5. ECOLOGICAL ISSUES

This chapter covers a miscellaneous collection of issues that underpin decisions on design and management in a FHN.

5.1. Defining native tree species

'Native tree species' have to be defined before we can define 'native woodland', but no single definition is invariably appropriate. We generally agree on which species are native to Britain or a region of Britain, but we also need to decide where 'regionally-native' species and also 'site-native'. We also have to consider provenance.

Native status should be seen not as a black-and-white matter, but as a spectrum of attributes. The strictest definition would insist that a population of a species can only be described as 'native' if it owes its presence wholly to natural processes, and has descended on or near its present site from populations that were present in original-natural forest, i.e., its provenance is strictly local. This definition is appropriate to nature reserves and the more important ancient woods.

Elsewhere, it may be acceptable to use a wider definition. Species are recognised as 'regionally-native' if they have long been present and arrived by natural means, even though many of the existing stands have been planted, sometimes using non-local provenances. This wider definition can be refined to recognise a regionally-native species as 'site-native' if it occupies ground which it would occupy naturally. Thus, for example, sessile oak is regionally native to the NYM/HH, but probably not site-native to deep, wet soils on floodplains. The concept of regional- and site-native species would be appropriate for the generality of native woodlands.

A still wider definition might be appropriate in some circumstances. Species that were introduced to the region, but which are now self-supporting are usually described as 'naturalised', and it is possible that they will have become genetically adapted (through natural or forestry selection) to the site, i.e., they have developed a land race that grows better locally than any other provenance. Since the general public would probably accept any deciduous broadleaved tree species as native, it may be appropriate to accept naturalised (i.e, naturally self-perpetuating) deciduous broadleaved species as de facto natives in the less ecologically important sites, mostly recent secondary woodland.

A yet wider definition may be acceptable in limited circumstances. Naturalised coniferous and evergreen broadleaved species may be just as self-supporting and adapted to the site as naturalised deciduous broadleaves, but they form en masse an alien physiognomy. In recent secondary woods, natural regeneration of these species may be acceptable, provided it remains a minority of the stand.

In practice, there is no doubt that species such as oak and ash are regionally native and that, for example, Douglas fir is not, but between these a few species remain ambiguous. Where should forest managers treat them as native? In the NYM/HH, the following solutions are recommended on the basis of historical presence, conformity with prevailing woodland types, and ecological impacts, and in conformity with advice previously offered by the Forestry Commission (1994):

- Beech. Although beech is often regarded as native only in southern Britain, there is good evidence that the species was present, if rare, in the NYM in prehistoric times. On this basis, beech could be treated as a native species. However, it has been widely planted so we are not sure where it was originally site-native. It seems reasonable to accept it as natural regeneration (except where it has obviously arisen from planted stock), not plant it into stands that currently lack beech, and not to accept beech-dominated stands as native.

- Sycamore. There is no doubt that sycamore was introduced to Britain, but it has become widespread, thoroughly naturalised, has started to develop land races, and has been treated as a 'title-species' in the National Vegetation Classification. Moreover, it has the broadleaved, deciduous habit of most unambiguously native species. It should be treated as a native species in secondary woodland if it is self-sown, but restricted in ASNW on the grounds that it is not an original-native species. Stands dominated by sycamore should not be accepted as native in either woodland type.

- Scots pine. Pines were certainly present in prehistoric woodland, but might naturally have died out in the NYM/HH by now. They have, however, been reintroduced, and have become naturalised on moorland fringes. They can be accepted as native in secondary woodland, especially in forests on moorland and as self-sown individuals.

- Other naturalised deciduous broadleaves, e.g., turkey oak, horse chestnut. Accept as natural regeneration in secondary woods, provided they do not dominate.

- Naturalised evergreen broadleaves, e.g., rhododendron, cherry laurel. Although matched by holly as a native species, these should be treated as non-native, due to their disproportionate impacts on the diversity of native woodland.

- Naturalised conifer species. Accept in secondary woods where they are self-sown, provided they do not dominate. Since Western hemlock is capable of regenerating prolifically, this should not be accepted.

5.2. Provenance

When woodland is planted, foresters select a provenance, though not always explicitly. The advantages of selecting a local provenance are that (i) locally-adapted genotypes of native species will be perpetuated, (ii) land races of non-native species will be reinforced, (iii) the planted trees are more likely to grow successfully than non-local provenances. The disadvantage is that local genotypes may have been diminished by past selective felling of the better individuals. Local provenances can be perpetuated by using natural regeneration, or by planting from seed gathered from local trees, preferably those that have grown well.

Use of site-native seed origin is particularly important in ancient semi-natural woods managed primarily for conservation, and it is desirable in all ancient woods. Use of regionally-native origins is important where new native woodland is being planted primarily for conservation reasons. It is also prudent when introduced species are being replanted where they have previously grown well.

5.3. What counts as native woodland?

Native woodland is characterised by composition, origin and structure. As far as composition is concerned, native stands are those that (i) adhere to the principles outlined in 5.1 and 5.2, and (ii) comprise irregular mixtures of species, i.e., the condition found in near-natural woodland. Stands originating by natural regeneration or stump regrowth are more natural than planted stands. Young stands with an irregular structure (usually resulting from natural regeneration) are more natural. Mature stands, with subordinate strata and some old, large trees, are also more natural than immature and uniform stands.

These attributes do not necessarily work in tandem. For example, in the NYM/HH a uniform, thicket stage plantation of ash may have lower diversity and owe less to natural processes than a mature, naturally regenerating mixture of sycamore and larch. This demonstrates that native woodland is a multi-dimensional variable, in which composition is the main, but not the only factor.

Forest stands range from those composed wholly of site-native species, the great majority of which are broadleaved and deciduous, to stands composed entirely of non-native species of evergreen conifers. This spectrum has already been recognised by recent Forestry Commission surveys, which partitioned all stands into four groups defined by the proportion of site-native species, the thresholds being set at 80%, 50% and 20% native (section 4.7).

There is a case for recognising a spectrum of different qualities of native woodland. The following might provide a suitable basis for developing a classification for the NYM/HH. All the types listed could be recognised as native woodland.

Ancient woodland.

- ASNW composed of mixtures of site-native tree and shrub species inherited from the original-natural forests. These would be stands that have always had a substantial native component.
- Ancient woods that have been restored to native mixtures, either by natural succession or by planting site-native species. These have suffered a bottleneck in the continuity of native stands (not a break in continuity, since some original native trees and shrubs usually survive on margins).
- A single species plantation of site-native trees.

Recent, secondary woodland.

- Naturally regenerated stands of regionally-native species.
- Planted stands of regionally-native species.
- Self-sown stands of naturalised species.

5.4. Age class considerations

Woodland species are rarely so catholic that they can inhabit all kinds and conditions of woodland. Many are restricted by soil conditions, hydrology and other site factors (e.g., they only grow on wet, alkaline soils), and others - including many invertebrates - are restricted to particular kinds of structure. In short, we cannot assume that land is suitable for woodland species, just because it is green on the map. A species that depends on a particular age class of stand may be isolated even in a very well-wooded landscape if that age class is not well distributed.

Two specialist groups must be considered: (i) young-growth specialists and (ii) old-growth specialists. The former depend on temporary open spaces, such as felling coupes and natural gaps, and the regenerating stands prior to canopy closure. The latter depend on mature structures, such as large trees, complex stratification and dead wood. In most temperate natural woods, old-growth species would have been well-represented and young-growth species would have maintained a fugitive existence in temporary open spaces. In managed woods, many old-growth species are confined to end-of-rotation stands or particular management regimes that maintain mature timber habitats (e.g. the wood-pastures of Duncombe Park), whereas young-growth species prosper in felling coupes.

If both groups of specialised species are to be maintained in a forest habitat network, both types of stand must be provided. Young-growth species can be maintained by a programme of regular felling and restocking, and prosper most in short-rotation regimes, notably coppice. Most young-growth associates are good colonists. Old-growth species can be maintained if rotations are long-enough to generate old-growth conditions, which means either (i) allowing stands to grow more than 150 years, or (ii) providing mature structures (e.g. retained mature trees and large dead wood) in stands managed on shorter rotations. In minimum intervention stands, old-growth species will be at an

Plate 5. Old planted beech stands fringing the lake at Hackness Hall in the Southern Hills. Mixed with younger semi-natural ash woods, these 'policies' provide mature timber habitats, but also constitute a source of invasive exotic species.

Plate 6. The boundary between moorland and moorland valleys at Thunderheads, lower Farndale. Typically, this zone has a scatter of generally old trees (usually oaks) and shrubs (hazel and rowan) on field boundaries and a few small woods and plantations. Additional trees would reinforce the zone as parkland habitat and establish successors to the present trees.

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advantage, but young-growth species can be expected to survive, provided managed woodland is present nearby.

The key to maintaining both groups is to design the network and silvicultural regimes within the network so that:

- the age-class distribution conforms closely to the concept of a normal forest at a scale of individual woods or groups of woods, i.e. with all age classes present, well distributed through the total area.

- long-rotation stands of 150 years or more are always present, or mature structures are maintained within stands managed treated on shorter rotations. The latter would be achieved by two-storied high forest, coppice-with-standards and/or retaining substantial deadwood elements in felled areas.

- minimum intervention stands are embedded in managed woodland.

The same considerations apply to trees in farmland. A balanced age-class distribution and pattern should be maintained to ensure a succession of mature farmland trees.

5.5. Edge effects

This has two aspects, (i) the adverse effects of edges on species that require interior conditions, and (ii) the beneficial effects of edges on overall biodiversity.

The depth of 'edge' varies according to the factor being measured. Values given in a recent review (Murcia 1995), show that physical factors, such as increased air temperature and light intensity, are detectable up to 50m into a wood. Stand characteristics were more variable: for example, the higher basal area on a wood edge extended in only 15m, whereas increased vulnerability to windthrow extended 150m. Biological responses were also wide: enhanced seed dispersal extended 10m, whereas increased nest predation extended up to 600m

Since British woods have been managed for so long (and have therefore long had internal edges), species that are extremely intolerant of edge effects ("interior species") will presumably have vanished long ago. The extent of the general edge effect can thus be set fairly low in the range, say 50m. If this is accepted, then the smallest wood that can have interior conditions would be a circular wood of 0.785ha. In practice, of course, woods are rarely perfectly circular, so larger areas will be needed. In areas where elongated woodlands are characteristic, it is more relevant to point out that woods would have to be at least 100m wide to contain any interior conditions at all.

Edges, however, are usually regarded as beneficial habitats. Those within woodland and forest are sources of diversity and likewise those between woodland and other semi-natural habitats. On the other hand, edges between woodland and farmland/residential land are sources of vulnerability, admitting alien species, pollutants, and competition from farmland species.

Edge habitat provision is inevitably a compromise. The optimum combination can be developed in large, managed woods, where a large length of internal edge outweighs the relatively small length of external edge, and provision can be made for coherent blocks free of edge effects. Smaller woods will have optimal conditions if they are bordered by semi-natural habitats.

Boundaries can be either hard or fuzzy. The former have sharp transitions, the latter are wider, and usually richer habitats for wildlife Most lowland landscapes are 'high definition', i.e., they tend to have mainly sharp edges generated by intensive land management and well-defined property boundaries. Locally, where management is less intensive, boundaries may generally be wider, i.e., these are low definition landscapes. Fuzzy edges and low-definition landscapes are generally perceived as more natural and attractive.

5.6. Open space habitats in managed woodland

The ground not covered by trees and shrubs is critical for woodland biodiversity. In larger woods, the number of plant species associated with these open space habitats is likely to be as large as the number of shade-tolerant species, trees and shrubs added together (Peterken and Francis 1999), and fauna specialists have always stressed the importance of rides and glades for invertebrates and birds (Warren and Fuller 1990). On the scale of large woods and plantations, open space plant species may contribute over 60% of the total forest flora, if the woods of Central Lincolnshire are any guide (Peterken and Francis 1999). Permanent open spaces diversify woodland habitats by providing opportunities for edge species and the shade-intolerant species of grassland, mire and heath.

The principal types of open space habitat are:

- Rides. Permanent access routes that remain open in managed woodland, but can be completely shaded in neglected woodland and woods where all compartments reach the end of the rotation simultaneously.

- Glades. Permanent open spaces, maintained by natural factors (e.g. high watertable) or management (e.g., small paddocks).

- Pools and rivers. Waterbodies large enough to remain open.

- Coupes. Temporary open spaces created by felling or, rarely, natural disturbances.

- Margins. External wood margins with a narrow zone of high light intensity.

- Small patches of grassland and other unwooded habitats that are closely associated with forested ground, even if legally and cartographically they are not within woodland.

There is a case for maintaining the open spaces already present, rather than redesigning rides, etc on a new pattern. This is because open spaces include species that colonise only slowly, and which will be disadvantaged by change. The location of new permanent open spaces in woods should be as close as possible to existing semi-natural grassland habitats to facilitate colonisation. If semi-natural grassland is allowed to become woodland, open spaces must be retained to mitigate species losses, and contiguity with grassland elsewhere should be part of the design.

The Lincolnshire studies of Peterken and Francis (1999) also suggested that there are size thresholds for the plant species of open spaces in woodland. Woods below about 3ha generally have no open spaces, or small, temporary openings. Woods above about 30ha invariably contain open spaces, some of which are permanent. Between 3ha and 30ha the probability of containing open spaces permanently increases with size. The diversity of open space species depends on both the area of open spaces and their permanence. It is not known whether these thresholds apply in the NYM and HH, but it is a reasonable assumption.

5.7. Relationships between forest and other habitats.

Forests are generally recognised as tree-covered habitats, though that was not invariably how the term was understood, *vide* ‘Dartmoor Forest’. However, most woods above 3ha or so contain land that is permanently not wooded, i.e., rides, forest roads, glades, open water, mires. This land contributes disproportionately to the overall habitat diversity within the boundaries mapped as woodland or plantations.

Outside the forest or woodland boundary, farmland contains a variety of semi-woodland habitats. These are hedges, meadows, streamsides, bracken banks and any other niche that harbours woodland species. These not only contribute to the diversity of farmland, but improve the performance of the matrix to the FHN (see 3.10).

Unfortunately, intensive farming greatly reduces the incidence of semi-woodland habitats. Where arable and short-term leys predominate, hedges are reduced, meadows vanish and streams become ditches. In these circumstances, farmland matrix is hostile for forest species and the best remnants of semi-natural grassland, heathland and mires are found within the forest land. Even where farming is less intensive, semi-woodland habitats have generally been reduced.

This has two implications for a FHN. Forest land becomes the main refuge for the species of all semi-natural habitats, so management should be designed to maintain the habitats for the whole landscape, for they will not survive elsewhere. Thus, FHNs should be designed as multi-habitat networks. In effect, this means regarding ‘forest’ in much the same way as it was regarded in the medieval period, as a mosaic of many habitats. This is increasingly how FC treat their holdings, and it is abundantly justified as a complement to farmland.

The other implication is that FHNs have to be designed to work well within themselves. The matrix of farmland is unlikely to supplement the performance of the network. This means minimising internal barriers, i.e., providing a good mixture to habitats and structures throughout the FHN.

5.8. Means of increasing native woodland

New native woodland can be generated by three processes:

- Planting open ground. The future composition can be determined by the manager. Plantations tend to be even-aged and uniform in structure. Woodland species must colonise from outside the site.
- Natural succession on open ground. Future composition depends on seed sources and the site characteristics. Stand development is usually much slower than in plantations, but the resulting structure is usually more varied. Woodland species must colonise from outside the site.
- Restoration of PAWS. This can be achieved by planting and/or natural regeneration, combined with retaining any remaining native species. Despite a period of conifer dominance, most woodland plants (and possibly fauna species) will have survived from the original woodland.

Combinations of approaches are possible and desirable. In particular, there is no need to make a stark choice between planting and natural succession. Optimal results may be obtained by planting part of the ground, and leaving the gaps to fill naturally. This ensures that the new stand develops quickly, has a diverse structure and a natural composition, and that it includes desired species whose natural regeneration is uncertain.

Ecologically, the best results will usually be obtained by PAWS restoration, rather than establishing new secondary woodland. Local experience and the results of research recently sponsored by the Woodland Trust (Pryor et al 2002) suggest that optimal results will be obtained by a gradual approach. The recommendation is that stands should be thinned heavily to favour existing broadleaves and any concentrations of ground flora diversity (often the same patches). Further interventions would favour natural regeneration by thinning the planted trees. Planting is often not necessary, since natural regeneration is generally sufficient to restock with native trees. Where planting is undertaken, the recommendation is to plant 50-70% of the available ground, then allow the remaining ground to regenerate naturally.

5.9. Ecological development of new woodland

New native woodland does not develop quickly into a full complement of woodland species. Natural stand development proceeds through a sequence of phases which take about 30 years for trees to fully occupy the ground; 100 years for forest dominants to grow to full height; 150 years for large trees and natural accumulations of deadwood to develop; and 300 years for a stand of forest dominants to break up. These processes can be accelerated by management: thus, planted stands may close canopy after 10 years, large trees would develop faster if stands were thinned; and deadwood would build up sooner if trees were felled and left on site.

There are also less obvious limits. Mycorrhizae take an unknown but long time to change back to a woodland assemblage, and this affects the growth of both trees and ground vegetation. Many woodland plant and animal species are very slow to colonise, and that is only partly because time is needed for their particular structural conditions to develop. One factor in failure to colonise is isolation from existing woodland and populations of woodland species, which can be minimised by connecting new woodland to existing woodland. Another is the direct and indirect legacy of soil changes brought about by the preceding non-woodland land use and vegetation. Yet another is landscape heterogeneity: new woodland may not be on site types that the species in existing woodland can utilise.

These limitations can be partially overcome by planting ground that already has a woodland element, i.e., woodland species and contact with existing woodland or trees. Thus, bracken banks, which often support a relict woodland flora, are favoured places for new woodland. Likewise, ground adjacent to existing woodland is favoured.

5.10 Ecological isolation

There is some evidence that ecological isolation is an important factor in the NYM/HH. Gulliver (1995) surveyed a wide range of woodlands and found that 34 species of woodland vascular plants were wholly or partially restricted to ancient woods. Table 5.10 lists these species, together with 25 others that occur in the NYM/HH and are known from studies elsewhere in Eastern England to be biased in their occurrence to ancient woods. Several species associated with old grassland that may also be slow colonists are also listed. Collectively, these may be used as a provisional index of conservation value in existing woods.

Species associated with ancient woods are poor colonists. The mechanism behind this failure to colonise quickly, or at all, varies from one species to the next. The absence of suitable sites in secondary woodland accounts for some, but for most the probable cause is some limitation in seed production, dispersal or establishment.

Species in many other groups are known to be slow to colonise in at least part of their range. These include many of the saproxylic species associated with mature timber, dead wood and large trees.

Table 5.10 Woodland vascular plants wholly or partially restricted to ancient woods.								
56	W			Aconitum napellus	Monkshood			
52	W			Actaea spicata	Baneberry/Herb Christopher		A	
160	W			Adoxa moschatellina	Moschatel?Town Hall Clock		A	
180	W		A	Allium ursinum	Ramsons/Wild garlic	a	A	
52	W	G		Anemone nemorosa	Wood anemone	a	A	
56	W			Aquilegia vulgaris	Columbine		A	
206	W	G	A	Calamagrostis canescens	Purple small reed	a		
156	W			Campanula latifolia	Giant bellflower	a	A	
62	W		A	Cardamine amara	Large bittercress			
198	W			Carex laevigata	Smooth-stalked sedge			
198	W	G		Carex pallescens	Pale sedge	a		
198	W		A	Carex paniculata	Greater tussock sedge			
200	W			Carex pendula	Pendulous sedge	a	A	
200	W		A	Carex remota	Remote sedge	a	A	
200	W			Carex strigosa	Thin-spiked wood-sedge	a		
200	W			Carex sylvatica	Wood sedge	a	A	
198				Carex viridula ssp brachyrrhyncha (formerly C. lepidocarpa)	Long-stalked yellow-sedge (formerley Yellow-stalked sedge)			
102	W		A	Chrysosplenium alternifolium	Alternate-leaved golden saxifrage		A	
102	W		A	Chrysosplenium oppositifolium	Opposite-leaved golden saxifrage		A	
170		G	A	Cirsium dissectum	Meadow thistle			
170		G		Cirsium heterophyllum	Melancholy thistle			
112	W	G		Conopodium majus	Pignut			
180	W			Convallaria majalis	Lily of the valley	a	A	R
100	W			Crataegus laevigata	Midland hawthorn			
186	W			Cypripedium calceolus	Lady's slipper orchid			E
48	W			Dryopteris aemula	Hay-scented buckler fern	a		R
186		G	A	Epipactis palustris	Marsh helleborine			R
43	W		A	Equisetum sylvaticum	Wood horsetail			
84	W			Euonymus europaeus	Spindle	a		
206	W			Festuca altissima	Wood fescue	a		
180	W			Gagea lutea	Yellow star of Bethlehem		A	
156	W			Galium odoratum	Woodruff	a	A	
136		G	A	Geniana pneumananthe	Marsh gentian			E
86		G		Genista tinctoria	Dyers greenweed			
94	W	G	A	Geum rivale	Water avens		A	
52	W			Helleborus viridis	Green hellebore			
208	W			Hordelymus europaeus	Wood barley	a	A	
180	W			Hyacinthoides non-scriptus	Bluebell		A	
44	W		A	Hymenophyllum tunbrigense	Tunbridge fern	a		
70	W			Hypericum pulchrum	Slender St. Johnswort		A	
70	W	G	A	Hypericum tetrapterum	Square stalked St. Johnswort			
152	W			Lamiastrum galeobdolon	Yellow archangel	a	A	
146	W			Lathraea squamaria	Toothwort	a	A	
92	W	G		Lathyrus sylvestris	Narrow-leaved everlasting pea	a		
158	W			Linnaea borealis	Twinflower			E
184	W			Luzula pilosa	Hairy woodrush	a	A	
184	W			Luzula sylvatica	Greater woodrush	a	A	
72	W	G	A	Lychnis flos-cuculi	Ragged robin			
132	W			Lysimachia nemorum	Yellow pimpernel	a		
178	W			Maianthemum bifolium	May Lily	a		R
146	W			Melampyrum pratense	Common cow wheat	a	A	
210	W			Melica nutans	Mountain melick	a		

Page number of account in Sykes (1993)	Species associated with woodland	Species associated with grassland	Species associated with wet ground			Associated with ancient woods in eastern England	Associated with ancient woods in NYM/HH	Species in decline (Sykes 1993). R = rare/reducing. E = presumed extinct
210	W			Melica uniflora	Wood melick	a	A	
116	W			Mercurialis perennis	Dogs mercury	a	A	
210	W			Milium effusum	Wood millet	a		
184	W	G	A	Narcissus pseudonarcissus	Daffodil			
44		G		Ophioglossum vulgatum	Adders tongue fern			R
188	W	G		Ophrys insectifera	Fly orchid			R
188	W			Orchis mascula	Early purple orchid	a	A	
188		G		Orchis morio	Green winged/green veined orchid			R
44	W			Osmunda regalis	Royal fern			R
82	W			Oxalis acetosella	Wood-sorrel	a	A	
180	W			Paris quadrifolia	Herb Paris	a	A	
104		G	A	Parnassia palustris	Grass of Parnassus			
46	W			Phegopteris connectilis	Beech fern			
112		G		Pimpinella saxifraga	Burnet saxifrage			
186	W			Platanthera chlorantha	Greater butterfly orchid	a		R
188		G		Platanthera bifolia	Lesser butterfly orchid			
132		G	A	Primula farinosa	Birdseye primrose			
132	W	G		Primula veris	Cowslip			
132	W			Primula vulgaris	Primrose	a	A	
124	W			Quercus petraea	Sessile oak	a		
54	W	G		Ranunculus auricomus	Goldilocks buttercup	a		
146		G		Rhinanthus minor	Yellow rattle			
92	W			Rubus saxatilis	Stone bramble			
96		G		Sanguisorba officinalis	Greater burnet			
110	W			Sanicula europaea	Sanicle		A	
102		G	A	Saxifraga granulata	Meadow saxifrage			
194	W		A	Scirpus sylvatica	Wood club-rush			
154	W	G	A	Scutellaria galericulata	Skullcap			
172		G		Serratula tinctoria	Sawwort			
114		G		Silaum silaus	Pepper saxifrage			
100	W			Sorbus torminalis	Wild service tree	a		
74		G	A	Stellaria alsine	Bog stitchwort			
72	W		A	Stellaria nemorum	Wood stitchwort		A	
56		G	A	Thalictrum flavum	Common meadow-rue			
78	W			Tilia cordata	Small-leaved lime	a		
78	W			Tilia platyphyllos	Large-leaved lime	a		
132	W			Trientalis europaea	Chickweed wintergreen			
52	W	G	A	Trollius europeaus	Globe flower			
160	W	G	A	Valeriana dioica	Marsh valerian			
160	W	G	A	Valeriana officinalis	Common valerian			
144	W			Veronica montana	Wood speedwell		A	
90	W			Vicia sylvatica	Wood vetch	a	A	
68	W			Viola reichenbachiana	early dog violet	a	A	

The implications for FHN design are:

- New woodland should be located as close as possible to existing woodland, especially ancient woods.
- Concentrations of old trees should be maintained by maintaining the succession amongst and by the existing trees.
- Old grassland and other habitats should be maintained, and development of new open space habitats within forest land should be on ground close to existing open habitats.

5.11. The Dimbleby Plots: an experiment in recreating native woodland.

In 1950/1951 Geoffrey Dimbleby of the Imperial Forestry Institute at Oxford University established large-scale experiments on the establishment of broadleaves on heathland (Dimbleby 1958). The experiments were established in what is now compartment 6325 of the Forestry Commission's Broxa Forest (and possibly in adjacent compartments, 6330 and 6331) on ling heather moor, with wet depressions filled with cross-leaved heath, cotton grass, sphagnum moss and bare peat, growing over an iron pan podsol with an extremely acid (pH 3.0) reaction. Some 44 species of hardwoods were planted and/or sown in a grid of plots with various site treatments, including deep ploughing, fertilisation with basic slag, surface covering with gravel or broom.

Early results showed that many broadleaves could be established, and that some site treatments gave better results than others. Self-sown larch, Scots pine and sallows were removed for many years, but latterly the experimental stands have been allowed to develop naturally. By July 2001, the plots and the surrounding forest had long since matured into a forest environment, with little sign of the rigid geometry of the 1950/1 plots and plantations. All the experimental stands were developing into mixed broadleaved woodland, roughly equivalent to NVC type W16, the lowland form of very acid birch-oak woodland, a species-poor community. There were signs that a reasonably rich assemblage of fungi had developed, but this needs to be checked.

Moorland would not today be afforested in this fashion, though small parts of the plantations might be converted to native woodland. Nevertheless, the experiment demonstrates that native woodland can be developed even on the most inhospitable sites within 50 years, though its ecological development will always be constrained by the character of the site.

6. EVALUATION OF FOREST PATTERN AND CONDITION

This section analyses the existing forest pattern and condition against the criteria for a FHN, and aims to identify strengths and weaknesses. It concentrates on an analysis by zones, for each of which the main features are described and assessed, the biological SSSIs are listed (*with woodland SSSIs in italics*) and needs are identified.

6.1. The NYM and HH as a whole

Forest covers 23.9% of the land area. This is high in national terms, but significantly short of the 30% threshold required to minimise ecological isolation of forest habitats. However, it is largely meaningless to analyse the forest pattern in terms of the whole area. If we exclude the core moorland (i.e. the moorland zone outside the densely planted south-east quarter) the forested proportion comes close to 30%. Moreover, forested land is strongly clustered into certain zones, some of which exceed the 30% threshold. This points clearly to the need to target new woodland to those districts and locations where it can be most beneficial.

The degree to which forested ground can be connected throughout the NYM/HH is inevitably limited. The core of moorland forms an insurmountable barrier to connections between forested ground across the NYM. This moorland was originally wooded, and could still support the growth of trees, but there are many ecological, cultural and amenity reasons why this land should remain unwooded.

The links between unwooded semi-natural habitats and forested ground are exceptionally good. Virtually all moorland is linked to woodland or plantations. Almost all the unwooded, semi-natural habitats in enclosed farmland lie adjacent to forested ground. Within the plantation forests and the larger, compact woodlands the network of rides and open spaces must occupy 1,200-1,900ha (assuming that 5-8% of their total area is occupied by open spaces, based on the 23,700ha of conifer and conifer-dominated mixed plantation).

Both the NYM and HH are sources from which watercourses drain to land outside the areas. The principal exception is the Kirkham Gorge, through which water draining from the southern half of the NYM passes through the HH, albeit only after it has passed through intensive farmland in the Vale of Pickering. Since watercourses form a key location for links between woodland, this implies that FHN development within the NYM/HH should involve at least some land within the Vale of Pickering.

Continuing the theme of the wider context, the NYM/HH is collectively a well-forested area, but it is poorly connected to forested ground beyond its borders. The districts to the south, west and north are all poorly wooded, predominantly agricultural land, and to the east is the sea.

6.2. Network statistics

Chapter 4 gives the results of an analysis of the forested area and pattern. The significant figures for a network analysis are collected together in Table 6.2, and the implications are drawn out in sections 6.3-6.8.

These figures appear to be reasonably accurate estimates of the actual condition, with one exception. The row giving the proportion of all ancient woodland classified as semi-natural is based on small numbers of intersections, and only poorly represents the true position. An alternative calculation based on the proportion recorded by the OS as broadleaved or mixed with broadleaves in the majority is given in the following line is a little better, but, even so, the broadleaved parts of the ancient woods in the moorland valleys remain unrepresented.

Table 6.2. Summary of some forest network characteristics of each zone, based on grid-intersection sampling.

	1 Moorland	2 Moorland valleys	3 Coastal	4 Western fringe	5 Southern hills	Howardian Hills
Forest (% of all land)	18	12	14	29	36	19
Ancient woodland						
% of all land	0.4	3.2	4.7	5.0	12.5	9.9
% of all forest land	2	27	35	17	35	53
% semi-natural	50	0	67	33	51	5
% broadleaved (b, bm)	100	0	73	67	84	75
Broadleaved stands (b)						
% of all land	0.8	3.2	7.9	7.5	13.7	10.9
% of all forest land	4	26	58	26	38	29
Pattern						
% of all forest land in blocks of less than 30ha	3	40	30	11	8	21
Core woodland as % of all forest land	71	20	28	57	46	32
Semi-natural grassland and mire in enclosed farmland						
Area (ha)	0	1,200	3,000	200	500	300
% all enclosed farmland	0	16	13	3	3	2

6.3. Moorland zone (1)

Principal features

Forested ground forms a moderate proportion of the total area. Traditionally almost treeless, the moors only achieved moderate forest cover when several large plantations were established around the moorland fringe during the 1950s. Inevitably, given this history, almost all forest land is within large blocks, and an exceptional 71% of the area is more than 100m from a forest edge. On the other hand, both ancient woods and broadleaved stands are very limited indeed.

- The moorland contains small, isolated ancient woodlands, e.g. Wheeldale, which tend to be linked by scattered trees along headwaters to woodland in the Esk catchment and the Southern hills.

- The absence of forest from large parts of the core moorland is an asset, given the objectives of the NYMNP and for habitat diversity in general.

- The very large blocks of well-connected forest land is also an asset in terms of a forest habitat network. Given that this ground has now been transformed from moorland, it should be retained as a substantial tract of core forest, within which habitat diversity can be encouraged during the course of forest management.

Biological SSSIs

Bride Stones
Cawthorn Moor
Hole of Horcum
North York Moors cSAC and SPA
Scar End Wood

Needs

- Control of woodland colonisation on the fringes. However, limited retention of scattered birch, hawthorn and Scots pine would be appropriate.

- Remnant ancient woods and wooded riparian corridors require protection from sustained grazing.

- In particular, renewal of birch and alder populations of gill woodlands in headwaters by means of temporary exclosures. Grazing reduction should permit natural regeneration.

- Retention of Wheeldale Plantation as a protection for one of the few moorland ancient woods. Substantial conversion of plantations to native woodland on lower slopes, perhaps associated with woodland pasturage, would help to safeguard the ancient woodland.

6.4. Moorland valleys (2)

Principal features

This is the least-wooded zone of the NYM/HH, well short of the 30% threshold, and both broadleaved and ancient woodland fall shorter still. Moreover, a high proportion (40%) of all woodland is in small blocks, and only 20% is core woodland, i.e., stands more than 100m from a forest edge. These deficiencies are reinforced by the low proportion of ancient woodland that is semi-natural or ancient. On the other hand, the valleys still have a good stock of mature trees in farmland and on riparian sites. The enclosed farmland retains a high proportion of semi-natural grassland mainly on the moor fringe.

- Woodland tends to be concentrated at the southern ends of valleys, where it is close to the woodland concentrations of the Southern hills.

- Plantations tend to be coniferous, small-medium sized and concentrated on the moorland margins, i.e., upper slopes of valley sides.

- Low density of moderate-size ancient woods, especially in Bilsdale.

- Frequent patches of riparian woodland, reinforced by lines of alders and other trees on riverbanks, and small woods on terrace banks. These are key components in a network.

- Headwater streams and tributaries tend to be incised and lined by narrow strips of woodland.

- Field trees tend to be common on the lower slopes, and to include a good stock of mature oaks and ash. As such, they tend to reinforce the riparian network.

- Scattered boundary trees, wooded pasture and bracken banks are found intermittently along the upper slopes, where they are mixed with trees on the fringes of the adjacent moorland, and collectively form a zone of semi-woodland.

Biological SSSIs

Farndale
Snaper Farm Meadows
North York Moors cSAC and SPA (includes former Tripsdale SSSI)

Needs

- Renewal of the succession of boundary trees in farmland, especially on lower slopes and upper margins of enclosure, combined with retention of the mature trees that are still present.

- Protection of woodland and trees on river margins and incised tributaries from sheep pasturage, combined with some attempt to renew coppicing of bankside alders. This could be combined with enlarging riparian woodland strips by marginal planting.

- In addition to planting new woods develop wood-pasturage systems where woodland, field trees and bracken banks are concentrated, especially where remnants survive. This could be particularly appropriate on both riparian ground and the moorland fringes.

- Some restoration of PAWS to native woodland to enlarge semi-natural elements from existing low levels.

6.5. Coastal zone and Esk catchment. (3)

Principal features

Forest covers only 14% of this zone, broadleaved woodland covers 7.9% and ancient woodland 4.7%, all well below the 30% threshold. On the other hand, a high proportion of ancient woodland is semi-natural. A relatively high proportion of the total forest area is in small blocks and subject to edge effects: this is a negative characteristic, since the proportion of core woodland is relatively low at 28%, and many woods are bordered by intensively used farmland. Semi-natural grassland still forms a reasonably high proportion of enclosed farmland.

(a) Esk Catchment.

- Moderately well-wooded, but with woodlands concentrated along steep ground close to the Esk and its tributaries. Notable concentrations include the West and East Arnecliff Woods and Limber Hill Wood above Egton Bridge; Dorsley Bank and Hecks Wood below Grosmont; Beck Hole and other woods near Goathland; Stonegate Gill Wood; and Crunkley Gill Wood at Lealholm.

- Riparian concentration of woodland is reinforced by concentration of village and field boundary trees in the lower ground of the main Esk valley.

- Farmland is mainly pasture with a variable but generally reasonable stock of mature oak and ash.

- Small patches of floodplain woodland, e.g., Lealholm.

(b) Coastal plain and valleys.

- Woodland concentrated into narrow, moderately deep valleys running down to the sea cliffs. These are especially well developed at Mulgrave Woods, Easington and Roxby Becks, and the valley that runs down to Skinningrove (most of which is outside the NP).

- Wooded valleys are inherently isolated. However, their isolation is slightly mitigated by habitats along the rugged sea cliffs, including many patches of scrub, and well-developed scrub-coppice at Beast Cliff.

- Farmland matrix is somewhat bleak, with low density of trees, and extensive tracts of arable and leys. Boundaries with woodland are generally sharply defined.

- Moorland and moorland edge plantations impinge on coastal farmland at several points, including Newton House, Hutton Mulgrave, Upper Glaisdale.

Biological SSSIs

Arnecliffe and Park Hole Woods cSAC
Beck Hole
Biller Howe Dale
Castlebeck and Scar Woods
Littlebeck Wood
Pinkney and Gerrick Woods
Tranmire.
Beast Cliff cSAC

Needs

- More woodland is needed to improve linkages and increase the proportion well above the present 14% cover. This would be particularly valuable within 1km of the coast, where it would help to link wooded valleys.
- Retain substantial tracts of mature ASNW at Mulgrave and Easington-Roxby, which appear to be the largest contiguous patches of ASNW in the whole area. [These appear to be worth considering as SSSIs, especially the latter]
- Buffer the main valley woods by marginal habitat strips and field boundary tree planting within, say, 100m of the wood edge.
- Renew succession of farmland trees in the Esk catchment, especially (a) on lower ground within, say, 200m of river, and (b) along the top margins of fields in the headwater valleys.
- Enlarge small woods, which are relatively common in this zone.

6.6. Western fringes (4)

Principal features

Very well wooded, with 29% of land covered by forest. The southern parts of this zone are contiguous with the Southern hills, and together they constitute a Core Forest Area within a national Forest Habitat Network. However, much of this is secondary conifer woodland: the proportions of broadleaved stands at 26% of all forest land and ancient woodland at 5% are both low. An exceptionally high proportion (89%) of forest lies in large blocks and forms core woodland (57%). Semi-natural grassland forms a surprisingly low proportion of enclosed farmland.

- Forest land is very well connected through the southern parts of the range from Wass-Byland to Boltby, and reasonably well-connected further north. These connections run entirely along the steep ground. Collectively, this is an important forested connection between the south and the north of the NYM.

- Significant gaps in this belt of scarp woodland break this contiguity, e.g., north of Kepwick, and round Osmotherley and Battersby. These gaps are partially bridged by semi-natural habitats with scrub and trees on the intervening ground.

- On the other hand, there are several very large woods that form both long-distance connections and substantial areas of core woodland.

- Farmland below the hills contains scattered, generally small woods, many of which are isolated, in a matrix of more intensively farmed land.

- The ancient woodland is not species-rich, since it occupies generally dry, base-poor ground. Some small riparian woods along incised streams (e.g., Thirlby) may be foci of greater diversity.

Biological SSSIs

Gormire

Needs

- Fill gaps in the main forested belt by ensuring that gaps between woods do not exceed, say, 100m.

- Improve links to woodland in Bilsdale by increasing the amount of woodland at the head of the dale.

- Increase the native woodland content of plantations, especially on ancient woodland and in riparian strips.

- Diversify the structure in large plantation blocks by achieving a normal age distribution of stands, enlarging the mature elements and diversifying patterns of retention and restocking.

6.7. Southern hills. (5)

Principal features

The zone constitutes a Core Forest Area within a national forest habitat network. Forested land covers 36% of the area, well above the 30% threshold for an effective network. Ancient woodland at 12.5% of the land and broadleaved woodland at 13.7% are both abundant in national terms, but below the threshold. At 92% of all woodland, the proportion of the forested area in large blocks is very high by national standards. Likewise the 46% of the forested area in core woodland is high. These characteristics are due to both the concentrated survival of ancient woodland in the valleys and the concentration of afforestation in and around the eastern valleys. Semi-natural grassland forms a surprisingly low proportion of enclosed farmland.

- Ancient woods are strongly associated with high valley sides, but also with low flushed slopes and riparian ground. Both come together in the deep, narrow valleys, such as Ash Dale, but wherever there is a floodplain, the bottom land is usually not well-wooded.

- Ancient woods encompass a very wide range of site conditions, covering almost the whole national range of soil base status within single woods. This variation is expressed as a wide range of semi-natural stand types and ground vegetation composition.

- At least half the ancient woodland has been converted to plantations, many with a high proportion of conifers. This has simplified the structure and stand composition, and narrowed the age class distribution at the scale of stands and woods.

- Woodland is largely absent from the plateau ground between the valleys, except towards the east, where large plantations on moorland fringes have extended onto the limestone plateau.

- Trees in farmland and around settlements reinforce the pattern of woodland. The plateau farmland has few trees, but the valley farmland is reasonably well-stocked, and riversides are generally lined with alders and other trees.

The generally elongated character of the ancient woods, combined with the large, compact plantations, has generated an almost optimal forest distribution, combining a substantial area of core forest with maximum connectedness. From the outskirts of Helmsley, woodland extends almost contiguously to lower Bilsdale, almost to the head of

Plate 7. Travertine dams along the White Beck in Dalby Forest. An example of individual sites of high nature conservation interest within the forest matrix, these travertines enjoy a more natural environment than similar formations in limestone grassland.

Plate 8. Runswick Bay, with extensive scrub woodland extending up short valleys, but isolated from other woodland by bleak, treeless farmland.

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Ryedale, and to woods on the western fringe from Boltby to near Ampleforth: the maximum gaps recorded on the OS are 125m, and these may be bridged by farmland trees and riparian wooded strips. A similar degree of connectedness has been achieved from near Scarborough to Thornton le Dale via Hackness and Langdale End.

- Good representation of wood-pasture and wood-meadow conditions, both as survivals of ancient wood-pasture, and as mosaics of semi-natural grassland,, scrub, coppice and mature trees in farmland, e.g., around Hawnby.

- Concentration of non-woodland SSSIs and non-woodland habitats generally.

- Marked contrast between the valleys and plateau in the incidence and value of semi-woodland habitats, the former being rich, the latter poor.

Biological SSSIs

Ashberry and Reins Woods
Blaiskey Bank Springs
Bull Ings
Castle Hill Wood
Cockrah Wood
Cropton Bank and Howlgate Head Woods
Duncombe Park
Ellerburn Bank
Ellers Wood and Sand Dale
Gowerdale Windy Pits / Peak Scar
Low Pasture
Nabgate
Newtondale
Noddle End
Raincliffe and Forge Valley Woods
Rievaulx Wood
Ruston Cottage Pasture
Ryedale Windy Pits
Sieve Dale Fen
Sleightholme Dale
Spring Wood, Hawnby
Troutsdale and Rosekirkdale Fens

[Hough and Gundale Slacks are just outside the NP]

Needs

- Additional woodland would be useful in particular locations, notably the weak links in the network at Sleightholmedale-Harland Moor, and around Lockton.

- Substantial need for restoration of site native tree species to those ancient woods that have been converted to plantations, combined with diversification of structure on both stand- and whole-wood scales.

- Restoration and development of wood-pasture and wood-meadow structures within the valleys.

- Inclusion of native tree species within 20th century plantation forests, both on riparian ground and in places that link directly with existing native woodland.

- Continued maintenance and enlargement of open space habitats within 20th century plantation forests, especially in association with native trees and riparian land.

- Development of old-growth conditions within the core forest land. This lies mainly within the large 20th century plantation forests.

6.8. Howardian Hills

Principal features

The coverage of forested land at 19%, broadleaved woodland at 11% and ancient woodland at 10% are all well above national averages, but well below the 30% network threshold. This is due mainly to the survival of many ancient woods, which still constitute a majority (53%) of all forest land. However, 95% of the ancient woodland has been converted to plantations, an exceptionally high proportion, explained by the prevalence of large estates with a strong interest in forestry and pheasant shooting. Forested ground is generally distributed in large, compact blocks, with 79% in woodland over 30ha and core woodland of 32% of area, both probably high in national terms.

- The landscape has a lowland character of intensive agricultural usage and high definition patches. Very little of the ground is in any sense 'wild' and most boundaries are sharply defined.

- Agricultural land is almost entirely arable, ley or improved grassland. Hedges largely date from Inclosure and generally contain only a poor woodland flora. Trees in farmland are now limited. Semi-improved grassland is mainly sheep-grazed and of limited floristic value. In general semi-natural and semi-woodland habitats are very limited and are currently largely unmanaged.

- Verges and green lanes are reasonably rich remnants of neutral-alkaline grassland, especially where hedges also survive. Where hedges have been removed, verges and green lanes are floristically limited.

- Streams and riparian corridors are reasonably rich, often tree-lined, and some watercourses still have natural meanders. Several are bordered by narrow marshes in pasture. Alder is common on stream banks and around headwaters.

- The woodlands, though large, are of limited interest as tree-covered land. They include some localised species (e.g., Baneberry or Herb Christopher, *Actaea spicata*, Wood vetch, *Vicia sylvatica*, Lily of the Valley, *Convallaria majalis*), and some remnants of semi-natural stands, but most stands are 19th century oak plantations or 20th century conifer, beech and sycamore plantations.

- Woodland open spaces are reasonably rich. In effect, these maintain samples of the vegetation that existed in farmland before modern farming, such as neutral grassland, heathland, dry acid grassland, acid mires by headwaters and meadow grasslands. The woods may be the only places where strongly acid and poorly-drained soils survive in the AONB.

- The high proportion of woodland in plantation forestry has helped to maintain open space habitats within woodland, but these are poorly linked on a larger scale, due to the generally low density of semi-natural habitats within farmland.

- Woodland is well-connected along the north side of the Hills, and in the Kirkham Gorge – Castle Howard estate. However, even here there are many gaps of more than 200m.

- Elsewhere, woods are generally smaller and more isolated. This isolation is reinforced by the generally low density of farmland trees.

Biological SSSIs

Horsefield, Gilling
Kirkham Park and Riverside
River Derwent (part)
Jeffry Bog
Dalby Bush Fen

Needs

- Concentrate on developing habitat-rich riparian corridors, with marshes, meadows, woodland, trees-in-farmland. These would pass through both woodland and farmland.

- Within woods, concentrate on open space habitat expansion and management, developing heathland, neutral grassland and acid mires.

- Link the woods in the main belt by new woodland and hedge trees, but not at the expense of semi-natural grassland.

- Renew the stock of farmland trees, especially in gaps between woodland concentrations, and along and near to watercourses. Retain surviving mature trees.

- Expand the small, isolated woods to achieve either the 3ha or 30ha thresholds.

- Restore site-native trees to a proportion of plantations, especially in ancient woods, and retain mature trees where they exist. A proportion of 30% native would achieve good linkages.

- Develop semi-natural habitats along the Rye, including floodplain woodland and buffer strips with trees between cultivated ground and the river. This would involve the whole length between the NYM and the Kirkham Gorge, including reaches outside the HHAONB.

7. DEVELOPING A FOREST HABITAT NETWORK IN THE NORTH YORK MOORS AND HOWARDIAN HILLS

This chapter aims to bring together the needs identified in chapter 6 into an outline list of practical proposals. The measures are summarised in Table 7 and explained in more detail in subsequent sections.

Table 7. Summary of possible measures to develop native woodland and trees in the NYM/HH. For each zone the number of + indicates the relative importance of that measure in that zone.

MEASURES	NYM1 Moorland	NYM2 Moorland valleys	NYM3 Esk and coast	NYM4 Western fringes	NYM5 Southern hills	HH
A. NEW NATIVE WOODLAND						
Complete links in main belts				++	+	+
Reinforce coastal links			++			
Establish native woodland links on bracken banks	+	+	+			
Expand and link small isolated woods		++	+			++
Buffer woods against intensive agriculture			+++	+	+	+++
Reinforce riparian woodland	++	+++	++			+
B. PLANTATION DIVERSIFICATION						
PAWS restoration to native woodland		++	++	+	+++	+++
Expand native stands in secondary plantations	++	+	+	+	++	+
Develop old-growth retentions	++			+	++	
Develop normal age-distribution in large blocks	+++			++	++	++
Diversify stand structure / silvicultural systems	++			+	++	++
Expand and maintain open space habitats	++			+	++	++
Riparian strips of native woodland	++				+++	++
C. MANAGING ASNW AND NATIVE WOODS						
Restore management of ASNW (coppice, HF)		++	+++	+	+++	++
Minimum intervention stands			+		++	
Restore management of riparian woods and trees		+++	++		+	++
Rhododendron control			+			
D. WOODLAND-GRASSLAND						
Retain and maintain ancient parkland			+		++	+
Retain and maintain pastured woods	+	++				
Restore trees in association with arable farming			+		+	++
Restore farmland trees, riparian fringes	+	+++	+	+	+	++
Restore farmland trees, moorland fringes	+	++	++			
Create wood-meadows	+	+			++	+
E. CONTROLLING BIOTIC DAMAGE						
Control deer at levels that permit tree recruitment		++	++	++	++	++
Control grey squirrels to minimise de-barking		+	+	+	+	+
F. EXTERNAL LINKS						
New woodland outside NP/AONB				+	++	++

7.1. Increasing the area of native woodland outside plantations.

New native woodland should be targeted at particular places, where it would reinforce and protect existing small woods, or generate better links between woods.

New woodland, most of which should be native, would be most beneficial if it:

- Completed linkages within the Western Fringes and from them to woodland in Bilsdale by new planting or new wood-pasture from planting in farmland.

- Reinforced links in Southern Hills to complete the chain of woods by planting in the two main gaps. The weakest links appear to be across the ridge south from Lockton Low Moor across which the A169 runs, and the diffusely-wooded zone at the southern end of Pockley and Skiplam Moors.

- Expanded small, isolated woods in Howardian Hills, Moorland valleys and Esk catchment.

- Buffered woods in coastal plain and Howardian Hills against intensive agriculture by new plantings or allowing marginal scrub development.

- Reinforced riparian woodland in moorland, moorland valleys, Esk catchment and the coastal plain, throughout their length and into headwaters.

- Expanded and linked woods in coastal valleys and scrub on cliffs with coastal belts of forest habitat. In the exposed position along the cliff tops, these would take the form of scrub and grassland.

Most new woodland would be generated by a mixture of planting and natural regeneration. In a few other places, trees would be allowed to colonise naturally until a structurally diverse condition has been developed. New oak parkland could be developed by scattered planting, reinforced by natural regeneration during temporary grazing reduction. Development of this kind would be attractive on some moorland fringes around the Moorland Valleys and upper Eskdale and tributaries.

7.2. Plantation diversification: treatment in relation to native elements

The large plantations represent not just large tracts of forest, but the main repositories of forest land that remains free from the influence of intensive agriculture. They offer the best opportunities for:

- Restoring PAWS to native woodland (see section 7.3)

- Expanding native stands in secondary plantations. This would be a continuation of the ‘5% broadleaves’ policy. It would be most beneficial in the large plantations in the Southern Hills and the south-eastern moorlands, where good linkages can be achieved with ancient woodland.

- Developing old-growth stands in the interior of large forests. Some plantation sub-compartments would be retained indefinitely as either minimum intervention reserves, or as long-rotation, continuous-cover stands yielding some timber. Both would be expected to develop into mixed conifer – broadleaved stands eventually. Old broadleaved stands could also be treated this way if they are well inside the forest.

- Maintaining a normal age-class distribution of managed stands within coherent blocks of forest. This is probably already developing as plantations pass well into second rotation.

- Developing a range of stand structures within a coherent block of managed forest. This seems to be poorly developed: most stands are still even-aged. There should be opportunities for shelterwood regeneration of pine stands, which would simulate natural structures.

- Restoring a substantial network of open space habitats free from the effects of intensive agriculture. Continued enlargement of open space habitats in large plantations, in association with remnants mires, heaths, watercourses, forest roads and rides. In the Southern Hills plantations, ride and road margins form a network of herb-rich meadows. These already link well to semi-natural habitats outside woodland.

- Maintaining headwater streams under more-or-less natural conditions. It would be beneficial to focus native woodland restoration on and around streams within forests whilst maintaining open ground interests. Some have important relict faunas. Most are foci of diversity, with alkaline seepages. Many are already lined with native trees. This is particularly important in the Southern Hills.

Other points:

The native woodland in Wheeldale Plantation is a rare example of ancient woodland within moorland. Continued protection from excessive pasturage within the plantation fence would be desirable, but some expansion of native woodland would reinforce the protection. Wood-pasture treatment of restored native woodland has been mooted, and would be acceptable: the steep ground close to the stream affords both protection from severe browsing, but presumably also presents a problem in managing stock within woodland. Native woodland within plantations already links well with native woodland lower down the valley.

The large Western Fringe plantations appear to be somewhat uniform. Since they form a major element in north-south network connections, there is a case for introducing a larger native element, and diversify age-class distributions.

7.3. Treatment of ancient and native woodland

Three main issues, though they overlap:

(a). Restoration of PAWS to native cover

This is the most pressing issue, because (i) so much ancient woodland is PAWS, (ii) many plantations appear to be coming up to harvesting age, (iii) the woods form part of a ecologically rich area, and are (or were) themselves diverse.

Priorities for PAWS restoration have not been examined in detail, but the following should be considered:

- Substantial restoration of native elements in native woodlands of Southern Hills would be highly desirable, since this is inherently the most diverse group of woodlands. FC is planning a substantial restoration in its holdings. There would be a case for consolidating large blocks of native woodland, e.g., Forge Valley and around Rievaulx and Hawnby, combined with limited native retentions scattered through the rest.

- Restoration of native elements in the large woods of Howardian Hills. The most advantageous pattern would be to concentrate native woodland in riparian zones and as part of multi-habitat corridors. Where planting is necessary, the selection should concentrate on oak, ash, birch, alder and gean, according to site. Small-leaved and large-leaved limes would be acceptable as reintroductions from local origin stock.

- Restoration of native stands in more important groups of ancient woods elsewhere. These will include the riparian concentrations in Esk valley, e.g., Arnecliff, Beck Hole.

- Re-assessment of the conservation value of the major coastal woods (Mulgrave, Easington-Roxby) and combined with arrangements that maintain or seek restoration of predominantly native cover.

(b). Management of neglected ancient semi-natural woods.

These are mostly former coppices on steep slopes that have been left uncut for decades, and have now grown to a high forest form. As such, they form conspicuous features in the landscape, and important remnants of increasingly natural woodland.
Minimum intervention management is an option. This would help to build up large trees and dead wood habitats to close to natural levels within 50-100 years (depending on the scale and frequency of natural disturbances), but it would also tend to exclude oak and increase shade-bearing species, such as beech, sycamore and (subject to disease) wych elm. This approach would be acceptable in a proportion of stands, especially those where

there is already a good stock of large trees and dead wood. Stock exclusion and pest protection measures would be essential to ensure regeneration. Some control of sycamore and other naturalised species may be necessary. An inventory of 'old-growth' stands would be worth compiling as a basis for selecting preferred minimum-intervention stands.

Elsewhere, the optimum course might be to promote low-intensity, long-rotation treatments that permit timber harvesting, and allow foresters to exert some control over stand composition. This woodland would be supplemented by the PAWS restored to native woodland. Combined also with some secondary semi-natural woodland, this represents a significant resource that could form a basis for promoting local hardwood utilisation.

(c). Management of riparian native woodland and trees.

Riparian woodland presents much the same issues as the semi-natural woodland on the upper slopes. Most have been coppiced, but have long been allowed to grow tall, and many have been grazed. Although there seems to be no immediate concern, minimum intervention with grazing (the recent regime in many) will inhibit regeneration, and in particular jeopardise the light-demanding trees, mainly alder and oak. Continued heavy grazing will also impoverish ground vegetation and associated fauna.

Riparian woods should be amongst the most diverse in the landscape – in fact, this could be said of riparian habitats in general. There is a need to reduce the intensity or extent of grazing in combination with both enlarging the smaller woods and reinforcing riverbank strips of alder coppice (see 7.1), and renewing the succession of farmland trees on lower ground (see 7.5). If uses can be found for the wood, a degree of restoration of coppicing of small woods and riverbank strips would be beneficial.

7.4. Relationship between forested and other land.

The effectiveness of a forest habitat network is enhanced if the matrix of non-forest habitats offers some opportunities to forest species. If matrix quality is high for forest species, populations within the forest will have larger and more-resilient populations, and be better able to move through the landscape. The creation and maintenance of wood-pasture and wood-meadow is included here.

Measures worth considering:

- Maintaining wood-pasture elements in the valley farmland of the Southern Hills. This is not just a question of sustaining Duncombe Park and the oak (car)parkland at Castle Howard, but also maintaining succession of trees in and around villages, lower ground fields, e.g., Hawnby.

- Maintaining pastured woodlands on the moorland fringes, and reinforce by planting in bracken banks. These are a distinctive feature, but in the long-term the succession of trees will have to be assured by new regeneration.

- Renewing the succession of farmland trees by new planting, and protect existing mature trees, at least until successors are maturing. This is desirable throughout the areas, save for the Moorland zone, but is particularly desirable in the Howardian Hills, where there are few habitats between woods.

- Increasing the density of field trees in moorland valleys and Esk valley would be especially desirable on lower ground, where they can reinforce riparian woodland and strips, and on upper ground, where they can reinforce moorland fringe trees.

- Creating or restoring semi-natural habitats in association with woodland. This could take the form of new wood-pastures on riparian ground, including by arable reversion.

- It would be exciting and innovative to develop wood-meadow structures in association with open spaces in the Southern Hills woods and plantations. This has already been successfully initiated e.g., Deepdale, Dalby Forest. A wood-meadow is land with a scatter of large trees, scrub and patches of coppice, in which the intervening ground is mown and perhaps grazed later in the season. These were a feature of continental Europe, and surviving examples are exceptionally attractive and biodiverse places (Emanuelsson and Bergendorff 1986). The flushed, alkaline ground within the plantations of the Southern Hills would be particularly appropriate.

7.5. Limiting biotic damage.

Control of deer populations is essential. Without it, native woodlands will regenerate only with difficulty, and herbaceous communities will be impoverished. This does not mean deer exclusion, but recognising that culling will be necessary to restrict populations to levels that permit tree and shrub recruitment in gaps.

Grey squirrel control is desirable, but a cost-effective form of control remains a pipe-dream. In so far as grey squirrels reduce the stature of sycamore and beech, they may be having some marginal benefits in woods of high conservation value, but they also deform birch, oak, sallow and other trees. In some circumstances it is possible to ‘bend with the wind’ by using squirrel-damaged saplings to start new pollards in pasture woods and near glades.

Elm disease has greatly changed the composition of semi-natural woodland on alkaline and base-rich soils, where wych elm was often co-dominant with ash. The elms are not

Plate 9. Meadow grassland on calcareous soils in Deepdale, with ladys-bedstraw and fragrant orchid. This is actually a clearing within the Forestry Commission's Dalby Forest, that was restored following the early clearance of a conifer crop and is maintained by mowing. Such grassland should be regarded as a component of a network of forest habitats, where it will remain shielded from the impacts of intensive agriculture.

Plate 10. Spaunton Lodge, set against an isolated plantation in Spaunton Moor. Chickweed wintergreen, *Trientalis europea* is present in the plantations, having presumably survived under bracken on the open moor. The foreground shows a bracken bank near the edge of the moor which might be planted with groups of oak or birch.

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threatened with extinction, but survive as underwood, sub-canopy trees and a crude form of coppice. Some attenuation of the disease can be anticipated, but it seems best to assume that few elms will grow into full-stature trees.

7.6. Relationships with land outside NYM/HH

A network approach to forest restoration should look outside the immediate district under consideration to consider how that district would fit into a hypothetical national network. Where it is not bounded by the sea or industrial Tees-side, the NYM/HH is surrounded by the low relief landscapes of the Vale of Pickering and the Vale of York.

Two points seem worth making:

- It would be desirable to restore riparian habitats along the river Rye between the NYM at Helmsley (and on other tributaries to the east) and the Kirkham Gorge part of HH. More information is needed before particular suggestions can be made, but the general approach would be to increase the number of farmland trees on the floodplain, and develop semi-natural habitats generally between the river and arable farmland. These habitats could take the form of patches of floodplain woodland (including energy coppice), meadow/pasture developed as washlands, or combinations, all linked by hedgerows.

- The Swale-Ouse-Ure rivers represent links to the Pennine fringes. Habitat connections towards these rivers from the Howardian Hills and the Western Fringes of the NYM would be desirable. Only the headwaters are within the NYM/HH.

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8. PRIORITIES

We have identified ten measures that seem most important and practicable at the present time, and the zones in which they seem most needed. The summary in the following table links each to the measures listed in Table 7. No order of importance has been identified within the list. Most measures would be beneficial in most zones, so empty boxes indicate only that a particular measure is regarded as less necessary in a particular zone.

Table 8. Priorities by zone.

	Priority	1 Moor - land	2 Moor - land valleys	3 Esk and coast	4 West -ern fringes	5 South -ern hills	HH	Ext	Table 7
1	Linking woods with new woodland to improve connectivity		+	+	+				A
2	Inserting trees onto bracken banks to diversify moorland fringes and marginal sheep-pasture	+	+	+					A/D
3	Restoring PAWS to native woodland by thinning and steady replacement of existing planted stands					+	+		B
4	Developing riparian multi-habitat corridors in and between woodland	+				+	+		B
5	Developing and managing open space habitats within large woods and plantations					+	+		B/D
6	Controlling incipient Rhododendron infestations			+	+	+			C
7	Managing ancient woods to generate a greater variety of structures		+	+		+			C
8	Regenerating woodland, parkland, riverbank trees and field trees in areas used mainly as pasture	+	+	+		+			D
9	Controlling deer populations to levels that permit tree recruitment in gaps.	+	+	+	+	+	+		E
10	Habitat restoration on the Rye-Derwent floodplain to link forest habitats within NYM/HH						+	+	F

The following notes amplify the priorities and show that there is a degree of overlap between the various measures.

1. Linking woods.
New woodland, principally as closed-canopy high forest. The majority of the ground would be planted, but enough space would be left for natural colonisation to add diversity to the developing woodland. Open space habitats would be included as rides and glades.

2. Bracken Banks.
A particular form of new woodland on the moorland fringes and bracken banks, where establishing a scatter of trees within bracken-dominated patches would diversify a currently low-diversity vegetation type, help to link existing scattered trees and small woods. Such ground often has woodland species already on site under the bracken. Would probably mostly take the form of wood-pasture.

3. Restoring PAWS.
Converting existing plantations on ancient woodland sites to native woodland. This would not necessarily be by immediate clear-felling and replanting. In most instances there would be advantages in proceeding at a measured pace by thinning and replacement of the plantations over a period of decades. The eventual outcome should be better retention of the woodland ground vegetation and a more diverse native woodland.

4. Riparian corridors.
Where existing semi-natural vegetation and diversity is strongly associated with riparian corridors (i.e., streamsides, floodplains, lower slopes, springs), both within woodland and in farmland, there is a case for developing this pattern as a well-linked dendritic network. Restoration of PAWS to native woodland would be particularly appropriate in this zone.

5. Open spaces.
Where the principal interest within large woods and plantations is in the open space habitats, this pattern should be developed by restoring meadows, pastures, heaths and mires with associated fringes and groups of native trees and shrubs.

6. Rhododendron control.
Rhododendron has the capacity to reduce woodland diversity and increase the costs of woodland management. It needs to be controlled before it spreads further.

7. Managing ancient woods.
Most ancient woods have not been managed recently. Ultimately, it would be desirable to generate a variety of structures, from minimum-intervention old-growth to traditional coppice-with-standards, in stands that have remained semi-natural. PAWS restoration will generate new native stands on ancient sites. Silvicultural interventions would not only increase biodiversity, but provide utilisable timber and facilitate any necessary control of sycamore and other species.

8. Wood pasture and meadow.
This concerns the relationship between trees, woodland and herbivores generally. There are inherent difficulties in places where trees and woodland are important components of the landscape, but the land is used predominantly as pasture. Woodland has to be given periodic opportunities to regenerate, and the stock of farmland trees has to be renewed. This is not just a matter of temporarily fencing sheep out of woods or away from boundaries, but also includes developing wood-pasture and even wood-meadow management locally.

9. Deer Control.
Deer control is an on-going requirement if native woodland is to be regenerated cost effectively, by planting or using natural regeneration.

10. Rye-Derwent linkage.
That part of the Rye-Derwent rivers that lies between the North York Moors and the Howardian Hills (Kirkham Gorge) is functionally part of the combined area. Habitat restoration combined with measures to impound floodwaters could have multiple benefits.

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The abbreviations, tables, figures and plates

Abbreviation

AONB	Area of Outstanding Natural Beauty
CAP	Common Agricultural Policy
cSAC	candidate Special Area of Conservation
EN	English Nature
FC	Forestry Commission (including Forest Enterprise)
FHN	Forest Habitat Network(s)
GFP	George Peterken
HH	Howardian Hills
NP	National Park
NPA	National Park Authority
NVC	National Vegetation Classification
NYM	North York Moors
OS	Ordnance Survey
RFS	Royal Forestry Society
SSSI	Site of Special Scientific Interest

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