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Forests and Wildlife

R. C. Steele

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Forests and wildlife

By R. C. Steele
Natural Environment Research Council, 27–33 Charing Cross Road, London, W.C.2

Woodlands quite quickly became the most extensively occurring vegetation after the last glacial period so it is not surprising that a large part of the British flora and fauna consists of woodland species or species which in some way are dependent on trees.

The biological bases for sustaining the numbers and variety of woodland wildlife are described as are the habitats provided by woodlands. Examples are given of the numbers of species of different groups of organisms that occur in woodlands and the relationships between them.

The wildlife of broadleaf and conifer woodland are discussed and examples given of the characteristic wildlife of these main woodland types. Finally, the effects of past and present forestry practices on forest wildlife are considered.

Introduction

Woodlands are spacious and structurally complex systems which provide a vast number and range of habitats for a great variety of plants and animals. The structural complexity of a woodland is derived at both the individual and community level. Thus trees are differentiated into leaves, buds, flowers, fruits, seeds, twigs, branches, stems, roots, hearwood, sapwood and so on. When several trees are aggregated together to form a woodland there is a horizontal zonation into a canopy layer, a stem layer, shrub and field layers, a litter and humus layer and soil layers. Where several species occur together the zonation is even more complex and in addition to the horizontal zonation there may be vertical differentiation based on different species, sizes, ages and densities of trees, shrubs and other plants. The different layers and zones in a woodland have special biological characteristics and a related and specialized flora and fauna.

The total mass of plant material in a British woodland is very large and may weigh 200 tonnes per hectare. The annual rate of organic matter production has been calculated at about 25 tonnes/ha for a Scots pine (*Pinus sylvestris*) woodland (Ovington 1965). This does not represent the rate of organic matter accumulation in the trees as about two-thirds of the annual production is used in respiration or lost in litter fall. Few data are available for the mass of animals in a woodland but the figure is comparatively small – say up to about 1 tonne/ha. Foresters harvest some of this accumulated organic matter to provide timber or wood pulp but under natural conditions sooner or later this mass of organic matter, both plant and animal, is available as food for other plants and animals.

Woodlands provide shelter for plants and animals. Part of this shelter is the amelioration of climate in woodlands which results in milder and more uniform conditions shown by a reduction of temperature fluctuations and wind speeds and the maintenance of a more even humidity. Species live in woodlands which could not survive the more extreme climatic conditions found outside woodlands. The other aspect of shelter is the seclusion provided by woodlands which allows many species to live and breed with little disturbance.

Woodlands are thus important as wildlife habitats for several reasons: they are spacious; they are structurally very varied; they ameliorate the climate within them; and they harness vast quantities of energy from outside sources some of which is stored and is available as food for other organisms. They are complex, self-sustaining systems which contain and support a large variety and number of plants and animals.

Wildlife is used in this paper to mean all the plants and animals of a woodland including flowering plants: ferns, bryophytes, lichens, fungi, mammals, birds, amphibians, reptiles and invertebrate animals.

Woodland plants

Trees and larger shrubs

The climate and soils over much of Britain are very favourable for tree growth. Oaks (*Quercus petraea* and *Q. robur*) were once the most widespread species either pure or in mixture, depending on climate, soil and soil moisture, with ash (*Fraxinus excelsior*), elm (*Ulmus* spp.), lime (*Tilia cordata* and *T. platyphyllos*), hornbeam (*Carpinus betulus*) and birch (*Betula pubescens* and *B. verrucosa*). Beech (*Fagus sylvatica*) is still dominant on the chalks of south and south-eastern England – for example, in the Cotswolds and the Chilterns – but on the limestones of the west and north, ash is the main forest tree. Birch is widespread often invading open woodland, heathland or abandoned agricultural land but it is also the main tree under more extreme climatic conditions such as found at higher altitudes or latitudes. Alder (*Alnus incana*) and the willows (*Salix* spp.) are characteristic of wet soils. Britain's main native conifer is the Scots pine (*Pinus sylvestris*), which is considered now to be native only in Scotland, where it still forms extensive forests – for example, in the Cairngorm mountains (see Godwin, this volume, p. 1111).

More recently the numbers of trees and shrubs in Britain have been greatly increased by the importation and widespread planting of non-native species. Woodlands dominated by introduced species now cover a greater area than woodlands dominated by native trees. Introduced trees of commercial forest importance include conifers such as pines (*Pinus* spp.), spruces (*Picea* spp.), larch (*Larix* spp.), Douglas fir (*Pseudostuga taxifolia*), western red cedar (*Thuya plicata*), hemlock (*Tsuga heterophylla*), firs (*Abies* spp.) and broadleaved species such as sycamore (*Acer pseudoplatanus*), sweet chestnut (*Castanea sativa*) and poplars (*Populus* spp.).

Native understory and shrub species and the less important canopy species include common maple (*Acer campestre*), cherry (*Prunus avium* and *P. padus*), hazel (*Corylus avallana*), hawthorn (*Crataegus monogyna* and *C. laevigata*), blackthorn (*Prunus spinosa*), aspen (*Populus tremula*), holly (*Ilex aquifolium*), privet (*Ligustrum vulgare*), willows (*Salix* spp.), spindle (*Euonymus europaeus*), elder (*Sambucus nigra*), roses (*Rosa* spp.), buckthorn (*Rhamnus catharticus*), alder buckthorn (*Frangula alnus*), dogwood (*Thelycrania sanguinea*), bramble (*Rubus* spp.) and juniper (*Juniperus communis*). Introduced species that occur widely in woodland are rhododendron (*Rhododendrum ponticum*), Oregon grape (*Mahonia aquifolium*) and snowberry (*Symphoricarpos rivularis*). The main woodland climbers are ivy (*Hedera helix*), honeysuckle (*Lonicera periclymenum*) and *Clematis vitalba*.

Field layer

It is in the field layer that the greatest variety of plants are found in a woodland. About 240 species of flowering plants and ferns belonging to the field/low scrub layer occur exclusively

or mainly in woodland or if they occur more widely are frequently found in woodland. These and later figures are based on an analysis carried out for the Nature Conservation Review, and to be published by the Nature Conservancy Council and Natural Environment Research Council. Of this total 76 species are presumed to have a need for shade conditions but for some there is a more definite saprophytic, semi-parasitic or parasitic association with woody plants or their litter, e.g. *Goodyera repens*, *Monotropa hypopithys*, *Neottia nidus-avis*, *Melampyrum pratense*, *Lathraea squamaria* and *Viscum album*. One notable point is that few species belong to a particular woodland type as defined by tree dominants. The main exception is a group of species occurring in the Scottish pinewoods which include *Goodyera repens*, *Linnaea borealis*, *Pyrola minor* and *Trientalis europaea*. Other plants which appear specific to woodlands dominated by particular tree species are really characteristic of a special habitat e.g. *Equisetum telmateia*, *Thelypteris palustris*, *Corallorhiza trifida* and *Pyrola rotundifolia* are associated with alder–willow woodland because they need moist conditions; *Cypripedum calceolus*, *Carex digitata*, *Polygonatum odoratum* and *Polemonium caeruleum* occur in ash wood because this is the usual type of woodland on the rocky limestone ground they require.

Only 66 of these 240 species are associated with acidic, base-poor soils and of these 15 are ferns and 9 are grasses. The richest woods floristically are those on base-rich or calcareous soils. Most of the basiphilous species grow over a wide range of base-rich substrata but some are found on highly calcareous rocks such as chalk and limestone, e.g. *Actaea spicata*, *Daphne maezereum*, *Polemonium caeruleum*, *Lithospernum purpuro-caeruleum*, *Atropa belladonna*, *Cardamine impatiens*, *Phyteuma spicatum*, *Polygonatum odoratum*, *Orchis militaris*, *Orphrys insectifora*, *Helleborus viridis*, *H. foetidus* and *Cephalanthera rubra*. Some northern calcicoles are associated with limestone pavement and can grow in the shade provided by the deep clefts of 'grykes' even where there are no trees.

Some woodland species have a preference for heavy, moist and base-rich clay soils, e.g. *Equisetum telmateia*, *Phyllitis scolopendrium*, *Polystichum setiferum*, *P. lobatum*, *Ranunculus repens*, *Stellaria nemorosa*, *Primula elatior*, *Glechoma hederacea*, *Ajuga reptans*, *Eupatorium cannabinum*, *Allium ursinum*, *Carex sylvatica* and *C. pendula*. Other species need soils rich in humus either of the mull type with a high base status, e.g. *Neottia nidus-avis*, *Impatiens noli-tangere*, *Cardamine amara*, or with a mor humus with low base status, e.g. *Goodyera repens*, *Trientalis europaea*, *Pyrola minor*.

There is a predominance of base-rich soils in southern Britain and base-poor soils in the north and this trend is paralleled by the tendency for southern woodland species to be basiphilous and northern species to be acidiphilous or indifferent. The greater number of woodland species in the south than in the north may be explained by this greater extent of base-rich soils but it may also reflect the originally greater area of woodland in the south. Another group of species shows a wide distribution in Britain except in the lowlands of eastern and central England, e.g. *Vaccinium myrtillus* and *Erica tetralix*. Most of these species are calcifuges (i.e. plants intolerant of calcium) and their scarcity matches the very limited occurrence of acidic soils in these parts of Britain.

Twenty-three woodland species are classified as rare (occurring in 15 or fewer 10 km squares) of which one, *Euphorbia pilosa*, may be extinct. Of the remaining 22, 12 are plants of basic soils in southern England and the remainder vary widely in distribution and soil requirements.

The best represented taxonomic groups of vascular plants in woodlands are the ferns (19 species), Ranunculaceae (10 species), Rosaceae (12 species), Scrophulariaceae (8 species), Liliaceae (10 species), Orchidaceae (20 species), Cyperaceae (9 species) and Gramineae (26

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species). Groups such as the Cruciferae, Caryophyllaceae, Chenopodiaceae, Papilionaceae, Umbelliferae and Compositae are poorly represented in proportion to their size in this country.

The bryophytes and lichens of British woods have been described by Watson (1963). On acidic soils a characteristic group occurs over the whole country and includes *Hypnum cupressiforme*, *Pleurozium schreberi*, *Hylocomium splendens*, *Plagiothecium undulatum*, *Dicranum scoparium*, *Polytrichum formosum*, *Mnium hornum*, *Leucobryum glaucum*, *Lophocolea bidentata*, *Lepidozia reptans* and *Diplophyllum albicans*. In the extreme west, where there is a permanently humid atmosphere, in addition to these generally occurring species there is a strong representation of large and conspicuous bryophytes with a markedly oceanic or atlantic distribution. These include *Dicrodentum denudatum*, *Hylocomium imbratum*, *Sphagnum quinquefarum*, *Scapania gracilis*, *Plagiochila spinulosa*, *Mylia taylori*, *Saccogyna viticulosa*, *Bazzania trilobata*, *Lepidozia pinnata* and *Adelanthus decipiens*. The Atlantic bryophyte flora consists mainly of calcifuge or indifferent species and is thus represented mainly in oak and birchwoods on poor to moderately rich rocks and soils.

Britain has a poor vascular epiphyte flora. Ivy (*Hedera helix*), honeysuckle (*Lonicera periclymenum*), mistletoe (*Viscum album*) and the fern *Polypodium vulgare* are among the most commonly occurring species. The most abundant epiphytic bryophytes are *Hypnum cupressiforme*, *Isothecium myosuroides*, *Dicranum scoparium*, *Ulota crispa* and *Frullania tamarisci*. Strongly Atlantic species especially characteristic of trees include *Ulota vittata*, *Frullania germana*, *Plagiocila punctata* and *Mylia cuneifolia*. Widespread corticolous lichens include *Lecanora conizaeoides*, *Evernia prunastri*, *Parmelia physodes*, *P. sulcata*, *P. caperata*, *P. saxatilis*, *Cetraria glauca*, *Ramalina farinacea*, *Alectoria* spp., *Usnea* spp. and *Physcia* spp. Communities which are specially well developed in the west include strongly Atlantic species and contain large foliose types such as *Lobaria pulmonaria*, *L. laetevirens*, *L. laciniata*, *Loberina scrobiculata*, *Stictina sylvatica*, *S. limbata* and *S. fuliginosa* and smaller species such as *Pannaria rubiginosa*, *Parmeliella plumbea*, *P. atlantica* and *Normandina pulchella*. These rich lichen floras containing oceanic species are not confined to the west and numerous outposts occur in eastern and southern England where the rainfall is low. Epiphytic lichens are less tolerant of deep shade than many woodland bryophytes and, in England, some of the richest areas for epiphytic lichens are park woodlands.

Ratcliffe (1968) has pointed out that in the global context one of the most outstanding features of the flora of the British Isles is the strong representation of plants, especially bryophytes, which depend on an oceanic climate. The British flora is poor in many respects by comparison with continental Europe but in its Atlantic bryophyte element it is not only the richest part of the whole continent but also one of the richest areas in the world. Other floristic features of international importance in Britain's woodlands are ash as a woodland dominant; holly and several species of endemic whitebeams (*Sorbus* spp.); bluebells (*Endymion non-scriptus*) and various ferns (*Osmunda regalis*, *Hymenophyllum* spp., *Trichomanes speciosum*, *Dryopteris aemula* and *Polystichum setiferum*); ivy as an epiphyte; and lichens, especially the Atlantic species, as epiphytes.

Woodland animals

Reptiles and amphibia

Woodland is not a specially important habitat for reptiles and amphibia but adders (*Vipera berus*), grass snakes (*Natrix natrix*), frogs (*Rana temporaria*) and toads (*Bufo bufo*) may frequent the more open or damper places.

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Mammals

Many British mammals are associated with woodland to some degree but few species are exclusively forest dwellers. Red deer (*Cervus elaphus*), fallow deer (*Dama dama*), Sika deer (*Cervus nippon*), roe (*Capreolus capreolus*), muntjac (*Muntiacus reevesi*) and Chinese water deer (*Hydropotes inermis*) are all present in Britain's woodlands. In Scotland Red deer have become adapted to treeless upland country but in other areas, e.g. the Lake District and Breckland in England, Red deer are still very much forest animals. Southern (1964) states that evidence for Fallow deer being indigenous to the British Isles is disputable but they are recorded in the Domesday Book as being well established. Descendants of these herds are still living wild in Epping Forest, the New Forest, Rockingham Forest and Cannock Chase, and other herds, developed from park escapes, are widespread in England but less so in Wales and Scotland. Feral herds of the introduced Sika deer occur in woodlands in Britain.

Roe deer have a particularly close connextion with woodland. An indigenous species which was once widespread but then became very restricted, it has expanded its range in the past few decades and is once again a widely occurring species. This is due to the extension of its woodland habitat as a result of planting. The Chinese muntjac and the Chinese water deer were both introduced to Woburn in Bedfordshire just before the turn of the century and have since escaped and become established in many woodlands in the southern counties of England.

Carnivorous mammals are well represented in forests. Badgers (*Meles meles*) are perhaps the most typical woodland dwellers although the animals may forage in the surrounding open countryside. They occur widely as does the fox (*Vulpes vulpes*). The wild cat (*Felis sylvestris*) is found in forests as well as open country as is the pine marten (*Martes martes*). Both appear to be increasing in numbers which may be connected with the increased area of woodland. The polecat (*Mustela putorius*) became very scarce early this century but now seems to be holding its own in mid-Wales and may even be increasing again, perhaps helped by the increasing area of woodland. The smaller mustelids, the stoat (*Mustela erminea*) and the weasel (*M. nivalis*), both also occur in woodlands.

The most characteristic small rodent of woodlands is probably the wood mouse (*Apodemus sylvaticus*), which is widespread. It is especially associated with woodlands with an open field layer, in contrast to the bank vole (*Clethrionomys glareolus*), which prefers woodlands with a denser field layer. The field vole (*Microtus agrestis*) is more a species of dense grass and often is found in very large numbers in grassland areas which have been recently fenced and planted with trees. The dormouse (*Muscardinus avellanarius*) is local mainly in southern England in scrub and dense woodland containing trees such as beech, hazel and Sweet chestnut. The red squirrel (*Sciurus vulgaris*) has the strongest association with woodlands of all the British mammals. Once widespread it has declined in numbers and vanished from many southern localities in recent decades. Its favoured habitat is conifer woodland but it also occurs in mixed woodland and broad-leaved woodland. The grey squirrel (*S. carolinensis*), introduced from North America, has largely replaced the red squirrel over much of southern Britain and is especially characteristic of broad leaved woodland.

Insectivores are also well represented in woodlands. The mole (*Talpa europaea*) and common shrew (*Sorex araneus*) are widespread and common and the pygmy shrew (*S. minutus*) and water shrew (*Neomys fodiens*) are also widespread but less common. The hedgehog (*Erinaceus europaeus*) prefers rather open woodland and scrub.

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Both the rabbit (*Oryctolagus cunninculus*) and brown hare (*Lepus europaeus*) include woodlands in their range of habitats.

Many species of bats are associated with woodland. They hunt insects over the canopy or along rides and margins or they roost or hibernate in hollow trees. These include the whiskered bat (*Myotus mystacinus*) Daubenton's bat (*M. daubentoni*), noctule (*Nyctalus noctula*), pipistrelle (*Pipistrellus pipistrellus*) and the long-eared bat (*Plecatus auritis*). More local species include the barbastelle (*Barbastella barbastellus*), Natterers bat (*Myotis nattereri*), serotine (*Eptesicus serotinus*) and Leisler's bat (*Nyctalus leisleri*).

Birds

In a Presidential address to the Society of Foresters in 1938 (Taylor 1938) it was stated that 'ornithology in regard to forestry in Great Britain is almost a virgin field for observation and research'. Since then there have been numerous papers and books on this subject and woodland birds are probably now better described than any other woodland animal group (see, for example, Lack & Venables 1939; Colquhoun & Morley 1943; Yapp 1953; Condry 1960; Watson 1969; Williamson 1970; Simms 1971; Murton 1971; Hope-Jones 1972). The following account is drawn largely from these authors and from the Nature Conservation Review.

A large number (nearly 100 but the exact number depends on definitions) of the breeding species of birds in Britain have some association with woodland, with trees or with scrub. Of this number about one third are invariably associated with these habitats in the breeding season and a further two dozen are mainly associated. The passerines are especially well represented and of the British breeding birds of prey only two, the peregrine falcon (*Falco peregrinus*) and marsh harrier (*Circus aeruginosus*), have no association with trees. The best defined ecological–geographical group of birds (as with the vascular plants) is associated with the pine forests of central Scotland. This group includes the capercaillie (*Tetro urogallis*), crossbill (*Loxia curvirostra*), siskin (*Carduelis spinus*) and crested tit (*Parus cristatus*), together with a few pairs of golden eagle (*Aquila chrysaetos*) and osprey (*Pandion halioetus*). More widespread species showing a preference for coniferous woods include long-eared owl (*Asio otus*), collared dove (*Streptopelia decaoca*), coal tit (*Parus ater*), redpoll (*Acanthis flammea*) and goldcrest (*Regulus regulus*).

Birds especially associated with broadleaved woodlands are the green, great spotted and lesser spotted woodpeckers (*Picus viridis*, *Dendrocopos major*, *D. minor*), marsh tit (*Parus palustris*), willow tit (*P. montanus*), nuthatch (*Sitta europaea*), tree creeper (*Certhia familiaris*), redstart (*Phoenicurus phoenicurus*), nightingale (*Luscinia megarhynchos*), blackcap (*Sylvia atricapilla*), garden warbler (*S. borin*), willow warbler (*Phylloscopus trochilus*), chiffchaff (*P. collybita*), wood warbler (*P. sibilatrix*), pied flycatcher (*Ficedula hypoleuca*), hawfinch (*Coccothraustes coccothraustes*) and greenfinch (*Carduelis chloris*).

The nightingale, blackcap, garden warbler, whitethroat (*Sylvia communis*), lesser whitethroat (*S. curruca*), wren (*Troglodytes troglodytes*), chiffchaff and long-tailed tit (*Aegithalos caudatus*) prefer woodlands and clearings with a good deal of undergrowth, especially tangles of bramble, honeysuckle or tall herbs, in which they breed. By contrast, the wood warbler and, to a lesser extent, the willow warbler favour woodland with a rather bare floor. Other ground nesters, such as the woodcock (*Scolopax rusticola*), capercaillie and robin (*Erithacus rubecula*), nest most often where there is a moderate cover of low shrubs and herbs.

Species which breed in the tall shrub layer and below the tree canopy include wood pigeon (*Columba palumbus*), turtle dove (*Streptopelia turtur*), collared dove, jay (*Garrulus glandarius*), song thrush (*Turdus philomelis*), blackbird (*T. merula*), hawfinch, greenfinch, redpoll and chaffinch

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(*Fringella coelebs*). Other species such as the raven (*Corvus corax*), carrion crow (*C. corone*), hooded crow (*C. c. cornix*), rook (*C. frugilegus*), magpie (*Pica pica*), siskin and crossbill prefer to nest at a considerable height above the ground. Where only low trees are available they can adapt to breed much closer to the ground, e.g. the sparrowhawk (*Accipter nisus*), crow and magpie nest in birch and willow scrub where taller trees are absent and the heron (*Ardea cinerea*) also breeds in low scrub.

Tree hole breeders may be divided into those which utilize existing holes and those which excavate their own. The former group includes goosander (*Mergus merganser*), kestrel (*Falco tinnunculus*), tawny owl (*Strix aluco*), little owl (*Athenae noctua*), stock dove (*Columba aenas*), wryneck (*Jynx torquilla*), jackdaw (*Cervus monedula*), great tit (*Parus major*), blue tit (*P. caerulus*), marsh tit, redstart, pied flycatcher, starling (*Sturnus vulgaris*) and tree sparrow (*Paser montanus*). The excavators are the three species of woodpecker and the willow tit (*Parus palustris*). The nuthatch takes over a natural or excavated hole and uses mud to make it the right size and the tree creeper prefers to nest behind partially detached bark.

Richness of bird species in a woodland depends to a large extent on diversity of structure, including the presence of old trees. In general, the number of species decreases with distance north. Probably the most important woodland area in Britain for the variety of species and population sizes of birds is the New Forest in Hampshire, which has at least 75 species of birds associated with woodlands, trees and scrub breeding in it. By contrast the birch woods of Sutherland together include about 15 breeding bird species. Of the rare woodland birds the red kite (*Milvus milvus*) is a true relict now confined to limited areas in central Wales. Other species which are rare because they are on the fringes of their distribution include the goshawk (*Accipter gentilis*), honey buzzard (*Pernis apivorus*), osprey, hobby (*Falco subbuteo*), wryneck, redwing (*Turdus musicus*) and firecrest (*Regulus ignicapillis*).

Invertebrates

The enormous variety and number of invertebrate animals living in woodland and their habitats have been well described by Elton (1966). This variety is brought home by table 1. This list is by no means complete as many of the listed groups are poorly recorded and many groups are not recorded at all. It does illustrate the variety of invertebrate groups occurring in a woodland, the large number of species in many of these groups and the great range of habitats occupied. All these species occur in 157 ha of woodland that has been managed by man for centuries and was heavily and extensively felled half a century ago and than left to regenerate naturally.

Probably more than half the British species of lepidoptera are to be found in woodland; more than occur in any other vegetation type. Not all are associated with trees although trees support large numbers of them, e.g. more than 100 species feed on oak, sallow, birch and hawthorn. Some species are widely distributed e.g. the purple hairstreak butterfly (*Thecla quercus*), mottled umber moth (*Erannis defoliaria*) and poplar hawk-moth (*Laothoe populi*). Others are very local, e.g. the heath fritillary butterfly (*Melitaea athalia*), black hairstreak butterfly (*Strymonidia pruni*), the Kentish glory moth (*Endromis versicolora*) and lime pug moth (*Eupethecia egenararia*). In general, the lepidoptera of broadleaved woodland is richer in species and distinct from that of conifer woodland. A few species such as the green-veined white (*Pieris napi*) and pearl-bordered fritillary (*Argynnis euphrosyne*) occur in both where suitable rides exist. Some moths can cause severe defoliation of trees, e.g. the oak roller moth (*Tortrix viridana*) on oak,

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the mottled umber and the winter moth (*Opherophthera brumata*) on oak and other broadleaved species, the northern winter moth (*O. fagata*) on birch and pine looper (*Bupalus piniaris*) on pine.

Welch (Steele & Welch 1973) has listed the number of Coleoptera species for different woodland areas. About half the known species of British coleoptera have been recorded in Windsor Forest and the New Forest in southern England. About a quarter have been recorded in Epping Forest, Wytham Wood and Monks Wood National Nature Reserve, also in southern England. This illustrates the exceptional importance of woodlands for coleoptera.

Table 1. The number of invertebrate species recorded in Monks Wood National Nature Reserve in England (Steele & Welch 1973)

group	number of species recorded in Monks Wood
Crustacea	20†
Insecta	
Collembola	48
Odonata	6
Orthoptera	9†
Psocoptera	13
Hemiptera	
Heteroptera	124
Homoptera	85
Neuroptera	21
Trichoptera	10†
Lepidoptera	
butterfiies	43
moths	416
Diptera	452
Siphonaptera	17
Hymenoptera	219
Coleoptera	1017
Arachnida	
Araneae	122
Chelonethi	3
Opiliones	16
Acari	140
Myriapoda	
Diplopoda	13
Chilopoda	9
Mollusca	42
Annelida, Lumbricidae	13
total	2858 species

† Additional specimens unidentified.

A similar study of the spider fauna of woodlands carried out by Duffey (in Steele & Welch 1973) reveals that from about 20 to 35 % of the known British species have been recorded in the most intensively studied areas. About 17 % of the British spider fauna occurs exclusively or most abundantly in woodland.

These examples illustrate the extent to which some invertebrate groups occur in woodlands. Many other groups can also be shown to have a major representation in woodlands.

Southwood (1961) studied the numbers of insects associated with various trees. From his work he concluded that the number of insect species feeding on a tree is a reflexion of the cumulative abundance of the tree in this country through recent geological history – that is,

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since the last Ice Age. This means that the dominant and longest established trees will have most insect species associated with them and recently introduced trees will have the fewest. Other factors also affect this relation, e.g. leaf structure and chemical composition (holly and ash are examples of long established trees with comparatively few insect species feeding on them), but it has been shown to hold in Sweden, Russia and Cyprus as well as in Britain. Oak has nearly 300 species of invertebrates (Heteroptera; Homoptera (part); Lepidoptera; Coleoptera) feeding on it; sycamore has about 30. To replace a forest of one with the other is to reduce the potential number of invertebrate species that can be maintained there. These insect/plant relations are one reason why those concerned with wildlife place such emphasis on the conservation of native species of plants and the conservation of woodlands of native species.

Effects of forestry on wildlife

A century ago about 3% of Britain's land area was under forest. Now the total has risen to over 8%. The increasing use of land for forestry was given impetus by the formulation of Britain's first national forest policy in 1919, which emphasized the need to build up a strategic reserve of timber. Much land of marginal agricultural use was planted up and species found to be most successful under these conditions were mainly non-native conifers. The policy of a strategic reserve of timber gave way to one of maximum wood production, which in turn was replaced by a policy of maximum financial return. These policies continued to favour the use of non-native conifers, and the policy of maximum financial return necessitated shorter rotations being adopted. In the past few years forestry in Britain has become concerned with broader issues than timber production and recent pronouncements indicate that the maintenance of environmental 'quality' will be an important aspect of any future policy. What have been the effects of these changes on forest wildlife?

In the past woodland management, broadly speaking, was successful in maintaining a variety of wildlife even if this was not done consciously. Traditional methods of silviculture, including coppice and coppice-with-standards and the use of native tree species, sustained, and perhaps even enhanced, the range of woodland wildlife. Recent changes in forestry practice have often made conditions less suitable for wildlife. The most important of these changes has been the increasing use of non-native tree species, mainly conifers. This situation is not peculiar to Britain and is paralleled in other countries of the world. Many organisms, notably mammals and some birds, can adapt to this change of species as they are affected more by the structure of a woodland than its species composition. However, for a large number of species it is the kind of tree that matters, e.g. the larvae of most butterflies and moths are specific in their food requirements. As explained, native trees have in general a greater variety of wildlife associated with them than non-native trees. This is particularly so in relation to invertebrate animals but the species of trees used in forestry can affect the other woodland plants both in the field layer and those growing as epiphytes.

A distinction needs to be drawn between forestry in the uplands and the lowlands of Britain. In the uplands most planting is done into land which has not recently been forested. Non-native trees are used not only because they will produce more wood but also because they are often the only species which will grow reasonably well under the difficult soil and climatic conditions frequently found. The formation of these new plantations may have an adverse effect on the wildlife of grassland and moorland or may be aesthetically objectionable, but in terms of

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woodland wildlife they are beneficial. This is because a woodland habitat is being created which, especially if management is sympathetic to these aims, will develop a woodland flora and fauna. In the lowlands planting usually takes place on to land from which existing woodland has been cleared. Much of this lowland woodland was dominated by native trees and the change from native tree species to non-native species is, on balance, detrimental to the general variety of wildlife. Forestry has thus in the past few decades improved the possibilities for woodland wildlife in the uplands but reduced the opportunities for woodland wildlife in the lowlands.

Wildlife has also been affected by the more intensive forestry now being practised. Extensive monocultures reduce the number of habitats through reducing both plant variety and structural diversity. Loss of plant variety will reduce the variety of invertebrate wildlife. Loss of structural diversity can affect the number of breeding bird species. The development of ploughing techniques and machinery enable wet sites to be drained and peats to be planted. Short rotations have meant that trees are not allowed to reach a size where they develop holes suitable for the hole-nesters. Large, old trees, which often have a rich and specialized plant and animal life, are removed earlier than they would have been. The philosophy of maximum timber production and a desire to avoid possible epidemic outbreaks of pests have caused dead and dying standing trees and fallen timber to be removed. Elton (1966) states that 'dying and dead wood provides one of the two or three greatest resources for animal species in a natural forest and if fallen timber and slightly decayed trees are removed the whole system is impoverished of perhaps more than one fifth of its fauna'. Nearly 1000 species of animals, of which a large proportion are insects, are known to be associated with dead and dying trees. Wood provides food for many animals which, in turn, are preyed on. Loose bark and the holes, crevices and tunnels in decaying wood are also useful in providing shelter and hibernation sites.

Clear-felling and replanting is the most common method of regeneration now used in forestry. Even if fast growing species are planted there is a gap of some years between felling and the re-establishment of a closed canopy. The loss of shelter that woodlands provide can have serious consequences – for example, for the Atlantic bryophytes referred to earlier. With coppicing, which was once widely practised, the cut stems sprouted from the stumps and closed canopy conditions were very quickly re-established. Shelter was lost for a very short period only and this had a less serious effect on sensitive species. Coppicing had other benefits. By increasing the mount of light reaching the ground it encouraged the development of a pre-vernal and vernal flowering field layer. Species such as bluebell (*Endymion non-scriptus*), primrose (*Primula vulgaris*), oxlip (*Primula elatior*) in restricted areas of East Anglia and wood anemone (*Anemone nemorosa*) are a feature of coppice woodlands.

Grazing was formerly a common practice in many woodlands and the grazing of woodlands by sheep still occurs extensively in upland Britain. Grazing tends to reduce the amount and height of certain species, e.g. *Vaccinium myrtillus*, and often succeeds in replacing a field layer containing forbs with one dominated by grasses. However, grazing may have helped to establish the extensive bryophyte carpet in many western woodlands by reducing competition from more vigorously growing herbs and grasses.

The practice of forestry affects wildlife but wildlife also affects the practice of forestry. Heavy growth of field layer plants after felling, called weeds, require that newly planted trees must be cleaned. Some plants, notably honeysuckle, can be a serious pest of young plantations by climbing and choking the young stems. Animals too can be a problem. Rabbits were very destructive to young trees until their numbers were much reduced by myxomatosis. Deer

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damage trees by eating them, fraying stems and stripping bark. However, deer in a woodland are not necessarily a source of loss only and Prior (1972) has shown that good financial returns can be obtained from venison if roe deer are properly managed. The balance between deer production and timber production in a forest is often delicate. Jenkins & Heinrich III Prinz Reusz (1969) have described a case where forestry and red deer management are reconciled by feeding the deer in winter in special fenced areas to reduce damage to trees. The writer on a recent visit to northern Yugoslavia was shown deer damage that was so heavy that the authorities were considering segregating deer and timber production into different forest areas. Heavy deer damage to trees would be accepted in some areas and deer encouraged; in other areas damage to trees would be kept down by heavily culling the deer. Deer numbers have often been maintained at too high a level in forests because of sporting interests and the trees suffer severely. The grey squirrel has taken over as the number one forest pest in many areas of lowland Britain and is seriously affecting the ability to grow some species, e.g. beech, in certain areas.

Birds can damage forests, e.g. the capercaillie feeds on Scots pine and black grouse on birch and many species feed on seeds and fruit. This may reduce the regeneration potential to some extent by destroying seed, but birds may play an important role in the spread of seeds and hence of trees, e.g. jays and acorns. Birds may be beneficial also in limiting the outbreak of insect pests in woodlands. In Britain the evidence is not clear but on the continent, e.g. in Russia and Germany (Bruuns 1960), there is a belief that the presence of birds can reduce outbreaks of pest species such as the pine looper moth (*Bupalus piniaris*) and steps are taken to encourage birds by providing nest boxes. Nest boxes have increased the numbers of hole-nesting species such as great and blue tits, pied fly catchers and redstarts in British woodlands (Campbell 1968). Gibb (1960) has shown that birds eat vast quantities of lepidopterous larvae daily. This may help to stabilize insect populations but birds probably have little effect on controlling an insect pest outbreak once it has broken out.

Woodlands can provide an income from sporting birds. Gray (1972) has shown how the shooting rents from a farm can be increased substantially if small areas of woodland are provided for shelter and roosting sites for pheasants.

Managing forests for wildlife

Wildlife conservation has been described (Steele 1972*a*) as being concerned with maintaining a representative variety of plants and animals interacting freely with each other and with the environment. It thus seeks to preserve biological diversity under free-living conditions. What is 'representative' can be defined at the international, national, regional or local level, and the level at which any situation is actually considered will depend on local circumstances. The aim is to retain a representation of Britain's native plants and animals both as individuals and as a part of larger communities and to retain this representation as widely as possible. It is useful to draw a distinction between intensive wildlife conservation and extensive wildlife conservation.

Intensive wildlife conservation takes place in those areas managed primarily for wildlife and these are usually known as nature reserves. Timber production, recreational use or other management objectives are not necessarily precluded but the main objective of management is to maintain the wildlife. In theory at least, representatives of all our native species and communities could be included in nature reserves rather like a fleet of Noah's Arks. In practice there are severe limitations on the area of woodland that can be set aside solely for wildlife

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conservation. The Nature Conservancy Council manages about 6000 ha of woodland in statutory nature reserves and in addition there are other non-statutory woodland nature reserves managed by organizations such as county naturalist trusts, the Royal Society for the Protection of Birds, local authorities, etc. It is doubtful though whether the whole area of woodland managed as nature reserves exceeds about 10000 ha or about 0.5% of the total area of forest in Britain. Nature reserves cannot therefore by themselves conserve a widely distributed and abundant wildlife. For this we need to practice conservation extensively – that is, in woodlands managed mainly for other purposes, such as timber or pulpwood production or recreation. The distinction between intensive and extensive wildlife conservation is not sharp and in practice there are many gradations between.

Intensive conservation

Nature reserves are usually created with specific objectives in mind and management is concerned, as always, with marrying together the resources, including time, money, manpower and technical ability, available to achieve these objectives. The formulation of management objectives for nature reserves is thus in theory straightforward but these objectives are often very difficult to put into practice. For example, a common management objective is 'to maintain an uneven-aged, naturally regenerating woodland dominated by oak'. This represents three objectives and if they are all compatible no problems may arise. If they are not, then it is necessary to state priorities. Is it the uneven-age, natural regeneration or oak that is the major feature to be maintained? If we cannot have them all which must we have?

An example might illustrate better the problems which arise. Monks Wood was established as a National Nature Reserve in England in 1949. Its management objectives are:

(1) To obtain variants of ash–oak woodland, both natural and managed, typical of the heavy clays bordering the fens.

(2) To preserve as a viable ecological unit sufficient coppice-with-standards woodland – the traditional form of management in Monks Wood.

(3) To maintain a diversity of habitats, such as fields and rides, and special communities such as aspen, sallow and blackthorn supplementary to the woodland and coppice areas and thereby to maintain conditions suitable for the preservation of the variety of fauna and flora associated with Monks Wood.

(4) To provide facilities for study, research and education so far as these are compatible with the other management objectives.

The number of plant and animal species so far recorded for Monks Wood (Steele & Welch 1973) are:

plants		
vascular plants	379	
bryophytes	97	
lichens	34	
larger fungi	336	
total plants		846
animals		
invertebrates	2858	
amphibians and reptiles	10	
birds	115	
mammals	25	
total animals		3008
grand total		3854

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The list is very far from complete but it is clear that it is impossible to plan in detail for the management of each species. To enable any management to be carried out assumptions must be made. For Monks Wood these assumptions were:

(1) Woodland has been the dominant vegetation over much of the reserve throughout recorded history and probably long before. Many of the plants and animals in the reserve are woodland species so woodland is needed to maintain them. So far as it is possible to judge the woodland has been of the oak–ash type so the maintenance of oak–ash woodland may be the most effective way of maintaining the flora and fauna.

(2) The coppice-with-standards system of silviculture has been practised at Monks Wood for centuries so some of the species may need the conditions produced by this system.

(3) Many species of invertebrates are dependent on specific food plants. To keep a variety of invertebrate animals it is therefore necessary to maintain a variety of plants.

(4) Different organisms need different habitats. The larger the range of habitats in the woodland the greater the number of species that can be maintained.

(5) Against all this it may be that the plants and animals of an area are best maintained by allowing the area to develop naturally, i.e. a *laissez-faire* policy may be the most effective way of maintaining the greatest variety of plants and animals.

Monks Wood National Nature Reserve is thus being managed to maintain the larger plants and the existing habitats. It is assumed that if the variety of plants and habitats are maintained then the variety of animals will also be maintained. To facilitate the achievement of all the management objectives the woodland is divided into five blocks in each of which one management objective has priority. Thus although there are several management objectives for the reserve each has priority in specified areas.

Nature reserves may be used for purposes additional to wildlife conservation, e.g. for research and education, but comparatively few are also used deliberately for wood production. This is unfortunate as there seems to me to be very strong reasons for seeking to combine wood production with wildlife conservation not least of which is the very small area of land in Britain relative to its population. The extent to which these objectives can be integrated will vary, but many forestry practices are compatible with the maintenance of a rich variety of wildlife. For example, regular coppicing is a proved and valuable way of maintaining a rich field layer and invertebrate fauna and the coppice-with-standards management system can maintain a very wide range of wildlife. Once conservation objectives are clear and are being achieved there is every reason to use a woodland for other subsidiary purposes.

Extensive conservation

All woodlands contain wildlife whether or not the maintenance of this wildlife is a management objective. The question to be asked in extensive conservation is not whether wildlife should be maintained but how far will management be orientated specifically towards wildlife conservation. This is a matter partly of policy and partly of the technical skill and judgement of the manager. Management prescriptions have to be put into practice on a local basis but there is much to be said for planning the integration of extensive wildlife conservation with timber or other types of forestry on a bigger scale, preferably in regions which have some ecological and historical coherence. An example of a far-sighted approach to such an integration is given in the Chilterns Plan put forward by the Chilterns Standing Conference (1971).

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Methods that can be used in extensive conservation include:

(1) Using part of the woodland for nature conservation. This may be on areas which are less suitable for other uses such as timber production or recreation. This is in effect creating nature reserves in part of a woodland.

(2) Using tree species which encourage a variety of wildlife.

(3) Maintaining structural diversity.

(4) Maintaining a diversity of plant species.

(5) Maintaining cover and hence shelter.

(6) Maintaining a variety of habitats.

The methods used will depend on the main management objective as well as the subsidiary objectives. A general description of methods of maintaining wildlife in forests is given in Steele (1972*a*). More detailed descriptions relating management to bird life are given in Williamson (1970).

Nature reserves are fixed in position and site management is aimed at achieving a fixed objective. This is not so with extensive conservation. For example, a young plantation favours scrub nesting bird species and a mature plantation may favour the hole nesters. Thus any particular site will be useful for the conservation of different types of organism at different times. By planning the management of a large area conditions suitable for the maintenance of the flora and fauna can be provided somewhere within that area but a given site may not be suitable for a particular plant or animal at all times. However, it is one thing to provide suitable conditions and another to ensure that they are colonized by the appropriate plants and animals. Many species of both plants and animals are remarkably slow to move from one area to another and once lost from a site may be extremely difficult to get back. This danger is reduced if felling areas are kept small and the rotation is kept as long as possible.

A special plea must be made for the retention of small areas of woodlands, or even large groups of trees, in otherwise agricultural landscapes. They are visually important but also have an important function in conserving wildlife. The question of the minimum size of woodland for wildlife conservation is frequently raised. Given a free hand there may be theoretical reasons for conserving woodlands of certain sizes for certain species but in as densely populated and cultivated an area as Britain a free hand is seldom available. A large woodland may be preferable to a small woodland and a small woodland to a clump of trees but even a single tree is better than no trees at all. What is practical and available must be used and developed and not ignored because it is not ideal.

The conservation of wildlife in woodlands costs money. These costs can be incurred in several forms (Lorrain-Smith 1972). Increased expenditure may be incurred by small-scale working, by using mechanical or hand rather than chemical weeding, by increased fencing costs due to coupes of irregular outline, or by having to alter the timing of operations. Smaller cash receipts may result from leaving some old trees or leaving some areas uncleared or undrained. Delayed receipts will be obtained if rotations are lengthened or if slower growing species are planted or species which have no value in small sizes. Quantifying the loss to timber production of wildlife conservation measures is not difficult but how does one quantify the benefits? How does one get an estimate of the net benefit, that is the benefit remaining when what has to be paid is offset against what has been gained? It is fairly easy to assess the value of some of the benefits, e.g. marketable produce, sporting rights; it is less easy to assess other values, e.g. research benefit or the possibility of biological control of pest species; and almost

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impossible to value bird song or the visual beauty of a woodland. The questions raised are complex and cannot be gone into in detail here (see Grayson 1972; Helliwell 1973). Even if it is not possible to quantify the value of all benefits from conserving wildlife it is helpful to count the cost as this can assist in making management more efficient.

Conclusion

Because a benefit cannot be properly valued in financial terms does not mean that it cannot be recognized as a benefit. The case for conserving wildlife can be argued on various grounds (Lorraine-Smith 1972):

(i) Financial, e.g. the return from pheasants or deer.
(ii) Sport, e.g. shooting.
(iii) Possibilities of using woodland species for biological control of pests.
(iv) Maintenance of plant and animal gene pools.
(v) Possibility of future economic use of species that have no present economic value.
(vi) Recreation, e.g. photography, bird watching, walking, pioneering.
(vii) Amenity, e.g. landscape and general enjoyment of the countryside.
(viii) Research, e.g. as an aid to understanding our environment and the relation between animal and plants and the communities they form.
(ix) Moral, e.g. man's trusteeship for the plants and animals he has inherited.

Whichever of these or other reasons or combinations of reasons appeals to each of us there is no doubt that many people feel that wildlife should be conserved. I suggest to you that woodlands provide the most attractive and effective way of conserving a very great number and wide variety of plants and animals.

Johnston (1972) states that 'Foresters have responded to uncertainty (in relation to policy) by choosing species for afforestation which will produce a versatile, non-specialized product capable of a number of applications in industry'. We must consider extending this idea so that we produce versatile, non-specialized forests. To do so planning for wildlife must be introduced at the same time as planning for timber or pulp or recreation. By doing so we shall help to ensure that our forests can meet all the different demands made on them in the future.

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