Comment

MANAGEMENT FOR BIODIVERSITY IN BRITISH WOODLANDS – STRIKING A BALANCE

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With the possible exception of a handful of small inaccessible gorges and islands, there is hardly any woodland in Britain today that could be regarded as natural. Our heritage of ancient woodland has been almost entirely modified by centuries of cutting, planting, burning and grazing. Nonetheless, British woodland is extraordinarily varied in its plant and animal life. This richness is partly a product of man's treatment of woodland, which has differed from one region to another, and partly reflects the fact that Britain is so diverse in topography, soils and climate.

Against this background, it is not surprising that the historical interaction between man and woodland has emerged as a major theme in woodland conservation in Britain. By 'woodland conservation' we mean the ways in which the biodiversity of British woodland can be maintained and, so far as possible, enhanced. Three main processes are involved (Kirby 1993; Kirby & Rush 1994; Fuller & Peterken 1995):

1) the protection of ancient semi-natural woods and their associated management practices;
2) the integration of conservation management into commercial forestry;
3) the creation of 'natural' woodland habitats.

In this article we explore approaches to woodland conservation in Britain. We argue that conservation in woodland is best served by seeking

to maintain a balance between different woodland types, in terms of growth stage, management type and tree-species composition. It has been suggested that conservation in Britain should focus on natural processes and the later stages of succession (Hambler & Speight 1995). Whilst an increased area of 'mature and old-growth woodland' is certainly desirable, we argue that a policy that goes too far in this direction would actually diminish biodiversity within British woodland.

Biodiversity is concerned with the full range of variation among living organisms. Strategies for its conservation within Britain have been published by government (HMSO 1994) and the voluntary conservation bodies (Wynne *et al.* 1995). Implicit in the biodiversity concept, and this is fully recognised in both strategies, is the fact that conservation of biodiversity cannot be achieved simply by concentrating on those places or habitats with the largest number of species. An appreciable part of our wildlife, including many rare and specialised species, is restricted to places that are relatively poor in numbers of species. Examples are moorland and heathland, which are generally species-poor in higher plants and vertebrates but which, nonetheless, support several species that are confined to these habitats. The importance of conserving as wide a range of habitat types as possible, together with their associated biological communities, was recognised in *A Nature Conservation Review* (Ratcliffe 1977) and remains a cornerstone of conservation in Britain. Looking at the issue another way, biological diversity can be measured on several different scales (Whittaker 1977): at the level of individual habitats (alpha diversity), at the level of the landscape, which is composed of several different habitats (beta diversity), and across different landscapes (gamma diversity). Diversity on the larger scales is essentially a cumulative effect of diversity on the smaller scales, so land-use and habitat management on the scale of the individual site are extremely important factors determining biodiversity.

Extending this thinking further in a woodland context suggests that conservation policies should embrace all stages of growth and a variety of management systems, as well as botanical woodland types, so as to create and maintain conditions for a wide range of plant and animal communities. We discuss how this might be achieved both on the scale of individual woods and more widely across woods. The so-called traditional management practices, novel approaches to treating woodland and minimum intervention all have a role to play. It is essential to realise in conservation management that one cannot cater for all species at all woodland sites. Nor is it desirable to manage by following rigid prescriptions. To attempt to do so may compromise the special features of individual woods and could eventually lead to a loss of woodland biodiversity. It is far more appropriate to follow general principles (e.g. Fuller & Peterken 1995) and to adjust them to suit individual sites. The importance of determining objectives for individual sites cannot be stressed too highly.

Bob Gibbons

Inaccessible ravine woodlands, like this example in the Wye Valley, have been relatively little influenced by management.

Variation in the wildlife of British woodland

From the perspective of biodiversity conservation in British woodland, four major gradients of variation need to be considered. These are:

- geographical location,
- plant-species composition,
- physical structure and
- soils/hydrology.

Box 1 A summary of factors that determine the numbers, types and abundance of breeding bird species occurring in woods. For further details, including references, see Fuller (1995)*.

1 Geographical location Woods in southern and eastern Britain tend to support more species than ones in northern and western Britain. Many bird species have restricted ranges within Britain so the 'species pool' differs from one region to another. For example, Lesser Spotted Woodpecker, *Dendrocopos minor*, Nightingale, *Luscinia megarhynchos*, and Marsh Tit, *Parus palustris*, are essentially south-eastern species, but Wood Warbler, *Phylloscopus sibilatrix*, and Pied Flycatcher, *Ficedula hypoleuca*, are mainly western and northern.

2 Altitude The number of species and density of birds decline with increasing altitude, though this has not been studied in Britain.

3 Land productivity The density of birds tends to be greater in woods that are growing on fertile soil than in woods on unproductive soil.

Hans Gebuis/Aquila

The Pied Flycatcher is a classic bird of western and northern oakwoods with a sparse understorey.

4 Woodland area The number of species increases with size of the wood but the overall density of birds decreases with size of wood. Some species may avoid very small woods. Furthermore, small woods may support less stable bird communities than large woods.

5 Woodland isolation There is evidence from other countries that some bird species occur less frequently in woods that are relatively isolated from other woods. Woodland isolation is of far less significance to birds, which as a wildlife group are highly mobile, than to many invertebrates and plants.

6 Edge effects The length and structural characteristics of internal edges (e.g. edges of rides and boundaries between compartments), but especially of external edges, can be an important influence on densities of several bird species. Examples of bird species that are often associated with external edges are: Garden Warbler, *Sylvia borin*, Blackcap, *S. atricapilla*, Chiffchaff, *Phylloscopus collybita*, Willow Warbler, *P. trochilus*. Unlike in North America, there are no genuine forest-interior bird species in Britain, i.e. ones that avoid the woodland edge.

7 Growth stage and patchiness Different stages of growth in coppice, plantations and natural woodland support very different bird communities. Some species are confined to the earliest, open stages of growth (e.g. Whitethroat, *Sylvia communis*, and Yellowhammer, *Emberiza citrinella*) and others to the older stages (e.g. Nuthatch, *Sitta europaea*, and woodpeckers). Some species are more or less confined to the intermediate bushy stages (e.g. Nightingale, Garden Warbler, Willow Warbler). Generally, the numbers of bird species and the overall bird density increase as the trees grow. Because growth stages differ in their characteristic bird species, woods with a wide variety of growth stages will tend to hold the most species.

8 Stand structure The more complex the woodland vegetation, in terms of the numbers of layers of foliage, the richer the bird community tends to be. Woods with dense shrub and field layers generally support more species and higher densities of birds. Some species, however, such as Wood Warbler and Pied Flycatcher, prefer woods with sparse undergrowth. Structural 'microfeatures' of importance to birds are tree holes and dead wood: the former for nest sites, the latter as a food source for insectivorous birds.

9 Tree species Different trees vary in the types and amounts of foods, and in the nest sites, that they offer birds. Furthermore, different tree species tend to create stands that vary in understorey structure and amounts of tree holes and dead wood. Accordingly, there is much variation in the bird communities of stands composed of different tree species. In general, broadleaved stands support more species and higher densities of birds than conifer stands.

10 Social factors Some species may be attracted to settle in places where other individuals of the same species are already present, possibly because established birds are used as indicators of suitable habitat. It is possible that such mechanisms could lead some species to show patchy distributions, thus leaving some areas of otherwise suitable habitat unoccupied.

11 Population size Where the regional population size of a species is large, it is more likely to be present in any particular wood. When numbers are low, it is most likely that birds will be confined to the best-quality habitats but will be absent from poorer-quality habitats that might nonetheless be occupied when the population size was higher.

* No attempt has been made to rank the factors in order of importance. Many will be inter-related and in practice it can be extremely difficult to isolate the effects of any one of these factors from the others.

Many species of plant and animal show a marked restriction of range that does not relate obviously to the distribution of their preferred habitat. In some cases this may be because there is a climatic limit to their range. One of the best examples of such a species is Small-leaved Lime,

Table 1 Perennial herbs of ancient woodland considered by Barkham (1992) to be ones likely to benefit from either coppicing or non-intervention.

Coppicing (light-demanding)	Non-intervention (shade-tolerant)	No preference
Adoxa moschatellina	*Allium ursinum*	*Anemone nemorosa*
Calamagrostis canescens	*Convallaria majallis*	*Hyacinthoides non-scripta*
Campanula latifolia	*Lamiastrum galeobdolon*	
Carex pendula	*Luzula sylvatica*	
Conopodium majus	*Mercurialis perennis*	
Narcissus pseudonarcissus	*Sanicula europaea*	
Orchis mascula		
Paris quadrifolia		
Primula vulgaris		
Ranunculus auricomus		
Veronica montana		
Viola reichenbachiana		
Viola riviniana		

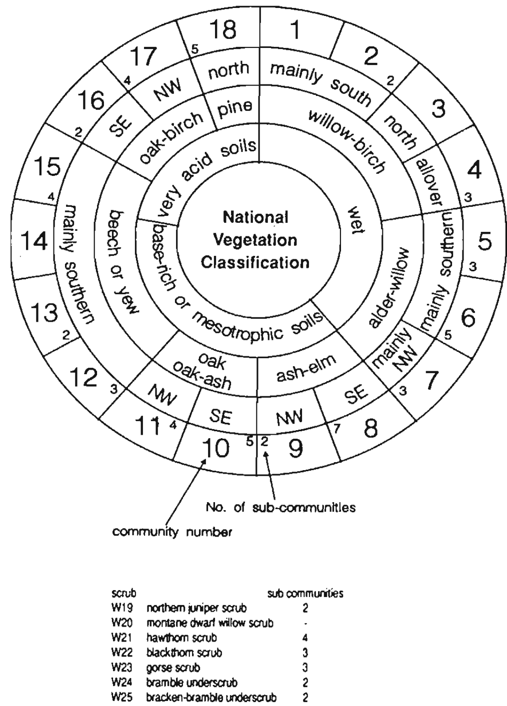
Tilia cordata (Pigott 1991). Similar habitats in different regions may, therefore, carry rather different communities of plants and animals. Maintaining different woodland types (defined in both botanical and structural terms) throughout their current ranges is extremely important.

The National Vegetation Classification has provided a framework for describing the botanical variation in British woodland (Rodwell 1991). The classification recognises 25 woodland and scrub communities with the emphasis on semi-natural woodland vegetation and is based on the ground flora as well as the trees and shrubs. There are six types of mixed deciduous woodland, three of Beech, *Fagus sylvatica*, woodland, seven types of wet woodland, Yew, *Taxus baccata*, woodland, Juniper, *Juniperus communis*, woodland, Scots Pine, *Pinus sylvestris*, woodland and six types of scrub or underscrub (see Fig. 1 and summary in Kirby *et al.* 1991). In addition, a range of sub-communities is recognised. Peterken (1993) has developed an independent classification of woodland based on variation in tree composition.

For many animals, however, the structure of woodland is at least as important as its botanical make-up (e.g. Elton 1966; Warren & Key 1991; Kirby 1992; Fuller 1995). There is immense structural variation in British woodland: for example, woods vary in the size of their trees, the density of their undergrowth, and the openness of their canopies. To some degree this variation is linked with the botanical woodland type, but often it is strongly influenced by man's treatment of the woodland. The stage of growth and the dominant management system have striking effects on the types of plant and animal communities found in a wood.

Different management systems produce contrasting vegetation structures with particular communities of associated animals. From a conservation perspective, therefore, different woodland management systems should be regarded as complementary. Each of the three main classes of woodland management – coppice, high forest and wood-pasture – can be implemented in dif-

Figure 1 NVC woodland and scrub types (from Kirby *et al.* 1991)



ferent ways, leading to substantial variation in woodland structure. Within coppice, for example, at least five components can be varied: length of rotation, density of standard trees, the dominant tree species, density of coppice stools and size of panels. The bird populations found within any area of coppiced woodland will be strongly influenced by these management variables (Fuller 1992). There are also substantial differences in bird communities between the management variants of high forest (Fuller 1995).

Woods differ in the numbers and types of animal species they support, and there can be huge variation in the population density of many species both within and between woods. As an example, Box 1 summarises the large number of factors thought to lie behind this variation for bird communities in British woodland. Similarly complex effects operate for other wildlife groups. Despite the complexity of the factors determining bird communities, some have a far more obvious effect than others, in particular growth stage and stand structure, both of which are largely determined by the management system.

Conservation effort within woods has focused on the two ends of the growth spectrum: very young open stages and very old trees (Warren & Key 1991; Fuller & Peterken 1995). We term these *young-growth* and *old-growth* respectively. Both of these broad habitat types have become increasingly scarce and fragmented in British woodland and require positive measures to maintain their associated wildlife. The special conservation interest of each of these stages is outlined in the following two sections.

The conservation value of young-growth habitats

Many studies of individual species of plants and animals in British woodlands have highlighted the importance of early successional habitats, ranging from permanent grassy or heathy glades to young regrowth in coppice or plantations. The exact requirements of individual species differ, but key features of such habitats for wildlife seem to be:

- structural diversity close to the ground;
- botanical diversity: a mix of light-demanding and shade-tolerant species;
- warm microclimate/increased sunshine at ground level;
- great microhabitat diversity, ranging from bare ground, low ground flora to shrubby regrowth;
- possible increased palatability of young growth to herbivores;
- high invertebrate diversity and biomass, providing good food sources for bats and birds;
- juxtaposition of habitats: open habitats, wood-edge habitats and mature woodland to create a habitat mosaic;
- historical continuity in lowland areas due to human activity, notably coppicing.

The changes in the ground flora following coppicing and clearance have been well researched (e.g. Mitchell & Kirby 1989; Barkham 1992; Peterken 1993). After cutting, the number of plant species increases; many of the existing perennial and shade-tolerant plants grow more vigorously and are joined by other annuals, biennials or perennials which develop from buried seed, wind-dispersed seed, or vegetative spread. Growth and flowering of many species peaks 1-3 years after cutting, producing the spectacular show of flowers characteristic of many actively coppiced woods. After this period, a smaller number of more vigorous species tends to dominate and plant diversity declines slowly. Following canopy-closure (the timing of which varies from stand to stand) only shade-tolerant plants persist, often at a low level of activity (particularly if shade levels are great where tree regrowth is vigorous). One view of which species of perennial herbs are likely to benefit from coppicing in ancient woodland is summarised in Table 1.

Open spaces and early successional habitats are extremely important to invertebrates. The sheer number of species (30,000 or more in Britain) and huge variety in lifestyles confound an easy summary, though an admirable attempt has been made by Kirby (1992, 1994). In the most comprehensive study of invertebrates in coppiced woodlands, Steel & Mills (1988) found that both the species richness and abundance of the ground fauna peaked just 1-2 years after cutting and low-vegetation fauna after 2-3 years. They found similar patterns among the fauna of the bark and lower canopy of standard oak trees

Paul Sterry/Nature Photographers

Recently coppiced Hazel woodland with typical spring flourish of Lesser Celandines, Early Purple Orchids and Bluebells. The re-growth at this stage also supports a wide variety of invertebrates.

present within the coppice. In all their samples, invertebrate diversity and abundance were higher, sometimes substantially higher, in the early successional stages compared with a 40-year-old abandoned stand nearby. They concluded that the increased productivity of ground flora, coppice regrowth, and oak standards simply allowed more invertebrates to survive.

Although many invertebrates are associated with middle-aged woodland and high forest (e.g. Sterling & Hambler 1988; Waring & Haggett 1992) and diversity can be very high in these habitats, there is no doubt that a substantial proportion of woodland invertebrates depend on early successional stages (e.g. Fry & Lonsdale 1991; Warren & Key 1991; Greatorex-Davies & Marrs 1992; Kirby 1992). From a conservation perspective, some of these are especially important as they are either extremely rare or rapidly declining. Some of the most well-known are butterflies such as the High Brown Fritillary, *Argynnis adippe*, and Heath Fritillary, *Mellicta athalia*, which have suffered sudden and widespread declines during the present century (approximately 94% and 82% respectively: Warren 1992, 1994). The Pearl-bordered Fritillary, *Boloria euphrosyne*, is now declining by over 40% per decade in many southern counties. Of the 16 true woodland butterflies, half are strongly associated with early successional stages or wood-edge habitats (Warren & Fuller 1993). Among the 125 scarcer woodland moths, around 60% occupy transitional stages, including open woodland rides, clearings and scrub (Waring 1989). Other examples of declining early-successional invertebrates are the beetles *Chrysomela tremula, Cryprocephalus coryli* and *C. nitidus* and the syrphid fly *Cheilosia fasciata* (Warren & Key 1991). The biological importance of early-successional and woodland-edge habitats appears not to be just a British phenomenon. For example, a wide-ranging study in Germany found that the richest terrestrial ecosystems for animals were open glades in woodland (Heydemann & Muller-Karch 1980).

Several bird species prefer early-successional woodland or scrub. These include a high proportion of long-distance migrants such as Turtle Dove, *Streptopelia turtur*, Tree Pipit, *Anthus trivialis*, Nightingale, *Luscinia megarhynchos*, and several species of warbler. Within coppiced woodland, it is possible to identify several phases in the development of bird communities corresponding with the structural growth of the coppice (Fuller 1995). The earliest stages where the canopy is very open are typified by Tree Pipit, Dunnock, *Prunella modularis*, Whitethroat, *Sylvia communis*, and Yellowhammer, *Emberiza*

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Seatoller Woods in the Lake District, a western, grazed woodland important for epiphytes and saproxylic invertebrates.

citrinella. As the canopy closes, these species are replaced by Nightingale, Garden Warbler, *S. borin*, Blackcap, *S. atricapilla*, Chiffchaff, *Phylloscopus collybita*, and Willow Warbler, *P. trochilus*. Further growth of the coppice and shading of the understorey results in the loss of many of these species, which, in turn, are replaced by others such as several species of tit and Robin, *Erithacus rubecula*. Surprisingly, woodlands hold rather few rare or threatened birds, but some young-growth species such as Nightingale and Turtle Dove have declined substantially in recent years, though it is unclear how much of this can be attributed to change in their breeding habitats rather than to problems on their over-wintering grounds in Africa.

The abundance of mice, voles and shrews can increase substantially in early-successional woodland (e.g. Gurnell *et al.* 1992), but most species occur in grassy habitats outside woodland. The main exception is the Common Dormouse, *Muscardinus avellanarius*, which is an arboreal species associated with the closed-canopy in the middle to late phases of the coppice cycle. It seems to benefit from the mixed structure and variety of foodplants, such as Bramble, *Rubus fruticosus* agg., that are associated with this phase of woodland development (Bright & Morris 1991; Gurnell *et al.* 1992).

The conservation value of old-growth habitats

The term 'old-growth' has been used in rather different ways by different authors (e.g. Thomas *et al.* 1988; Peterken 1992). In this context we define it as stands composed predominantly of large trees that have been allowed to grow well beyond their economic felling age and where there are large quantities of dead wood in various stages of decay, both as standing dead trees and as fallen wood. A wide range of microhabitats is associated with old-growth, including various kinds of rot holes and fungal growths. These features are scarce in woodland across western Europe because of the long history of human exploitation. Old trees support a large number of saproxylic invertebrates, many of which are now extremely rare and endangered. Thomas & Morris (1994) have shown that saproxylic species account for almost 40% of Britain's extinct, endangered and vulnerable invertebrates. Two orders – Coleoptera and Diptera – are particularly rich in saproxylic species and are typified by species such as the cardinal click-beetles, *Ampedus* spp., and rot-hole hoverflies, e.g. *Pocota personata*. Many saproxylic invertebrates require open areas adjacent to their breeding habitats where an abundant supply of flowers can provide nectar for the adult stages (e.g. Harding & Rose 1986; Warren & Key 1991; Kirby 1992). Mature and old-growth

S G Ball/JNCC

RS Key

R S Key/English Nature

English Nature

Invertebrates dependent on deadwood exhibit a variety of niches as illustrated by four species shown clockwise from top left: the bumble-bee mimic fly *Pocota personata* breeds high up in rot holes in large Beeches; the longhorn beetle *Anaglyptus mysticus*, a species that requires a combination of mature deadwood positioned in the sun and nectar sources in sunny areas; the click beetle *Ampedus cardinalis* needs cool, damp, heart-rotted oak; *Xylota segnis* is a common deadwood hoverfly with catholic tastes in deadwood breeding habitat, even using saw-dust heaps.

habitats are also extremely important for fungi, lichens and bryophytes (e.g. Harding & Rose 1986; Marren 1991; Rayner 1993; Rose 1993). The communities of epiphytes are often very rich and in some cases are likely to be relics of epiphytic communities that occurred in the wildwood. Some British epiphytic assemblages are of international importance, such as the *Lobarion* communities and bryophytes in Atlantic woods. Old-growth can support distinctive assemblages of hole-nesting birds, and the cavities in old trees, both dead and living, are important sites for bats.

The most impressive stands of ancient trees and accumulations of dead wood survive among the relic ancient pasture woods where the character and ecology of the woodland have been shaped by a long history of grazing (Chatters & Sanderson 1994). It would be a mistake to assume that the special interest of wood-pasture can be maintained without human intervention. The continuity of old trees and associated deadwood habitats is essential because many saproxylic invertebrates are sedentary and, therefore, could not readily recolonise in the event of a lapse in habitat availability. To maintain habitat continuity it may be necessary to undertake carefully planned actions such as pollarding and premature tree-ageing, while management may also be needed to maintain any open areas providing food sources for saproxylic invertebrates (for details see Speight 1989; Read 1991; Warren & Key 1991; Kirby 1992; Kirby & Drake 1993). The decline of saproxylic species is a major conservation concern across Europe, where many countries have far fewer old trees than Britain (e.g. Speight 1989). Strict legal measures protecting Royal Forests and the long continuity of land tenure on large private and royal estates have perhaps left us with more old trees than in many other countries. Such habitats are thus a major conservation priority.

The role of historical changes in determining conservation priorities for invertebrates

There are, of course, scarce and declining species associated with 'middle-aged woodland', such as

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In the past, large mammals, such as Wild Boar, had an important influence on the structure of some of our woodlands.

the Light and Dark Crimson Underwing moths, *Catocala promissa* and *C. sponsa*. These habitats are undoubtedly vital for the maintenance of biodiversity in Britain and certainly merit closer attention from ecologists. However, many of the species known to depend on these mid-succession stages appear to have quite wide tolerances of woodland management and occupy rather broad niches. Consequently, in terms of species conservation, they do not seem to be such an urgent priority as the species of early- and very late-successional woodland, which offer the main conservation challenge, especially where they depend on very specific transient stages of woodland growth. Similar conclusions were reached by Warren & Key (1991) and Thomas & Morris (1994).

The most likely explanation for this pattern is the nature of historical change in the management of British woodland. The area of high forest and 'middle-aged' deciduous woodlands has actually increased in the last century by around 36% compared with early-successional coppiced habitats, which have undergone a 94% loss, and 'old-growth' habitats, which disappeared many centuries ago except in relic wood-pasture (Warren & Key 1991). These historical changes have led to changing fortunes in invertebrates associated with different successional stages and to severe declines in species associated with the two extremes of young and old growth.

More 'natural woodland'?

Old-growth stands are extremely scarce in British woodland, and those that do exist have generally been modified by unnaturally high grazing pressure. The potential value of creating woodland stands that exhibit natural structural characteristics has been recognised from several different perspectives (Peterken 1991; Peterken *et al.* 1992; Fuller 1995; Hambler & Speight 1995). With this background, an increasing number of British woods, or parts of woods, are being left for natural processes to take their course (Phillips 1994). Most such places are within nature reserves and the majority of areas involved are small (often <10ha). One of the best-documented examples is Lady Park Wood where a substantial area of woodland supporting a rich mixture of trees has been allowed to develop naturally since 1944 (Peterken & Mountford 1995). It may never be possible to create a truly natural woodland in Britain, but, for convenience, we use the term 'natural woodland' to denote stands where attributes of natural growth (e.g. massive trees, accumulation of dead wood) are allowed to develop over a long period of time.

This trend towards minimum intervention (as discussed below, true non-intervention may be appropriate in rather few cases) in British woodland is welcome for several reasons. More natural and, possibly, new assemblages of plants and animals are likely to develop, saproxylic invertebrates being one group that is likely to benefit in the very long term. The resulting habitats will be shaped by natural processes, which will offer new educational and research opportunities. These more natural woods will also create a baseline for assessing effects of habitat change in managed woods. In addition, there are aesthetic arguments for wishing to see more so-called natural woodland.

It is important, however, to be realistic about what can be achieved through minimum intervention. It is unlikely that increasing the area of natural woodland will result in many new species using British woods (i.e. colonising from Europe), even on a long timescale. This is because species that depend on substantial areas of old-growth probably became extinct in Britain long ago, and it is most unlikely that natural woodland will develop on a large scale in terms of

either number or total area. Similarly, it may take an extremely long time for the scarcer species associated with our existing old-growth woodland to establish themselves in the new natural woods, because their dispersal ability is often weak. Possibly this process could be enhanced by siting some minimum-intervention areas adjacent or close to existing old-growth.

The real benefits of a policy of minimum intervention will take many years, even centuries, to develop. Natural woodland should not be seen as a substitute for existing woodland types but rather as complementary: an opportunity to diversify yet further the range of types of British woodland. There are strong arguments in favour of aiming for some large (several square kilometres) tracts of natural woodland in Britain. Only at such a large spatial scale and over a long timescale will it be possible to appreciate the real dynamics of a natural forest and the full range of successional stages and microhabitats. Even then, some of the features of the prehistoric wildwood will be missing. Several of the mammals that played a role in creating or maintaining gaps are now extinct, for example, Beavers, *Castor fiber* (Worsley 1978; Coles & Orme 1983), Aurochs, *Bos primigenius*, and Wild Boar, *Sus scrofa*. Nonetheless, it should prove possible, even in the absence of these animals, to encourage natural woodland structures containing a mosaic of old-growth and open areas where the main agents of change would be windblow and tree diseases.

Natural woodland should not be regarded as a simple option, because it raises many difficult questions about the level of intervention that is acceptable. Clearly, we cannot hope to re-create the conditions that prevailed over much of lowland England several thousand years ago, even on a small scale. So what sort of naturalness should we seek? This article is not the place to deal with this issue in detail, but decisions need to be taken about attitudes towards invasive species such as Sycamore, *Acer pseudoplatanus*, and whether to reduce the impacts of extremely large deer populations. Such decisions perhaps need to be taken on a site-by-site basis.

Concluding thoughts

If Britain were rich in virgin forest, there is no doubt that protection of this habitat would be one of the most important conservation issues, as it is in North America and the Tropics. The reality is that we greatly value the existing variety of woods and woodland wildlife that are products of a long history of human activity superimposed on a diversity of climate and soils. Accordingly, Kirby (1993) has suggested that a key objective for woodland conservation should be to maintain and expand the area of ancient semi-natural woodland, which, by implication, involves reducing any further loss of its distinctive plant and animal communities. Kirby (1993) suggested further objectives which can be applied to all woodland, not just to ancient woodland:

1) maintain and enhance the populations of all woodland species in particular those that are rare;
2) maintain the traditional range of native species and communities.

In working towards these objectives, it is clear that there is no single 'best' management method for woodland wildlife. We need to integrate both young-growth and old-growth into our woodland by adopting different management strategies in different places. There is a strong case for seeking to establish woodland reserves that complement one another in terms of broad structure. This balanced strategy is the one most likely to maintain biodiversity, but it raises the issue of how to decide exactly what policy to pursue where. The following points may help to tackle this question.

1) **Setting the objectives** The five general considerations in Box 2 may be helpful in setting the wildlife priorities and objectives when planning the management for individual ancient woods. Many potentially conflicting demands between different species or wildlife groups can be resolved by developing a clear understanding of the objectives for individual woods. If in doubt, consult relevant experts and undertake surveys to establish the status of existing features or species of interest before reaching a decision. People often have deep affection for 'their' woods, so always explain what is being done and why to those who know and use the wood.

2) **The management approach** Do not try to achieve too much within individual woods. In general, it is better to have relatively large areas

Box 2 Five general considerations should be borne in mind when planning the management of ancient woods (reproduced from Fuller & Peterken (1995) with the permission of Cambridge University Press).

1 Woods often act as reserves for the whole landscape, especially in intensively arable regions. Many, for example, should be regarded as grassland reserves, as well as woodland reserves, because ancient rides sometimes carry relict semi-natural grassland. Management of open spaces within the woods may, therefore, be at least as important as management of the tree stands themselves. Many woods are still linked to a network or mosaic of habitats in their surroundings, effectively a 'landscape-scale reserve'.

2 Management should aim to sustain all species now present within the wood. Most woods, especially small woods in intensively arable districts, are now so isolated that species with limited mobility cannot readily recolonise after local extinction.

3 Managers should base silvicultural treatments on the native tree and shrub species already in the wood. Maintenance of each species at its present level of abundance is not necessary, provided all species are retained. Maintenance of their present distributions within a wood is desirable, but minor adjustments are usually acceptable, especially if these come about by natural regeneration.

4 The long-term aim should be a balanced age structure within each wood or cluster of small woods. Ideal treatments should aim to (i) maintain a continuous supply of young growth through regular felling and (ii) protect and enhance mature features, such as large trees and dead wood.

5 In the great majority of ancient woods, management should either continue or revive the management which was traditional in the wood, or incorporate the main habitat features of traditional management within high-forest systems. The creation of near-natural woodland is, however, an entirely valid objective for some ancient woods.

under particular management systems, though rarely is this feasible with conservation coppice, which often forms just a fraction of the woodland area. General prescriptions about woodland management have their limits – it is important to maintain regional identity where it exists (the Natural Areas approach of English Nature is a step in this direction; English Nature 1993) and to recognise unique or special features of individual woods. Always try to integrate management for rare species into the management of the wood as a whole, having regard for the wider wildlife interest as well as forestry and financial imperatives.

3) **Continuity and sustainability** Maintaining continuity of management is vital at sites with a long history of either young-growth or old-growth. For example, in the case of coppicing, the priority is to maintain or revive this management on sites where it has a long unbroken history, or only recently fragmented history, or where there has been continuity of young-growth nearby. Start coppicing (or, indeed, any management regime) only where it is sustainable. Even on nature reserves, many coppice plans are too ambitious given labour requirements, specialised markets and pressure from deer. In the face of increasing deer numbers, it is becoming increasingly difficult to regenerate coppice in many areas. Recoppicing may not be the best option in long-abandoned coppice (Fuller & Peterken 1995).

4) **Minimum intervention** In selecting sites for minimum-intervention it is essential to ensure that the value of existing important sites is not reduced. It would be folly to abandon felling and grazing in established coppice and wood-pasture respectively. To do so would result in loss of already scarce habitat types. There are many opportunities for locating minimum-intervention woodland (i.e. future natural woodland), both in ancient and in recent woodland, that do not compromise existing values. For instance, many large areas of derelict mixed coppice exist in lowland England. Their current structure is often one of leggy underwood beneath scattered large standards. Given time, many of these woods will gradually assume a high-forest appearance.

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An information pack on the conservation of woodland butterflies and moths is available for £3.95 (incl. p. & p.) from Butterfly Conservation, P.O. Box 444, Wareham, Dorset BH20 5YA. For details of current BTO activities write to BTO, The Nunnery, Thetford, Norfolk IP24 2PU.

Managing Woodland for Biodiversity Course

A course entitled 'Managing Woodland for Biodiversity' will be held on 7th-10th May 1996, at the Kingcombe Centre, led by Martin Warren, Rob Fuller and Andrew Poore. For further details, contact the Kingcombe Centre (tel. 01300 320684).