BRITISH FOREST LANDSCAPES
THE LEGACY OF WOODLAND FRAGMENTATION

In an article based on his presentation at this year's RFS/RASE conference, 'Joined-up Forestry', **Kevin Watts** explains the new ideas in managing fragmented woodland for conservation and biodiversity.

The woodlands of Britain, in common with many natural habitats throughout the World, have experienced considerable loss and fragmentation through a long history of human activity. Current woodland cover has fallen to less than 12% from an estimated high of around 75% around 6,000 years ago. The majority of woodlands are now very small and isolated within a primarily agricultural landscape. This is especially true for ancient semi-natural woods that often have the highest biodiversity value.

The process of fragmentation basically involves habitat change that results in large woodlands being broken into smaller pieces. This threatens woodland biodiversity by reducing woodland area, which may increase the risk of local extinction, and by extending the isolation between woodlands thereby hindering the movement of individuals between the remaining fragments. However, these woodland fragments may actually be functioning at a larger scale as a network of habitats, dependent upon the distribution of semi-natural habitat and the intensity of the surrounding land use; management may be more effective at this scale. As a result, forest and conservation plans and strategies are increasingly incorporating the concept of habitat networks in an attempt to target and prioritise action to combat habitat fragmentation and conserve woodland biodiversity. These larger-scale approaches may also assist the further integration of environmental, economic and social objectives in order to create 'joined-up' sustainable forest landscapes.

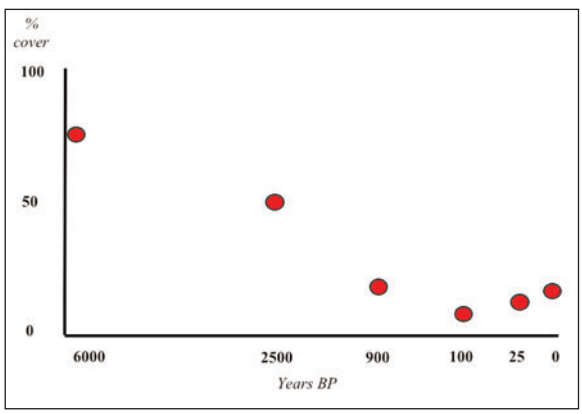

Figure 1. Changes in woodland cover over time in the British landscape – adapted from Rackham (1986) and Peterken (1993).

The woodland resource

Woodland once covered most of the British landscape and represented the climax vegetation community. Woodland colonised Britain around 10,000 years ago, following the last glaciation, reaching a natural equilibrium between 7,000 and 5,000 years ago (Godwin, 1975; Peterken, 1993). During this peak period the 'wildwood' is thought to have covered around 75% of the landscape (Peterken, 1993). However, a long history of human activity has greatly reduced forest cover, with woodland clearance beginning as far back as Neolithic times (5500BP) with the advancement of agriculture. Rackham (1986) believes that woodland cover in England had been reduced to 50% by the early Iron Age (2500BP). By the time of the Domesday Book (900BP) woodland cover in England had declined further to 15%, with most of the landscape comprising farmland with small, scattered islands of woodland (Rackham, 1986).

Woodland cover in Britain has recently increased from a low point of 5% at the start of the 20th century to around 11% today, due largely to afforestation with exotic coniferous species which now account for over half the total woodland cover (Forestry Commission, 2003). These changes in woodland cover are illustrated in Figure 1.

Today many woods are very small and isolated from each other, and this is especially so for ancient semi-natural woods (woodland that has a continuous history since at least 1600), which often have the highest biodiversity value. 75% of the woodlands in Britain are now under 2ha in size, but these small woodlands only account for around 5% of national woodland area. In contrast, the relatively few large woodlands over 100ha, which represent less than 1% of the total number, account for nearly 65% of the total woodland area (Table 1). The bulk of these larger woodlands comprise conifer plantations established in the 20th century.

Woodland fragmentation

The process of fragmentation basically involves the sub-division of large woodlands into smaller pieces (Figure 2). During this process large woodlands may initially undergo perforation through clearance for agriculture, urbanisation and other land uses. They may then be dissected by linear features, such as tracks and roads, to form smaller discrete woodlands. These areas

Table 1. Distribution of woodland size in Great Britain. Source: National Inventory of Woodland and Trees (Forestry Commission, 2001a; 2002c; b; a; 2003)

	England	Scotland	Wales	GB
All woodland				
No.	222,461	82,306	33,036	337,803
Area (ha)	1,097,000	1,281,000	287,000	2,665,000
% land cover	8.4	16.4	13.8	11.6
Mean wood size (ha)	4.9	15.6	8.7	7.9
Woods >100ha				
No.	1,315	1,287	357	2,959
No. %	0.6	1.6	1.1	0.9
Area (ha)	503,000	1,053,000	170,000	1,726,000
Area %	45.9	82.2	59.2	64.8
Woods 10-100ha				
No.	13,019	5,006	2,644	20,669
No. %	5.9	6.1	8.0	6.1
Area (ha)	339,000	148,000	71,000	558,000
Area %	30.9	11.6	24.7	20.9
Woods 2-10ha				
No.	41,351	11,488	6,630	59,469
No. %	18.6	14.0	20.1	17.6
Area (ha)	180,000	52,000	29,000	261,000
Area %	16.4	4.1	10.1	9.8
Woods 0.1-2ha				
No.	166,776	64,525	23,405	254,706
No. %	75.0	78.4	70.8	75.4
Area (ha)	75,000	29,000	17,000	121,000
Area %	6.8	2.3	5.9	4.5

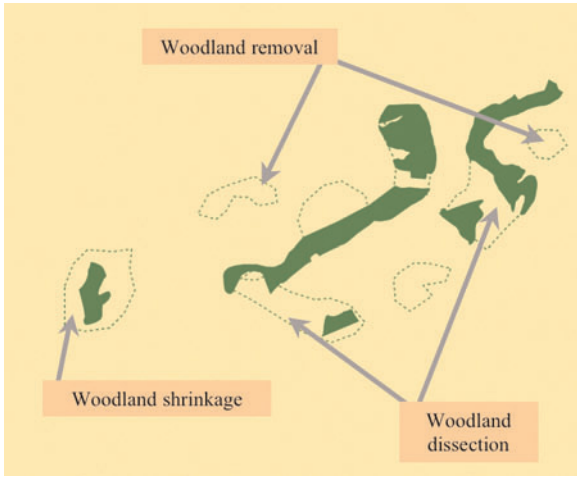

Figure 2. Illustration of key elements within the process of woodland fragmentation. The dotted line depicts previous woodland extent.

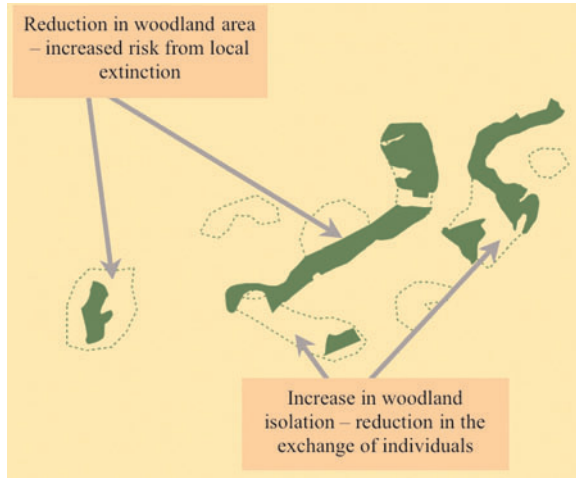

Figure 3. Main consequences of woodland fragmentation.

may be further eroded and shrunk by land use activities, such as agricultural intensification, in the surrounding landscape. These factors, combined with poor woodland management, may lead to a general decline in woodland quality, while some woodland may be completely destroyed and disappear from the landscape.

Such fragmentation poses one of the key threats to the conservation of woodland biodiversity. Forests and woodlands support a large proportion of Britain's biological diversity with over 40% of species within the UK Biodiversity Action Plan being associated with woodlands, and nearly 15% of habitats being specific woodland types (UK Biodiversity Steering Group, 1995a; Simonson and Thomas, 1999). Many of these woodland species have developed within the past extensive network and are poorly adapted to live in fragmented landscapes.

Fragmentation causes a reduction in the area of available habitat (particularly core habitat due to edge impacts) and an increase in the distance between woodlands. A number of scientific theories (MacArthur and Wilson, 1967; Hanski, 1998) suggest that the reduction in area may lead to increased local extinctions, while increased isolation may cause a reduction in the exchange of individuals between isolated patches, threatening their long-term viability (Figure 3). Intensification of land uses within the surrounding landscape may further hinder species movement and increase ecological isolation. Although agricultural activities have in the past produced complex and diverse habitats and landscapes, since the Second World War their influence has been profoundly negative (Sheail, 1995). There are also concerns that climate change may further compound these effects as woodland species may be unable to keep pace with the movement of climate conditions to which they are accustomed/adapted.

The attrition of biodiversity is evident within wild bird populations, which are considered to be a good indicator of the broad state of biodiversity (Defra, 2003). Populations of wild birds, especially farmland and woodland birds, have progressively declined from high levels recorded in the mid-1970s. The index of farmland birds declined by over half between the late 1970s and the late 1990s, while the woodland birds index declined by about a quarter during a similar period. In 2002 the index for farmland and woodland birds stood at 55% and 81% of 1970 values, respectively (Defra, 2003).

From woodland islands to woodland networks

Attempts to conserve woodland biodiversity have often focussed towards the safeguarding and management of a small number of 'islands' of high conservation value (Adams, 1996), such

as ancient semi-natural woodland (Figure 4). However, it is becoming apparent that biodiversity within these 'islands' may also depend, particularly in the long-term, on other areas of semi-natural habitat, including other woodland types (Figure 5) and less intensively used land within the surrounding landscape (Figure 6). Adams (1993, p.200) confirms that the "landscape cannot effectively be separated from the status of the semi-natural habitats within it. Neither can the conservation of species within preserved sites be divorced from the wider countryside matrix within which they lie". These surrounding landscape elements may have their own biodiversity value and provide vital support for these high-value conservation areas.

As a result, these perceived habitat islands may actually be part of, and managed more effectively within, a larger scale network of habitats, based on the distribution of semi-natural habitat and the intensity of the surrounding land use (Figure 7) (Watts et al., 2005). These networks are considered especially important for fragmented and formerly extensive habitat systems such as woodland within Britain. This has been reflected in a marked shift in conservation policy and effort to the larger 'landscape' scale, acknowledging that individual sites are an important but an insufficient system to conserve biodiversity in the long-term (Adams et al., 1994).

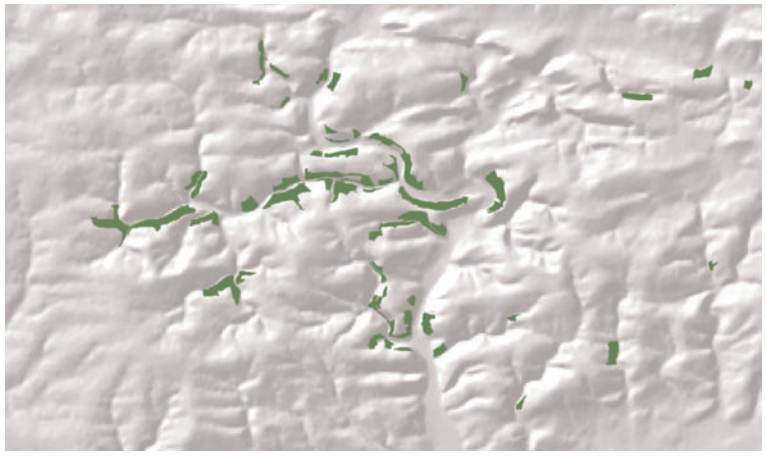

Figure 4. Ancient semi-natural woodland (green) within an area of Exmoor, Somerset.

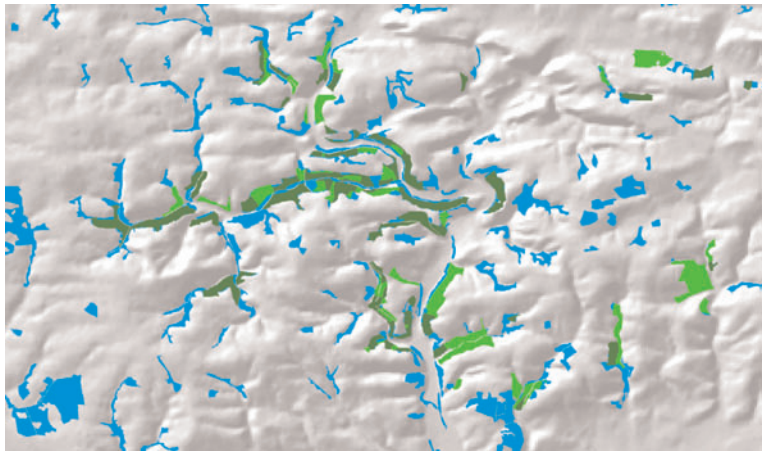

Figure 5. Ancient semi-natural woodland (dark green), plantations on ancient woodland sites (light green) and secondary broadleaved woodland (light blue).

The move towards landscape-scale action

Forest and biodiversity strategies within Britain and beyond are increasingly incorporating the concept of habitat or ecological networks in an attempt to conserve woodland biodiversity, combat fragmentation, and mitigate the impacts of climate change (UK Biodiversity Steering Group, 1995b; Forestry Commission, 1999; 2000; 2001b).

A good example is the new Ancient and Native Woodland

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Policy for England 'Keepers of Time' which aims to ensure that "ancient woodlands, veteran trees and other native woodlands are adequately protected, sustainably managed in a wider landscape context" (Forestry Commission, 2005, p.8). By considering woodlands as an integral part of the wider landscape, the policy seeks to create opportunities to expand networks of woodland and other semi-natural habitats into ecologically functional landscapes. These networks provide a potential basis for targeting and prioritising future management actions at strategic and operational levels in order to gain the largest ecological benefit (Watts et al., in press).

The following sequence of management actions, which could be applied to the example network in Figure 7 emphasise the need to secure existing resources before undertaking more ambitious habitat restoration and creation/recreation.

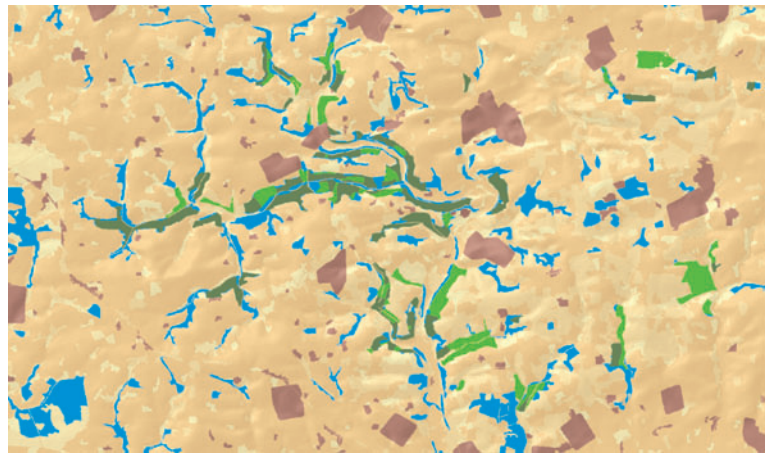

Figure 6. Different woodland types from Figure 5 combined with a land cover map representing the intensity of land use systems in the surrounding landscape matrix (from dark brown for urban areas, medium brown for improved land and light brown for semi-natural habitats).

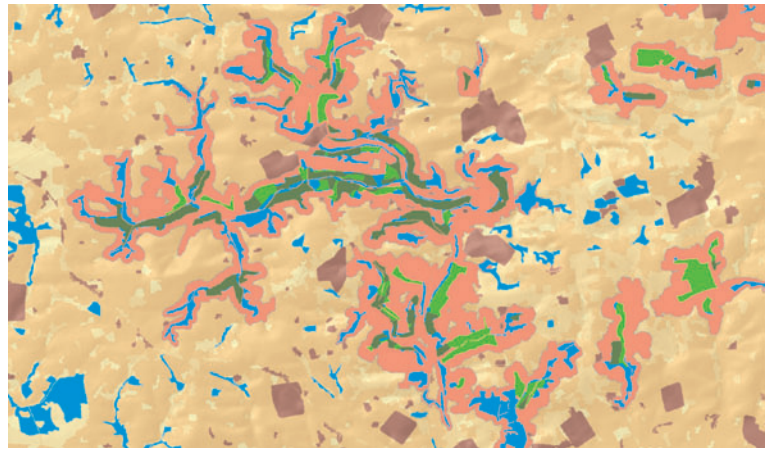

Figure 7. A functional woodland network (pink) based on the distribution of woodland types and the land use intensity in the surrounding landscape matrix (Figure 6).

1. Protect/manage areas of existing high quality habitat, in this case areas of ancient semi-natural woodland and associated habitats, especially where they form clusters within potentially large habitat networks. Many fragmentation sensitive species, with limited dispersal abilities, will be restricted to these areas and will be unlikely to take advantage of recent/near future habitat expansion and linkage.

2. Restore/improve sites with high restoration potential, including plantations on ancient woodland sites, particularly where they extend, buffer, protect and link existing woodlands. There is now a major process of restoration and improvement of plantations on ancient woodland sites underway in the UK as many still have remnants of the previous, biodiversity-rich ancient woodland.

3. Improve/manage secondary broadleaved woodland sites. There are opportunities to improve recent broad-leaved woodland sites for their inherent value and for the ecological support of other woodlands.

4. Improve matrix by reducing the intensity of the land use through the use of extensification measures such as the targeting of agri-environment schemes. This may increase core woodland area by removing negative edge impacts, and improve the exchange of individuals between isolated sites.

5. Create/recreate new broadleaved woodland and associated semi-natural habitat at strategic locations within and between woodland networks. Adhoc woodland planting may have limited benefits in combating habitat fragmentation.

In conclusion, woodland fragmentation, coupled with the growing risk from climate change, is a serious threat to the conservation of woodland biodiversity. Plans and strategies for forestry and conservation are now addressing these issues through the coordination of action at larger spatial scales. This landscape scale approach also promotes the integration of biodiversity goals with other environmental, economic and social objectives, which are being planned at similar scales. This marks a significant and necessary shift from segregated to integrative landscape planning which is necessary to create 'joined-up' sustainable forest landscapes.

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