WILDCRU
Wildlife Conservation Research Unit

Wildlife & Farming

Conservation on lowland farms

Ruth Feber & David Macdonald

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Preface

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This is a practical Handbook, providing advice to practical people. The question it answers is a crucial one: how to conserve wildlife on working farms in Britain.

Modern British farmers, and the agri-environment schemes that incentivise them, aspire to be custodians of a countryside that provides the nation with food security alongside vibrant wildlife and an inspiring landscape. Farmers and policymakers want to know what to do to fulfil this vision for wildlife and farming.

Over twenty-five years ago, the Wildlife Conservation Research Unit (part of the University of Oxford's Department of Zoology) set out to help provide the answers. Our purpose was to work with farmers, not against them, to foster the sort of countryside that society values. So, we began by seeking farmers' opinions and ideas for how better to integrate wildlife on farmland and to learn about their problems with wildlife. The down-to-earth approach reflects the WildCRU's mission, which is to achieve practical solutions to conservation problems through original scientific research. The key word is evidence: the WildCRU's role is to provide the scientific evidence that helps practitioners decide what to do. The evidence that supports the advice in this Handbook has taken us 25 years to gather.

This WildCRU Handbook is an idea whose time has come. In the last couple of years the nation has been formulating a new vision for the environment. The Government's Chief Scientific Advisor took the lead on reviewing food security. Natural England produced its audit of 'Lost Life: England's lost and threatened species'. September 2010 saw the publication of Professor Sir John Lawton's review, 'Making Space for Nature', with its catchy advice of 'better, bigger, more, joined', ranking the priorities for improving management of protected areas, increasing their size, creating new ones and joining them up. 2010 also saw publication of the UK's National Ecosystem Assessment and, in 2011,the Natural Environment White Paper 'The Natural Choice: securing the value of nature', advocates moving towards a landscape-scale approach to conservation. The concept of paying for ecosystem services is beginning to be understood and applied.

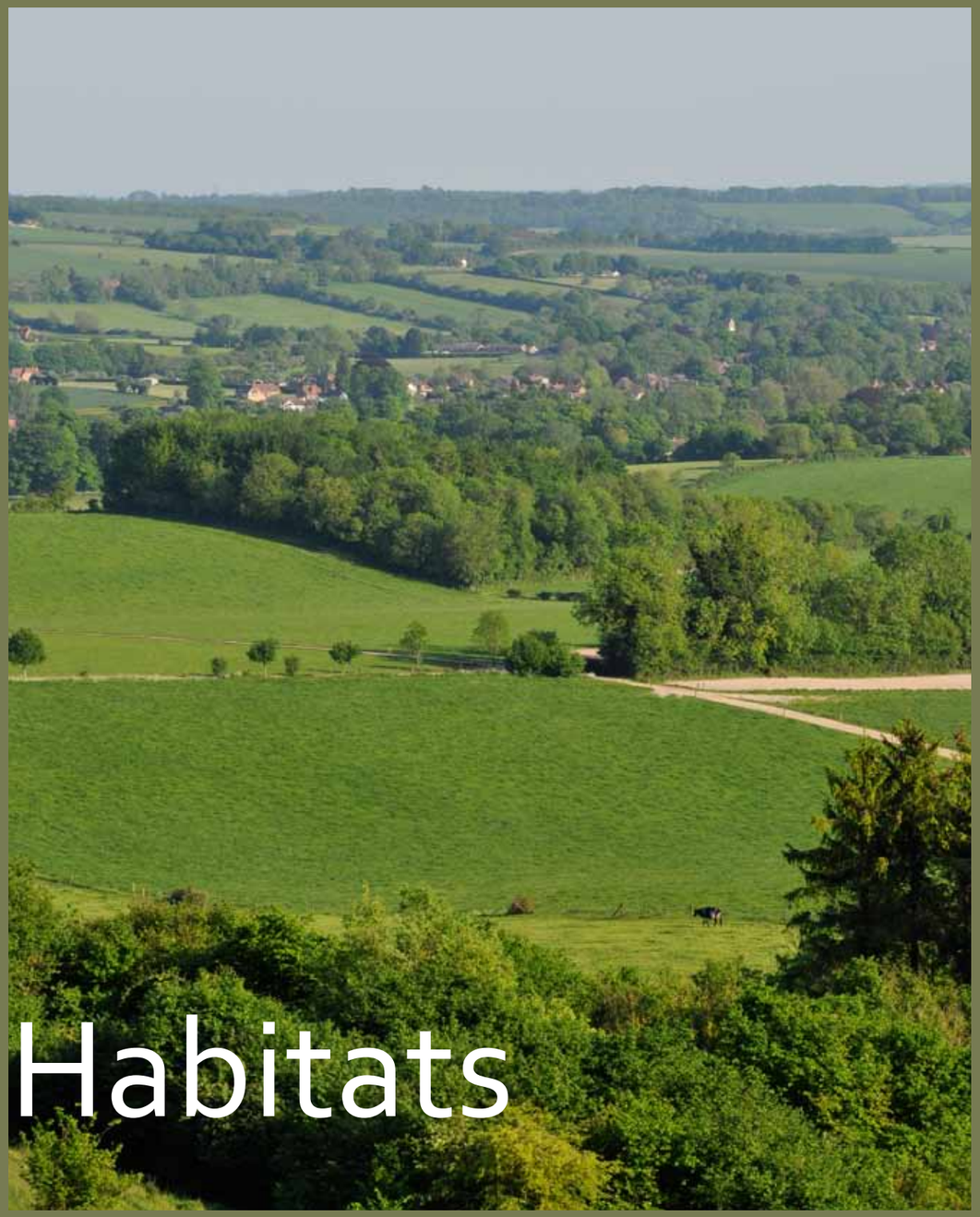
This Handbook is about delivering part of that vision: functioning farms, alive with wildlife, in a rich landscape that will engage and exhilarate the public who, ultimately, pay for it.

Science in general, and the WildCRU in particular, is collaborative. We are quick to acknowledge, and sincerely to thank, the many colleagues whose excellent work in diverse institutions underpin the advice and information given here. Because we know our own work best, we use our own case studies as examples. Our farmland history began with large scale experimental studies of field margin management at Wytham, near Oxford. Thereafter our journey took us to field-scale experiments with set-aside, then farm system comparisons of conventional and organic farms, then landscape systems in the Chichester Plain and, most recently, the Upper Thames - lessons from all of these are found herein. But some readers will want more detail, so we are publishing a companion volume 'Wildlife Conservation on Farmland', which will synthesize the scientific evidence from our farmland studies over the last 25 years.

We have worked closely with government and non-government organisations, amongst them the Wildlife Trusts, Defra, Environment Agency and Natural England - we thank them, acknowledge warmly their input, and hope that they and their constituencies will find this Handbook useful. We are thrilled that the Handbook is endorsed by Natural England and we are indebted to the Rivers Trust, the Holly Hill Charitable Trust and Natural England for their generous support.

The Handbook is simple to use. There are nine chapters on habitats and nine on wildlife groups. Each chapter follows the same format. Each briefly summarises up to date knowledge on each habitat/wildlife group, making key points leading to a management summary and a list of relevant Environmental Stewardship options for each habitat/wildlife group, together with sources of more information. Each chapter has two feature Boxes giving WildCRU research highlights. This is a 'What to do' book, and we are already at work on a companion volume on 'How to do it'.

Ruth E. Feber and David W. Macdonald
WildCRU, Oxford



Habitats

Overleaf image: view from Beacon Hill National Nature Reserve, Hampshire
© Ruth Feber


Oxeye daisies © Ruth Feber

Field margins

Field margins are among the most extensive and ubiquitous uncropped habitats on farmland and have the potential to provide habitat for a range of wildlife. Over-wintering sites for invertebrates, refuges for small mammals, nectar and pollen resources for pollinators, and nesting and feeding sites for birds can all be encouraged by establishing field margins. As well as being habitats in their own right, field margins protect other features, such as hedgerows or watercourses, from farm operations. They can also act as corridors, helping wildlife move through the landscape.

Key points

- **Field margins or buffer strips will benefit a range of farm wildlife species**
- **Different field margin options are possible, such as sowing with a tussocky grass mixture, including wildflowers to benefit nectar feeders, or cultivating margins for rare arable plants**
- **Aim for a mosaic of patches of taller and shorter vegetation around the farm, cut infrequently once established and do not cut in summer.**

Field margins

Female common blue butterfly © nutmeg66 CC BY NC ND 2.0

Field margins are the strips of land between the field boundary (such as a hedge) and the crop. Field margins can be deliberately managed to benefit key farmland species and buffer strips are one of the most popular agri-environment scheme options.

Field margins may contain a great diversity of plants, including those characteristic of woodland (hedge bottoms), wetland (ditch banks), grassland (grass margins) and arable (field corners and crop edges). Field margins can be established around both arable and grass fields; in arable areas they are especially valuable as they provide undisturbed breeding and overwintering sites for wildlife. They act as buffers, protecting hedgerows, ditches and streams from farming operations, and they form a network across the landscape, often linking bigger areas of wildlife habitat, such as woodlands or wetlands.

© Emily Ledder/Natural England

Simple grass-only margins (above) provide breeding and overwintering habitats, while the addition of wildflowers (below) can greatly enhance their value to wildlife

© Michael Trolove CC BY SA 2.0

Establishing and managing field margins

Field margins can be established and managed in several ways, described below, which will have different consequences for the wildlife that use them.

Sown field margins or buffer strips

Many buffer strips are established by sowing with a simple grass mixture, often including tussocky species such as cocksfoot. Tussocky margins encourage invertebrates such as carabid beetles, which predate aphids, and they can act as a source from which predatory invertebrates can colonise fields. They also provide cover and nesting sites for many small mammals, and habitat for amphibians and reptiles. Wild grass seeds are less important in the diet of farmland birds than broad-leaved weed seeds, but they are consumed by a number of finches and gamebirds.

Field margins help buffer other features, such as ditches, from farming operations

© Rosalind Shaw

Naturally regenerated margins are the best conservation option on light or shallow soils without grass weed problems

© Evelyn Simak CC BY SA 2.0

However, grass-only strips rapidly form dense swards and can exclude naturally colonising wildflowers, often resulting in low species diversity. Including wildflowers (such as yarrow, black knapweed and oxeye daisy) in the seed mixture will greatly increase the value of margins for wildlife, providing a greater diversity of seed sources and host plants for invertebrate larvae, as well as pollen and nectar supplies for pollinators. Choosing species that flower and set seed at different times throughout the season will be even more beneficial.

Naturally regenerated margins or buffer strips

Field margins can also be established through natural regeneration. If soil fertility is relatively low, and the soil seed bank and local flora relatively rich, these swards may have a higher conservation value than sown ones, making this method of establishment the most beneficial option. The decline of rare arable plants, such as the cornflower, can also be helped through naturally regenerated buffer strips on light or shallow soils that are cultivated every one or two years. Varying the depth and timing of cultivation can enhance plant diversity.

Naturally regenerated margins can also provide important food resources for birds, both in summer and winter, in the form of weed seeds and grain from volunteer crops and a range of invertebrates. The patchy sward may make it easier for birds to find their prey. However, on very fertile soils, where the existing plant community is poor, or where there is a grass weed problem, naturally regenerated strips may be difficult to manage, and sown grass and wildflower mixtures would be the better option.

Grassland field margins

Field margins, or buffer strips, benefit wildlife in grassland as well as arable situations. Grassland margins can be established by leaving a strip uncut around the edge of grass fields. These measures allow a taller, tussocky sward to develop. This encourages seed production and increases invertebrate abundance, both of which provide food for other wildlife. Field margins in grass fields also buffer other habitats such as hedgerows and ditches, in a similar way to margins in arable fields.

© Ros Shaw

Field margins can develop from the existing grassland, or a grass and wildflower seed mixture can be used to create them, following guidelines for arable fields. The margins will need occasional management, either through grazing or cutting, to prevent too much scrub developing. Agri-environment scheme funding is available for grassland field margins.

Field margins

Margins should not be cut in summer, to allow plants to flower © Raj CC BY NC ND 2.0

Structural diversity of vegetation helps beneficial invertebrates such as spiders © Martin James CC BY 2.0

Tussocky beetle banks help predatory invertebrates to colonise arable fields © Andrew Smith CC BY SA 2.0

Cutting management

Most margins are managed by some form of mowing, initially to aid establishment, and in later years to prevent the encroachment of scrub and maintain floral diversity. In the 12-24 months following sowing, frequent cutting may be needed to help the margin establish but, after this, mowing should be carried out not more than once every two years, or less often if possible. A diversity of structure is especially valuable (Box 1), and this can be encouraged by only cutting margins infrequently, cutting different margins in different years, or cutting half the margin and leaving half uncut. If possible, leaving some woody vegetation or scrub to develop will add to the habitat diversity for wildlife.

Margins and buffer strips should not be cut during the late spring or summer, as this removes sources of pollen and nectar when they are crucially important, and may disturb nesting invertebrates, small mammals and birds. Where cutting is needed, for example to maintain the plant diversity of grass and wildflower sown buffer strips, or to control scrub, cutting in autumn will open the sward and reduce competition in winter (Box 2). However, it is still important to leave some patches or strips of the margin uncut each year to provide undisturbed areas for overwintering invertebrates and other species.

Ideally, cuttings should be removed. Leaving cut hay lying, rather than removing cuttings, may slow down the decline of annual weeds, such as black grass, and increase some perennial weeds, such as common nettle. Over the longer term, if the cuttings are left on the margins, plant species able to exploit higher soil nutrient status tend to increase, resulting in a less diverse sward.

Beetle banks

Beetle banks are linear grassy ridges about 2m wide, created across the middle of large cereal fields. Tussocky grass species, such as cocksfoot, are sown on the bank to provide over-wintering cover for invertebrate predators of cereal aphids. Beetle banks also help to reduce field size, enabling predators, such as ground beetles and wolf spiders, to fully colonise the crop before the start of an aphid invasion. The banks do not extend to the field margin so farm machinery can pass, and the field continues being used as a single unit. Tussocky grasses sown on beetle banks also provide ideal habitat for small mammals and are used by ground-nesting birds.

Knapweed is an important component of nectar flower mixes © Miles Wolstenholme

Margins are best situated next to other features, such as hedges © Ruth Feber

Linking field margins across a landscape increases their value to wildlife © Rosalind Shaw

Wild bird seed mixture and nectar flower mixture

Typically, wild bird seed mixture comprises a variety of species, planted in blocks or strips, including cereals, millet, kale, quinoa and sunflower. In general, kale seems to support high densities of the widest range of birds (insectivorous and seed-eating species). Quinoa can support large numbers of finches, sparrows and buntings.

Nectar flower mixtures, designed to provide food resources for invertebrates, contain at least four nectar-rich flowering plants, for example, red clover, birds-foot trefoil, common knapweed and sainfoin. Nectar flower mixtures are particularly valuable for supporting populations of pollinators.

Siting of field margins or buffer strips

Permanent grass only, or grass and wildflower, sown margins should not be sited where there are populations of rare arable plants in the crop edge, as the arable plants will not be able to compete with the grassy sward. Cultivated margins are, instead, appropriate for arable plants, as these species need regular disturbance to survive.

Field margins are often best situated next to other features such as hedgerows or wetland features such as ditches. Field margins can help buffer hedgerows and ditches from farm operations, and a diversity of habitats in close proximity will have wildlife benefits, providing a greater range of food resources, shelter and breeding habitats, especially benefitting less mobile species. Corners of fields can be particularly valuable. In general, wider field margins or buffer strips will be best for wildlife.

Field margins should ideally be established in such a way that they link to each other, and link other habitats across the farm. Increasing the linkages will help maximise their effectiveness as movement corridors for wildlife around the farm and across the landscape. Wood mice, for example, use different habitats at different times of year, often moving out of fields and into woodlands after harvest. A network of field margins, especially alongside other habitats such as hedgerows, will help them move and disperse safely.

Peacock butterfly © Roy Stead CC BY NC ND 2.0

Patchy margin management is best for butterflies

Field margins are important breeding areas for butterfly species on arable farmland. Two of the most well known butterflies are the peacock and small tortoiseshell. These butterflies hibernate in the winter and, after emerging in the spring, lay clusters of eggs on nettle plants. Although an extremely common plant, our studies showed that nettles must be of a certain height and in the right place to be suitable for the caterpillars.

Small tortoiseshell butterflies chose small plants, often young nettle regrowth, on which to lay their eggs. Such leaves are typically higher in water and soluble nitrogen than older leaves, providing better nutrition. Peacock butterflies chose the tips of much taller nettle plants for their eggs, perhaps because the typically larger clusters of caterpillars needed more plant material on which to feed.

Aspect was an important factor for egg-laying, particularly in spring, when clumps of larvae were found on margins that received maximum sunlight. More larval clumps were located on south-facing margins than on any other aspect, for both species. Warmth can increase caterpillar survival rates.

Mowing some areas and leaving other areas uncut will result in structurally more diverse swards, providing greater opportunities for egg-laying and feeding for butterfly species and other invertebrates. Mowing different areas in different years, or not mowing the entire margin width, could be used to help achieve this effect.

Key results

- **Even common butterfly species often have precise habitat requirements for feeding or breeding**
- **Managing field margin vegetation to create structurally different areas will help provide a range of habitats**
- **Leave some areas uncut, mow different areas in different years, or do not mow the entire margin width**

Cluster of peacock caterpillars on common nettle © Ruth Feber

Grass and wildflower mixture © Ruth Feber

Wildflowers on field margins

In a large-scale field experiment we investigated how mowing affected the performance of different sown wildflowers on field margins. The greatest effect was that margins mown in spring and autumn, with cuttings removed, had more species compared to cutting at other times. More germination opportunities in margins that were more open during the autumn and winter appeared to be a critical factor in helping species establish and persist.

Open swards and reduced competition during the winter was particularly beneficial to winter-green species such as lady's bedstraw. Other species, such as cowslip and oxeye daisy required some cutting to maintain their frequency. In contrast, common knapweed did best when it was left uncut in summer and able to regenerate from seed.

Where the local flora are impoverished or the conditions are unsuitable in other ways for naturally regenerated buffers or margins, sowing a mixture with even just a few wildflower species rather than grasses only will have many conservation benefits. Choosing species with similar management requirements can help maximise return on the investment.

Key results

- **Timing of mowing affects wildflower species in field margins differently**
- **If mowing is required, mowing in autumn encourages wildflower species to persist. Mow different areas in different years**
- **If only a few wildflowers are sown, choose species with similar requirements and tailor the management to suit them**

Scabious is a valuable nectar source for many insects © Kate Jewell CC BY SA 2.0

Field margins

Management summary		
	Key actions	Potential benefits
Grass-only margins	• Include tussocky grasses such as cocksfoot and cut infrequently • Margins situated next to hedgerows and ditches are especially valuable	Benefits all small mammal species and predatory invertebrates such as carabid beetles Creates a diversity of habitats
Grass and wildflower margins	• Include nectar sources such as knapweed, scabious and oxeye daisy • More species-rich seed mixtures will enhance plant, seed and invertebrate food supplies • Cut infrequently, and not in summer once established	Benefits pollen and nectar feeders, other invertebrates, and a range of wildlife species
Naturally regenerated margins	• Preferred establishment method on light, less fertile soils	Encourages local flora and provides conditions suitable for rare arable plants if cultivated
Beetle banks	• Create beetle banks across arable fields • Include tussocky grasses and manage as grass-only margins	Benefits small mammals and predators of cereal aphids, such as spiders and carabid beetles
Wild bird seed mixture and nectar flower mixtures	• Sow in strips or plots	Encourages nectar feeding invertebrates and a range of bird species

Options especially relevant for field margins		
Code	ELS/OELS options	ELS/OELS points
EE1-EE3	2/4/6m buffer strips on cultivated land	255/340/340 per ha
OE1-OE3	2/4/6m buffer strips on rotational land	340/425/425 per ha
EE4-EE6	2/4/6m buffer strips on intensive grassland	255/340/340 per ha
OE4-OE6	2/4/6m buffers strips on organic grassland	340/425/425 per ha
EE9/OE9	6m buffer strips on cultivated land/rotational land next to a watercourse	400/500 per ha
EE10/OE10	6m buffer strips on intensive /organic grassland next to a watercourse	400/500 per ha
EE12/OE12	Supplement to add wildflowers to field corners and buffer strips	63 per ha
EF1/OF1	Management of field corners	400/500 per ha
EF2/OF2	Wild bird seed mixture	450/550 per ha
EF4/OF4	Nectar flower mixture	450/550 per ha
EF7/OF7	Beetle banks	580/750 per ha
EF11/OF11	Uncropped cultivated margins for rare plants	400/460 per ha
HLS code	HLS options	Payment (£)
HE10	Floristically enhanced grass buffer strips (non-rotational)	£485 per ha
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HF20	Cultivated fallow plots or margins for arable plants (rotational or non-rotational)	£440 per ha
HE11	Enhanced strips for target species on intensive grassland	£590 per ha

Find out more at:
www.wildlifetrusts.org www.rspb.org.uk www.plantlife.org.uk www.gwct.org.uk
www.naturalengland.org.uk

Mixed species mature hedgerow, Herefordshire © Tree Council Image Bank

Hedgerows

Hedgerows are among the most important remaining areas of semi-natural habitat on lowland farmland. Many of our hedgerows are ancient and of historical interest, and all hedgerows are able to provide a host of resources for wildlife: food, shelter, nesting sites, refuge from farm operations and corridors across the landscape. A whole range of wildlife species, common as well as rare and declining, depend on hedgerows for their survival.

Key points

- **Hedgerows are of huge value to farmland wildlife**
- **Trim not more than every three years in January/February and aim for a variety of hedge heights**
- **Hedge-laying or coppicing can rejuvenate hedges**
- **Protect hedgerow trees**

Hedgerows

Hedgerows are important for the declining yellowhammer © Malene Thyssen GNU

Hedgerows are the most important wildlife habitat over large stretches of lowland farmland and are essential for a great variety of plants and animals. They are especially important for farmland birds, butterflies and moths, bats and dormice, with at least 47 species of conservation concern using hedgerows as their main habitat. The Hedgerow Biodiversity Action Plan concludes that over 600 plant species, 1500 insects, 65 birds and 20 mammal species have been recorded at some time living or feeding in hedgerows.

Hawthorn flowers provide nectar and pollen, and the berries provide food over winter © Dave Key, Hedgelink

Many different aspects of hedgerows are important for wildlife. Species-rich hedges will provide a variety of foods at different times of year, with flowers supplying nectar and pollen for insects in the spring and summer, and fruits and berries sustaining birds and mammals over the winter months. Hedges are used as nesting sites, while bats will use tall hedgerows to commute between feeding and roosting areas. Hedgerow trees provide shelter for insects such as moths, and may act as stepping stones across farmed landscapes. Hedges and hedge base vegetation provide many species with cover from predators and refuge from farming operations such as ploughing and harvest.

Hedgerows and dormice

Dormouse occurrence in hedgerows has declined by 64% since the late 1970s. Dormice need species-rich hedgerows that can provide different foods at different times of year, such as hawthorn flowers in spring, insects in summer, and hazelnuts in autumn to build fat reserves for the winter. Hedgerows can support breeding populations of dormice and are also used as dispersal corridors, linking copses that are too small to support viable populations on their own. However, even small gaps in a hedgerow can prevent dormouse dispersal, so sympathetic management is crucial.

Dormice leave tooth marks on the outside of hazelnut holes, while neat gnaw marks follow its circumference, smooth to the touch © PTES

Gappy hedge, probably due to flailing at same height for many years © Rob Wolton, Hedgelink

If hedges need to be cut, aim for different heights around the farm © Rob Wolton, Hedgelink

Brown hairstreak caterpillar on blackthorn © Rob Wolton, Hedgelink

Trim hedges not more than once every three years to increase fruit supplies © Rob Wolton, Hedgelink

Hedgerow management

Hedgerows are still being lost from the English countryside but, over recent years, this has been due more to neglect or harmful management, particularly repeated annual cutting to the same height for many years, rather than grubbing out. Many remaining hedgerows are in poor condition. The main problems are excessive gaps, a structure that is too short or too thin (especially at the hedge base), or low fruit (e.g. berry) production. Hedges need to be rejuvenated through laying or coppicing, as well as cut on a rotation that allows growth and flowering, both of which will have benefits for the health and vigour of the hedge as well as for the wildlife that use it.

Cutting

Recent studies show hedges should be cut on a minimum of a three year cycle to deliver more benefits for biodiversity. Hedge shrubs produce few flowers in the second year and, since many hedges are cut early in the autumn, any berries that are produced are removed before they can be taken by birds and other wildlife. Cutting not more than once every three years will result in much better flowering and fruit production, and will help birds, and insects such as the brown hairstreak butterfly, whose eggs need to safely overwinter on young blackthorn stems. Trimming in January or February rather than the autumn will allow berries to be used by wintering birds, and will avoid the destruction of birds' nests during the spring and summer.

Rather than trimming all hedges to the same height, it is important to aim for a variety of hedge heights and widths to provide a range of habitats for wildlife. Yellowhammers and partridges, for example, prefer short hedgerows with grass margins, while bullfinches prefer wide hedgerows over 4m tall. Dormice and many species of bat benefit from tall hedgerows, especially if they link patches of woodland.

Hedgerows

Laying a hedge in the Midland style © Rob Wolton, Hedgelink

A hedge one year after laying
© Durham Hedgerow Partnership, Hedgelink

Newly coppiced hedgerow
© Durham Hedgerow Partnership, Hedgelink

Hedge laying

Hedge laying was once common practice on nearly all farms and its decline has resulted in a decrease in the value of hedges for wildlife. Hedge laying is another form of hedge management. Each stem is partially cut through, then the stems are laid over and woven together to produce a thick living barrier which re-grows from the base. There are over 30 styles in the UK, each developed over many years to suit different climates, farming practices and tree and shrub types. Laying the hedge rejuvenates it, encourages new shrub growth and keeps it bushy and healthy. Once laid, trimming should keep the hedge in good order for up to 50 years when it may be laid again.

Coppicing

Coppicing involves cutting stems to ground level and allowing the stools to re-grow. It is particularly useful if a hedgerow is ready for rejuvenation but has too few stems for hedge-laying, or if the hedgerow is very wide. If the re-growth is protected from grazing by deer and livestock, a thick dense hedgerow can be recreated in this way in just a few years. It also gives the opportunity to plant up any gaps.

Hedge base vegetation

The value of a hedge for wildlife can be greatly enhanced by managing the hedge base to encourage plenty of vegetation. Hedge bases may have remnant populations of woodland flowers such as primroses, or plants such as cow parsley and hedge garlic, all of which provide important sources of nectar for a range of pollinator species. Tussocky grasses at the hedge base provide safe places for invertebrates, amphibians, reptiles and small mammals. Roots and woody stumps provide additional wildlife habitat.

A mature oak hedgerow tree
© Tree Council Image Bank, Hedgelink

Hedgerow tree with protective tree shelter
© Emily Ledder, Hedgelink

Recently planted hedge
© Durham Hedgerow Partnership, Hedgelink

Hedgerow trees

Hedgerow trees are traditionally part of the UK landscape and havens for wildlife (Box 3), but their numbers have declined dramatically because there are not enough young trees to replace specimens that die or are felled, mainly because saplings are prevented from growing by hedge cutting. Mature or dead hedgerow trees should be replaced by avoiding some saplings of native species during hedge trimming, or by planting new trees. If they are not a hazard, some old or dead trees can be retained, as they support important insect communities and may be used by hole-nesting birds. In 2010, Entry Level Scheme (ELS) options were introduced to support the tagging of young hedgerow trees and to protect the root systems of mature hedgerow trees by creating buffer strips.

New hedgerows

A good hedgerow, planted in the right place, can provide shelter, make a stock-proof barrier, enhance the landscape and benefit wildlife. New hedgerows that link with existing ones or with other habitats will be particularly valuable (Box 4), and hedgerows in combination with other features, such as ditches or field margins, may be especially valuable.

Planting hedgerow species that have a diversity of flowering and fruiting times will help wildlife. In general, native plants, such as blackthorn, hawthorn, and hazel, will support more species than non-native plants, and hedge plants that are characteristic of the local area will fit best into the landscape and be most likely to establish well and flourish. The best time to plant hedges is in the winter, and they may need protection from livestock and wildlife for the first few years. Detailed information on how to plant hedgerows can be found on the Hedgelink website.

Hedgerows and the Single Payment Scheme

To meet the conditions of the Single Payment Scheme, hedge trimming between 1 March and 31 July must be avoided, and hedgerows must have at least a 2m wide uncultivated strip from the middle of the hedge.

Swallowtail moth © Rob Wolton, Hedgelink

Hedgerow trees for moths

The importance of two key farmland elements - field margins and hedgerow trees - was assessed for moths, by light trapping over four summers across Upper Thames farmland. We recorded a total of 311 larger moth species, many of them spectacularly beautiful.

Our findings highlighted the importance of hedgerow trees, and wide field margins, in the conservation of wider-countryside moths. Wide field margins were beneficial for moths, but hedgerow trees had an even greater impact. Why did hedgerow trees increase moth numbers? When we looked at the types of moths found, we discovered that even those species whose caterpillars did not feed on the trees were in greater numbers. This suggested that hedgerow trees do not merely act as food resources, but provide important shelter for many moths in exposed agricultural landscapes.

Hedgerow trees may act as 'stepping stones' for some moths, especially less mobile ones, helping them to cross open agricultural landscapes in search of resources. They could become increasingly important, since they may help species to move northwards in response to climate change. Since 2010, options for tagging and buffering hedgerow trees are included in Environmental Stewardship.

Key results

- Hedgerow trees are even more important for many moths than wide field margins
- They provide shelter in open agricultural landscapes
- Support for hedgerow trees is now available through Environmental Stewardship

Hedgerow trees provide shelter for moths © Ruth Feber

Bank vole © Michael J. Amphlett

Hedgerows and small mammals

We wanted to find out which features of hedgerows were most important for small mammals. Using live-trapping methods (the animals are released after capture), we surveyed 180 hedgerows in four pastoral farmland locations throughout England and south Wales for five different mammal species (wood mice, bank voles, field voles, common shrews and yellow-necked mice). We also recorded information about each of the hedges we surveyed.

The results showed that the wider the hedgerows, the more small mammals they supported. Another important feature was how well linked the hedgerows were to each other and to woodland patches: higher levels of connectivity of a hedgerow increased the numbers of wood mice found. Conversely, the more gaps there were in hedgerows, the fewer bank voles were found. Where hedgerows had other habitats associated with them, such as ditches and conservation headlands, we also found increased numbers of small mammals.

The ages of animals captured indicated they were resident and breeding in the hedgerows, rather than using them as migration routes alone. These results further highlight the importance of hedgerow habitats on farmland.

Key results

- Wider hedgerows support more small mammals
- Hedgerows that are connected to other hedgerows and woodland are especially valuable
- Hedgerows next to other habitats such as margins and ditches had more small mammals

Hedgerows well linked to others have more wood mice ©Tree council Image Bank, Hedgelink

Hedgerows

Management summary		
	Key actions	Potential benefits
Hedge management	• Cut hedges on a rotation and do not cut more than once every three years	Will allow growth and fruiting of hedge
	• Aim for hedgerows of different heights around the farm	Will provide a variety of suitable habitats for different birds and mammals
	• Lay or coppice hedges to rejuvenate them	Laying or coppicing will give them a new lease of life
	• Avoid repeated cutting to the same height	Relaxing the cutting regime encourages a dense growth of healthy hedgerow stems
Hedge planting	• Use a mixture of native species, preferably those that are locally common	Will provide the best food resources for wildlife, and fit best in the landscape
	• Where possible, try to link areas of woodland, other hedges or semi-natural habitats	Hedgerows can help wildlife move through the landscape from one patch of habitat to another
Hedgerow trees	• Encourage and protect hedgerow trees	Hedgerow trees are very valuable for wildlife

Options especially relevant for hedgerows		
Code	ELS/OELS options	ELS/OELS points
EB1/OB1	Hedgerow management for landscape (on both sides of a hedge)	16 per 100m
EB2/OB2	Hedgerow management for landscape (on one side of a hedge)	8 per 100m
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB8/OB8	Combined hedge and ditch management (incorporating EB1/OB1 Hedgerow management for landscape)	38 per 100m
EB9/OB9	Combined hedge and ditch management (incorporating EB2/OB2 Hedgerow management for landscape)	26 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
EB14/OB14	Hedgerow restoration	10 per m
EC23/OC23	Establishment of hedgerow trees by tagging	1 per tree
EC24/OC24	Hedgerow tree buffer strips on cultivated land	400/500 per ha
EC25/OC25	Hedgerow tree buffer strips on grassland	400/500 per ha
HLS code	HLS options	Payment (£)
HB11	Management of hedgerows of very high environmental value (both sides)	£54 per 100m
HB12	Management of hedgerows of very high environmental value (one side)	£27 per 100m

Find out more at:
www.hedgelink.org.uk www.rspb.org.uk www.ptes.org www.hedgelaying.org.uk www.naturalengland.org.uk

Muntjac © Andrew Harrington

Woodland & scrub

Woodland has the potential to be one of the richest lowland habitats for wildlife. From the flowers that carpet woodlands in spring, to mosses, fungi, and invertebrates that, in turn, provide food for many mammals and birds, woodlands are home to an immense number of species. They are especially important in the wider landscape, and much farmland wildlife will use woodlands or scrub at certain times of year for nesting or foraging. The trees themselves can provide timber, shelter, or amenity value.

Key points

- **Farm woodlands and scrub have great potential for wildlife**
- **They provide vital food, nesting sites and shelter for wildlife in the farmed landscape**
- **Encouraging native tree and scrub species, and managing for a range of structures and varying light levels will result in a rich diversity of wildlife**

Woodland & scrub

Primroses are one of the most well known woodland flowers, providing important early nectar for butterflies and bees
© Chris Gardiner/Natural England

Woodlands can support a great diversity of plants and animals. There are around fifty native tree species in the UK and a number of non-native trees (often planted). The range of species present defines the type of woodland and, to an extent, the biodiversity it can support. Ancient and native woodlands are especially important for wildlife, but many are now small in size (almost half of the ancient woodlands in England are between 2 and 5ha) and frequently isolated from other woodlands and semi-natural habitats. Woodland species are often not very mobile, and so are particularly vulnerable to impacts from surrounding land use and the effects of climate change.

Woodlands can have a diverse and species-rich vegetation. Shrubs, such as hazel, hawthorn and holly, often provide an important understorey vegetation, while mosses, ferns and wildflowers appear throughout the year. Among the most characteristic and well known are flowers such as bluebell, primrose, wood anemone and snowdrop, which carpet the woodland floor in spring and provide early sources of nectar for pollinators, such as bumblebees.

Noctule bats use woodland for roosting and feeding © wolf359 CC BY NC SA 2.0

Woodland vegetation supports a complex community of invertebrates, birds and mammals. Most UK mammals use woodland habitats for at least some of their time. Some small mammals, such as wood mice, may move into woods from surrounding farmland at times when food or shelter in the fields is scarce. Dormice are much more dependent on woodland, requiring species-rich, structurally diverse woods with good canopy cover. Nearly all bat species found in the UK spend some of their time in woodland, and some are restricted to ancient woodland.

Tawny owls are found in woodland
© Paul Buxton CC BY NC ND 2.0

Broadleaved woods have an abundant birdlife, including resident species such as tree creepers, great tits, nuthatches and greater and lesser spotted woodpeckers. Spring and summer visitors to woodland include chiffchaffs and blackcaps, and coppiced woods are especially important for nightingales. The nocturnal tawny owl is a woodland resident, and several species of raptor will use woodland for nesting.

The threatened pearl-bordered fritillary butterfly can be found in coppiced woodland clearings in spring © Vince Garvey1 CC BY NC ND 2.0

An abundance of insects and other invertebrates thrives in broadleaved woodlands. Of Britain's native trees, the English oak, in particular, supports the greatest number of insect species. A high proportion of the UK's beetles are associated with woods and trees, especially ancient ones. Some declining butterfly species, such as pearl-bordered fritillary, rely on coppiced woodland for their survival, while other species, such as speckled wood and green-veined white, are commonly found in woodlands. Woodland moths are even more diverse (Box 5).

As well as the species of tree in a woodland (whether native or non-native), how much biodiversity a woodland can support depends on three other main factors: the amount of light beneath the canopy, the age of the trees (and how long woodland cover has been there), and the structural diversity within the woodland. This is affected by management and other factors such as deer browsing (Box 6). Native broadleaved woodland (especially ancient woodland), managed to allow different amounts of light through, and having different habitat structures, will have the greatest diversity of wildlife. Wildlife can nonetheless be encouraged in all woodlands, with the right management.

Which trees are best for biodiversity?

English oak © Rob Wolton, Hedgelink

Woodland biodiversity is affected by whether the main tree species making up the woodland are native to Britain or not. In general, native trees will be best for biodiversity. Tree species introduced from other countries are often unpalatable to native species of invertebrates, which have not evolved to feed on them. For example, over 200 invertebrates are associated with native oaks, compared to fewer than 50 species on introduced larch.

Coniferous woodlands tend to have a lower biodiversity than broadleaved woodlands, partly due to the fact that most coniferous woods in England are plantations of non-native tree species. However, they still have value, often for different species to those which occur in broadleaf woodlands. For example, birds such as goldcrests prefer conifers, and will provide food for predators such as the sparrowhawk, which often uses conifers for nesting.

Woodland & scrub

Coppiced woodland in spring with rich ground flora © Roger Jones CC BY SA 2.0

A coppiced chestnut stool
© Roger Jones CC BY SA 2.0

The striking amethyst deceiver is found in deciduous woods © Rob Wolton, Hedgelink

Woodland management

Coppicing and creation of rides and clearings are effective ways to increase biodiversity within broad-leaved woodlands. Coppicing is an ancient form of management, which involves repetitive felling on the same stump, near to ground level, and allowing the shoots to regrow from that main stump. It is a highly effective method of producing a great deal of fast growing, sustainable timber without the need to replant. Coppiced woods are also exceptionally good for wildlife. Where coppicing is done on a rotation, the areas of varying canopy density through the woodland provide a range of habitats for wildlife. Coppicing, ride widening and glade creation all allow more light into the woodland, encouraging a rich ground flora and an abundance of invertebrates and birds.

Areas of good tree cover and shade should also be present in a woodland. These areas are important for a variety of other plant and animal species which cannot survive in more open areas. The cover and shade provide a damp, cool, sheltered microclimate in which certain species thrive, including a number of invertebrates, mosses, liverworts, ferns and fungi. Many common dead wood invertebrates need rotting wood that is left to decay in the shade, while some of our rarest moths are only found in dark, shady woodlands.

New woodlands

New woodlands can be planted to encourage biodiversity. The choice of species, planting density and management will all affect the wildlife that will colonise and use the new woodland. Woodlands that are linked to other areas of habitat will be of great value, and if the woodland can be designed to have a sympathetically managed buffer zone around it, this will also encourage species that need woodland edge habitats. Care should be taken to ensure the site is not already of high biodiversity interest, such as a species-rich meadow. Much information is available on how to manage existing woods or create new woodlands, and specialist advice is available using the website links at the end of the chapter.

Whitethroats favour young, scattered scrub for nesting © Steve Garvie CC BY SA 2.0

Bullfinches nest in older, mature stands of scrub © Geli CC BY 2.0

Oak tree in arable field
© Rob Watling CC BY NC ND 2.0

Scrub

Many farms that do not have woodland may have scrub. This is a vegetation stage intermediate between open ground and woodland, and can comprise scattered shrubs, young trees, or a dense thicket. Influenced by soil type and location, common scrub species are hawthorn, blackthorn, willow or bramble. Scrub of varied age, species and structure supports the greatest wildlife diversity, through the provision of nectar, pollen, fruits, seeds, shelter and nest sites. Scrub in field corners, along woodland edges and as scattered patches along hedgerows are all highly valuable wildlife habitats, and may also buffer woodland, hedgerows and ditches from farm operations.

Scrub will establish and develop naturally if left to do so, ultimately growing into woodland, and so will require management to ensure the desired balance of habitat is maintained. Older stands can be removed, and younger growth allowed to develop, using rotational management around the farm. Grazing and browsing, as well as mechanical means, can be used to manage scrub, although the grazing pressure needs to be appropriate to allow scrub to regenerate or to control it where required.

In-field trees

Many large, old trees can be found in wood-pasture, or as in-field trees within arable or grassland areas. Ancient in-field trees, such as mature oaks or old pollards, may often be a remnant from a former hedgerow, long since destroyed. Such trees are important for a range of wildlife, including invertebrates, fungi, bats and birds that depend on them for all or part of their lifecycles. At a landscape scale they are highly valuable features, providing 'stepping stone' habitats across farmland, and may help wildlife to move through the landscape. In-field trees are particularly threatened by cultivation and other agricultural activities. Environmental Stewardship support is available to help support their protection.

Clifden nonpareil © Mark Parsons/Butterfly Conservation

Managing woodland for moths

In the UK, 71 formerly widespread moth species are suffering rapid and severe declines and are listed as Biodiversity Action Plan (BAP) species (in addition to another 80 threatened BAP moths with more specific requirements). Most of the formerly widespread moths use woodlands to a greater or lesser extent.

Using light traps, we surveyed moths in Tytherley woods, on the Hampshire/Wiltshire border. The aim was to find out how moths are affected by woodland management. Moth numbers were lowest in young coppice (characterised by plenty of bare ground) and highest in sheltered standard rides and woodland. Sheltered, dark, humid woodland was especially valuable for some scarce moths, while moths that depend less on woodland, but are nonetheless declining in the wider countryside, preferred wide woodland rides and young coppice. Young coppice can support different suites of species. The results highlight the importance of having a variety of woodland habitats for moths.

We recorded 11,670 individuals and 265 moth species over three months, with some exciting new records. A notable find was that of the beautiful Clifden nonpareil, a rare moth recorded from only a handful of sites in southern England and, until recently, thought to be an immigrant. The numbers of this moth found strongly suggest the existence of a resident breeding population.

Key results

- **Create or maintain cores of dark woodland habitat**
- **Create lighter woodland zones around the darker core by coppicing or wide woodland rides**
- **Having different zones will benefit a range of species, from deep shade- or moisture-loving woodland moths, to moths that prefer lighter, more open, woodlands**

Moths can be sampled by light trapping © nutmeg66 CC BY NC ND 2.0

Roe deer © Don Sutherland CC BY NC ND 2.0

Deer grazing affects small mammals

Long term studies in Wytham Woods, Oxfordshire, suggest that increasing deer numbers may have had significant impacts on small mammals.

We established deer exclosures to study the effects of deer grazing on small mammals. The 2.5m high deer fence around each exclosure excluded all deer but allowed mice and voles to move freely. The fence minimized grazing pressure, leading to a much denser understorey. Between 2001 and 2003, we compared numbers of wood mice and bank voles inside the deer-free exclosures with those in the surrounding deer-grazed woodland. Bank voles were found to occur in much higher numbers inside the exclosures, while wood mice were much more common in the surrounding woodland.

A further study looked at how the three-dimensional forest structure was used by woodland rodents One in five wood mice and one in ten bank voles were caught in trees, up to heights of 2.20m, confirming that arboreality is common in small mammals. Bank voles, however, were less likely to climb as high as wood mice due to their lack of agility and their need for dense vegetation as protection from predators. This may help to explain why densities of bank voles increased significantly where browsing pressure was eliminated, highlighting the potential effect of deer over-grazing on small mammals.

Key results

- **Deer overgrazing can affect woodland small mammals**
- **Bank voles and wood mice will both climb trees but bank voles are less agile**
- **Bank voles need more understorey cover than wood mice**
- **Where deer are excluded in woodland, bank voles increase**

Bank voles in woodland are vulnerable to overgrazing by deer © Evan James CC BY 3.0

Woodland & scrub

Management summary		
	Key actions	Potential benefits
Woodland management	• Coppicing	Opens up areas of woodland and creates a dynamic environment
	• Ride creation or widening	Allows light into the woodland to benefit species such as butterflies
	• Leave darker areas for specialists	Many rarer invertebrates have specific requirements for dark, damp woodland areas
Woodland creation	• Seek advice on existing habitats	Woodland should not be planted in existing areas of high biodiversity e.g. meadows
	• Plant native species	Native species support more wildlife
	• Woodlands that extend existing ones or link other habitats are especially important	Can help species move through the landscape
	• Seek advice on woodland creation and management	
Scrub	• Balance management to have a variety of ages, structures and locations of scrub	Provides good habitat for a range of invertebrates and birds Scrub at sheltered field corners and woodland edges is especially beneficial
In-field trees	• Retain and protect in-field trees	Valuable for a range of wildlife

Options especially relevant for woodland & scrub		
Code	ELS/OELS options	ELS/OELS points
EC1/OC1	Protection of in-field trees on arable/rotational land	16 per tree
EC2/OC2	Protection of in-field trees on grassland/organic grassland	11 per tree
EC3/OC3	Maintenance of woodland fences	4 per 100m
EC4/OC4	Management of woodland edges	380 per ha
HLS code	HLS options	Payment (£)
HC5	Ancient trees in arable fields	£25 per tree
HC6	Ancient trees in intensively managed grass fields	£25 per tree
HC7	Maintenance of woodland	£100 per ha
HC8	Restoration of woodland	£100 per ha
HC10	Creation of woodland outside SDAs	£315 per ha
HC12	Maintenance of wood pasture and parkland	£180 per ha
HC13	Restoration of of wood pasture and parkland	£180 per ha
HC14	Creation of wood pasture	£180 per ha
HC15	Maintenance of successional areas and scrub	£100 per ha
HC16	Restoration of successional areas and scrub	£100 per ha
HC17	Creation of successional areas and scrub	£100 per ha

Find out more at:
www.forestry.gov.uk www.woodlandtrust.org.uk www.buglife.org.uk www.naturalengland.org.uk
www.ptes.org www.butterfly-conservation.org

Poppy in barley © Nick Ford CC BY NC ND 2.0

Crops

While creating habitats alongside cropped areas is extremely beneficial to wildlife, the cropped area itself can deliver enhanced benefits for wildlife through reducing inputs, incorporating stubbles and fallows, and adjusting rotations.

Cropped areas of the farm are valuable for a range of wildlife. Some species, such as arable plants, flourish under conditions of regular annual disturbance, and require absence of broad-leaved herbicides and low levels or absence of fertilisers. Invertebrates are helped by changes in management that enhance plant communities, in turn supporting other groups such as birds. Cropped areas are particularly important for a number of declining farmland birds, such as skylark, which need open areas of the field for feeding and nesting.

Key points

- **Cropped areas are important for a range of species**
- **Reducing pesticides and fertilisers on field edges or whole fields encourages plant and invertebrate diversity**
- **Incorporating stubbles, fallows, and spring cropping will benefit farmland birds and other wildlife**

Crops

Crop edge flora © Michelle Jones CC BY NC ND 2.0

There are a number of ways in which cropped areas can be managed to help increase their wildlife value, which are supported by agri-environment scheme funding. Conservation headlands, fallow plots, spring cereals, overwinter stubbles and careful management of inputs will all help wildlife. Together with field margin management, sympathetic crop management will also benefit predatory invertebrates such as beetles and spiders, which help control crop pests.

Conservation headlands help gamebirds, such as grey partridge, to raise more young
© oldbilluk CC BY NC SA 2.0

Conservation headlands can encourage rare arable plants, such as corncockle
© BerndH CC BY SA 2.5

Conservation headlands

Conservation headlands were originally developed by the Game and Wildlife Conservation Trust, to help halt the decline of the grey partridge. A conservation headland is the outer edge of a cereal crop (around 6-24m wide), which has reduced pesticide inputs (only to control grass weeds and some insect vectors of plant viruses). Summer use of insecticides and the use of herbicides targeted at broad-leaved plants are avoided. Fertilisers are not used on the headland.

Conservation headlands particularly benefit gamebirds such as the native grey partridge and the introduced red-legged partridge and pheasant. They provide nesting and brood rearing areas and abundant invertebrates, such as sawflies, that are important in the diet of their chicks. All three gamebird species feed chicks at field edges rather than centres, particularly where broad-leaved weeds are present as host plants for invertebrate prey. Under reduced herbicide regimes, cereal crops provide insect food as well as an ideal sward structure for cover from predators and adverse weather conditions.

Conservation headlands can also help other wildlife. Rare arable plants that depend on regular cultivation of cropped areas will benefit from the lack of herbicide use, while small mammals will make use of the more abundant supplies of seeds and invertebrates that are found in conservation headlands (Box 7).

Fallow plots encourage skylarks
© Don Sutherland CC BY NC ND 2.0

Fat-hen is beneficial for birds and insects
© Melganzenvoet Bloeiwijze CC BY SA 3.0

Brown hares benefit from undersowing
© sootyskye CC BY NC ND 2.0

Fallow plots

Where naturally regenerated stubble is left fallow over the following growing season, the patchy, diverse vegetation that regenerates provides an insect rich habitat during the summer and an undisturbed breeding area for ground nesting birds and mammals, such as the brown hare. The benefits of fallows for invertebrates largely depend on seed bank diversity. Fallows can also have an agronomic benefit, allowing soil fertility to recover and soil structure to improve following continuous cultivation. Management of fallows for wildlife should aim to delay cultivation or mowing of the vegetation until at least late July to protect ground-nesting birds.

Spring cereals

Spring-sown cereal crops offer better wildlife benefits than winter-sown cereals as they can normally be grown with no insecticide sprays and many of the spring germinating weeds, such as fat-hen, are very beneficial for birds and insects. They also have a crop structure that is suitable for a number of ground nesting birds, including skylarks, which enables birds to nest and feed within the crop. RSPB research has identified a noticeable difference in skylarks' nesting activity in spring wheat compared to winter wheat. Skylarks in spring-sown crops nest for longer and can raise two or three broods, but in winter crops most stop nesting in late May, raising just one brood, as the crop becomes too tall and dense and stops the birds having easy access to the ground.

Undersowing

The addition of a grass/clover ley as an understorey to cereal crops increases the diversity of the habitat; making them insect-rich foraging grounds for birds such as grey partridges and corn buntings. It also benefits farm wildlife such as the brown hare. The undersown crop will also help prevent pollution by reducing soil erosion and run-off at source.

Any undersown grass leys should be maintained until the crop is harvested, which should be not be before 1 July. The grass ley remains in place until the following summer.

Crops

© Evelyn Simak CC BY SA 2.0
Cereal stubbles (above) and stubble kale (below), retained over winter, provide rich food sources for farmland birds

© Peter Roworth/Natural England

Overwinter stubbles are especially good for corn buntings © P.N. Watts/Natural England

Overwinter stubbles

Retaining stubble following the harvest of combinable crops until the following year is a valuable option for wildlife. Overwinter stubbles can be moved around the farm within the normal rotation and fit into most arable systems.

This option will provide winter food sources for farmland birds and habitat for brown hare with further wildlife benefits from spring-grown crops. Stubbles have traditionally been one of the most important sources of seed food and shelter for farmland birds over the winter. Spilt grain and weed seeds among the stubble can attract large flocks of finches, larks and buntings. Stubbles for wildlife should ideally be left unploughed as late as possible (end of February). Sawflies spend the winter as pupae in the soil, and another benefit of late ploughed stubbles is that sawflies can emerge safely and provide important food for birds. To deliver widespread benefits for seed-eating birds, 10-20% of arable land should be left as late ploughed stubbles. The value of stubbles for wildlife is dependent on them providing a rich source of seeds, so management of the previous crop is important.

Skylark plots

Skylark plots are undrilled or sprayed-out patches in winter cereal fields. In a conventional winter cereal field, skylarks can forage easily during spring but, by June, they struggle to find food in the tall and dense crop. However, in fields with skylark plots, skylarks can continue to forage easily throughout the season because of the less dense patches of habitat. Two plots per hectare in winter wheat can boost skylark productivity by around 50%. Skylark plots are usually created by switching off the drill to create undrilled patches at least 3m wide. Plots need to be located away from hedges and field edges, in large fields of more than 5ha.

Low input cropping and organic management

Reduced pesticide use can be carried out over the whole field, rather than just the field edge, and this may be supported by agri-environment funding. An integrated farming approach that combines measures such as choosing crop varieties for disease resistance, minimum tillage and precision farming to optimise nutrient and crop protection inputs has the potential to deliver significant financial and environmental benefits.

Reduced or no use of herbicides increases plant and insect diversity in the crop
© Duncan Harris CC BY 2.0

Low input farming can encourage beneficial invertebrates, such as these linyphiid spiders
© P.R. Harvey, Spider Recording Scheme (2011)

Many of the environmental benefits of integrated farming relate to soil and water conservation but there are also specific benefits for wildlife, particularly through measures that reduce nutrient and pesticide inputs (Box 8). Reduced crop inputs are likely to increase plant diversity within the crop, with associated benefits for rare arable plants, insects and seed-eating birds, through increasing summer and winter food availability. Many of the more desirable weeds for wildlife are the less competitive or more easily controlled species, making it possible to consider management techniques that might allow some non-crop plants to flourish without encouraging the problem species.

Restrictions on pesticide and fertiliser use are greatest in organic farming systems. Research has shown organic cereals to have higher numbers of non-crop plants, which in turn increases the numbers of predatory spiders in the crop, which respond to the increased structure in the understorey vegetation.

Rare arable plants

Pheasant's eye was once gathered for cut flowers
© Alberto Salguero CC BY SA 3.0

Many species of arable plants are rare, declining or of conservation concern. Some of the species that can be found in arable fields are cornflower, pheasant's eye, corn buttercup and Venus's looking glass. Arable plants need annual ground disturbance in either spring or autumn, minimal competition from a crop (either an unfertilised crop or no crop sown at all) and no application of herbicides. Arable plants favour sands and freely draining acidic soils or chalk and limestone derived soils, including clays, in sunny situations. Sites tend to have been in arable cultivation for a long time (often more than 100 years).

The richest seed banks are often on field edges, where management may be most easily focused. Cultivated margins and conservation headlands are effective ways of encouraging arable plants. Organic farming, or other low-intensity regimes, such as low-input spring crops and summer fallows can also encourage arable plants and increase the diversity of insect life throughout the crop.

Poppies © Nick Ford CC BY NC ND 2.0

Wood mice prefer conservation headlands

Conservation headlands, where the outer 6m or so of cereal fields receive reduced selective pesticide applications, can be very beneficial for wildlife and are widely supported through agri-environment scheme funding. Conservation headlands were originally developed by the Game Conservancy Trust (now the Game and Wildlife Conservation Trust) and were shown to have higher abundances of insects and arable weeds than fully sprayed headlands, which in turn supported populations of grey partridge.

Insects and arable weed seeds are also eaten by small mammals such as harvest mice and wood mice and so conservation headlands might be beneficial in other ways. To find out whether wood mice could tell the difference between conservation headlands and other within-crop areas we fitted tiny radio-transmitters to wood mice and tracked their movements. It was clear that mice preferred to spend more time in conservation headlands and unsprayed headlands compared to sprayed headlands and mid-field areas. Further investigations revealed that in these areas they were pausing more often to feed.

Key results

- **Conservation headlands are beneficial for small mammals such as wood mice**
- **There is a higher diversity of plants and invertebrates in conservation headlands**
- **These provide rich food sources for small mammals**

Radio-tracking was used to reveal the movements of wood mice in arable fields © Fran Tattersall

Wood mouse © Hans Hillewaert CC BY SA 3.0

Methiocarb affects wood mice

Methiocarb is a non-specific carbamate pesticide that is widely used to control slugs and snails on farmland. It is usually applied as cereal-based pellets and may thus potentially be attractive to other, non-target species. Wood mice are known to eat methiocarb pellets and may therefore be particularly at risk of exposure.

We wanted to investigate whether broadcast applications of pellets affected the size of wood mouse populations, and whether these effects varied with the timing of application. To answer these questions, we captured, marked and released wood mice on four fields. One of the fields was treated with methiocarb in autumn, two of the fields were treated in spring, and the remaining field was not treated and acted as a comparison.

The results showed that broadcast application of methiocarb pellets caused a significant decline in wood mice in both spring and autumn. Importantly, though, the decline was greatest in fields treated in autumn. This may have been due to seasonal variation in food availability, and the ease with which pellets were found by mice.

We conclude that the use of methiocarb pellets could have an impact on wood mouse populations and, potentially, on species that feed upon wood mice, such as tawny owls and kestrels. If methiocarb pellets need to be used, spring applications may have fewer adverse effects than autumn applications.

Key results

- **Wood mouse populations declined in fields treated with methiocarb pellets**
- **The greatest declines were observed on fields treated in autumn, compared to fields treated in spring**
- **Changing the timing of methiocarb applications may reduce their impact on non-target wildlife species**

Slug control may have less impact on wood mice if carried out in spring © CropShot CC BY NC ND 2.0

Crops

Management summary		
	Key actions	Potential benefits
Conservation headlands	• Selective inputs to field headlands • No fertilisers or broad-leaved herbicide	Encourages rare arable plants and insect communities Provides key food items for birds such as grey partridge
Stubbles, fallow plots and spring cropping	• Overwinter stubbles are a rich source of seeds and spilt grain • Natural regeneration on fallow plots results in a diversity of vegetation structure • Spring cropping needs fewer inputs, and has a more open sward	Supply vital food for wintering farmland birds Reduces soil disturbance allowing some invertebrates to complete their life cycles Plant and insect communities are enhanced, supporting other wildlife Particularly beneficial for birds such as skylark
Low input farming	• Reducing inputs to field edges or whole fields	Benefits plant and invertebrates, and reduces risk of harming non-target species

Options especially relevant for crops		
Code	ELS/OELS options	ELS/OELS points
EF6/OF6	Overwintered stubble	120/150 per ha
EF8/OF8	Skylark plots	5 per plot
EF9	Cereal headlands for birds	100 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EF13/OF13	Uncropped cultivated areas for ground-nesting birds on arable/rotational land	360 per ha
EF15	Reduced herbicide cereal crops followed by overwintered stubble	195 per ha
EF22	Extended overwintered stubble	410 per ha
EG1/OG1	Undersown spring cereals	200/150 per ha
EG4/OG4	Cereals for whole-crop silage followed by overwintered stubble	230/250 per ha
HLS code	HLS options	Payment (£)
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HF20	Cultivated fallow plots or margins for arable plants (rotational or non-rotational)	£440 per ha
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	£475 per ha
HG5	Brassica fodder crops followed by overwintered stubble	£90 per ha
HG6	Fodder crop management to retain or recreate an arable mosaic	£150 per ha
HG7	Low-input spring cereal to retain or recreate an arable mosaic	£250 per ha

Find out more at:
www.naturalengland.org.uk www.gwct.org.uk www.leafuk.org www.plantlife.org.uk
www.arableplants.org.uk www.rspb.org.uk

Self heal © Rosalind Shaw

Grasslands

Lowland grasslands range from intensively managed grazed pastures and silage fields, through to remnant patches of species-rich downland and floodplain meadows. Modern intensive agricultural grasslands are very different from the grasslands of even 50 years ago, with far fewer species. Nonetheless, the management of these grasslands can be modified to enhance their value for wildlife.

Semi-natural grasslands are home to an enormous number of plants and invertebrates. Such grasslands are often the result of a long history of a particular grazing or cutting regime, and have very special value. The wide range of plants provides food for a great variety of invertebrates. These, in turn, support a rich fauna of birds and mammals.

Key points

- **Grasslands are valuable for a range of wildlife**
- **Species-rich meadows and grasslands are rare habitats to be protected and cherished**
- **Agriculturally improved grasslands are less species-rich, but can still be managed to help wildlife**

Grasslands

Crickets and grasshoppers are found in grasslands and flower rich meadows
© Richard Bartz CC BY SA 2.5

Grasslands have changed dramatically over the last sixty years. The introduction of inorganic fertilisers, increasing mechanisation, drainage, increased stock densities, reseeding of old pastures and a switch from hay to silage production have all contributed to reductions in sward diversity. The pockets of species-rich grassland that remain are habitats to be protected and cherished for the abundance and diversity of wildlife they support.

Agricultural grasslands range from being semi-natural to improved, depending largely on the number of different species found. More improved grasslands tend to have fewer species and therefore lower biodiversity or wildlife value. The more species a grassland has, the less likely it is that it has been fertilised.

Semi-natural grasslands

There are five main types of semi-natural grassland in England: limestone (calcareous) grasslands, marshy grasslands, acid grasslands, lowland meadows and pastures and upland hay meadows.

Chalk downland (a type of limestone grassland) is often unsuitable for intensive agriculture because of the nutrient-poor, shallow soil and difficult slopes. For this reason it has often survived uncultivated; however, its shallow soil structure makes it extremely fragile and easy to destroy. The decline of extensive grazing has meant that many areas of downland have reverted to scrub or other less rare habitat. Chalk downland needs to be managed carefully to safeguard its unique flora and fauna. Ideal grazing regimes create varied turf structure with some short and some tall areas, with the precise level of grazing depending on the interests of the site.

Acid grasslands are less well known than lowland meadows or limestone grasslands. They tend to occur as mosaics with lowland heathland. The tussocky vegetation and bare ground that characterise lowland acid grassland allow a wide range of invertebrates to thrive including solitary wasps, butterflies and moths. In some areas, such as Breckland, soil disturbance is an important part of conservation management to help these species thrive.

Chalk downland has unique flora © Guy Riddoch

Common blues are found in abundance on downland © Steve Chilton CC BY NC ND 2.0

Species-rich hay meadows are rare and important havens for wildlife © Peter Roworth/Natural England

Wet grasslands are vital for birds such as redshank
© Don Sutherland CC BY NC ND 2.0

Cattle-grazing is often used to manage wet grasslands
© Peter Roworth/Natural England

Lowland hay meadows that are rich in wildflowers are a rare and irreplaceable habitat. Closing fields off from grazing livestock allows broad-leaved plants to flower and seed, providing summer food for seed-eaters like linnets, and nectar and pollen for insects. The continuation of haymaking provides a greater diversity of wildflowers, habitats for insects and mammals, and food for birds.

By managing grassland with low or very low inputs, soil erosion and run off from the farm can be reduced. Permanently grassed areas will slow down the flow of water on natural drainage pathways and reduce the channelling of runoff water, which can produce rills and gullies. Grassland managed or retained with little or no fertiliser has a greater value to wildlife, such as butterflies and bees, and will sustain a wider variety of plants. Permanent grassland is also an important historical feature demonstrating how farming has shaped our landscape over the centuries.

Wet grassland is a highly valuable habitat for a range of plant and animal species. These areas are especially important for wintering and breeding wildfowl and waders, and support a rich variety of other wildlife, including dragonflies and damselflies, water beetles, and wetland vegetation. Wet grasslands are usually managed by grazing, mowing, or both, and the timing of management, its intensity and frequency, all influence the habitat (Box 10). Some species-rich wet grasslands, such as floodplain meadows, have been managed in the same way for hundreds of years, and care should be taken not to change this.

Grasslands

Including more plant species in improved swards will have biodiversity benefits

Uncut grass margins will benefit invertebrates

Later mowing for silage can reduce damage to ground-nesting birds, and allow plants to flower

Agriculturally improved grasslands

Even in agriculturally improved grasslands, modifications can be made to improve the habitat for wildlife. Increasing plant diversity in productive swards results in a greater variation of sward structure, and this can be achieved by the inclusion of even just a couple of species other than ryegrass. Timothy, cocksfoot and red fescue are generally suitable species. Adding legumes or herbs to the sward can be even more beneficial.

Farmyard manure is the best fertiliser to use from the wildlife point of view as it boosts soil invertebrates. Earthworms, for example, are encouraged where manure has been applied the previous season, with benefits for wildlife species such as hedgehogs (Box 9). Solid manure brings invertebrates to the soil surface where they are more accessible to birds.

Mechanical operations such as spreading, rolling, topping and harrowing can be particularly damaging to ground-nesting birds in the spring so, wherever possible, they should be timed before or after the breeding season in fields with breeding birds.

Similarly, the timing of mowing for silage is important. Early mowing, whether for hay or silage, can destroy eggs and chicks, so late mowing is preferable. Later mowing will also allow flowering, providing pollen and nectar sources for grassland invertebrates. Even better, if some plants can be left to go to seed, this will provide food for birds late into the year, and even through the winter.

Leaving uncut margins and corners in grass fields provides a refuge for wildlife from farm operations. Such structural, tussocky areas are good habitat for voles and other small mammals, which are preyed upon by owls and kestrels. Invertebrates, including pollinators and other beneficial invertebrates, will also benefit from these uncut areas.

Species-rich grassland can be created through arable reversion

Arable reversion to permanent grassland

The reversion of arable land to permanent grassland is a major work area funded through agri-environment schemes. Arable reversion can have a number of environmental benefits including ecological, landscape, archaeological and resource protection benefits. It may provide opportunities for the re-creation of species-rich grassland and other valuable habitats such as wetland and heath, and habitats can be created to benefit specific species, such as wet grassland for wading birds and wildfowl. It can provide a buffer from fertiliser run-off and sprays, for example, alongside Sites of Special Scientific Interest (SSSIs), rivers and other important wildlife areas. Additionally, areas of existing semi-natural habitat can be linked, creating larger, more coherent blocks. Additional grazing can be provided which may aid the management of other habitats, for example by allowing stocking rates to be reduced, or by making grazing of small areas of semi-natural grassland more viable. Details of how to undertake arable reversion are found on the Natural England website.

Some grassland statistics

Around 100,000ha of semi-natural grassland survives in England. This is roughly 3% of the total area of grassland. About half of this is lowland calcareous grassland (chalk downland and wold and other limestone grasslands such as the Cotswolds and Mendips). The rest consists of lowland meadows and pastures (20%), lowland acid grassland (10%), purple moor-grass/rush pastures (10%), upland hay meadows (2%) and upland calcareous grassland (10%). These figures are approximate, and in many parts of England the exact extent of the surviving resource is still not known.

North Meadow, Cricklade

Most surviving wildlife-rich grasslands in Britain are isolated fragments of formerly much larger grassland landscapes or farmland rich in grassland habitats. It is estimated that, overall, 97% of lowland meadows in England have been agriculturally improved or lost since 1940.

(Source: www.grasslands-trust.org)

Hedgehog © Gaudete CC BY SA 3.0

How to help hedgehogs

The unmistakable hedgehog, although widespread, is believed to be suffering severe population declines. Possible factors include changes in land use, resulting in loss of habitat (such as rough pastures and hedgerows) that they need for feeding and breeding. Pesticide use, particularly molluscicides, may also be a factor. Finding out how hedgehogs use the landscape in which they live is a crucial part of understanding how declines might be reversed. We marked hedgehogs to find out where they spent their time and we surveyed a range of factors which characterised the fields occupied by hedgehogs.

The surface availability of earthworms was the principal factor affecting whether or not a field was occupied, together with the number of molehills, which themselves are associated with earthworm abundance. Another important factor was the proximity of badgers. Badgers are significant predators of hedgehogs, and fields occupied by hedgehogs tended to be further away from fields with signs of badger activity. However, many hedgehogs were also closer to urban settlements, which happened to be further from badger activity.

Grassland management that increases earthworm populations, together with the provision of other habitats such as hedgerows and woodland habitats, and reductions in pesticide use, will have important benefits for hedgehogs on farmland.

Key results

- Hedgehogs are believed to be suffering severe population declines
- Fields with abundant earthworms attract hedgehogs
- Grassland management that increases earthworms will help hedgehogs and other wildlife

Earthworms are one of the chief food items of hedgehogs on pasture © pfly CC BY SA 2.0

True-fox sedge © Liam Rooney, Floralimages CC BY NC ND 3.0

New discoveries of rare plants: true fox-sedge

True fox-sedge is a Red Data Book plant classified as Nationally Vulnerable. Until 2004, its presence in Oxfordshire was limited to just a few sites along the River Ray, but in 2004/2005 eight new sites were found by a BBOWT/WildCRU survey, proving that the Upper River Ray floodplain is an important stronghold for the species. The area has been remarkably unaffected by intensive farming practices and retains an uncommon amount of species-rich grassland, along with abundant wetland areas such as ponds and ditches. These are probably critical factors in the survival of the true fox-sedge.

True fox-sedge does not appear to grow under intensive agricultural management. It grows well under hay-cutting and light grazing management, and also where no management is carried out at all. It was not found close to larger watercourses, possibly due to past engineering / maintenance, but also because it may not tolerate deep or running water.

Regular flooding, and the availability of agri-environment scheme grants in the Upper Ray floodplain, make extensive management a relatively attractive option in this area. Heavy clearance of watercourses is no longer carried out and there is little arable land in the floodplain. The primary threat is hedgerow and scrub growth, causing too much shade. This should be monitored, with landowners advised and assisted where necessary to carry out management work.

Key results

- The River Ray floodplain is an Oxfordshire stronghold for the rare true fox-sedge
- True fox-sedge flourishes under extensive management such as hay cutting or light grazing, in wetland areas
- Heavily maintained ditches or large watercourses are not suitable for this species

The River Ray floodplain, a stronghold for true fox-sedge © Michael CC BY SA 2.0

Grasslands

Management summary		
	Key actions	Potential benefits
Species-rich grasslands	• Have often been managed in the same traditional ways for hundreds of years, usually by grazing or cutting for hay	Management should not be changed without careful consideration
Improved grasslands	• Time mowing to avoid the nesting season, and to allow plants to flower and set seed and to reduce disturbance to invertebrates	Increases survival of chicks Enhances food for wintering farmland birds
	• Use manure to fertilise where possible	Encourages earthworms
Arable reversion	• Can help restore species-rich grasslands • Follow agri-environment scheme guidelines	Has many ecological and environmental benefits

Options especially relevant for grasslands		
Code	ELS/OELS options	ELS/OELS points
EK1/OK1	Take field corners out of management	400/500 per ha
EK2/OK2	Permanent grassland with low inputs	85/115 per ha
EK3/OK3	Permanent grassland with very low inputs	150/180 per ha
EK4/OK4	Management of rush pastures	150/180 per ha
EK5/OK5	Mixed stocking	9 per ha
EK20/OK20	Ryegrass seed-set as winter/spring food for birds	80/190 per ha
EK21/OK21	Legume and herb-rich swards	200/250 per ha
HLS code	HLS options	Payment (£)
HK6	Maintenance of species-rich, semi-natural grassland	£200 per ha
HK7	Restoration of species-rich, semi-natural grassland	£200 per ha
HK8	Creation of species-rich, semi-natural grassland	£280 per ha
HK9	Maintenance of wet grassland for breeding waders	£335 per ha
HK10	Maintenance of wet grassland for wintering waders and wildfowl	£255 per ha
HK11	Restoration of wet grassland for breeding waders	£335 per ha
HK12	Restoration of wet grassland for wintering waders and wildfowl	£255 per ha
HK13	Creation of wet grassland for breeding waders	£355 per ha
HK14	Creation of wet grassland for wintering waders and wildfowl	£285 per ha
HK15	Maintenance of grassland for target features	£130 per ha
HK16	Restoration of grassland for target features	£130 per ha
HK17	Creation of grassland for target features	£210 per ha
HE11	Enhanced strips for target species on intensive grassland	£590 per ha

Find out more at:
www.grasslands-trust.org www.naturalengland.org.uk www.rspb.org.uk www.plantlife.org.uk
www.floodplainmeadows.org.uk www.wildlifetrusts.org

Common toad

Ponds

Ponds are an extremely valuable habitat for wildlife on farmland. Species such as frogs, toads, and dragonflies rely on ponds for at least part of their life cycle, while others live in ponds for the whole of their lives. Other wildlife, including grass snakes, bats and birds, benefit from the plants and invertebrates that are associated with ponds. Many different pond types have wildlife value, but good water quality and shallow banks with emergent vegetation are especially important.

Key points

- **Farm ponds are very important wildlife habitats**
- **Good water quality and shallow banks are especially important**
- **Consider creating one or more ponds on the farm, in places where they will receive clean water, to help wildlife**

Ponds

© Katrin Wicker GFDL

Emergent plants such as yellow flag (above) and floating species such as broad-leaved pondweed (below) are good for wildlife

© Eva Raebel

Grass snakes are often found around ponds © Fafner GFDL

Ponds are one of the richest freshwater habitats. At a landscape scale, they will support more large invertebrates than rivers, ditches and streams. They vary greatly in their size and characteristics, but a healthy pond will contain a diverse community of plants and aquatic invertebrates.

Pond plants may include those that live submerged beneath the water (sometimes called oxygenators, such as hornwort), floating species (such as broad-leaved pondweed), and emergent species (such as reed mace), and all of these contribute to the health and diversity of the pond. Invertebrates that are found in or around ponds include mayflies, dragonflies and damselflies, water beetles, water bugs, caddis-flies and snails and these are, in turn, fed upon by species higher up the food chain, such as newts, frogs and toads.

Ponds provide a valuable source of water for other wildlife for drinking and bathing; for example, birds will regularly visit ponds, and ponds can provide an essential source of water for pollinating insects. Honeybees, for example, need water for diluting honey stores and for cooling the nest. Grass snakes are frequently found near ponds because they eat frogs, and bats visit ponds to drink and to feed on the many flying insects found there. The damp conditions around ponds may have their own distinct communities of plants and invertebrates, many of which have declined with the loss of farm ponds over the last century (Box 11). Many birds, such as tree sparrow and lapwing, also benefit from the soft pond margins as they are a good source of insect food for rearing chicks.

Creating ponds

Creating a pond for wildlife is straightforward if a few basic guidelines are followed. Once established, a pond should need little intervention for many years. As a pond matures, the plant and animal communities it supports will change; both young and old ponds are good for wildlife, and the more ponds in the landscape, the better (Box 12).

Good water quality is vital for a healthy pond © Eva Raebel

Ponds with poor quality water will support less wildlife © Eva Raebel

Broad-bodied chasers are one of the first dragonflies to colonise a pond © Stever Hiner/Natural England

The three basic principles for creating a good wildlife pond are: first, find a place with a clean water source; second, leave the pond to be colonised naturally and third, ensure the pond is protected from damaging impacts once it is created.

Water quality is one of the key factors affecting the richness of the invertebrate community (Box 12). The best sources of water for ponds are rain and surface water draining into the pond from non-intensively farmed areas. Ponds should not be sited where land is likely to be high in nutrients, particularly where fertilisers and pesticides are applied and could run off into the pond. Water from ditches and streams can carry silt, nutrients or pollutants, so generally should not feed into ponds.

New ponds should not be planted up as they are best left to be colonised naturally. Some creatures, such as water bugs, will start to colonise ponds within hours of their creation and, over the years, many other species will arrive of their own accord. Some important and rare plants and animals are found only in new ponds, because they need bare mud without the competition of later colonists. It is tempting to accelerate the process if the pond looks bare, but introducing species to the pond risks the accidental transfer of invasive alien species, particularly plants, such as water fern or parrot's feather. These can dominate a pond, preventing native species from flourishing, and make the habitat unsuitable for other pond life.

Ponds that are good for wildlife can be many shapes and sizes. However, there are some broad guidelines that will help to make the most of a new pond for wildlife. Ideally, most of the pond margin should be broad and shallow (less than 1:5 and preferably <1:20) and the drawdown zones (the parts of the pond that are exposed when water levels drop during the drier summer months) should be broad and undulating. These shallows will be the richest part of the pond and water depths during the winter should be less than 10cm for as broad a zone as possible.

Ponds

Newts may arrive in ponds in spring
© Ruth Feber

In areas of clean unpolluted water, deeper sections of the pond will support many submerged and floating leaved plants. But ponds deeper than 1-1.5m provide little additional value for wildlife. Varying the depths across the pond will create a range of beneficial habitats for plants and animals.

If possible, create pond complexes or multiple pools including both permanent and seasonal ponds of varying areas and depths, rather than a single waterbody. It is important to remember that new ponds should not be dug where there are existing valuable habitats, such as species-rich wetlands, or where uncommon species already live. If there is any uncertainty, seek advice.

Pond management

Existing ponds may not always be in good condition. The most common problem is poor water quality due to fertiliser, pesticide and sediment run-off. Once polluted, ponds can be very difficult to clean up and it is often more cost effective to create new clean water ponds for wildlife. Similarly, eradicating invasive non-native plants can be difficult and it is better to take measures to stop them getting into the pond in the first place.

Temporary ponds are important too

Some ponds regularly dry out in the summer. These temporary, or ephemeral, pools often have historical and cultural significance and are home to a wide range of plants and animals that have evolved to survive and flourish in these conditions. One of these, the fairy shrimp, produces eggs that can survive desiccation when the pond dries out, and will hatch out and breed when the pond wets up again. High quality temporary ponds are now a rare habitat type in the UK, placing many of the plants and animals that depend on them under threat. Temporary ponds should not be filled in, or dug out to create permanent ponds, and they often benefit from some trampling by livestock.

Fairy shrimps need ponds that regularly dry out
© Dirk Ercken

A pond clogged with invasive parrot's feather
© Xavier Cervera

Buffer strips around ponds can help improve water quality
© Eva Raebel

There are lots of myths about the need to manage ponds. Most wildlife ponds don't need to be managed to keep their wildlife value, unless they contain a rare species which has very specific habitat requirements. Poor pond management has the potential to do more harm than good. Decide which ponds on the farm you want to be for wildlife, as you will manage these differently from ponds which have been created for other uses, such as drainage or fishing.

If the pond is to be managed for wildlife, take a cautious approach. Begin by making an inventory of important habitats that should be kept, including poached muddy margins and dense stands of emergent vegetation (large areas of deep open water will be the least valuable habitat for wildlife). Avoid making all ponds on the farm the same; for example, allow some ponds to become shallow and temporary as they slowly fill with sediments. Don't undertake drastic work, such as deepening the whole pond, cutting back all the trees or completely fencing off the pond from livestock. If management will affect more than 1/4 of the pond, seek advice.

It is important to remember that different species use different types of ponds, whether shaded, trampled, temporary or permanent. All sorts of ponds will have great value for wildlife and should be retained. The most effective way of maintaining wildlife ponds is to ensure that they are buffered by semi-natural habitat.

Ponds and the law

Creating a pond may require a licence from the Environment Agency or local authority, depending on the planned size, and where it is to be sited. Clean silt can be disposed of on land near the pond, as long as it is part of the same farm and won't cause damage to other habitats or get washed back into the pond. Pond management could impact upon sites with archaeological value, especially if the pond is over 50 years old. If in doubt, seek advice.


Healthy Oxfordshire farm pond © Eva Raebel

Ponds in the Upper Thames region

In the UK, 50% of farmland ponds have been lost over the past century and only 8% of the estimated remaining 482,000 ponds are of good quality. Pond loss in the Upper Thames region is no exception. Our research on dragonflies and damselflies suggests that up to 50% of recorded ponds have disappeared from the Upper Thames area over the same time period.

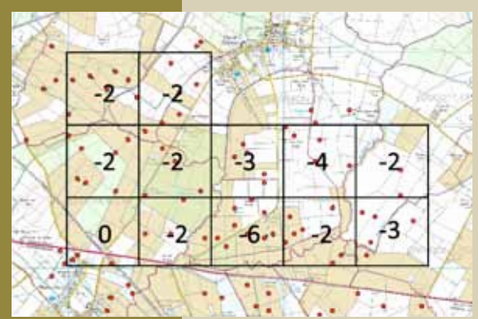
From a questionnaire survey of 90 farmers, 73% stated that they would consider pond creation, compared to 40% that would increase wet grassland, by considering in-channel enhancements such as bunds. Positive attitudes among farmers towards pond creation increased between 2003 and 2008, with 65% in favour in 2003 compared with 80% in 2008.

As part of our habitat creation work in the Upper Thames, we advised upon 28 pond creations, of which 18 were implemented. Of these, over half were created outside agri-environment scheme agreements. Support for the creation of new ponds currently comes through Higher Level Stewardship (HLS), but other sources of help and funding may also be available (see Pond Conservation's Million Ponds Project website).

While many of the landowners we worked with took particular pride in their ponds and would maintain them in the absence of agri-environment scheme funding, these tended to be fish ponds with low conservation value. The uptake of pond options within ELS and HLS was low relative to other options.

Key results

- **Over 50% of ponds have been lost from the Upper Thames Area**
- **Many farmers would consider creating new ponds**
- **Higher Level Stewardship (HLS) and Entry Level Stewardship (ELS) provide support for pond creation and enhancement (pond buffering)**



Grid shows numbers of ponds lost across the River Ray catchment, Oxfordshire © Eva Raebel


Large red damselfly © P.C. Watts

What makes a pond good for dragonflies and damselflies?

We studied ponds across the Upper Thames to find out which features are most important for dragonflies and damselflies. Ponds that were dominated by floating and submerged vegetation had the highest numbers, and the greatest number of different species, of dragonflies and damselflies. They also had the most transparent water. These good quality ponds were always surrounded by buffer strips (unfertilised grass strips).

Pond vegetation provides dragonflies and damselflies with refuges from predators and a variety of suitable sites for egg-laying. Vegetation and clean water will also encourage prey for the aquatic larvae of damselflies and dragonflies, such as insect larvae, water-fleas, crustaceans and tadpoles. Buffers of semi-natural vegetation around the pond help by providing roosting areas for adults, and may improve water quality by reducing surface run-off, encouraging species whose larvae cannot live in poor water-quality ponds.

Many dragonflies like open water, and newly created ponds were rapidly colonised by dragonflies and damselflies, with evidence of breeding in the year after their creation. We also found that having several good quality ponds within 100m of each other helped populations of dragonflies and damselflies, by acting as 'stepping stones' across the landscape.

Key results

- **Dragonflies prefer ponds that have plenty of native submerged/floating vegetation and water with open pond surface areas**
- **Buffer strips around ponds provide roosting habitat and help improve water quality**
- **More good quality ponds across the landscape help dragonfly populations**


An ideal pond for dragonflies
© Eva Raebel

Ponds

Management summary		
	Key actions	Potential benefits
Pond creation	• Site pond where there is a clean water source	Water quality has biggest impact on pond wildlife
	• Leave to colonise naturally	Planting can introduce non-native, invasive plants which will dominate the pond
	• Protect from damaging farm operations	Livestock trampling, fertilizer and pesticide run-off reduce water quality
	• Seek advice	
Pond design	• Keep margins shallow and undulating	Encourages emergent vegetation and movement of animals
	• Create different depths within the pond	Provides a variety of habitats
	• If possible, aim for more than one pond	Networks of ponds act as 'stepping stones'
Pond management	• Leave ponds alone as much as possible	Leaves wildlife undisturbed and allows ponds to develop naturally
	• Plan pond management at the farm level	Ensures that there is a variety of habitat types across the landscape without trying to achieve everything in the same pond
	• Do not clear whole pond at the same time	Will allow elements of important habitats to remain

Options especially relevant for ponds		
Code	ELS/OELS options	ELS/OELS points
EE7/OE7	Buffering in-field ponds in improved permanent grassland/organic grassland	400/500 per ha
EE8/OE8	Buffering in-field ponds in arable land/rotational land	400/500 per ha
HLS code	HLS options	Payment (£)
HQ1	Maintenance of ponds of high wildlife value (less than 100m²)	£90 per pond
HQ2	Maintenance of ponds of high wildlife value (more than 100m²)	£180 per pond

Find out more at
www.pondconservation.org.uk www.buglife.org.uk www.environment-agency.gov.uk

Ditches

Ditches are highly valuable wet farmland features. Whether permanent or seasonally flooded, they support many types of farmland wildlife, including plants, invertebrates, amphibians, reptiles, birds and mammals. Ditches can sustain a range of rarer plants and invertebrates, and provide food, shelter and breeding areas for more common species throughout the year. They also act as a network of wildlife corridors across the landscape, linking other species-rich areas.

Key points

- **Ditches are valuable wetland areas for farmland wildlife, home to a rich community of plants and animals**
- **Ditches should have clean water and be managed on a little and often basis**
- **Field margins and well-managed hedgerows can add to the wildlife value of ditches**

Ditches

Blue-tailed damselflies are found in ditches
© P.C. Watts

Farmland ditches provide a range of wildlife habitats in the form of water (which can vary in quantity and permanence), channel substrate, and aquatic, bank side and bank top vegetation. Ditches provide important habitat for farmland birds, invertebrates, plants, amphibians and reptiles, and mammals. Some priority species are especially associated with ditches. Of the 70 Biodiversity Action Plan (BAP) species listed as being associated with ponds, around 20 are also associated with ditch habitats. Ditches may also support uncommon species and temporary water invertebrates due to their seasonality.

Frogs and toads will spawn in ditches
© Miles Wolstenholme

In intensively farmed landscapes, ditches can be highly valuable habitats for wildlife, particularly so if well managed. They can provide food, shelter and breeding habitats, for both common and uncommon species, where these resources might be scarce in the surrounding landscape. Ditches are home to a range of aquatic invertebrates, and the edges of ditches often have diverse plant communities which can support abundant insects, through food for insect larvae, and nectar and pollen for the adult stages (Box 13).

These invertebrates, in turn, supply birds with a particularly good source of food through the spring and summer. Ditches are known to be valuable for yellow wagtails, song thrushes, starlings and reed buntings. Taller vegetation at the fringes of ditches can provide nesting habitat for species such as grasshopper, sedge and reed warblers. Other animals that are particularly associated with ditches are the declining water vole, and amphibians and reptiles, such as common toads and grass snakes.

Ditches in cattle grazing marsh are often species-rich © Evelyn Simak CC BY SA 2.0

In some places that are prone to flooding, land drainage has created grazing marsh, which is damp pasture with networks of ditches. The wildlife interest of these coastal and floodplain grazing marshes generally lies in the water-bodies, rather than the grassland, with the ditches being particularly important for invertebrates. Grazing marshes throughout England and Wales have distinctly different habitats and species, so need to be managed in specific ways to protect their wildlife.

Hedges and margins can add to the wildlife value of a ditch © Rosalind Shaw

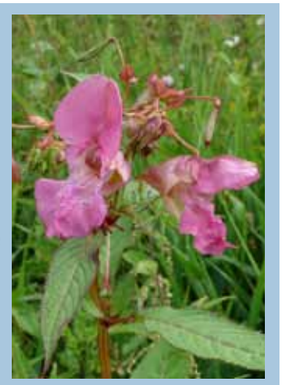
Where hedgerows are overgrown, ditches may become shaded and poorer for wildlife
© Rosalind Shaw

Ditches in more intensively farmed land are often found next to field margins and hedgerows (Box 14), which can act as important buffers for ditch communities, as well as adding to the range of habitats available for wildlife. The management of these adjoining habitats is important. Well managed hedgerows and field margins will add to the wildlife value of the ditch, but allowing hedgerows to become very overgrown can shade out the ditch, resulting in a poorer community of plants and animals.

Like hedgerows and field margins, ditches are a linear habitat and help increase habitat connectivity across the landscape. This facilitates species' movements, helping them disperse and expand their ranges, which may be especially important in the face of climate change.

Invasive plants

Some invasive plants will readily spread along ditches and watercourses. Examples include Japanese knotweed and Himalayan balsam. Himalayan balsam, first introduced in 1839, is now widely established in the UK. Its aggressive seed dispersal, coupled with high nectar production which attracts pollinators, often allows the Himalayan balsam to outcompete native plants. Today it is found throughout most of the UK.



Himalayan balsam
© Peter Roworth/Natural England

Recent research suggests that one way to help control the spread of riparian Himalayan balsam is to decrease eutrophication, thereby permitting the better-adapted local vegetation that gets outgrown by the balsam on watercourses with high nutrient load, to rebound naturally. However, where it is well established, other methods of control, either mechanical or chemical, may be needed. Advice should be sought from the Environment Agency. The use of herbicides in or near rivers, canals, lakes and drainage channels in England and Wales requires EA's prior agreement.

Ditches

Avoid clearing ditches in the summer to help leave plants and animals undisturbed © Ruth Feber

A recently cleared ditch with recovering vegetation
© Rosalind Shaw

Ditch management

In order to drain land effectively, ditches need to be routinely managed to prevent silt and vegetation building up, which will restrict the water flow. Ditches should be managed on a rotational basis to maintain habitat diversity. Many species have poor mobility, so management should aim to achieve a patchwork of ditches at different stages with a cycle of 5 years or more wherever possible. A 'little and often' approach, only working on one bank at a time and cutting or clearing different ditches in different years, will minimise the impact on wildlife and benefit the environment.

Ditches should not be cleared between March and the end of August; clearing in autumn will reduce the disturbance to birds, aquatic insects and the setting of seeds. As much vegetation as possible should be left on the ditch banks to help wildlife re-colonise the ditch.

Some species require particular ditch profiles, so aiming for a variety of ditch bank profiles around the farm will help a greater diversity of species to find suitable habitats. For example, water voles and kingfishers prefer steeper banks, but the majority of wetland plants and invertebrates prefer very shallow water. Shallow ditch edges are particularly important in areas where waders breed, to provide access to insect rich feeding areas and prevent chicks being trapped in steep-sided ditches. Where possible the shallower slopes should receive the most sunlight: gentle slopes on south-facing banks provide excellent habitat for a variety of plants and animals.

Reed buntings use ditches for feeding
© Thermos CC BY SA 2.5

High water quality benefits aquatic plants and invertebrates
© Peter Roworth/Natural England

Frog-bit in farm ditch © Paul Lacey/Natural England

Cattle create a variety of habitats by poaching shallow margins and grazing. Grazing the ditch edges benefits plants and a variety of invertebrates. However, fencing off some sections will permit the growth of taller vegetation, targeting species such as reed buntings and water voles.

High water quality is essential to the wildlife value of drainage channels. The agricultural management of the surrounding land strongly influences water quality. For example, it is important to keep pesticide and fertiliser inputs away from the water, and slurry and manure should not be spread within 10m of a ditch. Buffer strips adjacent to ditches help to keep inputs away, and timely application and appropriate rates of inputs will reduce leaching and wastage.

Good soil management on grass and cropped land facilitates the retention of valuable topsoil and minimises nutrient-loaded sediment entering water bodies. Visual monitoring of ditches can give an indication of quality: clear water, a range of plants and an abundance of insects are signs of good water quality.

As well as having benefits for wildlife, good ditch management can help to maintain optimum field drainage conditions for crop growth, minimise sediment and nutrient transport from the field to the river, improve the health of livestock, and be an early indicator of pollution problems.


Farm ditch in Oxfordshire © Rosalind Shaw

Ditches are important for bumblebees

The relative importance for bumblebees of three linear feature types - ditches, hedges and field margins - within an arable landscape was evaluated. Of the three features, bumblebee abundance was highest in ditches in late spring surveys, while hedges and field margins had similar, but lower, numbers of bumblebees.

Flower coverage was highest in ditches and field margins in late spring surveys, but bumblebee abundance in the different features was not a simple reflection of this. It appeared that suitable bumblebee foraging plants varied between ditches, hedges and field margins in a different pattern to the total flower coverage. For example, some plants found more often within ditches, for example, hedge woundwort and white deadnettle, provided important bumblebee foraging. Additionally, the shelter from wind provided by ditches relative to margins may have benefited bumblebees.

The finding that bumblebee abundance was greater in ditches than hedges and field margins at certain times of year is interesting as considerable emphasis has been placed on improving and protecting field margins for bumblebee conservation, while ditches have been largely neglected. It is also interesting to note that the importance of linear features to bumblebees changed over the season. Pollinators such as bumblebees are likely to use different habitats throughout the season as different flowers become available.

Key results

- Ditches can be rich sources of nectar and pollen for bumblebees
- Ditches may also be sheltered from wind and farm operations
- Ditch management is supported by Environmental Stewardship


Hedge woundwort is often visited by bumblebees
© Joysaphine
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Surveying a ditch © Ruth Feber

Biodiversity of farm ditches

Much of the information on ditches in lowland farmland has come from surveys in coastal grazing marshes which contain rich plant and invertebrate communities. There is much less information on the wildlife found in ditches on intensively managed agricultural land, and how it is affected by management. We carried out surveys of 170 ditches in Oxfordshire, and interviewed land managers, to investigate the factors affecting plant and invertebrate communities of farmland ditches.

The most important impacts on the species richness of ditches were water depth and amount of shade. Shallow, shadier ditches had fewer plant and invertebrate species than less shaded ditches with deeper water. Of the farmers surveyed, many carried out little management of ditches. The average time since ditches were last dredged was 15 years, and time since the vegetation was cut was around 8 years. Whether or not a ditch was entered into an agri-environment scheme (AES) appeared to have little impact on either the reported management regime or the biodiversity value of the ditch.

Increasing the amount of water in ditches, by increasing the water depth or retaining water in ditches for longer periods, could increase the biodiversity value of ditches in agricultural landscapes. Reducing the amount of shade over narrow ditches by managing adjacent hedgerows is also likely to increase the species diversity of plant and invertebrate communities within the ditch.

Key results

- We surveyed the biodiversity and management of ditches in Oxfordshire farmland
- Ditches with deeper water, and that were less shaded, had more species of plants and invertebrates
- Measures to increase water depth and reduce shade over ditches could increase their wildlife value


Ditch dredging and cutting of vegetation was very infrequent for many farm ditches
© Rosalind Shaw

Ditches

Management summary		
	Key actions	Potential benefits
Ditch structure	• Aim for a range of ditch bank profiles, steeper areas and shallower areas	Species have different requirements
	• Create some places where grazing animals can access ditches, but restricting access in others is also important	Some cattle poaching can be very good for ditch wildlife, but water voles need dense bank vegetation and benefit from fenced areas
	• Aim to have field margins and hedgerows next to ditches	Provides a greater complexity of wildlife habitat and buffers the ditch
Ditch management	• Clear ditches in the autumn or winter rather than spring or summer, on a 3-5 year rotation	Will reduce disturbance to wildlife
	• Clear on a little and often basis	Leaves areas from which species can re-colonise Leaves some areas undisturbed at any one time
	• Keep pesticides, fertilizers and other inputs away from ditches	Good water quality is crucial for wildlife

Options especially relevant for ditches		
Code	ELS/OELS options	ELS/OELS points
EB6/OB6	Ditch management	24 per 100m
EB7/OB7	Half ditch management	8 per 100m
EB8/OB8	Combined hedge and ditch management (incorporating EB1/OB1 Hedgerow management for landscape on both sides of a hedge)	38 per 100m
EB9/OB9	Combined hedge and ditch management (incorporating EB2/OB2 Hedgerow management for landscape on one side of a hedge)	26 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
HLS code	HLS options	Payment (£)
HB14	Management of ditches of very high environmental value	£36 per 100m

Find out more at:
www.rspb.org.uk www.buglife.org.uk www.environment-agency.gov.uk www.naturalengland.org.uk

Otter © Andrew Harrington

Rivers & streams

Rivers and streams support a great diversity of wildlife, and are important providers of other environmental and ecological services. As well as supplying water, rivers, streams, and their associated wetlands play a vital role in land drainage, retaining water, and in flood management. A healthy river has a rich community of plants and animals that depend on the water for their survival, and a range of other species will make use of riparian habitats for food and shelter. The protection and conservation of rivers and streams as they flow through farmed landscapes has great benefits for farmland biodiversity and the wider environment.

Key points

- **Many plants and animals depend on rivers and streams**
- **Management of the surrounding land affects the health of the river**
- **Controlling livestock access, management of bankside vegetation and keeping inputs away from the water are all important**

Rivers & streams

River Windrush © Peter J Dean CC BY NC ND 2.0

Streams and rivers are home to a wide range of plants and animals, which are dependent upon freshwater habitats for their survival. Submerged, emergent and floating plants, and a range of substrate types and water depths (for example, riffle pool systems), provide habitat for aquatic invertebrates, and shelter and cover for fish. As well as species that live within the water, many others rely on streams and rivers as foraging or breeding habitat. Riparian vegetation is especially important. Many birds depend on these habitats for foraging and nesting, and water voles need well vegetated banks for their burrows.

Daubenton's bats hunt along rivers
© Danielle Linton

Water voles need well-vegetated riverbanks
© Tom Moorhouse

Riparian corridors provide a crucial habitat for many wildlife species and a means of safe movement and dispersal. Watercourses provide rich hunting grounds for bats, as they support an abundance of their insect prey, and declining species such as damselflies and dragonflies will use riparian vegetation for the adult stage of their lifecycles. Other invertebrates and fish benefit from this vegetation as a source of food, cover and shade. As well as being good for wildlife, bankside vegetation plays an important role in limiting erosion and silt and nutrient run-off from adjacent fields.

Rivers and streams are under constant threat from a range of domestic, agricultural and industrial activities, and this has been reflected in the severe declines in many freshwater species. Dredging, channelisation and the removal of tree cover have caused the erosion of riverbanks, resulting in changes in the frequency and magnitude of flooding, and patterns of sediment transport and nutrient exchange. Flood defence structures prevent rivers functioning as dynamic systems, reducing their ability to create new habitats. Those rivers that have not significantly been modified represent a very valuable ecological resource.

Aspects of modern agriculture, such as high stocking rates, fertiliser and pesticide inputs, and drainage are among the factors putting pressure on the habitat for wildlife. Many of these negative impacts can be mitigated through careful land management practices. For example, fencing and providing alternative drinking arrangements for cattle can reduce sediment and nutrient inputs, leading to improved water quality, stock health and productivity. Creation of buffer strips and the management of bankside vegetation help to protect the watercourse from agrochemical inputs and add to the wildlife habitat available, and selective coppicing of bankside trees can improve fisheries. Other threats to native wildlife, such as those from invasive or alien species, may need targeted management (Box 15).

Too much grazing and trampling by stock can reduce water quality and degrade the bankside habitat © Rosalind Shaw

The bullhead has been affected by silting of streams
© Hans Hillwaert CC BY SA 3.0

Livestock impacts

Unrestricted access to rivers by large numbers of livestock can have detrimental effects on wildlife habitats. Water quality may be lowered, the riparian habitat becomes degraded and typically the watercourse becomes wider and shallower.

Compacted and livestock-poached soils and eroded banks in unfenced areas lead to greater run-off and potential for sediment to reach the river, where it is detrimental to fish spawning areas and other habitats. The sediment settles out to smother river-bed gravels. This can reduce the flow of oxygenating water to fish eggs laid in these spaces, which can result in the death of large numbers of eggs. Sediment on the stream bed also reduces the range of habitats available for other organisms, such as invertebrates, and so reduces their abundance. These organisms tend to be at the bottom of the food chain and are the food source for larger predators and fish. Nutrient enrichment may occur both directly from livestock excreta and by the introduction of nutrients bound to soil particles. Over-grazing is also a threat to the quality of bankside vegetation.

Rivers & streams

Fencing to restrict access by livestock has many environmental and wildlife benefits © Alison Poole

Kingfishers will benefit from measures that improve water quality of rivers and streams © Paul Lacey/Natural England

In arable areas, buffer strips can act as barriers to run-off and pollution © Alison Poole

Bankside vegetation and buffer strips

Carefully designed fencing along watercourses can help to reverse detrimental effects of over-grazing. By managing stock access, erosion rates are reduced, and grasses and other vegetation are able to become established and help to stabilise the bank, thereby reducing the rate of bank erosion, soil loss and attached nutrients. The increase in long fringing grasses provides ideal habitat for young fish which require cover and hiding places. A reduction in contamination from animal waste can improve water quality and hence the survival rate of a wider range of aquatic wildlife.

On a local scale, well vegetated buffer strips along the water's edge can help trap topsoil from ploughed fields before it reaches the watercourse. The buffer strip acts as a physical and chemical barrier between modern agriculture and the river. Where buffers are present, manure, fertilisers and pesticides are less likely to be accidentally spread directly into the watercourse and soil bacteria can break down pollutants before they reach the river.

Ongoing management of bankside vegetation, by light grazing or cutting, is likely to be required to prevent the area scrubbing over, and may be needed to maintain capacity and reduce flow resistance. Mowing and cutting can radically alter the plant communities and habitat structure for invertebrates, birds and mammals. Where possible, it is best to cut on a rotational basis, on alternate banks, which allows wildlife to seek refuge in uncut areas. If channel vegetation needs to be removed this should be done as patchwork clearance rather than all at once.

Fencing guidelines and methods for providing alternative drinking sources are available from the Environment Agency and the Rivers Trust.

Coppicing lets light into the river
© Richard Webb CC BY SA 2.0

Coppicing bankside trees

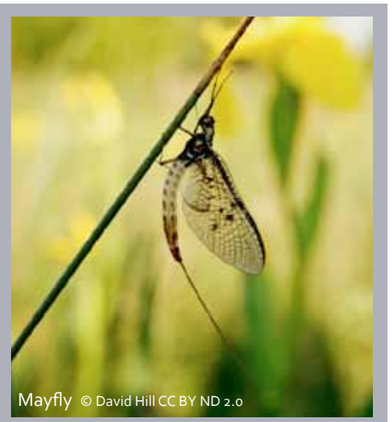
The presence of woodland within 25m of a river is beneficial for aquatic invertebrates (Box 16). However, problems can be caused by over-shading of rivers by trees that have not been managed for several years. Heavy shading reduces photosynthesis for plant and algal growth and so reduces the numbers of dependant invertebrates. Erosion creates bays between trees which then become undercut and fall in, smothering the river bed in silt and reducing the value of fisheries and wildlife.

Bankside coppicing work can increase the amount of light getting through the canopy, which promotes the growth of aquatic vegetation, and terrestrial grasses and low growing plants that will stabilize the banks. Selective coppicing of bankside trees along over-shaded sections leads to significant increases in juvenile fish numbers, as well as increasing habitat diversity for other species.

Riparian habitats are important for bats, otters and water voles, all of which are protected by law. Any work could potentially cause damage or disturbance so checks should be made as part of planning. Advice on what to look for is available from Natural England.

Riverflies can indicate river health

Riverflies (mayflies, caddisflies and stoneflies), along with other freshwater invertebrates, are at the heart of the freshwater ecosystem and are a vital link in the aquatic food chain. Freshwater invertebrates spend at least part of their life cycle in rivers, streams, ditches or ponds, and provide a vital food source for fish, birds and mammals. They also help to break down organic matter.



Mayfly © David Hill CC BY ND 2.0

Riverflies are sometimes known as the 'canaries' of the waterways as they can be used to assess the health of freshwater systems. They have several characteristics which make them particularly useful as indicators of changes in water quality. These include limited mobility, relatively long life cycles, presence throughout the year and specific tolerances to changes in environmental conditions. There are a total of 278 species of mayflies, caddisflies and stoneflies, eight species of which have Biodiversity Action Plan status and therefore are recognised as a priority for conservation.

American signal crayfish © Tom Moorhouse

The invasive American signal crayfish

The American signal crayfish is a non-native species of crayfish now widespread in British rivers. It is damaging to our native biodiversity, directly predating on other species, and out-competing them for food resources. Signal crayfish burrow extensively into banks, having detrimental effects on riverine habitats, and fishing interests.

We conducted a large-scale project in the Upper Thames to see if signal crayfish could be controlled by trapping and removal. We found that efforts to remove signal crayfish by trapping were counteracted by immigration of large individuals from neighbouring stretches of water. Removal trapping also resulted in better body condition of the remaining crayfish. While our study was not long enough to discover whether survival or breeding success was greater as a result of lower numbers and better body condition, the results suggest that this could be a possible feedback mechanism.

However, signal crayfish remaining in areas that had been trapped were found to move around much less, perhaps because more food and shelter was available. This suggests that removal trapping at the edge of a colonisation front may be sufficient to slow the rate at which a signal crayfish population spreads. It is unlikely, however, that removal trapping would be sufficient to prevent the spread of signal crayfish populations.

Key results

- **Signal crayfish are a species invasive to Britain and damaging to the riverine ecosystem**
- **Removal trapping does not appear to be an effective way to control their numbers**
- **Large crayfish moved into the trapped areas, and the crayfish that remained had better body condition**

The native white-clawed crayfish has suffered huge declines since the arrival of the American signal crayfish © Paul Glendell/ Natural England

River and woodland in Oxfordshire ©Alison Poole

Nearby woodland benefits river invertebrates

Aquatic invertebrates are very important indicators of the health of a river. We used monitoring and mapping data from the Environment Agency, Natural England and Ordnance Survey, together with our own data, to investigate which features in a river catchment were most important for increasing the diversity of aquatic invertebrates in the river. We studied the Thames and its tributaries (including the Windrush, Oxon Ray, Cherwell and Evenlode) upstream of Wallingford. In total over 160 samples were used from 80 different sites located across the catchment. We looked at how surrounding land use affected different measures of aquatic invertebrate biodiversity, such as how rare the invertebrates were at a site and how pollution tolerant each species at a site was.

The amounts of both organic land and woodland upstream of the invertebrate monitoring site affected the invertebrate communities of the river. The most important effect was the amount of woodland within 25m of the river. The more woodland there was within 25m, the healthier the river, as indicated by the aquatic invertebrate community. The proportion of land in an organic scheme within 500m of the river upstream also had a positive effect, as indicated by the aquatic invertebrates, but not to the same extent as the woodland.

Key results

- **Riparian woodland has a positive effect on river quality, as indicated by aquatic invertebrates**
- **Woodland within 25m of the river was particularly important**
- **Preserving woodland may be more important than organic farming for river invertebrates**

Sampling rivers for invertebrates © Alison Poole

Rivers & streams

Management summary		
	Key actions	Potential benefits
Livestock protection	• Use fencing to restrict access and protect watercourses from heavy use by stock	Limits erosion, silt and nutrient run-off Benefits wildlife, especially species that need dense bank vegetation, such as water voles
Bank vegetation and buffer strips	• Establish buffer strips next to watercourses on arable land or ungrazed strips in livestock areas • Manage by topping or light grazing • Keep pesticides, fertilizers and other inputs away from rivers and streams	Provides a greater complexity of wildlife habitat, thicker vegetation, reduces siltation and pollution in the river Will reduce disturbance to wildlife Prevents scrubbing over Good water quality is crucial for wildlife
Coppicing bankside trees	• Where overshading is a problem, coppice bankside trees	Allows light to river, increases plant growth and invertebrate diversity, reduces erosion and silting

Options especially relevant for rivers & streams		
Code	ELS/OELS options	ELS/OELS points
EE9/OE9	6m buffer strips on cultivated land/rotational land next to a watercourse	400/500 per ha
EE10/OE10	6m buffer strips on intensive grassland/organic grassland next to a watercourse	400/500 per ha
EJ5/OJ5	In-field grass areas to prevent erosion and run-off	454 per ha
EJ9/OJ9	12m buffer strips for watercourses on cultivated land/rotational land	400/500 per ha
EJ11/OJ11	Maintenance of watercourse fencing	4 per 100m

Find out more at:
www.theriverstrust.org www.environment-agency.gov.uk www.naturalengland.org.uk
www.riverflies.org www.buglife.org.uk

Chilterns landscape

Landscapes

Sympathetic management of habitats across farmland is vital for helping to conserve wildlife populations. Farm-scale efforts can increase the size of wildlife populations, and encourage species diversity across a farm. It has become increasingly recognised, though, that for conservation efforts to be even more effective, local populations of wildlife need to be linked at the landscape-scale. This can be done by enhancing habitats and their connectivity across neighbouring farms, rather than by working at single sites and in isolation.

Key points

- **Wildlife populations have become fragmented, leaving them vulnerable to further loss**
- **Enhancing habitats and increasing their connectivity helps wildlife populations**
- **Landscape-scale approaches can help achieve this very effectively, by joining up habitats across larger areas**

Landscapes

Species-rich patches of habitat have often become isolated in intensively farmed landscapes © Paul Howzey CC BY NC ND 2.0

Over a number of years, habitats for farmland wildlife have changed. Many patches of habitat have been lost altogether, while others have become less species-rich, because of production demands on the land. Added to this, the land in between habitat patches is generally more inhospitable to wildlife than it used to be, with fewer or poorer quality connecting habitats such as ditches, ponds, hedgerows or field margins. These changes have together resulted in many wildlife populations becoming isolated and disconnected.

Farm-scale conservation is vital, but even more effective when applied across landscapes © Tara Proud

Hedgerows are one way to increase landscape connectivity © Rob Wolton, Hedgelink

A landscape-scale approach to wildlife conservation recognises that linkages and stepping stones need to be established between high quality wildlife sites and across the wider landscape. The overall environmental quality of landscapes needs to be enhanced to enable species movement and re-colonisation of areas to occur. There also needs to be a greater variety of habitat types and features to support higher numbers and a wider range of wildlife within the wider landscape. Adopting a landscape-scale approach to nature conservation also brings wider economic and social benefits (known as ecosystem services).

More, bigger, better, joined

An independent review of England's wildlife sites and the connections between them was published in 2010. 'Making Space for Nature' gave recommendations to help achieve a healthy natural environment that will allow plants and animals to thrive.

Led by Professor Sir John Lawton, the review was set up to look at our wildlife sites and whether they are capable of responding and adapting to the growing challenges of climate change and other demands on our land. The essence of what needs to be done to halt and reverse the declines in Britian's wildlife was summed up in four words: more, bigger, better and joined. We need to develop an approach to nature conservation that results in more and bigger areas that are rich in wildlife, better managed sites, and more inter-connected sites.

Ponds can be viewed as 'stepping stones' in the landscape © Colin Smith CC BY SA 2.0

Birds are generally mobile but also need resources over a larger area © Ruth Sharville CC BY SA 2.0

Inhospitable landscapes may present particular difficulties for ground-dwelling species such as toads ©LHG Creative Photography CC BY NC ND 2.0

Protecting existing species-rich areas, including designated sites, such as SSSIs or county wildlife sites, is fundamental to landscape-scale projects. These core areas of high nature conservation value provide places within which species can thrive and from which they can disperse to other areas. Wherever possible they should be buffered by managing the land area around them in a way that helps protect the core area and its wildlife.

A crucial part of landscape approaches to wildlife conservation is to try and re-establish the linkages between such areas. Even if a population appears to be flourishing, if it is isolated from others it is vulnerable to extinction. A catastrophic event, such as flood or fire, puts an isolated population at risk as individuals may be unable to escape, and there is less chance of recolonisation from other areas. Isolation from other populations increases the chances of inbreeding and loss of genetic diversity, which again increases the risk of the population becoming extinct. Enhancing connectivity between species-rich areas must take into account the differences in mobility between species. Birds, for example, can generally more easily disperse or move across fields or farms (although there are differences in mobility between species). Other creatures, such as those that are ground-dwelling, or closely linked to particular habitats such as ponds, may be especially sensitive to habitat connectivity, requiring habitat patches to be near to each other or better connected.

Increasing habitat connectivity can be done by creating physical corridors of habitat such as hedgerows, field margins or ditches. Connectivity can also be enhanced by creating more features such as ponds or hedgerow trees; these can act as stepping stones across a landscape, making it easier for species to move through the farmed landscape. By managing intervening farmland as sympathetically as possible, wildlife is able to disperse more easily, helping species to colonise new areas, re-colonise old ones (Box 17), and reduce the chances of inbreeding.

Landscapes

River quality is particularly affected by the surrounding landscape © Stephen McKay CC BY SA 2.0

Farming and landscape-scale conservation

Farmers and land managers have a vital role to play in landscape-scale projects. To conserve wildlife, the delivery of habitat management and enhancement has traditionally been carried out at a farm level. These individual actions and participation in schemes such as Environmental Stewardship have delivered substantial and important wildlife gains on farmland.

A key aim of the landscape-scale approach is to try and ensure that these actions are not done in isolation. A strategic approach across neighbouring farms will ensure that blocks of habitat are looked after, and dispersal opportunities are created for fragmented populations of farm wildlife. For example, some habitat features can only be conserved effectively by a landscape-scale approach. An example is that of a river, the health of which is affected by management of all the land in the catchment. Actions to conserve and improve river quality will be much more effective if they are carried out across the whole landscape through which the river flows. This may involve, for example, working with neighbouring farmers and land owners to manage their land in a way that reduces nitrate use near water courses to improve water quality, or promoting wildlife through, for example, pond restoration.

Wildlife and climate change

© Mohammed Mahdi Karim GFDL 1.2

Some birds, insects, mammals and plants are showing changes in their geographic distribution and have moved northwards or to higher altitudes in response to changes in the UK climate. There is increasing evidence that many species with the northern limit of their range in the UK are expanding further north and onto higher ground (275 of 329 animal species analysed moved north by 31-60km in the last 25 years: Hickling et al. 2006, Global Change Biology, 12). In contrast, some cold-adapted species with their southern limit in the UK are retreating northwards and are being lost from now climatically unsuitable southern sites and lower ground.

Typically, widespread species with general habitat requirements and good dispersal ability are expanding into new areas; whereas species with small geographical distribution, poor ability to disperse and specific habitat requirements are less able to move. These species are greatly affected by factors such as habitat loss and fragmentation.

For a species to respond and move to a suitable climate, it needs increased habitat availability and connectivity. This further highlights the importance of landscape-scale conservation approaches.

Connecting habitats creates dispersal opportunities for wildlife © Rob Wolton, Hedgelink

Partnerships are crucial for landscape scale projects © Rob Wolton, Hedgelink

A recent large-scale initiative is Catchment Sensitive Farming © Stephen McKay CC BY SA 2.0

Landscape-scale conservation will also help farmland to provide more resources for a range of different species. A greater diversity of habitat types and features across the wider landscape will support more wildlife, and a greater range of wildlife. For groups such as bats or birds, individuals may use large areas, for example, spanning several farms. For these species, habitat improvements may need to be carried out over a much larger scale to provide them with the resources they need. A single farm might be unable to meet their habitat needs, while a landscape-scale conservation project could do so.

Working in partnerships

Landscape-scale projects and approaches will all be different, but a common theme is that of partnerships between those involved in managing the landscape and other stakeholders (Box 18). Projects do not need to start big - setting achievable objectives over a smaller area and building upon successes is a positive way to engage others and help a landscape scale project develop.

Opportunities exist, via Environmental Stewardship, to receive funding for such group applications that can maximise environmental benefits. At a policy level, there are now many initiatives designed to support larger-scale conservation efforts. One example is Catchment Sensitive Farming. This is a joint venture between the Environment Agency and Natural England, funded by Defra and the Rural Development Programme for England, working in priority catchments within England. It delivers practical solutions and targeted support to enable farmers and land managers to take action to protect water bodies and the wider environment.

Water vole © Andrew Harrington

Conserving water voles on Chichester Plain

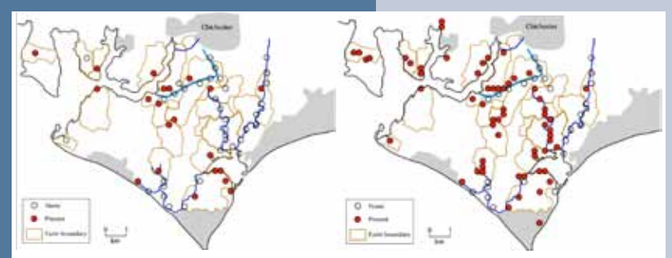
In a partnership project across the Chichester coastal plain, farmers were encouraged to participate in agri-environment scheme agreements to benefit the rapidly declining water vole. The water vole had declined in numbers by 95% in Sussex over the previous 20 years, as a result of degradation of habitats and predation by introduced American mink. Instead of viewing farms as individual entities, the project considered the whole landscape of the coastal plain in terms of land-use and river catchment management.

Through the delivery of whole-farm conservation plans, the partnership was able to create linked habitat corridors across and between neighbouring farms, mostly through agri-environment agreements. These created over 61km of 6m-wide grass margins and, as many of these margins were targeted beside rivers and watercourses, they formed direct linkages across and between farms.

Before the project, water voles were scarce within the area, with the populations highly fragmented and largely confined to a small number of farm ditches and ponds. However, they responded well to the habitat enhancements and linkages across the landscape so that, three years later, their numbers had more than tripled. In particular, 68% of the ponds and ditches had been occupied, together with those watercourses protected from cattle trampling by fencing.

Key results

- **In a landscape-scale project, linked habitat corridors were created across Chichester Plain**
- **Water voles and other wildlife benefitted from these habitat linkages**
- **Partnerships were crucial, and advice and agri-environment scheme funding underpinned the work**



Sites (in red) where water voles present in 2000 (left) and in 2003 (right) © Rob Strachan

Oxfordshire landscape © Rosalind Shaw

The Upper Thames Project

Restoring wildlife species and their habitats across farmland is best achieved through a landscape approach that aims to link local populations. This can be done by enhancing the connectivity of habitat across neighbouring farms, rather than by working at single sites and in isolation.

We aimed to 'join-up' habitats in this way, across the Upper Thames river catchments. Our success hinged on a partnership approach involving farmers, landowners and a range of conservation organisations, an approach that proved enormously successful in our pilot study on Chichester coastal plain (opposite). We offered farmers a funded service, including a Whole Farm Conservation Plan and advice on available grants. Conservation advice and activity at any one farm not only considered the species and habitats found on that farm but also the context of the farm in relation to neighbouring farms and areas of wildlife importance, such as nature reserves.

We achieved a range of targets for habitat improvements and monitored the impact of these changes on wildlife. We found, for example, that some habitat features, such as hedgerow trees, had a much bigger positive impact on wildlife when they were in these joined-up landscapes. Moths, bats and brown hares all benefited from landscape-scale conservation.

The Upper Thames Project highlighted the importance of considering landscapes in terms of the needs of, and benefits to, both humans and wildlife. Wildlife gains came about with great effort from the many partners working with our team.

Key results

- **The Upper Thames Project took a landscape-scale approach to conservation**
- **This partnership project delivered a range of habitat enhancements across catchments**
- **Benefits to a range of wildlife, including moths and hares, were recorded**

Brown hares benefited from landscape-scale conservation
© Keith Marshall CC BY NC SA 2.0

Landscapes

Management summary	
Key actions	Potential benefits
• Safeguard species-rich areas and increase habitat connectivity	Helps conserves wildlife populations
• Create habitat corridors and 'stepping stones'	Helps species move through the landscape
• Provide more wildlife resources over larger areas	The variety of habitats will support a greater diversity of wildlife Species can shift more easily in response to changing conditions Helps wildlife adapt to climate change
• Advice, knowledge, partnerships and governmental and agency support are crucial	These are the keys to success

Find out more at:
www.naturalengland.org.uk www.environment-agency.gov.uk www.wildlifetrusts.org
www.nationaltrust.org.uk www.rspb.org.uk www.cfeonline.org.uk www.butterfly-conservation.org

Wildlife

Great burnet © Peter Roworth/Natural England

Plants

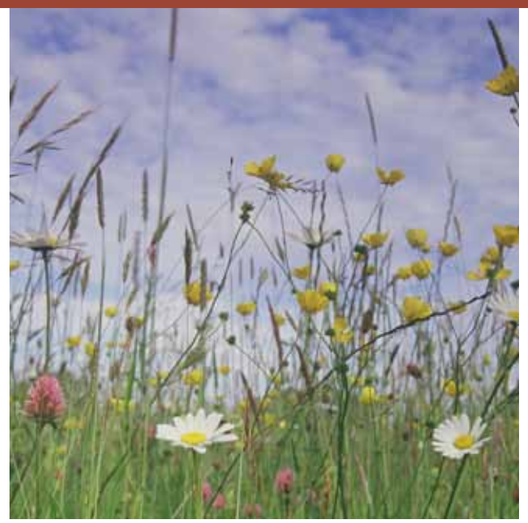
From hay meadows to downland, and cereal fields to hedgerows and field margins, farmland supports hundreds of plant species. As well as being important and beautiful in their own right, plants are the essential providers of food and other resources for farmland wildlife, including pollinators, other beneficial invertebrates and wildlife higher up the food chain. Management of farmland for floral diversity ranges from the continuation of traditional management for habitats such as species-rich floodplains, to active restoration measures on more intensively farmed land, aimed at enhancing and encouraging a greater diversity of plants.

Key points

- **Management for plant diversity depends on the existing flora and the conservation objectives**
- **Many plant communities, such as rare arable or species-rich meadow communities, have specific management needs**
- **Other measures, for example reducing herbicides and fertilisers, will benefit wild plants across the farm**

Overleaf image: marbled white butterfly on knapweed © Mark Kilner CC BY NC SA 2.0

Plants



Species-rich meadow © Paul Glendell/Natural England

Lowland farmland encompasses a range of habitats crucially important for plants. Many species of farmland plants have declined during the last sixty years, some to the point of extinction. Arable farmland contains some of Britain's endangered plants, once regarded as 'weeds', while ancient meadows have a rich variety of grassland plants. Species-rich areas that have been farmed in the same way for many years need protecting, as these rare habitats are irreplaceable. While intensification of farming has had an impact on plants of both arable and grassland habitats, there are nonetheless a number of ways in which wild plants can be encouraged or restored back to farmland.

© G. Hagedorn CC BY SA 3.0

Shepherd's-needle (above) and cornflower (below) are rare arable plants

© Nigel Gibson CC BY NC ND 2.0

Arable plants

Many species of arable plants are rare, declining or of conservation concern. Just a few of the rare plants that can be found in arable fields are cornflower, pheasant's eye, corn buttercup, Venus's-looking-glass, prickly poppy and blue pimpernel. Presence of arable plants such as small toadflax or dwarf spurge, often on lighter soils, may indicate that one or more of the rare plants may also be present. Reasons for the declines in arable plants include the increased use of herbicide, the development of more competitive crop varieties, the increased use of nitrogen, and improved seed-cleaning.

To survive and thrive arable plants need conditions that allow them to flower, fruit and return their seed to the soil. In general, arable flowers benefit from open cultivated margins or in-field areas where there is limited competition from aggressive weeds, cereal stubbles left uncultivated over winter, or cropped headlands that are unsprayed and unfertilised. Rare arable plants can be difficult to spot. Field edges, corners and gateways which have missed herbicide applications are often the areas in which they are found. Their seeds can lie dormant for many years, germinating when conservation management practices are adopted. Rare arable plants may suddenly appear in fallow fields or in the first year or two of establishing grass margins; if this happens, advice should be sought, as management may need to be changed.

Hay meadows, Lower Derwent Valley NNR
© Peter Roworth/Natural England

© Peter Wakely/Natural England

Snake's head fritillary (above) and green-winged orchid (below) are iconic plants of lowland meadows

© Paul Glendell/Natural England

Grassland plants

Lowland meadows

Lowland meadows are wildflower rich grasslands on neutral (neither acid nor alkaline) soils. They may be traditional meadows cut for hay, or pastures managed through grazing alone, and can support rare and iconic plant species such as snake's head fritillary and green-winged orchid.

A staggering 97% of lowland meadows were lost between 1930 and 1983 through conversion to cereal crops and improved grassland. Those that remain are now highly localised and fragmented. Significant concentrations can still be found on the floodplains of the Thames, Yorkshire Ouse and Derwent, Severn, Avon, on the Somerset Levels and in drier situations in Worcestershire. The high nature conservation value of these meadows stems from their species richness - sometimes supporting up to 40 species of plant per square metre. Many sites are ancient grasslands and have not been ploughed for many hundreds of years (the earliest record for hay-making on Pixey Mead, near Oxford, dates as far back as 1142). Ancient wildflower meadows can be conserved by continuing to graze or cut in a traditional way. However, such meadows need careful management and advice should be sought.

Lowland dry acid grassland

Lowland dry acid grassland typically occurs on nutrient-poor, generally free-draining soils. Often forming a mosaic with dwarf shrub heath, acid grasslands, particularly parched acid grassland, can provide habitat for a number of rare plants including mossy stonewort, sticky catchfly and spring speedwell. It is also an important habitat for invertebrates. Important concentrations of this habitat occur in the Breckland, the New Forest, Dorset, Suffolk Sandlings, the Weald, and Dungeness, and specific management is needed to maintain their condition. Advice should be sought.

Plants

Chalk downland flora, Hampshire
© Chris Gomersall/Natural England

A chalk downland mosaic of shorter grass, bare ground, tussocks and scrub is rich in wildlife © Ruth Feber

Sheep grazing can help maintain an open and varied downland sward © Ruth Feber

Chalk and limestone grassland

Chalk and limestone grasslands comprise some of the most species-rich habitats in lowland England. They vary widely from the south-facing, shallow soils of the chalk Downs in the south, to the north-facing slopes of the limestone Dales. Whatever the location, if they are in the right condition, chalk and limestone grasslands can support a huge number of plants and animals.

An open and varied sward is best achieved through grazing by cattle or sheep in combination with rabbit grazing. However, it is vital to avoid overgrazing, which will result in a uniform expanse of close-grazed short turf. Cessation of grazing may result in the encroachment of rank grasses or scrub, which will shade out the specialist chalk or limestone flora. A mixed regime of heavy and light grazing may be needed to create areas of bare ground, short turf and longer grassland including tussocks. Where possible livestock, rather than cutting, should be used to manage the sward. Correct management will allow and encourage more plants to flower over the summer months.

Lowland heathland

Lowland heathland occurs on acidic, impoverished, dry sandy or wet peaty soils, and is characterised by the presence of a range of dwarf-shrubs, including heather and gorse. Lowland heathland is a rare and threatened habitat. It has declined greatly in extent during the last two centuries – in England it is estimated that only one sixth of the heathland present in 1800 remains – and it still faces major pressures. Lowland heathland is generally dependent on regular grazing by livestock, controlled burning, and prevention of encroachment by bracken, scrub or trees to maintain it in favourable condition.

Grassland restoration and arable reversion

The restoration of species-rich, semi-natural grassland, normally from semi-improved swards, is an important means of increasing the plant diversity of grasslands. This may be achieved by simply amending management practices, for example, changing the timing and intensity of grazing. However, on sites where the potential for natural regeneration and re-colonisation of desirable plant species is judged to be low, then pro-active restoration will be required. This will involve the introduction of seeds and the creation of gaps in the sward to allow them to establish. Seeds can be introduced by over-sowing, slot seeding or the spreading of green hay. Adding yellow rattle to a seed mixture can help establishment of other wildflowers. Yellow rattle is a native annual which parasitises other plants, particularly grasses. It can reduce the dominant biomass in grasslands, allowing other wildflower species to establish.

Yellow rattle is often used to help wildflowers establish in restoration projects © Sannse GFDL

Arable land can be reverted to grassland to increase the variety of habitat in predominantly arable areas, or to link areas of grassland, either as whole fields or field margins (Boxes 19,20). The objective may be to create a species rich sward (comprising species characteristic of semi-natural grassland communities) or a grass dominated sward (often comprising productive, agricultural species or varieties). Seed used to establish the new grassland can come from a variety of sources, from natural regeneration to the addition of complex commercial seed mixtures. Seed used in seed mixtures should be of UK, and preferably local, provenance as this will help conserve local genotypes and ensure a flora that is visually appropriate to an area and likely to thrive there.

The importance of grazing

Livestock grazing is often crucial in maintaining species-rich habitats by controlling more aggressive species and preventing scrub encroachment. For example, grazing hay meadows after they have been cut helps control competitive coarse grasses, and trampling creates gaps in the vegetation which allow seedlings to grow. Grazing calcareous grassland can prevent too much scrub encroachment. Different types of livestock favour different plants for feeding, and graze in different ways, which shapes the structure and composition of the vegetation. Even within livestock types individual breeds can graze differently.

Cattle grazing is an important management tool © Paul Glendell/Natural England

Livestock grazing removes plant material more gradually than cutting or burning. It also supports other farming activities such as hay-making which provides active management for valuable meadow habitats, allowing slower-growing grasses to flower and seed. This ensures a variety of species continues to flourish. To ensure that wildlife habitats are managed for greatest environmental benefit it is important that the type, number and timing of livestock grazing is tailored to the needs of an individual site.

Teasel © davidpiano92 CC BY ND 2.0

Long-term changes in field margin plant communities

We established a large-scale experiment at Wytham, Oxford to look at different ways of establishing and managing uncropped arable field margins. Field margins around arable fields were either sown or left to regenerate naturally, and were managed by cutting, with the timing and frequency of cutting varying. We monitored the experimental margins for thirteen years to see how the plant communities changed over that time period.

In the early years, naturally regenerated margins were dominated by annual species, but this did not persist and annuals were lost from both naturally regenerated and sown margins, most rapidly from sown margins. After thirteen years, sown margins still had distinctly different, and richer, plant communities from those that had naturally regenerated, and in all of the margins the number of plant species present declined over the thirteen year period. Leaving cut hay lying led to field margins that were less diverse than those where the cuttings were removed. Overall, the changes we recorded over the first three years did not necessarily predict the longer term outcomes, either for weed control or the development of biodiversity on the field margins.

Many agri-environment agreements last for around 10 years. Long-term studies, such as the one described here, are vital if conservation advice and management recommendations are to be appropriate for more than just the first few years of a management plan.

Key results

- **Field margin plant communities continue to change over many years**
- **Some types of management take a long time to affect plant diversity**
- **Long-term studies are vital to help inform conservation recommendations**

Thirteen years after establishment, nettles were more common on margins where cut hay was left lying © Frank Vincentz GFDL 2.0

Tussocky field margin © Phil Caterall CC BY SA 2.0

Do field margins affect weed occurrence in the crop?

One potential concern with uncropped field margins or buffer strips is that they may result in unwanted weed infestations in the adjacent crop. We collected data from ten experimental field margin types, which varied in whether they were sown or naturally regenerated, and in the frequency and timing of cutting, to investigate this question.

Within the uncropped field margins, the annual plants that were initially the most abundant (including some major weeds of cereals, such as wild oats and sterile brome) declined rapidly, particularly in sown field margins. But did the adjacent crop have higher numbers of undesirable weeds? The only weedy species which was initially frequent in the crop adjacent to margins, particularly those cut in spring and autumn, was wild oats. This species declined rapidly in the uncropped margins as perennial cover increased, from the first year of fallow onwards, and was also lost from the crop edge within two years of the margins being fallowed. The management of uncropped arable field margins for wildlife is unlikely to affect weed levels within the crop, especially where they contain, or are sown with, non-invasive perennial species.

Key results

- **Wild oats were initially more common in the crop next to new margins**
- **This did not last and they were no more frequent than anywhere else within two years**
- **Once established, uncropped field margins will not usually increase weed levels in the crop**

Wild oats were temporarily more common adjacent to uncropped margins, but this did not last © Keith Edkins CC BY SA 2.0

Plants

Management summary		
	Key actions	Potential benefits
Rare arable plants	• Where conditions allow, leave crop headlands unsprayed and unfertilised, establish open cultivated margins or field corners, leave cereal stubbles over winter	Will create the conditions arable plants need to germinate and set seed each year
Grassland plants	• Management of species-rich grasslands should not be changed without advice	Traditional management, usually by grazing or cutting for hay, maintains species-richness
	• Calcareous grasslands are best managed by grazing, and regimes may need to be tailored to the site	An open and varied sward will allow a range of chalk and limestone grassland species to flourish
	• Dry acid grasslands and lowland heaths need careful management, seek advice	The right management will be needed to maintain these habitats in good condition
Grassland restoration and arable reversion	• Follow agri-environment scheme guidelines	Can help restore species-rich grasslands with many ecological and environmental benefits
Uncropped field margins	• Establish margins by natural regeneration or sowing. Margins should not be sown where rare arable plants are present.	Can help restore diverse plant communities around arable and grass fields.

Options especially relevant for plants		
Code	ELS/OELS options	ELS/OELS points
EF9	Cereal headlands for birds	100 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EF11/OF11	Uncropped cultivated margins for rare plants	400/460 per ha
HLS code	HLS options	Payment (£)
HE10	Floristically enhanced grass buffer strips (non-rotational)	£485 per ha
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HF20	Cultivated fallow plots or margins for arable plants (rotational or non-rotational)	£440 per ha
HK6	Maintenance of species-rich, semi-natural grassland	£200 per ha
HK7	Restoration of species-rich semi-natural grassland	£200 per ha
HK8	Creation of species-rich semi-natural grassland	£280 per ha

Find out more at:
www.plantlife.org.uk www.naturalengland.org.uk www.floodplainmeadows.org.uk

Elephant hawkmoth © Rob Wolton, Hedgelink

Butterflies & moths

Butterflies and moths are among the most strikingly bright and beautiful insect species found in the British countryside. They need specific plant species for the caterpillars to feed on, flowers as nectar sources for the adults, and safe places to shelter and overwinter. Butterflies and moths can be regarded as indicators of habitat quality on a farm: the more butterflies and moths there are, the more likely the farm will have a rich variety of wildlife.

Key points

- **Butterflies and moths need nectar sources, specific foodplants for the caterpillars, and sheltered areas**
- **Grassland, hedgerows, field margins and woodland habitats are all valuable**
- **Creating a variety of habitat types will benefit the widest range of species**

Butterflies & moths

Moths and butterflies, such as these marbled whites, require suitable breeding habitat as well as nectar sources © Tara Proud

Around 60 species of butterfly are seen regularly in the UK, comprising less than 3% of British Lepidoptera (butterflies and moths). The remaining 2, 500 or so species are moths but, as most of them fly at night, they are far less well known. Farmland is the main habitat for over three quarters of British butterflies. Many butterflies and moths, both common and rare, have suffered population declines, but a range of measures can help encourage them and increase their numbers on farmland.

Butterflies and moths have complex life cycles, comprising egg, caterpillar, pupa, and adult stages. Some species live as adults for only a few days or weeks, while others live for many months and hibernate over the winter. Some moths live as caterpillars for a few years. The most important requirements of adult butterflies and moths are suitable sites for laying their eggs and sufficient nectar sources to supply them with food. Sheltered areas are particularly important. Butterflies and moths will make use of all areas of the farm - hedgerows, margins, meadows and grassland, wet flushes and patches of woodland.

Close-up of comma butterfly eggs on common nettle © Gilles San Martin CC BY NC 3.0

Butterflies will take nectar from a range of plants, but plants such as knapweeds, scabious, thistles, marjoram, teasel, fleabane and bird's-foot trefoil are especially favoured. Because different butterfly and moth species are on the wing at different times throughout the spring and summer it is important to have a succession of flowering plants through the season. Early nectar sources include sallow and blackthorn blossom, self-heal, primrose and lady's smock, while important late sources of nectar are bramble and ivy. Berries, including blackberries, are also useful. Moths are important pollinators and some plants, such as the campions, have evolved to be pollinated by moths.

Silver-spotted skippers have precise requirements for egg-laying
© Mark Kilner CC BY NC SA 2.0

Breeding requirements vary according to the species. Some moths and butterflies have very precise needs for egg-laying. Female silver-spotted skippers, for example, are extremely fussy, laying single eggs on the leaf blades of sheep's fescue in short turf, up to 4cm, and often next to patches of bare ground. This, and other so-called specialist species, often depend on tailored management to maintain the correct habitat.

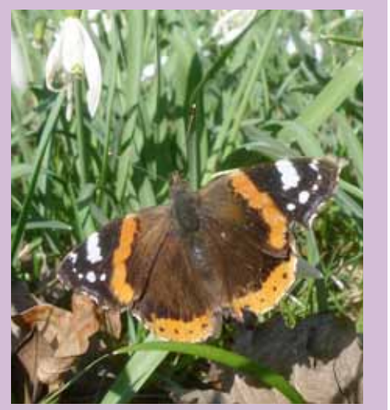
Caterpillars of the gatekeeper butterfly feed on grasses © Mark Kilner CC BY NC SA 2.0

The most common butterflies and moths are those that are less demanding, whose caterpillars feed on a common plant or a number of different plants. Meadow brown and gatekeeper butterflies, for example, lay their eggs on grasses, while commas, peacocks and small tortoiseshells lay on nettles. Widespread species such as these will benefit from management that encourages a diversity of plants and habitat types on the farm.

Butterflies and moths vary in their mobility, with the more widespread species often able to travel large distances to feed and lay eggs. Others, usually the habitat specialists, may be weak fliers and will need all their habitat requirements met in a small area.

Butterflies and climate change

The red admiral butterfly used only to be seen as a summer visitor to Britain but, since the 1990s, it has been recorded overwintering here in ever-increasing numbers. They are now seen in every month of the year, even flying amongst snowdrops in February! This is a sign of one impact of climate change on British wildlife. UK Butterfly Monitoring Scheme data show that other butterflies, such as the speckled wood, are expanding their ranges northwards in response to warmer temperatures. By linking habitats such as hedgerows and woodlands to facilitate movements across the farmed landscape, butterflies and other wildlife can be helped to adapt to the changing climate.



© Martin Warren, Butterfly Conservation

Butterflies & moths

The chalkhill blue butterfly is confined to calcareous grasslands
© Mark Kilner CC BY NC SA 2.0

Unimproved calcareous grasslands should be managed to create mosaics of grassland and scrub © Ruth Feber

Damp grasslands can support rich communities of plants and butterflies, such as this marsh fritillary
© nutmeg66 CC BY NC ND 2.0

Habitat management

Semi-natural grassland

Semi-natural grasslands containing wild grasses and flowers, such as unimproved calcareous or wet grasslands, are some of the richest habitats for butterflies. Semi-natural grasslands provide breeding habitat for over 90% of resident butterfly species, with just under half of these largely relying on calcareous grassland.

Management of calcareous grasslands should aim for a mosaic of different habitats, with patches of bare ground and scrub, variations in sward height, and abundant nectar sources. Most often this is achieved through stock grazing. Management prescriptions are usually site specific and, in all situations, the right grazing pressure is vital for creating the desired habitat.

Damp, unimproved grasslands, such as the culm grasslands in the south-west of England, are strongholds for some declining species such as the marsh fritillary butterfly. These and other species-rich wet grasslands, such as floodplain meadows, rely on the continuation of traditional grazing or hay-cutting management to maintain their special flora and fauna.

Semi-improved grassland

Any grassland that contains some native grasses and wild flowers can be important for butterflies and moths. Damp grassland with rushes will support green-veined white and orange tip butterflies, while acid or neutral grassland will be used by ringlets, meadow browns and common blue butterflies. Leaving some areas of grassland uncut during the spring and summer will allow plants to flower and provide undisturbed breeding habitats. Where possible, avoiding or reducing fertiliser and pesticide use will increase plant and butterfly diversity.

Orange tip butterflies use cuckooflower both as a nectar source and a caterpillar foodplant
© Guido Gerding CC BY SA 3.0

Brown hairstreak overwinters as eggs on blackthorn hedges © Paul Gee CC BY NC ND 2.0

The figure of eight moth may have suffered from intensive hedgerow management
© Nigel Jones CC BY NC ND 2.0

Hedgerows and field margins

Hedgerows are vital for these insects on farmland. Butterflies will make great use of hedgerow nectar, such as bramble, and caterpillars of many butterflies and moths will feed on hedgerow species. Hedgerows provide important shelter in exposed agricultural landscapes. Leaving hedges uncut, or cutting not more than once every three years, helps eggs and caterpillars to survive. Brown hairstreak butterflies, for example, lay their eggs on young blackthorn, and the eggs need to overwinter safely before the caterpillars hatch and feed on the new leaves in spring. Butterflies and moths have suffered from overly intense hedge management. The figure of eight moth, for example, has declined by 95% over the last 35 years.

Field margins are very important for butterflies and moths, especially in arable areas (Box 21). Field margins that contain wildflowers (either sown or naturally regenerated) will be much more valuable than grass-only strips. Common blue butterflies, for example, use bird's foot trefoil both as a nectar source and a caterpillar foodplant, and orange tips use cuckooflower in the same way. Leaving some field margins uncut each year will allow plants to flower, and provide undisturbed breeding habitats. A variety of sward heights will also benefit more species; for example, retention of nettle patches of different heights in sunny locations will help small tortoiseshell and peacock butterflies. Field margins adjacent to hedgerows or ditches are especially valuable as these provide shelter and food. Organic farming has been shown to have benefits for some butterfly species (Box 22).

Woodland and scrub

Many moth species are largely restricted to woodlands, and others use it in addition to other habitats. Native tree species often support their own suite of moths, with deciduous oaks alone supporting about 220 species. Butterflies such as the declining pearl-bordered fritillary also depend on woodland, particularly if it is managed by coppicing. Moth and butterfly diversity can be increased by creating a diverse woodland structure. This should include areas of active management such as ride creation, coppicing and glades, in addition to retention of existing dark woodland areas. This will help shade- or moisture-loving woodland specialists, whilst at the same time helping species of mixed and more open woodland habitats. Scrub, cut in patches, provides shelter and breeding habitat for many species.

Pale shining brown moth © Dave Green

Oxfordshire farmland stronghold for rare moth

An exciting discovery of a very rare moth, the pale shining brown, was made in 2006 during moth surveys in Oxfordshire. This moth has undergone massive declines in Britain since the 1970s, and had been thought to exist only in small numbers on Salisbury Plain, and at a handful of sites in Wiltshire, Norfolk and Hertfordshire.

Eighty-eight individuals were caught in West Oxfordshire, making it the largest colony known in Britain. The field in which 57 were captured was next to a block of mixed woodland, had tall hedges, and 6m wide field margins. The landscape was largely arable, with 2m margins, sparse trees and low hedges, on well-drained calcareous soil. Little is known about the moth, although in captivity the caterpillars will eat a variety of herbaceous plants. Caterpillars have never been found in the wild.

It is perhaps surprising that such a large population had been overlooked, but arable farmland may often be under-recorded. The landscape in which the moths were found also suggests that agri-environment scheme options such as field margins may benefit rare and localised species as well as more widespread ones.

Key results

- Large colony of rare moth found in Oxfordshire
- Arable farmland may often be overlooked as a habitat
- Field margin options may be valuable for rare as well as widespread species

Pale shining brown moths were discovered on arable farmland © Rosalind Shaw

Meadow brown butterfly © Annies Pics CC BY NC 2.0

Butterflies on organic farms

Organic farms differ from non-organic farms in several ways. As well as the lack of pesticides and artificial fertilizers, organic farms have more complex crop rotations, and tend to be mixed (arable and grass) farms. We investigated whether these differences might affect their biodiversity.

We monitored butterflies on organic and non-organic farms in southern England, over three summers. Uncropped field margins had more butterflies than crop edges, for both farm types. For both field margins and crop edges, there were more butterflies, and more butterfly species, on organic farms.

Important factors were larger hedgerows on organic farms, lack of pesticide usage, and rotational cropping. Grass leys helped increase numbers of butterflies. Species such as the meadow brown and common blue all prefer sheltered grassy areas, and more of these butterflies were found on organic farms.

Some of these benefits, such as hedgerow creation and management, may readily be achieved on non-organic farms, for example through agri-environment schemes. However, there are other benefits for wildlife that are particularly associated with organic farming, such as those derived from different patterns of cropping and cessation of artificial pesticide use.

Key results

- Butterflies were more abundant and species-rich on organic farms
- Larger hedgerows, rotational cropping and lack of pesticide use were important factors
- Agri-environment schemes create some similar benefits through hedgerow and buffer strip management

Hedgerows are important for butterflies © Rob Wolton, Hedgelink

Butterflies & moths

Management summary		
	Key actions	Potential benefits
Grassland	• Semi-natural grassland management depends on situation and history • In other grasslands, reduce fertiliser, leave some areas uncut for 2-3 years, and encourage diversity of grasses and wild flowers	Will benefit many butterfly and moth species
Hedgerows and field margins	• Cut hedgerows not more than once every 3 years • Field margins with mixtures of native grasses and wildflowers, and areas that are left uncut, will benefit butterflies and moths	Provides shelter and food for butterflies and moths Provides nectar sources and larval foodplants
Woodland and scrub	• Woodland edges, rides and shadier woodland centres are all important, so aim for a diverse structure, with lighter and darker areas • Try to link areas of woodland or semi-natural habitats	Some rarer moths need dark woodland while most butterflies and other moths benefit from lighter conditions Helps species move through landscapes

Options especially relevant for butterflies & moths		
Code	ELS/OELS options	ELS/OELS points
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife	56 per 100m
EC4/OC4	Management of woodland edges	380 per ha
EC23/OC23	Establishment of hedgerow trees by tagging	1 per tree
EC24/OC24	Hedgerow tree buffer strips on cultivated land/rotational land	400/500 per ha
EC25/OC25	Hedgerow tree buffer strips on grassland/organic grassland	400/500 per ha
EE1-3	2/4/6m buffer strips on cultivated land	255/340/340 per ha
OE1-3	2/4/6m buffer strips on rotational land	340/425/425 per ha
EE4-6	2/4/6m buffer strips on intensive grassland	255/340/340 per ha
OE4-6	2/4/6 buffer strips on organic grassland	340/425/425 per ha
EE12/OE12	Supplement to add wildflowers to field corners and buffer strips	63 per ha
EF1/OF1	Management of field corners	400/500 per ha
EF4/OF4	Nectar flower mixture	450/550 per ha
HLS code	HLS options	Payment (£)
HB11/12	Management of hedgerows of very high environmental value (both/one side)	£54/27 per 100m
HC7	Maintenance of woodland	£100 per ha
HC8	Restoration of woodland	£100 per ha
HC15/16/17	Maintenance/restoration/creation of successional areas and scrub	£100 per ha
HE10	Floristically enhanced grass buffer strips	£485 per ha
HK6/7/8	Maintenance/restoration/creation of species-rich, semi-natural grassland	£200/200/280 per ha

Find out more at:
www.butterflyconservation.org www.mothscount.org www.ukbutterflies.co.uk

Bumblebee ©Rosalind Shaw

Beneficial invertebrates

Many of the thousands of invertebrate species found on farmland are beneficial to agriculture, providing vital ecological services such as pollination and natural pest control. Insect pollinators include honeybees and bumblebees, hoverflies, moths and butterflies, while hundreds of species of beetles, spiders and other invertebrates are important predators of crop pests. Sympathetically managing a diversity of cropped and non-cropped areas of the farm will enhance populations of beneficial invertebrates and increase the ecological services they provide.

Key points

- **A diversity of crops and non-cropped habitats on the farm will encourage beneficial invertebrates**
- **Flower-rich areas will help pollinators, and a range of other beneficial invertebrates that regulate crop pests**
- **Non-cropped areas, such as hedgerows and field margins, provide shelter for nesting and overwintering species**

Beneficial invertebrates

Hoverflies are important pollinators
© Miles Wolstenholme CC BY NC SA 3.0

Insect pollination can increase seed set of oilseed rape
© Julian Dowse/Natural England

The carder bee is one of Britain's 24 species of bumblebee
© Rob Wolton, Hedgelink

Pollinators

Pollinators are vital both for native plant communities and for the productivity of many crops. There are many wild pollinating insects in Britain, including bumblebees, hoverflies, various other flies, moths and butterflies, as well as the domesticated honeybee. Insect pollination in the UK is thought to be worth over £400 million to the economy. Crops such as beans and soft fruit are pollinated primarily by bumblebees, and seed set, and thus oil yield, of oilseed rape is enhanced by pollinators.

Both honeybees and bumblebees have struggled in recent years. Many bumblebee species have undergone declines in the UK, and areas of intensive farming have seen some of the biggest declines. It is generally agreed that loss of wildflowers (both abundance and diversity) in the landscape has been the major factor contributing to these changes. Honeybees have suffered particularly from disease and it is also thought that environmental factors, including use of some pesticides (particularly neonicotinoids), may be involved in colony losses. Less information is available on other pollinators such as hoverflies, but it seems likely that these have also suffered reductions in number. Declines in other pollinator groups, such as wider countryside moths, are well documented.

Habitat management for pollinators

Encouraging a diversity of plants is important for pollinators, since different species have different requirements. For example, bumblebee species tend to feed on different flowers, with long-tongued and short-tongued bumblebees generally feeding on deep or shallow flowers respectively. Clovers, vetches and trefoils are particularly important.

Red clover is a valuable nectar source for bumblebees © Rosalind Shaw

Bumblebees also need underground or tussocky places to nest
© Nigel Jones CC BY NC ND 2.0

Valuable nectar sources such as tufted vetch are found at hedge bases and on field corners
© Rob Wolton, Hedgelink

Nectar and pollen also need to be available to bumblebees and other pollinators throughout the flight season from March through until September. By encouraging a range of suitable wildflowers it is more likely that this continuity will be achieved. A diversity of plants will also benefit other pollinators, such as butterflies and moths, which need larval foodplants as well as nectar sources for the adults.

Bumblebees also require undisturbed nesting sites and refuges in which to hibernate over the winter. Bumblebee nests can be large (containing around 50-400 sterile workers) but only the queen overwinters. Most bumblebees nest underground, often using disused small mammal burrows, while others need tussocky, above ground vegetation for their nests. Protection from farm operations is important for all species and this may be provided in the form of uncropped buffer strips, beetle banks and sympathetic hedgerow management.

Hedgerows can provide good early sources of nectar, for example, blackthorn and hawthorn blossom, as well as rich hedge base flora if managed sympathetically. Hedges also give shelter and protection, and hedge bases and banks often provide suitable nesting sites for bumblebees. Plants growing within wet areas, such as ditches, can provide rich pollen and nectar sources, and ditches themselves provide sheltered habitats (Box 13).

Although pollinators differ in their precise requirements, habitat management that encourages diverse flowery swards and leaves some uncropped areas undisturbed for nesting and overwintering (such as flowery uncropped field margins and field corners) will benefit a whole range of pollinator species. Several Environmental Stewardship options will help provide these resources, with pollen and nectar mixes being one of the most important. All options that create uncropped areas, especially floristically rich ones, will be of great benefit.

Many pollinators are not especially mobile, and so managing larger areas of farmland sympathetically will ensure that populations do not become isolated and at risk of local extinctions. By providing the resources they need across the landscape, bumblebee and other pollinator populations will be much more likely to survive and flourish.

Beneficial invertebrates

Ladybird larvae feed on aphids in the crop
© Dean Morley CC BY ND 2.0

Linyphiid, or 'money' spiders, are tiny spiders that can disperse on air currents high above the landscape © James Bell

Predatory invertebrates

Many beetles (particularly ground and rove beetles), spiders, harvestmen and other invertebrates (such as hoverflies and nematodes) that occupy arable farmland are vitally important in helping control pests, such as aphids and slugs, that attack crops. There is a great diversity of species which differ in their life-histories and habitat requirements. For example, some species reside in the crop throughout the year, while many others will colonise the crop in the spring from other, uncropped, areas such as field margins, where they have overwintered. The diets of predatory invertebrates differ. A great number are generalists, feeding on a range of prey, while others are more specialist - ladybirds and lacewings, for example, prefer to feed on aphids.

The mobility of predatory invertebrates also varies enormously. Some spiders such as linyphiids ('money' spiders) are able to travel for many miles using a dispersal method known as 'ballooning'. These spiders let out a line of silk which, if the air currents are favourable, drags them to great heights from where they are carried to new locations. Other, less mobile, species, such as some ground beetles and ground-dwelling spiders, will move within only two or three fields during their lifetime. The management of the landscape as well as the local surroundings will thus influence the diversity of predatory invertebrates found on a farm.

What are parasitoids?

Parasitoids are similar to parasites in that they spend at least a part of their life obtaining nourishment from a host organism. However, unlike parasites, parasitoids ultimately kill their host and prevent it from reproducing. For this reason, parasitoids are very important for helping control agricultural pests. The grain aphid, for example, infests the ears of wheat, barley and other cereals, reducing yields. In the UK, there are 9 species of parasitoid wasp that lay their eggs inside the grain aphid. Once hatched, the parasitoid larvae will consume the aphid host from the inside, helping to control these pests. Furthermore, while aphids can develop resistance to insecticides, they remain susceptible to parasitoids.

Almost all parasitoids are insects, most are wasps, and the largest group are ichneumon wasps. Pollen and nectar are important food for parasitoid wasps, providing energy and nutrients. Important nectar sources for parasitoids are flowers with an open structure, such as umbellifers, for example, cow parsley and hogweed.

Parasitoid wasp (top) and mummified aphid host (below).
Photos: Gilles San Martin CC BY NC 3.0

This wolf spider has spiderlings on her back. Spiders benefit from good vegetation structure © Peter Wheelwright

Field margins will enhance predatory invertebrate populations. Adding wildflowers to a mixture will increase its value
© Keith Edkins CC BY SA 2.0

Ground beetles will overwinter in tussocky grass strips or beetle banks © James Bell

Habitat management for predatory invertebrates

Tussocky grasses support high densities of overwintering beetles and spiders. If they are positioned around arable fields, or across fields as beetle banks, they can aid colonisation of the crop in the spring, as well as increasing numbers of other invertebrates that can act as alternative prey for beneficial predators when pest species are not available. Margins and beetle banks should only be cut occasionally to control scrub, as taller and more complex vegetation structure will support more invertebrates (Box 23). Cutting in summer should be avoided. Where wildflowers are added to a seed mixture used to establish buffer strips, this will help further to provide other sources of food for predatory invertebrates, such as nectar, pollen, and other insect prey.

Hedgerows and hedge bases are very important habitats for beneficial invertebrates, providing shelter and a refuge from farm operations, as well as sources of alternative prey. As well as providing resources in their own right, buffer strips help protect the hedgerow from pesticide drift.

Many beneficial invertebrates are vulnerable to insecticide use, and sensitive to cultivation and soil disturbance. Insecticide use should be reduced wherever possible, or targeted so as to minimise effects on non-target beneficial invertebrates. Beneficial populations are most vulnerable to damage from insecticides and molluscicides in spring and summer, when they are active within the crop. Even in autumn, though, insecticide may drift into non-cropped overwintering areas and reduce survival. If herbicide inputs are reduced within fields this will encourage beneficial invertebrates (Box 24).

Minimum tillage and other techniques that reduce soil disturbance will have significant benefits for some species, such as the larvae of some ground beetles that overwinter in the soil within the field. Different crop types will support different communities of predatory invertebrates, so having a variety of crops will help raise their overall diversity.

In general, aiming to create a mosaic of habitats across the farm and reducing pesticide use where possible will increase the habitats and resources needed by different beneficial invertebrates and a range of other wildlife.

Linyphiid spider © James Bell

Spiders on field margins

Spiders are mobile and almost entirely carnivorous, and this predatory lifestyle makes them of potential benefit to farmers. The web-building activity of many species suggests they might be particularly sensitive to the structure of vegetation in uncropped areas of the farm such as field margins or buffer strips.

We looked at spider abundance and number of spider species on experimental field margins around arable fields at Wytham, Oxfordshire. The field margins were managed in contrasting ways, differing in the timing and frequency of mowing, and whether they were established by sowing with a grass and wildflower seed mixture, or by natural regeneration.

The key result was that spiders were found to be much more abundant on field margins that were not cut in the summer. Avoiding mowing the margins in the summer preserved the structural complexity of the vegetation, with positive impacts on the spider communities. Where field margins were mown, spiders fared better when mowing took place in spring and autumn compared to those margins mown in spring and summer. The lower number of spiders found on margins that were cut in the summer persisted into the following year.

Leaving field margins uncut, or cutting infrequently (every 3-4 years) to control scrub, and never cutting in the summer, will encourage populations of these beneficial invertebrates on farmland.

Key results

- **Field margins and buffer strips that are left uncut increase spider populations**
- **Structural complexity of the vegetation is very important for spiders**
- **If possible, cut only infrequently to control scrub, and do not cut in summer**

Vegetation with plenty of structure encourages web-building spiders © Peter Wakely/ Natural England

Barley © Peter J Dean CC BY NC ND 2.0

Spiders are more abundant on organic farms

Previous studies have suggested that biodiversity on organic farms is higher than on non-organic farms. Over three years, we studied cereal fields and their field margins on 89 pairs of organic and non-organic farms across England. The aim was to find any differences between the farm types in terms of two groups of beneficial invertebrates, spiders and carabid beetles.

The results were quite complex, with numbers and species richness of spiders and carabid beetles varying with time of year, crop type, location (whether margin or crop), and the nature of the surrounding landscape. In general, though, spiders showed consistently positive responses to organic farming. Carabid beetles also showed some positive responses to organic farming but these were generally less consistent. Individual species were affected in different ways by organic farming. An important factor seemed to be the structural complexity of the crop and its understorey vegetation, with greater complexity of vegetation especially benefitting spiders.

The study confirmed that organic systems were generally beneficial to the invertebrate groups in the study, particularly so for spiders, especially within crops before harvest.

Key results

- **Eighty-nine pairs of organic and non-organic cereal fields were sampled for spiders and carabid beetles**
- **Spiders showed the most consistently positive responses to organic farming**
- **Organic farming may have benefits for both these groups of beneficial invertebrates**

Carabid beetles (left) and spiders were monitored on organic and non-organic farms © James Bell

Beneficial invertebrates

Management summary		
	Key actions	Potential benefits
Pollinators	• Create flower-rich patches around the farm, including field corners and buffer strips, ditch banks, and semi-improved grassland	Pollinators need supplies of high quality nectar and pollen throughout the season
	• Include legumes and trefoils in pollinator seed mixes	These plants are especially good for bumblebees
	• Protect hedge bases and establish tussocky field margins and beetle banks	Will help provide suitable sites for bumblebees to nest
	• Reduce pesticide inputs	Increases invertebrate and plant diversity (pollinators are sensitive to insecticide use and herbicides reduce flower availability)
Predatory invertebrates	• Aim for mosaic of different crops and non-cropped habitats	Provides food and shelter for wide range of predatory invertebrates
	• Hedgerows, uncropped field margins and beetle banks are especially important	Provides overwintering habitat and helps crop colonisation
	• Reduce mowing of field margins to increase vegetation structure	Enhances populations of spiders, especially web-building species
	• Reduce or target pesticide use and adopt minimum tillage where possible	Predatory invertebrates are sensitive to pesticide use and soil cultivation

Options especially relevant for beneficial invertebrates (pollinators and predatory invertebrates)

Code	ELS/OELS options	ELS/OELS points
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
EE1-3	2/4/6m buffer strips on cultivated land	255/340/340 per ha
OE1-3	2/4/6m buffer strips on rotational land	340/425/425 per ha
EE12/OE12	Supplement to add wildflowers to field corners and buffer strips	63 per ha
EF1/OF1	Management of field corners	400/500 per ha
EF4/OF4	Nectar flower mixture	450/550 per ha
EF7/OF7	Beetle banks	580/750 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EG1/OG1	Undersown spring cereals	200/150 per ha
EK1/OK1	Take field corners out of management	400/500 per ha
EK3/OK3	Permanent grassland with very low inputs	150/180 per ha
EK21/OK21	Legume- and herb-rich swards	200/250 per ha
HLS code	**HLS options**	**Payment (£)**
HB11/12	Management of hedgerows of very high environmental value (both/one side)	£54/27 per 100m
HE10	Floristically enhanced grass buffer strips (non-rotational)	£485 per ha
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HF20	Cultivated fallow plots or margins for arable plants (rotational or non-rotational)	£440 per ha
HK6/7/8	Maintenance/restoration/creation of species-rich, semi-natural grassland	£200/200/280 per ha

Find out more at:
www.bumblebeeconservation.org www.gwct.org.uk www.soilassociation.org www.leafuk.org
www.buglife.org.uk

Grass snake © Ian McIntosh CC BY SA 2.0

Amphibians & reptiles

Amphibians and reptiles are highly charismatic creatures and an important part of Britain's natural and cultural history. Over recent decades, changes in land use have resulted in population declines of all Britain's amphibians and reptiles. Pond loss has been a particular problem for amphibians, while reptile populations have become isolated and vulnerable; hibernation areas have been destroyed or sunny basking areas shaded out. Creating and managing habitats for most amphibians and reptiles can be complementary to broader conservation management on farmland.

Key points

- **Amphibians and reptiles are charismatic creatures that have suffered population declines**
- **Amphibians need good quality ponds, especially warm ones**
- **Reptiles require open areas for warmth and more vegetated areas for shelter.**
- **Suitable areas of habitat, linked across the landscape, are particularly important for reptiles**

Amphibians & reptiles

A young common toad in the palm of a hand
© TJ Blackwell CC BY NC 2.0

Amphibians

There are seven species of amphibian native to Great Britain: the common frog, natterjack toad, common toad, smooth newt, palmate newt, great crested newt and northern pool frog. Despite being widely distributed, the great crested newt and common toad are listed as priorities under the UK Biodiversity Action Plan (BAP) due to their declining numbers. The other three widespread species, smooth newt, palmate newt and common frog, have also experienced declines.

The great crested newt has suffered severe declines across Europe © Fred Holmes

Spawn of common frog and toad © Fred Holmes

The remaining two native species, the natterjack toad and northern pool frog, are conservation priorities due to their rarity. The natterjack toad is confined to fewer than 60 locations, while the pool frog has only relatively recently been recognised as a native species - coinciding with its extinction in the wild. Pool frogs have been reintroduced, from Sweden, to a single site in England.

Amphibians have complex life cycles and are all dependent on suitable terrestrial as well as aquatic habitats. British amphibians breed primarily in standing water, especially ponds, where the eggs (spawn) and the larval (tadpole) stages can often be seen (Box 25). After metamorphosis, juvenile and adult amphibians spend long periods, often several years, living on land. High quality habitats are important: common toads, for example, require access to wooded areas, tussocky grassland, scrub or hedgerows, for hibernation sites, feeding and shelter.

The great crested newt is believed to have declined more rapidly than other widespread amphibian species and has particularly suffered from the degradation of rural ponds due to agricultural intensification. Great crested newts prefer to breed in deep ponds that contain plenty of aquatic vegetation and they do not range far from their breeding pond. At the other end of the spectrum is the common toad, the most terrestrial of the widespread amphibians. Outside its breeding season it may move up to three kilometres from water, although distances of 400-1500m are more typical. The common toad is more tolerant of dry conditions than the other amphibians, except for the natterjack toad.

Common frog and spawn © Richard Burkmar

Rough grassland and scrub provide important areas for amphibians to feed, shelter and hibernate © Chris Gleed-Owen

Pond creation and management is crucial for amphibian conservation. The principles for creating good wildlife ponds also apply to amphibian breeding sites (see Chapter: Ponds). One feature that is particularly important for amphibians is warmth. Warm ponds are favourable for amphibian growth and development, so new ponds should be positioned in sunny locations. A belt of trees or scrub several metres to the north of a pond can act as a windbreak and create a warm microclimate around the pond. Management over the longer term should incorporate measures to control scrub and trees to avoid excessive shading, and the southern pond edge is best completely unshaded.

Telling a frog from a toad

Common toads often breed in the same water as the common frog and may be confused with them. At 8-13cm the toad is larger than the frog (6-9cm) which prefers to hop, whereas the toad generally walks. The toad has a rounder snout than frogs when viewed from above and the much more warty skin of the toad distinguishes it from frogs. Frogspawn is laid in large clumps, while toads lay spawn in strings.

There are two toad species in the UK, the common toad and the natterjack toad. The natterjack toad is a conservation priority and a habitat specialist with very different ecological requirements to the other native amphibians. It is a rare and elusive creature with a distinctive yellow dorsal stripe, and is almost exclusively confined to coastal sand dunes, coastal grazing marshes and sandy heaths.

Common frog
© Steve Hiner/Natural England

Common toad © Rosie Salazar

Natterjack toad
© Neil Pike/Natural England

Amphibians & reptiles

© Chris Gleed-Owen
The slow-worm (above) and the common lizard (below) are both declining

© Steve Hiner/Natural England

Grass snakes can be found on farmland
© Simon Collinson CC BY NC ND 2.0

Reptiles

Six reptiles are found in the British Isles: sand lizard, common lizard, slow-worm, smooth snake, grass snake and adder. All of Britain's reptiles have suffered population declines and all six species are now listed as priorities in the UK Biodiversity Action Plan (BAP).

The slow-worm (a lizard) is the commonest reptile in the British Isles but, like the others, it has suffered declines in recent decades due to loss of suitable habitat. Slow-worms require dense vegetation, coupled with sunny areas to allow thermoregulation and, preferably, loose soil into which to burrow. The rarest reptile in Britain is the sand lizard, restricted to just a few heathland sites in southern England and Merseyside. On farmland, the reptile most likely to be encountered is the grass snake. This beautiful snake is a good swimmer and may often be found close to fresh water, basking or hunting on pond edges and ditch banks.

Reptiles are ectothermic, meaning that they need external warmth to raise their body temperature to levels sufficient for optimal activity. They thus require warm, relatively open habitats, with a high degree of structural diversity of vegetation, to provide the conditions needed for basking and shelter under a range of ambient temperatures. On farmland, hedgerows, ditches and ditch banks, stone walls, meadows, orchards, field margins, ponds and manure heaps can all provide habitat for the widespread reptiles (Box 26). Field margins should be managed as rough grassland or scrub, and grassland areas should be maintained by winter cutting every one to three years. A scattered scrub habitat (a mix of rough grassland and scrub), and scrub growth along the edges of hedgerows and woodland, are particularly beneficial.

Rank grass and brambles will benefit grass snakes
© Chris Gleed-Owen

Manure heaps and rotting hay bales are good for reptiles
© Chris Gleed-Owen

Field margins and hedgerows are important corridors for reptiles © Chris Gleed-Owen

During the winter, reptiles will hibernate, either singly or communally. Old animal burrows, rotted tree stumps, or under debris or fallen logs are examples of suitable hibernation sites; sites will nearly always be south-facing, in full or partial sun, and must be free from flooding. As well as hibernation sites, Britain's only egg-laying snake, the grass snake, needs decomposing material such as manure or compost heaps in which to lay its eggs. The other British reptiles incubate their eggs internally.

Enough of the right sort of habitat must always be present, especially on isolated sites. Reptiles have limited dispersal abilities so, if management such as scrub removal or intensive grazing affects the whole of a site at the same time, they may be unable either to escape the harmful impacts of these operations or to recolonise isolated sites at a later date. Linking patches of suitable habitat by favourable management of intervening habitat, either as continuous blocks, or as corridors such as hedgerows, field margins, boundary banks and forest rides, is especially important. For example, sympathetically managed hedgerow edges and sunny field margins will help provide linked habitat networks for reptiles and other wildlife.

As relatively sedentary predators, the presence of reptile populations indicates favourable management for a range of other species. All British reptiles consume animal prey: slow-worms eat soft-bodied invertebrates such as slugs and worms, legged lizards favour insects and spiders, while grass snakes feed primarily on amphibians and fish. If reptiles can thrive on a site, then so too will many other creatures requiring warm microhabitats or living within the diverse vegetation structures needed by reptiles. Managing habitats for reptiles will help increase overall biodiversity.

Common toads © Rosie Salazar

Toads in the Upper Thames region

Adult toads visit water bodies such as ponds, lakes and even slow flowing streams or rivers for just a few days or weeks during spring to mate and deposit toad spawn. For the rest of the year toads are almost exclusively terrestrial, typically dispersing 400-1500m from their breeding pond.

During spring 2010, more than 20 sites (incorporating around 75 water bodies across the Upper Thames catchment) were visited and surveyed for toads, toad tadpoles or toad spawn. The ponds were searched using direct visual observation or binoculars as required (during daytime) and by torchlight (at night). Potential terrestrial refugia in the vicinity of ponds, such as logs or substantial litter (e.g. carpets, tyres, metal sheeting etc.) were also examined.

Of the 75 water bodies surveyed, only 9 (at 7 sites) contained adult toads, toad spawn or toad tadpoles (historical records and recent sightings of toads were reported for some of the other water bodies). This level of waterbody occupancy was comparable with findings from other contemporary studies in lowland farmland. The survey identified important toad breeding sites within the Upper Thames although the future for toad populations at some of these ponds is by no means certain.

Key results

- **Ponds can be surveyed for toads in the spring, when they visit to breed**
- **In the Upper Thames, toads were recorded at only 9 out of 75 ponds**
- **This result is similar to other surveys of farmland ponds**

Future work may show it is possible to identify individual toads from their wart and belly patterns © Rosie Salazar

Grass snake © Peter Wakely/Natural England

Use of ditches and hedgerows by amphibians and reptiles

Some agri-environment scheme management options have the potential to provide good habitat for reptiles, in the form of a mosaic of refuges and areas to forage and bask. Examples include field margins, ditches and hedgerows in arable fields. Amphibians may also benefit from these options, as well as those relating to buffering of ponds. Data on the use of farmland habitats by declining reptile and amphibian species is crucial for informing future management plans and remedial action.

We conducted a pilot study to look at the frequency with which amphibians and reptiles use different combinations of field boundaries, including ditches, field margins and hedgerows (focusing mainly on the common toad and grass snake). A total of 51 lines of refugia (pieces of carpet or roofing felt) were set along field boundaries and checked between May and October 2011, following guidelines set out by the National Amphibian and Reptile Recording Scheme.

There were 37 sightings of grass snake recorded, 24 common lizard, 10 of common toad and one adder adjacent to the refugia, providing good evidence that these farmland habitats are potentially very important for reptiles and amphibians. These data will be used to determine in more detail whether the presence or absence of hedgerows and ditches affect the frequency with which amphibians and reptiles use the refugia lines.

Key results

- **Knowledge of farmland habitat use is crucial for reptile and amphibian conservation**
- **Reptiles and amphibians can be surveyed using refugia (following guidelines)**
- **Grass snakes, lizards and toads were all found to use field boundary habitats**

Common lizards were found on field margins © Rosie Salazar

Amphibians & reptiles

Management summary		
	Key habitats	Key actions
Amphibians	• Ponds and ditches	Follow guidelines for creation of good wildlife ponds and ditch management Ponds with warm, sunny aspects will especially benefit amphibians
	• Terrestrial habitats	Areas of tussocky grasses, field and woodland edges, and linear features through the landscape, will help frogs, toads and newts
Reptiles	• Vegetation structure	Manage for a variable structure with a mixture of vegetation heights, scrub, tangled areas, bare patches, lots of edges and good basking places
	• Aspect	Sunny, sheltered locations are important
	• Connectivity	Create and maintain continuous, linked, or close patches of suitable habitat

Options especially relevant for amphibians & reptiles		
Code	ELS/OELS options	ELS/OELS points
EB1/OB1	Hedgerow management for landscape (on both sides of a hedge)	16 per 100m
EB2/OB2	Hedgerow management for landscape (on one side of a hedge)	8 per 100m
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB6/OB6	Ditch management	24 per 100m
EB7/OB7	Half ditch management	8 per 100m
EB8/OB8	Combined hedge and ditch management (incorporating EB1/OB1 Hedgerow management for landscape on both sides of a hedge)	38 per 100m
EB9/OB9	Combined hedge and ditch management (incorporating EB2/OB2 Hedgerow management for landscape on one side of a hedge)	26 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
EE1-3	2/4/6m buffer strips on cultivated land	255/340/340 per ha
OE1-3	2/4/6m buffer strips on rotational land	340/425/425 per ha
EE7/OE7	Buffering in-field ponds in improved permanent grassland/organic grassland	400/500 per ha
EE8/OE8	Buffering in-field ponds in arable land/rotational land	400/500 per ha
EC4/OC4	Management of woodland edges	380 per ha
HLS code	HLS options	Payment (£)
HB14	Management of ditches of very high environmental value	£36 per 100m
HC15	Maintenance of successional areas and scrub	£100 per ha
HC16	Restoration of successional areas and scrub	£100 per ha
HC17	Creation of successional areas and scrub	£100 per ha

Find out more at:
www.arc-trust.org (Amphibian and Reptile Conservation)
www.narrs.org.uk (National Amphibian and Reptile Recording Scheme; also for submission of records)
www.pondconservation.org.uk

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

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.

The hazel dormouse (above) needs mature hedgerows and species-rich woodland for foraging and building nests (below)

Habitat management

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 than 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.

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

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.

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

Field margins and ditches

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

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

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

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.

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.

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.

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 mouse nest
© PTES

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	• 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	Benefits all small mammals Encourages fruit/berry production Facilitates movement of small mammals through the landscape
Arable field margins and beetle banks	• Create grassy or grass and wildflower field margin swards and cut infrequently • Margins situated next to hedgerows and ditches especially valuable	Enhances plant, seed and invertebrate food supplies Diversity of habitats increases small mammal diversity
Ditches	• Maintain ditches - manage banks on rotation similar to field margins and maintain water levels where possible	Particularly beneficial for water shrew and yellow-necked mouse
Crops and grassland	• Reduce fertiliser, herbicide, insecticide and molluscicide inputs • Create conservation headlands • Reduce stocking densities in grassland	Especially benefits wood mouse, harvest mouse, common and pygmy shrews and field vole (grassland)
Woodland	• Maintain woodlots in the farmed landscape • Diversity of native tree and shrub species especially beneficial • Manage by coppicing	Especially benefits dormouse, yellow-necked mouse and bank vole

Options especially relevant for small mammals		
Code	ELS/OELS options	ELS/OELS points
EB1/OB1	Hedgerow management for landscape (on both sides of a hedge)	16 per 100m
EB2/OB2	Hedgerow management for landscape (on one side of a hedge)	8 per 100m
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
EE1-3	2/4/6m buffer strips on cultivated land	255/340/340/ha
OE1-3	2/4/6m buffer strips on rotational land	340/425/425/ha
EF7/OF7	Beetle banks	580/750 per ha
EF9	Cereal headlands for birds	100 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EC3/OC3	Maintenance of woodland fences	4 per 100m
EC4/OC4	Management of woodland edges	380 per ha
HLS code	HLS options	Payment (£)
HB11	Management of hedgerows of very high environmental value (both sides)	£54 per 100m
HB12	Management of hedgerows of very high environmental value (one side)	£27 per 100m
HC7	Maintenance of woodland	£100 per ha
HC8	Restoration of woodland	£100 per ha

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 numbers have plummeted
© Peter G Trimming CC BY 2.0

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 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 predates water voles
© Peter G Trimming CC BY 2.0

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 re-instated - 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

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

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, 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.

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

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

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.

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.

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**

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

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.

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**

Mink being monitored using a raft trap © Rob Strachan

Water voles & otters

Management summary		
	Key actions	Potential benefits
Bankside management	• Use fencing to restrict access and protect watercourses from heavy use by stock	Water voles need dense bank vegetation
	• Manage by topping or light grazing every couple of years	Prevents scrubbing over
	• Establish buffer strips next to watercourses on arable land or ungrazed strips in livestock areas	Provides a greater complexity of water vole habitat and thicker vegetation; reduces siltation and pollution in the river
River management	• Leave mature trees with good root plates, and root plates of fallen trees	Provides resting sites for otters, good conditions for fish, reduces erosion and silting
	• Pollard trees where management is required; any clearing should be infrequent and one bank only, in winter	Reduces disturbance, otters will rest in pollarded crowns
Wider land management	• Keep pesticides, fertilizers and other inputs away from rivers and streams	Good water quality is crucial for water voles, otters and other wildlife
	• Maintain or restore connected wetland habitats such as ditches, wet meadows and woodland, and ponds	A mosaic of connected wetland habitats will support water voles, otters and a range of other species
Mink control	• Use mink rafts as a humane method for monitoring and controlling mink	Mink control is essential for water vole conservation

Options especially relevant for water voles & otters		
Code	ELS/OELS options	ELS/OELS points
EB6/OB6	Ditch management	24 per 100m
EB7/OB7	Half ditch management	8 per 100m
EB8/OB8	Combined hedge and ditch management (incorporating EB1/OB1 Hedgerow management for landscape on both sides of a hedge)	38 per 100m
EB9/OB9	Combined hedge and ditch management (incorporating EB2/OB2 Hedgerow management for landscape on one side of a hedge)	26 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Hedgerow management for landscape and wildlife)	56 per 100m
EE7/OE7	Buffering in-field ponds in improved permanent grassland/organic grassland	400/500 per ha
EE8/OE8	Buffering in-field ponds in arable land/rotational land	400/500 per ha
EE9/OE9	6m buffer strips on cultivated/rotational land next to a watercourse	400/500 per ha
EE10/OE10	6m buffer strips on intensive/organic grassland next to a watercourse	400/500 per ha
EJ9/OJ9	12m buffer strips for watercourses on cultivated land/rotational land	400/500 per ha
EJ11/OJ11	Maintenance of watercourse fencing	4 per 100m
HLS code	HLS options	Payment (£)
HB14	Management of ditches of very high environmental value	£36 per 100m

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

Brown hare © Frank Vassen CC BY 2.0

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 Environmental Stewardship options will benefit hares**

Brown hare

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

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.

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

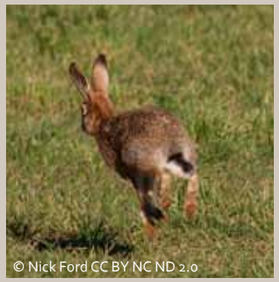
Hares are vulnerable to farm operations
© Cornishdave CC BY NC ND 2.0

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

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



© Nick Ford CC BY NC ND 2.0

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.

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 Hillewaert CC BY SA 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.

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

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

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	• A mix of crops such as wheat and beet, with some grass is good for hares. Overwintered stubbles are especially valuable.	Hares can find food and cover at different times of year.
	• Beetle banks or strips of grass across arable fields are valuable, also taking field corners out of management	Provide extra cover for hares
	• Plant game cover and wild bird seed crops	Helps provide food and cover for hares and other wildlife
Grassland	• Try to leave some areas uncut and/or ungrazed	Provides areas for leverets to hide
	• When making silage, cut from the field centre outwards	Allows hares to escape the farm machinery
Landscape	• Hares thrive in mix of arable and grass fields and non-cropped areas such as small woodlands	Provides food and cover for hares throughout the year

Options especially relevant for brown hare		
Code	ELS/OELS options	ELS/OELS points
EF2/OF2	Wild bird seed mixture	450/550 per ha
EF6/OF6	Overwintered stubbles	120/150 per ha
EF7/OF7	Beetle banks	580/750 per ha
EF9	Cereal headlands for birds	100 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EF13/OF13	Uncropped, cultivated areas for ground nesting birds on arable land	360 per ha
EF15	Reduced herbicide, cereal crops followed by overwintered stubbles	195 per ha
EF22	Extended overwintered stubbles	410 per ha
EG1/OG1	Undersown spring cereals	200/150 per ha
EG4/OG4	Cereals for whole crop silage followed by overwintered stubbles	230/250 per ha
EJ13/OJ13	Winter cover crops	65 per ha
EK1/OK1	Take field corners out of management	400/500 per ha
HLS code	HLS options	Payment (£)
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HG7	Low input spring cereal to retain or re-create an arable mosaic	£250 per ha

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

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

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.

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

Natterers' bats can glean prey from dense foliage © Keith Cohen

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

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.

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

Bats fly along treelines and tall hedgerows to cross the landscape

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

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 pipstrelle. 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

Caves are used by hibernating greater horsehoe bats

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 treelines 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	• 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	Many bats feed or rely on emergent aquatic invertebrates. Different bat species prefer to hunt in different ways Will encourage abundant invertebrate prey
Woodland	• 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	Provides roosting and foraging opportunities for many bats Some rarer bats are predominantly woodland species
Grassland	• Cattle grazed pasture especially important • Reduce inputs and vary vegetation height and structure; retain hedgerows	Encourages a rich insect fauna for bats to feed on
Treelines, hedgerow trees & tall hedges	• Retain treelines, protect hedgerow trees, allow hedges to grow tall	Linear features are important for helping bats move through the landscape, and can be rich feeding areas

Options especially relevant for bats		
Code	ELS/OELS options	ELS/OELS points
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EB6/OB6	Ditch management	24 per 100m
EB7/OB7	Half ditch management	8 per 100m
EB10/OB10	Combined hedge and ditch management (incorporating EB3/OB3 Enhanced hedgerow management)	56 per 100m
EC1/EC2	Protection of in-field trees on arable land/grassland	16/11 per tree
OC1/OC2	Protection of in-field trees on rotational land/organic grassland	16/11 per tree
EC4/OC4	Management of woodland edges	380 per ha
EC23/OC23	Establishment of hedgerow trees by tagging	1 per tree
EC24/OC24	Hedgerow tree buffer strips on cultivated/rotational land	400/500 per ha
EC25/OC25	Hedgerow tree buffer strips on grassland/organic grassland	400/500 per ha
EE1-EE10	All other buffer strip options	255-400 per ha
OE1-OE10	All other organic buffer strip options	340-500 per ha
HLS code	HLS options	Payment (£)
HB11/12	Management of hedgerows of very high environmental value (both sides/one side)	£54/27 per 100m
HB14	Management of ditches of very high environmental value	£36 per 100m
HQ1/2	Maintenance of ponds of high wildlife value (less than 100m²/more than 100m²)	£90/180 per pond

Find out more at:
www.bats.org.uk (Including directory of local bat groups across the UK)
www.naturalengland.org.uk www.ptes.org

Tree sparrow © Peter Roworth/Natural England

Birds

Over the last 40 years, many farmland bird populations have declined steeply, caused by the loss of nesting habitats and insect rich foraging habitats, and a decrease in supplies of seeds during the winter and early spring. The farmland bird package is a range of management measures which can help farmland birds when they are put in place across the landscape.

Key points

- **Farmland birds are continuing to decline**
- **They need safe nesting habitat, summer food and winter food (provided by seed and insect-rich areas): these are often referred to as the 'big three' for farmland birds.**
- **A range of measures, supported by agri-environment scheme funding, can help provide these requirements**

Birds

Starlings declined by 68% between 1970 and 2007 © Miles Wolstenholme

Farmland birds have three basic requirements: they need safe nesting habitat, food in summer and food in winter. The reduction in availability of these resources is believed to be responsible for the great declines in farmland birds.

Birds that have declined particularly steeply on farmland are seed-eating birds associated with arable farming that require abundant seed food throughout the winter and early spring. Many of these birds also require plentiful insect food during the spring and summer on which to feed their chicks. Lowland arable and mixed farms can support important populations of these seed-eating birds, and the key habitats to create for them are those that will be rich in insects and seeds throughout the year. This will encourage species such as grey partridge, lapwing, turtle dove, skylark, yellow wagtail, tree sparrow, linnet and corn bunting.

Curlew need sensitive grassland management © Hilary Chambers CC BY ND 2.0

Other birds, such as starlings, feed on soil invertebrates throughout the year, and lowland farms with grassland (particularly where it is grazed by cattle) often have good populations of these birds. Farms with wet grassland may have populations of breeding waders, such as lapwing, curlew, redshank and snipe, which require sensitive grassland management and the creation and/or maintenance of shallow wet features to provide nesting and feeding habitat. Other wetland features such as ponds and ditches are very valuable habitats for providing insect and seed food on all types of farm.

Chiff-chaff nest in tussocky vegetation at the base of a hedge © Rob Wolton, Hedgelink

Farmland birds will use a variety of habitats for nesting, depending on the species. For example, yellowhammers nest on or close to the ground in ditch vegetation or at the base of short, thick hedgerows and scrub, while skylarks nest in arable or late-cut hay or silage vegetation that is 20-50cm high, open enough to allow easy access to the ground, and at least 10m away from field boundaries. Lapwings may also nest in spring crops or on fallow plots.

A range of habitats will provide most resources for farmland birds © Rosalind Shaw

Mature trees and hedgerows are very important for many farmland birds © Rob Wolton, Hedgelink

Cattle grazing helps soil invertebrate feeders, e.g. song thrush © Rob Wolton, Hedgelink

Habitat management

Over the farm as a whole, the more different habitats there are, including arable, grassland and non-cropped areas (such as ditches, hedgerows, woodland and field margins), the more the farm will be able to support an abundant and diverse bird community. However, management for certain species will exclude other species, so management options should be targeted carefully. For example, hedgerow management which encourages large, tall hedgerows should be targeted away from areas where breeding waders are located, since these birds require more open habitats.

Non-cropped habitats

Hedgerows, woodland and scrub, field margins and ditches are some of the non-cropped habitats that are of great importance for birds on farmland, providing seed and invertebrate food, shelter and nesting sites. Birds will benefit from conservation management of all these habitats.

On farmland, many birds depend on hedgerows, with at least 30 species making use of hedgerows for nesting. Different bird species have different requirements (Box 35), so hedgerows should be managed to provide a variety of heights and types around the farm. Allowing hedges to flower and fruit by trimming not more than once every three years will help them provide the most fruit, seed and insect food for birds. Hedges that are adjacent to tussocky grass margins or ditches are particularly beneficial. Patches of woodland and scrub provide nest sites, food and shelter for a range of farmland birds, including song thrush and linnet. Where these patches are linked by good quality hedgerows they will be especially valuable.

Field margin management that enhances seed production and invertebrate numbers will benefit birds. Tussocky grass margins encourage overwintering invertebrates and provide nesting habitat for game birds, and wide grass margins next to thick hedgerows provide ideal nesting sites for yellowhammers and whitethroats. Wildflower-rich margins will further increase seed supplies and encourage pollinators, which are also food for birds. All farmland birds will make use of wetland features such as ditches or ponds, as these provide water for drinking and bathing, as well as being rich sources of food.

Birds

Wet grasslands are important for lapwing

Winter stubbles provide food resources for wildlife in the form of seeds and invertebrates

Linnets are one of the species helped by overwinter stubbles

Grassland

Grassland management that increases the abundance of invertebrates and seed will be particularly beneficial to birds. Birds differ greatly in their requirements: grazed pasture is favoured by birds that require short swards for nesting or feeding, while others prefer tall cover and will use meadows. The timing of mowing is particularly critical, since cutting for hay or silage too early threatens nests and chicks of ground-nesting birds, and may also reduce food supplies by preventing plants from flowering and setting seed. Species-rich hay meadows are rich in wildlife and their long-established management should be maintained.

Well-managed wet grasslands provide wintering and/or breeding habitat for wading birds and wildfowl. Waders such as snipe, redshank and lapwing need damp soil conditions, with some areas of shallow standing water in spring and early summer, to provide insect food for their chicks. These can be provided through the creation of scrapes (shallow depressions with gently sloping edges), which seasonally hold water. Grassland management is also important: lapwing prefer a short but varied sward while redshank prefer more tussocks within a varied short sward - best achieved by cattle grazing. Hedgerow management, including pollarding, is also important since waders prefer open habitats which lack predator perches. As with hay meadows, species-rich floodplain meadow management should be continued in the traditional way.

Cropped areas

A number of options are available for more specific habitat management for birds on the cropped areas of the farm. These include over-wintered stubbles, wild bird seed mixtures, conservation headlands and skylark plots.

Overwinter stubbles

Leaving stubbles over winter provides spilt grain and broad-leaved weed seeds, supplying important winter food. Birds that will benefit include grey partridge (Box 36), skylark, tree sparrow, linnet and yellowhammer. Arable plants most beneficial to birds in this situation tend not to be competitive weeds, but species such as chickweed, fat-hen and knotgrass. Spring barley stubble is especially good for farmland birds, but wheat stubble, and stubble of rape and linseed, may also provide abundant seeds, especially if they are weedy. If possible, aim for a variety of stubble heights around the farm. Tall stubble provides cover from predators for game birds and skylarks, while sparrows, finches and buntings prefer to feed in shorter stubble for better visibility.

Skylarks find foraging easier in sparse vegetation (above) which in turn can help increase the number of chicks they can rear (below).

Wild bird mixtures

Wild bird seed mixtures are an unharvested mix of seed-bearing crops that can provide vital food for seed-eating birds throughout the winter. They are particularly important in areas where traditional food sources, such as weedy stubbles, are no longer available. An annual cereal-based mix will provide the most reliable food source for yellowhammers and corn buntings, while gamebirds will make more use of kale-based biennial mixtures. A mix including a cereal and an oil-rich crop (e.g. kale, linseed or quinoa) will benefit the widest range of species.

Conservation headlands

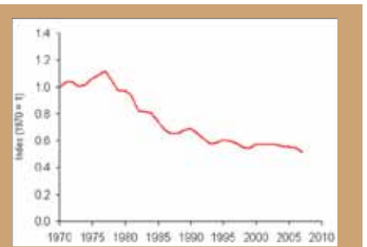
Conservation headlands are headlands of cereal crops that are not fertilised, and only sprayed with selective herbicides for grass weeds. The small populations of broad-leaved plants, together with their insect communities, provide increased food for birds that feed in the crop edge, such as grey partridge. Conservation headlands are best suited to light soils which are not infested with competitive weeds, and are best situated next to tussocky margins or grass and wildflower margins.

Skylark plots

Skylark plots are undrilled or sprayed-out patches in winter cereal fields that are used as feeding areas. Finding food can be a challenge for skylarks as winter cereals become taller and thicker, so the aim of skylark plots is to create sparse patches within the crop that make it easier for the birds to forage. This in turn can increase the number of chicks that skylarks can rear. Skylark plots are especially important where there is no spring cropping.

What is the Farmland Bird Indicator?

Farmland birds are used as an indicator of the general quality of the farmed environment, because birds sit near the top of the food chain, and their population trends have been well monitored by the British Trust for Ornithology since 1967. The Farmland Bird Indicator is made up of 19 species that are dependent on farmland. The graph shows an index based on the combined population trends of these 19 species. Between the mid-1970s and the mid-1980s the steepest declines in farmland birds occurred, with a shallower decline since then. The turtle dove, grey partridge, corn bunting and tree sparrow have declined by over 80 per cent. The overall average change for the 19 species is a 48% decline since 1970.



The Farmland Bird Index shows how farmland birds have declined since the 1970s.

Hedgerows are important for the declining yellowhammer © Mark Kilner CC BY NC SA 2.0

Hedgerow features important for farmland birds

Hedgerows are an essential habitat for many birds on farmland, providing food, shelter and nest sites.

We surveyed 266 hedgerows in Buckinghamshire, recording their height, width, gappiness and whether or not they had mature trees. We surveyed the same hedgerows for birds and analysed the data to see which types were best for them.

The single most important feature of the hedgerow for birds was its height. Bird numbers, species diversity and nest density all increased with higher hedgerows, up to a height of 3m. Bird diversity dropped sharply when hedges fell below 2m. This suggests that 2-3m is a critical height for hedgerows, below which their value to birds may be diminished, but above which there is little further benefit to birds. Hedge trimming may not necessarily be detrimental, as long as it does not lower the hedge below this threshold.

Mature trees within hedgerows were beneficial, providing shelter, nest sites, singing posts and food. Gappy hedgerows were a poor habitat for birds, emphasising the need for regular hedgerow maintenance.

Key results

- **Hedgerow height is important for birds: hedgerows should be 2-3metres tall**
- **Hedgerows with mature trees have more birds**
- **Maintaining hedgerows to reduce gaps helps bird populations**

Chaffinches nest in hedges
©Rob Wolton, Hedgelink

Grey partridge © Marek Szczepanek CC BY SA 3.0

Improving the survival of grey partridge

Once common in the English countryside, the grey partridge has undergone a dramatic decline in numbers, with a staggering 88% population decrease between 1967 and 2006.

One way in which populations of this traditional gamebird could be increased is through releases of birds that have been bred in captivity. We studied grey partridge behaviour to find out whether survival rates of released partridges could be improved. We found that partridges released as coveys (family groups) in autumn had lower mortality rates than those released as pairs in spring. The autumn releases used game covers more than in spring, suggesting these habitats could be used to induce settlement onto the release areas. Supplementary feeding could also be concentrated in these areas.

Covey stability was an important factor affecting survival. Stable coveys were more vigilant, more likely to fly to roost and had lower mortality. Rearing practices should therefore promote strong social bonds in grey partridge coveys and avoid early pairing if possible. In addition, autumn releases of coveys should not take place too late in the year and hence too close to the eventual pairing, so that the released birds would have the protection of their covey at least through the first few weeks when mortality rates are highest.

Key results

- **Release grey partridges as coveys in autumn rather than as pairs in spring**
- **Rearing practices should promote strong social bonds in grey partridge coveys**
- **Avoid early pairing if possible**

Radio-tagged grey partridge
© Elina Rantanen

Birds

Management summary		
	Key habitats	Potential benefits
Non-cropped habitats and grassland	• Field margins	Tussocky and wildflower-rich margins enhance invertebrate numbers and seed supplies
	• Hedgerows	Provide fruit, seed and invertebrate food, shelter and nest sites
	• Woodland and scrub	Coppiced woodland and woodland edge habitats are important for farmland birds
	• Grassland	Where possible, manage to increase seed and invertebrate food
	• Wetland features	Rich sources of plant and invertebrate food
Cropped areas	• Wild bird mixes	Provides food for seed and invertebrate feeding birds
	• Overwinter stubbles	Helps supply seed for birds over winter
	• Conservation headlands	Increases seed and invertebrate food
	• Skylark plots	Creates accessible foraging areas for skylarks in winter cereals

Options especially relevant for birds		
Code	ELS/OELS options	ELS/OELS points
EB3/OB3	Hedgerow management for landscape and wildlife	42 per 100m
EC4/OC4	Management of woodland edges	380 per ha
EF2/OF2	Wild bird seed mixture	450/550 per ha
EF6/OF6	Overwintered stubble	120/150 per ha
EF7/OF7	Beetle banks	580/750 per ha
EF8/OF8	Skylark plots	5 per plot
EF9	Cereal headlands for birds	100 per ha
EF10	Unharvested cereal headlands for birds and rare arable plants	330 per ha
EF13/OF13	Uncropped cultivated areas for ground-nesting birds on arable land	360 per ha
EF15	Reduced herbicide cereal crops followed by overwintered stubble	195 per ha
EF22	Extended overwintered stubble	410 per ha
EF23/OF23	Supplementary feeding in winter for farmland birds	630/612 per tonne
EG1/OG1	Undersown spring cereals	200/150 per ha
EG4/OG4	Cereals for whole-crop silage followed by overwintered stubble	230/250 per ha
HLS code	HLS options	Payment (£)
HC15/16/17	Maintenance/restoration/creation of successional areas and scrub	£100 per ha
HF14	Unharvested, fertiliser-free conservation headland	£440 per ha
HF12	Enhanced wild bird seed mix plots (rotational or non-rotational)	£475 per ha
HG6	Fodder crop management to retain or recreate an arable mosaic	£150 per ha
HG7	Low-input spring cereal to retain or recreate an arable mosaic	£250 per ha
HK9/11	Maintenance/restoration of wet grassland for breeding waders	£335 per ha
HK10/12	Maintenance/restoration of wet grassland for wintering waders and wildfowl	£255 per ha
HK13/14	Creation of wet grassland for breeding waders/wintering waders and wildfowl	£355/285 per ha

Find out more at:
www.rspb.org.uk www.bto.org www.wwt.org.uk www.naturalengland.org.uk www.gwct.org.uk

Small tortoiseshell © Peter Roworth/Natural England

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WILDCRU
Wildlife Conservation Research Unit

The mission of the Wildlife Conservation Research Unit (WildCRU) is to achieve practical solutions to conservation problems through original scientific research.

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