Discussion

Hedgerow Density Comparisons

The average hedgerow density for Suffolk, at 3.621 km/km^2, compares sensibly with the average for England of 2.91 km/km^2 (Barr 1993) and with measurements for individual sample sites, which ran from extremes of nil in Cambridgeshire, to 14.7 km/km^2 in Herefordshire (Westmacott & Worthington 1997). The fairest comparison from that study would be with 3.4 km/km^2 in Huntingdon's farmland, rather than the geographically closest Prickwillow in Cambridgeshire, which is hedgeless fenland, not unlike the Stallode tetrad. Two past surveys of specific sites in Suffolk found 4.92km/km^2 in the Stanton farmland in 1985 and 4.13 km/km^2 in part of the Suffolk Rivers Valley ESA in 1993 (Sibbett 1998). Both of these accord well with typical densities from agricultural areas in the present audit (Average 4.135 km/km^2 for East Anglian Plain, up to 7.3 km/km^2 maximum).

Comparison with Suffolk Countryside Survey.

The hedge measurements made in the Suffolk Countryside Survey of 1984/85 were generally less than those found by this audit, and deserve special mention. In 1984/85, volunteers surveyed the whole county and produced maps for every 10km grid square identifying 6 different habitat types (grassland, woodland, heath, scrub, reeds, saltmarsh) and showing 10,598 km of hedgerow. Most of the individual maps correlate closely to the present audit, particularly for long, well maintained hedges on farmland boundaries. However, less hedges are marked on the 1984/5 survey, and the average density works out at a mere 2.791km/km^2 against the area of the county at that time (3796.63 Sq km). There are several clearly identifiable reasons for this apparent discrepancy, which collectively account for the shortfall:

Urban Areas.

The countryside survey simply disregarded built up areas, thus the hedge total is short of all urban hedges. The precise built-up area unsurveyed is not known, but if this is taken as 7.2% of the county (Sanford 1998), the hedge density in the remaining 93% may be presented as an average of 3.01km/km^2. This equates to just 83% of the present audit's 3.621 km/km^2 average.

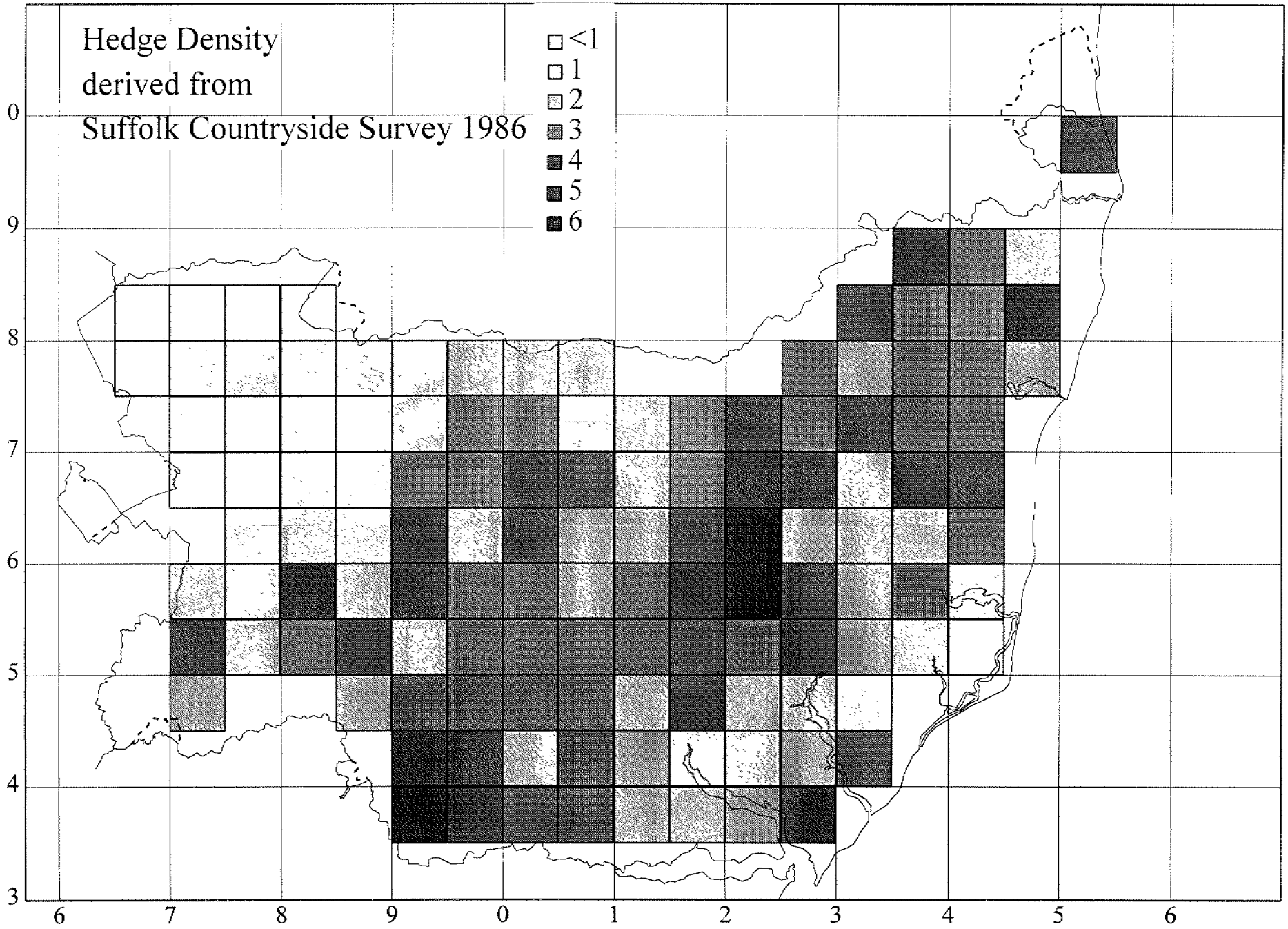
Habitat Types & Hedge Definition.

The volunteers identified woodland and scrub as habitat types in their own right, whereas the present audit counted lines of scrub and trees with bushy undergrowth as broken hedge. Comparison of the maps often shows that such features are recorded on both maps, but are not counted as hedge on the Countryside Survey maps. This may be considered a matter of hedge definition, and clearly such counting rules account for a significant proportion of the discrepancy.

Survey Method.
The different nature of photographic interpretation and field work is likely to result in a more comprehensive plot from aerial photography, with some field surveyors missing sections of hedge that are out of view.

Short Hedges.
The volunteers were instructed to record hedges as intact or broken, but were not given a minimum length figure. Given the scale of their undertaking (a 10km square), it is likely that their individual cut-off lengths resulted in short stretches being overlooked.

New Hedges.
In the 13 years that separate the two studies, there have been changes in attitudes to hedge management that have checked the removal of established hedges and encouraged the regrowth of neglected margins. New plantings have been made by Local Authorities and by land owners, both under the Hedgerow Incentive Scheme from 1991 or, more recently under the Countryside Stewardship Scheme, and often at their own initiative outside those schemes. There is every reason to be optimistic that the total hedge stock is materially more now than it was in 1985. Indeed, a National increase of 1% has been recorded over the 3 years 1990-93 (Barr 1994).


Hedge Density
derived from
Suffolk Countryside Survey 1986
<1
1
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6

Hedge Density Mapped from Countryside Survey.

The data from the 1984/5 Suffolk Countryside Survey has been plotted on the accompanying map as an alternative way of portraying the uniformity of hedge cover across the East Anglian Plain and the contrast with the lower density in the Breckland. Because data for the incomplete 10km squares around the edge of the County can not be incorporated, the picture for the Coast & Heaths, Broadland and Fens is masked. Comparison with the density map for the 24 tetrad sample generally shows the audit results to be one tone darker. The dotted lines at the margins show where the present Administrative boundary differs from the Vice county boundaries used for biological recording.

Hedgeless Country

There are a number of areas devoid of hedge, which if properly represented, will increase the accuracy of the sample.

Coastal/Estuarine.

Obviously there are no hedges in the inter-tidal zones, mud flats, saline lagoons, rivers or marshes. Each is represented in the sample in approximately the right proportions: coastline and lagoons in Minsmere, river and mud in Lowestoft, marsh in Blundeston and rivers in many tetrads. These mainly maritime habitats amount to 0.8% of the biological recording area, and depress the average hedge density in the Coast and Heaths natural area.

Forest.

One entire tetrad of the Thetford Forest is hedgeless coniferous plantation (Mayday Farm), and this highlights the role of chance in taking a random sample, as well as the importance of including the right amount of extreme terrain in selecting a representative sample. Hedges can often be found in conjunction with established deciduous woodland, but do not exist in the Forestry Commission plantations. Estimates for Suffolk suggest that woodland amounts to:

7.4% Woodland (1% ancient, 6% secondary) including
3% Thetford & Aldewood coniferous forests .....of Suffolk circa 1983
(Beardall & Casey 1995)

5.3% Woodland (2% conifer, 3.3% deciduous/mixed) of the biological recording area.
(Sanford 1998)

7.7% Woodland (4.7% plantation, 3%"interesting") of the 1986 Admin area.
(Holborn & Parker 1986)

The estimated area of each sample tetrad taken up with woodland is shown in a box at the top of each of the maps in the annex. These range from zero (Stallode) to 99% (Mayday Fm), and average out at 4.4% for 23 tetrads excluding Mayday, or 8.3% including it. This might be fairly presented as:

8.3% Woodland (4.1% conifer, 4.2% deciduous/mixed)

Clearly the 24 tetrad sample includes an adequate to generous sample of woodland, with a slight over-sample of hedgeless coniferous plantation, despite the non-sampling from the Aldewood Forest.

Heaths.
Even in the Sandlings, areas of heathland are relatively small. Many of the tetrads (e.g. Eriswell, Minsmere) include patches of heath/scrub and former heath now in agricultural use. Although such areas were not recorded, it is felt that piecemeal sampling was adequate, and this is borne out by the low hedge density figures for Suffolk Coast and Heaths and Breckland.

Road, Rail, Urbanisation.
Sample tetrads included, on average, 4.47km of public road, 0.5km of railway and just 2.5% "habitation". No major urban areas were sampled, nor any large industrial sites such as docks or active airfields. This may represent an under-sampling of Suffolk's 7.2% "developed" land (Sanford 1998), but is probably not significant overall.

Urban Hedges.
Villages and town margins, far from being hedgeless, exhibited a higher than average hedge density, particularly if short garden hedges were counted. Farmhouses generally retained their hedges, even where the adjacent farmland was sparsely hedged. Property developers had often retained boundary hedges, and homeowners were adding to them. Schools and public parks often had boundaries that kept the hedge density up.

Roads.
A good proportion of hedges were along roads (both public and private), and the increased number of boundaries tended to result in high hedge counts in rural areas where road density was high. Even trunk roads are often bordered by well-maintained hedges, sometimes the result of Highways Authority plantings, and sometimes due to scrub encroachment along an embankment.

Railway Lines.
The accidental co-alignment of the sample axis and the Bury St Edmunds to Ipswich line probably led to a slight over-sampling of railways, with a lot of broken hedge formed out of encroaching scrub. In the steam era this would have been eliminated, but presumably it causes no impediment to diesel or electric trains. Some disused railway lines now resemble "hollow roads" with good, wildlife-friendly hedgerow on both sides.

Airfields.
Much of Suffolk's one-time heathland (hedgeless) was lost to military airfields (hedgeless) during the war, and 6 of these remain as large (hedgeless) bases, although 2 have now closed and are awaiting redevelopment. In the past, most disused airfields have been returned to

agriculture, and one of these, (Great Ashfield) featured in the sample. Whilst the fields there were large and the hedge count was below average, it was encouraging to see that the present owners have planted quite a lot of hedge, to the considerable benefit of the landscape.

Hedge Type and Quality.

In the absence of any agreed National standard definition for a hedge, this audit has used the simple definition that includes any line of vegetation that looks like a hedge, both from aerial photography and from ground level. No standard definitions of remnant or relict hedge are to be found in the various references, and clearly the cut-off between hedge and non-hedge is a variable factor from survey to survey. This audit did not seek to measure hedge quality, but some judgements arose in passing.

New Hedges.

Hedges planted since the 95/96 aerial survey are not likely to have been comprehensively identified by the site visits. Hedges planted in the 3 years before that may well have been overlooked, but those planted before 1992 will generally have been visible on the photography, and (at age 6 plus) will have been confirmed by the site visit.

Potentially Ancient or Species-rich Hedges.

Plenty of hedges were noted that surrounded an ancient trackway or stream, enclosed a wood as a woodbank, were large in scale, either in length or in breadth/bushiness, and many of these had old trees established in the hedgerow. No species count was conducted.

Ordinary Hedges.

The majority of hedges were originally planted as single -species boundaries to field or road, and are still maintained as such. Hawthorn, blackthorn and elm predominate. Garden hedges exceeding 50 metres, lines of close-planted trees forming windbreaks in orchards and lines of pines planted as Breckland hedges, may also be counted in this "ordinary" category.

Broken Hedges.

This category includes remnant hedges, where poor management has resulted in gaps, and embryonic hedges, where a hedge is being created by naturally regenerating bushy growth along a line feature, typically a disused railway line. Both types were counted as follows:

Over 70% complete - counted as 100%
30 to 70% complete - counted as 50% of total hedgeline
Less than 30% - not counted, unless individual sections exceed 50 metres.

Non Hedges.

The following have not been counted as hedges. From above they appear as hedges, but can be eliminated by the site visit:

Avenues of trees.
Belts of trees without bushy margins at shoulder height.
Fences overgrown with ivy etc.
Ditches or banks with bramble overgrowth.

Overall Mix.
The balance of hedge types was very variable from one tetrad to another, and no serious attempt was made to count the individual components. However, a count of several samples towards the end of the study showed that typically 10-15% of the final count came from broken hedge, although this was as high as 25% in some places. As the sections that were less than 30% complete were judged relict and disregarded, it is not possible to say how many kilometres of relict hedge remain in the County, just that they are in addition to the 13,800 total. The total deserving the ancient tag is unknown, and as little as 1% was newly planted, but these both merit proper measurement. Figures available to SCC indicate that new plantings in 1998 (of 35-40km) would have boosted the total by at least 0.3%, with perhaps as much again being planted but not notified to SCC.

Assessing Species Richness and Structure.

The ongoing Suffolk Hedgerow Survey will report on hedge quality, using a more comprehensive breakdown into: Shrub Species (1-4/5-7/8+ species); Hedge Structure (newly planted, remnant, laid, mechanically cut, trimmed A-shape, overgrown/low trees, overgrown to ground, overgrown and spreading, line of trees) and; Landscape Connections (Walker 1999).

Overall Accuracy of the Audit.

Finally, a few thoughts are offered for those who need to know the accuracy of this audit, and the hedgerow estimates for the County. Even a careful definition of a hedge leaves some scope for subjective interpretation. This audit has sought to use the simplest definition, and to achieve consistency by using one surveyor only. Different ideas of what constitutes a hedge are a fundamental source of discrepancies between surveys. The statistical discipline of measuring the standard error and calculating a 95% confidence level is designed to cater for the variations in a random sample, but a tighter accuracy will be achieved if the sample contains a correctly balanced representation of the whole. The preceding paragraphs may give the reader confidence that this audit has achieved something close to this balance.

Scope for Further Study

Objectives.

Any future hedge studies should be carefully aimed at specific objectives:

Audit. Greater precision in measuring total lengths.
Species. Identification of shrub species in sections of ancient/species rich-hedge.
Types. Breakdown into constituent types (e.g. ancient/maintained/deteriorating/ relict/regenerating/new).
Change. Tracking increases/decreases over time.
Amenity. Benefit to wildlife, landscape, community.

One major survey (the Suffolk Hedgerow Survey) is already underway, and will involve local communities in a parish by parish study. Whilst the results will take time to come in, the data collated could help piecemeal with each of the above, although interestingly the prime motivation is to foster the appreciation of hedges. One of the audit sample tetrads (Gt Bealings) lies in one of the first parishes surveyed, and this should lead to some early feedback:

- An independent hedge length count for comparison.
- Hedge density for the parish as a whole should be close to the audit figure of 5.1km/km^2.
- The hedge map should match the audit map at Annex; a scrutiny of the differences could add confidence to the audit, or might identify errors.
- A breakdown of hedge type and quality will be available; this could lead towards an estimate of the total species-rich stock in the County.

In time, similar comparisons with other audit tetrads in other natural areas will be possible.

Audit Refinement.

If any further effort is to be put into refining the accuracy of the estimates offered from this audit, the following channels are suggested:

- Increase the sample size by adding freshly chosen tetrads to the 24 completed so far.
- Measure hedge density in every one-km square, rather than just averaging each tetrad.
- Increase the number of samples from entirely within the smaller natural areas.
- Sample some urban/developed areas.
- Review the extent and boundaries of the major hedgeless habitat areas.
- Calculate estimates by stratifying Natural Area averages.

All of the above would improve the statistical accuracy of the estimate, and add to our knowledge of hedge distribution in the Brecks, Fens, Broads, Coast and Heaths, particularly in the sparsely hedged parts.

Measuring Change.

It would be possible to use old photography to conduct a retrospective survey to measure hedgerow change over the last (say) 20 years, but this would probably not justify the effort. Neither will it be be meaningful to repeat this audit in less than (say) 5 years in order to measure change. If it is desired to monitor change, it will be necessary to set up a fresh study,

possibly using a few of the audit tetrads as specimens, to be accurately measured and mapped (perhaps during the Suffolk Hedgerow Survey), and then watched for change. Such a study would only make sense in conjunction with an analysis of of permitted removals and fresh plantings. The danger of selecting untypical samples might also mitigate against the effort. On present plans, the next SCC aerial photography will be integrated with the existing Geographic Information System so that it will be possible to display the imagery on screen overlaid with OS map detail. (There are no plans to retrospectively scan the 1995/96 photography in.) Any future study will therefore have the possibility of computer assisted analysis and refined mapping to support subdivisions in categories of hedge. It goes without saying that this will save effort in finding the right print and matching it with the tetrad edges, so that future results will be more accurate, more easily manipulated, and well suited to long-term monitoring.

Acknowledgements

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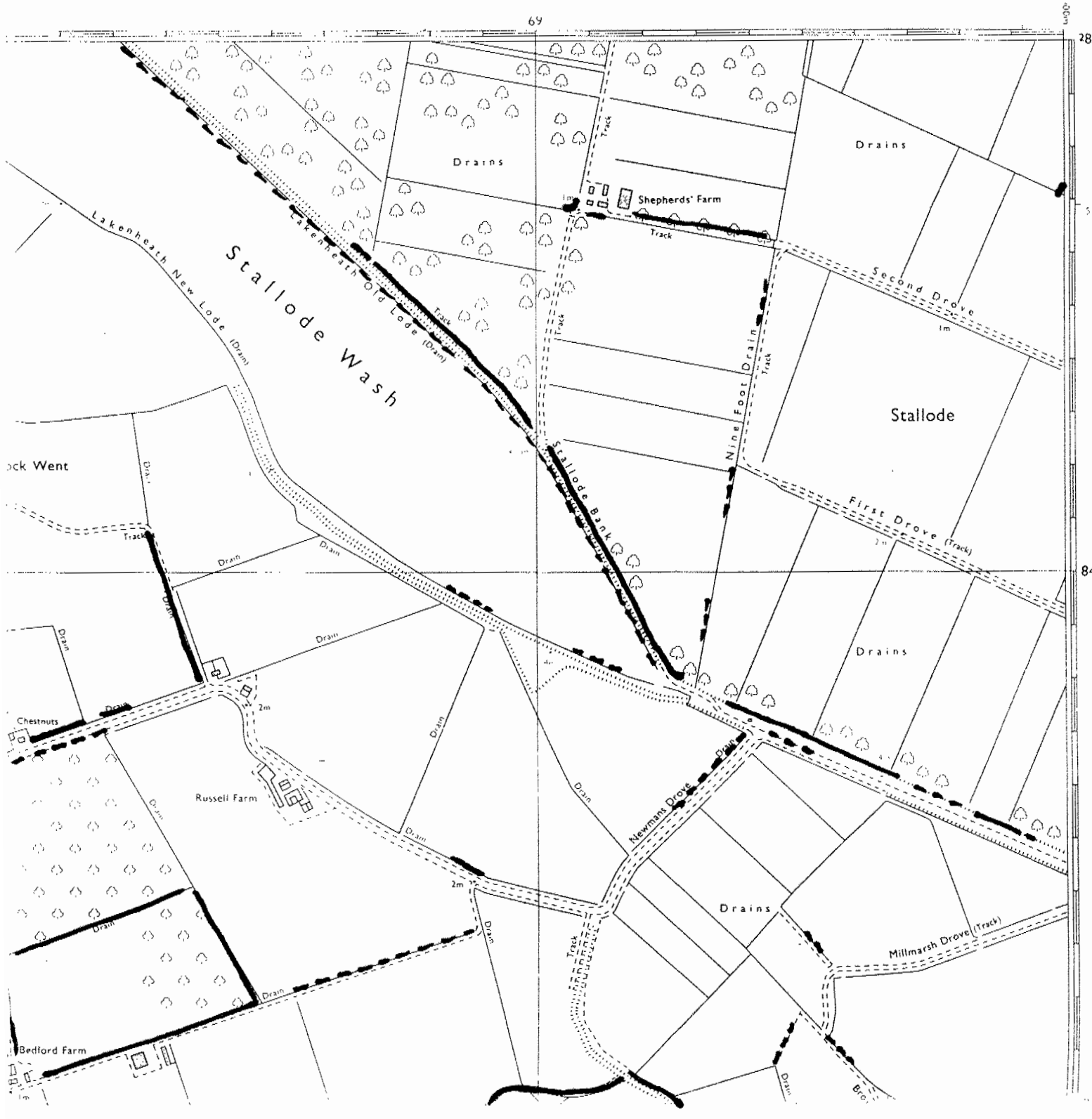
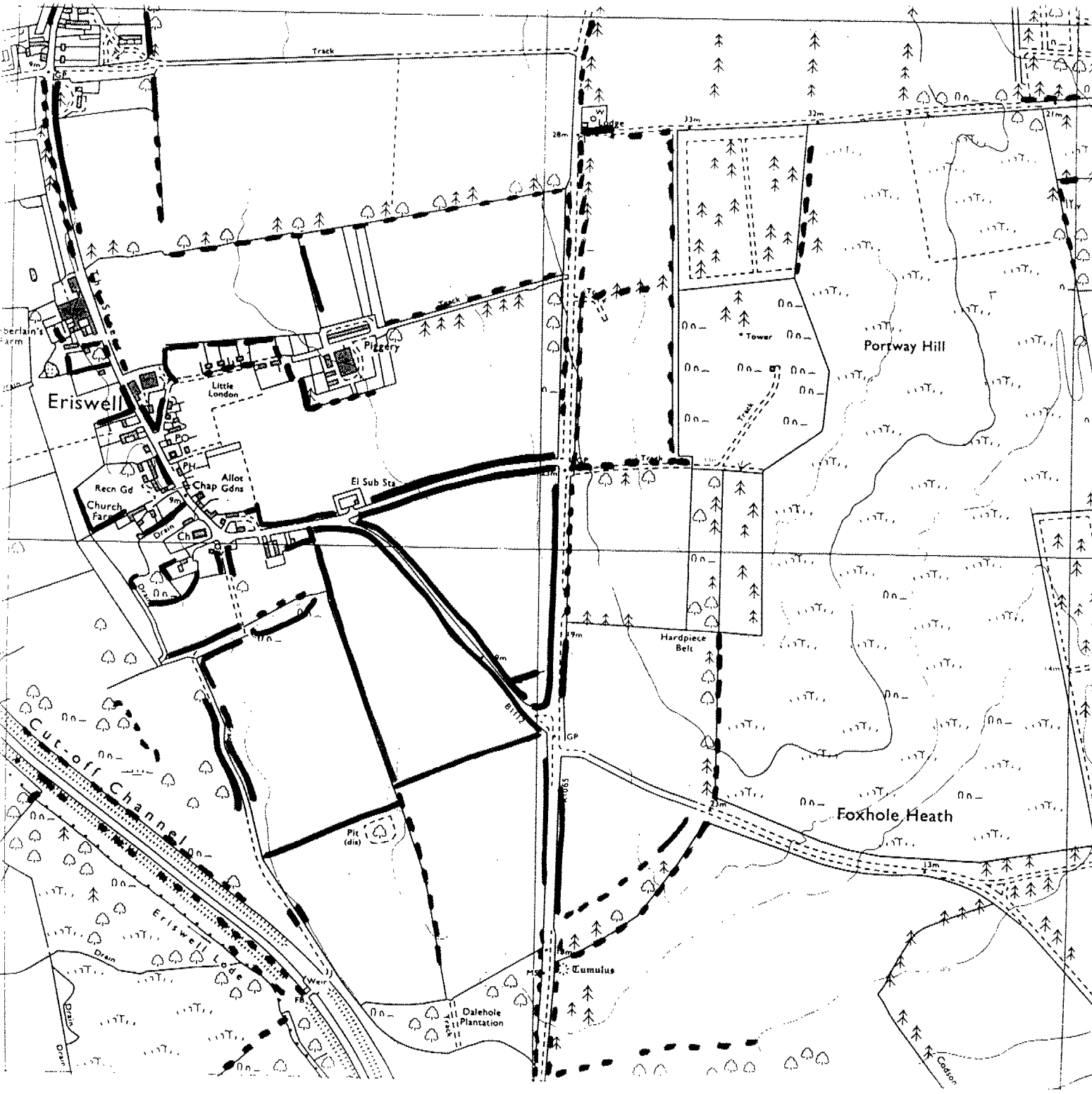
Annex - Map of hedgerows in each of the twenty-four tetrads sampled

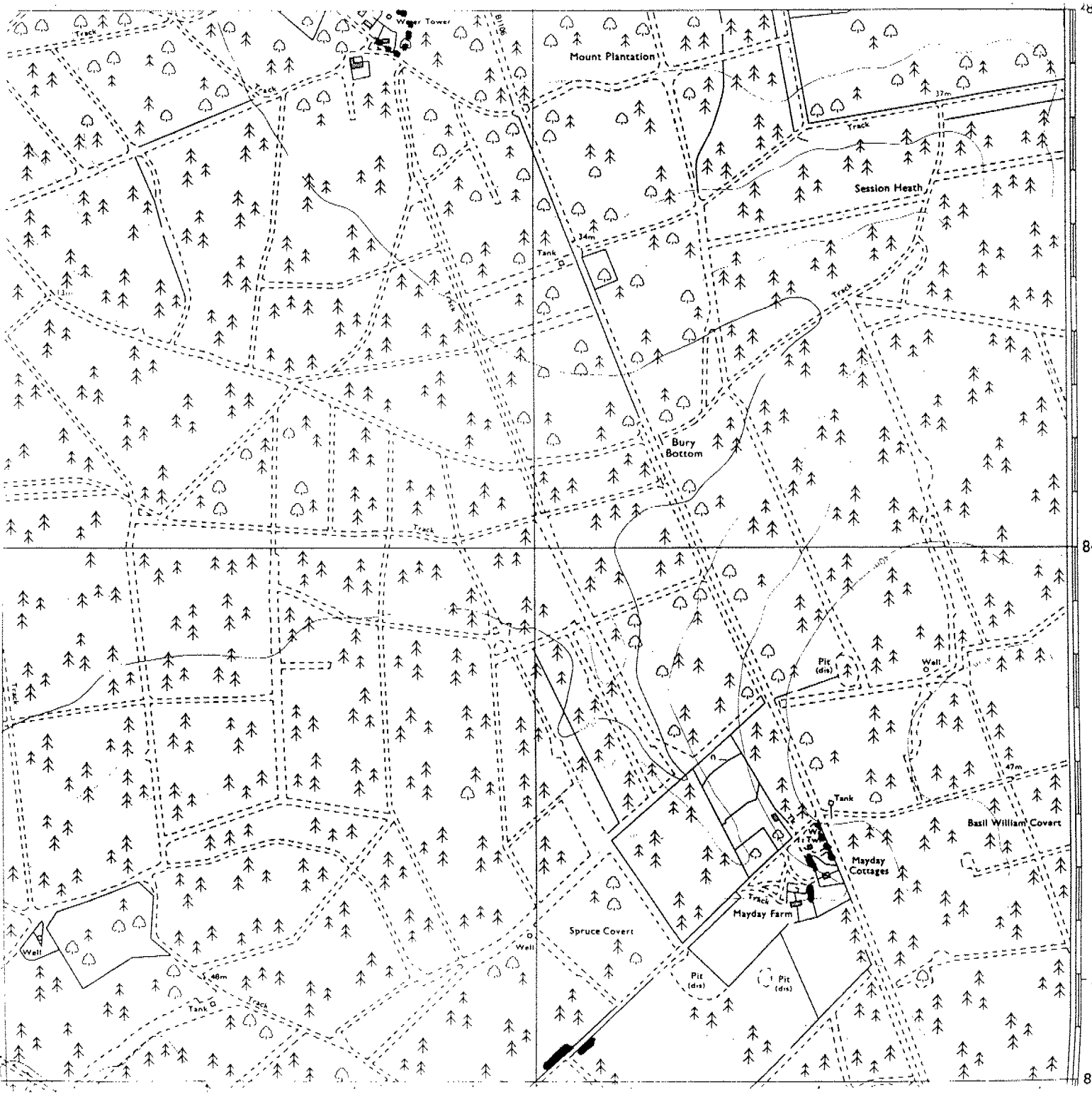
Tetrad name: **1. STALLODE**	Grid ref: **TL6883**	Hedge length: **5.0** km
Natural Area: **Fen**	woodland cover: **Nil**	habitation cover:**Nil**
Land use: **Agricultural fenland**	air photo date: **6May96**	road length: **2.4**km
Water features: **Drainage channels**	air photo nos: **2503**	railway: **nil**
Remarks: **Former woodlands now tilled. Numerous drains and banks**		



Tetrad: **2. ERISWELL**	Grid ref: **TL7277**	Hedge length:**10.6** km
Natural Area: **Breckland**	woodland cover: **8%**	habitation cover: **3%**
Land use: **Agriculture, heath**	air photo date:**21Aug95**	road length: **5.3**km
Water features: **Cut-off channel 0.9**km	air photo nos: **2565,2591,2592**	railway length: **nil**
Remarks: **10.6km hedgerow count excludes 1.2km of former "Breckland hedge"now reverted to conifer belt, but includes 3.9km (37%) of broken hedge, much of which lies beneath conifer belts.**		



Tetrad: **3. MAYDAY Farm**	Grid ref: **TL7883**	Hedge length: **0.3** km
Natural Area: **Breckland**	woodland cover: **99%**	habitation cover: **0 %**
Land use: **Coniferous forestry**	air photo date: **21Aug95**	road length: **2.1**km
Water features: **none**	air photo nos:**2662,2638,2663**	railway length: **0** km
Remarks: **Thetford Forest is solid, making this tetrad the lowest scoring of the whole sample.**		



Tetrad: **4. SOUTH ELMHAM**	Grid ref: **TM3083**	Hedge length: **19.4** km
Natural Area: **Plain**	woodland cover: **1%**	habitation cover: **1 %**
Land use: **Agriculture**	air photo date: **5Aug96**	road length: **5.2**km
Water features: **stream, drains**	air photo nos:**165,200**	railway length: **0** km
Remarks: **A significant proportion of hedges were (recently) laid. Count includes 0.4km of newly planted hedge.**		

Tetrad: **5. REDISHAM**	Grid ref: **TM4083**	Hedge length: **16.1** km
Natural Area: **Plain**	woodland cover: **2%**	habitation cover: **2 %**
Land use: **Agriculture**	air photo dates:**29Sep95,5Aug96**	road length: **3.2**km
Water features:**none**	air photo nos: **178,179,210,211**	railway length: **2** km
Remarks: **Some large fields. Rather typical overall.**		