Institute of Terrestrial Ecology

Centre for Ecology & Hydrology

Natural Environment Research Council

INSTITUTE OF TERRESTRIAL ECOLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

Project T95013e3
CS2000 Module 13

Hedges associated with roads, tracks and paths - an analysis of Countryside Survey 1990 data.

Report to the Department of Environment, Transport and the Regions

D C Howard, M K Gillespie, A S Culling and C J Barr
ITE Merlewood

Institute of Terrestrial Ecology
Merlewood Research Station
Grange-over-Sands
Cumbria
LA11 6JU

March 1998

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A rapid and crude examination of the Countryside Survey 1990 data was made to estimate the proportion of hedges adjacent to roads and the proportion adjacent to paths and tracks. A number of conclusions were drawn:

- tracks and roads both occur in about 80% of the sampled squares, hedges in less than 60%.
- 26% of the hedge length in Great Britain was found to be associated with roads while only 4% was associated with tracks and footpaths.
- when the number, rather than length, of hedge is considered both percentages increase (to 32% and 8% respectively).
- the relationship appears to be constant across all landscape types.

However, the conclusions need to be tempered by the following constraints:

- more confidence should be placed on the figures describing roads rather than tracks as, in the past, more time has been spent examining and correcting these data.
- definitions of roads and tracks/paths were made using existing surveyed data and require further investigation so that they can be properly formalised.
- adjacency was estimated using geometrical relationships and could under, or over, estimate numbers and lengths in different situations.
- the number of hedges is not a straightforward concept to apply - hedges are not uniform units and may have different attributes when viewed from different positions. A clear definition, with which the data can be interpreted, is needed before any confidence can be given to the results.
- the analysis requires further examination and possible correction to allow for potential inclusion of hedges which run at right angles to a road or track.
- only the rural environment has been described, further investigations are needed before anything can be said about urban areas.

INTRODUCTION

Data from ITE's Countryside Surveys (Barr *et al.*, 1986; Barr *et al.*, 1993; Bunce & Heal, 1984) have been analysed to show changes in land cover and landscape elements in Great Britain (GB) in the last quarter of the 20th Century. One of the landscape elements which has undergone considerable change and for which protective legislation has become increasingly important is hedges (Barr *et al.*, 1991).

The surveys map a sample of 1 kilometre (km) squares which are stratified using the ITE Land Classification (Bunce *et al.*, 1996). They are selected at random within each strata or land class from a 15 km grid placed over GB. In 1990 there were 508 sample squares. Squares were thematically mapped for land cover (physical features, agriculture, semi-natural vegetation, forestry, buildings, communications and boundary features) and soils.

One of the criteria that is being considered in a current re-drafting of hedgerow protection legislation is the adjacency of hedges to public rights of way. Funded by the Department of the Environment, Transport and the Regions (DETR), this exercise has extended previous analyses by looking at the proportion of hedges that are associated with roads and other causeways.

DATA

For this study, spatial analysis was only carried out for the 284 squares which had a hedgerow recorded within them. The other 224 squares were included in the production of national estimates as zeros so as to give an appropriate weighting to the means used in calculation of national figures. Digital maps of all survey squares are held in Arc/Info, a Geographical Information System (GIS). The GIS is linked to ORACLE, a database management system, which was used to supply coding information and to integrate the results across all squares prior to making national estimates.

Definition of road and track

Roads and tracks/footpath were defined as two separate and distinct landscape elements. Their definitions were derived from the existing datasets with no additional information. When the survey squares were digitised, public roads covered in tarmac were digitised as their map area and given a Definition Code of 52 (Wyatt *et al.*, 1994). All areas with this code and no other areas were considered as roads. Tracks and footpaths were generally digitised as lines rather than areas and had been identified in the field with Field Assessment Booklet (FAB - (Barr,

1990)) codes 452, 456, 457, 458 or 459 (tarmac road, constructed track, un-constructed track, footpath (exclusive), footpath (other)). These codes were grouped and called track.

Definition of hedge

Boundaries in GB are often composed of several elements (e.g. fence, bank, wall, hedge, etc.). For the purposes of this analysis, any boundary containing a hedge element was included; these categories are shown in Table 1.

Table 1 Composition of boundaries included as hedges in analysis.

Code	*Composition*
451	Hedge
76	Hedge & Bank
56	Hedge & Fence
39	Hedge & Wall
27	Hedge, Fence & Bank
14	Hedge, Wall & Bank
7	Hedge, Wall & Fence
2	Hedge, Wall, Fence & Bank

Hedgerows are recorded in the GIS as vectors with no width. Where hedges coincide with field boundaries, the same vector was used as a section of the polygon boundary. Unfortunately, in the case of roads, hedges are not always the road boundary as there may be a grass verge immediately adjacent to the road and separating the carriageway from any physical barrier; the displacement can be considerable, especially where verges are wide and features such as cuttings and embankments occur.

Data used in analysis

Only data collected during Countryside Survey 1990 were used in the analysis. Of the squares surveyed in 1990, 381 had also been surveyed in 1984, and a smaller proportion of them were re-visited in 1993 to record hedgerows (Barr, Gillespie & Howard, 1994). The results are therefore directly compatible with the 1990 survey.

ANALYSIS

The analysis was carried out in two phases; first, the digital maps were manipulated and interrogated for each survey square; and second, the individual square information was amalgamated into a single database on which statistical analysis was performed. The

computation of national totals and standard errors was identical to that used in the production of the Countryside Survey 1990 reports. A statistical appendix is provided in the main report (Barr *et al.*, 1993).

The two phases of analysis are briefly described below:

Interrogation and manipulation of digital maps

Buffering

The problem of separation of hedges from carriageways by verges was addressed by widening the mapped lines and polygons representing roads and tracks by 10 metres in the GIS (buffering). This is a simple form of spatial manipulation that quickly produces results, but it has some limitations (see section on limits and problems).

Removal of overlap

One problem caused by buffering is overlap at the junctions between the two different buffered areas which can lead to double counting. The line and polygon ends are buffered in an unrealistic way which will extend the feature beyond its natural extent; consequently any hedges falling into this portion would not be considered adjacent. An example of this can be seen at the end of the road terminating in the north east of the square in Figure 1. An attempt to reduce the problem was made by removing the section of tracks that occur in the buffered region around roads.

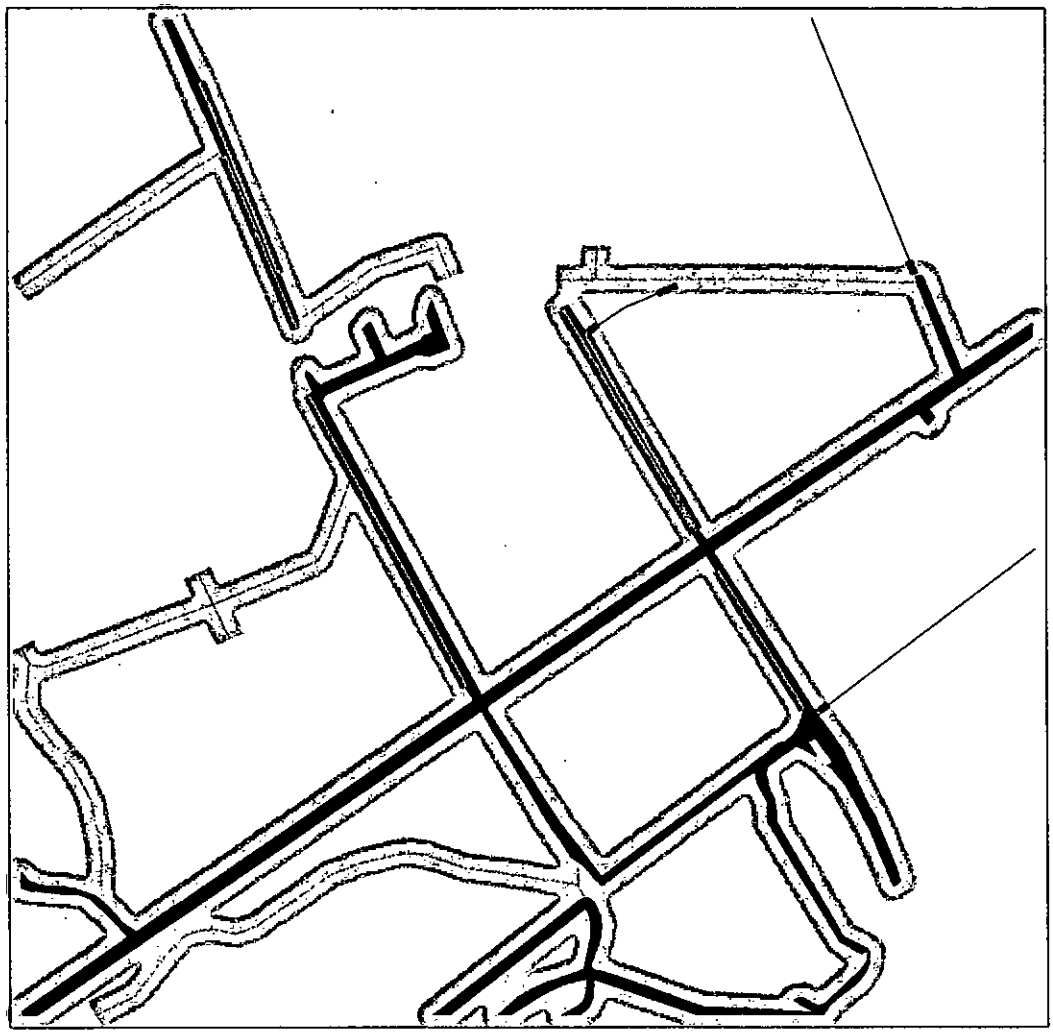
Overlay

Having created a buffered region around roads and another around tracks, the vectors describing hedge positions were overlayed and the portions common to both coverages were identified and used to create a new digital layer of data.

Plots

As the work was carried out in an automated way with new digital maps being created, analysed then and erased (to conserve computer space), detailed examination of the different steps could not be made. As a record of the analysis which could be examined in the future, a digital image of the final map, containing roads, tracks, both sets of buffering and the hedges coloured to show their interaction with the buffer was produced and archived. An example of the image is presented in Figure 1.

Figure 1 An example Countryside Survey 1990 square showing the selected features, buffering and overlay. Note the box drawn is slightly outside the kilometre square, due to the buffering of the roads as they leave the square. Grey areas indicate buffered zones surrounding roads (red thick lines) and tracks (mauve thin lines). Hedges are shown in shades of green; where not associated they appear as thin green lines, when overlapping with buffered zones they are thicker.



Estimation of national figures

Divisions of data

Two data tables were produced, one describing hedges adjacent to (or within 10 metres of) a road, the other holding equivalent information for tracks. The tables hold a range of

information about the hedges including the length and label. Analysis was only performed on the lengths, although the datasets could still be analysed for hedge characteristics.

Within the database, each hedge on a map would have a record containing its characteristics. For each of the data tables, two sets of data were extracted; the first was the total length of hedge in each square and the second was the number of hedge lengths.

Rejection of tails

Where a boundary between two fields intersects a road, buffering will overlap with the short piece or tail of the hedgerow at the junction. Two identical analyses were performed, the first included all data (Tables 3, 5 and 6), the second used a reduced dataset where hedge lengths of less than 15 metres were rejected (Tables 4, 7 and 8). A length of 10 metres would only have corrected for the junctions made at right angles, using 15 metres will reject hedge lengths where the intersection between the road edge and the hedge is at an angle of up to about 45 °.

RESULTS

The numbers of squares containing the elements in different combinations is presented in Table 2. Hedges are found in 56% of the surveyed squares, roads in 78% and tracks in 84%. There were 10 squares which contained a hedge but no road and 7 which contained a hedge but no track. In terms of numbers of squares, hedges were more often associated with roads than tracks as 66% of squares with hedges and roads have at least one length of hedge adjacent to a road, while only 41% of squares with hedges and tracks have them in close proximity.

Table 2 Number of Countryside Survey 1990 squares containing different features.

Elements	*No. of squares*	*Percent of total*
Roads	395	78
Tracks	428	84
Hedges	284	56
Hedges within 10 metres of a road	181	36
Squares with road and hedge but not adjacent	274	54
Hedges within 10 metres of a track	115	23
Squares with track and hedge but not adjacent	277	55

Table 3 shows the summary of national figures using all hedge lengths, the individual land class totals can be found in Tables 5 (lengths) and 6 (numbers). The total hedge length agrees with the total published in the CS1990 Main Report (Barr *et al.*, 1993); numbers of hedges was not included in the Main Report.

Only 26% of the length of hedgerows could be found in the proximity of roads and only 4% by tracks. The figures are slightly higher when the number of hedges are used (32% and 8% respectively). These values are smaller than the proportion of squares which contain hedges were associated with roads and tracks (Table 2); the difference is largest for tracks, where 23% of the squares have a hedge within 10 metres of a track, but that is only 4% of the length.

Table 3 Hedge statistics for Great Britain from Countryside Survey 1990 data. Lengths and associated standard errors (SE) are presented in '000s of kilometres and numbers and associated SE are per 1 kilometre square.

Feature	*Length*	*SE*	*Number*	*SE*
Hedge	464.0	23.7	18.4	1.1
Hedge adjacent to road	122.7	10.0	6.0	0.5
Hedge adjacent to track	17.7	2.2	1.5	0.2

When the analysis was re-calculated removing the hedge lengths of less than 15 metres, then a number of effects become apparent (Tables 4, 7 and 8). Most importantly, the length of all hedges ignoring adjacency to road or track drops by half a percent while the number of hedges drops by about 6%. The difference between the two percentages can easily be explained, as the short lengths dropped contribute relatively less to the total length rather than the number. However, that there is a reduction suggests that the correction for 'tails' of hedges that are abutting roadsides is overcorrecting and removing some hedges that should be included.

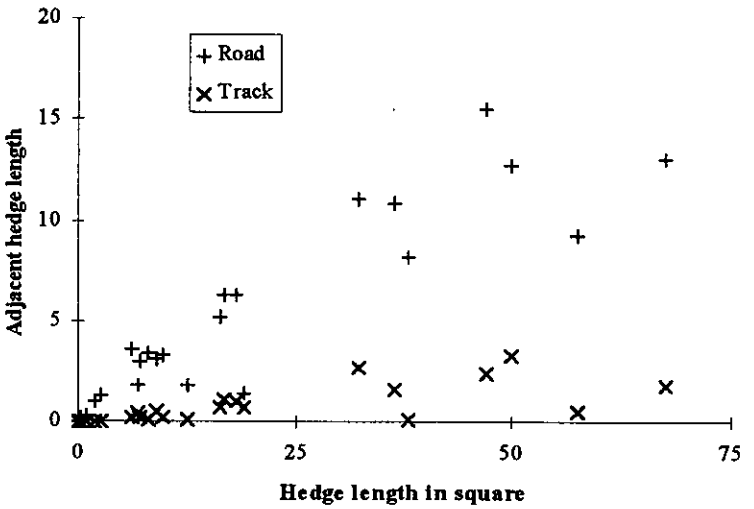
The relative proportions within the dataset remain reasonably constant, with the numbers of hedges showing more divergence than the lengths. The stability and interpretation of the numbers of hedges needs serious investigation, as discussed later, and care should be taken if the numbers are to be taken further.

Table 4 Hedge statistics for Great Britain from Countryside Survey 1990 data ignoring lengths of less than 15 metres. Lengths and associated standard errors (SE) are presented in '000s of kilometres and numbers and associated SE are per 1 kilometre square.

Feature	*Length*	*SE*	*Number*	*SE*
Hedge	461.8	23.6	17.3	1.0
Hedge adjacent to road	121.4	9.9	5.3	0.5
Hedge adjacent to track	16.8	2.1	1.0	0.1

When looking at the distribution of hedges in different land classes, the dominance of arable and pastural landscape types is apparent and there are generally good linear relationships between the length of a hedge in a class and the length adjacent to roads or tracks with no serious outliers (Figure 2). When comparing between analyses using all hedges and only those greater than 15 metres there is a near perfect correlation between land classes calculated using different datasets (Figure 3). The short lengths of hedge appear to be evenly scattered throughout the dataset.

Figure 2 The relationship between total length of hedge in a square and the length found adjacent to a road or track . Each point represents a single land class, figures are in `000s of km.



Graphical presentations have only been made for the lengths of hedge, not the number of hedges. There are similar relationships for numbers, but they are not as clear.

Figure 3 The relationship between estimates calculated using all hedge lengths and those greater than 15 metres for lengths of hedge adjacent to roadsides and lengths adjacent to tracks. Points represent different land classes and figures are in `000s of kilometres.

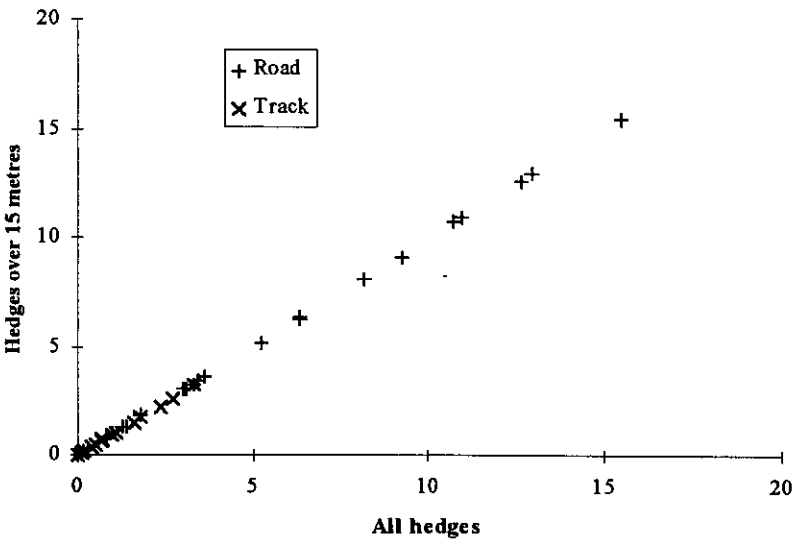


Table 5 Lengths of hedgerow recorded during Countryside Survey 1990 by land class. Total hedge length, length adjacent to roads and tracks and standard errors (SE) are all presented in '000s of kilometres. Zeros with no decimal place (0) represent no hedge length recorded

Land class	*Hedge*		*Adjacent to Road*		*Adjacent to Track*	
	Length	*SE*	*Length*	*SE*	*Length*	*SE*
1	67.6	9.4	13.0	4.4	1.8	0.8
2	38.2	6.6	8.2	2.3	0.1	0.1
3	50.0	4.4	12.7	2.7	3.3	1.0
4	19.0	7.5	1.4	0.9	0.7	0.7
5	12.4	2.8	1.8	1.1	0.1	0.1
6	57.5	9.5	9.3	3.2	0.5	0.4
7	2.5	1.2	1.3	0.7	0.0	0.0
8	1.8	0.6	1.0	0.4	0	
9	36.5	7.0	10.8	2.8	1.6	0.7
10	47.2	7.6	15.5	3.6	2.4	0.8
11	32.4	3.2	11.0	1.8	2.7	0.7
12	6.7	1.8	1.8	1.1	0.4	0.2
13	18.0	5.1	6.3	2.3	1.0	0.4
14	0.3	0.2	0.2	0.1	0.0	0.0
15	16.1	4.5	5.2	1.4	0.7	0.5
16	8.8	1.8	3.1	0.7	0.5	0.2
17	16.7	4.8	6.3	2.5	1.1	0.7
18	7.1	5.6	3.0	2.7	0.2	0.2
19	0		0		0	
20	0		0		0	
21	0		0		0	
22	0.1	0.1	0.0	0.0	0	
23	0		0		0	
24	0		0		0	
25	9.6	3.8	3.3	1.3	0.2	0.1
26	8.0	2.6	3.4	1.6	0.1	0.1
27	6.2	2.9	3.6	1.6	0.2	0.1
28	1.0	1.0	0.3	0.3	0	
29	0		0		0	
30	0		0		0	
31	0.2	0.2	0.2	0.2	0.0	0.0
32	0.1	0.1	0.0	0.0	0	

Table 6 Number of hedges recorded per 1 kilometre square during Countryside Survey 1990 by land class. Zero lengths with no decimal place (0) represent no hedges recorded

Land	*Hedge*		*Adjacent to Road*		*Adjacent to Track*	
Class	*Number*	*SE*	*Number*	*SE*	*Number*	*SE*
1	48.7	7.3	11.0	4.0	3.4	1.3
2	21.3	4.1	5.5	1.7	0.4	0.3
3	27.0	2.9	8.9	1.9	3.2	0.9
4	20.1	10.6	1.1	0.5	0.8	0.7
5	35.8	7.2	7.5	3.5	0.8	0.8
6	55.9	10.0	11.2	4.5	1.0	0.8
7	14.2	6.9	9.2	4.8	0.2	0.2
8	5.6	1.9	3.8	1.3	0	
9	26.6	6.4	11.1	3.4	2.9	1.2
10	32.6	5.9	13.0	3.3	3.8	1.3
11	29.8	3.2	11.1	1.8	5.4	1.1
12	16.2	5.3	5.2	3.2	2.0	0.8
13	25.8	7.6	11.3	4.3	2.6	1.1
14	4.3	2.0	3.0	1.5	0.7	0.7
15	44.8	9.4	20.0	4.5	3.8	1.6
16	26.6	5.8	11.7	2.5	4.8	1.8
17	12.4	3.6	5.5	2.3	1.8	1.1
18	12.5	9.9	5.8	5.1	0.8	0.8
19	0		0		0	
20	0		0		0	
21	0		0		0	
22	0.1	0.1	0.0	0.0	0	
23	0		0		0	
24	0		0		0	
25	8.1	3.1	3.7	1.4	0.7	0.3
26	8.9	2.7	4.7	1.9	0.7	0.3
27	7.9	3.8	4.9	2.4	0.5	0.4
28	1.4	1.4	0.3	0.2	0	
29	0		0		0	
30	0		0		0	
31	0.6	0.6	0.6	0.6	0.4	0.4
32	0.3	0.3	0.3	0.3	0	

Table 7 Lengths of hedgerow greater than 15 metres. Total hedge length, length adjacent to roads and tracks and standard errors (SE) are all presented in '000s of kilometres. Zero lengths with no decimal place (0) represent no hedge length recorded

Land	*Hedge*		*Adjacent to Road*		*Adjacent to Track*	
Class	*Length*	*SE*	*Length*	*SE*	*Length*	*SE*
1	67.3	9.3	12.9	4.4	1.7	0.7
2	38.0	6.6	8.1	2.3	0.1	0.1
3	49.8	4.4	12.6	2.7	3.2	0.9
4	18.9	7.4	1.3	0.9	0.7	0.7
5	12.3	2.7	1.8	1.0	0.1	0.1
6	57.2	9.5	9.1	3.2	0.5	0.3
7	2.5	1.2	1.3	0.7	0	
8	1.8	0.6	1.0	0.4	0	
9	36.4	7.0	10.7	2.8	1.5	0.6
10	47.1	7.6	15.4	3.6	2.2	0.8
11	32.2	3.2	10.9	1.8	2.6	0.7
12	6.7	1.8	1.8	1.1	0.4	0.1
13	17.9	5.1	6.2	2.3	0.9	0.3
14	0.3	0.2	0.2	0.1	0.0	0.0
15	15.9	4.5	5.1	1.4	0.6	0.5
16	8.8	1.8	3.0	0.7	0.5	0.2
17	16.6	4.8	6.3	2.5	1.0	0.6
18	7.0	5.6	3.0	2.7	0.2	0.2
19	0		0		0	
20	0		0		0	
21	0		0		0	
22	0.1	0.1	0.0	0.0	0	
23	0		0		0	
24	0		0		0	
25	9.6	3.8	3.2	1.3	0.2	0.1
26	8.0	2.6	3.4	1.6	0.1	0.1
27	6.2	2.9	3.6	1.6	0.2	0.1
28	1.0	1.0	0.3	0.2	0	0
29	0		0		0	
30	0		0		0	
31	0.2	0.2	0.2	0.2	0.0	0.0
32	0.1	0.1	0.0	0.0	0	

Table 8 Number of hedges greater than 15 metres recorded per 1 kilometre square during Countryside Survey 1990 by land class. Zero lengths with no decimal place (0) represent no hedges recorded

Land	*Hedge*		*Adjacent to Road*		*Adjacent to Track*	
Class	*Number*	*SE*	*Number*	*SE*	*Number*	*SE*
1	45.5	6.8	9.6	3.5	2.2	0.9
2	20.1	3.9	5.1	1.6	0.3	0.2
3	26.1	2.7	8.0	1.7	2.2	0.7
4	18.5	9.2	0.9	0.5	0.8	0.7
5	32.0	6.3	5.8	2.5	0.5	0.5
6	52.0	9.4	9.8	4.0	0.7	0.5
7	13.6	6.5	8.2	4.3	0	
8	5.6	1.8	3.5	1.2	0	
9	25.3	6.0	10.2	3.1	1.9	0.8
10	31.1	5.6	11.9	3.1	2.4	0.8
11	27.8	2.9	9.9	1.6	3.8	0.8
12	15.8	5.2	4.9	3.2	1.5	0.5
13	23.5	6.9	10.2	4.0	1.6	0.6
14	4.3	2.0	3.0	1.5	0.7	0.7
15	40.2	8.8	16.3	3.8	2.2	1.3
16	25.4	5.5	10.1	2.2	2.8	1.1
17	11.6	3.4	5.0	2.1	1.2	0.7
18	11.5	9.0	5.6	5.0	0.6	0.6
19	0		0		0	
20	0		0		0	
21	0		0		0	
22	0.1	0.1	0.0	0.0	0	
23	0		0		0	
24	0		0		0	
25	7.9	3.0	3.5	1.4	0.2	0.1
26	8.7	2.7	4.4	1.7	0.3	0.2
27	7.5	3.7	4.6	2.3	0.3	0.2
28	1.3	1.2	0.2	0.2	0	
29	0		0		0	
30	0		0		0	
31	0.5	0.5	0.5	0.5	0.2	0.2
32	0.3	0.3	0.3	0.3	0	

DISCUSSION

Limits of analysis and suggested improvement

Numbers of hedges

Hedges are not clearly defined units. The difficulty of trying to present results in terms of numbers of hedges is the definition of what is a hedge unit. A hedgerow bounding a square field could be considered as a single hedge, or four hedges. The numbering becomes more complicated as surrounding fields are included. For the analysis here, a hedge unit is defined as a continuous length of hedge, with no junctions and constant characteristics. Within this definition, a gappy hedge would still be considered continuous.

During the analysis using the buffer zones surrounding roads and tracks, some of the hedge units would have been divided and it is possible for a sinuous hedge, running between 9 and 11 metres from a road to appear as several units.

To use hedge numbers, a stronger, more formal definition would be needed and the analysis would need to be repeated applying that definition.

Unique codes

The analysis was performed entirely on standard CS1990 reporting and FAB codes; there may be unique codes describing elements that could not be coded using those suggested. The new codes, generated by field surveyors, are especially likely to be found describing tracks and footpaths as there has not been the same thorough examination and re-interpretation as made for the Definition Code area features.

The investigation should also look at the method of recording of tracks and footpaths to ensure that none were digitised as areas which were then subsumed into other cover categories.

Buffering limits

The GIS holds a description of the real world using different data models. The model used here uses vectors to describe areas, lines and points. Data for roads were entered as polygons, but the area will be dependent upon the width of the feature which is usually mapped at standard lengths for different types of road. Some of the tracks and footpaths may have similar widths to the roads, but they were recorded as simple vectors with no width. Buffering in both cases was extended to 10 metres either side, but as the figure shows the area of the buffer shows an exaggerated difference between the types. Roads would therefore be expected to 'capture' more hedges than tracks and paths.

Differential buffering

The roads, tracks and paths were buffered to a standard width, but it is possible, with more time to buffer to different extents for different features (e.g. tracks further than footpaths). This can be done with data already held within the database, but if extra time was available, the database could be improved by the addition of road grade (eg motorway, 'A' road dual-carriageway, etc.) and the buffering performed with different distances for different road types. The ideal solution would involve the maps being individually examined by eye and the hedges labelled using expert judgement; this would be time consuming.

Visual check

Although care was taken while processing the data, and an image equivalent to Figure 1 was produced and has been archived for all 284 squares used in the analysis, this can not be seen as an adequate substitute for a more thorough examination of the analysis and results.

Urban areas

An area requiring further investigation is the relationship between hedges and roads around urban areas. In the Survey, urban areas are not mapped in detail and internal roads are not recorded. The interaction with the edge of urban areas could be assessed by examination of Ordnance Survey maps and aerial photographs.

Public rights of way

The Survey data does not include a breakdown into legal rights of way, merely routes recorded by field surveyors. Additional information from sources such as the Ordnance Survey could sharpen the analysis by drawing a distinction between public rights of way and other routes. Other sources could possibly offer information such as hedge and road history. If hedge planting is now predominantly occurring along roadsides following road works, we would expect to see movement of hedges in the landscape towards roads.

CONCLUSIONS

More analysis is needed to improve the confidence in the results. A number of areas have been identified which should be addressed:

1. The definition and composition of the tracks should be formalised and verified.
2. If a visual analysis by an expert is not to be performed, the buffering should be repeated at different widths to assess the sensitivity of the results to the method of analysis.

3. Hedges as units rather than lengths, need a clear definition and may then require additional field information to be collected, otherwise they should be dropped.

4. Other information from different sources should be included to assist the interpretation.

5. The relationship between roads/tracks/hedges and urban areas needs further investigation.

REFERENCES

Barr, C. J. (1990). *Countryside Survey 1990 Field Handbook.* Internal report, Institute of Terrestrial Ecology.

Barr, C. J., Benefield, C. B., Bunce, R. G. H., Ridsdale, H. & Whittaker, M. (1986). *Landscape Changes in Britain.* Institute of Terrestrial Ecology.

Barr, C. J., Bunce, R. G. H., Clarke, R. T., Fuller, R. M., Furse, M. T., Gillespie, M. K., Groom, G. B., Hallam, C. J., Hornung, M., Howard, D. C. & Ness, M. J. (1993). *Countryside Survey 1990 main report.* Institute of Terrestrial Ecology.

Barr, C. J., Gillespie, M. K. & Howard, D. C. (1994). *Hedgerow Survey 1993 (stock and change estimates of hedgerow lengths in England and Wales, 1990-1993).* Institute of Terrestrial Ecology, Grange-over-Sands.

Barr, C. J., Howard, D. C., Bunce, R. G. H., Gillespie, M. K. & Hallam, C. J. (1991). *Changes in hedgerows in Britain between 1984 and 1990.* Institute of Terrestrial Ecology, Garnge-over-Sands.

Bunce, R. G. H., Barr, C. J., Clarke, R. T., Howard, D. C. & Lane, A. M. J. (1996). The ITE Merlewood Land Classification of Great Britain. *Journal of Biogeography* **23,** 625-634.

Bunce, R. G. H. & Heal, O. W. (1984). Landscape evaluation and the impact of changing land-use on the rural environment: the problem and an approach. In *Planning and ecology* (ed. R. D. Roberts and T. M. Roberts), pp. 164-188. Chapman and Hall, London.

Wyatt, B. K., Greatorex Davies, N., Bunce, R. G. H., Fuller, R. M. & Hill, M. O. (1994). *Comparison of land cover definitions.* Institute of Terrestrial Ecology.

ITE has six Research Stations throughout Britain, which allows the efficient use of resources for regional studies and provides an understanding of local ecological and land use characteristics. The Institute's administrative headquarters is at Monks Wood.

ITE sites

Monks Wood
(Admin HQ)
Abbots Ripton
HUNTINGDON PE17 2LS
Telephone 01487 773381-8
Fax 01487 773467
Email MONKSWOOD@ITE.AC.UK

Merlewood Research Station
GRANGE-OVER-SANDS
Cumbria LA11 6JU
Telephone 015395 32264
Fax 015395 34705
Email MERLEWOOD@ITE.AC.UK

Edinburgh Research Station
Bush Estate
PENICUIK
Midlothian EH26 0QB
Telephone 0131 445 4343
Fax 0131 445 3943
Email BUSH@ITE.AC.UK

Furzebrook Research Station
WAREHAM
Dorset BH20 5AS
Telephone 01929 551518-9, 551491
Fax 01929 551087
Email FURZEBROOK@ITE.AC.UK

Banchory Research Station
Hill of Brathens
Glassel, BANCHORY
Kincardineshire AB31 4BY
Telephone 01330 823434
Fax 01330 823303
Email BANCHORY@ITE.AC.UK

Bangor Research Unit
University of Wales, Bangor
Deiniol Road
BANGOR, Gwynedd LL57 2UP
Telephone 01248 370045
Fax 01248 355365
Email BANGOR@ITE.AC.UK

Details about the Institute are available on the Internet via the World Wide Web (http:/www.nmw.ac.uk/ite)