Table 4.1.3b. The eight woodland types recognised in the Forestry Commission's Guides.

	Woodland type (Forestry Authority 1984)	NVC equivalent woodland types	Estimated area in GB (1000 ha)
1	Lowland acid beech and oak woods	15, 16	15 - 25
2	Lowland beech-ash woods	12, 13, 14	10 - 15
3	Lowland mixed broadleaved woods	8, 10	130 - 160
4	Upland mixed ashwoods	8, 9	40 - 50
5	Upland oakwoods	11, 17	60 - 70
6	Upland birchwoods	11, 17	15 - 25
7	Native pinewoods	18	16
8	Wet woodlands	1, 2, 3, 4, 5, 6, 7	25 - 35
TOTAL			311 - 396

4.1.4 The total number of minimum intervention reserves

It is easy to designate a wood and then do nothing with it, but that does not constitute a minimum intervention reserve. Grazing pressures may have to be controlled by fencing, stock management or deer control. Invasions by non-native species may have to be resisted. Access and use by people may have to be restricted. Above all, given the scientific basis of minimum intervention reserves, the woodland has to be observed and recorded.

Observing and recording in minimum intervention reserves is considered in section 7.5, but briefly it can be undertaken at almost any level of detail. Casual observation and recording by photography may provide something of value, but only more detailed observations constitute useful science. However, even detailed recording can be undertaken at different intensities and frequencies, and the resources for such recording are far from fixed. All this precludes any calculation relating resources available to the number of sites needed as minimum intervention reserves.

Perhaps the only basis on which the total number of minimum intervention reserves can be determined is to accept the judgement by informed stakeholders (ecologists, conservationists, foresters, etc), bearing in mind (i) the level of resources required, (ii) some concept of the minimum useful provision, and (iii) competing claims on woods and resources.

The proposal here is that a maximum target of 50-60 minimum intervention reserves in ancient semi-natural woodland be sought on a GB basis, which would imply a target of about 30 in England. These reserves relate to the high forest model (3.4): the parallel set of wood-pasture reserves and reserves in other types of woodland (4.1.1) would be additional. This judgement is reached on the following bases:

- a full range of woodland types should be included, spanning several examples of each main type as defined by the Forestry Authority (1994);
- the number is similar to the number of *de facto* minimum intervention reserves, defined as woods in which minimum intervention management is linked to scientific

investigations. This assumes that the resources available for research are unlikely to increase substantially;

- permanent minimum intervention is inappropriate for the great majority of woodland reserves, which will continue to provide benefits for nature conservation, recreation and amenity, and also produce timber.

4.1.5 Selection for representation

The proposed selection for representing the main woodland types is summarised in Table 4.1.5. The basic approach has been to ensure a minimum representation of 5 sites, then supplement this in rough proportion to each type's internal variety, total area, geographical range, and intrinsic importance. The table summarises the considerations for each type.

The total number of sites falls within the target range of 50-60 sites. However, it has little significance, for some minimum intervention reserves will represent more than one site. Potentially, the total number of sites could be far less than the 56 indicated. In practice, each type is likely to form a major component of some sites, and a minor component of several others.

Table 4.1.5. Proposed distribution of minimum intervention reserves between the eight woodland types recognised by Forestry Authority (1994).

	Woodland type (Forestry Commission 1994)	Number of sites	Considerations
1	Lowland acid beech and oak woods	8	Beech-oak woods are widespread, but the strict natural range of beech is geographically limited. Beech-dominated stands often planted. Lowland acid oakwoods often occur in mosaic with other woodland types. Currently interesting, due mainly to recent storm impacts. Special provision required for high representation of wood-pastures.
2	Lowland beech-ash woods	6	Geographically limited to southern Chalk and limestones, but include borderland beech-ash woods in the uplands. Beech-dominated stands often planted. Currently interesting, due to recent storm and drought impacts.
3	Lowland mixed broadleaved woods	12	The most abundant and widespread type. Includes major variation in stand composition: ash-elm on upland fringes; ash-maple; lime-ash; lime-oak; hornbeam; suckering elm, alder-ash (NVC W7). Includes substantial original-natural stands.
4	Upland mixed ashwoods	7	Wide latitudinal, edaphic and topograpical ranges. Limited variation in stand composition. Includes some original-natural stands. Includes alder-ash stands (NVC W7) Examples on both dry and wet soils required. Includes extreme oceanic stands.

	Woodland type (Forestry Commission 1994)	Number of sites	Considerations
	Upland oakwoods	8	Wide latitudinal and topographical ranges. High proportion of stand planted or nurtured as coppice. Examples required on strongly acid soils and base-rich sites. Includes extreme oceanic stands. Should include northern wood-pastures.
6	Upland birchwoods	5	Geographically limited. Stands relatively simple. Include both pure birch stands and hazel-birch stands. Includes woodland at its limits in GB.
7	Native pinewoods	5	Geographically limited, but important as main Boreal type in GB. Examples in the large eastern pinewoods, the oceanic western woods, treeline example, oak-pine woods.
8	Wet woodlands	8	Throughout GB, but limited topographically. Since hydrology is a key factor, need examples where natural drainage and fluvial processses operate. Large riverine sites would span full NVC range. Includes birch stands on bogs. Excludes slope alder-ash stands (some NVC W7)
	TOTAL	56	

4.2 Selecting individual sites

This brief review of selection criteria relates to the core set of minimum intervention reserves (4.1.1).

4.2.1 Area

Theoretically, minimum intervention reserves should be large enough to ensure that the full range of dynamic states will be permanently maintained within its boundary, ie that it is larger than the minimum dynamic area for the woodland type represented. That rule is easily stated, but difficult to realise, because (i) we have very little information on how large the minimum dynamic area actually is for any given woodland type, (ii) woodland types that naturally occur as small patches will be below the minimum dynamic area. The minimum dynamic area for types naturally subjected to large-scale disturbances, such as fire-prone Boreal forests, will be large, at least 100s of hectares. The minimum dynamic area for types that typically function through small-scale gap dynamics will be much smaller, perhaps 30-100ha, but for the rare occasions when the type is catastrophically disturbed the minimum dynamic area should be very much larger. Another consideration affects floodplain forest types that may be disturbed by events in the entire upstream catchment: if we want to reconstruct a natural floodplain forest, we would require a natural river as well. Henk Koop has developed a similar concept, the 'Minimum Structural Area', which has been set at 10-50ha for a variety of woodland types in Belgium (Vanderkerkhove 1998).

Pragmatically, minimum intervention reserves are limited by what is available, but minimum standards should be set. Opinions given by the consultees (Annex) indicated that 20ha would generally be too small. If extrapolations from continental Europe are allowed, the minimum dynamic area for most British forest types would be closer to 50ha. A target of at least 25ha seems reasonable.

4.2.2 Edge effects

Allowance must be made for edge effects (3.1.4), which diminish the effective area of natural woodland. If we accept that the general depth of edge effects is 50m, and that minimum dynamic area is at least 25ha for British woodland types, then the minimum area for a reserve with its buffer zone would be 28.65ha (which would be circular).

4.2.3 Shape

Most woods are elongated to some extent, and this will increase the proportion of the area that is subject to edge effects. The most economic approach is to select compact woods as minimum intervention reserves, but this is often not possible. Woods surviving around outcrops and on the steep valley slopes tend to be elongated, and riparian woodland types must naturally be narrow and elongated. Promontories on an otherwise compact wood are best discounted for minimum intervention reserves.

4.2.4 Context: adjacent land use

Adjacent land uses will have direct impact on the reserve. They determine which species are nearby and will interact with species in the reserve. They also influence the impact of disturbances within the reserve, eg by shielding a stand from wind and the source of fires. The best adjacent land use would be mature forest, managed by continuous cover methods, for this would set the reserve in a context that in many respects increases its effective size.

A minimum intervention reserve may have an impact on its surroundings (3.6). There is an obvious case for separating recreation activities from a minimum intervention reserve, since large trees might fall on nearby car parks or caravan sites (and visitors may damage the reserve). The danger of fire or disease spreading from a natural wood into surrounding land is rarely raised in British conditions, but it may be a consideration in Boreal pine woods.

The research value of a minimum intervention reserve is increased if comparisons can be made with managed woodland on similar ground nearby. This point was made by several respondents. Rob Fuller considered that the pairing of minimum intervention reserves with managed blocks of similar initial tree species should be a key principle of selection.

Adjacent managed woods may mitigate the loss of native species sometimes associated with a minimum intervention reserve. In particular, they could provide refuges for the species of permanent open spaces.

4.2.5 Management history

The special value of ancient semi-natural woods has been discussed (4.1.1). In addition, there is a case for some minimum intervention reserves in secondary woodland (4.3). Most ancient woods include disturbed patches (eg charcoal hearths, abandoned tracks). Many have small secondary portions that have been incorporated with the ancient wood. In giving priority to ancient woodland, there is no need to exclude disturbed ground and secondary inclusions.

Every potential minimum intervention reserve will have a management history, so stand structure will almost inevitably include artificial features, and stand composition is likely to have been modified by past use. Even after decades of neglect, ancient semi-natural woods retain many structural features of their history as coppices or wood-pastures. Furthermore, artefacts such as boundary banks, charcoal hearths, sunkways and ditches will remain. In so far as the standard and pollard trees inherited from past management provide the main element of stand maturity, the inherited remains of past management may be a positive feature.

4.2.6 Stand structure

It is better to start close to a natural condition, if only because that minimises the wait for the minimum intervention reserve to become near-natural. However, that begs the question: even young, plantations are not so structurally different from the even-aged thickets that spring up naturally after a catastrophic disturbance. The best general rule is probably to select for conditions that would take the longest to create from scratch, ie (i) stands that are completely free of planted trees, (ii) mature stands, or old-growth, preferably with snags, gaps, etc, and (iii) stands recently subjected to a catastrophic disturbance. The priority is to inherit mature features, particularly a good stock of old or large trees.

Opportunities exist for pre-treatments to make stands more natural. In particular, the absence of gaps and fallen dead wood should not disqualify a site, because we can make both (5.1).

4.2.7 Stand composition

Although there is a special value attached to original-natural stand composition, it is not always possible to assess composition in these terms. Stands wholly composed of site-native species can readily be specified, but this would include stands that have been strongly selected for a particular species, such as beech in the Chilterns or hazel in Downland coppices. Priority should be given to (i) mixtures of site-native species, (ii) fewest naturalised species, and (iii) stands not dominated by shrubs/small trees, such as hazel [although this would be allowed in western Scotland].

Rather more difficult issues are raised by the profound modifications of composition that have taken place in distant times. In southern Britain, there is a good case for regarding *Tilia*-dominated stands as closest to original-natural on mesic sites. Some of the mature beech stands occupy sites that originally had much *Tilia* (eg New Forest, Epping Forest). The precise status of the various kinds of semi-natural stand types remains uncertain, and in any case there is a case for including all kinds of naturalness in the selection, but the former prevalence of lime in the southern districts provides a firm basis for preferring woods where *Tilia cordata* or *T. platyphyllos* is present.

From the scientific and nature conservation standpoint, there is much to be gained from including transitions between stand types. This will help to maintain diversity within a reserve, and provide insights into the factors limiting small-scale patterns. Whilst selection for representation of a particular woodland type should form the foundation of selection, the actual site chosen as the representative should include other types.

Composition of a buffer zone should be a consideration. There is no point in carefully selecting stands with no naturalised species, if these species are present on the boundary waiting to invade.

4.2.8 Natural ecosystem

Stand structure and composition are not the only features that should start as natural as possible. The same consideration should be given to other aspects:

- **Unmodified geology, soils, hydrology**. This will generally be the condition of ancient semi-natural woods.

- **Grazing intensity, which should be close to natural levels**. There is some debate about what this amounts to (3.2), but a low or moderate level is likely to be more appropriate than either heavy grazing or exclusion of herbivores. It would be reasonable to accept heavier grazing in near-natural stands with a wood-pasture history.

- **Intact ground vegetation**. Sites that have been heavily grazed in the past, but which no longer have the large old trees should be excluded.

- **Representative natural woodland fauna**. Since we cannot select woods with bears, wolves, lynx and wild pigs [though the last is changing], there is a premium on including a good representation of saproxylic species.

4.2.9 Conservation implications

Since a minimum intervention reserve 'should be for ever', care should be taken to exclude woods containing features or species which depend on interventionist management, and which are too important to sacrifice. In particular, species of open space habitats are likely to be lost, so there must be a strong preference for woods where these species are not outstanding, or where they can survive nearby in managed woodland.

Conversely, minimum intervention reserves may develop into excellent habitats for shade species and saproxylics, which implies a small premium on sites where these are already well represented.

4.2.10 Ownership

The objectives of minimum intervention reserves and research in them require a long-term, indefinite commitment. There is no point in deciding to develop near-natural woodland or study long-term changes if the decision comes up for review and possible change every few years. Minimum intervention reserves should ideally be owned by an organisation that can justify the objectives indefinitely.

What does this mean in practice? Freehold ownership by a nature conservation or scientific organisation appears to be ideal, but even these may be subject to pressures for change. For example, if a reserve manager finds that a valued feature is declining under minimum intervention, and believes that it can be restored by some kind of intervention, this will generate pressures to abandon a decision for minimum intervention. Academic and research institutions may want to conduct experimental research, which could alter the reserve. Ownership by a forestry or amenity organisation could be just as satisfactory if the minimum intervention reserve is a small proportion of the land holdings. Long lease from an individual owner may be satisfactory, depending on the terms. Short-term agreements over woods in private ownership should only be considered exceptionally. The minimum intervention woods in which studies have continued for more than 30 years are owned by the Forestry Commission (3 sites), Duchy of Cornwall, Oxford University, Rothamstead Agriculture Research Station and several National Nature Reserve woods.

Nothing is certain (*vide* the proposal in the late 1980s to privatise National Nature Reserves and Forestry Commission holdings), but there must be a premium on freehold nature reserves. Any decision to designate land as a minimum intervention reserve should be taken with the full authority of the owner after careful consideration.

4.2.11 Precedent

There is much to be gained by building on established arrangements. Stands that are mature and have already 'enjoyed' several decades of minimum intervention will have developed some way towards a near-natural state. If a wood has long been a reserve with little or no silvicultural intervention, its status will be more readily accepted by the general public and the land managing professions alike. If a record of past conditions or detailed recording has already been started, a minimum intervention reserve acquires a head start for research and monitoring.

4.2.12 Conclusion

We should be looking in ancient woodland for compact-shaped, mature stands with a minimum area of 20ha, surrounded by a buffer of at least 50m of forest on all margins, in a well-forested landscape. The stand should comprise a mixture of site-native tree species with few if any non-native species. Alternatively, if no buffer zone is possible, a minimum of 25ha of such woodland should be reserved. Smaller areas can be accepted if the minimum area can be made up on adjacent ground by allowing semi-natural woodland to develop into a similar condition. Larger areas would be desirable, especially in Boreal and floodplain forest types.

4.3 Selection of other forest types

The core set of minimum intervention reserves based on type IIa (section 3.4), the inherited-natural, high forest model, should be supplemented by other types, which broadly conform to other models. The following four types can usefully be distinguished.

4.3.1 Restored original-natural woodland

There is a case for attempting to restore a few examples of original-natural woodland, which would conform to the type Ia (original-natural, high forest model) of section 3.4. On the assumption that major changes in forest composition in recent millennia have been due more to the influence of people than to changes in climate and site conditions, the aim would be to re-introduce lost tree and shrub species, evict naturalised species and reduce site-native species that have assumed dominance under human influence. The main benefits would be scientific.

In some places the original-natural mixture has apparently persisted, so 'restoration' is not strictly necessary (and types Ia and IIa of section 3.4 are the same). Save for an over-representation of beech and an under-representation of lime, Lady Park Wood appears to be original-natural in composition. In wood-pastures such as Epping Forest and New Forest, however, palatable species, such as lime and hazel, have been eliminated, so restoring original-natural woodland would require re-introduction of such species. In the uplands, the conversion of mixed deciduous woodland into sessile oak woods, and the elimination of alder from pinewoods, has probably been accompanied by soil degradation in some places, so any attempt at restoration of the original composition may be difficult, if not invalid.

4.3.2 Future-natural ancient woodland

There is also a case for allowing naturalised species to spread freely in some minimum intervention reserves, ie to allow type IIIa (future-natural, high forest) woodland of section 3.4 to develop. The benefits would be scientific: observation would allow the developing relationships between native and naturalised tree species to be studied, and thus to assess the growth and competitive potential of naturalised species, and their potential for developing distinctive associated communities.

The sites chosen would already have established, mature populations of naturalised trees. An example might be Oxwich Wood on the Gower, which is an old-growth mixture of oak, sycamore, beech, and ash.

4.3.3 Succession from bare ground

Another form of minimum intervention reserve that would conform to the type IIIa, future-natural, high forest model, takes the form of un-regulated succession from 'bare' ground. This is the classic minimum intervention reserve of early ecologists and conservationists, who were primarily interested in succession. Today, the value of such reserves would still be to science, eg, in understanding natural woodland restoration. Broadbalk Wilderness is one famous example, which has been recorded for 120 years.

The re-creation of lost woodland types necessarily has to start with 'bare ground', though it could be achieved by planting or natural processes, or a combination of the two. Of the types identified by Peterken (1996, ch.18), treeline forest and calcareous pine forest may be re-created by natural processes within minimum intervention reserves, whereas floodplain poplar woodland and large-leaved lime-dominated woodland on calcareous loam would have to be planted.

4.3.4 Conifer plantations

Yet another form of minimum intervention reserve which would conform to the type IIIa, future-natural, high forest model, would be minimum intervention reserves established in plantation forests. Peterken (1987) and Peterken *et al* (1992) made a case for allowing some plantations to grow on long rotations as a means of diversifying habitats and the plantation landscape, and also for establishing a small number of minimum intervention reserves in mature plantations for further habitat diversification and for the study of the long-term potential of these stands in British conditions.

4.4. The case for very large reserves

Most discussions of minimum intervention reserves in Britain revolves round reserves of 20-200 ha, but in other countries with a greater land area and larger forests minimum intervention reserves have been created which extend to thousands of hectares (section 8). This brings them within the size range which can maintain populations of the larger mammals; substantially exceeds the Minimum Dynamic Area for the component forest types; and generates a truly wilderness experience for the large number of visitors that such large areas can absorb. Examples include the Bayerischerwald National Park in south-west Germany and the recently extended Bialowieza National Park in eastern Poland.

The nearest approach to such reserves in Britain would be the major Caledonian pinewoods, such as Abernethy, Affric, Glentanar, Rothiemurchus and Strathfarrar, which extend to 1000ha or so, and run into larger areas of moorland. These, however, are not minimum intervention reserves, and most contain substantial areas of timber plantations. Broadleaf counterparts can be found in some upland valleys, such as Maentwrog and Sunart, but these are fragmented, intermixed with farmland, and they too are generally not treated as minimum intervention reserves. In the lowlands, woods take the form of patches within a farmed or urban matrix, most woods being no more that 20ha in extent.

Recently, Whitbread and Jenman (1995) floated an idea for large natural reserves in lowland England. In districts with concentrations of woodland intermixed with low-quality farmland they suggested that opportunities might arise to create large reserves, which would then be left to function naturally. The woods would be treated as minimum intervention reserves and large herbivores would be allowed to roam free. Initially the landscape would retain the hard-edged form inherited from farming, but in the long term edges would be softened by woodland expansion, though grazing and browsing would be sufficient to ensure that open habitats survived. The question of large predators was not discussed, but the idea was to make such large reserves open to public access and possibly to use free-range domestic stock as grazers, so presumably herbivore populations would be controlled by people. These size of such reserves was not explicitly discussed, but areas of 1000s - 10,000s ha were implied. West Sussex was seen as one possible location. Similar ideas were discussed by Wallis de Vries (1995) for western Europe as a whole.

Simultaneously, Peterken and Hughes (1995) discussed the re-creation of floodplain forests in Britain. Most floodplain woodland was long ago replaced by grassland or arable, but the evidence from other parts of Europe indicates that such forests would have been perhaps the richest forest type in Britain. Several kinds of benefit would flow from establishing more forest on floodplain and other riparian land. One form of re-creation would be to regenerate functioning natural floodplain forests, which can only be achieved with a landscape-scale initiative in which natural fluvial processes are restored in (and upstream of) the forest.

Very large minimum intervention reserves in the lowlands raise many practical issues. Some progress has been made in this direction in the Highlands at, for example, Abernethy, Beinn Eighe, Creag Megaidh and Glen Finglas. Proposals based wholly on new woodland have been debated at Carrifran in the southern Uplands. In England the New Forest appears to give some idea of what Whitbread and Jenman had in mind, though herbivore populations would presumably be held at lower densities than those now prevailing there. Otherwise, large reserves remain as a fine idea, awaiting substantial changes in public attitudes and farming economics.

Despite their apparent impracticability, very large minimum intervention reserves should continue to be borne in mind. They largely nullify the edge effects and outside influences that limit smaller minimum intervention reserves. They expand possibilities in that populations of large species can be maintained within the reserve, and floodplain forest (which depends on the whole landscape) can be included. The balance between high forest and wood-pasture structures can be resolved by natural processes, not debate between ecologists. And, the benefits relate equally to nature conservation, culture and science. Nevertheless, smaller minimum intervention reserves will still be necessary, for a few very large reserves could not represent the full range of conditions that many smaller reserves could include.

4.5 Inventory of old-growth

Neil Sanderson has suggested that an inventory be compiled of old-growth stands, and there is much to recommend this. Old-growth stands approximate to the conditions that probably prevailed in most British natural woodland. They take longer to re-create than any other type of stand. And, they are the pool from which most of the minimum intervention reserves would be drawn. An inventory would back up a set of minimum intervention reserves by identifying alternative sites and sites into which the set of reserves might be extended. It would also monitor one of the important components within the range of woodland habitats.

Old-growth would have to be defined and delimited, and that may be difficult. We all know broadly that old-growth stands are mature, with old trees and accumulations of dead wood, but: how old?; what density of old trees is enough?; how can we estimate dead wood volumes efficiently? American forest ecologists have debated definitions for years, partly because decisions at the margins have substantial commercial implications, and partly because the huge range of forest types require flexible definition. In Britain it should not be so difficult. Semi-natural stands with a reasonable (to be defined) stock of trees over, say, 150 years ought to qualify.

5. Management of minimum intervention reserves

Management (in the sense of physical interventions on the ground) will be necessary for almost all reserves, but operations should obviously be the minimum necessary. General rules can be evolved, but these will have to be interpreted to suit the circumstances of each reserve. When circumstances change, managers will have to respond. A system for defining the limits of discretion for individual site managers will be needed, which may be best formulated as a code of practice.

Two kinds of intervention can be envisaged: (i) set-up treatments and (ii) on-going maintenance. When a reserve is designated, it may not be in the best state for 'releasing' to natural processes, and in such cases modifications should be carried out before the woodland actually enters a minimum intervention regime. Once established in a satisfactory state, however, minimum intervention reserves should be left untouched, save for necessary maintenance. This maintenance involves regulating influences from outside (eg fencing), providing suitable access, and acting as surrogate natural processes (eg deer control).

5.1 Set-up treatments

Given that an objective of minimum intervention reserves is to generate or retain near-natural woodland, there is a clear case for starting with sites which already conform to this specification, if only so that the benefits are felt without undue delay. However, since most woods bear the clear imprint of past management and exploitation, any selected site is likely to fall short in several respects. In response, managers could adopt minimum intervention immediately, ie simply wait for natural processes to take their course, but more likely they will decide that some kinds of initial treatment will be desirable or necessary.

5.1.1 Eliminating unwanted non-native species

Most woods contain tree and shrub species that are not site-native. The commonest of these are sycamore, beech and rhododendron, but several other species are well established and spreading, such as cherry laurel, turkey oak, western hemlock and snowberry. The presence of substantial and spreading populations of these or any other non-site-native species will normally be a reason for not selecting the site as an minimum intervention reserve, but (i) small populations may still be present, and (ii) these species still have the capacity to colonise or recolonise from the surroundings.

If the intention is to retain the reserve in an original-natural or inherited-natural composition, these species should be removed before the reserve is consigned to minimum intervention. If the reserve is assigned to the future-natural category, then the only action needed would be to record the present distribution of these species.

Other non-native plant species may also be present. Most will have to be accepted on the grounds that it would be impractical to remove them, and in any case they probably have little impact on the woodland structure and dynamics. Those which require attention are the mat- and clump-forming perennials, such as periwinkle, Gaultheria and Japanese knotweed. Unless a wood is to be treated as future-natural, it seems logical to try to remove them at the outset.

5.1.2 Re-introducing lost site-native tree species

Conversely, there may be a case for re-introducing species that are known to have been present in the past. Such restoration might be necessary if the objective is to be original-natural woodland.

This is a particularly debatable action. Ideally, it should only be attempted in woods where explicit evidence is available that a species was formerly present, but such evidence is rare and normally only available for plants from pollen profiles taken from small-hollows or buried soil horizons. In practice, in the absence of direct evidence, it is reasonable to assume that lime (2.3) and hazel were present in most southern lowland woods. Small-leaved lime is being planted into a proposed natural reserve in the New Forest, although in this instance pollen in buried soil profiles clearly demonstrates the former occurrence of this species.

5.1.3 Diversifying an even-aged stand

The structure of most woods proposed as minimum intervention reserves will have been strongly influenced by past management, which in practice means that the stands (i) contain strong even-aged components, (ii) lack of very old and very large trees, and (iii) have little or no natural regeneration. The assumed structure of most natural woodland, on the other hand, includes some very large, old trees, a mixed age structure at a sub-compartment scale and larger, and gaps containing natural regeneration.

The difference can be accepted, leaving time and natural processes to close the gap, but that can take a very long time, especially if the even-aged component is a population of a long-lived tree, usually oak. Alternatively, the wood can be diversified by cutting patches and leaving the felled trees on the ground. This simulates the gap pattern, established locations for natural regeneration, increases the volume of dead wood, and provides some space in which gap-margin trees can grow faster, but it is a poor simulation of natural processes. Better - because they are more natural - are other approaches, such as ring-barking trees (which simulates drought and fungi-induced mortality), blasting crowns with explosive (which simulates wind and ice damage to wind-firm trees), or winching down living trees (which simulates windthrow).

Another reason for prior modification of stand structure would be to protect large, old trees. In many woods these grew large in open conditions, but in minimum intervention woodland they become vulnerable to taller, younger trees around and through their canopy. Under such changes, mature trees are generally unable to compete and rapidly die, leaving the wood with a long gap before new large trees can develop. In order to bridge this gap, there is a case for removing trees that are competing at crown level with established large, old trees.

5.1.4 Human artefacts, such as banks, charcoal hearths, etc

We might also argue that banks, ditches, and other physical remains of past management and exploitation should be eliminated from a minimum intervention reserve, since these are manifestly artificial. That, however, would destroy minor archaeological monuments and erase information about the actual history of the wood.

In reserves assigned to inherited- and future-natural compositions, it seems logical to retain banks, ditches, etc. In reserves assigned to original-natural restoration, there is a case for attempting to restore the site as well as the stand, though the cost and loss of information would normally preclude this. Perhaps the only action that is generally beneficial and practicable would be to stop the ditches.

5.2 Fencing and levels of grazing/browsing

It is commonly asserted that the act of fencing a minimum intervention reserve is itself a form of human interference. True, but fencing is more a matter of two wrongs making a right: by creating an artificial barrier it prevents unnaturally high grazing and browsing levels by uncontrolled deer populations or domestic stock. The problem is that a fence tends to be an all-or-nothing solution to grazing intensity, when we may actually want a moderate level of grazing.

If fences are deemed to be necessary, there is a case for setting them back from the edges of woods surrounded by semi-natural vegetation, mostly upland woods. This will at least enable naturally diffuse boundary structure to develop.

The need for fencing depends on: how we resolve the issue of grazing/browsing in natural woodland; how much and what kind of grazing we want in the minimum intervention reserve; and whether sheep, deer, cattle, etc are present in the surroundings. Until the role of grazing and browsing in natural woodland is better understood, the best course would be to assign each minimum intervention reserve to either the high forest or wood-pasture models (section 3.4):

- **High forest model.** Maintain grazing and browsing at levels that permit regeneration in gaps and allow some advance regeneration to persist in shade. This will usually require strict control of deer and may also require domestic stock to be kept out by fences or hedges. Regeneration will have to be monitored (section 7.5).

- **Wood-pasture model.** Permit grazing and browsing, combined with monitoring regeneration. A level of grazing/browsing should be agreed that will allow sufficient regeneration on a long-term basis.

The most intractable issue is deer management in minimum intervention reserves. True, deer numbers in minimum intervention woods may be less than those in managed woods, where paths and glades are more frequent (Langley Wood, David Burton, pers. com.), but this is not invariably the case, and in Lady Park Wood there is reason to believe that the minimum intervention reserve acts as a focus for deer populations that find dense surrounding plantations less attractive. Whatever the position, there can be little objection to standard methods of deer control within minimum intervention reserves, since even high seats have little impact on the reserve.

5.3 Paths

Access is necessary to realise the scientific and cultural benefits of minimum intervention reserves, but any impacts by people on the reserve or its wildlife detract from the near-natural status of the reserve. Fortunately, people tend to stay on paths in minimum intervention woods, so the direct impacts are generally confined (David Burton). On the other hand, minimum intervention reserves are marginally more dangerous than stands maintained at a younger stage of growth which have fewer large, old trees and no tall snags. Since public access may generate pressure for lopping or felling overhanging trees, there is a strong case for minimising access paths, placing warning notices on the entrances, and erecting boundary markers (or fencing) to define the reserve edge unambiguously.

Dead wood accumulates on paths and trees fall across paths. In Hatfield Forest these obstructions are removed every three years (Vikki Forbes, pers. com.), but in Lady Park Wood they are not removed, but used as a demonstration of the accumulation rate of debris. (The date when path clearance stopped is known.) Although fallen material can force walkers to deflect into the stand, a policy of non-clearance eventually restricts access.