management should be avoided: for example, current recommendations for dormouse conservation are that most hedgerows are cut at three yearly intervals, with some left to grow for at least seven to ten years. It is important that only a minority of hedgerows on a farm are cut in any one year. Coppicing or laying should be used to restore hedgerows that become gappy, and species-rich hedgerows are especially valuable.



© Rob Wolton, Hedgelink



Hedgerows linking other habitats such as woodlands will help small mammals move through the landscape © Ruth Feber

As well as being important habitats in themselves, hedgerows promote animal dispersal and can be referred to as 'corridors'. For example, connected, rather than isolated, hedgerows typically support more wood mice and bank voles. For dormice, which have suffered from fragmentation and isolation of their populations, suitably managed hedgerows may be crucial to dispersal. This is another important reason to maintain a network of hedgerows in the farmed landscape and, if new hedgerows can be planted to link other types of habitat such as woodlands, this may increase their benefits.

Field margins and ditches



Well managed ditches are highly valuable for wildlife, including small mammals
© Ruth Feber

Grassy field margins are important refuges on farmland for many small mammals including bank and field voles, harvest mice and pygmy shrews. Sowing with tussocky species such as cocksfoot enhances invertebrate food, and provides cover and nesting sites. Harvest mice, for example, favour cocksfoot, hawthorn and blackthorn as nesting sites on infrequently cut field margins and beetle banks. Wider margins and those adjacent to hedgerows are especially good for bank voles.

Grassy margins act as buffers, helping to protect the hedgerow and hedge base vegetation from farming operations and spray drift. They are particularly valuable if they have a diversity of structure, which can be encouraged by not cutting every year. Reducing the frequency of cutting, and not cutting field margins during the spring and summer when small mammals are nesting, as well as reducing other disturbance such as driving along margins, will have positive impacts on small mammal populations.

Well-managed ditches can encourage bank voles and yellow-necked mice. They provide good burrowing habitat, and ditch vegetation will increase plant and invertebrate food resources and cover from predators.

Small mammals



Field margins provide food and cover for small mammals © Ruth Feber

Crops and grassland

While uncropped field margins, hedgerows and woodlands are very important habitats for small mammals, cropped areas can also provide plant and invertebrate food and, at some times during the year, cover from predators and nest sites. In other ways, though, they are an unforgiving habitat for small mammals, which must contend not only with agrochemical applications, but also the removal of cover at harvest (Box 28), quickly followed by ploughing, leaving bare ground over winter.

Nonetheless, there are ways to help small mammals survive in this challenging environment. Perhaps the most important of these is, where possible, to reduce the use of herbicides and insecticides within the crop. Conservation headlands, where the outer 6m or so of cereal fields receive reduced selective pesticide applications, can be beneficial, through increasing the abundance of plants, seeds and invertebrates which are food for small mammals. In a similar way, organic farming has been shown to increase small mammal numbers by increasing food resources throughout the entire cropped area, with knock-on benefits for the mammal species that feed on them.



Reducing herbicides increases seed and insect food for small mammals © billywhizz21 CC BY NC ND 2.0

The principles of management for grassland are broadly the same as those for arable and field margin habitats. Increasing sward diversity to enhance plant and invertebrate food resources, reducing pesticide and fertiliser inputs where possible, and minimising disturbance to the sward will all help improve the habitat for field voles and other small mammal populations. Field margins around grass fields provide many of the same benefits as those around arable fields, providing extra cover and undisturbed habitat, and taller vegetation.



Grassland is habitat for voles, mice and shrews © Andrew Hill CC BY SA 2.0



Coppiced woodlands are especially good for dormice ©Peter Wakely/Natural England

Woodland

Many of our native mammals are woodland species, reflecting the dominance of this habitat in prehistoric times. Creating or retaining woodland within the farmed landscape encourages a rich community of small mammals and helps to buffer populations against farm operations.

Broadleaf woodland is used, at least in part, by most small mammal species. Some species, such as dormice, have very specialised requirements. Dormice cannot easily digest woody material, so need diverse woodlands which can provide flowers, fruit and insects across different seasons. Woods that are managed to reduce the canopy cover and maintain the understorey, for example by coppicing, are particularly suitable for this species. Where woodlands can be linked across farmland by mature, continuous hedgerows there will be even greater benefits for more sedentary species such as dormice.

Field voles and barn owls

Barn owls are specialist birds and highly adapted as hunters of small mammals in open habitat and low light conditions. Hunting while flying is their main method. Typically, owls will leave their roost sites shortly after dusk and fly slowly back and forth across a patch of rough grass, listening and looking downwards. When a small mammal is heard the owl hovers overhead, pinpointing it, before finally dropping into the grass.

The best habitat for barn owls is rough tussocky grassland containing a high density of field voles, which are the barn owl's main prey, forming up to 90% of their diet. The most important feature of good rough grassland is the presence of a litter layer of vegetation at the base of the grass. Grass that is allowed to grow tall in the summer will collapse in the autumn and, by the following summer, it will have formed a litter layer of about 75mm deep. Through this layer the field voles make their runs - a matrix of small tunnels leading to food stores, latrines, and nests. Field voles do occur in other types of long grass (such as hay meadows that are short-mown annually) but without a permanent litter layer their numbers will remain relatively low.



© wolf359 CC BY NC SA 2.0
Field voles (above) are the main prey of barn owls (below)



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Harvest mouse Ben Hall (rspb-images.com)

How to help harvest mice

The harvest mouse is Britain's smallest rodent and one of our most endearing wildlife species. As its name suggests, it is a species historically associated with farmland, but surprisingly little is known about its ecology. It is believed to have suffered population declines with changes in farming practice and is now a priority Biodiversity Action Plan (BAP) species.

Harvest mice weave a distinctive breeding nest, usually from grass, about 0.5m above the ground in tall vegetation. These nests are often more clearly revealed in winter when the surrounding vegetation dies back. We searched for harvest mouse breeding nests in the Upper Thames area and found that, rather than being scattered throughout the survey areas, nest sites were highly clustered. Nests tended to be associated with diverse, large hedgerows, particularly those along ditches or bordering unimproved pasture. While suitable habitats do exist for harvest mice, our data suggested that it may be difficult for harvest mice to recolonise areas from which they have disappeared. Increasing the connectivity of habitats across landscapes, for example through hedgerow and field margin creation, may help harvest mice to survive in modern agricultural landscapes.



Harvest mouse nest
© PTES

Key results

- Create hedgerows to connect to each other and link other habitats such as woodland
- Hedgerows next to ditches and pasture are especially valuable
- Large, species-rich hedgerows benefit harvest mice



Harvest © Paul Glendell/Natural England

Impacts of harvest on wood mice

Perhaps the most marked disruption in an arable landscape for wildlife is harvest, when the crop is removed and the ground prepared for sowing. Using a combination of radio-tracking and live-trapping, we followed the fates of 33 wood mice through combine harvesting and cultivation.

The mechanical actions of harvest had little direct effect upon the mice, killing only one individual. However, surviving mice inhabited a vastly changed landscape, with the removal of the crop leaving them much more exposed to predation. Radio-tracking showed that mice either left the fields for nearby woodland, or reduced their activity, and over half the mice disappeared following harvest. In 9 of 17 of these mouse disappearances, predation by weasels or tawny owls was directly observed or inferred from their remains. Interestingly, we observed that tawny owls changed their hunting patterns after harvest. Before harvest, they concentrated their hunting along hedgerows and grassy banks, but after harvest, owls hunted much more over the fields.

Direct effects of harvesting therefore had only a minor impact on wood mouse populations. The removal of cover, on the other hand, resulted in most of the mice either emigrating to other habitats or being eaten. The results highlight the importance for wildlife of non-crop cover on arable land, in the form of woodland patches and hedgerows.

Key results

- Following harvest, many wood mice leave arable fields
- The removal of the crop leaves those that remain vulnerable to predation
- Cover provided by hedgerows and woodlands is especially important after harvest



Owls changed their hunting behaviour following harvest
© Andrew Harrington

Small mammals

Management summary		
	Key actions	Potential benefits
Hedgerows	<ul style="list-style-type: none"> • Aim for wider hedgerows with some trees • Cut infrequently • Create hedgerows to connect to each other and link other habitats such as woodland in the landscape 	<ul style="list-style-type: none"> • Benefits all small mammals • Encourages fruit/berry production • Facilitates movement of small mammals through the landscape
Arable field margins and beetle banks	<ul style="list-style-type: none"> • Create grassy or grass and wildflower field margin swards and cut infrequently • Margins situated next to hedgerows and ditches especially valuable 	<ul style="list-style-type: none"> • Enhances plant, seed and invertebrate food supplies • Diversity of habitats increases small mammal diversity
Ditches	<ul style="list-style-type: none"> • Maintain ditches - manage banks on rotation similar to field margins and maintain water levels where possible 	<ul style="list-style-type: none"> • Particularly beneficial for water shrew and yellow-necked mouse
Crops and grassland	<ul style="list-style-type: none"> • Reduce fertiliser, herbicide, insecticide and molluscicide inputs • Create conservation headlands • Reduce stocking densities in grassland 	<ul style="list-style-type: none"> • Especially benefits wood mouse, harvest mouse, common and pygmy shrews and field vole (grassland)
Woodland	<ul style="list-style-type: none"> • Maintain woodlots in the farmed landscape • Diversity of native tree and shrub species especially beneficial • Manage by coppicing 	<ul style="list-style-type: none"> • Especially benefits dormouse, yellow-necked mouse and bank vole

Options especially relevant for small mammals		
Code	Countryside stewardship options	Tier
AB2	Basic overwinter stubble	Mid
AB3	Beetle banks	Mid
AB7	Whole crop cereals	Mid
AB10	Unharvested cereal headland	Mid
AB14	Harvested low input cereal	Mid
BE3	Management of hedgerows	Mid
GS1	Take small areas out of management	Mid
GS2	Permanent grassland with very low inputs (outside SDAs)	Mid
OP5	Undersown cereal	Mid
OR3	Organic conversion - rotational land	Mid
SW1	4-6m buffer strip on cultivated land	Mid
SW2	4-6m buffer strip on intensive grassland	Mid
SW11	Riparian management strip	Mid
WD1	Woodland creation - maintenance payments	Higher
WD2	Woodland improvement	Higher
WD3	Woodland edges on arable land	Mid
WD7	Management of successional areas and scrub	Mid
WD8	Creation of successional areas and scrub	Higher

Find out more at:
www.ptes.org www.wildlifetrusts.org www.barnowltrust.org.uk



Water vole © Peter G Trimming CC BY 2.0

Water voles & otters

Some mammals live in close association with rivers and streams, feeding in them, or using them as a place of safety or means of escape from predators. In Britain, the otter and the water vole are the mammals most dependent on these riparian habitats. These charismatic animals are emblematic of the health of our riverine environments. Both species have undergone enormous population declines over the last 50 years, for different reasons. While otter numbers are now recovering, water voles continue to decline in many areas of the UK.

- Key points**
- Otters and water voles are dependent on freshwater habitats such as rivers, streams and ditches
 - Water vole conservation focuses on improving bankside habitats and controlling the non-native American mink
 - Otters need high quality riverine environments

Water voles & otters



Water vole

The water vole is a semi-aquatic mammal that was once a familiar sight on waterways and ponds throughout England. Known as 'Ratty' in 'Wind in the Willows' (although it is not a rat), it has suffered one of the most catastrophic declines of any British mammal this century and its widespread survival is now seriously threatened. This decline has been most rapid in the last 30 years; a survey in 1998 showed that the species has been lost from almost 90% of the sites where it occurred earlier in the 20th century. Remaining populations are often severely fragmented.

Water vole numbers have plummeted

© Peter G Trimming CC BY 2.0



Water voles need well-vegetated banks

© Evelyn Simak CC BY SA 2.0



Increasing habitat connectivity is vital to prevent water vole colonies becoming isolated

© Paul Lacey/Natural England

The reasons for this decline involve a combination of loss and fragmentation of bankside vegetation, altered riparian management and the introduction and spread of the non-native American mink, an effective predator of water voles. Water voles are now patchily distributed, with the strongest remaining populations in the north Midlands, parts of East Anglia and parts of southern England.

Water voles occur mainly along well vegetated banks of linear habitats such as slow flowing rivers and streams, and ditches, but they are also found in habitats such as reedbeds. Water voles are herbivorous, primarily feeding on the lush aerial stems and leaves of waterside plants. The best sites tend to have a highly layered bankside vegetation, often with tall grasses and stands of willowherb, meadowsweet, nettles or loosestrife, or fringed with rushes, sedges or reeds. Water voles excavate extensive burrow systems into the banks, with sleeping/nest chambers at various levels. These burrows often have underwater entrances to give the animals a secure route for escape if danger threatens.

Water voles live in colonies of varying sizes, but loss and fragmentation of suitable habitats and local extinctions have meant that many water vole populations have become isolated from each other. This makes them very vulnerable to further loss as they cannot be recolonized from surrounding populations if they experience a poor breeding season, predation from American mink, or flooding. Increased habitat connectivity between colonies is crucial for their long-term conservation.



The American mink predate water voles

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Habitat management for water voles

Conservation work for the water vole has concentrated on protecting remaining strong populations, maintaining and improving bankside habitats (Box 29) and controlling the American mink (Box 30).

Almost all wetland areas on farms are potentially very valuable for water voles and there are many opportunities to improve or create them, while balancing the needs of other environmental objectives such as flood control. A swathe of emergent and bankside vegetation is essential for providing water voles with food and cover. This can be achieved by reducing cutting/strimming management, or by fencing to protect the bank from livestock. Grazing or cutting every few years will be needed to prevent succession to scrub. Best practice methods for weed cutting and waterway de-silting include rotational cuts of vegetation along alternate banks, and patchwork clearance of channel weed and silt. In each case, refuge areas for water voles can be created.

Restoring the connectivity of a river system and its floodplain habitats is ambitious but, if networks of floodplain ditches, connected backwaters, ponds and oxbows can be created or reinstated - all with a dense fringe of aquatic vegetation - this will be of great benefit to water voles and other species of riparian habitats, including otters.



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Water vole reintroductions

Reintroducing water voles to areas where they once occurred is one potential means of helping water vole population recovery. There are several crucial aspects to any proposed reintroduction. First, mink control is essential in preparing habitats for water vole reintroductions. Without effective mink control the likelihood of a positive conservation outcome is small. Second, aside from mink control, water vole reintroductions will only stand any chance of success if

the correct quality of habitat in the correct quantities is available. The wider the swathes of riparian vegetation bordering the river, the greater the survival of water voles, and therefore the larger the resulting population. Lastly, there must be a sufficient length of watercourse, at least 1.5-2km, to support all the released animals and a self-sustaining population over the long-term.

Water voles & otters



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Otter

The only otter species in the UK is the Eurasian otter, one of a number of such species found worldwide. Otters were present throughout Great Britain in the early 1950s, but from the mid-1950s to late 1970s there was a dramatic decline, particularly in England. This was closely linked to the introduction of certain organochlorine pesticides, such as dieldrin, that were used in agricultural seed dressings, and sheep dips. The impacts were greatest among top predators, notably birds of prey and mammals, because the chemicals built up in the food chain.



Otters have returned to many of Britain's rivers
© Herry Lawford CC BY SA 2.0

After these chemicals were withdrawn, otters began to recover slowly. At the lowest point of the decline, in the late 1970s, otters were absent from parts of Scotland, much of Wales and most of England. Since then, otter distribution has expanded, so that Wales and Scotland are now extensively occupied and England's population has few large gaps outside the south-east corner of the country. The return of the otter is one of the major conservation success stories of the last 30 years. As well as the reduction in levels of toxic pesticides, improvements in water quality and consequent increases in fish stocks have probably played a significant part. Conservation effort continues to focus on encouraging natural recovery through improving river habitats.



Fish form the bulk of an otter's diet
© Peter G Trimming CC BY 2.0

Otters have been recorded on virtually every type of water body. In England and Wales they are mainly found on freshwater but they can also exploit coastal habitats; in Scotland they are familiar animals of rocky coasts, where they are sometimes referred to as 'sea otters', but they are in fact the same species.

Much of the otter's diet comprises fish (e.g. 46-67% in the Upper Thames), but amphibians, crayfish, waterfowl and small mammals are also taken. Otters are opportunistic feeders and will take fish and other prey in proportion to their local and seasonal availability. An otter will occupy a 'home range' which, on fresh waters, usually includes a stretch of river as well as associated tributary streams, ditches, ponds, lakes and woodland. The size of a home range depends largely on the availability of food and shelter, and the presence of neighbouring otters. Within a home range an otter may use many resting sites. These include above-ground shelters, such as stands of scrub or areas of rank grass,



Thick bankside vegetation with trees is good for otters © Peter Jordan CC BY 2.0

and underground 'holts' - for example, cavities under the roots of an old riverside oak or ash tree, the crown of a coppiced willow, a crevice in a rock face or pile of rocks, some dense scrub or a flattened area of reedbed.

Habitat management for otters

There are a number of ways in which habitats can be managed to encourage otters. For example, mature riparian trees with good root plates should be retained to help prevent erosion, maintain the right conditions for fish, and also create natural holt sites. Trees can be pollarded when management is required - this is good for other species and the pollard crowns are used by resting otters. River banks should be left uncut in some areas to encourage dense vegetation and thick patches of scrub and reeds. Where possible, flood debris such as tree branches should be left in the river channel as these are often used as otter resting sites. Rivers should be protected from excessive grazing and pollution should be prevented.



Otters use a variety of resting places
© Michael Hammett/Natural England

At a larger scale, the retention and restoration of wetlands, including marshy meadows, floodplain grazing, reedbeds, ponds and wet woodland will be highly beneficial for otters and other species, including many invertebrates that need wetland habitats. The management of land for a specific species is useful when they are as rare as the otter, but managing for one species can exclude other species or cause damage to the habitat of other species. Managing land as a mosaic of connected habitats within the local landscape will be good for a wide variety of wildlife. Conservation advice from Environment Agency staff should always be sought before any riverbank or channel management work is carried out.

Legal protection of water voles and otters

Otters and water voles, and their resting places, are fully protected. It is an offence to deliberately capture, injure or kill them or to damage, destroy or obstruct their breeding or resting places. It is also an offence to disturb otters and water voles in their breeding or resting places. There is, however, provision within the legislation to undertake some actions under a licence in certain defined circumstances. Natural England administers licence applications and their advice should be sought. The Environment Agency and Wildlife Trusts can provide guidance on otters and fisheries management.



Water vole © Peter G Trimming CC BY 2.0

Livestock management beside watercourses

Livestock affect waterside vegetation and water quality. Where cattle have direct access to bankside vegetation their feeding and trampling can remove food sources and reduce cover for wildlife. They can also cause erosion and increased siltation of the watercourse, and their dung can affect water quality. Indirectly, poor livestock management can lead to increased run-off through poaching and compaction and, where livestock are regularly moved, their pathways may become channels for nutrients and soil to enter the watercourse.

A number of WildCRU studies have looked at the effects of bankside fencing on water vole populations. The results have shown that watercourses with unfenced banks are largely unable to support water voles if the banks are heavily cattle-trampled, as this removes their food and cover. Intensively sheep-grazed banks also support far fewer voles than ungrazed banks. However, fencing can lead to banks being scrubbed over by woody plants such as bramble and hawthorn, ultimately leading to reduced grass cover. Long-term maintenance of fenced banks should therefore include either occasional grazing (perhaps once every two years), or flail mowing, to stimulate grass cover. The fenceline should have a gate for stock access, or be sited to allow flail mowing. Cattle drinking bays could also be incorporated.



Restricting cattle access to riverbanks will help water voles
© Tim Page/Natural England

Key results

- Water voles need lush, undisturbed bankside vegetation
- Livestock trampling removes food and cover for water voles
- Fencing to control livestock access protects watercourses and water voles



American mink © Andrew Harrington

Water voles and the American mink

The non-native American mink is the only species of mink seen wild in Britain (the European mink is an extremely rare species found in other parts of Europe). It has spread widely beyond its native range, having been introduced by the fur trade into Europe. American mink are versatile opportunists, able to adapt to almost any body of water, including coastline, and will feed on a range of prey including fish, birds, amphibians and small mammals.

Although they have many predators, water voles are particularly vulnerable to the American mink. American mink are able to counter the water voles' anti-predator behaviour because they swim well, hunt efficiently and the females can fit down water vole burrows. The foraging of a nursing female mink is likely to locate all local water voles in a given habitat. American mink can also disperse large distances (20-40km) and so can easily colonise new areas.

Mink control is an essential element in any water vole conservation strategy in riparian habitats, whether preserving existing populations or preparing habitats for water vole reintroductions. Without effective mink control the likelihood of a positive conservation outcome is small. The Game and Wildlife Conservation Trust's mink raft is an effective and humane method for detecting and controlling mink. Using a large-scale experiment we showed that local mink control using rafts could be effective, provided that monitoring effort was frequent and continual, and response to mink presence was rapid.



Mink being monitored using a raft trap © Rob Strachan

Key results

- American mink are widespread and occupy the same habitats as water voles
- Mink will hunt and feed on water voles
- Mink control is an essential part of water vole conservation strategy

Water voles & otters

Management summary		
	Key actions	Potential benefits
Bankside management	<ul style="list-style-type: none"> Use fencing to restrict access and protect watercourses from heavy use by stock Manage by topping or light grazing every couple of years Establish buffer strips next to watercourses on arable land or ungrazed strips in livestock areas 	<p>Water voles need dense bank vegetation</p> <p>Prevents scrubbing over</p> <p>Provides a greater complexity of water vole habitat and thicker vegetation; reduces siltation and pollution in the river</p>
River management	<ul style="list-style-type: none"> Leave mature trees with good root plates, and root plates of fallen trees Pollard trees where management is required; any clearing should be infrequent and one bank only, in winter 	<p>Provides resting sites for otters, good conditions for fish, reduces erosion and silting</p> <p>Reduces disturbance, otters will rest in pollarded crowns</p>
Wider land management	<ul style="list-style-type: none"> Keep pesticides, fertilizers and other inputs away from rivers and streams Maintain or restore connected wetland habitats such as ditches, wet meadows and woodland, and ponds 	<p>Good water quality is crucial for water voles, otters and other wildlife</p> <p>A mosaic of connected wetland habitats will support water voles, otters and a range of other species</p>
Mink control	<ul style="list-style-type: none"> Use mink rafts as a humane method for monitoring and controlling mink 	<p>Mink control is essential for water vole conservation</p>

Options especially relevant for water voles & otters		
Code	Countryside stewardship options	Tier
SW1	4-6m buffer strip on cultivated land	Mid
SW2	4-6m buffer strip on intensive grassland	Mid
SW4	12-24m watercourse buffer strip on cultivated land	Mid
SW8	Management of intensive grassland adjacent to a watercourse	Mid
SW11	Riparian management strip	Mid
SW12	Making space for water	Higher
WT1	Buffering in-field ponds and ditches in improved grassland	Mid
WT2	Buffering in-field ponds and ditches on arable land	Mid
WT3	Management of ditches of high environmental value	Higher

Find out more at:
www.environment-agency.gov.uk www.gwct.org.uk www.wildlifetrusts.org



Brown hare

The brown hare is one of the best known of Britain's farmland mammals. Brown hares have distinctly long, black-tipped ears and a tall and leggy appearance. They are most easily seen during March and April, boxing and chasing each other on open fields. Brown hares are widespread on low ground throughout England but have declined greatly in numbers since the Second World War. Hares prefer a mix of arable and grassland fields, some woodland, a mixture of vegetation height, and some large uniform fields.

Key points

- Brown hares are more common in eastern counties, and on arable farms.
- They prefer a farmland 'mosaic' mix of arable and grassland fields and other habitats such as woodland
- A number of Countryside Stewardship options will benefit hares

Brown hare



Brown hares are believed to have been introduced to Britain in Roman times but this is not certain. Whatever its origins, the brown hare is now a fully integrated member of our mammalian fauna. Although still considered to be abundant, hares have significantly declined in numbers over the last sixty years, believed to be due to changes in farming practice. Because of these declines, the brown hare has a Biodiversity Action Plan.

Brown hares often lie up in ploughed fields
© oldbilluk CC BY NC SA 2.0



Hares feed on grasses and herbs



A patchwork of arable, grassland, hedgerow and woodland will provide food and cover for hares through the year © Ruth Feber

Brown hares are mainly nocturnal, preferring to feed at night in open countryside with short vegetation. Young grasses, herbs and arable crops form the bulk of their diet. During the day they lie up in shallow depressions called forms, in vegetation or in ploughed fields, keeping very still and relying on their cryptic coloration to avoid being seen by predators. They also avoid predation by running at speeds of up to 45mph.

Hares are most easily seen when boxing and chasing each other on open fields during March and April. About three litters are born each year to each doe, usually between February and October. Breeding success is partially dependent on summer weather, with poorer survival in cold and wet conditions. Although birds of prey frequently take young hares (leverets), the main natural predator of adult and juvenile brown hares is the fox.

Habitat management

The ideal farmland for hares should have a mixture of arable and grassland fields and woodland - a 'patchwork quilt' effect (Boxes 31, 32).

On arable farms cereal crops provide cover in summer, but they are not good feeding areas once the crop is tall. Providing more grass in the form of wide strips or patches of pasture is the best way to improve habitat on arable farms. Grassy strips will help provide summer grazing and, if the strips run across open fields (such as beetle banks) rather than alongside hedgerows, this will reduce the hares' vulnerability to predators such as foxes which may lie in wait for them. In winter, cover may be provided by game crops, hedgerows and small woodlands. Overwintered



Hares are vulnerable to farm operations
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Hares will use arable fields over winter and spring © Nick Ford CC BY NC ND 2.0



Cut silage from the middle of the field outwards, to allow hares to escape
© Sebastian Ballard CC BY SA 2.0

stubbles are very valuable for hares. Planting game cover and wild bird seed crops will also provide cover and food for brown hares.

On livestock farms, the problems facing hares include lack of cover and high mortality of leverets through predation and grass-cutting machinery. Hares are most often found in fields without stock or where the stocking densities are very light. They prefer pasture grazed by cattle and fallow land rather than sheep pasture, as sheep grazing produces a short turf that is unsuitable for brown hares to lie up in. On livestock farms, leaving some areas of grass uncut and ungrazed will provide cover for leverets. When making silage, if the field is cut from the centre outwards rather than from the outside in, hares and other wildlife have a better chance of escaping the machinery into neighbouring fields.

Brown hare legislation

Around 200,000-300,000 brown hares are shot each year in Britain, principally in arable areas in eastern England. Scotland has recently introduced a closed season under the Wildlife and Natural Environment (Scotland) Act 2011, which prohibits the intentional or reckless killing, injuring or taking of brown hares between 1 February and 30 September. There is currently no close season for brown hares in England. The Hare Preservation Act 1892 provides limited protection by forbidding the sale of hares during the notional main breeding season of 1 March to 31 July inclusive. Hares should not be shot in late winter or spring unless crops are being severely damaged.



© Nick Ford CC BY NC ND 2.0

The Hunting Act 2004 outlaws all hare coursing and prohibits all hunting of wild mammals with dogs in England and Wales, except where it is carried out in accordance with the conditions of the few tightly drawn exemptions intended to allow certain necessary pest control activities to continue. Natural England provides full details of these exemptions and all the specific conditions of each exemption must be complied with if the hunting is to be lawful.



Brown hare © Hans Hillwaert CC BY 9A 3.0

Habitat use by brown hares

We investigated habitat use by brown hares at two sites in Oxfordshire using radio-tracking. One of the sites had a high density of hares, and the other site had a low density of hares. Both sites were mixed farmland.

At both sites in most seasons, cereal crops were favoured as habitats, even when the crop was past the tillering stage. The exceptions were July to September at the low density site when grass and stubble areas were preferred, and October to December at the high density site, when rough ground or ploughed areas were preferred. Use of weedy patches within and at the edge of crop fields was also seen.

Woodland was more commonly used by hares throughout the year at the high density site, but avoided at the low density site, perhaps linked to predation risk.

The results showed complex habitat use by brown hares, which varied with density of hares present, highlighting the importance of a diversity of crop, grass and woodland habitats on the farm, and also smaller scale habitat diversity such as weedy patches within or on the edge of fields. The results also suggested that factors other than food availability, such as predation and disturbance, affected how hares used their farmland environment.



Ploughed fields are sometimes preferred by hares
© Peter French
CC BY SA 2.0

Key results

- Hares used different habitats at different times of year
- Cereal crops were especially favoured
- A patchwork effect of different crops and habitats is best for hares



Brown hare © Tara Proud

Mixed farmland provides food for hares

Wild hares are selective feeders, eating different parts of a wide variety of wild and cultivated grasses and herbs. They require a diverse, high quality diet. We wanted to find out whether hares appeared to suffer from lack of food when living at different densities, or at different times of year.

We measured nutritional intake in wild hares from two different areas; in one they lived at high density, and in the other they lived at low density. The farmland habitats were used in different ways by hares at each of the two sites (Box 31).

There was no evidence that food shortages occurred at either site during summer, autumn or winter. Body condition of hares also did not differ between the two sites, or between seasons.

In this study area at least, it seemed that mixed farmland provided sufficient food for adult hares, even for populations at relatively high densities. However, it is possible that food shortages could affect breeding success and therefore recruitment into the population.

It remains likely that other factors associated with changes in agricultural practice, such as modern harvesting methods and fluctuations in predator numbers, as well as a reduction in mixed farming systems, are more likely to have contributed to the decline of the brown hare.

Key results

- Hares need a diverse, high quality diet
- Mixed farmland can usually supply sufficient food for hares
- Other factors are more likely to have contributed to the hare's decline



Foxes are the chief predators of leverets
© Paul Glendell/
Natural England

Brown hare

Management summary		
	Key actions	Potential benefits
Arable	<ul style="list-style-type: none"> A mix of crops such as wheat and beet, with some grass is good for hares. Overwintered stubbles are especially valuable. Beetle banks or strips of grass across arable fields are valuable, also taking field corners out of management Plant game cover and wild bird seed crops 	<p>Hares can find food and cover at different times of year.</p> <p>Provide extra cover for hares</p> <p>Helps provide food and cover for hares and other wildlife</p>
Grassland	<ul style="list-style-type: none"> Try to leave some areas uncut and/or ungrazed When making silage, cut from the field centre outwards 	<p>Provides areas for leverets to hide</p> <p>Allows hares to escape the farm machinery</p>
Landscape	<ul style="list-style-type: none"> Hares thrive in mix of arable and grass fields and non-cropped areas such as small woodlands 	<p>Provides food and cover for hares throughout the year</p>

Options especially relevant for brown hare		
Code	Countryside stewardship options	Tier
AB2	Basic overwinter stubble	Mid
AB3	Beetle banks	Mid
AB5	Nesting plots for lapwing and stone curlew	Mid
AB6	Enhanced overwinter stubble	Mid
AB7	Whole crop cereals	Mid
AB10	Unharvested cereal headland	Mid
AB11	Cultivated areas for arable plants	Mid
AB14	Harvested low input cereal	Mid
AB16	Autumn sown bumblebird mix	Mid
GS1	Take small areas out of management	Mid
OP1	Overwintered stubble	Mid
OP2	Wild bird seed mixture	Mid
OP5	Undersown cereal	Mid

Find out more at:
www.gwct.org.uk www.naturalengland.org.uk



Soprano pipistrelle © Julian Thornber

Bats

Bats are the world's only true flying mammals. There are at least 17 breeding species in the UK, ranging in size from the tiny 5g pipistrelle to the noctule, weighing in at 40g. Bats are intelligent, social mammals that can live for over 30 years. They sleep during the day and feed at night, consuming vast numbers of insects which they detect using echolocation. Bat populations have declined severely and conservation efforts involve the protection of summer roost sites and winter hibernation sites, and the protection and appropriate management of habitats where bats forage and commute.

Key points

- Bats have complex needs, and different species have different requirements
- The most important habitats for bats are water, woodland, grassland and linear features such as treelines
- Protecting these habitats safeguards bat roosting, commuting and feeding areas

Bats



Whiskered bat © Keith Cohen

Bats rely on many aspects of the landscape: different sites to roost in, hedgerows to commute along and good foraging areas. Bats in the UK feed only on insects, consuming thousands every night, so habitat management that encourages insects will be good for bats. Bats are mobile creatures, so providing the right habitats in the wider countryside, rather than solely within protected areas, such as nature reserves, is vitally important. The principal habitats used by foraging bats are freshwater, woodland, grassland and linear features.



A tree lined slow flowing river corridor near broad-leaved woodland is ideal bat habitat © Danielle Linton

Freshwater

Freshwater is important for all bat species in the UK. Bats drink from open water surfaces and many bat species also feed on emerging insects - such as caddis flies, crane flies, midges and mosquitoes - that have aquatic larval stages. Water features are particularly important foraging areas for Daubenton's bat and the soprano pipistrelle, which are most active over smooth, open water surfaces and along tree-lined riparian corridors.

Conserving insect populations and providing a varied habitat structure in the vicinity of open water will help bat populations (Box 33). Natural features of water bodies such as meanders, spits, shallows, pools and riffles should be retained, as these promote high insect diversity. Open ponds and pools should be conserved and, at the water's edge, aquatic plants and gently shelving banks are also important.

Variation in vegetation along the banks of rivers and ponds encourages insect diversity. Grassy margins, scrub and overhanging vegetation provide excellent conditions for insects and foraging bats. Habitat diversity can often be achieved simply through allowing growth of taller vegetation. Where bank management is necessary, it is best to restrict it to a small area and one bank at a time. Management needs to be carried out sensitively, aiming to enhance variation in vegetation. Bankside trees should be retained, pollarding where necessary.



Pools and ponds are a rich source of invertebrate food for bats © Paul Glendell/Natural England



Woodland is used by bats for feeding and roosting © Danielle Linton

Woodland

Woodland provides a wide diversity of insect food and a high degree of cover for bats (Box 34). It is also more sheltered and often warmer than open environments, giving valuable cover to foraging bats that avoid open areas. Many bats are strongly associated with broad-leaved woodland habitats, including several rare species such as barbastelle, Bechstein's bats, and lesser horseshoe bats.

Woodland is an important foraging habitat for bat species adapted to gleaning prey amongst dense vegetation, such as brown long-eared bat, Natterer's bat and Bechstein's bat. Woodlands can also provide numerous roost sites. Ancient, semi-natural woodland should be protected, for example, by continuing traditional management regimes or following a policy of non-intervention. Pollarding can help to maintain ancient trees which support many insects and provide roosting sites. If woodland has traditionally been managed by coppicing, long rotations are best for bats.

Woodland rides, clearings or glades are all important for insect diversity, and the variety of structures will benefit a range of bats. Woodland that is adjacent to, or near, water is particularly valuable. Woodland ponds, if present, should be part shaded, but also have some areas with open margins, perhaps next to glades or rides, to provide suitable 'approach routes' in dense woodland for larger, less manoeuvrable, bat species.



Natterer's bats can glean prey from dense foliage © Keith Cohen



Moths form a major part of many bats' diets © Rob Wolton, Hedgelink

Echolocation

Bats can navigate and detect tiny insect prey in complete darkness by using a sophisticated echolocation system. They produce high frequency calls - outside the range of human hearing - and listen for returning echoes to produce a 'sound picture' of their surroundings. In this way they can navigate through their environment and locate their prey. Different bat species emit unique sounds that will work best in different types of environments and for locating particular types of insects. Bat sound detectors can be used to identify bats by their echolocation calls.



Bat detectors identify bats from their unique high frequency calls © Gilles San Martin CC BY NC 3.0

Bats



Hedgerow trees provide shelter and insect food for bats
© Durham Hedgerow Partnership, Hedgelink



Bats fly along treelines and tall hedgerows to cross the landscape © Rob Wolton, Hedgelink



© Rob Wolton, Hedgelink
Cattle grazed grassland (above) has plenty of dung (below), which supports abundant invertebrate food for bats



© Danielle Linton

Treelines and hedgerows

Linear habitats such as hedgerows, tree lines, woodland belts, ditches and the edges of watercourses are important foraging habitats that provide an abundance of insects. They also act as corridors through the landscape, connecting other foraging or roosting habitats such as waterbodies and woodland. Hedgerows with mature standard trees, and treelines, are especially important as flight lines for bats such as the pipistrelle. Common pipistrelle is often the most frequently encountered species on farmland, and particularly high levels of activity are associated with treelines, with foraging rates increasing along treelines adjacent to stream corridors.

Many bat species will follow landscape features that provide shelter from wind for both the bats and their insect prey, shade at dusk or dawn or on moonlit nights, and cover from predators such as raptors and owls. Treelines and tall hedgerows may also be particularly important during the breeding season when female bats return from foraging areas to their maternity colonies frequently throughout the night.

Grassland

Levels of bat activity are generally higher in grassland compared to arable regions. Cattle-grazed pasture is particularly valuable for bats, because dung beetles and other insects associated with cattle dung are important food, particularly for greater horseshoe and serotine bats. The presence of cattle-grazed grasslands can even increase breeding success of greater horseshoe bat colonies, and influence their selection of hibernation sites.

Unimproved meadows have a wide variety of plants and hence support many different insects. Varying the grass height through selective cutting, and avoiding fertilisers and pesticides, will enhance insect diversity, though the management of sites of high nature conservation value should not be altered. More intensively managed and improved meadows may still have large numbers, but fewer species, of insects, which can lead to food shortages at certain times of the year. Trees and hedgerows associated with pastures and meadows should be retained as they provide additional important foraging sites.



Mature trees may be used as summer roosts
© Danielle Linton



Caves are used by hibernating greater horseshoe bats © Gilles San Martin CC BY NC 3.0

Some studies have shown organic farms to have higher bat activity levels, as well as having increased populations of key prey invertebrate species; this may be due to a number of factors such as differences in pesticide use, livestock presence and size of hedgerows.

Summer roosts and hibernation sites

Bats are most active during March to October, but some bat activity can occur on warmer nights throughout the year. Some bat species use the same traditional roost site throughout the year; other species may move roost every few nights. Mature native tree species, especially oak, ash, beech and willow, have numerous cracks, crevices, rot holes, woodpecker holes and flaking bark that bats will use as summer roost sites. Trees near waterbodies such as ponds or rivers will be especially beneficial. Bats may travel several kilometres from their day roosts (in buildings, bridges, trees or caves) each night whilst commuting and foraging across the surrounding landscape. Bats will also use artificial roosts, ranging from any of several commercially available 'bat box' designs, to custom built 'bat houses'. Placing boxes in a variety of shaded and open positions will encourage a range of bat species.

Bats are seldom seen in the winter. They generally choose undisturbed, cool places with an even temperature in which to hibernate, such as caves, mines, tunnels or unoccupied buildings. Some species hibernate near their summer roost or foraging grounds, while others migrate some distance to find a suitable hibernation site.

In the UK, all bat roosts are legally protected. Any works affecting known roosts should only be undertaken after consultation with your Statutory Nature Conservation Organisation (e.g. Natural England or Countryside Council for Wales).



High quality bat habitat © Danielle Linton

Bat activity varies with habitat

During 180 nights, 3600km of lowland farmland in the Upper Thames Project area were surveyed for bats (using a bat detector), by walking or driving. Bat activity was recorded within 82% of the surveyed area, which covered a wide range of habitat types, from open arable fields to broad-leaved woodland.

Common pipistrelle bats were most frequently encountered foraging and commuting along tree lines (accounting for 34% of common pipistrelle records) or adjacent to streams (24% of common pipistrelle records) within farmland study sites. Soprano pipistrelles and Myotis bats, however, were found to prefer woodland habitats (20% and 23% of records respectively) and river corridors (18% and 20% of records respectively) for commuting and foraging in lowland farmland.

The only habitat type that all bats used less than would be expected from its availability was hedgerows without trees. This habitat represented 20% of all transect routes, but accounted for fewer than 10% of records for any bat species or group.



Tree lines were favoured by common pipistrelle bats © Danielle Linton

Key results

- Bats will fly across many farmland habitat types, but activity is concentrated within particular habitats
- Common pipistrelle bats prefer tree lines and streams for commuting and foraging
- Soprano pipistrelle and Myotis bats prefer woodland and river corridors



Maternity roost of Natterer's bat © Keith Cohen

Bat roosts and social groups in woodland

Wytham Woods, in Oxfordshire, is a 390ha area comprising ancient semi-natural woodland, secondary woodland, and mixed plantations.

Over the past six years, studies of bat community dynamics within the woods have been conducted. At least eleven bat species have been confirmed roosting or foraging around Wytham Woods to date. Over 950 roosts and more than 2,500 individual bats have been found across the woods, mostly in artificial bird nest boxes, with potentially as many natural tree roosts still waiting to be discovered.

Several distinct social groups of Daubenton's, Natterer's and brown long-eared bats have now been identified occupying separate areas within this continuous woodland. Sympathetic woodland management is important, as even localised woodland clearances could have a significant impact on the resident bats.

Radio-tracking studies carried out across the UK have revealed that bats can fly several kilometres from their roosts for foraging each night, and even woodland specialist species such as Bechstein's, barbastelle, Natterer's, brown long-eared and lesser horseshoe bats may utilise networks of small, and even isolated, woodlands within agricultural landscapes.



Brown long-eared bat in artificial roost © Julian Thornber

Key results

- Woodlands are very important roosting areas for bats
- Different social groups of bats occupy distinct areas
- Bats can fly several kilometres to forage, so even small farm woodlands are useful for bats

Bats

Management summary		
	Key actions	Potential benefits
Water bodies	<ul style="list-style-type: none"> • Ponds, ditches, streams and rivers are all important • Both shaded and open parts of ponds and rivers are valuable • Manage for a range of vegetation types 	<p>Many bats feed or rely on emergent aquatic invertebrates.</p> <p>Different bat species prefer to hunt in different ways</p> <p>Will encourage abundant invertebrate prey</p>
Woodland	<ul style="list-style-type: none"> • Ancient woodland is especially important • Keep old trees • Avoid clear-felling, coppice on long rotation where coppicing is traditional management • Rides, glades and clearings are valuable woodland features 	<p>Provides roosting and foraging opportunities for many bats</p> <p>Some rarer bats are predominantly woodland species</p>
Grassland	<ul style="list-style-type: none"> • Cattle grazed pasture especially important • Reduce inputs and vary vegetation height and structure; retain hedgerows 	<p>Encourages a rich insect fauna for bats to feed on</p>
Treelines, hedgerow trees & tall hedges	<ul style="list-style-type: none"> • Retain treelines, protect hedgerow trees, allow hedges to grow tall 	<p>Linear features are important for helping bats move through the landscape, and can be rich feeding areas</p>

Options especially relevant for bats		
Code	Countryside stewardship options / capital items	Tier
BE1	Protection of in-field trees on arable land	Mid
BE2	Protection of in-field trees on intensive grassland	Mid
BE3	Management of hedgerows	Mid
BN11	Planting new hedges	Mid
GS2	Permanent grassland with very low inputs (outside SDAs)	Mid
GS17	Lenient grazing supplement	Mid
SW11	Riparian management strip	Mid
SW12	Making space for water	Higher
WD1	Woodland creation - maintenance payments	Higher
WD2	Woodland improvement	Higher
WD3	Woodland edges on arable land	Mid
WD4	Management of wood pasture and parkland	Higher
WD5	Restoration of wood pasture and parkland	Higher
WD6	Creation of wood pasture	Higher
WD7	Management of successional areas and scrub	Mid
WD8	Creation of successional areas and scrub	Higher
WT1	Buffering in-field ponds and ditches in improved grassland	Mid
WT2	Buffering in-field ponds and ditches on arable land	Mid
WT3	Management of ditches of high environmental value	Higher
WT4	Pond management - first 100 sq m	Higher
WT5	Pond management - (areas more than 100 sq m)	Higher

Find out more at:

www.bats.org.uk (Including directory of local bat groups across the UK)
www.naturalengland.org.uk www.ptes.org