Article

Barr, C. J.; Bunce, R. G. H.; Cummins, R. P.; French, D. D.; **Howard, D. C.**. 1992 Hedgerow changes in Great Britain. *Annual Report of the Institute of Terrestrial Ecology*, 1991/92. 21-24 woodpeckers (*Dendrocopos major*) readily cross gaps between woods and utilise groups of quite small fragments of woodland Marsh tits (*Parus palustris*) and long-tailed tits (*Aegithalos caudatus*) may be more restricted by their reluctance to cross open ground For the wren, the number of breeding pairs was found to increase linearly with woodland area, but no such relationship was apparent for the marsh tit, with its more specialised habitat requirements The effects of woodland area, isolation and other characteristics on individual species are currently being analysed

To investigate the role of dispersal in maintaining populations in very small woods, we are measuring the replacement rate of individuals In one breeding season, all the adult breeders of certain species in 16 small woods (mean area=1 51±0 27 ha) have been marked (colour ringed) and also, where possible, their young In the next breeding season, new emigrants can be identified (they are either unringed or have been marked with the colour code of a different wood), as can the local adults and young from the previous year Between 1990 and 1991, the replacement rate of adult breeders was high and local species extinctions occurred in many of the woods (Table 4) The large majority of replacements were immigrants Of 113 home-grown juveniles, only one (a wren) bred on its natal site in 1991 This indicates that immigration is essential for the persistence of bird populations in small woods However, without knowing the fate of the juveniles produced in these woods, we cannot say that they are acting as population sinks (ie sites which 'soak up' surplus individuals from elsewhere without contributing a surplus of their own) It may be that groups of small sites simply exchange juveniles To address this problem, birds have been marked in groups of small woods but, as yet, there is little evidence of substantial movements between these woods Juveniles may be dispersing further afield and only additional information will confirm this possibility

Although the study is still in progress, the results obtained so far have a number of implications for the management of small woodlands When creating new small woods (and when large woods are being reduced in size or broken into fragments), planting the largest possible area up to about 2 ha will give the greatest gains per additional unit of area in both breeding species numbers and population stability Planting such woods in groups will effectively create a larger woodland for those species willing and able to cross the gaps between them Movement of less mobile species can be facilitated using smaller woodland or scrub patches (which are also valuable bird habitat in their own right) as stepping stones between the larger woods Species/area relationships such as those discussed above provide information about bird species numbers but say nothing about which particular species may or may not be present Thus, individual species' requirements must also be taken into consideration in management decisions The high turnover of bird populations in small woods, especially those of less than 2 ha, means that a reservoir of larger woods must also be maintained in order to obtain stability and sustainability at a landscape scale Additional data will be required to determine the long-term viability of the populations of networks of small woods, and to establish the optimum ratio of large to small woods

Table 4 Replacement rates of adult breeders and local species extinctions in small woods (mean area=0 51± 0 27 ha, n=16) in East Anglia

Species	No of breeders ringed in 1990	% of 1990 breeders present in 1991	No of ringing sites at which species breeding in 1990	% of 1990 ringing sites at which species breeding in 1991
Wren (*Troglodytes troglodytes*)	52	4	16	50
Robin (*Erithacus rubecula*)	37	8	14	79
Chaffinch (*Fringilla coelebs*)	20	15	11	91
Dunnock (*Prunella modularis*)	57	23	16	75
Blackbird (*Turdus merula*)	31	26	15	73
Great tit (*Parus major*)	18	33	10	80
Blue tit (*Parus caeruleus*)	26	38	14	93

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Hedgerow changes in Great Britain

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Hedgerows are among the most important landscape features and wildlife habitats in Britain Their loss has been of concern to conservationists and countryside users for many years, but recent incentives and policies have resulted in changes in hedgerow management and in some planting of hedges, especially in the arable areas of East Anglia and the Midlands Has the balance been redressed, and what are the effects of current land use and management on hedgerow diversity?

In 1977–78 and in 1984, ITE carried out sample-based surveys of land use, landscape features and vegetation in Great Britain (Barr *et al* 1986) The sampling unit was a 1 km square and the survey approach was based on the ITE land classification, designed to ensure that a representative sample of sites was visited The surveys included the mapping of hedges as a field boundary type, and the 1977–78 survey recorded

Table 6 Estimates of hedgerow gains and losses in Great Britain, England, Scotland and Wales between 1984 and 1990 (lengths and standard errors (±) in '000 km)

	England	Scotland	Wales	Great Britain
1990 hedges gained				
New hedges	19.7 (±2.0)	3.3 (±0.5)	3.4 (±0.6)	26.4 (±2.5)
Change in boundary type	18.5 (±2.3)	3.2 (±0.7)	3.3 (±0.6)	25.0 (±2.9)
Buildings/curtilages	1.4 (±0.3)	0.2 (±0.1)	0.3 (±0.1)	1.9 (±0.4)
Total gain	39.6 (±3.3)	6.7 (±1.0)	7.0 (±1.1)	53.3 (±4.3)
1984 hedges lost				
Hedges removed	39.4 (±3.5)	6.1 (±0.9)	6.7 (±1.1)	52.2 (±4.5)
Change in boundary type	77.8 (±7.4)	17.2 (±2.7)	16.6 (±2.8)	111.5 (±10.1)
Buildings/curtilages	7.3 (±1.2)	1.4 (±0.4)	1.4 (±0.5)	10.1 (±1.7)
Total loss	124.8 (±8.6)	24.7 (±3.4)	24.8 (±3.5)	174.3 (±12.0)

independently from the hedgerow data, for 1984 and 1990. Many former hedgerows were redefined as lines of trees and shrubs in the 1990 survey. The figures in Table 7 support the contention that a relaxation of hedgerow management has led to a decrease in hedgerow length and a corresponding increase in lines of trees and shrubs.

An overall conclusion from the comparison of 1984 and 1990 data is that the rate of hedgerow removal between 1984 and 1990 is greater than in the period 1978–84. In addition, there has been a decline in the intensity of hedgerow management between 1984 and 1990, leading to an increase in the boundary type defined as relict hedgerow.

While the results of this analysis provide the most up-to-date figures available on

Table 7 Estimates of lengths of 'lines of relict hedgerow' in Great Britain, England, Scotland and Wales for 1984 and 1990 (lengths and standard errors)

	England	Scotland	Wales	Great Britain
1984	36.0 (±4.3)	7.3 (±1.5)	10.3 (±2.6)	53.5 (±6.3)
1990	63.1 (±6.3)	12.1 (±2.5)	15.2 (±3.6)	90.3 (±9.5)

recent hedgerow changes, caution should be used in their interpretation. These results are based on a sample-based survey and due regard should be paid to statistical errors associated with extrapolation from a sample to national estimates. ITE is analysing the results from a quality assurance exercise which will give a measure of the confidence that can be placed in the results from the survey, and which will comment on observer consistency and problems of definition.

Diversity in British hedgerows

As an integral part of the ITE field surveys in 1977–78 and 1990, vegetation was recorded in a variety of habitats and land cover types, in order to provide information on the quality of hedgerow habitats, as well as quantitative measures. A stratified sample of 322 1 m x 10 m plots was surveyed adjacent to hedgerows in 1978, these were from 256 squares stratified according to the 32 ITE land classes. These plots were surveyed again in 1990, but some were misplaced and 63 no longer had hedgerows present. As a result of sampling in other 1 km squares, additional plots were recorded for the first time in 1990, leading to a total of 1176 plots.

Data from all 1176 hedgerow plots were analysed using TWINSPAN to produce two classifications of hedges – one by woody species and the other by herbaceous (ground flora) species. In each case, simple keys were produced which require only limited botanical expertise to allocate further hedge plots to the TWINSPAN classes.

Resulting from the classification by woody species, 11 classes were identified.

Description	% frequency
1 Hawthorn (*Crataegus* spp.) dominant	46.9
2 Blackthorn (*Prunus spinosa*) predominant	23.0
3 Hazel (*Corylus avellana*) predominant	13.3
4 Mixed hawthorn	5.2
5 Elm (*Ulmus* spp.) dominant	4.2
6 Elder (*Sambucus nigra*)/ hawthorn	3.4
7 Beech (*Fagus sylvatica*) dominant	1.6
8 Non-native species dominant	0.8
9 Gorse (*Ulex europaeus*) dominant	0.7
10 Wild privet (*Ligustrum vulgare*) present	0.4
11 Other species dominant	0.5

An examination of the frequency of these classes in 1977–78 and 1990 showed that the overall proportions of the 11 groups had remained constant, although there was considerable movement of individual plots between classes.

The hazel dominant and mixed hawthorn classes were richer in woody species, averaging 4.4 and 3.6 woody species per 10 m plot respectively. The hazel dominant class was also richest in associated ground flora species (15.3 species per plot). In contrast, the commonest class of hedge, hawthorn dominant, had only 2.0 woody species per 10 m plot, with the associated herbaceous species count averaging 12.8 per plot.

Of the hedge classes which were richest in woody species, mixed hawthorn hedges were particularly abundant in the Midlands and East Anglia (having ground flora characteristic of cultivated fields), whereas hazel hedges were centred on south-west England (having a ground flora of meadow and woodland species). Of the plots that were not recorded in vegetation quadrats alongside linear features, including hedgerows.

Information collected on hedgerows in the 1977–78 and 1984 surveys allowed estimates of gains and losses to be derived for Great Britain and for major regions within it, as described by Barr *et al.* (1986) and summarised as follows:

	Hedgerow gain	Hedgerow loss
England	3 200 km	22 300 km
Scotland	<100 km	3 300 km
Wales	400 km	2 600 km
Great Britain	3 600 km	28 200 km

In 1990, as part of a wider research programme, Countryside Survey 1990 was completed, the third in the series of field surveys (Barr 1990). Over 500 1 km squares in Great Britain were visited by staff based at the six ITE research stations, and, as part of the field survey, hedgerows were mapped in the same way as in the 1984 survey. In addition, vegetation quadrats alongside hedgerows were recorded as in 1977–78. This field information will be integrated with the land cover map of Great Britain, being produced from satellite imagery by ITE's Environmental Information Centre (described earlier in this Report, pp15–19).

Changes in the lengths and characteristics of hedgerows

Comparisons of boundaries containing a hedge component show that the net change between 1984 and 1990 amounts to nearly one quarter of the length of 1984 boundaries which contained hedges (Table 5).

However, net change is a balance of gains and losses: hedges have been planted as well as removed. In addition,

Plate 4. Many hedges have grown into lines of trees, through lack of management

some boundaries have changed in their nature and appearance, leading to increases and decreases in boundaries that can be defined as hedgerows. For example, lines of immature trees that have been thinned out and then laid as hedges will lead to an increase in the estimate of hedgerow length. Conversely, where a former hedge has been unmanaged over a number of years, it will grow into a line of trees (a relict hedge) (Plate 4).

Other examples of change in boundary type include where a hedge has become 'gappy' and has been recorded as a line of shrubs, and no longer as a hedge, and, conversely, where vegetation growing on the top of a bank has been cut in such a way that a hedge is formed. Such changes are given in Table 6, which also shows the lengths of hedgerow that have been lost to the countryside by the development of buildings (both urban and agricultural). Included are hedges that have become 'curtilage' boundaries and are no longer defined as hedges for the purpose of this study. In some cases, where there has been a change in land use, some boundaries have been redefined as part of the countryside and so have led to a hedgerow gain.

Table 5. Estimates of net change in hedgerow lengths in Great Britain, England, Scotland and Wales between 1984 and 1990 (lengths and standard errors (±) in '000 km)

	England	Scotland	Wales	Great Britain
Total hedge length in 1984	410.5 (±25.1)	67.6 (±8.8)	71.1 (±8.4)	549.0 (±32.7)
Total hedge length in 1990	325.2 (±21.5)	49.6 (±7.0)	53.3 (±6.8)	428.0 (±28.3)
Net change between 1984 and 1990	85.3 (±8.5)	18.0 (±3.0)	17.8 (±3.3)	121.0 (±11.6)

Boundaries that were recorded as hedges for the first time in 1990 (other than those resulting from change in boundary type) totalled 26 400 km. The complete removal of hedgerows between the two dates amounted to 52 200 km, or 9.5% of the total hedgerow length in 1984.

Close inspection of the results shows that most change is associated with the management of hedgerows. About 111 500 km, or 20% of the 1984 hedgerows in Great Britain, were coded in 1990 as a different type of boundary (eg lines of trees or shrubs, or as relict hedgerows). Conversely, only some 25 000 km of 'new' hedges in 1990 came from the redefinition of boundary types. This suggests that hedgerows were subject to less active management in 1990 than in 1984. In Great Britain as a whole, the distribution between height and management classes of the lengths of boundary containing hedges remained similar between the two dates. However, when considering 'gappiness', the lengths of incomplete hedges have increased between 1984 and 1990.

Lines of relict hedges (defined as 'a line of shrubs or trees showing where a hedge has once been') were estimated

Plate 5. Composition of hedgerow ground flora may be determined by adjacent land use rather than hedgerow management

1990 because the associated hedge had been removed since 1977–78, 31% had been classified in the species-rich mixed hawthorn type and 27% were in the elm dominant class. These data suggest that hedgerows removed between 1977–78 and 1990 included many which were species rich, and therefore of high ecological value.

The herbaceous flora was also analysed and aggregated into four principal groups, representing arable, lowland grassland, marginal upland, and upland situations. These groups showed strong geographical patterns in species diversity. The most diverse types were in lowland grasslands and marginal uplands, in contrast to those of the eastern lowlands where the vegetation was dominated by species typical of disturbed and arable situations.

The hedge flora would seem, therefore, to be highly affected by the management of the surrounding fields (Plate 5). A preliminary examination of the data has shown a correlation between intensity of land use and overall species diversity (woody plus herbaceous species), with managed grasslands being associated with the greatest hedgerow diversity and agricultural crops with species-poor hedges.

Contrary to expectation, it was found that current hedgerow management (measured in terms of cutting regimes, height and gappiness) had little correlation with the diversity of either the herbaceous or woody vegetation in the hedges. Likewise, there was limited correlation between the overall number of woody species and the diversity of the ground flora.

In addition, between 1978 and 1990, there was an overall loss of species throughout the sample, and more species declined in cover than increased, with a trend towards species typical of more highly mangaged land use. There was also a trend in the overall vegetation composition towards species which are characteristic of higher nutrient levels, associated with agricultural intensification, and an increase in the number of species groups containing ruderal plants, characteristic of disturbed and highly managed land use.

Examination of survey data, therefore, indicates that diversity in the ground flora of hedgerows is generally associated with the characteristics of neighbouring land use, rather than with hedgerow management. This association may be due to the relatively transient nature of stages within the hedgerow management cycle (measured in the survey at only one point in time), as compared with the relative longevity of plant communities. In contrast, a fundamental change in the management of surrounding land use (eg with associated changes in fertilizer application, or herbicide rates) may have a rapid effect.

The mapped survey information suggests that hedgerow management has declined. Even though detailed analysis of hedgerow diversity shows no obvious relationship between management and diversity at any point in time, it seems likely that continued reduction in hedgerow management over a long period would lead to changes in the ground flora. Certainly it is well known that hedgerow management is important to more mobile species, such as insects and birds. We expect to follow up these aspects using more intensive, and experimental, studies.

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Insect diversity and farm woodland pattern

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Fragmented woodland

Fragmentation was a feature of forests before man became a predominant influence. Semi-permanent open spaces were created by the dynamic interaction of treefall gaps, beaver (*Castor fiber*) meadows and grazing areas with the processes of regeneration. Permanent open spaces in the woodland cover were provided along river valleys, lakes, wetlands, cliffs and areas of poor soil (Warren & Key 1991). Insect species evolved to utilise one or more of these mosaics. For instance, saproxylic larvae exploited dead wood in woodlands, whilst adults gained energy and protein for dispersal and reproduction from nectar and pollen sources in the open areas. Towards the industrial revolution, man's influence grew and total forest cover declined. However, coppicing and pollarding of native tree species partly replicated the natural balance of tree cover and open space in the fragmented