2 Learning more about your woodland and its wildlife

Before embarking on a programme of woodland management, it is useful to find out as much about the wildlife in your wood as possible. It is especially important to recognise whether any European Protected Species or other species of conservation concern are present and to help protect them if any management operations are undertaken. If your wood is part of a much larger block of woodland, it would also be worthwhile learning something about the wildlife in the woodland as a whole, so permission may be required to enter these areas. Whilst it is entirely possible to devise a conservation management plan based on a single compartment, it is much better if this takes account of the whole wood, and even better if the management of other compartments can be coordinated with other woodland owners.

Learning about the wildlife living in your wood can be a particularly enjoyable experience, especially if you are involved in surveys yourself. In the following accounts we introduce different groups of woodland flora and fauna, including some guidance on survey methods which might be used to learn more about your wood. Many of these methods are derived from more sophisticated survey techniques which are described more fully in other publications. Depending on your experience, you should be able to undertake some surveys yourself, although others may require specialist assistance, or may not be necessary for your wood. When it comes to identifying difficult groups such as lichens, the decision to survey your wood really depends on your own curiosity and motivation. In some areas, you may find that local specialist wildlife groups might be willing to undertake a survey for you for no charge, particularly if there may be species of conservation concern present. On the west coast of Scotland for example, where oak woods are rich in epiphytic lichens and mosses, you may have little problem in persuading local enthusiasts to carry out a survey. In lowland Britain, local bat groups may be keen to survey mature woods where specialist woodland bats might occur.

2.1 Woodland plants

The sites of ancient woods have been continuously wooded since medieval times (pre-dating 1600 AD), and in some cases may even be survivors of the wildwood itself, although all have been managed and modified at different times. Despite this interference, it is possible that the plant communities of the ancient woodland floor may have changed little in that time, and may therefore be considered as essentially semi-natural. Plants that typify ancient woodland are those which are not normally found in other habitats, although some may have survived woodland clearance where the original woodland edge has remained as a hedgerow. It is the general characteristics of most ancient woodland plants which restrict them to this habitat. These include poor dispersal mechanisms; production of few seeds which do not remain viable in the seed bank; a reliance on vegetative propagation; and limited competitive ability.

These ancient woodland plants are sometimes referred to as ancient woodland 'indicator' species (Table 2.1) and are used by ecologists to ascertain whether a wood is likely to be ancient or more recent. It is relatively easy for you to investigate the history of your wood in this way. However, some care is needed because not all ancient woodland plants are restricted to ancient woodland and some which are good indicators in one region may be more widely distributed in others. For example, marsh violet and golden-rod are classed as indicator plants in South East England, but not in East Anglia. Hedge woundwort and herb Robert are indicators of ancient woodland in Scotland, although they are cosmopolitan species south of the border. A final important point is that the presence of a small number of

ancient woodland plants is not a reliable indication of the age of a wood. If more species are present, this increases confidence that one is looking at ancient woodland, although there are no specific rules or limits. Other historical evidence may also be used to identify ancient woodland, such as wood banks and pollards.

Table 2.1
Examples of plants which are most strongly associated with ancient woods in Britain.

Bird's-nest orchid	Hay-scented buckler-fern	Sweet woodruff
Butcher's-broom	Herb Paris	Wild service-tree
Columbine	Lily-of-the-valley	Wood goldilocks
Cow-wheat	Midland hawthorn	Wood meadow-grass
Crab apple	Moschatel	Wood melick
Early dog-violet	Nettle-leaved bellflower	Wood sedge
Hairy woodrush	Sanicle	

Some plants are tolerant of a range of soil types and are widespread in ancient woodland whereas others have quite specific requirements of soil conditions and shade. For example, bracken, creeping soft-grass, wavy hair-grass and marsh violet are found on acid woodland soils; oxlip, lady orchid and early dog-violet on basic soils. Bluebell and wood anemone are primarily plants of mildly acid conditions, but will tolerate a wide range of pH; similarly, dog's-mercury is a plant of calcareous soils which is also pH-tolerant.

Because soil type and soil conditions vary, it is not unusual to find many different plant communities within a single wood. For example, if you own a wood in southern England situated predominantly on chalk downland, it may extend onto deposits of clay drift, while further variation in soil conditions might be brought about by even slight changes in slope and drainage. The woodland ground flora on the chalky soils may be dominated by dog's-mercury, with species such as yellow archangel and nettle-leaved bellflower, but on areas of clay drift these may be replaced by bluebell, wavy hair-grass and hard fern. This example also

Midland hawthorn has a strong affinity for ancient woodland, it can be distinguished from hawthorn by the leaf shape (see inset, not to scale), although hybrids do occur.

illustrates the fact that most woodland communities are dominated by one, or a few species, such as bluebell or dog's-mercury, whose structure influences the diversity and abundance of other species.

Very few woodland plants actually require shade and could more properly be classed as shade-evaders, leafing and flowering in the spring before the leafy canopy develops. Others which grow or persist when trees are in leaf are better classed as shade-tolerant. Some species such as wood vetch prefer the partial shade of woodland margins, whilst others, such as bluebell and pignut, are found both under the woodland canopy and in open grassland.

Plant communities in the woodland field layer also include species which are more mobile and therefore characteristic of more recent as well as ancient woodland. These species have highly effective dispersal mechanisms and in some cases also the ability to compete on more fertile soils. They include species such as black bryony, enchanter's-nightshade, sweet violet and lords-and-ladies (Table 2.2). Many other species, including those tolerant of partial shade and sun, are more likely to persist in the woodland seed bank.

Table 2.2
Woodland shade-tolerant plants with more efficient dispersal mechanisms which are often found in more recent woodland.

Black bryony	Giant fescue	Narrow buckler-fern
Bramble	Ground ivy	Raspberry
Broad buckler-fern	Hairy-brome	Red campion
Broad-leaved willowherb	Hedge woundwort	Sanicle
Common nettle	Herb Robert	Sweet violet
Common twayblade	Honeysuckle	Three-nerved sandwort
Dewberry	Ivy	Wood avens
Enchanter's-nightshade	Lords-and-ladies	Wood dock
False brome	Male-fern	

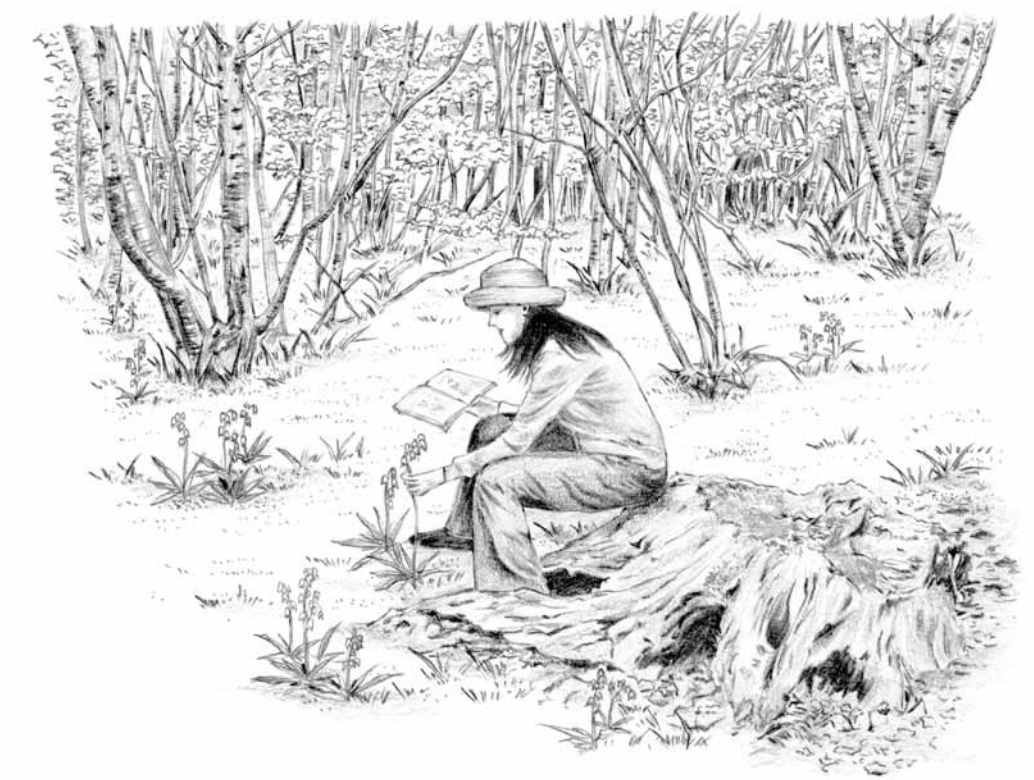
The common twayblade is an orchid which may be found in more recent woodland.

Other woodland plants are more characteristic of the woodland edge, and thrive in both partial shade and full sunlight. These include species such as cleavers, cow parsley, ground elder and nipplewort.

Plants of woodland rides and glades

How much open space is desirable in a wood? As a precedent, the amount present in the original 'wildwood' is a topic which is frequently discussed. Views often polarise towards one of two theories; that the wildwood contained large areas of open space, which may have been maintained by grazing herbivores; or that the wildwood was essentially a closed canopy forest, with smaller open areas associated with tree-fall gaps, for example. The true picture may lie somewhere in between, but this is not a topic which we will discuss in detail here. In more recent times, it is also difficult to quantify woodland open space, as it has rarely been recorded in the historical record. Rackham (1990) suggests that most woodland rides are likely to be post-medieval, and that woodland open spaces were used for sport and grazing.

Today rides, glades and woodland perimeters are very important components of mature woodland habitat (Section 4.1), particularly if they have a long history. More woodland herbs and grasses are likely to be associated with these areas than in the high forest itself. Open ground communities may be diverse, closely resembling species-rich grassland, heathland or marshy areas, although rarer species characteristic of these habitats may be absent. Species such as meadow buttercup, meadowsweet and tormentil are just as likely to be encountered in ancient woodland rides as in open grassland. Consequently, the importance of rides and glades in conservation terms should not be underestimated, and in some parts of Britain, some of the best examples of semi-natural grassland are to be found in ancient woodland rides.



Owner learning to identify woodland plants.

Survey methods
A lot can be learnt about the ground flora in your wood by identifying and recording flowering herbs and grasses through the spring and summer months, with the aid of a good field guide such as '*The Wildflower Key*' (Rose, 2006). Alternatively, woodland plants may be surveyed more formally using replicated quadrats placed in homogeneous areas of vegetation. In each quadrat, the species present and their cover should be recorded, noting any other species present in the environs. Surveys of the shade-tolerant plants of high forest or coppice woodland should be undertaken in spring, following the method of Hall *et al*. (2004). For rides and glades, surveys are best undertaken in mid-summer, when the majority of grasses and herbs are flowering. Homogeneous areas should again be selected, and surveys should be repeated if different communities are present, for example if heathland and grassland are present in different parts of the wood. Community types can be ascribed by reference to keys given in Rodwell (1991 *et seq*), or by using specialist computer programs.

2.2 **Woodland insects**

Old-growth ancient woodland supports more insects than any other habitat in Britain. This is due partly to its complex structure, resulting from the presence of 'old' trees, trees of different heights and ages, abundant deadwood on the ground and in the canopy, gaps in the high canopy, shrubby woodland margins and open sunny areas. Collectively, these habitats contain a large number of habitat niches for insects, including the following examples:

- living wood supports wood borers
- decaying wood on living trees, including damaged bark and roots support a diverse range of specialist insects
- fallen deadwood supports a specialist insect fauna
- fungi, soil, leaf litter and seepages in the ground support specialist insect faunas respectively
- bark is used for cover and by predators
- sap runs support specialist beetles and flies
- foliage of trees and shrubs is used by a very wide range of insect larvae
- flowers provide nectar
- gall-causing insects use roots
- climbers such as ivy provide food, cover and niches for hibernation
- mosses and liverworts provide cover.

Most insect families are represented in British woodland, some by a very large number of species; for example over 300 moth species can be found in an old oak wood. Trees and shrubs are particularly attractive to insects, but the number of species they can support varies enormously; top of the list are the willows, birches and oaks, each group known to support well over 400 insect species, many of which feed exclusively on the host tree. Other species such as blackthorn, hawthorn and alder also support a rich diversity of insects, although it is important to point out that not every individual tree or shrub, or small population will support all the insects known to use that species. At the other end of the spectrum elms, honeysuckle and yew support few insects, but they are still important components of a woodland community, because each hosts insects which feed exclusively upon them. Predatory and parasitic insects are also dependent on woodland plants, for the herbivorous insects upon which they prey.

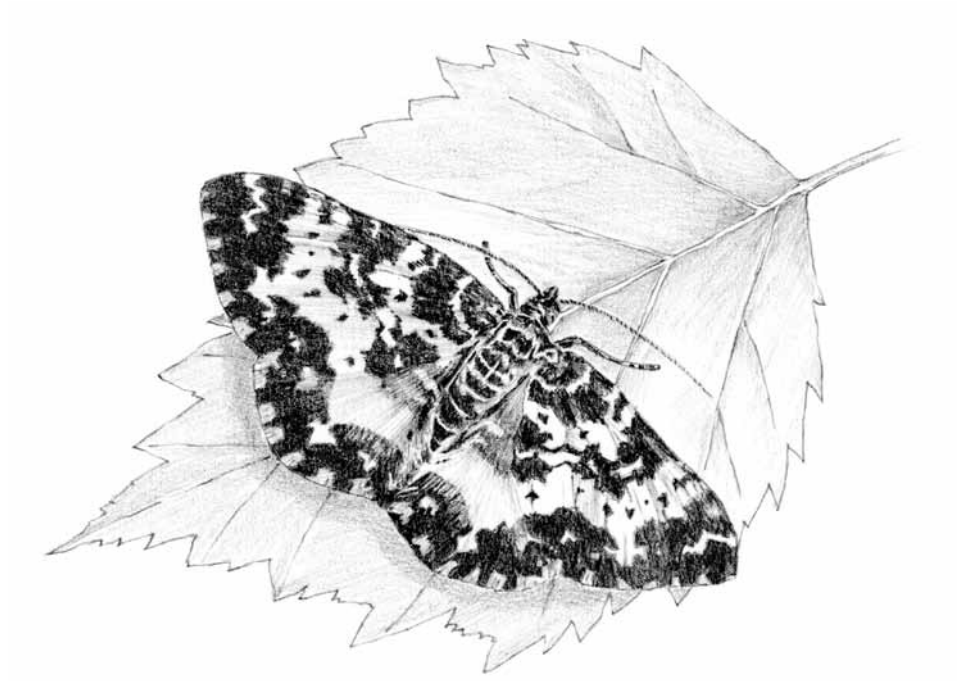
Rich assemblages of insects in old-growth woodland usually only survive where the habitat has benefitted from historical continuity of management. Many species are highly specialised, occupying particular habitat niches, which may vary with the insect's growth stage. Sadly, rich assemblages of woodland insects are now scarce, due to in part the loss of

native woodland, inappropriate management, conversion to chestnut coppice or conifers, and more recently to neglect.

Although there are many specialist habitat niches for insects in high forest; coppiced areas, shrubby woodland margins and open spaces in your wood are also important for insects and their predators. Insects make extensive use of shrubs, particularly dense clumps of bramble in sunny positions, patches of tall herbs and short turf, as the following examples illustrate:

- some insects are associated with lichens, algae and fungi growing on the bark of shrubs
- froghoppers and leafhoppers feed on plant sap
- a diverse range of insect larvae, such as moths, feed on leaves
- bumblebees and many other insect families feed on pollen and nectar
- purple emperor butterflies feed on aphid honeydew
- dragonflies and ants hunt along the woodland edge
- spiders use the vegetation to support webs
- leaf-cutter bees construct nests
- stem-nesting solitary wasps utilise bramble
- many insects including butterflies find shelter along the woodland edge
- a diverse range of adult insects bask on sunny woodland margins
- spiders hunt on bare ground.

Many insects which spend their larval stages in the damp shady conditions of the high forest, as adults require good quality woodland edge for basking and nectaring. Others may be associated with species-rich grasslands, but with the destruction of so much of this habitat, woodland open spaces may provide a refuge. Generalists, found in a wide range of habitat such as hedgerows, parks and gardens also use woodland margins and open spaces. When planning work in your woodland, it is important to bear in mind the value of these various habitats.



The argent and sable is a day-flying moth found in woodland open areas, easily recognised by its distinctive black and white pattern.

One of the few insect families which are relatively easy for you to observe and identify are butterflies. As well as being one of the most charismatic groups of woodland insects, butterflies are also widely recognised as indicators of ecosystem health. Surprisingly, the majority of butterflies found along woodland margins, and in sunny rides and glades are actually classified as 'wider countryside species' (Table 2.3). Wider countryside species are so called because they utilise habitat which is still widespread in the countryside, and many are relatively mobile. Some breed in colonies, and may therefore be resident in a wood. Others are more opportunistic, ranging widely across the landscape, breeding wherever suitable habitat presents itself. Despite these characteristics, many have declined in recent years, with white-letter hairstreak, small copper and small heath giving particular cause for concern.

Table 2.3
Wider countryside butterflies found in woodland habitats.

Small skipper	White-letter hairstreak [1, 2]	Comma
Essex skipper	Small copper	Speckled wood
Large skipper	Brown argus	Scotch argus
Brimstone	Common blue	Marbled white
Large white	Holly blue	Gatekeeper
Small white	Red admiral	Meadow brown
Green-veined white	Painted lady	Ringlet
Orange tip	Small tortoiseshell	Small heath [1, 2]
Purple hairstreak	Peacock	

[1] UK BAP priority species; [2] Red-listed species (Fox *et al*., 2010)

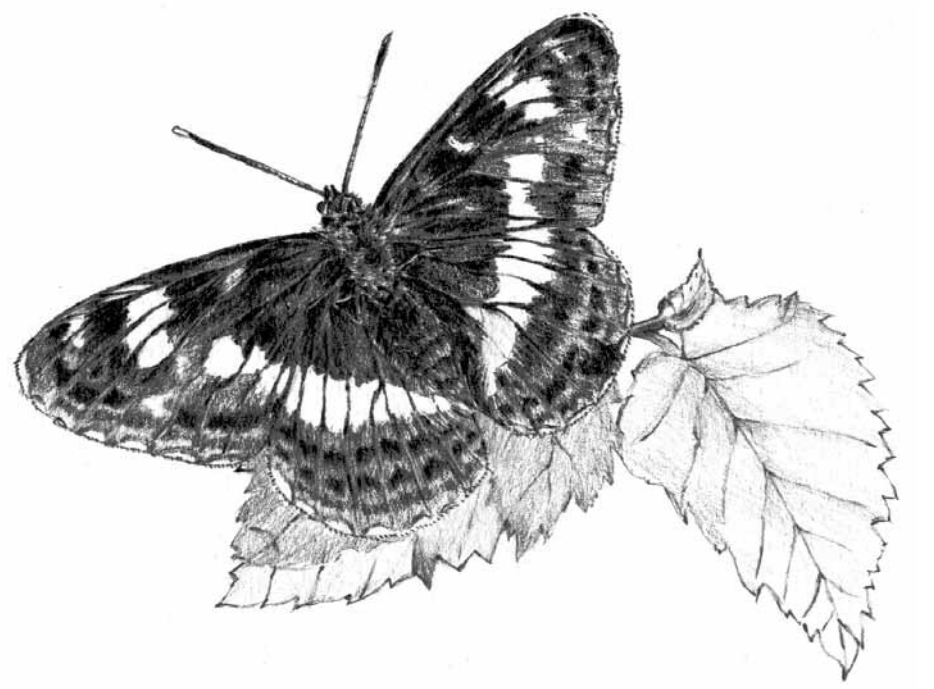
A second group of butterflies are classified as 'habitat specialists', as they require specific habitat types which tend to be localised and isolated, such as coppiced woodland or species-rich grassland (Table 2.4). These butterflies are relatively sedentary, and the larvae of most feed on just one or two foodplants. Most have suffered major range and/or population declines, and are on the UK Biodiversity Action Plan (BAP) priority list and the butterfly Red-list as a result.

Table 2.4
Habitat specialist butterflies found in woodland habitats.

Chequered skipper [1, 2]	Brown hairstreak [1, 2]	Small pearl-bordered fritillary [1, 2]
Dingy skipper [1, 2]	Black hairstreak [2]	Pearl-bordered fritillary [1, 2]
Grizzled skipper [1, 2]	Duke of Burgundy [1, 2]	High brown fritillary [1, 2]
Wood white [1, 2]	White admiral [1, 2]	Silver-washed fritillary
Green hairstreak	Purple emperor [2]	Heath fritillary [1, 2]

[1] UK BAP priority species; [2] Red-listed species (Fox *et al*., 2010)

Many habitat specialists which breed in woodland are also found in other habitats in the vicinity, including scrub, hedgerows, grassland or heathland. Others utilise different habitats in different parts of the country. Heath fritillary for example occurs in woodland open spaces in South East England but occupies sheltered heathland combes in the South West. Only wood white, black hairstreak, white admiral and silver-washed fritillary are predominantly woodland specialists.



The white admiral is a woodland specialist butterfly, here basking on elm leaves.

In woodlands, the majority of habitat specialists require woodland edge habitat, sunny rides and glades, or areas recently coppiced or clear-felled. The decline of many species has resulted from the abandonment of traditional management practices such as coppicing over the past 100 years or so, which has resulted in severely shaded conditions. Habitat specialists have quite specific microhabitat requirements which are easily disturbed or destroyed, and once a species is lost from an area, there is often little prospect of recolonisation, due to the sedentary nature of these butterflies and woodland fragmentation. Reintroduction programmes may therefore be the only prospect for some species. Pearl-bordered fritillary for example was lost from Kent this century, and is now being reintroduced at selected locations.

Survey methods

With the exception of butterflies, insect identification is a specialist area, beyond the expertise of many amateur naturalists. However, a lot can be learnt about a wood if you record the availability of habitat of high value to insects. Together with woodland edge, some of the more important habitats are listed earlier; the likelihood that the site has a high potential for insects increases with the number of features present.

Butterflies may be surveyed in promising open areas and along shrubby woodland edges. If you are not familiar with butterfly identification, refer to field guides such as the '*Pocket Guide to the Butterflies of Great Britain and Ireland*' (Lewington, 2003). When you are making changes in your woodland with a view to attracting insects, such as widening a ride, you may want to measure the effect of the changes, by doing a survey beforehand and over several years after the work. The most straightforward method is to plan a transect or route through the most promising habitat, and walk this on four, evenly-spaced occasions during the flight season noting species and numbers; typically early to mid May; the first two weeks of June; mid to late July; and mid August. If any habitat specialists are known to be present, then visits should be more frequent during their flight season.

Surveys are usually carried out between 11.00 and 16.00 hrs in suitable weather conditions for butterfly activity: dry and sunny (at least 60% sunshine); no more than a moderate breeze; at least 13°C in sunny conditions or 17°C if overcast. Strictly, only butterflies occurring within a 5 m line transect are recorded, up to 5 m ahead of the recorder. This will allow data to be compared with other years if so desired. Monitoring which is to be repeated year-on-year will benefit from more frequent visits; every two weeks, particularly during the period of peak activity from late June to mid August. Volunteers may be willing to help with surveys, particularly if habitat specialist butterflies are present. Contact Butterfly Conservation or the local county Wildlife Trust.

2.3 **Woodland birds**

Woodland is a more complex habitat in terms of its structure and the communities which it supports than any other terrestrial habitat in Britain. Consequently, woodland, scrub and young conifer plantations support more breeding birds (some 64 species) than any other habitat. These bird communities include some species which are widespread and abundant, such as robin, great tit and chaffinch; others such as great spotted woodpecker and treecreeper are widespread but present in limited numbers; whilst species such as lesser spotted woodpecker and hawfinch are confined to relatively few woods. The numbers of woodland birds are influenced by a range of factors, of which the weather and availability of food in the winter are particularly important. Prolonged periods of severe winter weather with lying snow can have significant effects on the populations of smaller birds such as wren and goldcrest. In the breeding season, the availability of food (particularly insects) and nest sites also influences the diversity and abundance of woodland birds, although our understanding of the factors which control woodland bird populations is surprisingly limited.

Birds and woodland types

The number and diversity of birds differs between woodland types, even when these are located in close proximity. Perhaps the greatest contrast is between an old-growth deciduous woodland in the lowlands, where an abundance of birds would be in stark contrast to the handful of species residing in a nearby mature spruce plantation. Every individual ancient wood is distinct in terms of its structure and floristic diversity and so woodland bird communities also differ between woods (in both species diversity and numbers), adding to this sense of uniqueness. Factors responsible for this include location, area, physical structure and the diversity of trees and shrubs. Although there is no such thing as a 'typical woodland bird community', one can identify birds which are characteristic of different woodland types.

Lowland deciduous woodlands support the richest diversity of birds, influenced to some extent by soil type, fertility and whether the woods are managed as high forest or coppice. Characteristic birds of oak and ash woods for example include wren, robin, warblers and chaffinch, which usually nest in the understorey; and hole nesters such as stock dove, woodpeckers, flycatchers, tits, nuthatch, treecreeper, jackdaw and starling.

In contrast, mature upland broadleaved woods tend to have a relatively simple structure, with a closed canopy and sparse understorey, which is often the result of heavy browsing pressure by deer and domestic stock. Chaffinch and willow warbler are the most abundant species in the upland birch woods of Scotland, along with species such as wren, robin, common redstart, wood warbler, spotted flycatcher, blue tit, great tit and coal tit. The more widely distributed upland oak woods of north and western Britain generally support fewer species and smaller populations of birds than their lowland counterparts. They may be characterised by different summer visitors, namely common redstart, pied flycatcher and wood warbler, and higher numbers of tree pipits. Resident breeding birds are similar to those found in lowland oak woods.

Native pinewoods in the Scottish Highlands support a distinctive woodland bird community, notable for capercaillie, crested tit and the endemic Scottish crossbill. Where birch and other deciduous species occur; black grouse, spotted flycatcher, willow warbler, lesser redpoll, common crossbill and siskin may also be found. In some areas, chaffinch and goldcrest are the commonest species.

It is difficult to generalise in the case of exotic conifer plantations, as the bird communities are affected by tree species and climate, and change considerably with each growth stage between planting and harvest. Communities are at their most diverse during the establishment and pre-thicket stages, when ground-nesting species such as nightjar, tree pipit, whinchat and species typical of scrub, such as dunnock and warblers may be found. Raptors such as goshawk, sparrowhawk and long-eared owls also hunt over young plantations. As the trees close canopy and develop to maturity, scrub species are lost, to be replaced by those which tend to feed in the high canopy: coal tit, chaffinch and goldcrest are often the dominant species, sometimes accompanied by siskin and common crossbill.

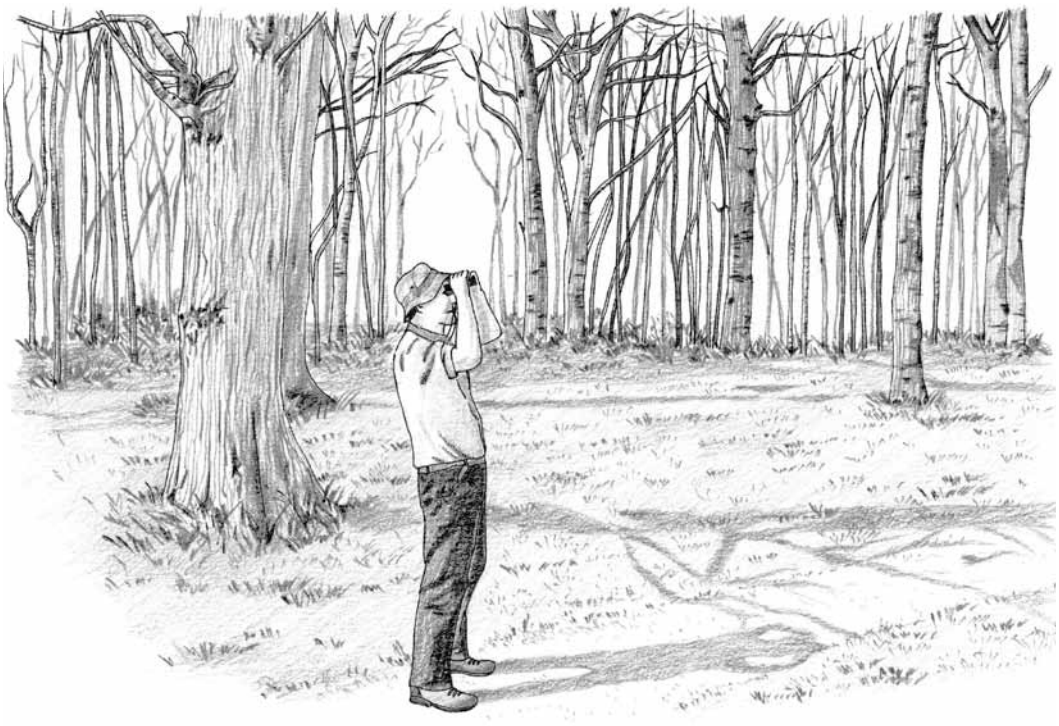
Birds of conservation concern

Woodland management should be sympathetic to bird populations in general, but in some cases you may wish to target management to support species which are of the greatest conservation concern, as their populations are the most threatened. *The State of the UK's Birds* is a series of annual reports produced by the Royal Society for the Protection of Birds (RSPB), British Trust for Ornithology (BTO) and the Wildfowl and Wetlands Trust with the UK Government's statutory conservation agencies, which summarise the fortunes of Britain's bird populations (available online). The reports include wild-bird indicators, population trends and Birds of Conservation Concern 3 – a non-statutory classification of species in decline; those of the highest concern are included on a Red list, with birds of moderate concern placed on an Amber list. Most Red-listed woodland birds and some Amber-listed species are also included on the UK BAP priority list of birds. These reports document the plight of some woodland species which have declined dramatically, such as woodcock, lesser spotted woodpecker, pied flycatcher, spotted flycatcher, wood warbler, willow tit and hawfinch. All of these are mature woodland specialists, with specific habitat requirements, which make them particularly vulnerable to any change in the condition of a wood. The causes are not well understood, but changes in management leading to more high forest, with a loss of structural diversity, may be a contributory factor. Some generalists such as the starling, and birds of more open woodland and scrub such as tree pipit and grasshopper warbler have also declined rapidly in recent years.

Survey methods

Woodland birds are relatively easy to monitor, and many woodland owners will have the skills to identify birds based on their appearance and song. If you are not familiar with bird identification, refer to a field guide such as '*Collins Bird Guide*' (Svensson *et al*., 2009). You may also find the bird identifier on the RSPB website helpful, as it includes sound clips of woodland bird song. Surveys loosely based on the BTO's Breeding Bird Survey can provide you with a better understanding of the birds which visit and breed in your wood. Just two formal visits are required: the first should be made between early April and mid-May, when resident birds are breeding; the second between mid-May and late June, when migrant birds breed. Visits may be later further north in the country. It is important to start these surveys early in the morning, when bird activity is at its height, although avoiding the period immediately after dawn when the intensity of the dawn chorus makes recording more difficult. A predetermined route through the woodland should be followed, recording all birds within 25 m, and those between 25–100 m, either side of the path. Detailed instructions and field recording sheets can be obtained from the BTO website.

When surveying, or undertaking any work in your woodland, you need to be familiar with UK legislation which protects all wild birds, their nests and eggs by law, with limited



An early morning bird walk can be a very rewarding experience.

exceptions. Some rare species are given special protection; for example it is a criminal offence to disturb, at or near the nest, a species on Schedule 1 of the Act, such as hobby or goshawk. In Scotland it is also an offence to disturb capercaillie and ruff at their leks. Nesting is considered to have started as soon as nest building starts. For more detailed information it is advisable to consult the Act itself.

2.4 **Woodland mammals**

Terrestrial mammals

Mammals began to return to Britain after the last ice age, but flooding of the landbridge with Europe brought this to an end (Yalden, 1999). In the 'wildwood', our three largest forest carnivores, wolf, lynx and brown bear hunted herbivores such as aurochs, wild boar and beaver. Smaller carnivores included wild cat, red fox, badger, polecat and pine marten (Table 2.5). Lynx and brown bear survived in Britain at least until Roman times, whilst the wolf finally became extinct in the Middle Ages. Of their prey, red deer and roe deer survive to the present day, despite intense hunting pressure in the Middle Ages. Other large herbivores did not fare so well; auroch and elk were both extinct by the end of the Bronze Age. Wild boar finally disappeared in the Middle Ages, although they are now recolonising British woodland after escaping from domestic farms in southern England. Beavers also became extinct in the early Middle Ages, and are now the subject of trial reintroduction programmes. Our woodland mammal fauna has also been increased by the introduction of grey squirrel and several exotic deer, including fallow deer, muntjac and Sika (Table 2.5), all of which can cause major problems in native woodland.

Deer reside mostly in woodland, but may also be found in more open farmland. Many people find them attractive, although they can be very elusive. However, when deer populations increase, they can have a major impact on woodland flora and fauna, through browsing herbs, shrubs and young trees. This can cause long-term changes to the composition of native woodland. Grey squirrels are also attractive animals, much easier to observe than deer. They were introduced from North America just over 100 years ago, and are now found in native woodland throughout Britain. Grey squirrels nest in trees and feed on a variety of nuts, fruits and shoots. They also damage trees, mainly through bark stripping on young stems (typically 10–25 cm in diameter) and branches of some mature trees. Oaks, beech and sycamore can be particularly hard hit, so that the composition of the tree community can be completely altered. Grey squirrels, which are legally classified as vermin because of the damage they do, also carry Squirrelpox virus, which is fatal to red squirrels.

Today, a number of native woodland mammals give real cause for concern, resulting in their designation as UK BAP priority species. Wild cats, pine martens and polecats were once widespread in Britain, but declined significantly due to persecution and habitat loss. The wild cat is still highly threatened and is restricted to the Scottish Highlands. Pine martens are now

Pine martens are spreading from their stronghold in West Wales, but can be elusive.

beginning to spread from their stronghold in West Wales; whilst polecats, trapped to near extinction by the early 20th century, began spreading from their last stronghold in Wales into 'middle England' late in the 20th century. Habitat quality and promoting tolerance and understanding are two factors key to the polecat's continued expansion. Red squirrels live in all woodland types, but seem to prefer conifers. It is thought that their well-publicised decline is due to competition from grey squirrels, as has been demonstrated on Anglesey, where eradication of greys has allowed red squirrel numbers to increase. Conservation measures include the use of feeders which provide food for red squirrels but not greys, and attempts to keep greys from colonising red squirrel strongholds, such as Scotland's native pinewoods.

The dormouse is a European Protected Species which has declined in Britain over the last century, with the loss of ancient woodland, fragmentation and the decline in coppicing likely to be key factors. It is a nocturnal animal, which spends most of its time off the ground when active, feeding on a variety of food including flowers, berries, nuts and insects. Nests may be woven in shrubs, but the dormouse prefers old bird nests, squirrel dreys or hollow tree branches. The best way to find out if this exceptionally secretive animal lives in your wood is to search for signs, such as nests of shredded honeysuckle bark woven into a ball, or the characteristic neat hole gnawed in an opened hazel nut. Dormice can be encouraged in woodland by putting up nestboxes (see Section 5.3).

Grey squirrels are the most easily observed mammal in British woodlands, but many terrestrial mammals like the dormouse are secretive or nocturnal, and difficult to see, especially in woodland. Badgers are also largely nocturnal, so setts, trails and signs are more likely to be encountered than the animals themselves. Badger setts are usually located close to the edge of woodland, in areas where the soil is easily dug and well drained. The most obvious feature of a sett is the large mound of earth, containing excavated soil and stones. A 'funnel' shaped entrance usually leads down into the ground at an angle of 45°. If you are fortunate to have an active sett in your wood, you may wish to observe the animals. Contact your local badger group, who will be able to offer expert advice on how to successfully observe these shy and retiring animals, and may visit with you.

Red foxes in contrast may be encountered along the woodland edge, sometimes basking in the early morning sunshine with their cubs. Red squirrels can be seen where their numbers are high, especially around artificial feeding stations. Native red and roe deer are easier to observe along the woodland edge or in open areas. You would have to be very lucky to see a polecat or pine marten – the closely related stoat and weasel are much more likely to be encountered, scurrying along woodland rides. Perhaps the most secretive mammal of all is the extremely rare wild cat, a solitary animal which hunts predominantly at night.

Table 2.5
Mammals found in woodland habitats in Britain.

Native		Introduced
Hedgehog*	Harvest mouse*	Brown hare*
Common shrew	Red fox	European rabbit
Pygmy shrew	Weasel	Grey squirrel
Water shrew	Stoat	Wild boar (re-colonising)
Mole	Polecat*	Fallow deer
Red squirrel*	Pine marten*	Sika deer
Dormouse*	Badger	Muntjac deer
Bank vole	Wild cat*	Chinese water deer
Field vole	Red deer	
Wood mouse	Roe deer	
Yellow-necked mouse		

* UK BAP priority species

Bats

Bats are also very difficult to observe in woodland, even for experts using bat detectors. Consequently far less is known about how bats use woodland compared with other habitats such as meadows and open water, or roosts in old buildings. However, we do know that all 16 species of British bats regularly use woodlands and that some are woodland specialists (Table 2.6). The abundance of insects in older woods provides a variety of feeding opportunities, whilst old trees with their numerous cracks, crevices, and woodpecker holes, and ivy-clad trees support roosts and maternity colonies.

Studies using lures to capture bats in woodlands in South East England have recently established a clear association between structurally diverse mature woodland with a well-developed understorey and the number and diversity of bat species (Hill and Greenaway, 2008). The implications of this study are clear – that reinstatement of management in a wood which has a dense understorey should only be undertaken after a thorough bat survey has been carried out.

The ideal landscape for bats would include a mosaic of different habitats for feeding, roosting and commuting; including ancient woodland, riparian woodland, scrub, hedgerows, species-rich grassland with some open water. One hundred years ago, such a landscape may have been common in the countryside, providing insect food in abundance, but not so today. Agricultural intensification and development has led to the loss or degradation of feeding habitat and to the destruction of natural and artificial roost sites, such as ivy clad trees and barns. As a result, most British bat species have declined over the past century, and some have suffered range contractions. All species are listed on the EU Habitats Directive Annex IV, with Bechstein's, barbastelle, lesser horseshoe and greater horseshoe bats – all

Table 2.6
The status and use of woodland by Britain's bats.

Species	Status and distribution	Use of woodland
Greater horseshoe bat*	S. Wales, South West, rare	Forages in deciduous woodland
Lesser horseshoe bat*	S. Wales, borders, South West, rare	Forages in deciduous woodland
Bechstein's bat*	Very rare	Forages in mature woodland with diverse structure
Natterer's bat	Widespread	Forages in variety of woodland habitats
Daubenton's bat	Widespread	Forages along riparian woodland and other woodland
Whiskered bat	Widespread	Hawks over woodland, edge and rides
Brandt's bat	Widespread, scarce	Hawks over woodland, edge and rides
Serotine	Mainly South East England, scarce	Forages along woodland edge
Noctule*	England and Wales, frequent	Forages along woodland edge/glades
Leisler's bat*	England, rare	Forages along woodland edge/glades, and over canopy
Common pipistrelle	Widespread, common	Forages along woodland edge and rides
Soprano pipistrelle	Widespread, common	Forages along woodland edge and rides
Nathusius' pipistrelle	Not known	Lowland woods
Brown long-eared bat	Widespread, common	Gleans from foliage/other surfaces in woodland and edge
Grey long-eared bat	South West England, very rare	Gleans from foliage/other surfaces in woodland and edge
Barbastelle*	Widespread, very rare	Forages in woodland canopy and edge

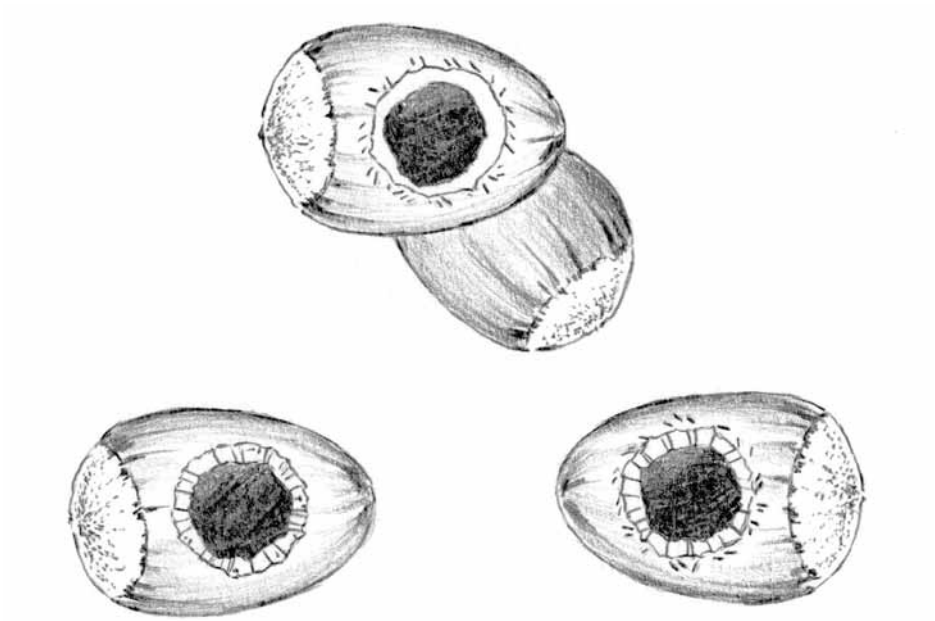
* woodland specialist
Source: Bat Conservation Trust and Altringham (2003)

woodland specialists – being given extra protection on Annex II. These, together with noctule (also a woodland specialist), soprano pipistrelle and brown long-eared bat are also UK BAP priority species, whilst Bechstein's bat and the barbastelle are on the IUCN Red List of Near Threatened Species.

Survey methods

General sightings and signs of mammals can be recorded during any visit to your woodland, noting down observations of animals and signs such as tracks or droppings. Active badger setts, squirrel dreys and fox dens may also be recorded. Anecdotal evidence from neighbouring woodland owners may also be important, especially for elusive creatures such as dormouse and pine marten. It should be assumed that dormice are present in any wood within their range, especially in southern England, unless proven otherwise. One of the easiest ways of establishing the presence of dormice is to examine gnawed hazelnuts in the autumn. The illustration below shows hazelnuts gnawed by different small mammals, but only the dormouse leaves a smooth round opening, distinguishing it from mice, voles and squirrels. The best time to look for nuts is from mid-August through to the end of the year, when the nuts are relatively fresh. Older nuts do gradually decay, making it more difficult to discern the teeth marks of other small rodents. If hazel is absent from your wood, look in nearby hedgerows and woodlands, on the assumption that if dormice are present close by, there is every chance that they will be present in your wood. Further information can be found in '*The dormouse conservation handbook*' (Bright *et al*., 2006).

Specialist surveys are most appropriate when the presence of species of conservation concern is suspected, especially if management activities are planned which might cause disturbance. Dormice surveys for example might require the use of nest tubes or nest



Close examination of a hazelnut will tell you which animal has been gnawing it; the dormouse (top) carves a smooth inner rim, with teeth marks on the surface of the nut at an angle to the hole; the wood mouse (lower right) leaves parallel toothmarks on the inner rim, and teeth marks on the surface; bank voles (lower left) leave parallel grooves on the inner rim, with no marks on the nut surface.

boxes, especially if hazel is not present in the wood. For specialist surveys such as these, advice must be sought from the statutory conservation agency prior to asking an expert to undertake a survey appropriate to the species concerned (for a summary of methods, see Institute of Environmental Assessment, 1995).

Some bat species such as pipistrelles may be observed at dusk, feeding along woodland margins and rides, others such Daubenton's bat may be seen foraging along a woodland stream. But most species require bat detectors, which can be purchased from ecological suppliers. These pick up bat calls using an ultrasonic microphone, which can be tuned to different frequencies to detect different species, although some training in their use is advised. However, bats are very difficult to survey in woodland, even for experts with sophisticated bat detectors. Volunteers from local bat groups may be interested to survey woodland, particularly if the habitat looks promising for bats. A relatively simple visual assessment of your wood should provide a good indication of the likelihood that bats are feeding and roosting there. The age and condition of the trees is the most important factor, as most tree species can support bats. If the wood contains any trees with holes or crevices offering protection, then bats could be present. Older trees, particularly if they have been damaged have a good chance of supporting roosting bats, and the chances are very much increased for veteran trees, with their diversity of rot holes, crevices, splits, snags and loose bark (see Section 4.4). In fact any deadwood attached to standing trees could support bats. Older trees covered by dense ivy or other dense climbers may also support roosting bats, and should be protected for this reason. The size of the wood is also important, with respect to the actual species which might be present. Some woodland specialists such as Bechstein's bat require woods of at least 25 ha, whereas other species such as noctule and long-eared bat may roost in very small woods. In particularly favourable habitat, bat experts with acoustic lures might be persuaded to visit the wood, especially if there is a chance of finding rare and threatened species such as Bechstein's bat or the barbastelle. The Bat Conservation Trust should be able to provide contact details for local bat groups.

Surveys assume much greater importance if management work is planned at any time of the year, as they can lower the risk of disturbing roosting bats as well as enabling woods to be managed to promote their value for bats. Roost surveys should be carried out in both winter and summer, so they need to be planned well in advance of any management operations. If carrying out a winter survey, it is important to systematically examine trees in discrete blocks, to avoid missing any roost trees. Inspect trees closely with binoculars, looking for potential roosting sites described above. Woods should be visited again in mid-summer, preferably just before sunset on very warm days, when the high-pitched squeaks of bats may be heard (by younger people) as bats become active. Further details may be found in the Forestry Commission's '*Woodland management for bats*' (Forestry Commission, 2005) which is freely available on the internet.

2.5 **Amphibians and reptiles**

Britain has far fewer amphibians and reptiles in comparison to mainland Europe, with 12 or 13 native terrestrial amphibians and reptiles, all of which are protected to varying degrees (Table 2.7). With the exception of natterjack toad and pool frog, all British amphibians can occur in suitable ponds and wetland habitat in woodland. Of these, the common toad is a UK BAP priority species and the great crested newt is a European Protected Species and a UK BAP priority species. Consequently, most published advice on conservation and woodland management for amphibians is focussed on great crested newt (e.g. Forestry Commission and Natural England, 2007; Forestry Commission Scotland and Scottish Natural Heritage, 2009).

British reptiles occur in a wide range of habitats, including lowland heath, moorland, tussocky grassland and woodland. Adder, grass snake, slow-worm and viviparous lizard are

widespread, and may be found in woodland rides and glades, bramble thickets, log piles and clear-felled forest. Sand lizard and smooth snake are very localised in southern England, often on the same sites, although sand lizard also occurs in Merseyside sand dunes. These rare reptiles are more usually associated with heathland and other open habitat, but both will use woodland edge, rides, clear felled or young restock sites and open pine stands. Any mechanised operations such as felling, spraying and mowing could harm these reptiles as they cannot move quickly enough to escape the threat.

If reptiles or amphibians might be present in a wood where management operations are being planned, surveys based on current best practice should be undertaken, with a view to implementing a mitigation programme if necessary. For further information, the '*Herpetofauna Workers Manual*' (Gent and Gibson, 2003) provides comprehensive guidance to all aspects of reptile and amphibian conservation and management, including site assessment, species translocation and the law. Natural England's '*Reptiles: guidelines for developers*' (English Nature, 2004) should also be consulted.

If European Protected Species are present, a very careful and well planned approach to woodland management is required. Specialist advice may be needed to help identify areas where animals rest, breed and hibernate. Guidance notes on managing woodlands for individual European Protected Species are available on the Forestry Commission and Natural England websites.

Surveys

The Field Studies Council's '*Guide to the Reptiles and Amphibians of Britain and Ireland*' (Roberts and Ovenden, 2003) should prove useful if you undertake surveys of reptiles in your own wood. Reptile activity is highly seasonal; animals hibernate between October and March, and their activity during the summer months is dependent on the weather. Reptiles may even go into partial hibernation in prolonged periods of hot weather (aestivation). Consequently reptile surveys should be considered well in advance of any forestry operations. Reptile surveyors usually search for animals which are basking or lying under warm objects, and use artificial refugia as part of a survey. These are usually sheets

Table 2.7
Britain's terrestrial amphibians and reptiles, including pool frog, whose status is uncertain.

	UK BAP priority species	European Protected Species
Amphibians		
Common frog		
Common toad	*	
Great crested newt	*	*
Natterjack toad	*	*
Palmate newt		
Pool frog	*	
Smooth newt		
Reptiles		
Adder	*	
Grass snake	*	
Sand lizard	*	*
Slow worm	*	
Smooth snake	*	*
Viviparous lizard	*	

of corrugated metal, roofing felt or a similar material, typically 70 x 70 cm, placed in sunny locations away from public routeways. If adders are likely to be present, stout boots should be worn and a stick or adder proof glove used to lift the artificial refugia, as an adder bite can cause poisoning or an allergic reaction. The best time to look for reptiles is in the spring, when animals tend to bask for longer in the cooler temperatures. In April, the best time of day is 11 am–3 pm; in late spring, mid morning and late afternoon are better. You could also carry out surveys in the autumn, whilst summer tends to be much more variable and difficult in very warm weather. Walk slowly, scanning from side to side and ahead in sunny areas, looking particularly at sheltered spots, and short vegetation where it occurs close to denser cover.

Surveys of amphibians on sites that support great crested newt can only be undertaken by surveyors with the necessary expertise and licence. Breeding ponds may be surveyed on several occasions using different techniques, including a visual search for eggs and bottle trapping. Night time searches by torchlight can be undertaken, but only with a licence as this is likely to disturb great crested newts. You may undertake casual searches in spring for the long gelatinous strings of toad spawn or clumps frogspawn in a pond, but eggs of newts are attached to leaves of variety of plants, and can be difficult to find. Tadpoles may also be observed; frog tadpoles are initially dark, becoming mottled with bronze spots, whilst toad tadpoles remain very dark.

Guides to amphibian and reptile identification may be found in the appropriate Survey Pack, freely available on the National Amphibian and Reptile Recording Scheme (NARRS) website.

Surveying artificial refugia for reptiles in a woodland glade. Note a stick was used to lift the sheet initially.

2.6 **Woodland fungi**

Woodland supports the richest diversity of fungi of any habitat in Britain, where they fulfil an essential role of recycling nutrients. It is the fruiting body – the mushroom or toadstool – which is most familiar, but fungi also possess thread-like hyphae, which form a web of mycelium, often out of sight, for example in the soil or roots of trees.

Woodland fungi are mainly associated with the decomposition of leaf litter and wood, whilst a group called 'mycorrhizal' fungi (literally 'fungus root') form mutually beneficial 'symbiotic' relationships with plants. Others such as the rusts and smuts are parasites of woodland plants, and lichen-forming fungi are essentially partners with their algal partners (see Section 2.7).

Mycorrhizal fungi help plants by forming extensive networks of fine fungal hyphae which radiate out into the surrounding soil, allowing the fungi to transfer nutrients to the tree from a much greater volume of soil than the tree's own root system. The relationship is symbiotic because the fungi gain sugars from the plant. There are two main types of 'mycorrhizae' which associate with trees, known as ectomycorrhizae and arbuscular mycorrhizae. Ectomycorrhizae form a sheath of fungal threads around the outside of tree roots which extends between the plant's cells, but does not penetrate them. Trees typical of more impoverished soils (which include the majority of British trees) tend to have ectomycorrhizal fungi; good examples are fly agaric on birch and amethyst deceiver on beech. Arbuscular mycorrhizae live within the roots and actually penetrate cells of the plant. They may be found on ash and field maple, although many produce no fruiting bodies, and are therefore difficult to observe.

The richest assemblages of fungi tend to be found in ancient woodland which has been unmanaged for a long period of time. Here, many species prefer the damp and shady conditions of the high forest. Wood pasture containing veteran trees – often pollarded – is also a rich hunting ground for fungi, especially rare species. Surprisingly, conifer plantations can also contain rich assemblages of species, particularly those planted with Scots pine, although many of the species associated with native pinewoods in Scotland are absent south of the border. Ultimately, the diversity of species present in a wood depends on a wide range of factors, which are summarised in Table 2.8.

Table 2.8
Factors affecting fungal diversity in woodland (after Spooner and Roberts, 2005).

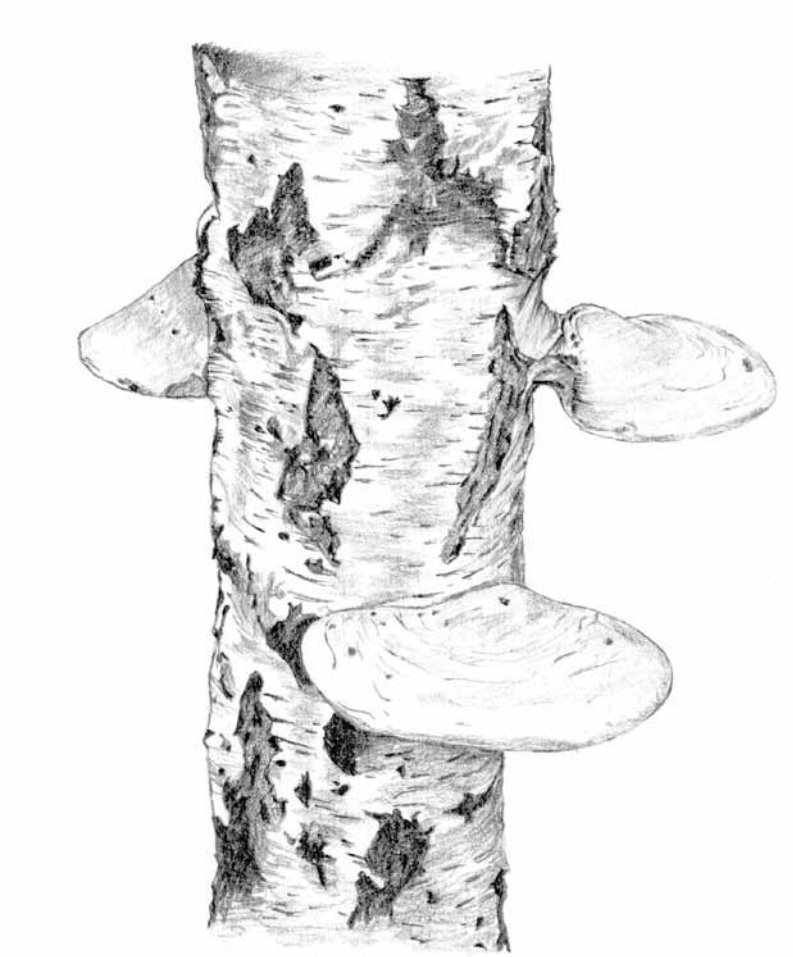
Factor	Fungal community
Woodland composition	Dependent on the woodland type, for example different mix of species in lowland oak wood compared to native pinewood; species richness increased by greater diversity of trees and shrubs
Soil composition	Affected by soil pH and presence or absence of litter
Climate and location	Some species restricted to regions of Britain; shelter can also influence diversity
Moisture	Strongly affected by ground moisture levels, humidity and rainfall (some species favour the west or east of Britain as a result)
Management	Historical management and current practices are important – very different communities may be found in unmanaged ancient woodland with abundant deadwood compared to heavily grazed woodland or an actively coppiced wood with low tree species diversity
Age	Ancient woodland tends to support more species than more recent woods or plantations; some lichens may offer clues to the age of a wood, but no macrofungi equivalent of ancient woodland indicator plants
Size	Larger woods usually contain more diverse habitat niches, and tend therefore to be richer for fungi

Fungal forays

Fungal forays have increased in popularity in recent years, and provide a good opportunity for you to gain some appreciation of the fungal community present in your own wood. A useful beginner's guide is '*Fungi (RSPB Pocket Nature)*' (Evans and Kibby, 2004) or the more comprehensive '*Collins Complete British Mushrooms and Toadstools*' (Sterry and Hughes, 2009). The following tables list some of the commoner species which might be encountered in mixed deciduous woodland, which collectively represent a range of shapes, colours and sizes:

Fungi which associate with plant roots

Deathcap	*Amanita phalloides*	Mild milkcap	*L. subdulcis*
Red cracking bolete	*Boletus chrysenteron*	Brown birch bolete	*Leccinum scabrum*
Penny bun	*B. edulis*	Brown rollrim	*Paxillus involutus*
Scarletina bolete	*B. luridiformis*	Purple brittlegill	*Russula atropurpurea*
Chanterelle	*Cantharellus cibarius*	Ochre brittlegill	*R. ochroleuca*
Purple stocking webcap	*Cortinarius pseudosalor*	Common earthball	*Scleroderma citrinum*
Poisonpie	*Hebeloma crustuliniforme*	Earthfan	*Thelephora terrestris*
Oakbug milkcap	*Lactarius quietus*	Blue spot knight	*Tricholoma columbetta*



Birch polypore on a dead standing birch tree.

Fungi which associate with wood

Jelly ear	*Auricularia auricula-judae*	Coral spot	*Nectria cinnabarina*
Smoky bracket	*Bjerkandera adusta*	Stinkhorn	*Phallus impudicus*
Glistening inkcap	*Coprinus micaceus*	Wrinkled crust	*Phlebia radiata*
Oak mazegill	*Daedalea quercina*	Birch polypore	*Piptoporus betulinus*
Blushing bracket	*Daedaleopsis confragosa*	Scarlet elf cup	*Sarcoscypha austriaca*
King Alfred's cakes	*Daldinia concentrica*	Hairy curtain crust	*Stereum hirsutum*
Southern bracket	*Ganoderma australe*	Lumpy bracket	*Trametes gibbosa*
Sulphur tuft	*Hypholoma fasciculare*	Turkeytail	*Trametes versicolor*
Beech woodwart	*Hypoxylon fragiforme*	Yellow brain fungus	*Tremella mesenterica*
Common puffball	*Lycoperdon pyriforme*	Waxy crust	*Vuilleminia comedens*
Common bonnet	*Mycena galericulata*	Candlesnuff fungus	*Xylaria hypoxylon*

Litter-inhabiting fungi

Clouded funnel	*Clitocybe nebularis*
Russet toughshank	*Collybia dryophila*
Collared parachute	*Marasmius rotula*
Milking bonnet	*Mycena galopus*
Lilac bonnet	*M. pura*

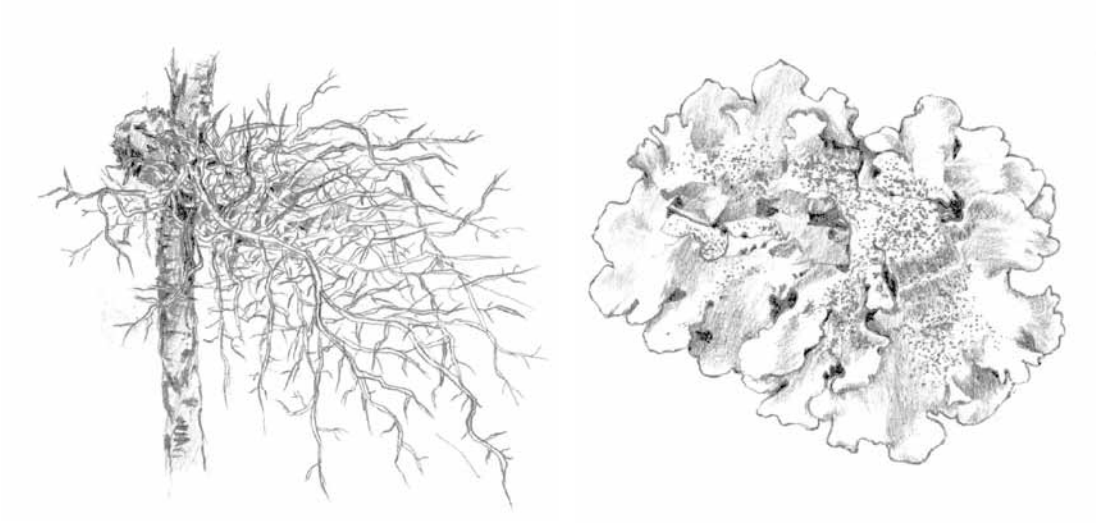
Eating wild fungi has become popular in recent years, so there may be a temptation to collect fungi found on a fungal foray. It is important to remember that many fungi are poisonous, and can result in severe illness or even death. Consequently, a good field guide should be used, and collecting fungi to eat is entirely at the reader's own risk.

2.7 **Lichens**

Lichens as a group are very colourful, and are surely familiar to most people, as they occur in urban as well as rural environments. They have an intrinsic beauty which inspires many people to photograph them, even if their true identify might remain a mystery. Lichens are not a single organism like a plant, but two separate life-forms, a fungus and an alga or cyanobacterium, which live together in a stable, self supporting or 'symbiotic' relationship. Thus, 'lichen' is a biological term which essentially describes a fungal lifestyle, rather than a taxonomic group.

What you see with the naked eye is known as the 'thallus', which is the body of the lichen, whose form is determined by the fungus. This is made up of several levels; the surface or cortex comprises densely packed fungal hyphae, below which the alga is to be found. Unlike many plants, lichens can be observed and potentially identified at any time of the year. Macrolichens are the most conspicuous and the easiest group to identify. Fruticose lichens may be shrubby, beard-like or hair-like in appearance. Foliose lichens are more leaf-like, with upper and lower surfaces which are distinctly different. The majority of lichens in Britain however are variations on the crustose form, which are closely attached to the substrate, which is often the bark of trees. Many such lichens require specialist knowledge and the use of a microscope or chemical tests to identify.

Lichens are also now used as Indices of Ecological Continuity for various woodland types, following the pioneering work of Francis Rose. 'Ancient woodland indicator' lichens are far more sensitive than plants, because rare lichens associated with old trees once lost, may take centuries to return. The number of indicator species in a wood is used to indicate the continuity of the woodland canopy, and can identify woodland which dates back to the early medieval period, or earlier.



The fruticose (shrubby) lichens (left) and the foliose (flat leafy) ones (right) constitute the macrolichens.

For lichens, structural diversity in a woodland is almost as important as its historical continuity. Most lichens require some light, so woods with open areas, and trees of different ages, usually host a greater diversity of lichen species. Veteran trees, often to be found in ancient wood pasture contain many specialist habitat niches for woodland lichens, which also have poor colonisation abilities. These ancient habitats are a magnet for lichenologists. Managed woods with even-aged canopies or coppice on the other hand generally support far fewer species, even if the woods are ancient in origin. Lichens are also sensitive to atmospheric pollutants such as sulphur dioxide, which is a further influence on their distribution.

The other main factors determining lichen distribution are climate and woodland type. In the west of Scotland for example, rich and luxuriant assemblages of macrolichens can be found in the wet, mossy oak-hazel woods on lower ground. Upland oak woods at higher elevations also have a western, Atlantic distribution, and support rich lichen communities, though lacking some of the specialities of the coastal woods. These oak woods are also rich in mosses, liverworts and ferns. The Caledonian pinewoods have their own distinctive lichen flora, which in contrast to deciduous woods is mainly to be found on standing deadwood and stumps. In the more continental climate of much of lowland south eastern Britain, oceanic lichens are replaced by those with a more continental distribution.

2.8 **The value of non-native trees for wildlife**

A wide variety of 'exotic' trees and shrubs have been introduced into Britain, most of which are contained in arboreta, parks and gardens. Amongst these, a small number of broadleaved species have become naturalised (i.e. ecologically adapted and self-perpetuating) in our native woods, including sweet chestnut, sycamore, Norway maple, red oak and horse chestnut, as well as several conifers which have spread from plantations. Small numbers of these species rarely change the character of a wood, but some have been planted extensively on ancient woodland sites. You may have some concerns about the value of these trees for wildlife.

Sweet chestnut, originally introduced from Southern Europe by the Romans, forms extensive coppice stands, often with oak standards, in many woods of South East England,

having replaced more diverse tree and shrub communities. While chestnut coppice appears to have little effect on the ground flora of the native woodland which it replaced, a recent review concluded that it supports many other species of fungi, invertebrates, birds and mammals associated with native broadleaved woods on similar site types, although the number and variety tended to be lower, especially in monoculture stands (Buckley and Howell, 2004). For example, Kennedy and Southwood (1984) listed just 11 species of insects occurring on chestnut, in comparison to over 400 species which use oak, and a similar number using willows. However, this is at least partly the consequence of limited survey data and the often low abundance, within the wider landscape, of the non-native tree species in question. More recent evidence suggests that sweet chestnut is an important and perhaps undervalued host plant for moths, with up to 72 species recorded as feeding on it (Parsons and Greatorex-Davies, 2006). Maintenance of the coppice cycle in commercially viable chestnut crops can also be beneficial to some notable species that are dependent upon young growth stages, such as butterflies, while the system of relatively small coupe sizes and extensive ride networks present in worked coppice adds diversity at the whole forest scale. Understorey woodland birds such as nightingale and willow warbler are unlikely to be numerous in chestnut coppice due to the paucity of insects. Bats may also suffer due to the lack of roost sites in mature and veteran trees.

Sycamore is a more recent introduction to Britain, probably dating back to medieval times. It is found mainly in England, but some woods in Scotland and Wales are dominated by sycamores. It grows on a wide range of sites, and resembles ash in its ecological requirements. Recent research suggests that ash and sycamore may be able to coexist on the same site, with alternating generations of seedlings capable of forming mixed canopies over time (Savill *et al*., 1997). Kennedy and Southwood (1984) listed 43 insect species on sycamore, which include a number of species of conservation concern. The base-rich bark of sycamore is also valuable for epiphytes: 170 lichens have been found on it, and abundant aphid populations on its leaves provide food for woodland birds.

Plantations

Some coniferous trees have also become naturalised in Britain, including Douglas fir, European larch, European silver-fir, lodgepole pine, Scots pine (in the south of Britain, outside its native range), Western hemlock, Norway spruce and Sitka spruce. These trees have had far greater ecological effects in Britain than introduced deciduous, broadleaved trees. Many were planted on land of low agricultural value, such as sandy heaths, lowland acid soils, and upland peat bogs. When introduced into native woodland, some species might affect the diversity of woodland plants, depending on the shade they cast and how long they have been established. Plantations on moorland however have a profound effect on the ground flora, resulting in the loss of more species on each successive rotation.

Relatively little quantitative work has been carried out to compare, objectively, the biodiversity of planted and semi-natural woodlands. A five-year programme by the Forestry Commission in the UK made biodiversity assessments of plantations in the late 1990s, using a range of study sites, tree ages and species. Sitka spruce, Norway spruce, Corsican pine, Scots pine and oak were examined at different growth stages: pre-thicket (8–10 years); mid-rotation (20–30 years), mature (50–80 years) and over mature (60–250 years). Native oak and semi-natural stands of Scots pine were added as 'controls'.

Assessments were taken of: vertical foliage cover, dead wood, fungi, vascular plants, bryophytes and lichens, invertebrates (present in deadwood, in the canopy, sub-canopy and on the ground) and breeding birds. More than 2,000 species were recorded, of which nearly 50% were invertebrates[1]. The lowland stands of Scots pine and Norway spruce were richest in invertebrates, and sites in northern Britain in general had less species-rich invertebrate communities, but were richer in bryophytes and lichens. The semi-natural stands examined

1 Including 202 beetles and 59 ground beetles: although this is only a fraction of the 30,000 named species of invertebrates in Britain.

were comparatively richer in vascular plants and lichens; but there were fewer of them than in the commercial crops. Plantations were good for hoverflies and beetles. For birds, young, pre-thicket stands made an important contribution to diversity, with such species as hen harrier, short-eared owl, woodlark and tree pipit; while there were conifer specialists such as goshawk, capercaillie, crested tit, siskin and crossbill. The conclusion is that the maturing plantations seem to have plenty of scope for biodiversity in its broadest sense and will 'improve' over time.

Returning to the ecological effects of introduced tree species in Britain, Peterken (2001) pointed out a number of instances where such species have caused long-term ecological damage. These include the vigorous spread of rhododendron into native woods on acid soils and the afforestation of moors and heaths with spruce and other conifers. However, in mitigation we would expect some long-term assimilation of less obviously damaging 'exotics' such as sweet chestnut and sycamore, which have already become colonised by native flora and fauna.