Durham Hedgerow Survey 2006

DURHAM COUNTY COUNCIL

Making a difference where you live

Durham **Biodiversity** Partnership

Action for wildlife in Gateshead, South Tyneside, Sunderland, Darlington & County Durham

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Executive Summary

The survey covered the Durham Biodiversity Action Plan area (hereafter referred to as Durham); 193 hedges were surveyed, representing a total length of 36km.

Aims

- Estimate the overall extent, composition and current condition of hedgerows within Durham and the number and age profile of isolated trees.
- Assess the variation in hedgerows with respect to hedge types, condition and management, and in relation to natural area.
- Establish baseline data that will enable change to be monitored.
- Assess whether Durham is reaching the targets of the UK Biodiversity Action Plan at a local level and help the Durham Biodiversity Partnership set revised targets in the Durham BAP.

Main findings

- The estimated hedgerow length in Durham is 9100km, of which 9% is remnant. Since the last survey in 1979, an estimated 21% of the hedgerow resource has been lost.
- Thirty-five percent of hedgerows are classed as species rich (i.e. contained four or more species per 30m section). The most frequently occurring shrub species were hawthorn, ash, blackthorn and elder respectively. However, it must be noted that a four species hedge containing mainly hawthorn, an ash sapling, dog rose, elder and a species poor ground flora is very common in Durham and is not comparable with a truly species-rich hedgerow.
- Of the surveyed hedges only half contained isolated hedgerow trees; the most common tree species were ash, sycamore and pedunculate oak.
- The estimated number of hedgerow trees in Durham is 68,000; to maintain the current isolated tree population, 580 trees per year need to be recruited into the hedgerows.
- Only 17% of the hedges surveyed were in 'favourable condition' under UK BAP condition assessment. Gappiness and canopy height at the base were the main factors causing hedges to fail.
- Hedges within the Countryside Stewardship Scheme were in better condition than those not in an agri-environmental scheme.
- Neglect is the biggest threat to Durham's hedgerows. Sixty-two percent of hedges showed no signs of management; of the managed hedges (38%), 90% had been actively flailed.
- A quarter of the hedges surveyed are associated with a ditch and a third of hedges had a bank. Only 6% of hedges were associated with a wall, all of which were remnant.

- The land use adjacent to the survey hedges was predominantly related to intensive agriculture (arable and improved grassland), and ground flora species diversity was found to be directly correlated with adjacent land use.

Content

List of Tables and Figures

1. Introduction

Hedgerows form an integral part of County Durham's historical landscape and are important, both as an environmental and cultural resource. Their primary function is to enclose land and livestock, provide shelter for crops and animals and prevent soil erosion. Some of the hedges in the county date back to the medieval period however the majority of present day hedges result from successive waves of enclosure between the 16th and 19th century. Two distinct period of enclosure occurred in Co. Durham (Hodgson, 1979); firstly, the early enclosures of town fields in the 16th and 17th century which is distinctive of the arable areas of the south and east of the county, and later (between the 18th and 19th) the enclosure of the commons, fell and waste land to the north and west of the county.

Hedgerows are a very significant habitat for large numbers of flora and fauna, providing food and shelter for birds, small mammals, amphibians, and invertebrates. Forty-seven species of conservation concern in the UK, (including thirteen globally threatened or rapidly declining species) use hedgerows as their primary habitat (JNCC, 2006). In addition, hedges and their associated features act as wildlife corridors aiding movement and dispersal of species between habitats.

Since 1945 there has been a dramatic loss of hedgerows in the UK, through changes in agricultural practices, towards more intensive farming and an increase in roads, housing and other developments. This has resulted in not only the removal of hedgerows but, hedges being neglected or over-managed, which in turn has led to the deterioration in hedgerow continuity and integrity. In Co. Durham, mineral extraction (especially opencast coal mining) may also have contributed significantly to the loss of hedgerows in the county (Bailey, 1979). This loss and fragmentation of hedgerows has implications for both the character and biodiversity of the landscape, through the loss of habitat and the connections between habitats. In turn, the wildlife, that increasingly depends on this habitat for food, shelter and dispersal are affected.

In 1947 there was as estimated 662,000 km of hedgerow in England, which by 1993 had more than halved to 328,800km and the Countryside Survey in 1990 estimated that between 1984 and 1990, the net loss of hedgerow length in England was *c.*23% (Barr *et al*., 1993). This picture of decline is also evident in Co. Durham. A study of Co. Durham's parish and township boundaries found that a quarter of the hedges had been lost since 1860, or survived only as relicts (DCC, 1995). Bailey (1979) suggested that during the mid 1960's hedge removal in Co. Durham rose to a peak with 1600km being lost a year.

Since the 1990's a range of grant schemes have been established to address the decline by encouraging the creation and restoration of hedgerows. In Co. Durham the Durham Hedgerow Partnership offers grants to farmers and landowners who wish to establish new hedges or manage existing ones, using traditional techniques. Since the establishment of the grant scheme in 1998, approximately 51km of new hedge has been planted and 27km has been restored. In addition, important hedgerows have been protected by legislation under the Hedgerow Regulations of 1997, by preventing the removal of hedges without prior planning approval. Ancient/species rich hedgerows have also been designated as a priority habitat in the UK Biodiversity

Action plan due to their historical, cultural and ecological importance with an aim of halting the net loss of these hedges and increasing the number in favorable condition.

The most recent Countryside Survey (CS2000) showed there had been no net change in the total length of hedgerow between 1990 and 1998, indicating that these measures seem to have stemmed the decline and new planting of hedges through grants schemes has helped offset the loss. However, the numbers of hedges being reclassified as line of trees, shrubs or relict hedgerow have increased by 31% (Haines-Young, *et al*., 2000). Barr and Gillespie (2000) suggested that any lost between 1990 and 1993 was almost entirely due to change of management, leading to overgrown hedges and lines of trees. This suggests that neglect is now the biggest threat to hedgerow survival.

The extent of Co. Durham's[1] hedgerows was last surveyed in 1979, giving an estimate of 9600 km of hedgerow (Bailey, 1979). If Co. Durham has followed the trend of national decline in hedgerow length, the current figure is more likely to be in the region of 7000km of hedgerow. In order to estimate the current extent and condition of Durham's hedgerows, funding was successfully secured from Defra to carry out a repeat survey.

The specific aims of this survey were:

- Estimate the overall extent, composition, current condition and/or current management of hedgerows within Durham.
- Estimate the number and age profile of isolated trees.
- Assess the variation in hedgerows with respect to hedge types, condition and management, and in relation to natural area.
- Establish baseline data that will enable change to be monitored.
- Assess whether Durham is reaching the targets of the UK Biodiversity Action Plan at a local level.
- Help the Durham Biodiversity Partnership set revised targets in the Durham BAP in order to secure the conservation and favourable management of hedgerows within the area.

[1] During this survey Co. Durham included the District of Darlington

2. Methodology and Field Survey

The survey followed the methodology described in the final draft of the Hedgerow Survey Handbook: A standard procedure for the local surveys in the UK (Defra, 2007). However a number of amendments were made to the methodology during this survey; Appendix A outlines the differences to that of the published methodology.

2.1 Definition of a Hedgerow

For the purpose of this survey the following definition of a hedgerow is used (Defra, 2007):

'Any boundary line of trees or shrubs over 20 metres long and less than 5m wide at the base'.

The hedgerow ends where:

- two or more hedges join
- it connects to another boundary feature
- where there is a gap greater than 20m.

2.2 Survey Area

This survey covers the Durham Biodiversity Action Plan (Durham BAP) area (an area of approximately 2650km^2). This includes; Co. Durham, Gateshead, Darlington, South Tyneside and City of Sunderland (i.e. most of the Watsonian Vice - County 66 or the pre-1974 Co. Durham minus the northern part of pre-1974 Cleveland). Unless otherwise stated where 'Durham' is used in the text, it refers to this study area.

Within this area there are five natural areas (North Pennines, Dales Fridge, Tees Lowlands, Northumbria Coal Measures and Durham Magnesian Limestone), all of which have unique characteristics resulting from the interaction of wildlife, landforms, geology, land use and human impact.

Map 2.1.1 shows the Durham BAP area, with the 1km^2 squares that contain hedges, colour coded by natural area. Also marked are the randomly selected 28, 1km^2 survey squares.

2.3 Selecting the sample

The entire selection process was carried out using ArcGIS (a Geographical Information System), using data held by Durham County Council on the landscape character of Co. Durham.

In order to randomly select survey squares and increase the accuracy of the selection, a shape file in ArcGIS was created that only contained 1km^2 squares that coincided with the 'hedged' landscape of the Durham. Areas that contained no hedges (e.g. urban areas and much of the North Pennine Natural Area to the west of

Co. Durham) were excluded. A number of additional squares were also removed, when on closer inspection were deemed to contain no hedgerows.

From this new dataset (an area containing approximately 1515km, 'hedged' kilometre squares), ArcGIS was employed to semi-randomly select the survey sites from within the five natural areas, to give a fair representation of each area, and thus a representative sample of Durham. Additional 1 km^2 squares were selected if squares were rejected for any reason (e.g. due to the lack of access).

Within each square a random sample of 9 (maximum) hedges were selected. Using ArcGIS, individual hedges were chosen by placing an appropriately scaled grid of 9 cells over an aerial photograph. Within each of the 9 cells, the centre was marked and the nearest hedge to this marker was selected. Only hedges adjoining common land, sites of special scientific interest (including national nature reserves, Special Protection Areas and Special Areas of Conservation), local nature reserves or land used for agriculture, forestry or the keeping of horses and ponies were selected. A total of 193 hedges were chosen in this way.

Each hedge chosen for detailed investigation was digitized, end points identified, length measured and labelled with a unique code. If, once in the field, the surveyors had to reselect a hedge for any reason (for example; lack of access; health and safety issues; or the 'hedge' chosen on the aerial photograph was discovered to be some other form of field boundary/feature), the next nearest hedge to the selection point was used.

2.4 Maps and Aerial Photographs

Field workers were given geographical and thematic maps produced in ArcGIS, highlighting the survey square and hedges to be surveyed, plus landownership details. Aerial photographs (taken in 2000) helped assess the grid square in terms of general character and the presence of hedges, and were used to plot the extent of the field boundary network in each square.

2.5 Access and Permission

To ascertain land ownership details for the chosen survey squares, a GIS dataset derived from the Rural Land Register was obtained from Defra.

Landowners/managers were contacted initially via a letter, which outlined the purpose of the survey and provided a map of the area we wished to survey. A follow up phone call was then made to each individual landowner to ask for permission to access the land. Due to difficulties in contacting landowners, if after four phone calls, no contact had been made, it was considered unpractical to keep phoning and if we did not have enough coverage of the square, these squares were discarded. Of those farmers that were contacted, three quarters granted permission.

2.6 Fieldwork

The fieldwork was contracted out to an ecological consultancy (Ptyxis Ecology); chosen due to their high level of expertise in botanical, including vegetative, identification and fieldwork experience. Approximately 5% of the field work was also conducted by the Project Officer. Fieldwork commenced on the 1st of October 2006 and was concluded by mid November.

2.7 Structural and Floristic recording

Each individual hedge was subjected to a detailed investigation.

The Hedgerow Survey Handbook survey form was used to record the necessary data. The survey form is divided into two parts. Part A contained all the essential assessments that are required to enable the BAP condition assessments to be made. Part B covered the optional assessments. The Durham Hedgerow Survey 2006 covered all sections.

Elements recorded for the whole length of the hedge were; hedgerow type, length, connections, adjacent land use, associated features, undisturbed ground and perennial herbaceous cover, hedgerow management, dimensions of hedgerow, integrity/continuity, isolated and veteran trees.

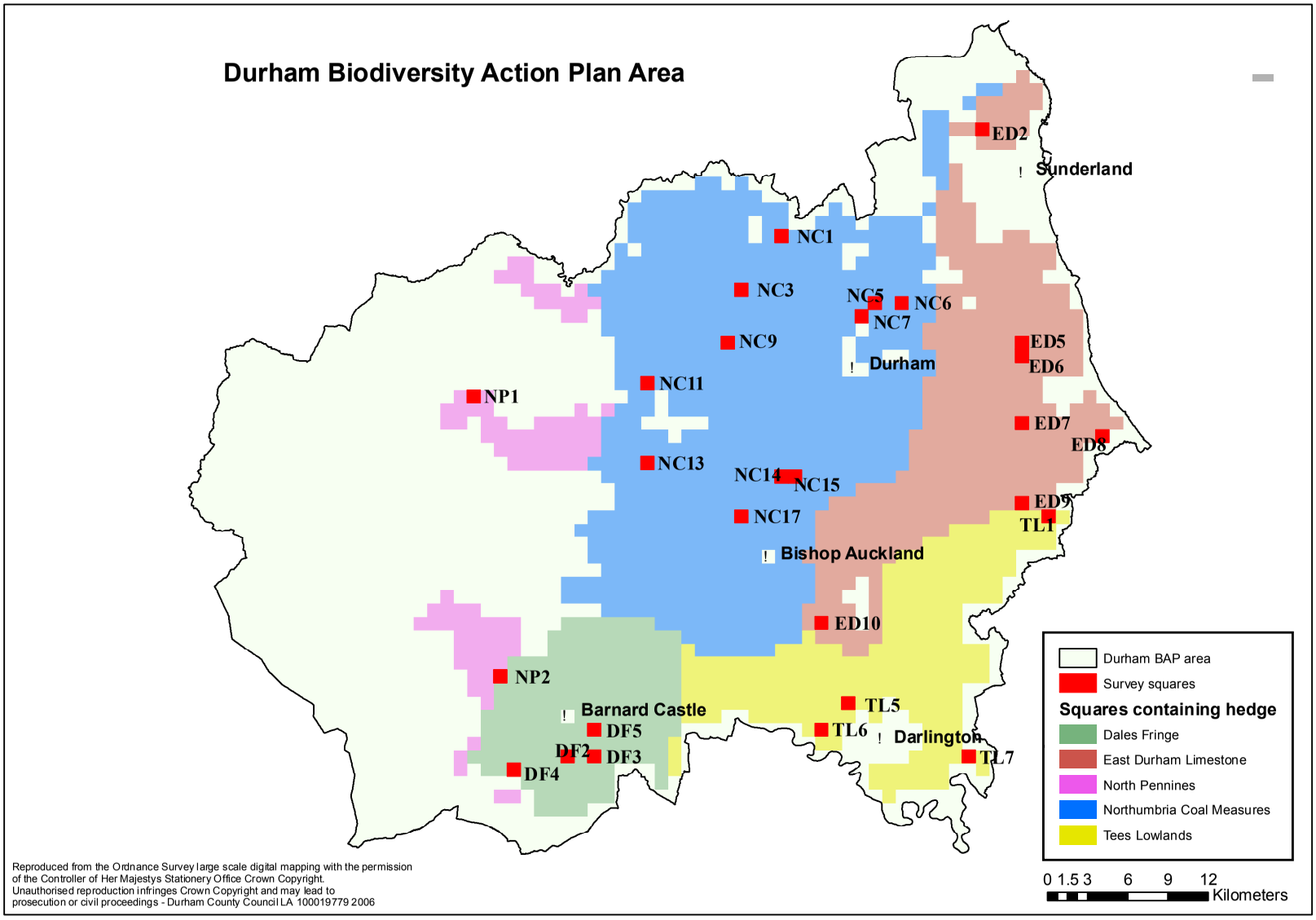
The following were recorded within the 30m section of each of the hedges only: woody species, ground flora and percent cover of docks, cleavers and nettles.

In general, the identification of ground flora species was determined using vegetative parts only, although in some instances dead floral parts aided identification. In some limited cases, vegetative identification was difficult and was based on the most likely species using the surveyor's experience. In the case of rose species and hybrids, these could only be identified if ripe hips were present (in some limited cases these had been flailed or were absent).

2.8 Recording the Extent of Hedgerows

The extent of the hedgerow resource within each survey square was carried out in a separate desk study using a combination of maps and aerial photographs within ArcGIS. All field boundaries within the surveyed squares were digitized, categorized into type of boundary and the length was measured. Additional information was gathered on hedgerows including; type (shrubby, line of trees or shrubby with line of trees), character, condition, length of vegetation, percent gappiness, number of connections, adjacent land use, and management (i.e. agri-environmental schemes).

From this, the data was extrapolated to give an estimate of the extent of the hedgerow resource within Durham.



Map 2.1.1 Durham Biodiversity Action Plan Area. 'Hedged' km^2 squares, colour coded by natural area and survey squares are highlighted

3. Data Management and Analysis

3.1 Data Management

All the data recorded during the field survey was transferred from the survey forms into the new Microsoft Access database that has been developed for the purpose of the local hedgerow surveys.

Early versions of the access database contained many errors and several versions were supplied to overcome these problems, leading to serious time delays.

3.2 Data Analysis

Data was transferred to Microsoft Excel to carry out standard statistical analyses (including frequency of species occurrence, mean species richness etc.).

4. Results

A total of 193 hedges were surveyed, representing a total length of 36km.

4.1 Extent of Hedgerows in Durham

Table 4.1.1 shows the extent of hedgerow and remnant hedgerow in the 28 individual sample squares. This represents approximately 1.8% of the total 'hedged' landscape within Durham.

Grid Reference	Square	Natural Area	Length (km/km^2)	Relict Hedge length (km/km^2)	Total Length (km/km^2)
NZ 0513	DF2	Dales Fringe	6.992	1.488	8.48
NZ 0713	DF3	Dales Fringe	1.928	0.096	2.024
NZ 0112	DF4	Dales Fringe	1.579	0.781	2.36
NZ 0715	DF5	Dales Fringe	6.341	0	6.341
NZ 2423	ED10	Durham Magnesian Limestone	8.078	0.236	8.314
NZ 3660	ED2	Durham Magnesian Limestone	6.284	0.542	6.826
NZ 3944	ED5	Durham Magnesian Limestone	12.046	0.743	12.789
NZ 3943	ED6	Durham Magnesian Limestone	8.611	0.489	9.1
NZ 3938	ED7	Durham Magnesian Limestone	1.222	0	1.222
NZ 4537	ED8	Durham Magnesian Limestone	4.497	0	4.497
NZ 3932	ED9	Durham Magnesian Limestone	5.437	0.082	5.519
NZ 2152	NC1	Northumbria Coal Measures	3.455	0.546	4.001
NZ 1141	NC11	Northumbria Coal Measures	2.925	0.2	3.125
NZ 1135	NC13	Northumbria Coal Measures	3.8	1.313	5.113
NZ 2134	NC14	Northumbria Coal Measures	4.24	0	4.24
NZ 2234	NC15	Northumbria Coal Measures	4.09	0.442	4.532
NZ 1831	NC17	Northumbria Coal Measures	8.872	1.309	10.181
NZ 1848	NC3	Northumbria Coal Measures	4.037	0.179	4.216
NZ 2847	NC5	Northumbria Coal Measures	2.426	0.103	2.529
NZ 3057	NC6	Northumbria Coal Measures	6.542	0.333	6.875
NZ 2746	NC7	Northumbria Coal Measures	6.737	0.917	7.654
NZ 1744	NC9	Northumbria Coal Measures	5.445	0.051	5.496
NY 9840	NP1	North Pennines	1.819	0.72	2.539
NZ 0019	NP2	North Pennines	9.287	2.019	11.306
NZ 4131	TL1	Tees Lowlands	5.35	1.444	6.794
NZ 2617	TL5	Tees Lowlands	7.735	0.558	8.293
NZ 2315	TL6	Tees Lowlands	5.024	0.367	5.391
NZ 3513	TL7	Tees Lowlands	8.522	0.128	8.65
Total			**153.321**	**15.086**	**168.407**
Average			**5.48**	**0.54**	**6.01**

Table 4.1.1 Extent of hedgerow and remnant hedgerow in each sample square.

Assuming that the squares surveyed are a representative sample of Durham, the estimated total hedgerow length is approximately 9100km with a 95% confidence interval of 7400 ↔ 10,800km. Of this, it is estimated that 800 km (±300 km) is remnant, i.e. 9% of the total hedgerow resource. For the purpose of this study,

remnant hedgerow has been classed as hedge boundaries that have equal to or less than 30% vegetation along its length.

Because of the limited size of sample from each of the natural areas, it was not feasible to derive a statistically valid estimate of the hedgerow length for each individual natural area.

Each hedgerow within the survey area connects on average to another 2 hedges. There was no difference between natural areas.

4.2 Species composition

Altogether there were 45 woody species (trees, shrubs and climbers) found in the survey hedges. Seven of which were rose *Rosa* species or hybrids.

4.2.1 Woody species occurring in the hedge layer

Not surprisingly, hawthorn *Crataegus monogyna* is not only the most frequently occurring hedge shrub, but also has the highest percent cover, covering on average 55 – 75% of each hedge in which it is found. Hawthorn was nearly two thirds more frequent than species ranked second and third (excluding climbers). Blackthorn *Prunus spinosa* and ash *Fraxinus excelsior* occurred in approximately a third of all hedges sampled however, ash had a slightly lower level of cover than blackthorn. Elder *Sambucus nigra* is also found in a high portion of hedges surveyed, but has a relatively low level of abundance (4-10% cover). A number of species occurred infrequently including gorse *Ulex europaeus* and beech *Fagus sylvatica*, but where they did occur, tended to have a high percentage cover (26-33% cover).

Of the climbing species, bramble *Rubus fruticosus* and dog rose *Rosa canina sensu stricto* occurred most frequently in the surveyed hedges, being found in 51% and 33% of hedges respectively. However, both contributed to only 4% - 10% of the overall cover of the hedges in which they were found. The frequency and abundance of each species is presented in Table 4.2.1, with the frequency of the more common species represented graphically in Figure 4.2.2.

Ninety-nine percent of the hedgerows were made up of greater than 80% native woody species.

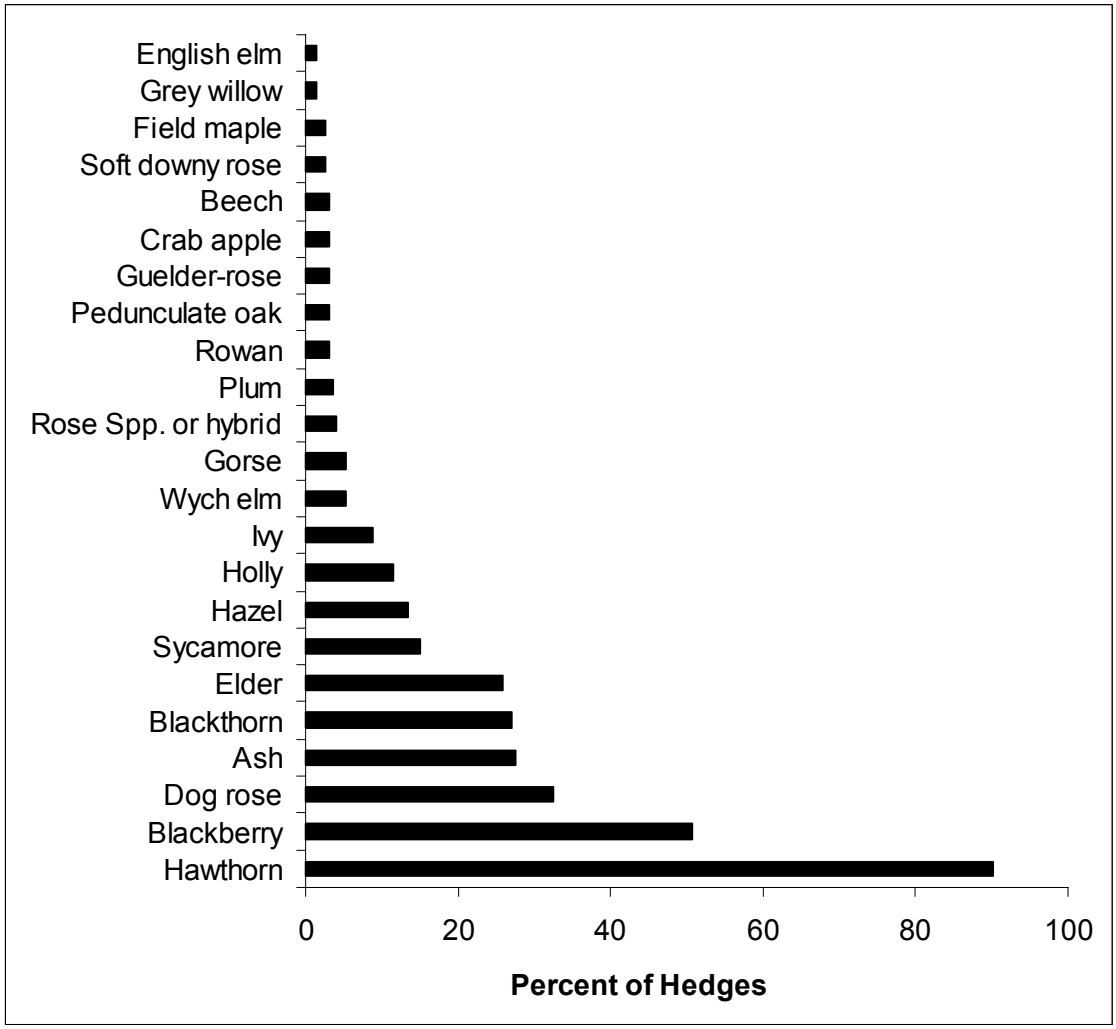


Figure 4.2.2 Percentage of hedges in which each of the main woody species were found

An isolated *Fraxinus excelsior* hedgerow tree

A veteran *Quercus robur*

Photographs by Ptyxis Ecology

Common name * non native species	Latin name	Percent frequency[1]	Species abundance (DOMIN[2])
Hawthorn	*Crataegus monogyna*	90	8 (51 - 75% cover)
Blackberry	*Rubus fruticosus*	51	4 (4 - 10% cover)
Dog Rose	*Rosa canina s.s.*	33	4 (4 - 10% cover)
Ash	*Fraxinus excelsior*	27	5 (11 - 25% cover)
Blackthorn	*Prunus spinosa*	27	6 (26 - 33% cover)
Elder	*Sambucus nigra*	26	4 (4 - 10% cover)
Sycamore	*Acer pseudoplatanus*	15	4 (4 - 10% cover)
Hazel	*Corylus avellana*	13	5 (11 - 25% cover)
Holly	*Ilex aquifolium*	11	5 (11 - 25% cover)
Ivy	*Hedera helix*	9	4 (4 - 10% cover)
Wych Elm	*Ulmus glabra*	5	4 (4 - 10% cover)
Gorse	*Ulex europaeus*	5	6 (26 - 33% cover)
Rose Spp. or hybrid (unidentifiable)	*Rose Spp.*	4	4 (4 - 10% cover)
Plum	*Prunus domestica*	4	4 (4 - 10% cover)
Rowan	*Sorbus aucuparia*	3	4 (4 - 10% cover)
Oak	*Quercus robur*	3	5 (11 - 25% cover)
Guelder-rose	*Viburnum opulus*	3	4 (4 - 10% cover)
Crab Apple	*Malus sylvestris*	3	5 (11 - 25% cover)
Beech	*Fagus sylvatica*	3	6 (26 - 33% cover)
Soft Downy Rose	*Rosa mollis*	3	3 (< 4% cover)
Field Maple	*Acer campestre*	3	4 (4 - 10% cover)
Grey Willow	*Salix cinerea*	2	7 (34 - 50% cover)
English Elm	*Ulmus procera*	2	5 (11 - 25% cover)
	Rosa x molletorum	1	4 (4 - 10% cover)
Glaucous Dog Rose	*Rosa dumalis*	1	5 (11 - 25% cover)
Hairy Dog Rose sub-sp.	*Rosa caesia caesia*	1	4 (4 - 10% cover)
Hairy Dog Rose	*Rosa caesia*	1	3 (< 4% cover)
Common Lime	*Tilia x europaea*	1	4 (4 - 10% cover)
*Gooseberry	*Ribes uva-crispa*	1	3 (< 4% cover)
Swedish Whitebeam	*Sorbus intermedia*	< 1	10 (91 - 100% cover)
Sherards Downy Rose	*Rosa sherardii*	< 1	4 (4 - 10% cover)
Salix Spp.	*Salix spp.*	< 1	5 (11 - 25% cover)
Raspberry	*Rubus idaeus*	< 1	5 (11 - 25% cover)
Privet	*Ligustrum vulgare*	< 1	5 (11 - 25% cover)
Oak Hybrid	*Quercus x rosacea*	< 1	3 (< 4% cover)
Midland Hawthorn	*Crataegus laevigata*	< 1	3 (< 4% cover)
Honey Suckle	*Lonicera periclymenum*	< 1	5 (11 - 25% cover)
Elm spp.	*Ulmus Spp.*	< 1	4 (4 - 10% cover)
Buckthorn	*Rhamnus cathartica*	< 1	9 (76 - 90% cover)
*Horse Chesnut	*Aesculus hippocastanum*	< 1	6 (26 - 33% cover)
	Rosa x scabriuscula	< 1	3 (< 4% cover)

Table 4.2.1 Frequency of species occurrence and abundance in sample hedges

[1]The frequency of occurrence is the frequency with which the species is found in the sampled hedges
[2]The Domin abundance level is a representation of the average degree of cover of each species within each 30m sample strip where they do occur.

4.2.2 Tree layer in the 30m section

Hedgerow trees are defined as having a clear trunk/stem and/or twice the average height of the hedgerow (Defra, 2007). Twenty-five percent of the 30m sample sections in the surveyed hedges contained hedgerow trees. A total of 16 tree species were found, of which all but one, horse chesnut *Aesculus hippocastanum* were native or archaeophyte species. The most common species was ash, which was found in 71% of samples containing trees. Figure 4.2.3 shows the frequency of tree species found in the 30m sample section of survey hedges.

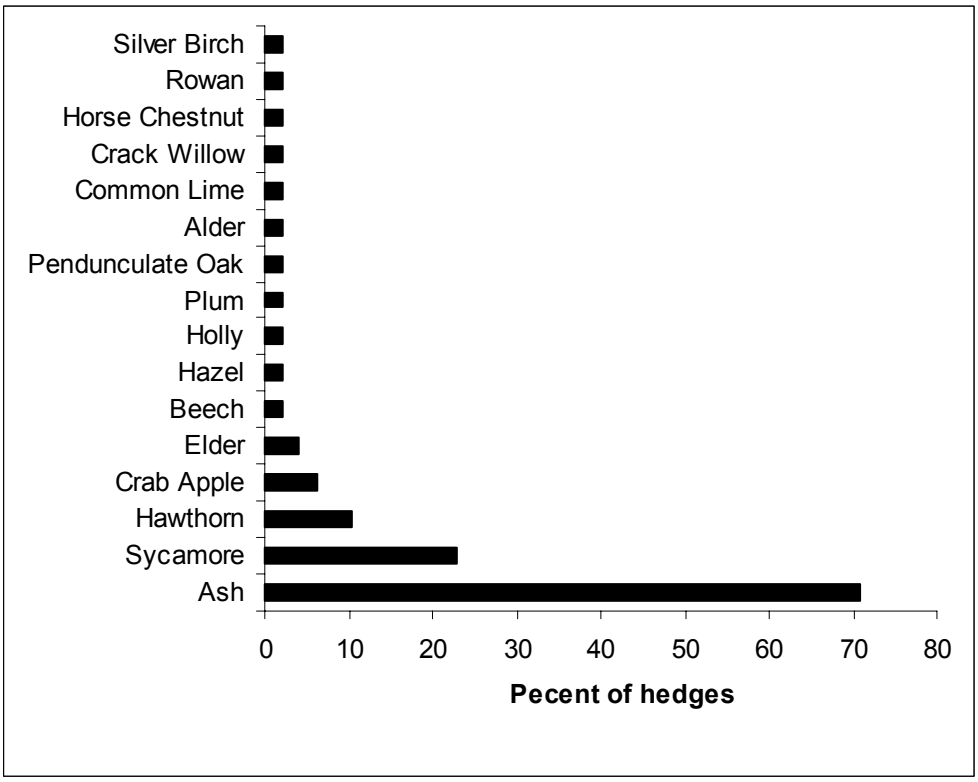


Figure 4.2.3 Frequency of tree species found in the 30m sample sections of the surveyed hedges (25% of hedge samples contained hedge trees).

Seventy-three percent of the hedges where hedgerow trees were recorded had just one species. Fifteen percent contained two species, 6% had three species and a further 2% had four species.

4.2.3 Isolated Trees

Isolated hedgerow trees are those whose canopies do not touch those of other trees, and have a clear stem, and/or twice the average height of the hedgerow (Defra, 2007). Isolated trees were surveyed along the entire length of the hedgerow.

Approximately half of the surveyed hedges contain isolated trees. A total of 23 species of tree where recorded; all but one species larch *Larix decidua* were native or archaeophyte species. The most common species was ash, sycamore *Acer pseudoplatanus*, and pedunculate oak *Quercus robur,* which were found in 72, 28

and 14% of the hedges that contained isolated trees respectively. Figure 4.2.4 shows the details.

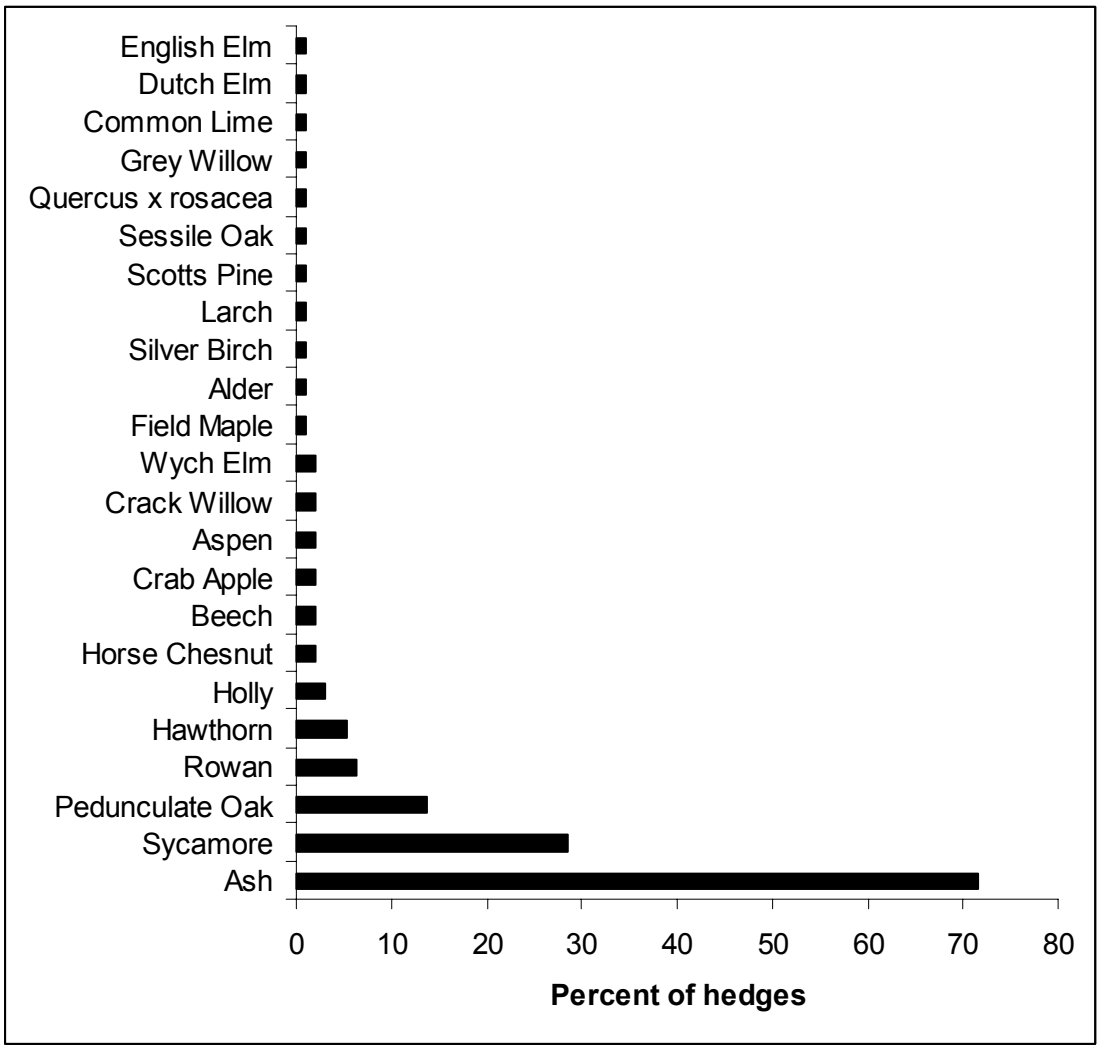


Figure 4.2.4 Frequency of tree species occurrence in survey hedges that contain isolated trees.

Ash and sycamore occur as frequently in the tree layer, as they do as isolated trees. However pedunculate oak was found more frequently as an isolated tree, whereas rowan *Sorbus aucuparia* occurred more frequently in the tree layer.

4.2.4 Veteran Trees

Veteran trees are a tree which, because of its great age, size or condition is of exceptional value culturally, in the landscape or for wildlife. For the purpose of this survey this included any tree with a diameter of more than 1m at breast height; smaller species that do not reach this diameter but are nevertheless classed as ancient, or trees (regardless of size) that posses large coppice stools, dead wood, dead bark, sap runs, tears, splits, scars or lightning strikes, hollow trunks or limbs and major rot sites.

13% of the surveyed hedges contained a veteran tree. Seven different species of veteran tree were found with ash (58%) being the most common, followed by sycamore (18%) and pedunculate oak (9%).

4.2.5 Ground Flora

A total of 143 species were found and are listed in Appendix B in order of frequency occurrence. Relative abundance of each species was not estimated. Cleaver *Gallium aparine*, couch *Elytrigia repens* and nettle *Urtican dioica* occur most frequently, occurring in 71, 69 and 64% of samples respectively.

4.3 Species Richness

In Northern England, a species rich hedge is defined as one that contains four or more native woody species (including archaeophytes and sycamore) in a 30m strip of hedge (Defra, 2007). Climbers (with the exception of rose species) are excluded.
Under these criteria, 35% of the hedges sampled in Durham are classed as species rich. However, approximately half of the hedges contained only one or two woody species per 30m. The overall, average species richness is 3.0 species; with the most species rich hedge containing nine native woody species. Species rich hedges were found in most parts of Durham with no obvious regional bias. Figure 4.3.1 shows the breakdown of species richness.

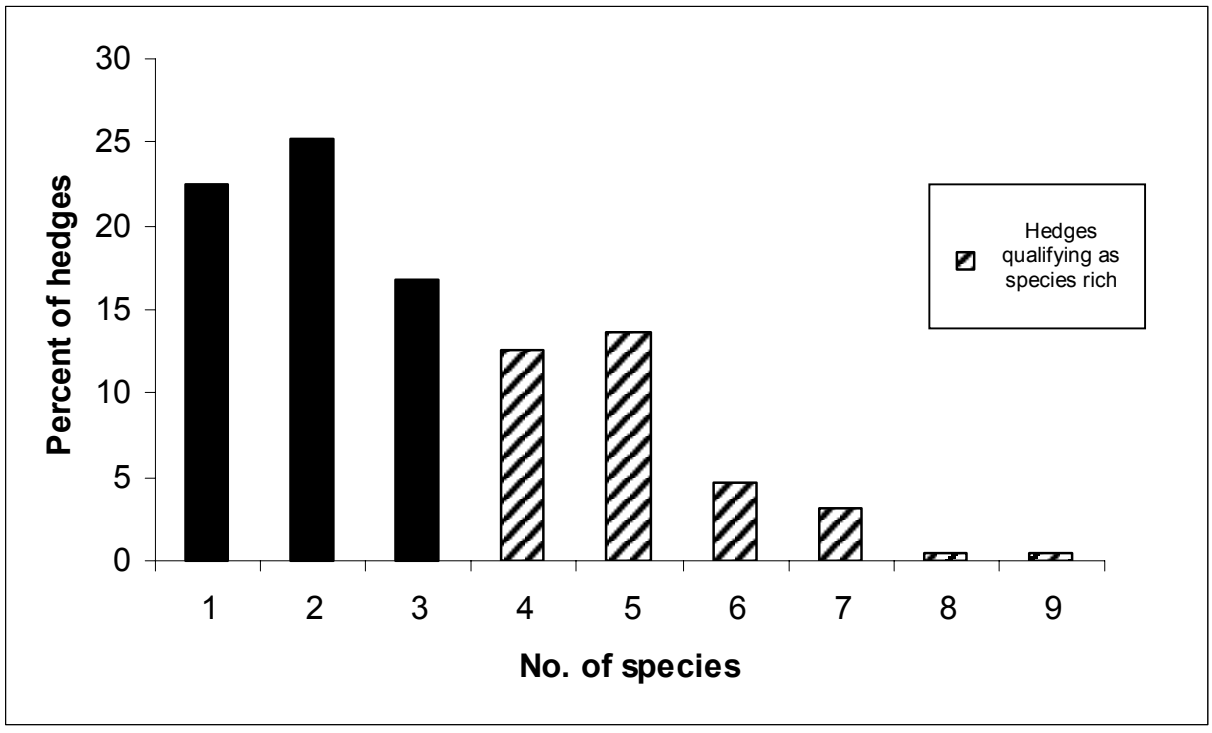


Figure 4.3.1 Number of native species in sample hedges.

The ground flora is an important component of hedgerows and can contribute significantly to species diversity. Overall, the average number of ground flora species per 30m section of hedge was 10.3. Ground flora species diversity varied in relation to natural area (Table 4.3.1). Hedgerows in the North Pennine natural area had a

higher ground flora species diversity (14.2 species), than the Tees Lowlands (8.25 species).

Natural Area	Average number of species
North Pennines	14.2
Dales Fringe	10.9
Northumbria Coal Measure	11
Durham Magnesian Limestone	9.2
Tees Lowland	8.25

Table 4.3.1 Species richness in relation to natural area.

Ground flora species richness also varied in relation to adjacent land use (Table 4.3.2). Hedges adjacent to arable fields had the lowest species richness, with an average of 8.5, while hedges adjoining grassland had an average of 12.9 species.

Adjacent Land use	Average Number of species
Arable	8.5
Improved Grass	10.4
Route	11.5
Grassland*	12.9

Table 4.3.2 Species richness in relation to adjacent land use. *Grassland includes semi improved and unimproved grass.

4.4 Character and Condition of the hedgerows

To assess the character and condition of the sampled hedges the following information was collected; the average height and width; the overall integrity/continuity of the hedgerow (both vertically and horizontally along its length) by measuring the percentage of gaps and the canopy height at the base; isolated trees and associated features. These features are indicators of the quality of the hedge for wildlife, but also highlight evidence of neglect through lack of cutting, laying and replanting or over-intensive management by over zealous flailing or intensive grazing by stock.

4.4.1 Boundary Type

Hedgerows were categorised into three types of hedge; shrubby hedgerow, line of trees or shrubby hedgerow with trees. Of the 193 hedges surveyed within Durham, nearly 80% of the hedges surveyed were shrubby hedgerows. Shrubby hedgerow with line of trees and line of trees represented a further 17% and 3% respectively.

4.4.2 Height

Figure 4.4.1 shows the breakdown of the sample in terms hedge height.

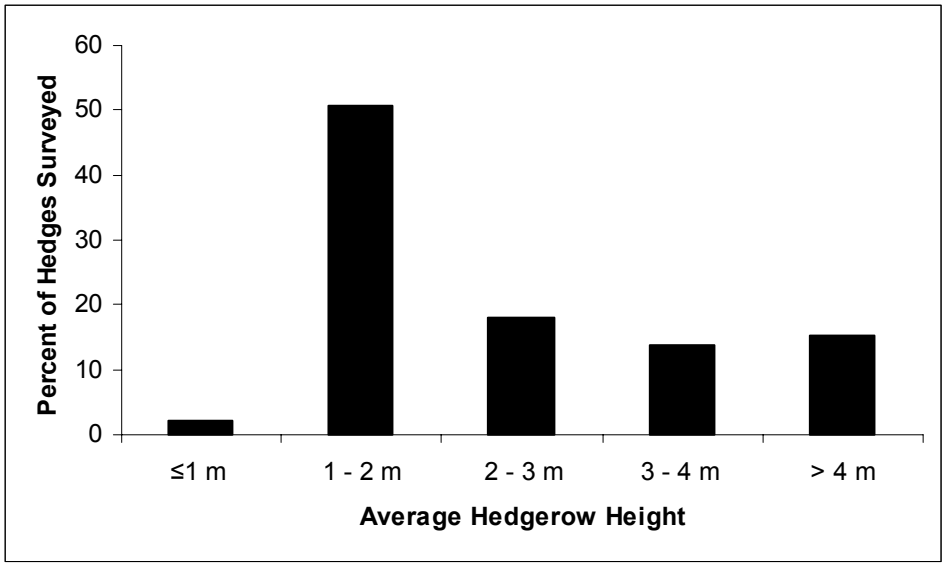


Figure 4.4.1 Hedgerow Height

Ninety-eight percent of the hedges surveyed are over 1m in height, with 50% falling within the 1–2m. Of the 2% (a total of four hedges) less than/equal to 1m, two had been planted, laid or coppiced in the last 5 years.

4.4.3 Width

As can be seen from Figure 4.4.2, the results of the survey show that 85% of hedges surveyed are over 1.5m wide, only 15% are less than 1.5m i.e. deemed in unfavourable condition.

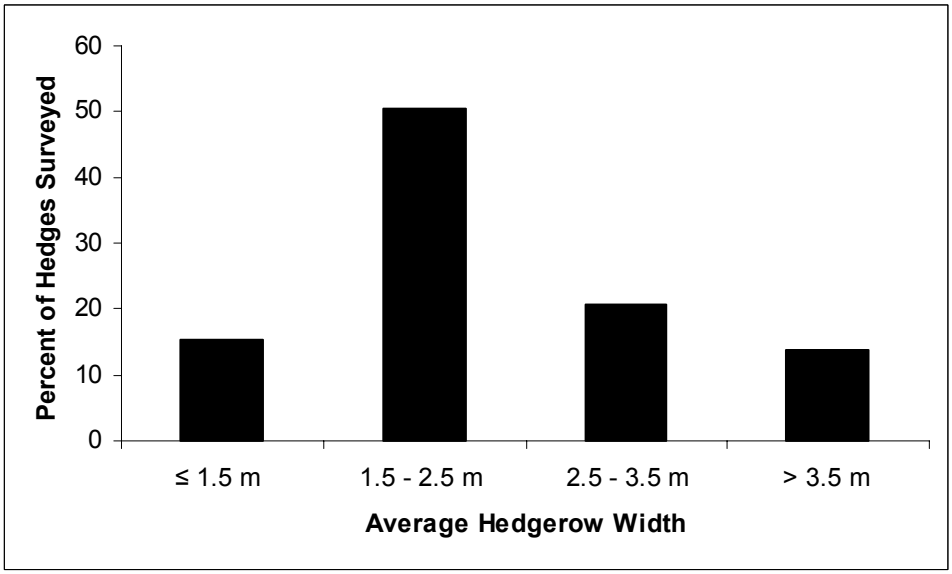


Figure 4.4.2 Hedgerow Width

4.4.4 Base Canopy Height

Figure 4.4.3 shows the breakdown of the canopy height at the base of the surveyed hedges. Lines of trees are not included in this assessment. Of these, over half of the hedges are in favourable condition, having a basal canopy height ≤ 0.5m.

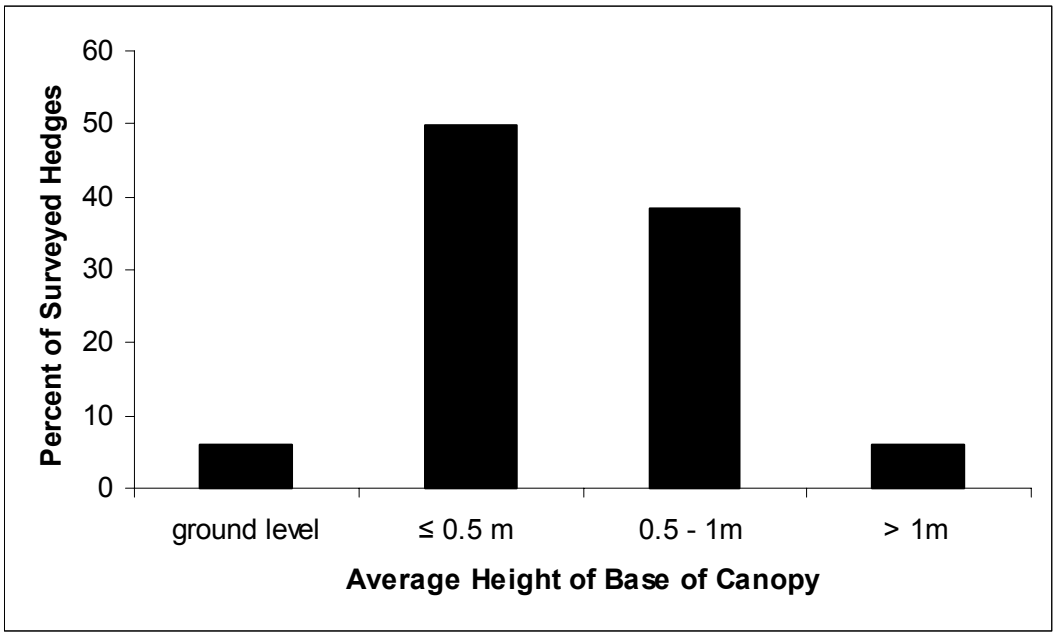


Figure 4.4.3 Height of the Canopy at the base of the hedge

4.4.5 Gaps

Gappiness is the term used for hedges with gaps greater than 10% and/or has a gap or gaps greater than 5m. Figure 4.4.4 shows the proportion of surveyed hedges in terms of the percent of gaps along the length of the hedge. The percent of hedges that contained a gap or gaps greater than five meters wide is also displayed.

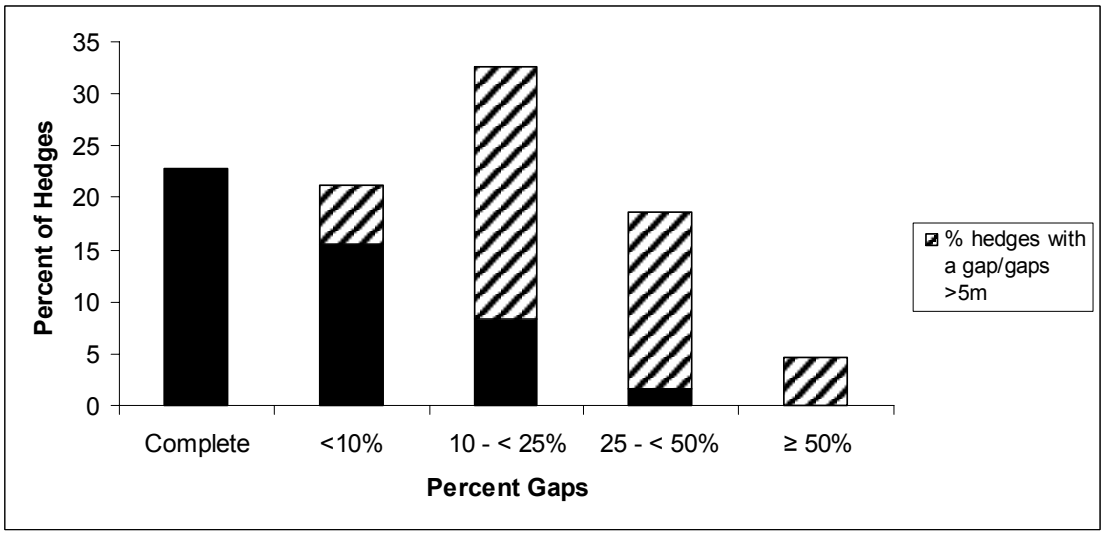


Figure 4.4.4 Proportion of hedges in different categories of gappiness. Hashed area indicates the proportion of hedges that contained a gap/gaps that were > 5m wide.

The threshold for 'favourable condition' is less than 10% gaps along the length of a hedge, and no gap/gaps greater than 5m. Less than a quarter of hedges were still intact and contained no gaps and only 21% of hedges have less than 10% gaps (of which 6% have a gap/gaps greater than 5m and therefore fail the condition assessment). Over half of the hedges surveyed were in unfavourable condition with greater than 10% gaps along the hedgerow length. Of the hedges that had greater than 10% gaps, the majority contained a gap greater that 5m in width (excluding gateways).

4.4.6 Condition of hedges

The UK BAP steering group, have produced a condition assessment which is comprised of six criteria in which the hedges needs to pass in order to be in 'favourable condition'. The six criteria are detailed in Table 4.4.1.

Figure 4.4.5 presents graphically the percent of sampled hedges within Durham passing or failing the different elements of the condition assessment. Only 17% are in overall favourable condition (i.e. passed all six criteria). Of the hedges in favourable condition, 50% are classed as species rich (i.e. have 4 or species in a 30m length).

Gappiness and canopy height at the base were the main contributing factors to hedges failing. The majority of surveyed hedges passed the herbaceous cover and recently introduced species criteria, indicating that these factors are not a significant threat to the condition of hedges within Durham.

Attribute	Threshold
Dimensions - (all of which, must be passed)	
➢ Height	**≥ 1m**
➢ Width	**≥ 1.5 m**
➢ Cross-sectional area	**> 3 m^2**
Continuity (Gappiness) – (both of which must be passed)	
➢ Total % of gaps	**< 10%**
➢ Size of gaps	**No gap >5 m**
Canopy height at the base	**≤ 0.5 m**
Undisturbed ground	**≥ 2 m**
Herbaceous vegetation cover	**≥ 1 m**
Recently introduced non-native species (both woody and herbaceous species.)	**< 10% cover**

Table 4.4.1 Criteria for Hedgerow Condition Assessment

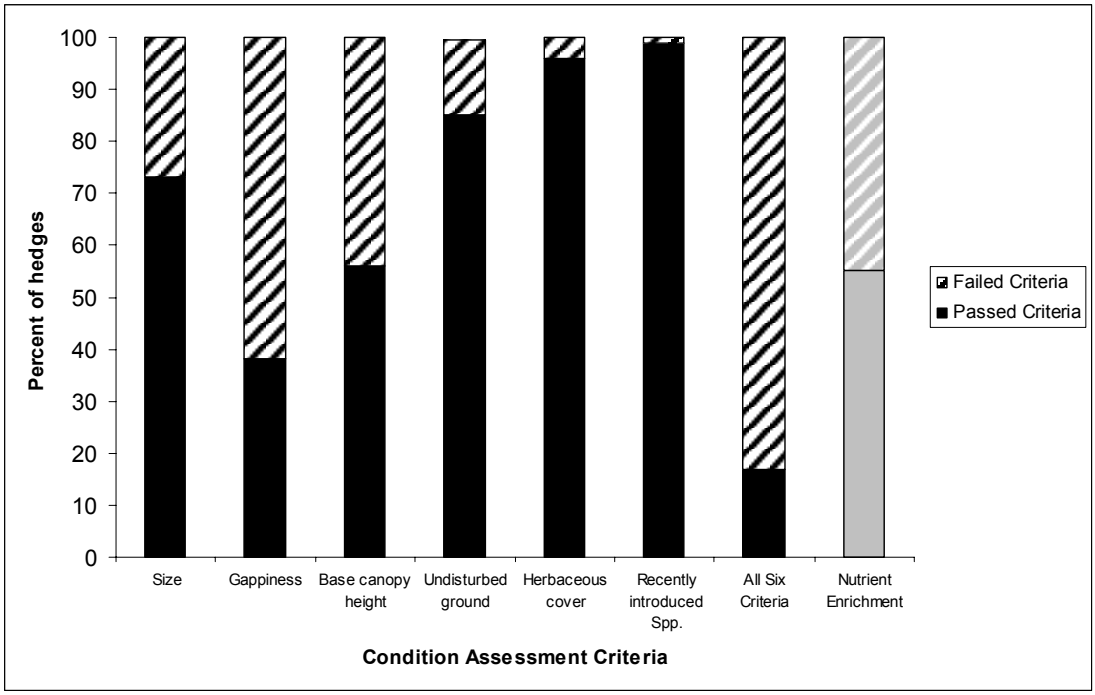


Figure 4.4.5 Condition of the surveyed hedges

Figure 4.4.5 also shows that nearly half of the hedges surveyed, have greater than 20% cover of nettles, cleavers or docks (either singly or collectively) in the hedge bottom indicating that they have been subjected to nutrient enrichment.

Figure 4.4.6 shows the hedges in agri-environmental schemes in relation to the attributes that contribute most significantly to the hedges failing the condition assessment. Only hedges wholly in agri-environmental schemes are included.

A hedge in 'favourable condition'
Photograph by Ptyxis Ecology

Although the differences are relatively small, a higher percent of hedges within the Countryside Stewardship Scheme (CSS) are in favourable condition. More hedges within CSS also passed the gappiness and base canopy height criteria.

'Favourable condition' was also looked at in relation to natural area. A few differences could be demonstrated, but it must be noted that a low number of hedges were surveyed in some natural areas. Despite this, the results showed that, no hedges in the North Pennine natural area were in favourable condition, with only 18% of the hedges having a base canopy height below 0.5m and only 27% of the hedges had less than 10% gaps. Within the Durham Magnesian Limestone, Dales fringe, Northumbria Coal Field, and Tees Lowland natural areas, 14, 17, 22, and 23% of the hedges were in favourable condition respectively. Gappiness contributed most to

hedges failing the condition assessment within the Durham Magnesian Limestone natural area.

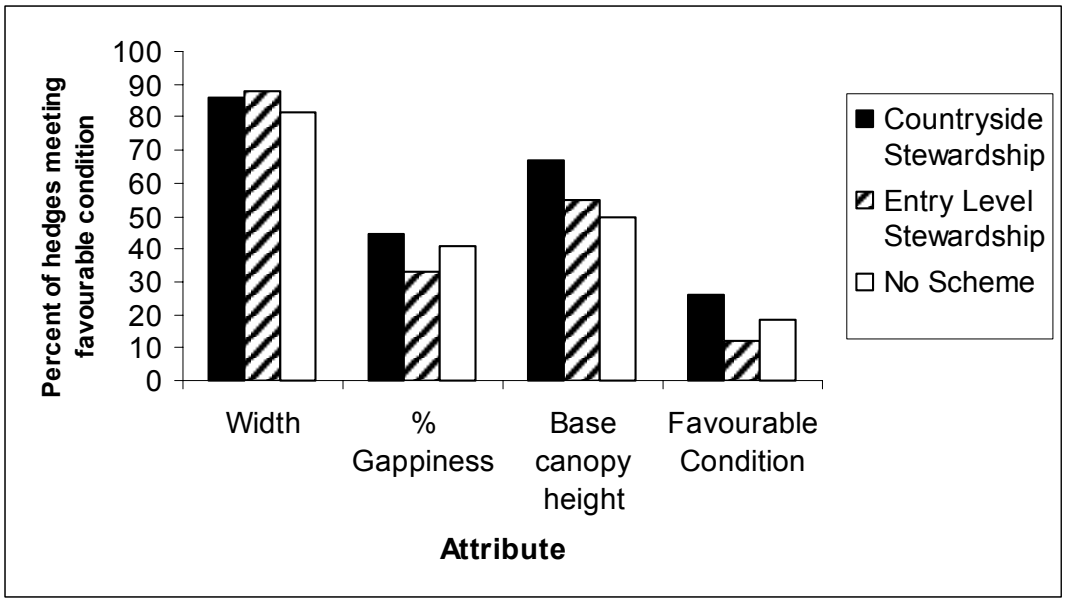


Figure 4.4.6 Percent of hedges in agri-environmental schemes in relation to certain attributes in the condition assessment. Overall favourable condition is the number of hedges that passed all six condition assessment criteria.

4.4.7 Isolated Trees

Hedgerow trees can greatly add to the landscape and wildlife value of a hedgerow. This survey looked at the abundance of isolated trees (Figure 4.4.7); a total of 270 isolated trees were recorded in the surveyed hedges, with an average of 0.75 isolated trees per 100m.

Over half of the hedges surveyed did not contain any isolated trees; approximately 30% had 1-2 trees, while only 18% had 3 or more trees.

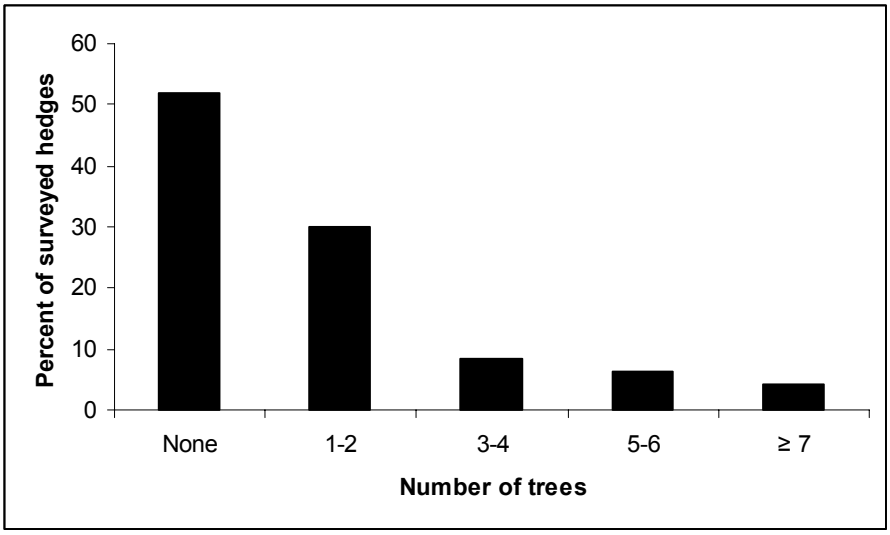


Figure 4.4.7 Proportion of hedges with isolated hedgerow trees.

Figure 4.4.8 shows the breakdown of the age classes of the isolated trees in the survey hedges. This can be used to broadly infer the age structure of the population. In the sample, approximately 12% have reached the veteran tree status (i.e. are greater than 100cm Diameter at Breast Height). Fifteen percent of the trees are classed as young trees (1-5 years old).

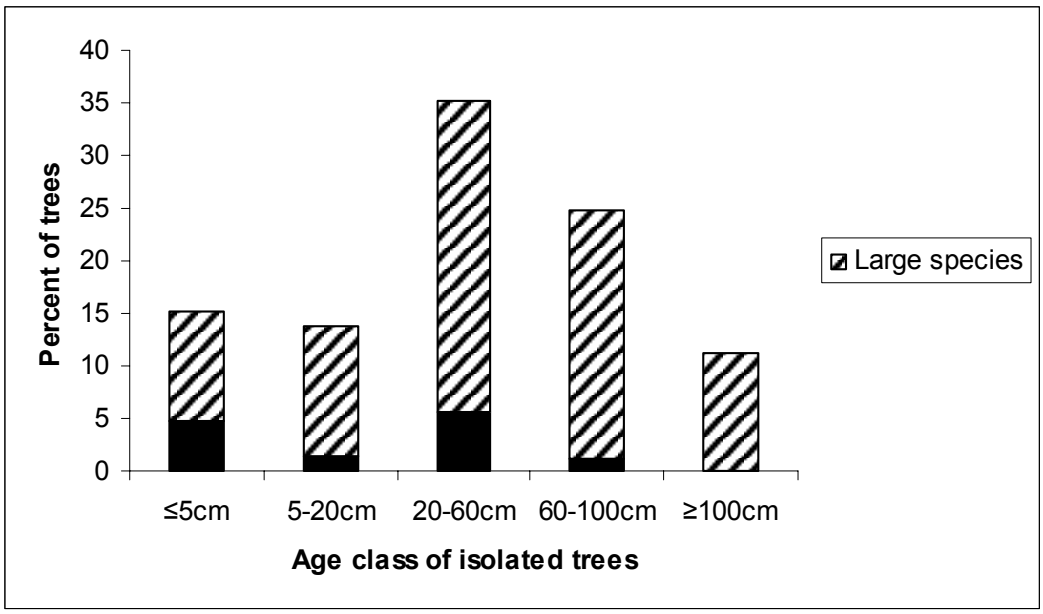


Figure 4.4.8 Size classes of isolated trees**.** Large tree species have been highlighted, this includes only the species that tend to form the large hedgerow trees; elm, oak, ash, beech and sycamore.

The number of isolated trees in Durham can be estimated, by extrapolating data from the surveyed hedges. This produces an estimate of approximately 68,000 isolated trees in Durham. The long term future of this isolated hedgerow tree population depends on young trees being recruited into the hedgerow.

The replacement rate per year is estimated by the total number of trees over 5cm DBH divided by 100 (Defra, 2007). This assumes that a 100 year period is needed to replace the number of trees larger than 5cm.

The replacement rate for the surveyed hedges is 2.29 trees per year. Therefore, in order to maintain the isolated tree population in Durham, 580 trees per year need to be recruited from the hedgerows. This is derived from the total length of hedgerow in Durham divided by survey length then multiplied by the surveyed hedges replacement rate.

4.4.8 Associated Features

Table 4.4.2 gives a detailed breakdown of the features associated with hedgerows, and Figure 4.4.9 shows graphically the percent of hedges associated with the different features.

Feature			% of hedges
Ditch	External	Wet	8
		Dry	12
		Total External	**20**
	Internal	Wet	1
		Dry	4
		Total Internal	**5**
Bank	Half Bank	Earth	21
		Stone	1
		Total Half Bank	**21**
	Full Bank	Earth	10
		Stone	1
		Total Full Bank	**11**
	Other		**4**
Wall	Good Condition		0
	Poor Condition		0
	Remnant		6
Fence	Post and Rail		13
	Post and Netting		55
	Post and Wire		13
	Other		1
Margin*			**68**

Table 4.4.2 Percent of hedges associated with different features. * this does not include road verges.

Twenty-five percent of the hedges surveyed were associated with a ditch, 33% with a bank (of which two thirds were half banks) and only 6% of hedges were associated with a wall (all of which were remnant). Overall 83% of the surveyed hedges were reinforced with additional fencing. Comparing the number of hedges with fences to

Example of a hedge that has been laid in the last 5 years and a one that has been historically laid. Photographs by Rebecca Beeston.

adjacent land use, 77% of hedges adjoining grassland had additional fencing, while only 41% of hedges next to arable land were reinforced with fencing.

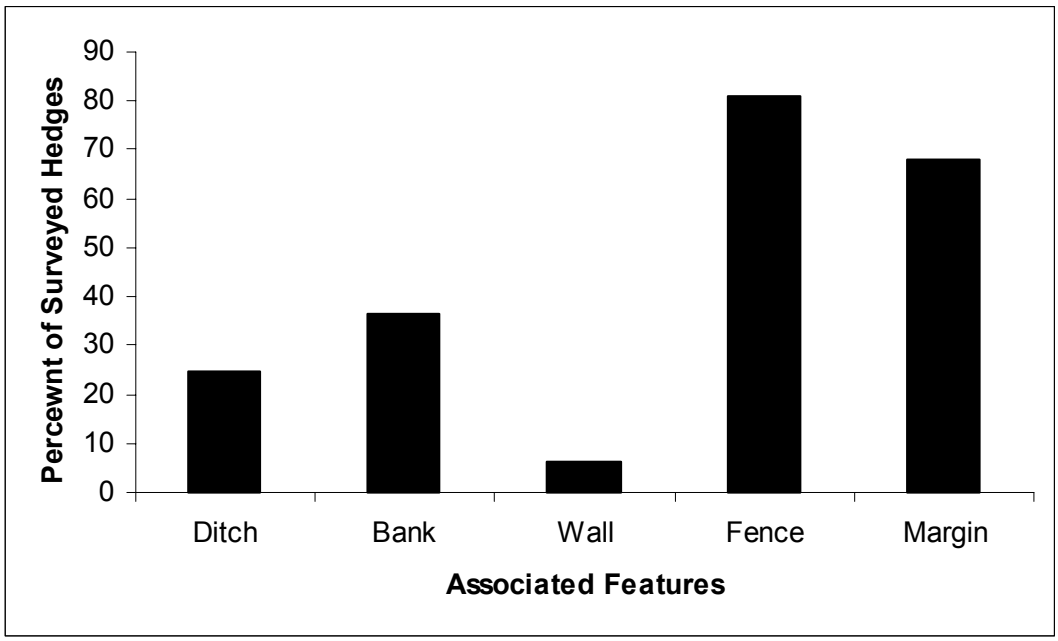


Figure 4.4.9 Proportion of hedges associated with different features (Note some hedges are associated with more that one feature).

4.5 Hedgerow Management

The general shape of a hedgerow can give a good indication of how it has been managed over the past few years. Figure 4.5.1 shows the different shapes of the survey hedges. Approximately 30% of the hedges fall in to the trimmed and dense category. A further 10% are intensively managed, indicating that they have frequently been flailed and/or browsed by high densities of livestock, while only 1% of the hedges surveyed have been laid within the past 2-3 years.

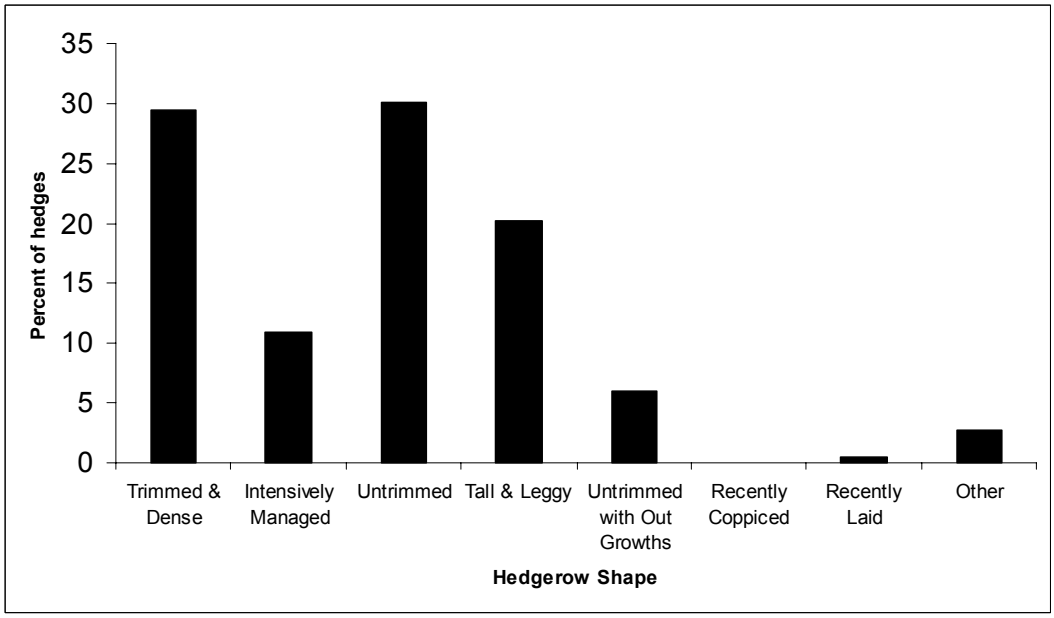


Figure 4.5.1 Proportion of hedges in each of the hedgerow management shape category. Lines of trees are not included.

Over half of the hedges were either untrimmed (not been trimmed >2 years), tall and leggy or untrimmed with outgrowths, indicating that these hedges are not being managed.

Figure 4.5.2 shows the different hedgerow management shapes in relation to natural area. Again it must be noted that some natural areas have fewer hedges surveyed. Despite this the results illustrate that within the North Pennines natural area no hedge had been intensively managed, but showed the highest percent of hedges (50%) in the unmanaged categories (tall and leggy/ untrimmed with outgrowths). Whereas in the Tees Lowland 73% of hedges were being actively managed, with 23% being intensively managed, i.e. were characteristically low and narrow and with a high basal canopy.

Figure 4.5.3 gives a breakdown of the different hedgerow management shapes in relation to agri-environmental schemes. Seventeen percent of hedges in CSS are trimmed and dense, indicating regular trimming, however by far the most frequent (over 50%) are hedges that are untrimmed, indicating they have not been trimmed in a couple of years, giving a 'straggly' appearance. Seventeen percent are unmanaged (Tall and leggy/ untrimmed with out growths). A small percent of hedges have been laid within the previous 2-3 years; no hedges in ELS or under no scheme had been laid. Hedges that were in no agri-environmental scheme have the most hedges that are intensively managed, whereas within CSS, no hedge was intensively managed.

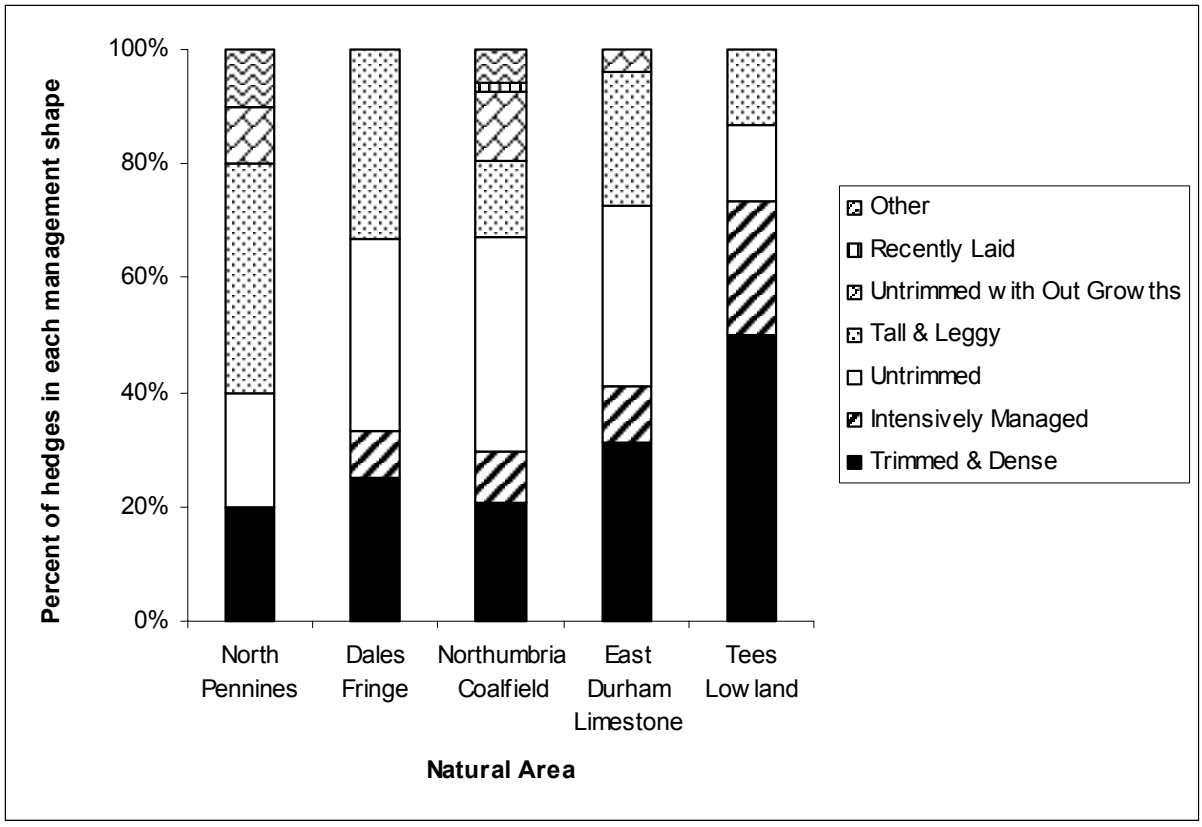


Figure 4.5.2 Hedgerow management shape in relation to natural area.

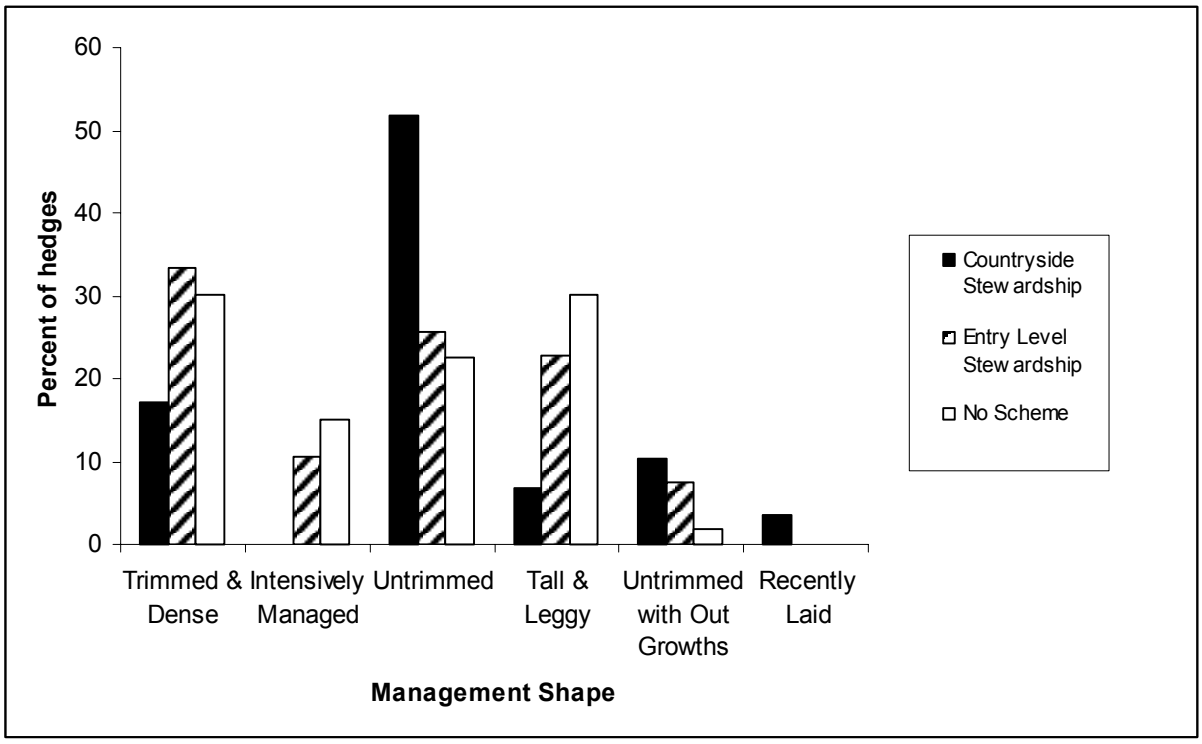


Figure 4.5.3 Hedgerow management shape in relation to agri-environmental schemes.

Figures 4.5.4 and 4.5.5 show a breakdown of the different management techniques used.

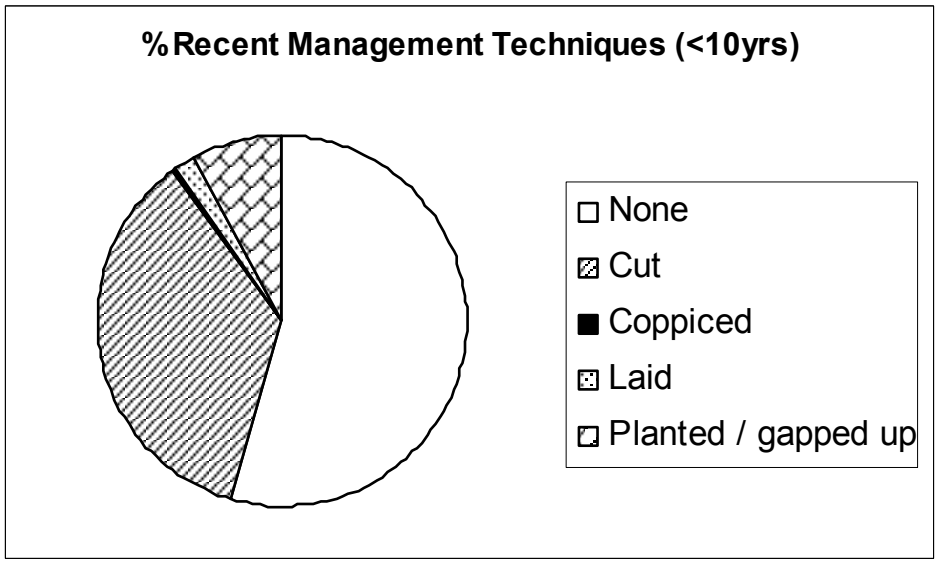


Figure 4.5.4 Breakdown of the recent (<10yrs) management techniques given as a percent

Fifty-four percent of the surveyed hedges showed no sign of management in the last 10 years. Flailing (35%) was the main management tool used in the last 10 years. Planting/gapping up was evident in 8% of hedges, while only 3% of hedges have been either coppiced or laid. In the last two years, 62% showed no signs of management, while those that had been managed, 95% had been flailed.

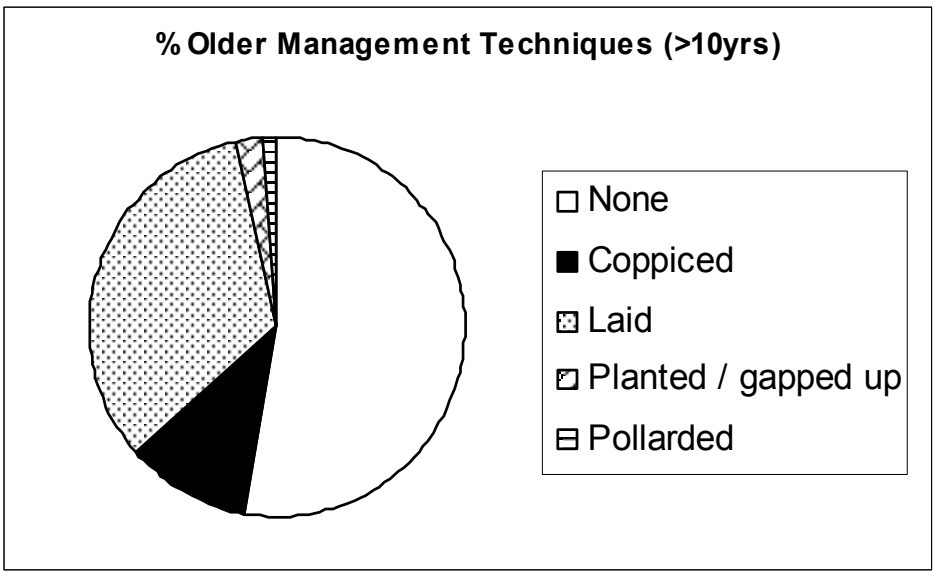


Figure 4.5.5 Breakdown of older (>10yrs) management techniques given as a percent

Older evidence (>10 years), shows that the most widely used techniques were laying (33%) and coppicing (11%), and to a lesser degree planting/gapping up (2%) and pollarding (1%). However, over 50% showed no signs of any management.

4.6 Adjacent Land Use

Adjacent land use is expressed as a percent of the total number (sides) of hedgerows in each of the adjoining land use categories. As might be anticipated nearly 70% of adjacent land use is related to intensive agriculture (arable and improved grassland), with arable being the dominant category. Grassland (semi-improved and unimproved), roads/routes and woodland contributed to 16%, 10% and 1% respectively.

Figure 4.6.1 shows the breakdown of the adjacent land use in relation to natural area. In the North Pennines, grassland (67%) is by far the most frequent adjacent land use, with no hedges bordering arable land. Both the Tees Lowland and the Durham Magnesian Limestone have a high proportion of land use related to intensive agriculture with arable and improved grassland contributing to nearly 70% of the adjoining land use.

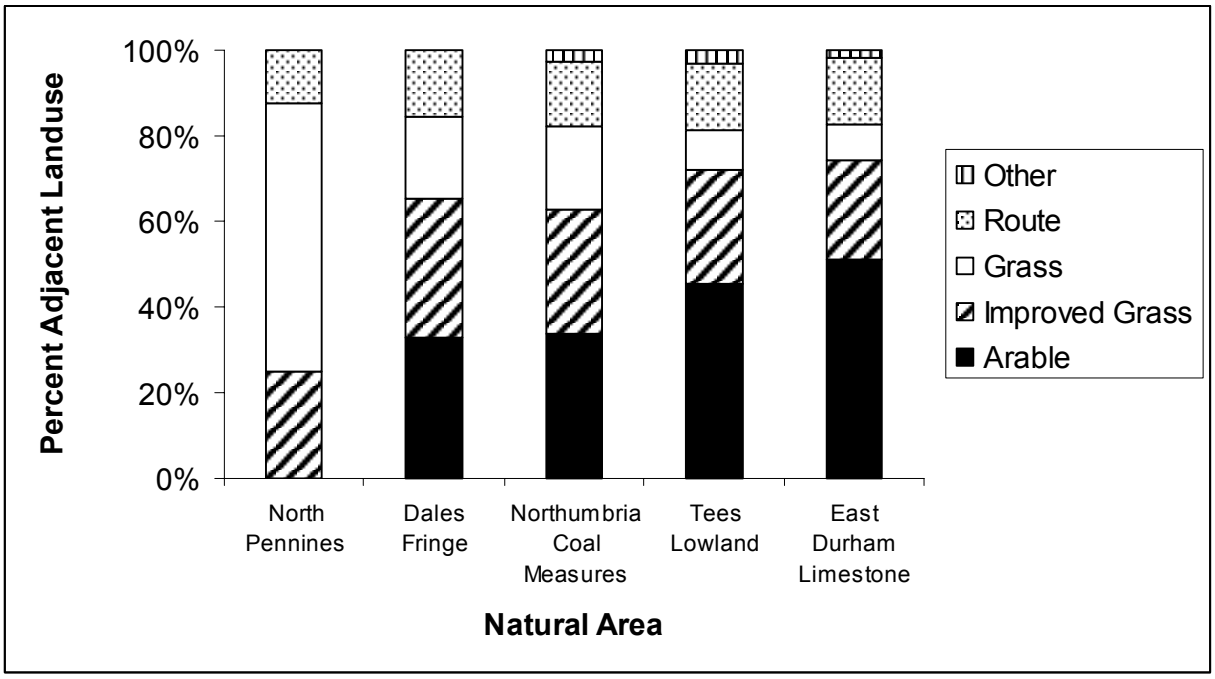


Figure 4.6.1 Adjacent Land use in relation to natural area. (Grass includes semi-improved and unimproved grassland)

5. Discussion

5.1 Assessment of the Survey Methodology

On completion of survey work, Ptyxis Ecology produced an assessment of the methodology outlined in the final draft of the Hedgerow Survey Handbook. See Appendix C. This assessment was sent to Defra in December 2006 in the hope that feedback from the Durham Hedgerow Survey could be incorporated into the new edition of the Hedgerow Survey Handbook, prior to its official launch.

5.2 Limitations of survey

At the outset, this study proposed to survey 40-50, 1km^2 by the end of October 2006. However this was largely dependent on arranging prompt access permission from landowners, but there was a huge delay in receiving vital data on landownership. This coupled with funding constraints, contributed to only 28 squares being surveyed. This initial delay meant fieldwork also continued into November.

By this point the majority of leaves had dropped off the trees and shrubs; several hedges had also been recently flailed at the time of the survey therefore, also removing the winter buds. This caused a number of issues. Firstly, the percent cover of live canopy for veteran trees could not be assessed if the tree had dropped its leaves and secondly, the surveyors found it difficult to assess which parts of the hedge (if any) were dead. A careful search was made for the presence of hips and remaining winter buds to indicate live plant material, however, it is possible that sections of dead hedge were missed and the gap condition assessment would therefore be incorrect in a small number of hedges.

In general, the identification of ground flora species was determined using vegetative parts only, although in some instances dead floral parts aided identification. In some limited cases, vegetative identification was difficult and was based on the most likely species using the surveyor's experience. In the case of rose species and hybrids, these could only be identified if ripe hips were present (in some limited cases these had been flailed or were absent).

Initially we were also concerned that data collected on ground flora would not be comparable, however due to the unseasonably mild autumn weather, ground flora surveys carried out in October are comparable to surveys carried out in mid November. However it must be noted that the Durham Hedgerow Survey will not be comparable with other local hedgerow surveys carried out during the summer months as not only would there be major differences between percent cover of many species, but some species will not have been detected during this survey.

5.3 Survey Data

Extent and Loss of Hedgerow

Durham has an extensive network of hedgerows throughout the area, with an estimated total of 9100km. Of this, 9% or 800km (± 300km) is remnant (i.e. has less

that 30% vegetation along its length). The average density of hedgerow per 'hedged' square kilometre was 6.0km/km^2. When all 1km squares (both hedged and non-hedged squares) were considered, the overall hedgerow density in Durham is 3.5km/km^2. This figure compares very favourably to figures for England, which has an overall density of 2.91km/km^2 (Barr, 1993).

In 1979, it was estimated that there was an average 6.7km/km^2 of hedgerow per 'hedged' kilometre square, producing an estimated 9600km of hedgerow within Co. Durham (Bailey, 1979). To make a meaningful comparison, present data was recalculated to include only 'hedged' squares falling within old Co. Durham (i.e. the present Co. Durham plus the District of Darlington). The definition of a hedgerow used in Bailey ('a more or less continuous line of shrubs along a field boundary') leaves some ambiguity as to whether remnant hedgerows were included. For the purpose of this comparison, remnant hedgerow has been discounted.

This produced a current estimate of 7600km (± 1550) of hedgerow for Co. Durham, giving an estimated loss of 21% (± 16%) since 1979. This would confirm that the overall decline seen in England has also been mirrored in Co. Durham. It is also reasonable to assume that this decline is reflected in the wider Durham BAP area also.

Like the national picture, a change in farming practices and an increase in urban developments will have contributed significantly to this loss. The impact of farming is varied over the survey area. In the more intensively farm areas of East Durham and the Tees Lowland hedge removal has been far more prolific than the North Pennines and Dales Fringe where neglect and abandonment of hedgerows have led to a more progressive decline. Opencast coal mining has also had a major effect on the landscape character of Durham. Since 1945, over 120km^2 of rural land has been worked for coal and it is estimated that 800km of field boundaries has been removed (DCC, 2007). Bailey (1979) suggested that at the time of the previous survey, the continued programme of open cast coal mining was the biggest threat to the hedgerow of Co. Durham, as many of the hedges were not replanted after the land was reclaimed. However, this policy has changed and hedgerows are now reinstated after reclamation.

Dog rose *Rosa Canina* in full flower in November
Photograph by Ptyxis Ecology

National figures show that between 1990 and 1998, there was no net change in the total length of hedgerow indicating that nationally, hedgerow loss has been stemmed (Haines-Young, *et al*., 2000) and it is hoped that Durham has also reflects this national picture.

A survey carried out between 1990 and 1993 (Barr *et al.*, 1994) found that outright removal of hedges accounted for approximately 0.8% per annum of the hedgerow

loss in the UK, but these losses were balanced by gains from planting of new hedges. However through the changes in hedgerow management, the number of hedges being re-classified as relict had increased, however the number of these hedges being restored was minimal and therefore not offsetting the loss of neglected hedgerows. Again, this picture is probably mirrored in Durham highlighting that loss through lack of management and neglect needs to be tackled. Although planting new hedges goes some way to offsetting the losses, it must be remembered that a new hedge can never replace the historical, wildlife and landscape value of a hedge many centuries old.

Species Composition

There was a wide range of hedgerow woody species (trees, shrubs and climbers) found within Durham, a total of 45 species in all, including seven species and hybrids of rose *Rosa*. The most common hedgerow species throughout the survey hedges was hawthorn which is not surprising as it was the favoured plant for hedging during the Enclosures and is still favoured for agricultural hedgerows today. In comparison with Bailey (1979), the top ten frequently occurring shrubby species are equivalent to those species found in the present survey.

Bailey was able to demonstrate a few variations in the distribution of species. Rowan had a marked western distribution, field maple was common in the South and East and holly appeared in most areas with the exception of East Durham on the Durham Magnesian Limestone. Data from this survey generally corresponds with this, but the numbers of hedges surveyed are too low to draw any definite conclusions from this survey. There were a few exceptions to Bailey's finding in the present study, but on closer inspection, it was found that, where species occurred out of this range, the majority were all in newly planted hedges, with the exception of two old hedges north of Sunderland on the Durham Magnesian Limestone that contained holly.

Based on Bailey's findings, the Durham Hedgerow Partnership agreed specific species mixes for each County Character Area, reflecting the composition of hedges found within these areas. However, as highlighted in this survey, some newly planted hedges contain species that are not recommended for the area. Particular mixes of shrubs and tree species contribute to the local landscape character and distinctiveness of an area, therefore better advice obviously needs to be given to landowners planting new hedges. See Appendix D for information on the recommended mixes.

Not only is the particular species mix important, but also the local provenance of the plants used. A study on the effect of provenance on the performance of hawthorn in hedges (Jones *et al.,* 2001) found that hawthorn of local provenance had greater establishment success and hence cost benefits in hedge planting. The uses of non-local provenance also lead to environmental implications; non-local provenances burst buds up to five weeks before the local provenanced plants. This change in timing and incidence of flowering and fruiting could lead to major implications on the wildlife that depends on the habitat.

This indicates how important it is to buy plants of local origin as many plants sold in nurseries, although are native species are actually grown on the continent and are in

fact a different variety to the that found in Britain. Flora locale (a registered charity) encourages, across Britain and Ireland, the wise use of wild plants for planting schemes and is an easily accessible source of advice and has produced a list of nurseries where native plants of local origin can be sourced. With this information widely available there really is no excuse to plant native species that are in fact continental varieties.

Species Richness

In terms of their woody component, 35% of the hedges sampled in Durham are classed as species rich (i.e. have four or more species per 30m section), although the overall average species richness was 3.0 species per 30m section. Using, five or more woody species to define species richness, to compare with the national statistic, 23% of Durham's hedgerows would be classed as species rich. This figure compares well with figures for Great Britain. CS2000 found that 26% of hedges sampled were considered to be species rich (Haynes-Young et al., 2000). However, it must be noted that during this survey, rose hybrids were identified, so this will have increased species richness in comparison to other hedgerow surveys elsewhere in Great Britain where this was not done.

It must also be noted that a four species hedge containing mainly hawthorn, an ash sapling, dog rose, elder and a species poor ground flora is very common in Durham and is not comparable with a truly species-rich hedgerow.

Bailey (1979) estimated the average species richness of hedges in Co. Durham to be as low as 1.75 species per hedge. There are a number of differences in the methodology; trees are not included in species richness, and *Rosa* and *Quercus* are not identified to species or hybrid level. In the present survey by recording rose species and hybrids, rather *than Rosa sp*., six more taxa were identified and these counted towards species richness. However, having made these amendments (i.e. grouping rose spp. etc) to the present data to allow a comparison, very little difference in the species richness was found, with species richness in this survey, still averaging 2.9 species per 30m hedge.

A change in planting practices today may account for the difference in species richness. Although hawthorn is still the most widely used shrub in new hedges, it is now common practise to include a variety of other shrub species to increase the species richness. In Durham the average species richness of just the newly planted hedges was 4.5 species per 30m section. However when these hedges were taken out of the dataset, the overall species richness was little affected, with an average of 2.9 species, which still does not account for the difference seen between this present survey and Bailey's survey in 1979.

Subsequent invasion and colonisation of species may have also played a role. However Bailey (1979) suggested that colonisation of hedges in Co. Durham is low. He found that hedges dating back to 1636 were still pure hawthorn after 350 years of life and attributed this lack of colonisation to the harsher climate and fewer shrub species found in Co. Durham. The occurrence of fast colonising species such as elder where compared to Bailey's figures and were found to have increased in

occurrence since 1979. However so have most other species (with the exception of hawthorn) so little or no conclusion can be drawn from this.

Frequent, over intensive flailing is detrimental to a number of species including hazel *Corylus avellana*, blackthorn, field maple *Acer campestre*, guelder rose *Viburnum opulus* and crab apple *Malus sylvestris*, while other species are more resistant (ash and hawthorn). As already mentioned, since 1979, hedges have become increasingly neglected and assuming that as a hedge becomes neglected, these species are able to re-establish, the species richness may increase. However, Garbutt and Sparks (2002) found that lack of management of hedges was as detrimental to species richness as over management. Again this does not account for the difference seen between the two surveys.

Ground flora is an important component of hedgerows and can contribute significantly to species diversity. A total of 143 species and an average of 10.3 species per 30m section of hedge found. Species composition is mainly related to adjacent land use (Mercer, *et al.,* 1999) rather than hedgerow species or the management regime of the hedge. Hedges adjoining arable land tend to have a lower number of species due the impact of agricultural operations such as herbicides and fertiliser enrichment which encourage growth of more aggressive species.

This correlation is evident in Durham, with hedges next to grassland (semi-improved and in one hedge only in this survey, unimproved) having a higher species diversity (12.9 species), than hedges adjacent to arable (average 8.5 species). Species diversity and natural area also show a strong correlation. The North Pennines, an area dominated by pastoral grasslands has the highest species diversity (14.2 species), while the Tees Lowlands, dominated by intensive agriculture has the lowest species diversity (8.25 species). Unexpectedly, the hedges within the Durham Magnesian Limestone natural area showed a low species richness (9.2 species). This is probably due to the limestone being overlaid by boulder clay deposits, but also the high proportion of hedges that adjoin intensive farmland.

Hedgerow Structure, Condition and Management

It is generally accepted that higher and wider hedges are more beneficial to wildlife and increase the biodiversity. Since the last survey, nearly 30 years ago, there has been a noticeable change in the dimensions of hedgerows. In 1979, over half of hedges were below 1.5 m high and 1.2m wide. Only *c.*15% exceeded 2m in width and height. In comparison, this survey found that nearly half of hedges exceed 2m in height and width. One of the reasons for this change in the dimensions is a change in hedgerow management.

An example of a hedge in unfavourable condition.
Photograph by Ptyxis Ecology

Hedgerows are predominantly man-made features and most require a degree of management intervention to fulfil its

ecological, historic and agricultural functions. However, only 38% of the survey hedges had been actively managed in the last 2 years (90% of which were flailed). In 1979 the reverse was true, 72% of the hedges had been clipped and only 28% showing no evidence of active management.

The shape of the hedgerow also gives an indication as to the management of the hedgerow. Only 10% of hedges in Durham were intensively managed (i.e. been closely and frequently flailed), but over half of the surveyed hedges were identified as untrimmed, tall and leggy or untrimmed with outgrowths, again indicating the lack of management and hence the dramatic change in hedgerow dimensions over the last 30 years.

Between 1984 and 1990 this pattern of decline in hedgerow management was also detected nationally, with an increase in larger and more over grown hedgerows (Barr & Gillespie, 2000). This downturn in hedgerow management comes hand in hand with the intensification and mechanisation of agriculture. This has tended to diminish the agricultural value of hedgerows, and because of this, there has been a fall in practical knowledge and skills to manage hedges appropriately. The number of people engaged in agriculture has also declined and the maintenance of hedges is not only labour intensive but an unwanted financial burden. Farmers now see fences as a much more attractive alternative (Agate, 2002).

This decline in management is leading to the increase in neglected hedgerows which, as indicated by CS2000 is now the biggest threat to hedgerow survival. CS2000 suggests that while there has been no net change in the total length of hedgerow between 1990 and 1998, numbers of hedges being reclassified as line of trees, shrubs or relict hedgerow have increased by 31% (Haines-Young, *et al*., 2000).

Although only a small percentage (10%) of hedgerows in Durham are being over-intensively managed, it may still contribute to the demise of these hedgerows. Frequent cutting damages the structure of the hedge, by inducing the loss of vigour of individual shrubs, eventually killing them and in turn leads to a gappier structure. Another problem associated with flailing is the decline in sapling being left in hedgerows to grow into mature hedgerows. CS2000 indicated that there has been a 3% national decline in the hedgerow tree population, with a 40% decline in the 1-4 year old tree category between 1990 and 1998 (Haines-Young, *et al*., 2000). Unfortunately no comparison can be made between this present survey and Bailey (1979), but again Durham is also likely to echo this decline.

By looking at the basal canopy height and percent gappiness of the hedgerow, the vertical and lateral structure of the hedge can be gauged. Nearly half of the hedges surveyed, had a base canopy height over 0.5m, and worryingly over 50% of the hedges surveyed had greater than 10% gaps indicating that the majority of hedges are in bad condition. Not only are the hedges losing their principle agricultural value as a stock proof barrier, but gaps at the base of the canopy mean shelter for invertebrates, mammals and amphibians are lost, while gaps along the length reduce the continuity and connections between habitats (Defra, 2007).

The UK BAP steering group for hedgerows have defined a number of criteria which assess the condition of a hedgerow. Only 17% of the hedges sampled in Durham

were found to be in 'favourable condition'. Gappiness, canopy height at the base, and dimensions (height, width and cross-sectional area) of the hedgerow are the main contributing factors to hedges failing the condition assessment. Most hedgerows passed the undisturbed ground and perennial herbaceous vegetation element of the condition assessment, indicating that the new measures brought in as part of the Common Agricultural Policy (CAP) cross compliance and agri-environmental schemes, are having a positive effect.

Allowing hedges to grow to the specific height/width easily rectifies hedges that are failing due to dimensions, however, gappy hedges and those with a high canopy base will require a more active intervention (i.e. laying, coppicing and planting of gaps) to bring then into favourable condition.

Only 3% of hedges in the last 10 years showed signs of having been laid or coppiced. This figure needs to be increased significantly if hedgerow length and condition is not going to decline any further. Encouragingly, 12% of the surveyed hedges showed evidence of being gapped up; at least in some hedges the problem of gappiness is being tackled. But in 25% of these hedges, the saplings had failed; lack of aftercare and browsing being the main contributing factors. To prevent saplings failing and in effect the waste of time, money and effort, appropriate aftercare of newly planted hedgerows needs to be stressed by advisory bodies.

Planting locally native provenance stock may also have potential for increasing efficiency of establishment and performance of hedges, especially in the more extreme climates of the uplands or under high levels of grazing (Jones *at al*., 2001).

Hedges in agri-environmental schemes were compared to the main attributes that contribute most significantly to a hedge being in favourable condition. Although the difference is small, the results illustrate that a higher percent of hedges within the CSS were in favourable condition. More hedges also passed the percent gappiness and base canopy height compared to hedges in the ELS or those in no agri-environmental scheme. As part of the CSS, farmers received payments to manage hedges across a given holding, by trimming no more than twice in five years and capital grants for the restoration and planting of hedgerows were also available. This has obviously had a positive effect on the hedges in Durham, this scheme however has been replaced by the Environmental Stewardship (ES) and although it is early days, fewer hedges in the Entry Level Scheme were found to be in favourable condition.

Berries are an important food source for birds
Photograph by Ptyxis Ecology

ELS promotes the sympathetic management of hedgerows. Farms entering into the basic ELS options are committing to manage hedgerows on a two year rotation, cutting to pre-defined dimensions (1.5m tall), outside the bird breeding season, as

well as establishing a 2m wide, uncultivated strip adjacent to the hedge. The enhanced hedgerow management option goes further and commits the land manager to trimming no more than every three years and to increase the hedge height to 2m in height. By using these prescriptions not only will this go some way to resolving the problem of over managed hedges and bring other under managed hedges back into management, it will benefit wildlife, by provide a diversity of different habitats and food resources. However, these general management prescriptions do not go far enough in tackling the problems of base canopy height and hedgerow continuity. Capital grants for hedge laying, coppicing or planting/gapping up are only available to farms in the Higher Level Scheme (HLS); they are not available under ELS. However, capital payments within HLS are only available when hedgerows are part of the targeting statement for the joint character areas. Worryingly, in Durham none of the targeting statements includes hedgerows on landscape grounds and capital hedgerow work can only be included in HLS agreements for the benefits of tree sparrows. To date only a handful of farms within Durham are in the HLS and are carrying out new planting and restoration of hedgerows.

To ensure the long term viability, hedges need to be rejuvenated by promoting vigorous re-growth from the base through a combination of laying and coppicing where practicable as a priority, combined with inter-planting if appropriate and as a second choice (as planting is less likely to be successful for hedge rejuvenation and risks accidental introduction of non-native species, varieties or genotypes. However laying and coppicing remains too much of a rarity. To tackle the problem of neglected hedges (especially in the North Pennines where many hedges are now a gnarled line of hawthorn trees), hedge rejuvenation needs to be introduced as a routine part of agri-environmental schemes. Without financial assistance farmers do not have the resources to carry out this much needed work. This highlights how important the work of Durham Hedgerow Partnership is in promoting the protection, restoration and management of Durham Hedgerows.

Comparison to the local biodiversity action plan (BAP)

The information collected from this survey will be used as a baseline to monitor local progress. However, one of the aims of the study was to assess whether the current (2000 – 2006) targets are being met and help Durham Biodiversity Partnership set revised targets in the Durham BAP.

- *Target 1: Halt the loss of ancient/species rich hedgerow in the action plan area.*
- *Target 3: Maintain the extent and quality of the hedgerow habitat*
- *Target 4: Create new hedgerows at a level which will at least match the loss of existing hedgerow*

Until a repeat survey is carried out, it cannot be fully determined if these targets are being met. However nationally, hedgerow loss seems to have been stemmed and any losses from outright removal are being balanced by gains from planting of new hedges.

Hopefully this has also been mirrored in Durham; the restoration and planting of new hedges through agri-environmental schemes and grants (such as the Hedgerow Restoration Grant, offered by Durham Hedgerow Partnership), have been very important in encouraging work on hedgerows and hopefully these have gone someway to offsetting current losses. The Hedgerow Restoration Grant supports the restoration, planting and management of individual hedges, and unlike the whole-farm-based agri-environmental schemes, applicants can receive funds solely for hedgerow work. However, funds tend to be capped at relatively low levels per applicant. Since the establishment of the Durham Hedgerow Partnership grant in 2000, approximately 51km of new hedge has been planted and 27km has been restored.

However, there have also been indications that changes in hedgerow management, are leading to an increase in neglected hedges. Unfortunately, national figures show that the number of these hedges being restored is minimal and therefore leading to increasing number of hedges being classed as relict. In Durham, this picture is also evident with hedges becoming increasingly neglected. The quality of hedges is deteriorating, with many hedges showing poor signs of continuity and integrity and this is likely, still to be contributing to a progressive loss of hedgerows in Durham.

- *Target 2: Achieve the favourable management of 25% of existing ancient/species rich hedges by 2003 and 50% by 2008*

Unfortunately, only 17% of Durham's hedges are in favourable condition (of which only, half are species rich). However all the criteria in the condition assessment can be influenced by management, leaving the potential for hedges to be brought back into favourable condition with the use of sympathetic management and restoration.

- *Target 5: Maintain overall numbers of hedgerow trees at least at current levels and ensure a balanced age structure.*

In Durham there are an estimated 68,000 isolated trees. However the long term future of this isolated tree population depends on young trees being recruited into the hedgerow. To maintain this population, approximately 580 isolated trees per year need to be recruited to reach the local BAP target of maintaining the number and age profile of the isolated trees. As this survey has provided the baseline data, a repeat survey will determine if this target is being met.

6. Recommended Actions

From this report a number of issues have be identified.

- **There is a gap in current funding for hedgerow restoration works.**

  Priorities for action include:

  - advising the Government on the need for increased financial support for hedgerow management and particularly restoration;
  - continuing to support the County Durham Hedgerow Partnership Field Boundary Restoration Grant.

- **A high proportion of Durham's hedges are in poor condition arising from neglect.**

  Priorities for action include:

  - securing a substantial increase in funding for hedgerow restoration works;
  - continuing to provide advice and training on hedgerow restoration through the County Durham Hedgerow Partnership;
  - targeting existing funding at hedgerow restoration to ensure the long term viability and rejuvenation of hedges, through a combination of laying and coppicing (combined with inter-planting where appropriate) rather than the planting of new hedges where resources are limited;
  - targeting funding more closely; priorities should include works which maintain hedges of particular wildlife, landscape, historical or wildlife value and those which contribute most to habitat connectivity at a landscape-scale;
  - targeting funding of new planting at the restoration of relict or former hedgerow boundaries (rather than the creation of entirely new hedges) and at those which contribute most to habitat connectivity.

- **A number of hedgerows are in poor condition arising from over-zealous mechanical trimming.**

  Priorities for action include:

  - promoting the use of sympathetic trimming techniques on intensively managed hedges (i.e. cutting less frequently, on rotation and allowing the hedge to grow wider/higher);
  - continuing to provide advice and training through the County Durham Hedgerow Partnership;
  - promoting the uptake of Entry Level Environmental Stewardship;
  - supporting the adoption of environmental modules in hedgerow management qualifications such as NPTC Certificates of Competence;
  - promoting the use of suitably qualified personnel in managing hedges.

- **There is a lack of recruitment of young hedgerow trees to replace a declining, and at times poorly-managed, mature stock.**

  Priorities for action include:

  - promoting the planting of native hedgerow trees that are of local origin;
  - encouraging the retention of native hedgerow trees by the tagging of saplings;
  - providing advice on the management of mature and veteran hedgerow trees.

- **There are some idiosyncrasies in the species composition of newly planted hedges.**

  Priorities for action include:

  - Increasing the awareness and education about the risks of accidental introduction of non-native species, varieties and genotypes;
  - promoting the use of native plant material of local provenance (i.e. guaranteed as cultivated from British as opposed to continental wild stock) or the appropriate Forestry Commission Seed Zone;
  - promoting the adoption of the County Durham Hedgerow Partnership's recommended planting mixes for different Countryside Character Areas.

- **The findings of the report are limited in their accuracy by the relatively small sample size.**

  Priorities for action include:

  - undertaking further surveys to increase the number of hedges surveyed in each of the natural areas;
  - undertaking repeat surveys using a compatible methodology at regular intervals to monitor changes in the extent and condition of the hedgerow resource.

7. Conclusion

This survey has been successful in determining the extent, composition, structure, condition and variations in Durham's Hedgerows and the information gathered will provide the baseline in which the local BAP partnership can revise their targets for hedgerows.

Large proportions of Durham's hedgerows are in poor condition and are vulnerable to further decline due to neglect and lack of suitable management. To ensure the long term viability, hedges need to be rejuvenated by promoting vigorous re-growth from the base through a combination of laying, coppicing, and inter-planting where appropriate. Through advice, training and the promotion of sympathetic management and restoration regimes, there is the potential for many hedges to be brought back into favourable condition.

However, as agricultural has become more intensive, the agricultural values of hedgerows are diminishing. Hedgerow management is no longer a priority, even to livestock farmers as it is not only labour intensive but an unwanted financial burden. Without the financial assistance through agri-environmental schemes and grants, these much needed traditional practices of laying, coppicing and inter-planting are unlikely to be carried out.

Therefore the problems of the deteriorating quality of the hedgerow resource within Durham will continue if there is not increased financial support for hedgerow management and particularly restoration. This highlights how important the work of Durham Hedgerow Partnership is in promoting the protection, restoration and management of Durham's hedgerows and especially the financial incentives given in the form of the field restoration grant.

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Further Information

- **Survey Methodology**

A copy of Defra's Hedgerow Survey Handbook which includes the methodology for local hedgerow surveys can be obtained from:

http://www.defra.gov.uk/farm/environment/landscape/pdf/hedgerow-survey-handbook.pdf

- **Financial Assistance**

Durham Hedgerow Restoration Grant

The grant is administered by Durham County Council, Durham Biodiversity Partnership and Tyne Tees FWAG. To obtain further information contact one of the following Project Officers:

County Durham	Gateshead, South Tyneside, Sunderland, Darlington	All Areas
Simon Chivers The Landscape Section Environment Durham County Council County Hall Durham DH1 5UQ Tel: 0191 383 3426 Email: landscape@durham.gov.uk	Andy Lees Durham Biodiversity Partnership Durham Wildlife Trust Rainton Meadows Houghton-le-Spring Durham DH4 6TU Tel: 0191 584 3112 Email: andylees@durhambiodiversity.org.uk	Jennie Stafford Tyne Tees FWAG Enterprise House Harmire Business Park Barnard Castle DL12 8XT Tel: 01833 696634 Email: tynetees@fwag.org.uk

Further information on the Grant can also be found on the County Durham Website (www.durham.gov.uk)

Environmental Stewardship Scheme

The Environmental Stewardship Scheme is now administered by Natural England and the contact details for the North East is:

Natural England
Customer Support Unit
PO Box 578
Newcastle upon Tyne
NE15 8WW
Tel: 0845 6024097
Fax: 0191 229 5508
Email: BDCNE.Genesis@naturalengland.org.uk

- **Information on native hedgerow species of local provenance**

Flora Locale

Flora locale aims to promote the wise use of native wild plants for planting schemes that have local origin.

www.floralocale.org

Appendix

Appendix A: Amendments to the Hedgerow Survey Handbook methodology

Part A – Section 3: Hedgerow type

- Planted lines of trees that form a boundary (or part of a boundary) are surveyed (although lines of trees are not included where obviously planted as a decorative feature along a dry stone wall).

Part A - Section 4: Hedge length

- Hedge length was measured using GIS (to the nearest 1m, instead of to the nearest 5m), and not in the field.

Part A – Section 10: % cover nettles/cleavers/docks

- Data was collected in respect of the 30m section only but *Rumex sanguineus* (wood dock) was excluded as it is not an indicator of significant nutrient enrichment in County Durham.

Part A – Section 13: Dimensions

- Three measurements to the nearest 25cm taken along the length of the hedge using a 2m pole marked with 25cm divisions. The mode of these 3 measurements was recorded.
- Hedge width was not estimated by measuring from the centre, as many hedges are lopsided.
- Hedge height excludes shoots of this year's growth – i.e. excludes the sparse, straggly bits sticking up above the main dense body of the hedge. This only applies to trimmed hedges.

Part A – Section 14: Integrity

- Where a hedge had gaps throughout, a 30m section was still surveyed and condition assessment completed where there was no alternative non-gappy hedge to survey.
- The % cover of the gaps in the 30m section were recorded to the nearest 1%.
- Gap measurements were to the nearest 0.5m.

Part A – Section 17: Woody Species

- The % cover of the woody species in the 30m section was recorded to the nearest 5%. (Where the field surveyors indicated a species was <5% cover, this data was imputed as 1% in the access database).
- Where any gaps are unavoidably present in the 30m section, these are recorded to the nearest 1%.
- Where a hedge is recorded as a line of trees and there is a gap in the canopy between every tree, the 30m-condition assessment was not conducted.

Part B – Section 19: Width of margins

- The mode was assessed visually and 3 measurements to the nearest 25cm taken along the length of the hedge using a 2m pole marked with 25cm divisions. The mode of these 3 measurements was recorded. However, if it was clear on visual assessment that the margin was more or less constant throughout the hedge length, only one measurement was taken.

Part B – Section 20: Ground Flora Species Per 30m

- Where a 2 x 1m quadrat could not be fitted in because ground vegetation changed dramatically after 0.5m width, the quadrat shape was altered to 0.5 x 4m. This only occurred where adjacent land use was pasture and there was a fence along the hedge edge, resulting in totally different vegetation on the field side of the fence which showed no influence of the hedge. In all other circumstances, where field vegetation was clearly influenced by the hedge, a 2 x 1m quadrat was located 0.5m on each side of the fence.
- Where a quadrat designated as 'under the canopy' fell in area of a gap (where the 30m section had unavoidable gaps), then the quadrat was moved to the nearest non-gappy area.
- Dead plant remains were not included in % cover for a species.
- Woody species such as ivy (*Hedera helix)*, bramble (*Rubus fruticosus)* agg. and rose *Rosa* species were included in the ground flora quadrats where these species were growing procumbent along the ground.

Appendix B: Ground Flora Species Occurrence

Species		No. of records	Percent Occurrence
Cleavers	Galium aparine	137	71
Couch	Elytrigia repens	133	69
Bryophytes	Bryophytes	123	64
Nettle	Urtica dioica	123	64
Cocksfoot	Dactylis glomerata	115	60
Creeping bent grass	Agrostis stolonifera	95	49
Red fescue	Festuca rubra	73	38
Perennial ryegrass	Lolium perenne	65	34
Cow parsley	Anthriscus sylvestris	62	32
False oat grass	Arrhenatherum elatius	61	32
Creeping thistle	Cirsium arvense	58	30
Blackberry	Rubus fruticosus	51	26
Annual Meadow Grass	Poa annua	49	25
Yorkshire fog	Holcus lanatus	45	23
Creeping soft grass	Holcus mollis	42	22
Creeping buttercup	Ranunculus repens	38	20
Dandelion	Taraxacum officinale	34	18
Hogweed	Heracleum sphondylium	31	16
Chickweed	Stellaria media	30	16
Bush vetch	Vicia sepium	28	15
White Clover	Trifolium repens	23	12
Rough meadow grass	Poa trivialis	23	12
Barren brome	Anisantha sterilis	21	11
Mouse-ear chickweed	Cerastium fontanum	21	11
Common bent	Agrostis capillaris	20	10
White dead-nettle	Lamium album	18	9
Garlic mustard	Alliaria petiolata	18	9
Great stitchwort	Stellaria holostea	18	9
Ivy	Hedera helix	18	9
Hedge Woundwort	Stachys sylvatica	17	9
Common Sorrel	Rumex acetosa	15	8
Broad leaved-dock	Rumex obtusifolius	14	7
Germander speedwell	Veronica chamaedrys	13	7
Crested dog's tail	Cynosurus cristatus	13	7
Tufted hair grass	Deschampsia cespitosa	12	6
Timothy	Phleum pratense	12	6
Horsetail	Equisetum arvense	11	6
Bracken	Pteridium aquilinum	11	6
Smooth Meadow Grass	Poa pratensis	11	6
Yarrow	Achillea millefolium	11	6
Herb Robert	Geranium robertianum	10	5
Herb bennet	Geum urbanum	9	5
Dove's foot Cranesbill	Geranium molle	9	5
Meadowsweet	Filipendula ulmaria	8	4
Meadow vetchling	Lathyrus pratensis	8	4
Nipplewort	Lapsana communis	7	4
Italian ryegrass	Lolium multiflorum	7	4
Spear Thistle	Cirsium vulgare	7	4
Common Rush	Juncus effusus	6	3
Tufted Vetch	Vicia cracca	6	3
Dog Violet	Viola riviniana	6	3

Creeping cinquefoil	Potentilla reptans	6	3
Crosswort	Cruciata laevipes	5	3
Foxglove	Digitalis purpurea	5	3
Tall fescue	Festuca arundinacea	5	3
Blackthorn	Prunus spinosa	5	3
Groundsel	Senecio vulgaris	5	3
Ribwort Plantain	Plantago lanceolata	5	3
Soft Brome	Bromus hordeaceus	4	2
Water avens	Geum rivale	4	2
Wood dock	Rumex sanguineus	4	2
Upright hedge parsley	Torilis japonica	4	2
Wheat	Triticum aestivum	4	2
Hedge Bedstraw	Galium mollugo	4	2
Ground Elder	Aegopodium podagraria	3	2
Shepherd's purse	Capsella bursa-pastoris	3	2
Wavy bittercress	Cardamine flexuosa	3	2
Indian Balsam	Impatiens glandulifera	3	2
Spreading meadow grass	Poa humilis	3	2
Barren strawberry	Potentilla sterilis	3	2
Rose spp.	Rosa spp.	3	2
Prickle sow-thistle	Sonchus asper	3	2
Lesser stitchwort	Stellaria graminea	3	2
Zigzag clover	Trifolium medium	3	2
Scentless mayweed	Tripleurospermum inodorum	3	2
Red Campion	Silene dioica	3	2
Creeping knapweed	Centaurea nigra	3	2
Lesser burdock	Arctium minus	2	1
Daisy	Bellis perennis	2	1
Oil seed rape	Brassica napus oleifera	2	1
Gaulcous sedge	Carex flacca	2	1
Fireweed	Chamerion angustifolium	2	1
Smooth Hawksbeard	Crepis capillaris	2	1
Great willow herb	Epilobium hirsutum	2	1
Red Dead-nettle	Lamium purpureum	2	1
Raspberry	Rubus idaeus	2	1
Smooth sow-thistle	Sonchus oleraceus	2	1
Vetch spp.	Vicia spp.	2	1
Bent	Agrostis	2	1
Red Clover	Trifolium pratense	2	1
Curled Dock	Rumex crispus	2	1
Gorse	Ulex europaeus	2	1
Male fern	Dryopteris filix-mas	2	1
Agrimony	Agrimonia eupatoria	1	1
Velvet bent	Agrostis canina	1	1
Bugle	Ajuga reptans	1	1
Wild oats	Avena fatua	1	1
Silver birch sapling	Betula pendula	1	1
False Brome	Brachypodium sylvaticum	1	1
Harebell	Campanula rotundifolia	1	1
Cuckoo flower	Cardamine pratensis	1	1
Heath grass	Danthonia decumbens	1	1
Sheeps fescue	Festuca ovina	1	1
Meadow fescue	Festuca pratensis	1	1
Wild strawberry	Fragaria vesca	1	1

Avens spp.	Geum spp.	1	1
Downey Oat Grass	Helictotrichon pubescens	1	1
Autumn Hawkbit	Leontodon autumnalis	1	1
Honey Suckle	Lonicera periclymenum	1	1
Dogs Mercury	Mercurialis perennis	1	1
Mat Grass	Nardus stricta	1	1
Hoary Plantain	Plantago media	1	1
Self heal	Prunella vulgaris	1	1
Salt marsh grass	Puccinellia distans distans	1	1
Meadow Buttercup	Ranunculus acris	1	1
Gooseberry	Ribes uva-crispa	1	1
Soft Downey Rose	Rosa mollis	1	1
Dock spp.	Rumex spp.	1	1
Dock hybrid	Rumex x pratensis	1	1
Salad Burnet	Sanguisorba minor	1	1
Great Burnet	Sanguisorba officinalis	1	1
Perennial Sow-thistle	Sonchus arvensis	1	1
Betony	Stachys officinalis	1	1
Devilsbit Scabious	Succisa pratensis	1	1
Brooklime	Veronica beccabunga	1	1
Common Vetch	Vicia sativa	1	1
Field Pansy	Viola arvensis	1	1
Ash seedling	Fraxinus excelsior	1	1
Heath Bedstraw	Galium saxatile	1	1
Bluebell	Hyacinthoides non-scripta	1	1
Cut leaved Cranesbill	Geranium dissectum	1	1
Elder seedling	Sambucus nigra	1	1
Field forget-me-not	Myosotis arvensis	1	1
Hawthorn	Crataegus monogyna	1	1
Lords and ladies	Arum maculatum	1	1
Meadow foxtail	Alopecurus pratensis	1	1
Oak seedlong	Quercus robur	1	1
Primrose	Primula vulgaris	1	1
Ragwort	Senecio jacobaea	1	1
Sweet vernal grass	Anthoxanthum odoratum	1	1
Violet spp.	Viola spp.	1	1
Willow seedling	Salix	1	1
Yellow Oat Grass	Trisetum flavescens	1	1

Species highlighted are those that are common indicators of ancient woodland due to their slow rate of colonisation.

Appendix C: Assessment of hedgerow survey methodology produced by Ptyxis Ecology on completion of the fieldwork for the Durham Hedgerow Survey.

Introduction

Further to survey work for the Durham Hedgerow Survey 2006 using the new methodology published in the Hedgerow Survey Handbook (Defra, 2007), this document presents comments and suggestions on the new methodology.

General

There should be some flexibility in the methodology to allow an experienced surveyor to give an opinion on the nature conservation value of the hedge. If necessary, for large county-wide surveys, this data could be collected in a structured way (e.g. by ranking the value of different aspects of the hedge from 1 to 5).

Differences of approach for small surveys and large surveys

For large county-wide surveys, in order to get best value for money, the data needs to be collected in the most efficient way. In several places in the handbook there are two options in how certain sections are approached and guidance is given on which approach might be more appropriate for small or large surveys. It would be helpful if this guidance was given in stronger language, so that people organising large surveys feel comfortable that adopting the less time-consuming approach will still result in valid data being collected. See 'surveying one or both sides of the hedge' and 'sections 7-16' below.

Design of form

The survey form seems to have been designed more for ease of data entry in the office rather than for recording in the field, separating the 'essential' and 'optional' data. In the field the surveyor has to record data on certain attributes in different parts of the form, e.g.:

- margins in sections 7a, 9a, 9b and 19c
- banks in sections 8a and 18a
- fences in sections 8c and 18c
- ditches in sections 8d-g and 18b

This increases the risk of forgetting to fill certain section in. It would be better to design the form in a more logical order for recording in the field as it is awkward filling in the form as it is. Two possible solutions:

- Present the questions in a logical order but with the 'optional data' highlighted in some way, e.g. shaded
- Simplify the system by having all the data as 'essential'. The optional data does not require a great deal more time to collect,

Defining a species-rich hedge

A hedge in Northern England with 95% hawthorn, 5% elder, 1 ash sapling, 1 dog-rose and a species-poor ground flora would be classed as BAP habitat if the handbook/BAP definition was followed rigidly. This type of hedge is very common and is not comparable with a truly ancient or species-rich hedgerow.

In many cases the ground flora is much more useful in deciding whether the hedge is quality habitat or not. Ground flora should be an 'essential' part of the survey rather than 'optional'. To determine the quality of hedges in a large area (e.g. a county) following a survey, large volumes of ground flora data could be analysed quickly based on numbers of positive and negative indicator species.

We suspect that ground flora was made optional in an effort to simplify the methodology and make it more accessible to a wider range of potential surveyors. While this is a laudable aim, involving non-qualified people could be achieved in other useful ways that do not compromise the usefulness of the data. Standards methods in common usage to assess other BAP habitats all require a minimum level of botanical survey which involves identifying the plant community to at least a basic level. If we are aiming to gather valid data on habitat quality of hedges, it is difficult to think of a valid reason why hedges should be treated any differently from other BAP habitats.

Surveying one or both sides of a hedge
For a large county-wide survey, data collected from just one side of a hedge is valid providing the sampling strategy is sound. There is no advantage in collecting any data from the other side of the hedge. Surveying both sides can be very time-consuming as it is often impossible to cross from one side to another without travelling some distance or climbing barbed-wire fences. It could be made more explicit in the handbook that surveying both sides is not always necessary or useful.

Assessing margins
Sections 9a, 9b and 19c all ask the surveyor to measure the width of slight variations of the same thing. This seems overly-complicated.

Selecting the 30m survey section
In the handbook, to choose the starting end for each hedge, the surveyor is instructed to choose the nearest and furthest side alternately. This is an unnecessary complication. There is no statistical bias involved if the end closest to the selection point is chosen every time.

Measuring 30m lengths
To be accurate, measuring with a tape really requires 2 people (especially with cattle in the field!). A quick alternative method (for one surveyor) is to use a 2m length of pipe and lay it out 15 times consecutively.

Locating the 30m length
There are some conflicting instructions on this in the handbook. The instruction is to choose 30m sections without any gaps. With large county-wide surveys data on sections 7 to 16 can be collected in the 30m section rather than the whole hedge. With this bias in selecting 30m sections that are the woodiest parts of the hedges, the data on gappiness of the hedgerow resource will be an underestimate and the data

on species-richness of the woody component will be overestimated. It would be simpler and more statistically accurate to just follow the instruction for selecting the 30m section on p29 of the handbook.

Marking 30m lengths and quadrats permanently
Permanent quadrats are generally overused (and often not useful) in surveying and monitoring. Providing the overall sampling strategy is sound, and the sample size is large enough, there is no advantage in using them for a county-wide survey. They may be of more use for monitoring individual hedges. The handbook should discourage their use or else outline the particular situations when permanent quadrats are necessary, otherwise people organising surveys that have only some knowledge of the subject tend to think they should be used. It is usually best to avoid permanent quadrats as

- it can be very time-consuming to re-find them
- there is a limited success rate in re-finding them
- there is often little or nothing to be gained from collecting data in this way

Hedges >5m wide
The handbook instruct you to include only those hedges where the woody component at the base is <5m wide. In our survey we noticed several good quality hedges > 5m wide which had to be omitted from the data. These were mostly tall, thick double hedges with an internal ditch or hedges with spreading branches at the base and with un-intensively managed land adjacent. These were excellent hedges from a habitat quality point of view. At least one of them was about 7m wide at the base and originated from a single row of trees and shrubs. Perhaps the definition should be changed to focus on the width between the trunks/stems on either side, rather than where the branches reach. Tall double hedges along green lanes, with touching canopies would also be excluded from the handbook definition.

3b – Lines of trees
Some lines of trees do not originate from hedgerows. The handbook should clarify that when it is obvious that the line of trees has not originated from a hedge (e.g. a line of recently planted ornamental trees) then this should not be included in the survey.

Also, in our survey we took ground flora quadrats along lines of trees even though there was no shrubby layer. Some of these quadrats were comprised of 10% wheat and 90% bare ground. The handbook does not clarify whether or not to omit ground flora quadrats if there is only a line of trees present.

Sections 7-16 - Elements that may be recorded for either the whole hedgerow or for a 30m survey section
In large county-wide surveys, all of the measurements in these sections should be based on the 30m section. This requires less effort (therefore more hedges can be surveyed). There is no difference in the statistical validity of data collected from 30m sections or the whole hedge, providing the sampling strategy is sound and the sample number is high enough. It is likely that data collected from a 30m section will be more precise, as there will be less variation than in whole hedge and therefore averages will be easier to estimate with a higher degree of accuracy.

While the handbook suggests that this is 'likely to be the only feasible method' for county-wide surveys, it would be helpful if it was more definitive on this point and stated that this is the 'most appropriate' approach for large county-wide surveys.

11a – Recently-introduced, non-native ground flora species
The handbook states that non-natives are often very damaging to the surrounding vegetation, which is correct. However there are also plenty of native plants that are invasive if unmanaged and there are also species that are non-native to particular areas of the UK that may be equally as damaging. We suggest that the methodology could ask for a record of any lack of management of potentially invasive species, whether those species are native (e.g. bramble, bracken) or non-native.

11b – Recently introduced, non-native woody species
Species native to parts of Britain are often planted outside of their natural range in hedges. These species should be included as 'recently introduced non-native species' in this section as this practise is undesirable for hedgerow conservation.

13 – Dimensions of hedges
The methodology described for measuring the average height and width of the hedge will give a misleading figure for the volume of the hedge (as described on p36 of the handbook). The volume will be significantly overestimated in most cases using this methodology as most hedges taper above and/or below their wide point.

14c – Average height of base of canopy
The instructions say to measure to the nearest 25cm, but the threshold for favourable condition is 50cm. Therefore, if the base of the canopy is 62cm, this is rounded down to 50cm, which comes out as favourable. This measurement needs to be more precise.

15 – Isolated hedgerow trees
It is difficult to think of a good reason why only 'isolated' hedgerow trees are recorded here and not all hedgerow trees. Why are they different from 'non-isolated' trees? Trees that are 'not isolated' include just as many young, mature and veteran trees as 'isolated' trees. Counting only isolated trees significantly underestimates the number of hedgerow trees and increases the chances of missing examples of important veteran trees.

Also, in the 'key results' box on p41 of the handbook, Q3 asks about number of trees per 100m length of hedgerow. This implies that trees should be counted and measured within either a 100m section or the whole hedge rather than the 30m section. Or can the results from the 30m section be extrapolated up to give average data per 100m length? This is a little unclear.

20 – Ground flora species per 30m
Providing the overall sampling strategy is sound, there is no need to flip a coin to decide where to place the 2 quadrats. A simpler protocol, e.g. - always put quadrat 1 under the canopy and quadrat 2 can be used in another position – will result in statistically valid sampling with no bias.

Some suggested changes to the species list;

- *Cirsium vulgaris* should be spelt '*vulgare'*.
- *Achillea millefolium, Centaurea nigra, Trifolium pratense* and *Plantago major* could be deleted as they are probably relatively infrequent in hedgerow vegetation. The first 3 sometimes occur in unintensively managed road verges, but did not occur very frequently in our survey. *Plantago major* is not really a feature of hedge ground flora – it is more common in trampled areas.
- *Anemone nemorosa, Hyacinthoides non-scripta, Primula vulgaris* and *Stellaria holostea* are also relatively infrequent (at least up here!) but they do indicate good quality habitat where they do occur. They could either be deleted from the standard list or retained but highlighted in some way to show that they are interesting species.
- Other species that we had to add to the list frequently included *Stellaria media, Vicia sepium, Lamium album, Veronica chamaedrys, Rubus fruticosus* agg. and *Hedera helix*
- Avoid using 'sp.' on the standard list, In a few cases, for example, vegetative specimens of *Viola riviniana*/*reichenbachiana* or *Salix* species suckers, can not be reliably identified to species, but generally use of 'sp.' on a form encourages sloppy recording.

21 – Veteran tree features

Coppice stools in hedges are often very irregularly shaped. The diameter in one direction can be much longer than the diameter in a perpendicular line to the first direction i.e. ellipsoid. It may be preferable to measure the circumference of coppice stools rather than the diameter.

Glossary – Gaps

Gaps are defined as including spaces filled by 'brambles or other non-structural hedgerow species, including climbers'. Ideally these terms need a precise definition with a list of species to avoid misinterpretation.

Reference

Defra 2007. *Hedgerow Survey Handbook*. *A Standard Procedure for Local Surveys in the UK*. Defra, London.

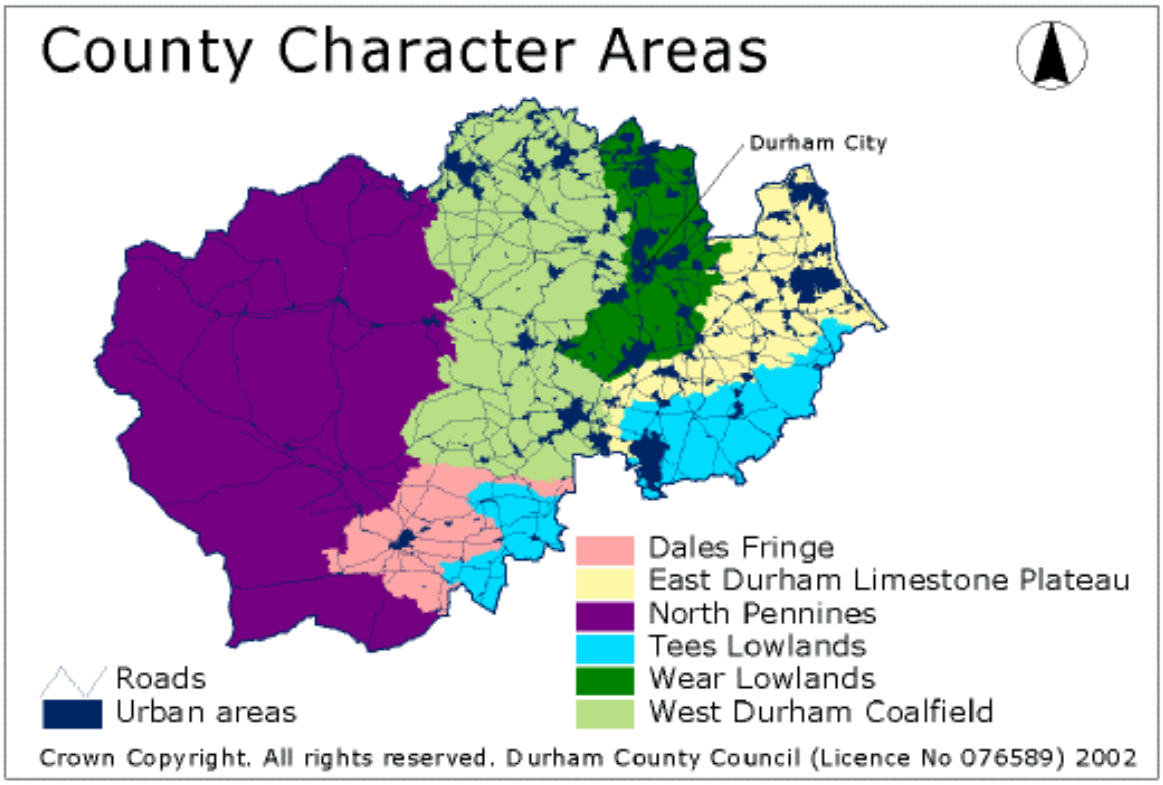
John and Clare O'Reilly
December 2006

PTYXIS ECOLOGY

www.ptyxis.com

Appendix D: Recommended Species Mix for Each of the County Character Areas within County Durham.

This information is also available on Durham County Council Website:
http://www.durham.gov.uk/durhamcc/usp.nsf/pws/Environment+-+Hedgerow+Species+Mix



County Character Area	Species	% recommended in the mix
Dales Fringe	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Holly	10-15%
	Bird cherry/Dog rose/Rowan/Wild privet	5%
East Durham Limestone Plateau	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Guelder rose	10-15%
	Holly/Crab apple/Field Maple/Dog rose/Wild privet	5%
North Pennines	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Holly	10-15%
	Bird cherry/Dog rose/Rowan	5%
Tees Lowlands	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Field maple/Holly	10-15%
	Crab apple/Guelder rose/Dog rose/Wild privet	5%
Wear Lowlands	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Holly	10-15%
	Crab apple/Guelder rose/Dog rose/Wild privet	5%
West Durham Coalfield	Hawthorn	60%
	Blackthorn	20-25%
	Hazel/Holly	10-15%
	Crab apple/Bird cherry/Guelder rose/Dog rose/Wild privet/Rowan	5%
Hedgerow Tree Species	Ash	Q. robur should be used mainly in the lowlands. Q. petraea should be used mainly in upland areas, especially on acidic, peaty or rocky soils. Hedgerow trees are normally planted at least 20 metres apart.
	English Oak (Quercus robur)	
	Sessile Oak (Quercus petraea)	