

HEDGEROW SURVEY OF COUNTY DONEGAL



May 2009

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Dhún na nGall
DONEGAL COUNTY COUNCIL



An Chomhairle Oidhreachta
The Heritage Council



An Action of the County Donegal Heritage Plan (2007-2011)

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ACKNOWLEDGEMENTS

We acknowledge the help and support of the following: Neil Foulkes and Anja Murray for training and advice regarding the Hedgerow Survey Methodology, Joseph Gallagher, Heritage Officer (Donegal County Council), Daragh McDonough (GIS Section, Donegal County Council), Lisa O'Grady (Greenmount Agricultural College, Antrim, Rural & Countryside Management Course Placement Student) and Dr. Kevin Cordes for assisting with the fieldwork, Liz and Ralph Sheppard for encouragement, advice and support, Annesley Malley (Landscape Historian), Hugh O'Donnell, Ton Bangert, IFA Donegal, Cronan Scanlon (Donegal News), Paddy Walsh (Donegal Democrat), Rosemary Hunter (Greenmount Agricultural College, Antrim), Dr. Peter Henderson and Robin Somes (Pisces Conservation Ltd.), Dr. Shirley Gallagher (EnviroSkillNet), Central Library in Letterkenny, Dr. Niamh Brennan (Donegal County Archives, Lifford) for historical information relating to land use, Steven Meyen (Teagasc) and all members of the public and community organisations who responded to the consultation process. We also especially thank all the landowners in County Donegal who allowed access to their land for survey.

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1.0 INTRODUCTION

Hedgerows are a valuable resource in our countryside, benefiting agriculture, wildlife, the environment, tourism, and communities in terms of contributing to a sense of place. In recent years, detailed data on the current extent, nature, variation and condition of hedgerows in several Irish counties has been collected using the hedgerow survey methodology of Murray & Foulkes (2006).

In the summer of 2008, a project to investigate the hedgerow resource of County Donegal was commissioned by the County Donegal Heritage Office, Donegal County Council with support from The Heritage Council as part of the implementation of the County Donegal Heritage Plan (2007-2011). The focus of this study was to determine the extent, composition, structure, condition, and management of hedgerows in the County. The information gathered and presented in this report will act as a comprehensive baseline for monitoring the hedgerow resource of County Donegal into the future. The information will be used to further the objectives of the County Heritage Plan and the pre-draft County Biodiversity Action Plan, to promote and strengthen positive hedgerow management and conservation in the county, to monitor changes in the resource over time, and as an information source for a wide range of end users including the farming community, planners, hedgerow-cutting contractors and environmental consultants.

The County Donegal Heritage Plan (2007-2011) highlights the need for a hedgerow survey under Objective 2: *'To collect, publish and disseminate data and information about County Donegal's heritage'*. Key action 2.22 under this objective states *'Selected survey of the distribution and state of conservation of roadside hedges, banks and stone walls'*

The County Donegal Development Plan (2006-2012) identifies policies to address issues of hedgerow conservation. Under this plan, POLICY NRD20 states:

'Ensure that the policies advanced in this Plan are compatible with the active conservation and protection of existing, native and semi-natural woodlands and hedgerows'.

In addition, POLICY BNH 2 also addresses the importance of hedgerows in the County:

‘Trees, stone walls and hedgerows within County Donegal contribute significantly to biodiversity and landscape character. In addition, hedgerows and stone walls constitute an important natural and historic resource, given their contribution to landscape quality, their ecological importance as wildlife habitats and historical significance as townland and field boundaries’.

It is Council policy to:

‘Promote the protection of trees and hedgerows from development that would impact adversely upon them and enhance existing hedgerows by seeking increased coverage in conjunction with new development’.

2.0 EXECUTIVE SUMMARY

In the summer of 2008, a project to investigate the hedgerow resource of County Donegal was commissioned by County Donegal Heritage Office, Donegal County Council in line with Key Action 2.22 of the County Donegal Heritage Plan. This comprehensive survey provides the baseline data in terms of extent, composition, structure, current and past management and condition necessary to devise policies and support actions for the conservation of the hedgerow resource of the County. Donegal's hedgerows are a valuable natural asset to the County providing benefits to agriculture through reducing soil erosion, contributing to the character of scenic landscapes that sustains the tourism industry, wild flora and fauna, protection of water quality, carbon sequestration, employment, and as a material resource through provision of fuel wood and wild fruits.

Consultations were held with all interested stakeholders to assess people's views and concerns about the hedgerow resource of the county. A total of 55 sample squares were surveyed, each 1km² in area. 19 out of the 55 sample squares were devoid of hedgerows. These tended to be in upland dominated by bog, heath or conifer plantation or coastal areas where walls are more commonly the main field boundaries.

These sample squares are the same as those used for the Badger and Habitats Survey of Ireland (Smal, 1995) and the ongoing BirdWatch Ireland Countryside Bird Survey, a national project that monitors population trends of Ireland's common and widespread breeding birds. The Countryside Bird Survey has been running since 1998.

The results of this survey estimate the total length of hedgerow in County Donegal as 10,408.30km. The corresponding figure for remnant hedgerow is an estimated length of 835.20km.

Five main hedgerow types were identified according to their floristic composition. These are:

Group 1 Hedges Characterised by Beech sometimes observed around existing or abandoned buildings.

Group 2 Hedges Characterised by Ash, Hawthorn and Blackthorn with Holly and Gorse. This type was the most common of all surveyed.

Group 3 Hedges Characterised by Hawthorn, Gorse and Rusty Willow characterised by Hawthorn, Gorse and Rusty Willow with some Ash, Holly, Sycamore, Broom and Rowan. This type was the second most species-rich type.

Group 4 Hedges Characterised by Eared Willow, Rusty Willow and Gorse with some Hawthorn, Hazel, Holly, and Rowan, and less frequently Blackthorn and Downy Birch. This type was the most species-rich hedge type.

Group 5 Hedges Characterised by Cotoneaster, Fuchsia and Privet often around existing and abandoned dwellings.

Forty-four hedges had trees comprising 13 species and 75 tree species occurrences across all hedges. The most frequent tree species was Ash comprising 28% of all tree occurrences. The next most frequent species was Sycamore (17.3%), followed by Holly (12%) and Rowan (8%).

The mean species richness in all 101 sampled hedges was 3.3. Hedges having on average ≥ 4 native woody hedge species in a 30m strip were considered to be species-rich. Only native woody species were used to determine hedge species richness. Climbers or scrambling plants although all identified to species level were not included in this calculation. 42 (41.58%) of all hedges where two strips were examined were species-rich. Some sample squares had a higher proportion of hedges surveyed that were species-rich. For example 7 out of the 10 hedges examined in the River Deele sample square (Grid ref. C200 000) conformed to the definition of species-rich. These squares should be targeted for hedge conservation actions.

In addition to species richness which is a function of age, other characteristics should also be examined when prioritizing hedges in terms of conservation value including hedgebank herb diversity, presence of rare species, or the importance of groups of intact hedges as a wildlife corridor network linking existing designated sites to allow free movement of at least some species of flora and fauna throughout the wider countryside in relative safety.

The species richness of roadside hedgerows was compared with non-roadside hedges, and it was found that the average (mean) species richness in roadside hedges in County Donegal was 3.2 compared to a non-roadside average (mean) of 3.4. This is in direct contrast to studies elsewhere where roadside boundary hedges were found to contain a higher diversity of native shrub species

than other hedges. This may however be due to what species have been included in the calculation of species richness.

Only 3 (2.97%) out of 101 randomly selected hedges surveyed formed part of townland boundaries. The mean species of these townland boundary hedges was 3.7 species as against a mean species richness for all hedges of 3.3. However the small sample size of townland hedges examined would merit a more detailed study of townland hedges to ascertain whether townland hedges are in fact more species rich than non-townland hedges as has been discovered in other areas.

A high proportion of hedges in the county are structurally poor, an indication that they are not in favourable condition for fulfilling their role in providing wildlife habitat and a stock-proof barrier etc. A total of only 6.9% of all hedges examined were either remnant (where only sparse shrubs or trees remain, covering <25% of the boundary length) or derelict (defined as where shrubs and thorns of the hedge component have mostly grown up into trees, no longer displaying shrubby or dense growth form in the bottom 1-2 metres of the hedge). Both of these profiles are no longer functional as stock-proof boundaries, although they may have additional fencing.

A further 39.53% of hedges however, are in the 'losing structure' category, where many of the shrubs and thorns of the hedge no longer display low dense growth, and most of the stems are visible. Hedges in this category can also be described as 'leggy' or 'scrawny'. Without careful management intervention, these hedges will soon move from becoming derelict to eventually becoming redundant with adverse impacts on their wildlife and landscape value.

Over 40% of hedges contained over 25% gaps. Gaps are taken to be breaks in the linear continuity of the hedge. Gaps are associated with a weak hedge structure, and are generally a symptom of the deterioration of the hedge, often caused by the demise of plants through age or inappropriate management. Most hedge functions are diminished if the level of gappiness is too high. Only a small number of hedges (5.15% in total) were without gaps in their structure. These figures are warning signals that a significant proportion of hedges in the county are under threat from lack of management, and may be lost without careful planning and intervention.

Recommendations have been made based on the study results and considered in the light of current conservation best practice. Due cognizance has also been made of any issues that were raised as part of the consultation process when drawing up the recommendations.

3.0 BACKGROUND

3.1 The History of Hedgerows in County Donegal

Under the Gaelic system of joint landownership there was little need for permanent enclosure or fencing. Instead tillage plots were protected with fencing for one season before being moved elsewhere. There is, however, some evidence to suggest that some ring forts (raths) were set with blackthorn and whitethorn. Permanent banks with or without hedges on them may also have existed. The Normans introduced the concept of land ownership. With the subsequent introduction of the Landlord System, tenants rented fixed plots of land from the landlord. The division of land and enclosure of commons was encouraged, even in some cases enforced by landlords. The Medieval Period saw townlands become the smallest unit of land tenure. They were bounded by banks and ditches, which often had hedges too. The land within was largely unenclosed, though this was dependent on the landowner and their preferences. Townland boundary hedges thus tend to have larger banks and ditches than other hedges, and are often among the oldest hedges in the Irish landscape. For these reasons they may also contain a more diverse flora than other, non-townland boundary hedges. Old double ditches with paths running up through them were used by pedestrians in times of flood, and were a favourite route to the fair with animals because the double ditch recognized no townland barriers (Sharkey, 1985). It is evident from the first series Ordnance Survey maps, made in the 1820s, that by this stage much of County Donegal's agricultural land had been subdivided into relatively small fields, whether by banks, drains, walls or hedges.

In 1824, a House of Commons Committee recommended a survey of Ireland at a scale of six-inches-to-one-statute-mile to facilitate a uniform valuation for local taxation purposes. The survey was directed by Colonel Thomas Colby who had available to him officers of the Royal Engineers and three companies of sappers and miners. In addition to this, civil servants were recruited to help with sketching, drawing and engraving maps, and eventually, in the 1830s, the writing of the Memoirs. The Memoirs, compiled between 1830 and 1840 under the general direction of Lieutenant (later Sir) Thomas Larcom, were written descriptions intended to accompany the Ordnance Survey maps. They are a unique source for the history of the northern half of Ireland before the Great Famine.

Arranged on a parish basis, they generally follow a particular pattern and record natural features (hills, lakes, bogs, woods, climate, etc); modern topography (towns, public buildings, mills, gentlemen's seats, bridges, roads, markets and fairs, etc); the social economy (local government, dispensaries, occupations, the poor, religion, emigration, habits of the people - dress, food, customs, etc); and

ancient topography (antiquities and ancient monuments). They therefore document a great wealth of information about the landscape and about society in the 1830s.

The Ordnance Survey Memoirs of Ireland Parishes of County Donegal I and II (Day & McWilliams (eds.) (1997) describes the quality of the land, the sizes of farms and the nature of the fields and their associated boundaries of several Donegal parishes.

It would appear that, at that time, field boundaries were often stone walls in some parishes:

Parish of Killygarvan: *'The fences are nearly all stone and the fields very irregularly laid out'*.

Parish of Mevagh: *'The cultivated lands are laid out badly in run and dale or with crooked stone fences and the whole appears to be, as a farming district, in a very low state'*.

It would also seem from the passage describing the **Parishes of Killea and Taughboyne** that field boundaries of land cultivated by lower socio-economic groups were described as little more than banks of mud or manure which were viewed as a waste of good cultivable land.

'The description of fence used by the intelligent and those of circumstance is either hawthorn hedges or stone walls; but the other class must be content without any fence or let the useless, I may say pernicious, banks of mud or manure which their forefathers had raised remain, many of which betwixt cultivated land and crop are 6, 7 or 8 yards asunder. Surely such a stupid waste of land, and that probably of the best quality, stands highly reprehensible'.

In other parishes there would appear to have been little enclosure as an extract from the description for the **Parish of Moville** testifies:

'The farms all various in size, but in general all small and scarcely any enclosures at all, as the greatest part of them are occupied in rundale. The method of cultivation is such as might have existed 2 or 3 centuries ago'.

The author goes on to recommend replacing this system by improving and enclosing the land with good clay ditches planted with thorn quicks (hawthorn) and leasing the improved land to individual farmers each with their own house to replace the current system of cabins built in clusters.

'I consider that the first great step to improvement would be to divide the farms into reasonable sizes, say from 10 to 20 acres, according to the ability of the occupier, and to cause the tenant to enclose his

farm with a good clay ditch planted with thorn quicks and to build his house upon his own farm, as the cabins at present are generally built in a cluster which is a continued source of contention, from their cattle, fowls etc. trespassing on each other’.

An extract from the **Parish of Drumhome** also relates the scarcity of enclosure in some areas: *‘They have hardly any enclosures in their farms. Their crops are in dales and, where they have a patch of grass, they are obliged to put a herd’s boy to watch their cow or horses’.*

‘The fences in the neighbourhood of Ballintra are mostly made of loose stones of a sufficient height to keep out sheep, broad at the base and ending with one stone on the top. In the country in general the fences are insufficient; ditches not of use to keep out any beast, which renders a herd-boy necessary in all cases’.

Parishes of All Saints and Killea: *‘The parishes of All Saints and Killea are doubtless best secured in this respect, yet even these are extremely deficient. With the exception of gentlemen’s seats and the enclosures of a very few farmers, the greater part of the district bears the resemblance of a vast common’.*

However, it would appear that hedges of hawthorn and gorse were well established in some areas by the time of the publication of an account of **Lough Swilly** in the 1820s by Mr. Montgomery and Others:

‘Farms are of various sizes. Some are 40 or 50 Cunningham acres but many are smaller, being from 10 or 12 to 16 or 20 acres each, of tillage and green pasturage. They are enclosed partly with clay ditches, some of which are quicked with thorn and some with whins, and partly with stone fences’.

Montgomery and others go on to extol the virtues of whin (gorse) as a hedging material and winter fodder.

‘Stone fences and ditches with clay banks; probably clay banks sowed with whins may be the best fence among ordinary farmers. Such, if well made, are pretty permanent and not expensive. The whins afford very good green winter feeding for horses, cows and sheep’.

In the description of the **Parish of Donegal**, single-sod ditches sowed with whin and broom seeds are described. Narrow double ditches, quicked with hawthorn on each side and topped with alder, sycamore or ash are recommended. The preference of alder for wet ground was also recognised.

'Single-sod ditches are now in use, sowed on the top with whin and broom seeds as already described, but the fence which I would recommend would be narrow double ditches, quicked with hawthorn on each side near the surface of the ground and on the top, alder, sycamore or ash. Alder would be preferable to any other description of trees on marshy ground'.

Passages from the Parishes of Iniskeel and Killymard also recommend whitethorn, broom or furze (gorse) planted on banks to afford useful shelter and a dyke on either side to drain the land.

Parish of Iniskeel: *'The fence commonly used is a mound of earth, which must be made anew annually. In the stony districts a badly built dry wall is made; I would recommend what is usually called a double ditch, that is, a mound of earth with a dyke on either side; and I would advise the planting either side of the mound with whitethorn. The dykes would drain the land and the thorn edge would afford useful shelter in our northern climate'.*

Parish of Killymard: *'The best description of fence, where the lands are dry and stones are attainable, are stone walls, but in wet lands a double ditch, sown with broom or furze or quickset closely with hawthorn, forms the best fence and affords a shelter which is of the utmost consequence both to the crop and grazing cattle. The prevailing winds in autumn, being from the north west, are most destructive to the potato crop. Fences of this description assist in draining the lands'.*

In the **Parish of Raymoghly** the virtues of using Gooseberry and Gorse were outlined. It would seem from the description that Gorse was an important fodder crop at that time notably in the beginning of spring when other fodder is scarce. We also get a feel for the relative prices of fencing materials.

Parish of Raymoghly: *'Gooseberry cuttings grow quicker by far than whitethorns, make a most excellent thick hedge and may be trimmed to any shape. The common whin or furze is much cheaper than whitethorn and, if properly attended to, make a good fence. I would strongly recommend the sowing of furze in the tops of fences in the mountainous districts. They will afford an excellent shelter and, in case of great scarcity of fodder in the beginning of spring, will afford a good supply of wholesome nourishing food for either cow or horse. I have known them carried 3 miles for that purpose. A man may cut and chop as much in a day as will feed their cows. This is no fanciful theory but a well-known fact.*

Ó Gallchobhair (1975) examined the agricultural history of the Hill Estate in Gweedore specifically how the land was managed with the aim of improving agricultural efficiency.

‘The Hill estate included the greater part of Gweedore Parish that was purchased by Lord George Hill in 1838. He acquired properties amounting to 25 000 acres, with a population of 3000 of whom seven hundred paid about 500 pounds in rent. Before Hill’s time, the estate was held in common by the tenants for farming, grazing and turbary; but Hill decided to divide a large portion of his property into small farms, of from six to 10 acres; and to compel the tenants to abandon their old homes and settle on the new farms or ‘cuts’ , as they were called. The new farms had to be fenced, drained and reclaimed, and new houses and outoffices built on them – all at the owners’ expense. Donegal landlords were informed by Scotch sheepowners that fabulous profits could be made from stocking the mountains with Scotch black-faced sheep. Some of them purchased thousands of sheep, and stocked the property formerly used by their tenants as common grazing. Others let their mountains to Scotch shepherds and graziers. Lord Hill himself went down the road of sheep farming. He deprived his tenants of mountain grazing and fenced off all his mountains in the year 1866, when he let them to Scotchmen’.

3.2 The Value of Hedgerows for County Donegal

Smal (1995) estimated the hedgerow/treerow network in Ireland to be approximately 382,000km. This is potentially a huge asset to the country with Donegal no exception in terms of their landscape, wildlife and agricultural value.

Landscape

Hedgerows, along with stonewalls, endow the countryside with a distinctive bocage landscape. In particular, regional and local variation in hedgerows contributes significantly to the distinctiveness of Donegal’s landscape character areas that contribute to our cultural heritage and form an integral part of the tourism product. Hedgerows give the impression that Ireland is a more wooded island that it really is.

Folklore

MacCoitir (2006) outlines some of the Irish placenames that are derived from plants many of which are found in hedgerows. Gleneany (Gleann Eidhneach) in County Donegal for example means Ivied Glen. MacCoitir (2006) also lists folk cures for a number of hedgerow species found

in the county. For example, in Donegal the juice from boiled bluebell (*Hyacinthoides non-scripta*) was drunk as a cure for coughs, and the common hedgerow fern Hart's-tongue (*Phyllitis scolopendrium*) used to soothe insect stings.

There is a story from Glenties of how Fionn and his men were put asleep with a mixture of bluebell and tormentil (*Potentilla erecta*) by Gráinne before she eloped with Diarmaid! Ramsons or wild garlic (*Allium ursinum*) was a metaphor for sharpness or bitterness; a Donegal saying 'Chomh searbh le creamh' means 'as bitter as wild garlic'.

Agriculture

Hedgerows have huge agricultural benefits, functioning as cheap and environmentally friendly stock-proof boundaries if properly maintained and managed. They also provide vital shelter and protection of stock and crops across the county. They trap airborne crop and animal pathogens preventing the spread of disease between farms. Well-maintained hedgerows reduce wind speeds thereby reducing soil erosion.

Flora and Fauna

Hedgerows are an important wildlife habitat and may be the only significant refuge available to wildlife on the more intensively-managed farms in the county. They are home to a range of our native flora and fauna. They support flowering plants and mosses and invertebrates like butterflies, moths, ladybirds, beetles, bumblebees and hoverflies. Two-thirds of our bird species nest in hedgerows, and rely on them for food and shelter. Birds of prey like the Kestrel, Merlin, Barn Owl and Sparrowhawk hunt along hedgerows. Bats depend on hedgerows for shelter, insect food and for roosting. The National Roads Authority outline the importance of hedgerows for bats in their best practice guidelines for the treatment of bats during the construction of national road schemes (NRA, 2005) and guidelines for the conservation of bats in the planning of national road schemes (NRA, 2005a). Hedges can support substantial breeding badger setts and also support other mammals like woodmice, and hedgehogs.

Hedges as Habitat Corridors for Biodiversity

Well-managed dense, tall hedges across the country provide links between surviving fragments of other wildlife habitats, thereby allowing the movement and dispersal of species especially small mammals such as bats through otherwise hostile agriculturally-improved landscapes of tillage and improved grassland.

Water Quality

Hedges help maintain water quality by absorbing and recycling nutrients, thus reducing the risk of pollution. Hedges also stop sediment from moving down-slope, preventing excessive siltation in waterways that would have an adverse impact on fish populations by smothering their spawning areas. They also reduce the risk of flooding by controlling the movement of water through the landscape.

Carbon Sequestration

Murray and Foulkes (2005) estimate that if the average hedgerow width is two metres, then the hedgerow resource covers an approximate area of 764 km² of the Country. The woody vegetation in hedgerows therefore plays a vital role in meeting Ireland's obligations under the Kyoto Protocol.

Employment

A number of people are directly or indirectly employed in the management of hedges or through the supply of hedging materials.

Material Resource

A significant proportion of the country's broadleaf tree resource is contained within hedgerows. These provide the raw materials for craft products, and if carefully harvested can be a sustainable source of carbon-neutral fuel.

4.0 SURVEY RATIONALE AND OBJECTIVES

4.1 The need for a Hedgerow Survey in County Donegal

Detailed information on the extent and quality of hedgerows in the county is required to guide their future management. The hedgerow survey of County Donegal provides the quantitative and qualitative baseline data towards achieving Action 32 of the National Biodiversity Plan (2002): *‘Review options on regulation of hedgerow removal and produce guidelines on hedgerows and biodiversity’*. It will also raise awareness of the value of the hedgerow resource as an important part of the heritage of the county and provide the baseline data to devise appropriate hedgerow management and protection policies.

The survey results provide the following information useful to a wide range of stakeholders:

- It quantifies and assesses the quality of the hedgerow resource in the county.
- It identifies threats facing hedgerows and makes recommendations to reduce these threats.
- The survey identifies the different types of hedgerow in County Donegal based on their species composition.
- It allows for comparison between hedgerows managed using different methods.
- Since the sampling squares for this survey are the same as those used by both the Badgers and Habitats Survey and the Countryside Bird Survey, the hedgerow survey results will complement the results from those two surveys to give a better picture of changes in the Donegal countryside and this will help to formulate better countryside management policies at county level. In addition, repeat surveys will be of use in monitoring changes to the countryside of the County.

The survey results and conclusions should provide a useful tool for decision makers and advisory bodies including:

- Local authority planners when drawing up hedgerow protection policies to be incorporated into future County Development Plans and Local Area Plans.
- National Roads Authority when reviewing hedgerow protection policies.
- Road engineers when planning, constructing and maintaining new roads.
- Landscape planners in producing landscape character assessments in order to guide landscape protection policies so as to sustain the tourism industry.
- Environmental consultants, particularly in drawing up Environmental Impact Statements.

- Department of Agriculture when reviewing the REPS scheme.
- Teagasc when reviewing courses in hedgerow management.
- Farmers, landowners and estate managers when maintaining and planting new hedges.
- Local community groups drawing up heritage plans for their areas.
- Foresters when planting new woodland.
- Schools and colleges for environmental education purposes.
- State bodies such as National Parks and Wildlife Service, OPW, and the fisheries boards when managing land under their remit.

4.2 The Aims and Objectives of the Donegal Hedgerow Survey

- Produce data using appropriate field survey techniques on the extent, woody species composition, distribution and condition of the hedgerow resource within County Donegal and collate this data and make it available for future research.
- Identify concentrations of hedgerows of conservation importance in the county, for example those of highest species richness.
- Make recommendations on the research, education, awareness and management actions required to sustain the hedgerow resource into the future.

4.3 National and International Hedgerow Protection Policies and Legislation

The importance of hedgerows is recognized in national and international environmental policies and legislation:

The Kyoto Protocol (1997) on anthropogenic greenhouse gases

This calls for the “*Protection and enhancement of sinks and reservoirs of greenhouse gases.*”

In the process of photosynthesis hedgerow trees and shrubs take in carbon dioxide and emit oxygen. Carbon Dioxide is a major greenhouse gas.

(EU) Habitats Directive (1992)

Article 10 of the Directive states: "Member States shall endeavour in their land-use planning and development policies, to encourage the management of features of the landscape which are of major importance for wild flora and fauna. Such features are those which, by virtue of their linear and continuous structure (such as rivers, riverbanks or hedgerows) or their functions as stepping stones (such as ponds or small woods) are essential for the migration, dispersal and genetic exchange of wild species."

(EU) Birds Directive (1979)

Article 3 of the Directive states: "Member States shall take the requisite measures to preserve, maintain, or reestablish a sufficient diversity or area of habitats for all the species of birds referred to in Article 1 - i.e. -all species of naturally occurring birds in the wild state."

European Council Regulation (EC) 1257/1999 - Agri-Environmental Schemes

Agri-environment schemes are an important tool in maintaining and protecting agricultural landscapes. At the very least, such schemes ensure the maintenance of existing features such as hedgerows, habitats, farm buildings and archaeological remains. The latest version of the Rural Environment Protection Scheme (REPS 4) runs until 2013 and encourages farmers to enhance the environment through a range of actions including maintaining existing hedgerows and planting new ones. The Rural Environment Protection Scheme (REPS) specifications set down the conditions by which participant farmers in the Scheme must manage their hedgerows. A number of the REPS measures are concerned with the maintenance and management of hedgerows and field margins (uncultivated strip alongside the hedgerow). These are as detailed in the farmer's handbook for REPS 4 (The Department of Agriculture, Fisheries & Food, 2007):

- Measure 4: Retain wildlife habitats.
- Measure 5: Maintain farm and field boundaries.
- Measure 6: Cease using herbicides, pesticides and fertilisers in and around hedgerows, ponds and streams.
- Measure 9: Produce tillage crops without burning straw/stubble and leaving field margins uncultivated.

Measure 5 Options aim to enhance and increase the length of hedgerows and stone walls in the interest of biodiversity, stock control and the scenic appearance of the farm. Farmers may either choose one from Options 5A (Hedgerow Coppicing), 5B (Hedgerow Laying), 5C (New Hedgerow Planting) and 5D (Additional Stonewall Maintenance), or a pro rata mix of them.

Hedgerows and linear features are regularly proposed as agri-environmental indicators. The amount of hedgerow can be measured as the length of hedge in metres or kilometres per hectare, or per hectare of utilised agricultural area (UAA). The Department of Agriculture, Food and Rural Development (1999) included the mean length of hedgerow per REPS farm as one of its indicators in the REPS mid-term review.

Nitrates Directive (1991)

In order to reduce or prevent pollution of watercourses one of the objectives of the Directive is to limit the losses of nitrates linked to agricultural activities. To this end, the Nitrates Directive promotes the "Buffer" effect of non-fertilised grass strips and hedges along watercourses and ditches.

Wildlife Act (1976) & Wildlife (Amendment) Act 2000

The purpose of **Section 40** of the original Act, as amended by **Section 46** of the Amendment, is to protect breeding birds during the nesting season by establishing a prohibition on the cutting of hedges during the period from 1st March to 31st August (inclusive) each year.

National Biodiversity Plan (2002)

In response to the Convention on Biological Diversity (CBD, Rio de Janeiro, 1992), a National Biodiversity Plan was produced. The plan lists a number of Actions that are relevant to Hedgerow Conservation namely:

Action 32: "Review options on Regulation of Hedgerow Removal and Produce guidelines on Hedgerows and Biodiversity."

Paragraph 2.27 of the plan that states:

"Field boundaries, mainly hedgerows, are a particularly prominent feature of the Irish countryside and provide important habitats for a variety of species. Hedgerows have suffered significant losses. Current legal controls for their protection are limited".

National Roads Authority

The National Roads Authority has published hedgerow protection policies within its guidance document for landscape treatments for national roads schemes in Ireland (NRA, 2006). It acknowledges the significant role that hedgerows play in providing connectivity for wildlife dispersal between habitats and the need to choose indigenous planting stock where direct planting of native trees and shrubs (especially those that reflect the composition of existing hedgerows in the surrounding landscape) is envisaged for example when reconnecting existing severed hedgerows or core habitat areas (e.g., hedgerows, wetlands, semi-natural grasslands and low or high-canopy woodland treatments) within bocage landscapes. It includes best practice hedge planting guidelines and also touches on how to increase the width of hedgerows for screening or as wildlife corridors using natural colonization where appropriate. It also deals with hedge

management and maintenance issues and presses for the retention of mature trees and hedgerows within the land-take for the new road. The NRA have also produced more specific detailed guidelines for the protection and preservation of trees, hedgerows and scrub prior to, during and post construction of national road schemes (NRA, 2006a).

5.0 CONSULTATIONS AND PUBLICITY

Previous Publicity Pertaining to Donegal Hedgerows

There had already been a certain amount of publicity given to the value and management of field boundaries in Ireland including County Donegal prior to the start of this project namely:

- Donegal County Council Heritage Office organised two free heritage seminars and workshops on the conservation of traditional field boundaries in 2007. The Hedgerow seminar and workshop took place in the former Carnowen National School at Carnowen Crossroads on Saturday, December 2nd and the stone walls seminar and workshop in Oideas Gael in Glencolmcille on Tuesday, December 5th.
- In January 2008, a press release compiled by Donegal County Council concentrated on the timing of hedge trimming including the need for a closed hedge-trimming season.
- Donegal County Council has produced a policy statement on hedgecutting (see www.donegalcoco.ie).
- Networks for Nature is a collaborative initiative, begun by Crann and the Irish Wildlife Trust, and now incorporating representatives from The Heritage Council, Teagasc, Local Authority Heritage Officers, The Irish Farming Association (IFA), The Department of Agriculture, National Parks and Wildlife, the Forest Service, and the Professional Agricultural Contractors (PAC). This unique structure allows for the input and involvement of all who have an impact on the future of our hedgerow resource, hence their motto 'conservation through collaboration'. Apart from raising awareness and understanding of the significant wildlife benefits of our hedgerows and the hedge corridor network, Networks for Nature have been raising the profile of hedgerows in terms of the many wider farming and environmental services that they provide. Traditional hedgerow management skills can provide a basis for the establishment of alternative farm-based enterprises, for instance hedge-laying, wood-turning, tourism green ways, and food produce from hedgerows, all of which are highly relevant to rural development initiatives. Networks for Nature have initiated The Certification Scheme for Hedgecutting Contractors in order to raise standards of mechanical management of hedges. They have also produced a travelling exhibition for ENFO, packed with excellent photos and information on all aspects of hedgerows. Other awareness raising activities have included Networks for Nature display stands and information at Country Shows and Fairs, distributing 'Hedgerow Food Web' posters, and activities for schools. They have also worked with local community groups, and promoted the 'Golden Mile' Competition.

- ENFO have produced an information leaflet on hedgerows focusing on the value of hedgerows and their management.
- Teagasc have produced leaflets on different aspects of hedge management including Planting Hedges, Hedge Rejuvenation, Hedge Trimming, and The Value of Hedges (downloadable from www.teagasc.ie)
- Stuart Dunlop has created a Donegal Hedgerow website (<http://homepage.eircom.net/~hedgerow/>). This website is a documentary of one year's life in a Donegal Hedgerow. Day-by-day, the sights he saw are presented in pictures and text. The pages take the form of a diary, and all photographs are placed in date sequence. The website therefore records as many of the encounters with wildlife as he can photograph or describe. The hedgerow is about 1.5 miles of continuous hedging just outside the town of Raphoe, County Donegal, Ireland. The number of species suggests that the hedge is several hundred years old.

Project Consultations and Publicity

- Liz Sheppard compiled an article on hedgerows to tie in with the survey for the 'Donegal Democrat' entitled 'Donegal hedgerows under the spotlight' for the Tuesday 19th August 2008 edition of this newspaper. The article requested that any information on particularly species-rich or historic hedgerows, and especially for any details of how hedges were planted or managed in the past be sent to the consultants.
- Articles publicising the Donegal Hedgerow Survey project also appeared in the 'Donegal on Sunday' and 'Donegal News' newspapers on 3rd August 2008 and Monday August 11th 2008 respectively again requesting the public to contact the consultants with their views on hedgerow management and conservation.
- Consultation poster (**Appendix 1**) was put up in public libraries throughout the county.

6.0 METHODOLOGY AND FIELD SURVEY

The methodology used for this survey was the one developed by Murray and Foulkes (2006).

6.1 Maps and Aerial Photographs

Discovery Series ordnance survey maps (scale 1:50,000) were used to physically locate the samples. The second-edition 1:10,560 scale Ordnance Survey maps were used for the identification of townland boundaries. Aerial photographs of each sample square enabled the terrain of each square to be assessed for planning the best access points for survey and to give preliminary indications of the presence of hedges. The colour aerials facilitated the identification of the randomly-selected hedge samples. Hedges were mapped onto the aerial photographs in the field and subsequently digitized into a geodatabase using ArcView 9.2 GIS software for spatial analysis and to determine the total hedgerow length in the County.

6.2 Selecting the Sample

The bottom left hand 1km square of each of the Ordnance Survey ten-kilometre grid squares of the county was chosen for the Hedgerow Survey, in accordance with the sampling procedure for the Badger and Habitats Survey of Ireland (Smal, 1995) and the on-going BirdWatch Ireland Countryside Bird Survey.

Each sample square is 1km² in area. A total of 55 of these squares were surveyed in the County. Nineteen (34.5%) of these squares were found to possess no hedges after close examination during a desktop study and/or in the field. Many of the squares with no hedges were in upland or coastal areas where stone walls are the dominant field boundary. A separate survey of stone walls and their associated flora and fauna is recommended. The grid reference and hedgerow extent for each square in Donegal is listed in **Table 2**. The hedges were selected randomly within each square by generating a numbered grid with 100 equal distant points and placing it on top of the colour aerial photographs using ArcView 9.2 GIS software. The randomly chosen numbers were matched with the numbered points on this grid, and the hedge nearest each point on the grid was chosen for detailed investigation. Ten hedges per sample square were selected in this way.

Where a significant portion of the sample square was covered in forestry, bog or other non-hedged landscapes, the number of hedges recorded was adjusted accordingly. This was to ensure that the sample would not be skewed by a higher sampling density in certain areas. Where the hedge chosen on the aerial photo or map was discovered to be something other than a hedge (e.g.

a tree line, a colonised drain, a vegetated bank, or a wall covered in vegetation), the next hedge nearest to the relevant point on the overlay sheet was recorded instead.

6.3 Defining Hedges

For the purpose of this survey, hedges are defined as linear strips of woody plants with a shrubby growth form generally less than 5m high and 4m wide that cover >25% of the length of a field or property boundary. They often have associated banks, walls, ditches (drains), or trees. Each hedge chosen for detailed investigation by the random selection process was clearly marked and labeled with a number on the field map. A length of hedge was taken as one side of a field or enclosure. End points were identified as the junction between adjacent sides of a field, or where three or more hedge lengths meet.

In a few instances end points were marked where the construction, management or character changed suddenly and conspicuously along its length, where a clear and obvious difference in the origin of the hedge was apparent, but where no junction was evident. This is normally a result of boundary removal, where the two portions of a linear hedge once bounded separate fields.

Hedges bordering curtilage [defined as habitat BL3 buildings and artificial surfaces (Fossitt, 2000)] are only recorded if they also border agricultural land, although for purposes of extent, curtilage hedges are also marked on the map. This is to avoid skewing the sample with garden hedges which do not border a field or property boundary and are not agricultural hedges. Hedges that are within afforested land are not recorded for the purposes of this survey, falling within a different habitat classification [e.g. WN, WD, and WS habitats (Fossit, 2000)].

6.4 Structural Recordings of Hedges

Each hedge subjected to a detailed investigation (maximum of 10 hedges per sample square) was assessed along its whole length. Hedges that have grown into a line of mature Hawthorn (or other) trees have not been considered as hedgerows, but as 'remnant' hedges. The assumption being that they are remains of hedgerows that have lost their structure and therefore deemed to have deteriorated. Based on reports from Statistical Surveys carried out by the RDS, some of these defunct hedges may be examples of unsuccessful attempts at establishing hedges.

A field survey sheet (**Appendix 2**) modified from that used in the 2005 Offaly Hedgerow Survey was used to record the characteristics of each hedge and its associated features. This sheet lists categories of hedge structural attributes, associated features, and management practices. Each

category has a corresponding code that is entered into the appropriate box on the data recording grid.

6.5 Floristic Recordings of Hedgerows

Floristics (from ‘flora’) is a subdomain of botany and biogeography that studies distribution and relationships of plant species over geographic areas. Two 30-metre strips were measured along each hedge from two randomly-chosen points along the hedge. The 30-metre strip is a generally accepted as an adequately representative sample size for recording woody species in a hedge. By recording woody species along a standardised length, the comparison of hedges of different lengths is possible. As there can be much variation in species from one end of a hedge to the other, two strips are recorded. This increased sampling intensity for each hedge gives a more accurate picture of the overall species of each hedge.

The Floristic data recording sheet modified from Murray & Foulkes (2007) is presented in **Appendix 3**. Each native and non-native woody shrub species present within the length of each strip was allocated an appropriate value of abundance (i.e. percentage cover) using the DOMIN scale (**Table 1**). Total percentage cover may add up to more than 100% because of layering of the vegetation. This scale has 10 levels of percentage cover as follows:

Table 1: DOMIN Percentage Cover Scale

DOMIN Value	% Cover
10	91-100
9	76-90
8	51-75
7	34-50
6	26-33
5	11-25
4	4-10
3	<4

Where other species were present in the hedge but did not fall within either strip, that species was recorded as present separately from the strips. The presence of Ivy (*Hedera helix*) at canopy level was recorded according to the DOMIN scale. Tree species present in the hedge were noted.

6.6 Target Notes

Where appropriate, notes were made of irregularities, special features, or notable characteristics within the sample square or about specific hedges. Observations of important flora and fauna (e.g. butterflies and invasive plant species) were collated and sent to the relevant specialists and/or the National Biodiversity Data Centre, Waterford. Invasive plant species recorded were *Gunnera tinctoria* (Giant-rhubarb), *Fallopia japonica* (Japanese Knotweed) and *Rubus spectabilis* (Salmonberry). The potentially invasive *Polygonum wallichii* (Himalayan Knotweed) which establishes readily by vegetative reproduction from outcast rhizomes was also recorded where it reached high abundance along roadsides in some areas. Owing to the adverse impact of these invasive species on semi-natural habitats and their associated native flora and fauna, it is recommended that a more comprehensive survey of the extent, abundance and distribution of these invasive species is initiated in the County.

6.7 Recording the Extent of Hedgerows in Samples

For the purposes of this survey, the extent of all the hedgerows within each sample square was recorded by visual inspection of all linear features apparent on the relevant aerial photograph. The presence of hedgerows was marked with a solid line on a colour photocopy of the aerial photograph. Remnant hedgerows were recorded with a broken line. Any other linear feature that was apparent on the aerial photograph/map was investigated and non-hedgerows were also marked on the aerial photographs in a different colour to prevent duplication of investigation. These included vegetated banks, vegetated drains, walls with or without shrubs, fence lines, and woodland strips >4m wide. Where clear and extensive gaps occurred in hedges, a line of a suitable colour was used to mark the gap section. This was done to minimize the over estimation of hedgerow length due to the inclusion of significant gaps. Hedgerows and defunct hedgerows marked on the colour aerial photographs were digitized into a GIS geodatabase using ArcView 9.2 software. The geodatabase was set up to ensure that as each hedge and defunct hedge was digitized, the database automatically calculated its length and enters it into a predefined length field in the database attribute table. After all hedges are digitized, the GIS database automatically returned total figures for the hedge and defunct hedge categories within each square by using the summary statistics option of the software package. This is the first time GIS software has been used to calculate hedgerow extent in any of the County hedgerow surveys to date. It is recommended that this useful planning tool is employed in any further County hedgerow surveys. Only that portion of the boundary that contained some remnant of a hedge was recorded. Some former hedge lines/boundaries have declined to the point that only a small fraction of the original

remains. It follows that the length of remnant hedgerow is likely to be underestimated. The extent of hedgerows and defunct hedgerows in each 1km square is presented in **Table 2**.

6.8 Photography

A wi-fi enabled Nikon P3 digital camera was used to document some of the notable hedges, specific characteristics, the surveyed hedge strips, good examples of the profile categories, hedge species composition, and to demonstrate threats such as the presence of invasive species. Photographs are useful for assisting explanations in presentations and reports relating to the hedgerow survey. Photographs are presented on electronic storage media appended to this report.

6.9 Access and Permission

Due to difficulties in identifying ownership of all parcels of land within the sample squares and the fact that landowners may not be around during the day, permission was only sought by direct approach to landowners when present, rather than by previous contact. Where access to land was through a farm close to a dwelling, or in any other situation deemed relevant by the surveyors for their work, permission was sought where possible. Where requested, permission was granted in all cases except for one landowner. In that case, it was obvious from the aerial photographs that the boundaries on the land in question were stone walls and so not entering the land did not affect the results. In a number of cases, landowners provided useful additional information on the management of particular hedges. The fact that the sample squares are the same as those used by BirdWatch Ireland for the Countryside Bird Survey meant that a number of landowners were well primed to see surveyors at work. The surveyors had full public liability insurance cover for their work.

7.0 DATA ANALYSIS

7.1 Floristic Classification of Hedge Types

A TWINSpan (Two Way INdicator SPecies ANalysis) classification was carried out on the dataset using Community Analysis Package 4 (CAP4), a composite software package of a number of ordination techniques including TWINSpan. The classification finds groups of samples (hedges) that equate to distinct hedge types based on their floristic composition. The data set used for the classification consisted of an average recording from the two 30-metre strips for each hedge, meaning that all species recorded from both 30-metre strips along the hedge were averaged to produce one set of percentage cover figures (DOMIN values) for each hedge. Species that occurred in less than 2 % of samples were not included in the classification process. Before the TWINSpan output was run, pseudo-species cut levels were set at 0, 5, 25, 50 and 75. The maximum number of indicators per division was set at 5; the maximum level of divisions was set at 3 and the minimum size of group to be divided at 5.

The output of this analysis is a 'two way ordered table' that breaks up all the samples (hedges) according to their floristic composition, based on the frequency of certain 'indicator species'. The groups are subjectively pulled out from the table by the user according to ecological understanding and indicator values. The classification process was considered a success, as 5 distinct and ecologically meaningful hedge types were drawn out from the table. These groups are presented and discussed in **Section 8.0**.

Both the floristic and structural characteristics of hedges in each group were fully examined using basic statistical procedures such as means (species numbers), frequency, and mode. These are presented in **Section 8.0**.

7.2 Statistical Analyses

All the data were subjected to standard statistical analyses (frequencies of species occurrence, mean species richness, frequency of structural characteristics, etc.) and graphed using Microsoft Excel spreadsheet programme.

8.0 RESULTS

8.1 The Extent of Hedgerows in County Donegal

Table 2: Extent (km) and Density of Hedgerows (km/km²) in County Donegal

Grid ref.	Nearest Town/Village/Townland/ Place of Interest	Area km²	Hedgerow Length km	Remnant Length km	Density km/km²*
<i>B700 000</i>	<i>Inishkeel</i>	<i>0.200</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>B700 100</i>	<i>Terman</i>	<i>0.230</i>	<i>0</i>	<i>0</i>	<i>0</i>
B800 000	Lettermacaward	1	0.181	0.075	0.181
B800 100	Lough Namuck	1	0.148	0.108	0.148
B800 200	Lough Noran	1	0.412	0	0.412
<i>B800 300</i>	<i>Glashagh Lower</i>	<i>0.380</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>B900 000</i>	<i>Crocam</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>B900 100</i>	<i>Owenwee River</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>
B900 200	Money Beg	1	1.424	0.026	1.424
B900 300	Gortahork	0.940	2.460	0	2.620
C000 000	Cronadun Td	1	0.462	0.107	0.462
C000 100	Owenbeg River	1	0	0.333	0
<i>C000 200</i>	<i>Derryveagh Mountains</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>C000 300</i>	<i>Lough Naboll</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>C000 400</i>	<i>Horn Head</i>	<i>0.999</i>	<i>0</i>	<i>0</i>	<i>0</i>
<i>C100 000</i>	<i>Thonevancil Hill</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>
C100 100	Rashedoge	1	3.04	1.35	3.04
C100 200	Tirkillin Td	1	5.48	0.449	5.48
C100 300	Drumlackagh Td	1	0.308	0.257	0.308
C100 400	Rosguill	1	0.515	0	0.515
C200 000	Deele River	1	5.920	0.205	5.920
C200 100	Dromore Td	1	9.880	0.583	9.88
C200 200	Leannan River	1	6.100	0.316	6.100
C200 300	Ranny Hill	0.86	2.170	0.786	2.520
C200 400	Springfield Td	1	2.280	0.262	2.280
C300 000	Ballindrait	1	12.78	0	12.78
C300 100	Dooish Mountain	1	6.310	0.535	6.480

C300 200	Lough Swilly	0.105	0.094	0.392	0.900
C300 300	Killygarvan Point	0.622	0.155	0.080	0.250
C300 400	Owenerk River	1	0.555	0.029	0.555
C400 300	Owenkillew River	1	0.113	0.064	0.113
C400 400	Owenboy River	1	0	0	0
C400 500	Doagh Island	1	0	0	0
C500 300	Carrowkeel	0.820	6.540	0.384	7.980
C500 400	Loughinn River	1	0	0	0
C500 500	Doonmore Hill	1	1.280	0	1.280
C600 400	Moville	1	8.430	0	8.430
G500 800	Malin Beg	1	0	0	0
G600 800	Glen River	1	0.185	0.092	0.185
G600 900	Slievetooley	1	0	0	0
G700 700	St John's Point	0.020	0	0	0
G700 800	Lough Nabradan	1	0	0	0
G700 900	Lamb's Island	0.83	3.88	0.194	4.67
G800 800	Leagans Hill	1	3.70	0.156	3.70
G800 900	Owentocker River	1	0.048	0	0.048
G900 600	Assaroe Lake	1	1.43	0.126	1.43
G900 700	Ballintra River	1	4.32	0	4.32
G900 800	Crockerinn	1	5.70	0.351	5.70
G900 900	Eany Beg Water	1	0	0	0
H000 700	Lough Nadarragh	1	0.123	0.138	0.123
H000 800	Lough Atlieve	1	0	0	0
H000 900	Croaghbarnes	1	0	0	0
H100 700	Mobagh Td	1	1.01	0	1.01
H100 900	Meenagarranroe Td	1	0	0.414	0
H200 900	Gleneely	1	6.65	0.54	6.65
Total = 55 sample squares					

Calculations were based on a County Donegal Land Area = 4,861 km² (source: www.donegalcoco.ie). When calculating the land area of coastal squares, only the land area was taken (e.g. the portions of squares within Mulroy Bay or Lough Swilly were not included as they are considered to be marine loughs). Where a square occurs in more than one county only the portion of the square within Donegal was counted. Squares with open water bodies were included

in area measurements. Squares are named after obvious physical features or in some cases townlands. Sample squares in **Table 2** in *bold italics* were devoid of hedges. Nineteen (34.5%) out of the 55 sample squares surveyed were devoid of hedges. Most of these were in upland or coastal areas. Smal (1995) maintained that poorer landscapes probably possess less hedge type boundaries for several reasons: boundaries may consist of stone walls, of dykes with sparse or no scrub or hedge vegetation, or of fence lines. Poorer returns from farming may mean that overall boundary length is smaller (i.e. field size is larger - though one should note that unimproved grassland in much of the west is rough pasture which often has few boundaries); poorer farming returns may also result in less attention to maintenance of hedges.

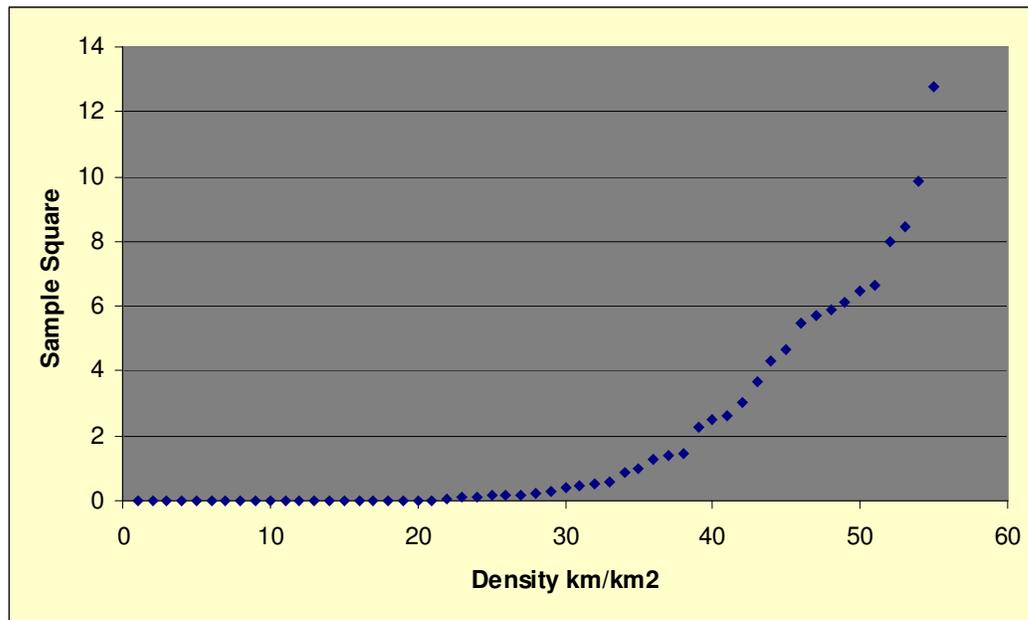
The total area surveyed was 50km² which is 1.0% of the total land area (i.e. 4,861km²) of the county. County Donegal was found to have a hedgerow length of 10,408.30km. This compares to 15,574km for County Roscommon (Foulkes & Murray, 2005). The corresponding figures for remnant hedgerows would give an estimated length of 835.20km compared to 2,165km for Roscommon. The total hedgerow resource is therefore 11,243.5km broken down into 92.6% hedgerow and 7.4% remnant compared to 87.8% hedgerow and 12.2% remnant for Roscommon. Donegal has less hedgerows despite its larger area probably as a result of the more mountainous and coastal nature of Donegal.



Photo 1: Donegal upland landscape devoid of hedgerows

The Ballindrait square (Grid ref. C300 000) had the greatest extent and density of hedgerows at 12.78km and 12.78km/km² respectively followed by the Dromore Td square (Grid ref. C200 100) at 9.88km and 9.88km/km². The third highest was the Moville square (Grid ref. C600 400) at 8.43km and 8.43km/km² respectively. The three squares with the highest hedgerow lengths and densities are all in the lowlands where agricultural land is richer and where cattle grazing require stock-proof field boundaries. The average figure for hedgerow density is 1.96km/km² compared to 5.43 km/km² for County Roscommon reflecting the larger area of County Donegal specifically its large expanses of upland with few or no hedges. A precursory look at field patterns on the aerial photographs shows that hedgerow densities were undoubtedly higher in some areas. Crop marks showing the original line of the hedge are clearly visible.

Figure 1 shows the distribution of hedgerow density throughout the sample squares.



hedgerow survey estimating the mean length for the Republic of Ireland to be 5.7 km [6.5 km] length per 1 km square. However, there are differences in the definitions used between the two surveys and therefore a direct comparison of the two data sets cannot be made.

Smal (1995) maintained that many of the western counties (Kerry, Galway, Mayo, Donegal, Roscommon), and also County Wicklow in the east, have low hedgerow and treeline length. He also deduced that thus proportionately more field boundaries in counties such as Donegal, Westmeath, Clare, Kerry, Carlow and Sligo consisted of scrub. Smal (1995) calculated the density of hedgerows in the County at 1.8km/km² if uncorrected for sea, lake and beach areas or 2.02km/km² if corrected for these physical features. Extrapolating up to the County land area of 4861km², would give a total hedgerow length of 8749.8km and 9819.22km respectively depending on whether the corrected or uncorrected figures were used. The current survey estimated a total hedgerow length of 10408.30km. During the current survey, new hedgerows (less than 20 years old) were rarely seen. However, very few instances of recent hedgerow removal were also observed. In the absence of comparable methodologies, there is no way of knowing whether there has been a real change in hedgerow extent since the badger habitat survey was carried out. Repeating this current baseline hedgerow survey using the same methodology of Murray & Foulkes (2007) will provide the answer.

8.2 Floristic Hedge Types for County Donegal

Appendix 4 gives a summary of the TWINSPAN data used in the TWINSPAN analysis and the outputs of the TWINSPAN classification. **Appendix 4** also shows a dendrogram of the groups of hedge types delimited by TWINSPAN. Five hedge type groups were outputted and their distinguishing species compositions are as follows:

Group 1 Hedges Characterised by Beech

No other species occur in this hedge type. Only one measured hedge fell into this category representing 1% of all random hedges surveyed. This hedge type was sometimes observed around existing or abandoned buildings.

Group 2 Hedges Characterised by Ash, Hawthorn and Blackthorn

This group is characterised by Ash and Hawthorn, and Blackthorn, with Holly and Gorse. The total number of species in all hedges in this group was 17. The average number of species for hedges in this group (i.e. mean species richness) is 3.25. This type was the most common of all surveyed. Forty-eight hedges were of this type representing 48% of all random hedges run

through the TWINSPAN analysis. The 48 hedges of this type surveyed were found throughout Donegal at an altitude range between 5.5m and 211m (Mean = 65m). Although this hedge type could be found at higher altitudes than Group 4 hedges, 63% of hedges of this type sampled occurred below 50m altitude and another 24% below 100m. This means that 87% of this hedge type occur below 100m altitude. Most hedges of this type (18.75%) were found in the Ballindrait sample square (Grid ref. C300 000) which will be recalled is the sample square with the highest hedgerow length and density values. In contrast to the lowland nature of this square, this hedge type was found at over 200m altitude in the Dooish Mountain square (C300 100).

Group 3 Hedges Characterised by Hawthorn, Gorse and Rusty Willow

This group is characterised by Hawthorn, Gorse and Rusty Willow with some Ash, Holly, Sycamore, Broom and Rowan. The total number of species in all hedges in this group was 21. This type was the second most species-rich type. The average number of species for hedges in this group (i.e. mean species richness) is 3.75. Thirty-six hedges were of this type representing 36% of all random hedges run through the TWINSPAN analysis. Interestingly the 36 hedges of this type surveyed were found in the eastern half of the County being absent from the extreme west and north-west. They occur at an altitude range between 9m and 190m (Mean = 32m). 58% of hedges of this type sampled occurred below 100m altitude and 42% >100m. This hedge type was most commonly found in sample squares C500 300 and C600 400 comprising 22.9% and 20% of all hedges of this type were found in the Carrowkeel (Grid ref. C500 300) and Moville sample squares (Grid ref. C600 400) respectively.



Photo 2: Group 3 type hedge



Photo 3: Gossamer (spider silk) on gorse

Group 4 Hedges Characterised by Willow

Hedges characterised by Eared Willow, Rusty Willow and Gorse with some Hawthorn, Hazel, Holly, and Rowan, and less frequently Blackthorn and Downy Birch. The total number of different species in all hedges in this group was 13. This type was the most species-rich hedge type. The average number of species for hedges in this group (i.e. mean species richness) is 5.6. Thirteen hedges were of this type representing 13% of all random hedges run through the TWINSPAN analysis. The 13 hedges of this type surveyed were found throughout Donegal at an altitude range between 29m and 130m (Mean = 63m). Four (30.8%) of all hedges of this type were found in the Lamb's Island sample square (Grid ref. G700 900) near Ardara.



Photo 4: Leaves of *Salix cinerea* ssp. *oleifolia* (Rusty Willow)

Group 5 Cotoneaster, Fuchsia and Privet Hedges

Hedges characterised by Cotoneaster with Fuchsia and Privet. They are often around existing and abandoned dwellings. The total number of different species in all hedges in this group was 3. The average number of species for hedges in this group (i.e. mean species richness) is 3.0. Two hedges were of this type representing 2% of all random hedges run through the TWINSPAN analysis.



Photo 5: Fuchsia-dominated hedgerow in sample square G88

Finally it is worth noting that the River Dee (sample square C200 000) was the only area supporting all three of the most species-rich hedge types (Groups 2-4) and therefore this may be sufficient justification for hedgerow conservation actions or on-site hedgerow awareness activities with the permission of landowners.

Appendix 4 shows the species dendrogram produced by TWINSpan. From this analysis we see that Alder is not associated with any other group where it occurs and neither is Fuchsia. The native species Hawthorn, Ash, Blackthorn, Elder, Guelder-rose, and Holly associate together. Likewise the native species Broom, Downy Birch, Eared Willow, Gorse, Rowan, Rusty Willow tend to occur together in hedges.

Table 3 shows the relationship between native species occurrence and species richness.

Table 3: The Relationship Between Native Species Occurrence and Species Richness

Hedges Containing	Mean Species Number
Guelder-rose	7.67
Broom	6
Hazel	5.86
Rowan	5.73
Rusty Willow	5.24
Blackthorn	5.11
Holly	4.93
Eared Willow	4.5
Gorse	4.31
Spindle	4
Hawthorn	3.73
Elder	2.8

From this analysis, it is clear that Guelder-rose is a good indicator of the most species-rich hedges in County Donegal. This species was found in only 2 out of 101 hedges examined within the Deele River (Grid ref. C200 000) and Leannan River sample squares (Grid ref. C200 200). Species-rich hedgerows should be targeted for special protection in the County Development Plan and Local Area Plans.



Photo 6: Guelder-rose a species-rich hedgerow indicator in County Donegal

8.3 Species Composition of Donegal Hedges

Species occurring in the hedge layer were as follows:

Table 4: The Frequency of Species Occurrence and Abundance in Sampled Donegal Hedges

Species Name	% Frequency	Mean DOMIN
Berberis	0.602409639	3 (1-4% cover)
Burnet rose	0.602409639	4 (4-10% cover)
Flowering Currant	0.602409639	3 (1-4% cover)
Griselinia	0.602409639	8 (51-75%)
Hebe	0.602409639	3 (1-4% cover)
Leyland Cypress	0.602409639	3 (1-4% cover)
Osier	0.602409639	4 (4-10% cover)
Rhododendron	0.602409639	3 (1-4% cover)
Scots pine	0.602409639	4 (4-10% cover)
Spindle	0.602409639	3 (1-4% cover)
Wild Cherry	0.602409639	3 (1-4% cover)
Escallonia	1.204819277	6 (26-33% cover)
Goat Willow	1.204819277	4 (4-10% cover)
Cotoneaster	1.807228916	5 (11-25% cover)
Guelder-rose	1.807228916	4 (4-10% cover)
Oak	1.807228916	3 (1-4% cover)
Privet	2.409638554	5 (11-25% cover)
Snowberry	3.012048193	5 (11-25% cover)
Broom	3.614457831	4 (4-10% cover)
Downy Birch	3.614457831	5 (11-25% cover)
Elder	3.614457831	4 (4-10% cover)
Fuchsia	3.614457831	6 (26-33% cover)
Salmonberry	4.21686747	6 (26-33% cover)
Alder	4.819277108	4 (4-10% cover)
Beech	4.819277108	4 (4-10% cover)
Eared Willow	6.024096386	5 (11-25% cover)
Hazel	8.43373494	4 (4-10% cover)
Rowan	9.036144578	4 (4-10% cover)

Sycamore	9.036144578	4 (4-10% cover)
Blackthorn	11.44578313	5 (11-25% cover)
Rusty Willow	19.87951807	4 (4-10% cover)
Ash	22.28915663	4 (4-10% cover)
Holly	24.69879518	4 (4-10% cover)
Gorse	30.72289157	6 (26-33% cover)
Hawthorn	48.19277108	7 (34-50% cover)

Note the table above refers to woody native and non-native species in the hedge including species that are normally classified as trees but as a result of cutting assume a shrub like form (i.e. are multi-stemmed). It does not include trees proper with a single stem. Hawthorn is both the most frequently occurring native hedge shrub and has the highest percentage cover in all hedges. Gorse is found in nearly a third of all hedges sampled, with a relatively high mean cover. Rusty Willow, Ash and Holly are also frequent (each in nearly a quarter of hedges). Rowan and Sycamore are also fairly frequent. Guelder-rose only occurs in circa 2% of all hedges but is a good indicator of species-richness in hedges. **Figure 2** presents the % frequency of these species in the sampled Donegal hedges.

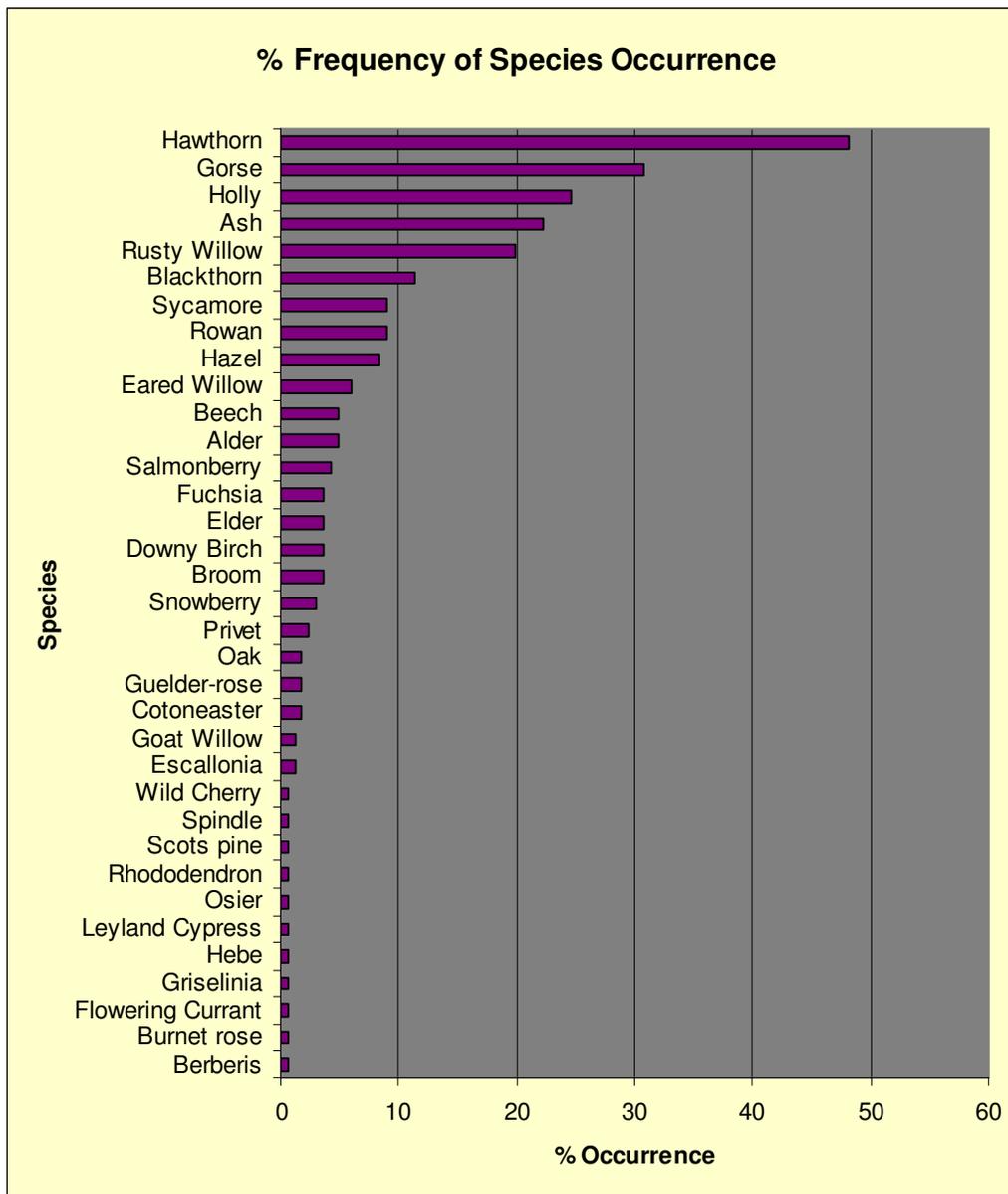


Figure 2: The % Frequency of Species Occurrence in Sampled Donegal Hedges

Tree Species Richness

Forty-four hedges had trees comprising 13 species and 75 tree species occurrences across all hedges. Each different tree species in a hedge was recorded present but no attempt was made to count the number of individuals of a given species. **Table 5** and **Figure 3** presents the frequency of each species is presented below. Some species such as individuals of Rowan, Sycamore and Ash were multi-stemmed and therefore may have been coppiced.

Table 5: % Frequency of Tree Species in Sampled Hedges

Tree Species	% Frequency
Ash	28
Sycamore	17.3
Holly	12.0
Rowan	8.0
Alder	6.7
Beech	6.7
Downy birch	5.3
Rusty Willow	5.3
Oak	2.7
Sitka Spruce	2.7
Wild Cherry	2.7
Crab Apple	1.3
Lawson's Cypress	1.3

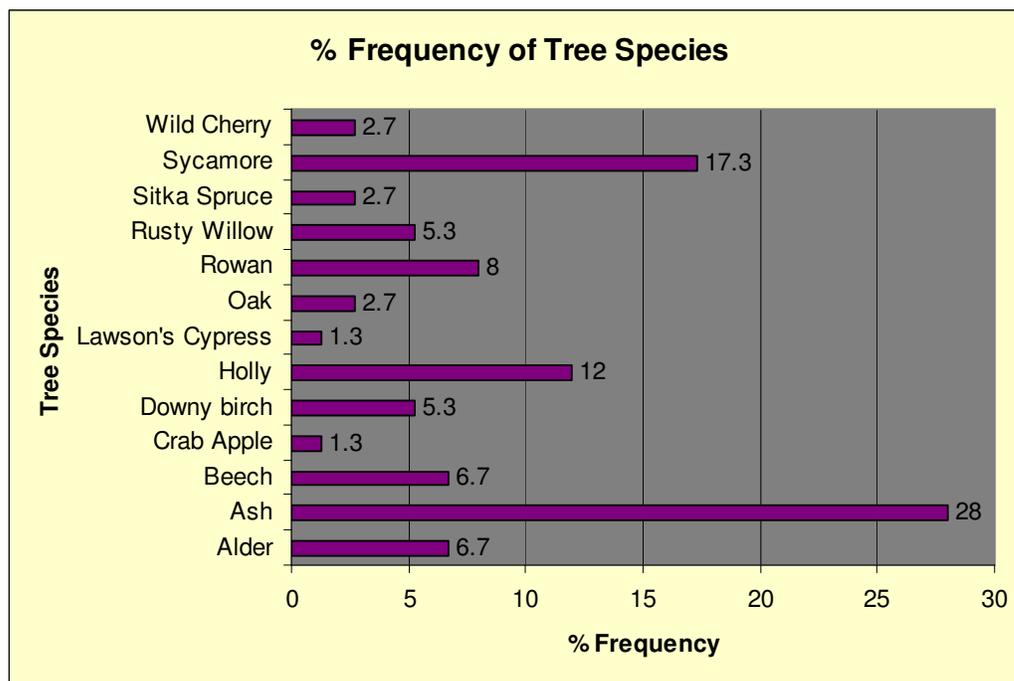


Figure 3: The % Frequency of Tree Species in Sampled Hedges

The most common hedgerow tree recorded was Ash followed closely by Sycamore. Next commonest in descending order of frequency were Holly, Rowan, Alder and Beech. Oak was rare as a hedgerow tree although it was observed to be locally common along some boundaries as tree lines rather than an integral part of a hedge.

There is little diversity of hedgerow tree species in the county. 27 hedges (61%) had only one tree species, 9 (21%) contained two species, 4 (9%) had three species, and 4 (9%) had four species or more.

Hedge Species Richness

Species richness is simply the number of species found in a 30m sample strip of a hedge. As two sample strips were recorded for each hedge, the average number of species from the two strips is the most representative figure of species richness for each hedge. Only native species based on Webb (1996) are included for the calculation of species richness. Climbing and scrambling plants are also excluded from this calculation. A diverse range of climbing plants was recorded in the hedgerows including Ivy, Bramble, Sweet Briar, Dog-rose and honeysuckle. These add to the wildlife value of the hedge. In comparison to other County hedgerow surveys, all roses were identified to species level if in fruit.

A species rich hedge, on the other hand, is defined as one that contains four or more native woody species on average in a 30m strip. This number is adapted from the UK Hedgerow Regulations, where five or more species are required for a hedge to be considered species rich in general, but only four or more are required in northern England, upland Wales, or Scotland. As Ireland's native flora is diminished from that of mainland United Kingdom, four species per 30m length or more has been used as a measure of a species-rich hedge. 42 (41.58%) of all hedges where two strips were examined were species-rich. The most species rich hedges occur in the following squares: 7 out of 10 sampled hedges in C200 000 square had 4 or more native species; 6 out of 10 sampled hedges in H200 900; 5 out of 10 sampled hedges in C200 200 and 4 out of 10 sampled hedges in G700 900, and G900 800. These sample squares should be targeted for hedge conservation actions. The mean species richness in all sampled hedges was 3.3.



Photo 7: *Hedera helix* (Ivy) in flower



Photo 8: *Rosa rubiginosa* (Sweet Briar) hips

Townland Boundary Hedges

Only 3 (2.97%) out of 101 randomly selected hedges occurred along townland boundaries. Two were in sample square C300 000 and the other in sample square C500 500. The mean species of these townland boundary hedges was 3.7 species as against a mean species richness for all hedges of 3.3. A more detailed study of townland hedges is needed to ascertain whether townland hedges are in fact more species rich than non-townland hedges as has been discovered in other counties considering the small sample of townland hedges examined in this study.

Roadside Hedges and Species Richness

The species richness (including all species) of roadside hedgerows (old farm tracks and minor roads were included although the vast majority were surfaced driveable roads) was compared with non-roadside hedges, and it was found that the mean species richness in roadside hedges in County Donegal was 3.2 compared to a non-roadside mean of 3.4. In contrast, corresponding figures for Roscommon were 3.0 for roadside hedges, compared to a non-roadside average (mean) of 2.4. The difference in the actual values for species richness could be due as much to a different consideration of what species are counted towards species richness. In this study only native woody species were counted towards the species richness figure with all climbers and scramblers being excluded from the species richness calculations.

Figure 4 and **Table 6** give a breakdown of the overall distribution of hedge group types and compares this with just roadside hedges.

Table 6: % of Roadside Hedges within Each Hedge Type

Group Type	1	2	3	4	5
No. of Roadside Hedges	1	13	21	7	2
% of all Roadside Hedges	2.3	29.5	47.7	15.9	4.6

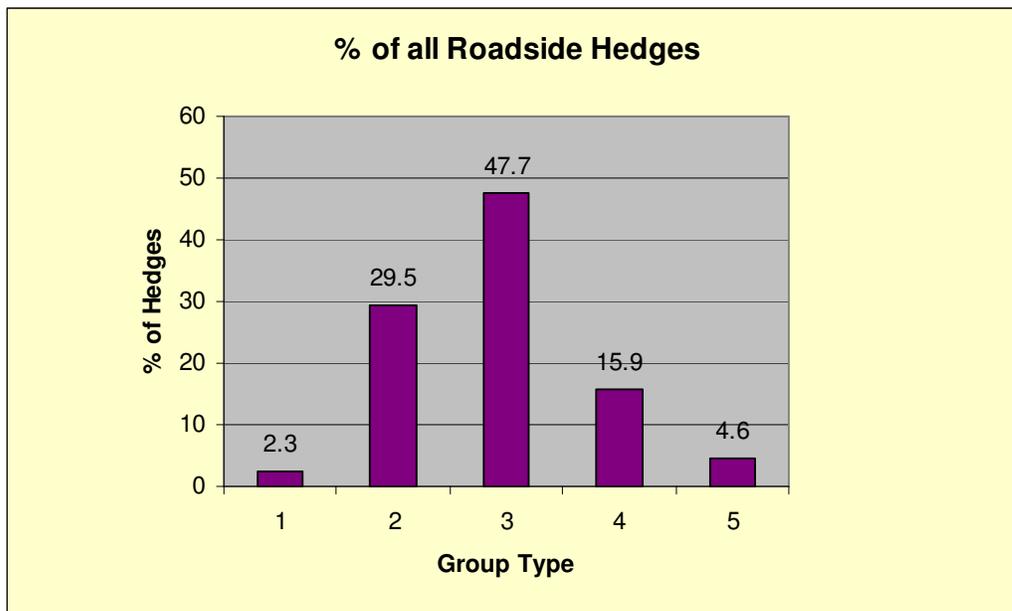


Figure 4: % of Roadside Hedges within each hedge type

As can be seen from the data table and chart, 47.7% of hedges were classified as Group 3 (second most species-rich group) and 15.9% fell into the most species-rich hedge Group 4.

8.4 Character and Condition of Hedges in County Donegal

The character and condition of hedges has been assessed in a number of different ways, including the overall profile of each hedge, the proportion of gaps in the length of hedgerow, height, width, the density of shrub growth in the base of the hedge, and the amount of fruit produced.

Information was also recorded on the boundary type and history, and on the links with other habitats.

Links with Other Habitats

Habitat linkages are the backbone of wildlife corridors that are important to ensure that flora and fauna can traverse throughout the countryside in relative safety. There were 129 habitat linkages to 101 hedges. Out of these 129 linkages, 82 (63.57%) were to other hedgerows. The next most common habitat linkage was watercourses at 14 (10.85%).

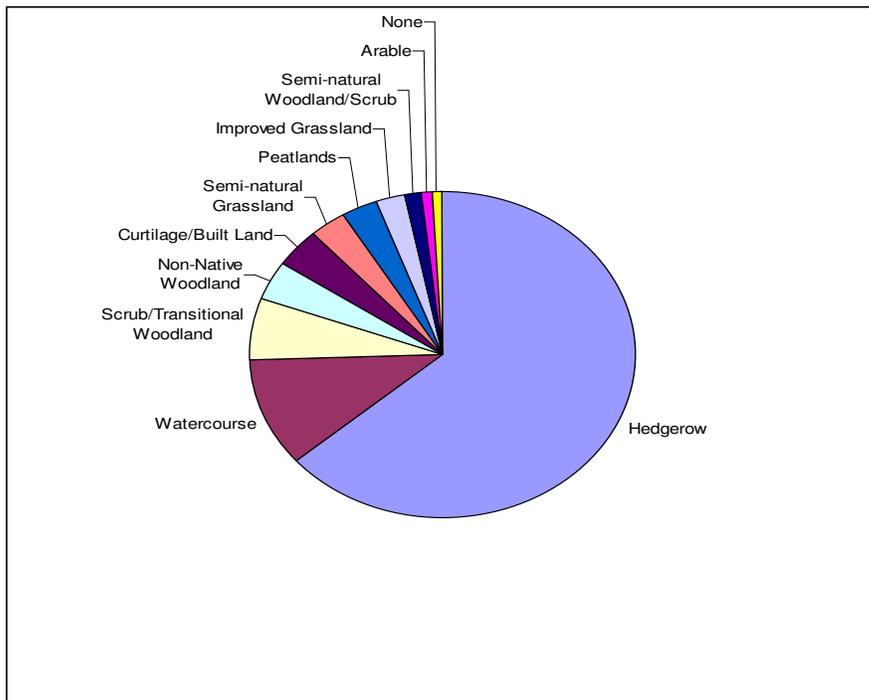


Figure 5: Linkages of Sampled Hedges to Other Habitats

Hedge Profile

A low proportion of hedges in the county are structurally extremely poor, with a total of only 6.9% being either remnant (where only sparse shrubs or trees remain, covering <25% of the boundary length) or derelict (defined as where shrubs and thorns of the hedge component have mostly grown up into trees, no longer displaying shrubby or dense growth form in the bottom 1-2 metres of the hedge). Both of these profiles are no longer functional as stock-proof boundaries, although they may have additional fencing.

A further 39.5% however, are in the ‘losing structure’ category, defined as where many of the shrubs and thorns of the hedge no longer display low dense growth, and most of the stems are visible. Hedges in this category can also be described as ‘leggy’. Without careful management intervention, these hedges will soon move from becoming derelict to eventually becoming redundant resulting in a decline in Donegal’s hedgerow resource.

27.5% of hedges are overgrown more often not with outgrowths at the base, a category which refers to those hedges that have been allowed to grow up tall and ‘wild’ and therefore of higher conservation value. These hedges tend to have thicker and denser form than those classed as derelict or losing structure.



Photo 9: Example of a hedgerow with good structure

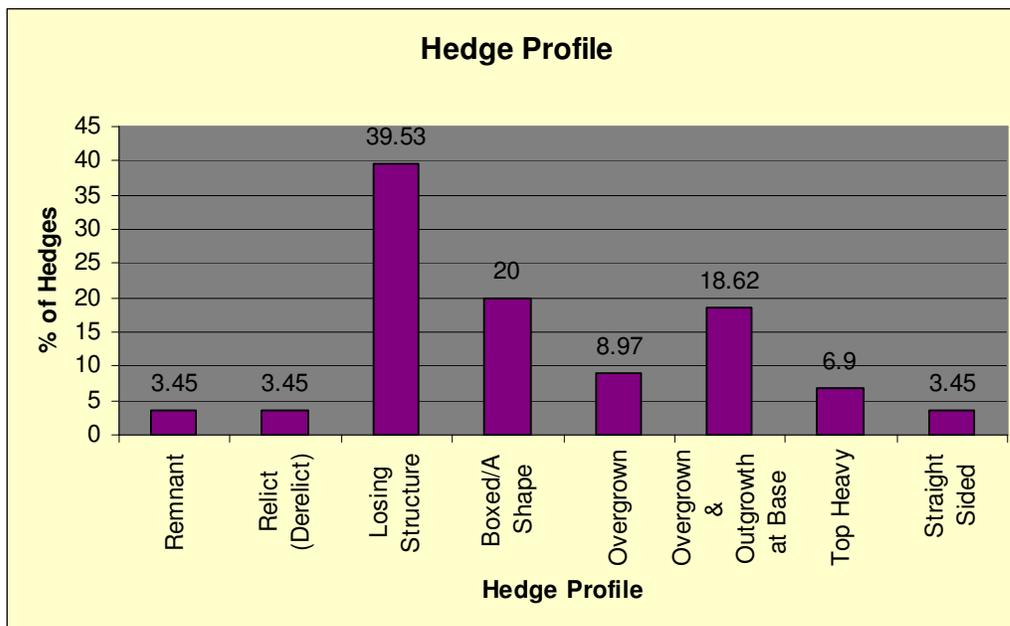


Figure 6: % of hedges in profile categories

Gaps in Hedge Structure

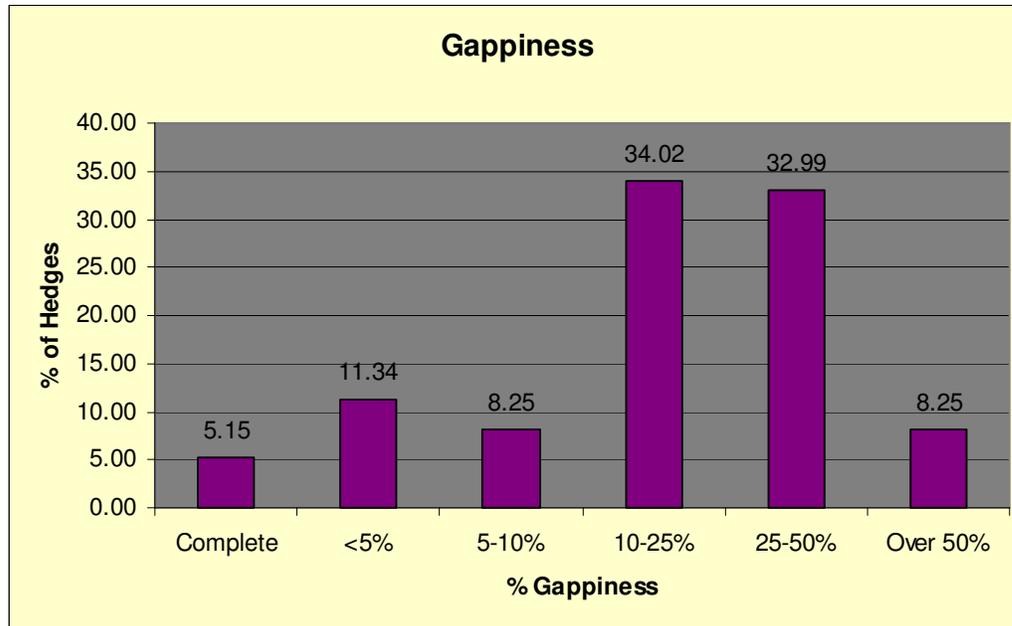


Figure 7: % of hedges in % gappiness categories

Over 40% of hedges contained over 25% gaps. Gaps are taken to be breaks in the linear continuity of the hedge. It is best assessed in the bottom 1m of the hedge. Some hedges have very distinct gaps, in other hedges the gappiness is more a result of the overall sparse number of hedgerow stems. Gaps are associated with a weak hedge structure, and are generally a symptom of the deterioration of the hedge, often caused by the demise of plants through age or inappropriate management. Most hedge functions are diminished if the level of gappiness is too high. Only a small number of hedges (5.15% in total) were without gaps in their structure.



Photo 10: Gappy hedgerow

Hedge Base Structure

The density of the growth of hedge shrubs in the bottom metre of the hedge is an important indicator of the hedge structure. An open base is normally associated with a hedge that is moving toward a tree line, with consequent decrease in the functional role of the hedge as a stock-proof barrier and its ability to support wildlife.

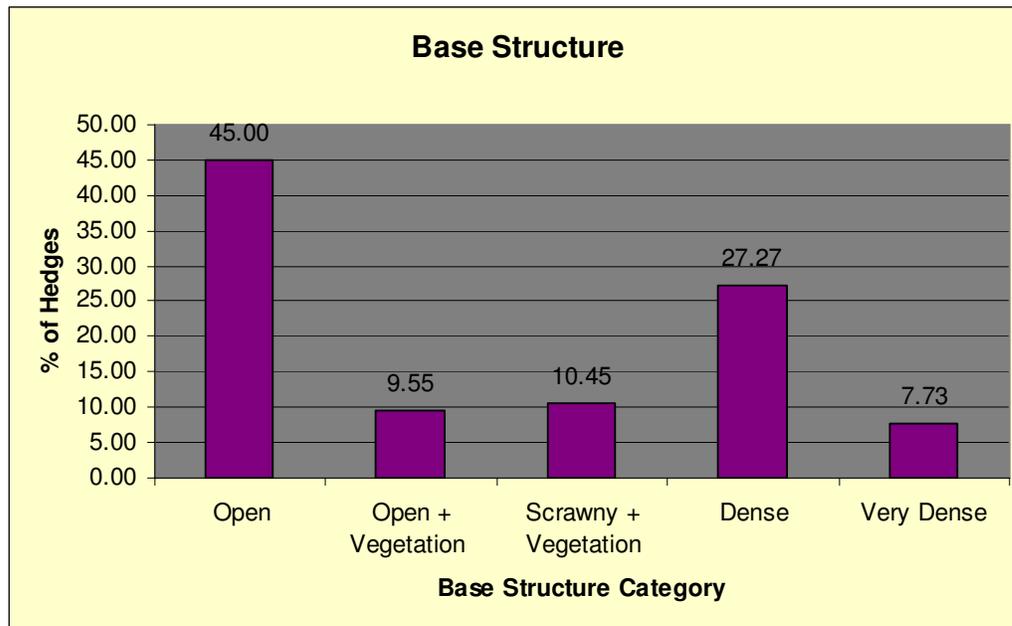


Figure 8: % of hedges in different base structure categories

The analysis shows that there is a worryingly high proportion of hedges (45%) with an open base structure with only 35% in the dense (Photos 11-12) and very dense categories combined.



Photo 11: Dense roadside hedgerow of high conservation value



Photo 12: Dense internal boundary hedgerow along old track

Hedge Height

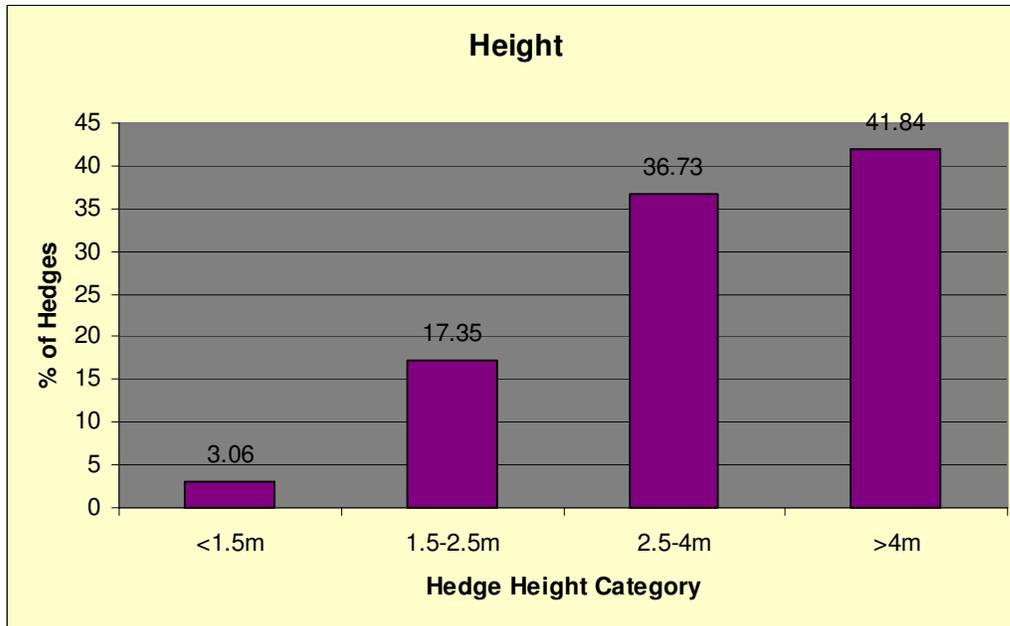


Figure 9: % of hedges in different height categories

Increasing hedgerow height correlates positively with increasing diversity of bird species in a hedge. Only 3.06% of hedgerows in Donegal are less than 1.5m in height. Encouragingly 41.84% are >4m although it is not to say that they fall down on other categories such as % gappiness or base structure.

Hedge Width

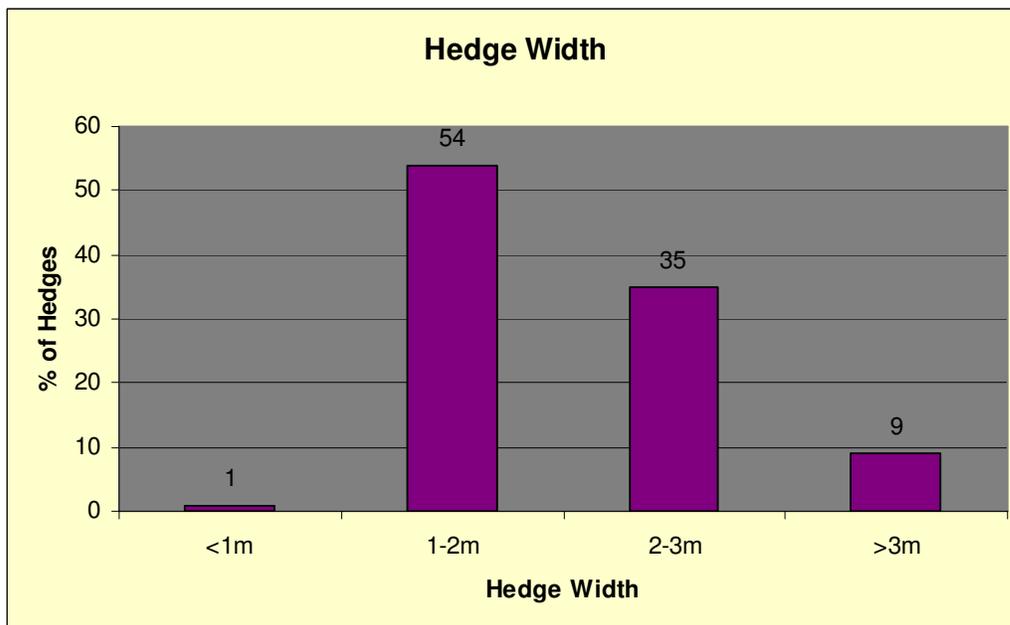


Figure 10: % of hedges in the different width categories

In general, the wider the hedge the better it is for wildlife. As the results of the survey show, 99% of hedges in Donegal are over 1m wide with most hedges (54%) in the 1-2m category.

Tree Abundance

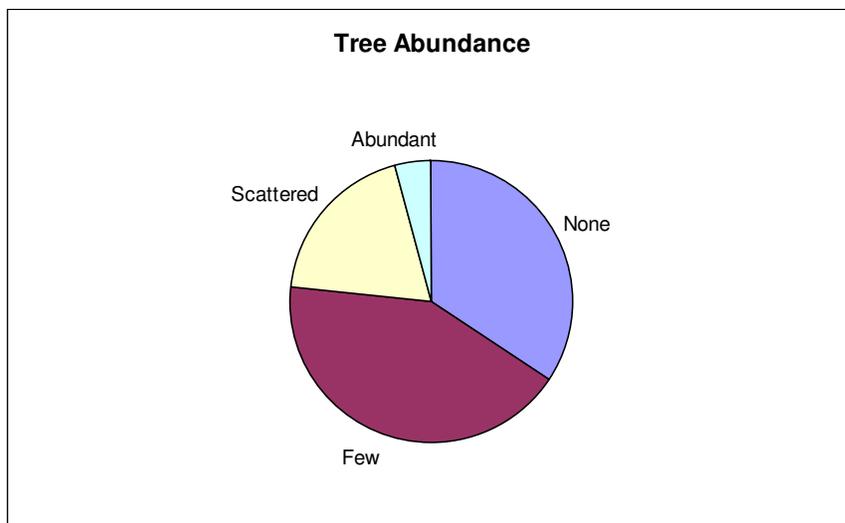


Figure 11: Tree abundance in sampled County Donegal hedges

Hedgerow trees act as and also provide breeding sites for birds. Hedgerows with trees provide a wider range of ecological niches for a wider range of flora and fauna than those without trees. Trees in hedges can also act as a source of fuelwood if harvested sustainably. 34% of hedges sampled in County Donegal have no trees at all, while 42% have few trees (defined as two or three isolated trees). There is therefore a need to increase the number of trees in Donegal hedgerows as a whole by protecting tree saplings during cutting operations thereby allowing them to grow on to maturity. **Figure 12** shows that only 36.74% of the hedges sampled have young trees present.

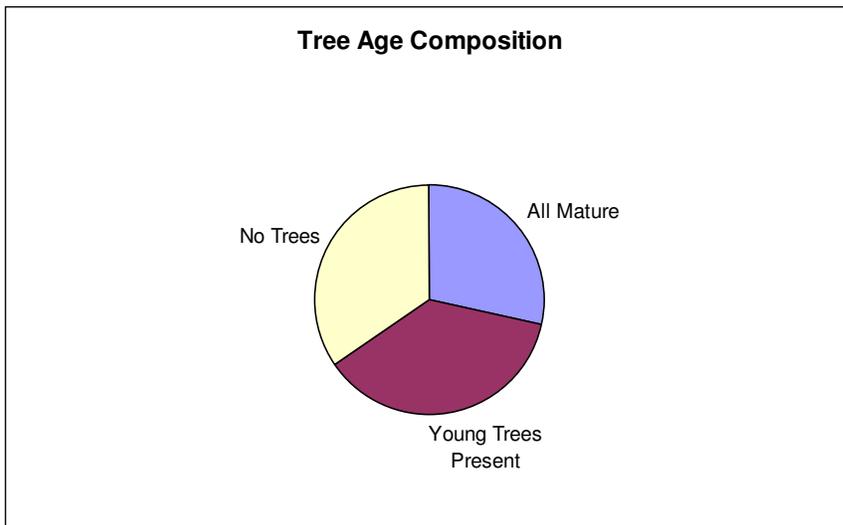


Figure 12: Tree age composition in sampled County Donegal hedges

It is generally considered that to achieve sustainable levels of hedgerow trees a balance between young, medium, and older trees needs to be maintained.

Associated Features

97% of hedges are associated with a bank or wall. 86% of all hedges surveyed have a bank or wall over 0.5m in height.

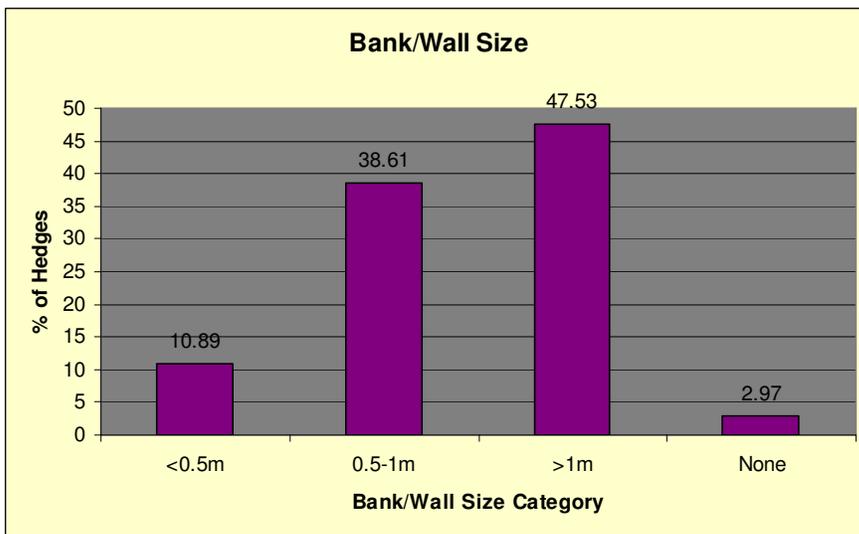


Figure 13: % of sampled hedges in different bank/wall size categories

The wall or bank is an integral component of the hedge structure. 47.53% of all sampled hedges had a bank/wall >1m. These banks and walls add to the species diversity of the hedge by supporting a diverse range of grassland, wall and woodland herbs.



Photo 13: Wide hedgebank supporting a diverse herbaceous flora



Photo 14: Hedgebank with a diverse herbaceous flora in sample square G700 900

The results of the recording of the condition of walls/banks (**Figure 14**) show that the vast majority (90.1%) are intact.

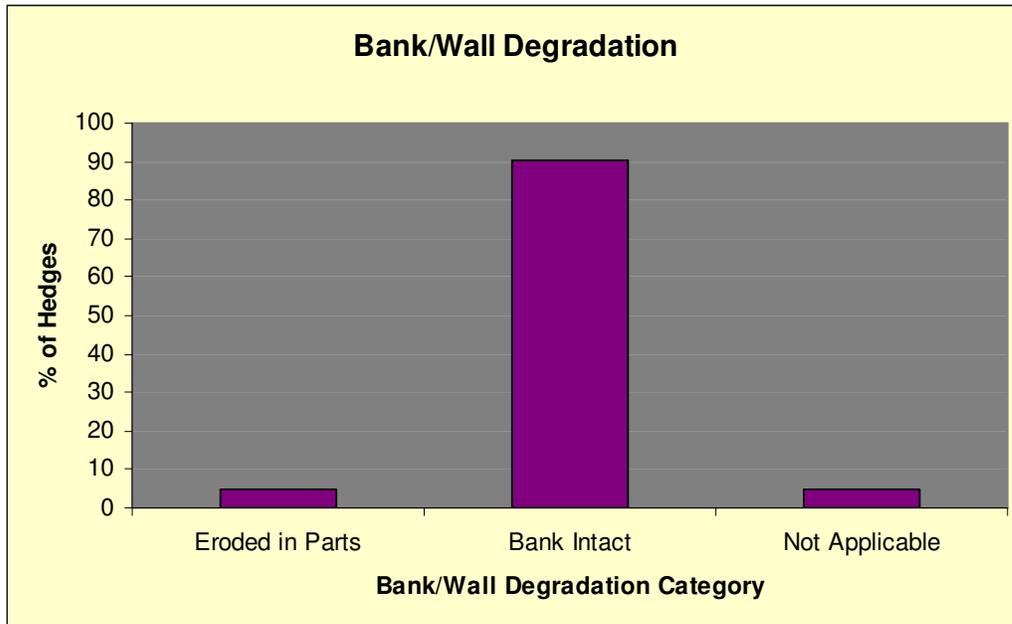


Figure 14: % of sampled hedges associated with different bank/wall degradation categories

Drains

91% of hedges are associated with a drain, with only 9% having a drain of over 1m in size. Drains if not overshadowed by dense shrubs can support important wetland herbs that add to the wildlife value of the hedge/drain unit.

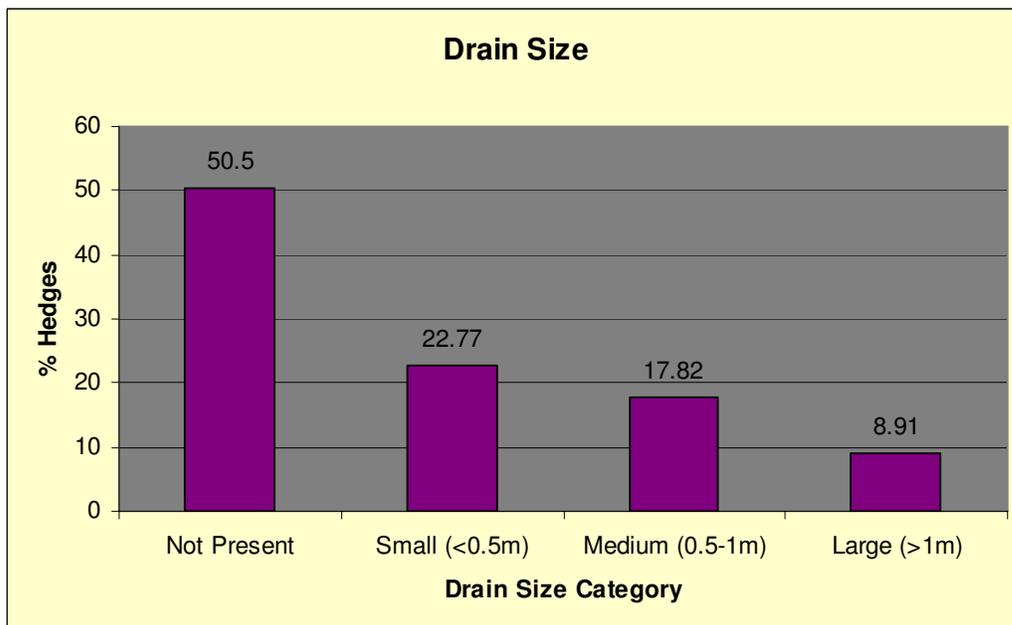


Figure 15: % of sampled hedges associated with different drain size categories

Fruiting

Fruiting has a bearing on the ability of hedgerows to sustain overwintering migrant birds. Levels of fruiting were gauged by assessing the fruiting of hawthorn which is by far the most frequently occurring and abundant hedgerow species.

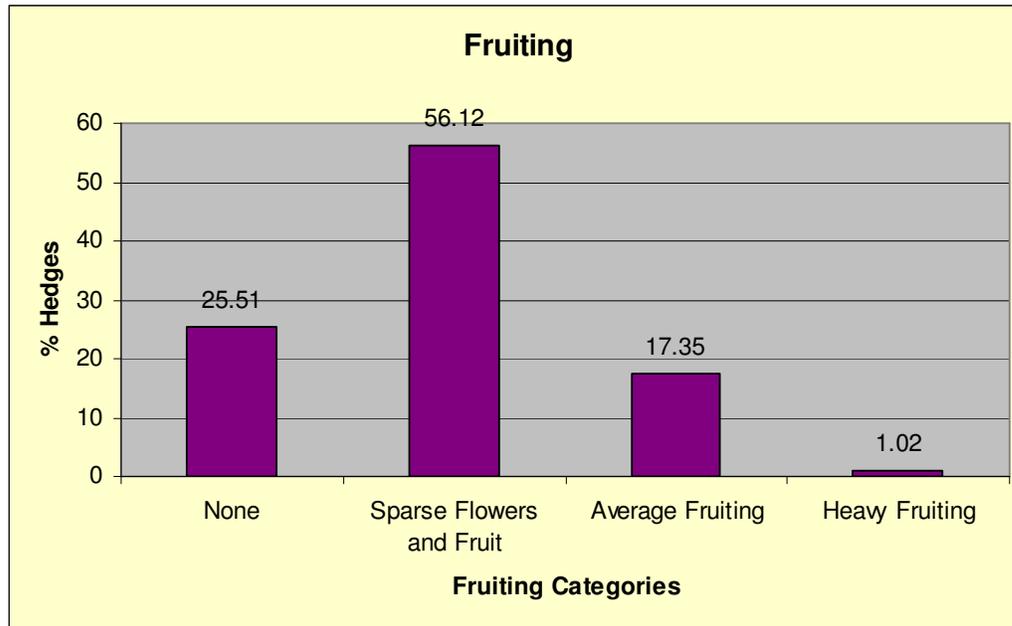


Figure 16: % of sampled hedges in different levels of fruiting categories

81.63% of Donegal's hedges show either no or limited signs of fruiting. 25.51% of Donegal's hedges show no fruiting. During hedgerow surveys of County Roscommon, 17% of Roscommon hedges showed no evidence of fruiting (Foulkes & Murray, 2005). Limited levels of fruiting can be explained largely in terms of how the hedgerows are managed, notably what methods are used.



Photo 15: Example of a prolifically fruiting Donegal hedgerow

8.5 Management of Hedges in County Donegal

Hedgerows are predominantly man-made features and require a degree of management intervention to be sustainable. Lack of management eventually results in a field boundary that is no longer stock proof as gaps start to appear while their wildlife and landscape value declines.

Boundary Function

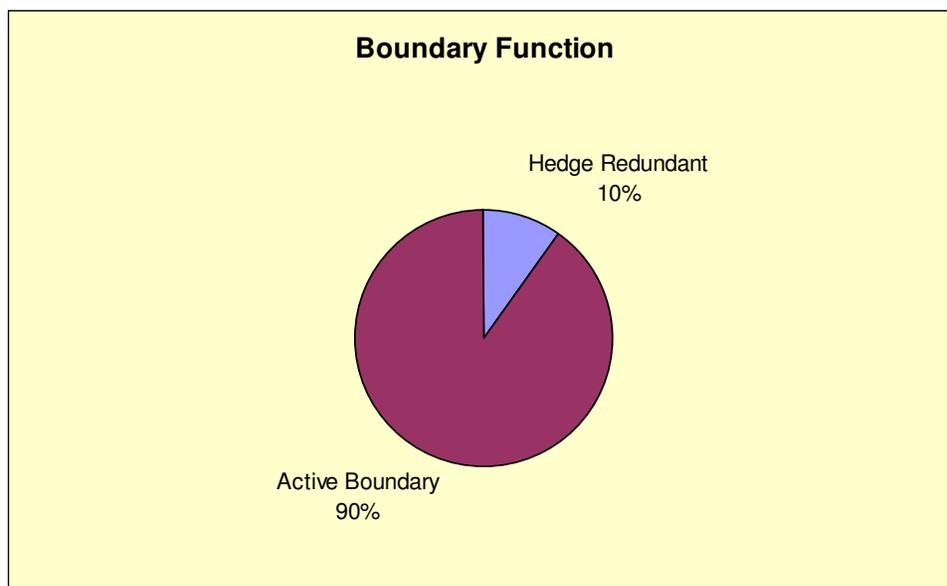


Figure 17: Proportion of active and redundant hedges

Active and redundant boundaries refer specifically to the functionality of the hedge as a stock-proof barrier. Only 10% of boundaries containing hedgerows are no longer functional. The proportion of active and redundant hedgerows in an area will vary in space and time in accordance with socially and economically driven changes in agricultural practices such as land ownership patterns and changing tastes in food crops. Ninety-one hedges were active. Worryingly, only 38 (41.8%) of these 91 active boundaries hedges are being actively managed. 68 (67.3%) of all hedges have additional fencing. 61 (67%) of all active hedges have some sort of additional fencing compared to 60% for County Roscommon (Foulkes & Murray, 2005). Only 1% of redundant boundaries are still being actively managed compared to 15% for Roscommon indicating that redundant hedges are no longer considered important by landowners (despite other roles that these hedges might play on the farm such as providing shelter for livestock) or that scarce resources are being deployed elsewhere on the land.

19.8% of all hedges sampled have wire fixed to hedgerow stems (**Figure 18**). This has implications for safety, the well being of the hedge, and the cost of restoration. Wire in the hedge is capable of damaging hedge-cutting machinery and makes the activity potentially unsafe. Where wire is attached to hedgerow stems it can lead to bacterial and fungal infection which weakens the structure of the plant and can even threaten the health of hedgerow stems. The cost of restoring degraded hedges is increased by the presence of wire which needs to be removed before work can be carried out safely.

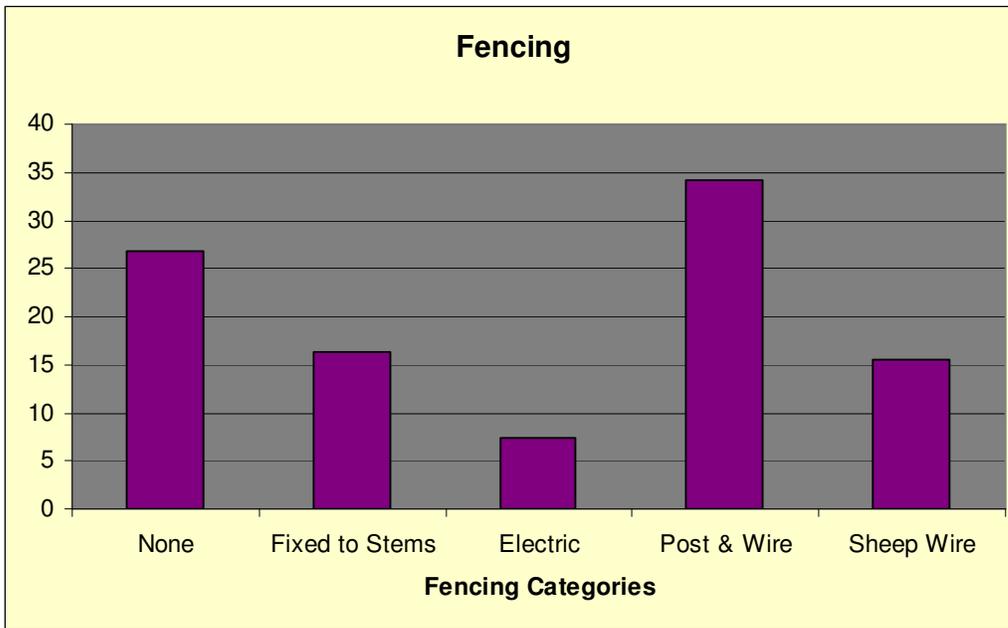


Figure 18: Proportions of hedges with different fencing categories

Boundary Type

As can be seen from **Figure 19**, most hedges (98%) in County Donegal are of the single line type. This would be indicative of a planted origin (Foulkes & Murray, 2005). 87% of random hedgerows have a bank as part of the structure. Only 6.9% of Donegal hedgerows have a stone wall compared to 11% of Roscommon hedges.

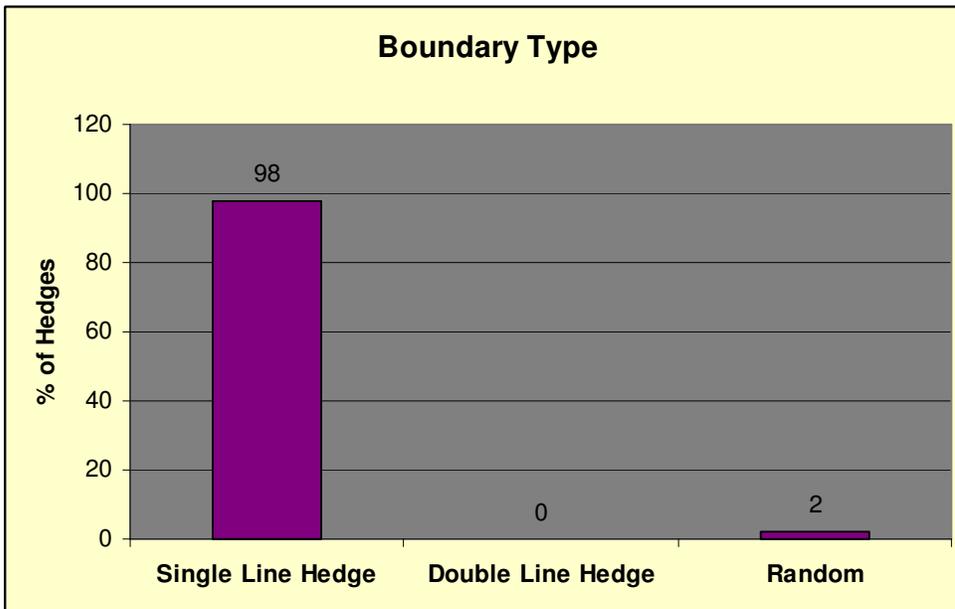


Figure 19: % of hedge boundary types

Management Type

None of the sampled hedges were managed by laying, excavator or coppicing. Hedges cut into an 'A' shape provide maximum benefits to wildlife providing a wider range of ecological niches and therefore more species. However during this study these only amounted to 2.97% of all sampled hedges. 44.55% of sampled hedges were long-term unmanaged. Short-term unmanaged hedges amounted to a further 16.83%. Clearly the management of hedges in the County needs to be addressed.

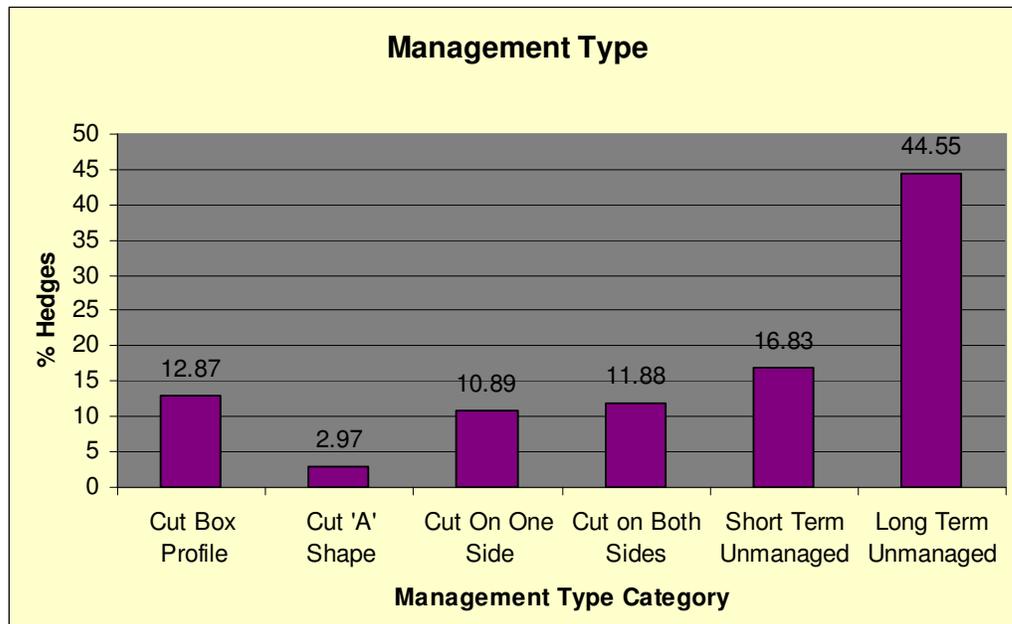


Figure 20: % of sampled hedges in different management type categories



Photo 16: Roadside hedge cut into a box profile



Photo 17: Side-trimmed hedge along boreen with top growth left uncut

Management Method

The flail is the main management tool, responsible for 41% of all sampled hedges. Hand tools were used for 2% of hedges. No hedge was managed by excavator, circular saw or bar cutter. Some hedgerows were poorly managed with unsharpened flails resulting in flayed branch ends that allow for the easy passage of pathogens. It demonstrates the need to ensure that all personnel involved in hedgerow management are properly trained and certified in best hedge-cutting practices.



Photo 18: Poorly managed hedge with flayed branch ends

Hedge Rejuvenation

None of the hedges surveyed showed past or recent evidence of laying indicating that it may not have been a widespread practice in County Donegal. This management method has however been used in County Donegal. **Photo 19** shows an example of an unsurveyed laid hedge observed in sample square H 200 900.



Photo 19: Hedge managed by laying in sample square H 200 900

9.0 DISCUSSION

County Donegal has an abundant hedgerow throughout the county. The altitude range of all sampled hedges lied between 5.5m and 211m (Mean = 68m). **Figure 21** presents a breakdown of the sampled hedges into the altitude ranges where they occurred.

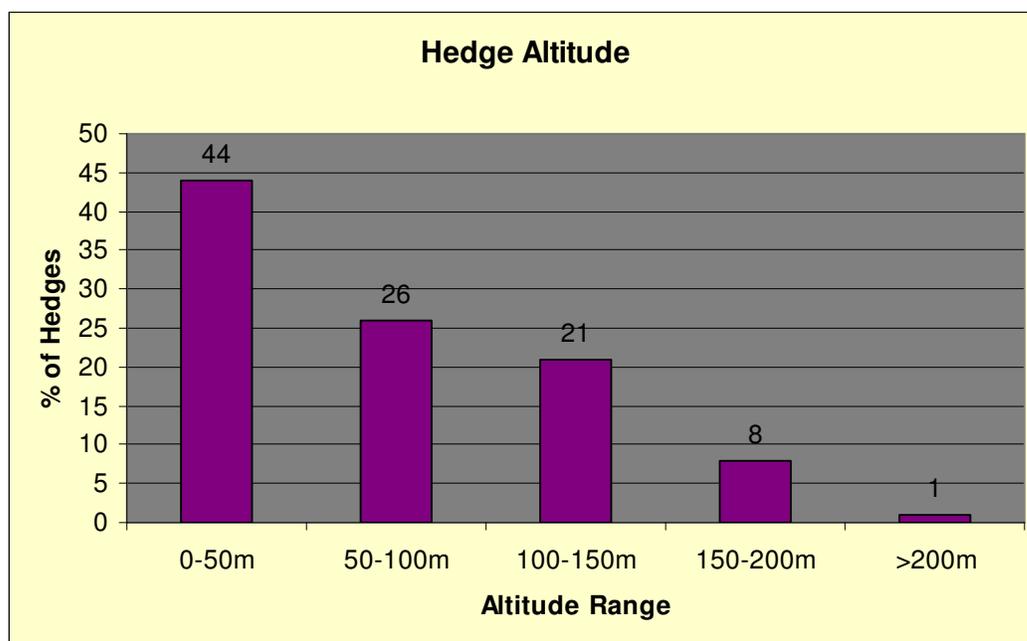


Figure 21: % of hedges sampled in different altitude range categories

It is seen that 44% of all sampled hedges occurred below 50m and 70% below the 100m mark. If the 100-150m altitude range is added then a massive 91% of all sampled hedges occur below 150m. Donegal hedgerows are therefore predominantly a feature of lowland agricultural landscapes. The increased exposure, lower temperatures and often poorer soils at higher altitudes is not conducive to the growth of a wide range of woody trees and shrubs characteristic of hedgerows.

The estimated total length of hedges in County Donegal is 10,408.30km, a huge natural asset to the County. There is a wide range of hedgerow shrub species to be found in the County. The mean species richness in all sampled hedges was 3.3, a total of 19 native species in all excluding climbing and scrambling plants.

The TWINSPAN analysis delimited 5 different hedgerow types in the County. Group 4 hedges were the most species-rich. These are characterised by Eared Willow, Rusty Willow and Gorse with some Hawthorn, Hazel, Holly, and Rowan, and less frequently Blackthorn and Downy Birch.

The total number of different species in all hedges in this group was 13. The average number of species for hedges in this group (i.e. mean species richness) is 5.6. These species-rich hedges should be prioritised for retention and active management through a mixture of awareness-raising activities and positive fiscal incentives.

Species richness is only one measure of a hedgerow's conservation value and other criteria need to be utilized in assessing a hedge's overall importance; for example, whether it supports rare hedgebank plants, its overall condition and structure and its role as part of a network of wildlife corridors within the wider landscape. Many hedgebanks themselves were observed to support semi-natural grassland communities (**Photos 13-14**) while the stone walls supported diverse bryophyte and lichen communities. These field boundary features should be comprehensively surveyed in the future to ascertain their conservation and landscape value. However, Foulkes & Murray (2005) emphasize the importance of establishing the overall frequency and distribution of different hedge types, at the national level to determine to what extent the importance of hedge types compares to evaluations based on species richness alone.

Only 3 (2.97%) out of 101 randomly selected hedges surveyed formed part of townland boundaries. Townland boundary hedges have been found to contain higher mean species richness than other hedge types in County Roscommon (Foulkes & Murray, 2005). This is assumed to be due to townland boundary and roadside hedges being generally of more ancient origins and with larger banks than other hedges. The mean species of the townland boundary hedges in the Donegal study was 3.7 species as against mean species richness for all hedges of 3.3. However this was based on a small sample size and therefore a more detailed study of townland hedges would be opportune to ascertain whether townland hedges are in fact more species rich than non-townland hedges.

This study has determined that a high percentage of hedgerows are losing structure, have a high proportion of gaps due to lack of or inappropriate management. As a result they are in danger of no longer fulfilling their diverse functional roles in providing wildlife habitat and a stock-proof barrier etc. 39.53% of all hedges examined, are in the 'losing structure' category, where many of the shrubs and thorns of the hedge no longer display low dense growth, and most of the stems are visible. Without careful management intervention, these hedges will soon move from becoming derelict to eventually becoming redundant with adverse impacts on their wildlife and landscape value. A lack of hedge management leads to a weakened hedge base and a gappier structure. Most hedge functions are diminished if the level of gappiness is too high. Over 40% of hedges

examined contained over 25% gaps. Gaps are taken to be breaks in the linear continuity of the hedge. Some hedges have very distinct gaps, in other hedges the gappiness is more a result of the overall sparse number of hedgerow stems. Only a small number of hedges (5.15% in total) were without gaps in their structure. However it is also worth noting however that hedgerows which are considered to be of relatively poor quality can, with proper management, become higher quality hedgerows.

In general, taller, wider, denser and structurally more intact hedgerows are also preferred by most wildlife, including small woodland plants (Murray, 2001), invertebrates (Burel, 1989), and hedgerow birds (Chamberlain et al, 2001; Arnold, 1983). Continuous hedges with a good basal structure also rarely need additional fencing, and good growth from the bottom of the hedge also allows it to function as a stock-proof boundary on a longer time scale. Taller hedges also provide more shelter for stock and crops (Foulkes & Murray, 2005).

None of the sampled hedges were managed by laying, excavator or coppicing. On the basis of the current survey results there does not appear to have been a traditional of hedge laying in the County at least in recent years. Further historical research will be necessary to determine how widespread this practice was in the past. Hedges cut into an 'A' shape as recommended by the Department of Agriculture, Fisheries and Food administered REPS, and Teagasc provide maximum benefits to wildlife providing a wider range of ecological niches and therefore more species. However during this study, these only amounted to 2.97% of all sampled hedges. 44.55% of sampled hedges were long-term unmanaged. Short-term unmanaged hedges amounted to a further 16.83%. Hedge management is an issue that clearly needs to be addressed if this natural asset is to survive in the long term. Hedges that are uncut tend to lack the dense base structure that is essential for a stock-proof barrier and increased nature conservation value. However, several examples of the side-trimmed/top heavy hedge profile (**Photo 17**) were observed during the current study especially along roads. Cutting appropriate hedges to this profile offers the advantages of a dense base and sides with a freer growing top or canopy which is able to flower and fruit satisfying both functional and wildlife requirements (Foulkes & Murray, 2005).

Hedgerow trees act as, and also provide, breeding sites for birds. Hedgerows with trees provide a wider range of ecological niches for a wider range of flora and fauna than those without trees. Trees in hedges can also act as a source of fuelwood if harvested sustainably. 34% of hedges sampled in County Donegal have no trees at all, while 42% have few trees (defined as two or

three isolated trees). There is therefore a need to increase the number of trees in Donegal hedgerows as a whole by protecting tree saplings during cutting operations thereby allowing them to grow on to maturity. **Figure 12** shows that only 36.74% of the hedges sampled have young trees present. It is generally considered that to achieve sustainable levels of hedgerow trees a balance between young, medium, and older trees needs to be maintained.

Few direct observations of recent hedgerow removal were observed during the current study. Many kilometers of hedgerow have undoubtedly been removed during the construction boom of recent years to facilitate sight-line requirements to new rural dwellings to be replaced with walls, fences and hedges of non-native species (e.g. *Griselinia*, *Escallonia* etc.) that are of little nature conservation value while detracting from the surrounding scenic landscapes of unique character in the County.



Photo 20: Escallonia hedge around new bungalow

Other hedgerows have been subsumed by forestry plantations, although with increased emphasis on sustainable forestry this is likely to have diminished. Other hedgerows will have been lost to field enlargements over the decades in the name of agricultural efficiency.



Photo 21: Donegal landscape of large fields with low hedgerow density



Photo 22: Recently removed section of hedgerow

Observations of new hedgerow planting were rare in the sample squares although it undoubtedly occurs as part of the REPS scheme. It is fundamentally important that when planting new hedgerows, only native hedging species planting stock of local provenances are used. Jones et al (2001) found greater establishment success where hawthorn (whitethorn) provenance is closely matched to the planting site and that plants of local provenance can be superior to commercially available material. In order to ensure that local provenances are used, the regulation of the commercial nursery sector will be required. It would also be prudent to encourage the setting up of plant nurseries in schools or on community-controlled land to act as a source of planting stock for local planting projects.

Hedgerows are only one component of the ecological landscape of conservation importance. They provide linkages between small habitat patches of local, regional and national nature conservation importance allowing the free dispersal of flora and fauna throughout the countryside. During the course of this survey, habitat patches including heath, bog, semi-natural woodland, vegetated rocky outcrops and stream corridors etc. were observed in a number of the sample squares. Many of these habitat patches are currently not protected within SACs, SPAs or NHAs and are at least of local nature conservation importance. These habitat patches could form stepping stones between existing nationally and internationally important sites. An example is the Lamb's Island sample square near Ardara (Grid ref. G700 900) (**Photo 22**) that supported heath, bog, woodland and vegetated rocky outcrop vegetation. It is strongly recommended that these habitat patches are surveyed in more detail and mapped before they are lost to development.



Photo 23: Sphagnum flush in sample square G79

Other linear feature observed during the survey that acts as wildlife corridors are old railway lines. As some sections have not been appreciably disturbed since closure, they have colonised with a diverse grassland, woodland and wetland flora depending on soil wetness and shade. These features should also be surveyed for their biodiversity value. This is especially important prior to subsuming them into recreational trails so that the biodiversity interest is not inadvertently damaged.



Photo 24: Old County Donegal railway line

It was apparent that invasive or potentially invasive species (e.g. Himalayan Knotweed, Salmonberry, Japanese Knotweed) have established themselves along or within hedge boundaries in some areas. It is vitally important that these species are controlled before they reduce the conservation value of the hedgerows further. Existing printed material on these species including their negative effects on wildlife and guidance on their control should be distributed to landowners.



Photo 25: *Persicaria wallichii* (Himalayan Knotweed) along Donegal roadside

10.0 RECOMMENDATIONS

The recommendations included in this section are based on the results of the survey, paying due cognizance to the recommendations outlined in Murray & Foulkes (2005) and Foulkes & Murray (2005), best practice in hedgerow conservation and management and issues raised during the consultation process.

These recommendations all relate to recommendations for the management and conservation of the resource in the county. Murray & Foulkes (2005) maintain that hedgerows are man-made features of the landscape and the majority need a degree of appropriate active management to ensure their long-term viability. As the results of this survey show, a high percentage of hedgerows are losing structure due to lack of or inappropriate management. As a result they are in danger of no longer fulfilling their diverse functional roles in providing wildlife habitat and a stock-proof barrier etc. 39.53% of all hedges examined, are in the 'losing structure' category, where many of the shrubs and thorns of the hedge no longer display low dense growth, and most of the stems are visible. Hedges in this category can also be described as 'leggy' or 'scrawny'. Without careful management intervention, these hedges will soon move from becoming derelict to eventually becoming redundant with adverse impacts on their wildlife and landscape value.

Some recommendations will be of most relevance to Donegal County Council and others to the various stakeholders in the hedgerow resource, including State and Semi-State bodies, the farming community, advisory agencies and the general public. As the majority of hedgerows are on private land, the active participation of landowners is essential.

There is a need for hedgerow management guidelines that take into account the unique Donegal hedgerow types, existing condition and the maintenance of traditional local hedgerow management styles. The maintenance of hedgerows is a cheaper option in the long term than the rehabilitation of neglected hedgerows. Management will require the building up of a hedgerow management skills base at county level.

As Murray & Foulkes (2005) point out, before the introduction of the REPS in 1994, the main agricultural trend for hedgerows was either for their abandonment or removal. Declining agricultural functional value led to a fall-off in the practical knowledge and skills for the appropriate management of hedgerows. The original agricultural value of hedgerows in providing shelter, soil, disease and erosion control is less relevant at the present time in that the number of

Donegal farms was shown to have substantially declined at the time of the last CSO census in 2000. In addition, there has been an increased mechanization of agriculture with a corresponding decline in the number of people employed in the agricultural sector.

The conservation of hedgerows in the county will involve instilling a new hedgerow value system based on an appreciation of their associated biodiversity and the diverse landscape types in the County. This will have indirect knock-on effects on the local economy bearing in mind increased interest in ecotourism initiatives that depend on high quality scenic landscapes of which hedgerows are one component to sustain them.

Local Planning

- It is recommended that a hedgerow management and conservation strategy that pays due cognizance to the findings of this report be drawn up by the council and implemented at local level when determining planning consents. Special attention should be made to those areas supporting the most species-rich hedgerows.
- Ensure that hedgerow removal to facilitate development is kept to a minimum and where unavoidable, a requirement for mitigation planting should be incorporated into the planning consent. Replacement hedges should be of similar length and species composition to the original, established as close as is practical to the original, linking into the existing hedgerow network. Native plants of a local provenance should be used for any such planting.
- Explore the possibility of making Hedgerow Preservation Orders (HPOs) for the most species-rich hedgerows, and those with large associated structural features (e.g. banks and ditches).
- Consider that the Council requests a bond for the retention or re-establishment of hedgerows in planning consents. The bond to be reimbursed on the successful retention or re-establishment of the hedgerows concerned within a given period.
- Ensure that Coillte pays due cognizance of hedgerow protection policies and the findings of this report are taken into account when reviewing and updating the Donegal Strategic District Plan 2006-2010 and FMU Forest Management Plans.

Fiscal Hedgerow Conservation Incentives

- Unless there are very specific management objectives (e.g. as part of a local landscape restoration plan), resources should not be directed into hedgerows that form part of redundant field boundaries. Resources would be better directed towards the conservation

and management of the most species-rich oldest hedgerows. Consider the provision of financial incentives in the form of grants for the conservation of “species rich” hedges in favourable condition to landowners not participating in REPS. The grant scheme could be jointly designed and administered by key stakeholders such as Donegal County Council, NPWS and The Heritage Council.

Training & Awareness

- Establish a network of hedgerow management demonstration sites incorporating all Donegal hedgerow types throughout the County in co-operation with the farming community and hedge management specialists.
- The presence and spread of invasive species (e.g. Salmonberry, Japanese knotweed etc.) in hedgerows is a serious problem in some areas. Distribute existing printed material on the control of such species to landowners.
- Technical advice should be provided to farmers and landowners wishing to manage hedgerows with the objective of producing wood fuel on a cyclical basis. This would be consistent with Ireland’s commitments under the Kyoto Protocol. By adding value to the hedgerow resource, the case for hedgerow conservation will be won more easily.
- All individuals involved in hedgerow management need to be sufficiently well informed so as to be able to direct, implement and evaluate best practice. Ensure all relevant council staff (and any contractors used) possess the necessary skills and data sources to implement or evaluate best practice hedgerow conservation. Provide appropriate training for staff in aspects of hedgerow conservation as necessary.
- Continue to train REPS planners regarding the value and appropriate management of hedges by developing and utilizing best practice demonstration sites around the county.
- General awareness of the values of hedgerows should be encouraged among local communities and schools through circulation of educational materials including a booklet and interactive DVD focusing on the wildlife, landscape and cultural value of hedgerows in Donegal and their appropriate management guided by the findings of this study. Continue promoting existing initiatives such as the ‘Golden Mile’ Competition and ensure that ‘Tidy Towns’ groups incorporate the findings of this report into any land management activities. Make available to the public the location of the most-species rich hedgerows on interactive Donegal hedgerow web pages hosted on the Council website.

Hedgerow Management

- All mechanical hedge cutting carried out by or for Local Authorities, State or Semi-state bodies, or as part of State subsidized programmes (e.g. REPS) should be carried out only by operators who have achieved the Teagasc proficiency standard MT 1302 – Mechanical Hedge Trimming. Hedge laying should be to National Proficiency Test Council (NPTC) (UK) Standard (AO2098) or equivalent. Coppicing of hedgerows should be carried out to standards currently being developed by the Coppice Association of Ireland in conjunction with Standards bodies in the UK. Planting of new hedgerows should be to NPTC standard or equivalent.
- Regularly review the Teagasc module MT 1302 – Mechanical Hedge Trimming to ensure that it is fully compliant with current best practice and remains consistent with standards in operation in other member states of the EU.
- REPS needs to favour the filling of gaps in existing hedgerows over the planting of new ones if the diminishing quality of hedges is to be addressed.
- Farmers and landowners in County Donegal should be encouraged to not reduce hedge height below 1.5m during routine maintenance. Breasting hedges but allowing the top to grow freely should be encouraged as a management technique along roadside hedges in that it satisfies both ecological and agricultural functions. Farmers and landowners should be strongly discouraged from attaching fencing to hedgerow trees and shrubs as this is potentially harmful as well as raising the cost of future hedgerow management.
- The appropriate restoration, maintenance and management of drains, hedge banks and walls associated with hedgerows should be regarded as an essential part of hedgerow management within REPS in that these features support their own characteristic flora and fauna.
- The appropriate aftercare of newly-planted hedgerows needs to be stressed by advisory bodies.
- Fencing from livestock must be an adequate distance away from the hedge to prevent browsing and also to allow maintenance.
- Ensure that hedgerow trees are planted in new hedgerows and that tree saplings in existing hedgerows are adequately protected by marking prior to cutting to ensure the continuity of the hedgerow tree population into the future.
- Carry out a study on the nursery sector in Donegal to determine its capacity to supply native hedging material especially of local provenances for the rehabilitation of the hedgerow network in the quantities required. Investigate ways of supporting the nursery sector in the supply of such material if deemed necessary. The Department of Agriculture

and Food through the Forest Service could look at providing financial and technical support to the nursery sector who wishes to expand into the supply of native shrub and tree hedging material through its direct provision of support services.

- The use of native tree and shrub species of local provenances should be specified/used for any hedgerow planting. Species choice should mimic those native species in the hedges adjacent to the newly-planted hedge. Local provenances are better suited to local soil and climatic conditions. A programme should be developed for the identification, registration, and certification of local provenance sites of woody hedgerow shrubs and trees that would be a source of seed and cuttings for the establishment of new hedgerows and rehabilitation of existing ones in the county.

Further Research & Monitoring

- Initiate a more comprehensive study of hedgerows along townland boundaries in the County to determine whether they are more species-rich than non-townland boundaries.
- Support a comprehensive survey of vegetated banks associated with hedgerows in the County so as to provide additional information necessary to further elucidate the ones of highest conservation value.
- Fund further comprehensive research by a landscape historian on the historical origins of Donegal hedgerows using the literature available in the National Library, local libraries, academic institutions etc.
- In order to monitor changes in the extent and condition of the county's hedgerows, a repeat hedgerow survey for the county should be carried out every 10 years.
- Some anecdotal evidence suggests that much of Ireland's hedgerow network was originally established using hawthorn quicks imported from Holland. Research could be conducted to establish the genetic origin of the hawthorn in Donegal, comparing material from townland boundaries and infill hedges of more recent origin. The results could also be compared with similar studies initiated in other counties. This research could be carried out by a third level institution supported by COFORD.

Landscape Ecology Issues

- Forest Biodiversity Guidelines should include consideration of the potential impact of the new forestry on the wider ecology in the locality including hedgerows in line with research findings of the BIOFOREST project. This includes the protection of existing hedgerows when new commercial plantations are established by maintaining adequate buffer zones between the newly-established plantation and the hedgerows to prevent adverse shading effects.

Roadside Trees

- During the consultation period of this project, concerns were raised about the health and safety of roadside hedges in the County. The condition and potential hazard of roadside hedgerow trees should be regularly assessed in a joint initiative by all relevant stakeholders (local authority, farmers and landowners, arboriculturalists) to alleviate public fears and build appreciation at the same time for the aesthetic and wildlife value of roadside hedgerows in the County. It would be more cost-effective if this issue of concern was examined more proactively to prevent crisis situations by all stakeholders than in a more piecemeal fashion.

Ivy

- In the light of the fact that Ivy is a native food plant for a number of bird and invertebrate species including the summer generation larvae of the Holly Blue butterfly, control of Ivy should be kept to an absolute minimum.

11.0 CONCLUSIONS

This study is the first comprehensive baseline survey of the hedgerows in County Donegal. The total extent of the hedgerow resource has been successfully calculated and the species composition, structure, condition, and variation in Donegal's hedgerows has been examined. The completion of the study is another step towards the goals of assessing the total extent of the hedgerow resource of Ireland as well as determining the regional spread of distinctive hedgerow types. The information gathered will be of enormous benefit to a wide range of interests and stakeholders in County Donegal. It is hoped that the study findings will raise awareness of the hedgerow resource and stimulate actions amongst the state and the voluntary sectors that will protect and conserve a vital part of County Donegal's heritage.

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Web Resources

www.teagasc.ie - Teagasc have produced leaflets on different aspects of hedge management including Planting Hedges, Hedge Rejuvenation, Hedge Trimming, and The Value of Hedges.

<http://homepage.eircom.net/~hedgerow/> - Stuart Dunlop has created a Donegal Hedgerow website.

www.hedgeline.org.uk - Hedgeline is the partnership of organizations and individuals leading and supporting the conservation of the UK's hedgerows.

Appendix 1: Consultation Poster



RE: County Donegal Hedgerow Survey Project

Hedgerows are important as wildlife corridors and also play a vital role in sequestration of carbon and in soil erosion and flood control. The importance of hedgerows is acknowledged in the Donegal County Development Plan (2006-2012) which states *“Trees, stone walls and hedgerows within County Donegal contribute significantly to biodiversity and landscape character. In addition, hedgerows and stone walls constitute an important natural and historic resource, given their contribution to landscape quality, their ecological importance as wildlife habitats and [their] historical significance as townland and field boundaries”*. Under Policy BNH2 in the Donegal County Development Plan (2006-2012), it is the policy of Donegal County Council to *“Promote the protection of trees and hedgerows from development that would impact adversely upon them and enhance existing hedgerows by seeking increased coverage in conjunction with new development”* and to *“Ensure the protection and conservation of hedgerows as natural heritage corridors”*.

Detailed information on the extent and quality of hedgerows in the county is required to guide their future management. As part of the implementation of the County Donegal Heritage Plan (2007-2011), a hedgerow survey of County Donegal has therefore been commissioned by Donegal County Council and The Heritage Council to provide the quantitative and qualitative baseline data towards achieving Action 32 of the National Biodiversity Plan (2002): *“Review options on regulation of hedgerow removal and produce guidelines on hedgerows and*

biodiversity". It will also raise awareness of the value of the hedgerow resource as an important part of the heritage of the county and provide the baseline data to devise appropriate hedgerow management and protection policies.

Aulino-Wann & Associates have been commissioned to carry out this study. We would be very grateful for any information on the biodiversity value and past or current management of the County Donegal hedgerow resource at the local or landscape level. We would also appreciate your views on how to advance the conservation and management of the hedgerows within the county. Please send your comments to:

**Aulino-Wann & Associates,
34 Windsor Avenue,
Whitehead BT38 9RX,
Co. Antrim,
NORTHERN IRELAND.**

Tel: 0044-28-93378250

Mobile: 0044-79-00181558

Email: john@aulinowann.com

We look forward to your valued input into this project to bring forward actions to conserve, protect and enhance the hedgerow resource of County Donegal.

Yours sincerely,

John Wann MSc. BSc. MIEEM

COMHAIRLE CHONTAE
Dhún na nGall
DONEGAL COUNTY COUNCIL



An Chomhairle Oidhreachta
The Heritage Council



An Action of the County Donegal Heritage Plan (2007-2011)

Appendix 2: Field Recording Sheet for Hedge Structural Attributes

2008 DONEGAL HEDGEROW SURVEY

Square ref.:

Survey duration:

Date:

Grid ref.:

Surveyors:

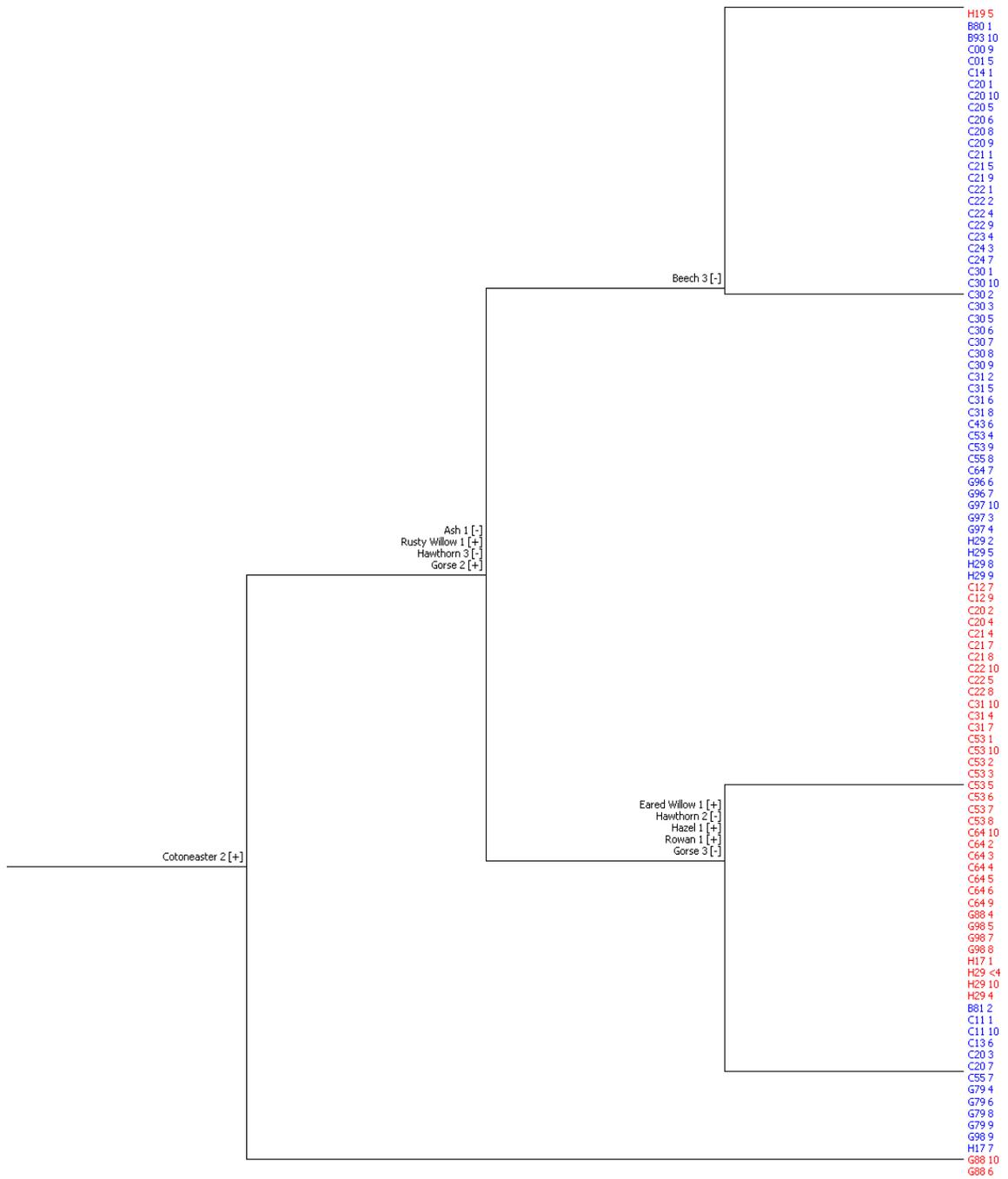
Context	Construction	Structure/ Condition	Structure/ Condition	Management
<p>A FARM TYPE</p> <p>a tillage b dairy c cattle d sheep e mixed stock f mixed stock + crops g stud h other</p> <p>B HISTORY</p> <p>1x infill 2x townland boundary 3x canal side boundary 4x railway line boundary x1 + roadside x2 + stream</p> <p>C ADJACENT LAND USE & LINKS WITH OTHER HABITATS</p> <p>a arable (BC) b improved grassland (GA) c semi-natural grassland (GS) d non-native woodland (WD) e semi-natural woodland/scrub (WN) f scrub/transitional woodland (WS) g curtilage/built land (BL) h peatlands (P) i lake/pond (FL) j watercourse (FW) k other (target note) l. none</p> <p>E BOUNDARY FUNCTION</p> <p>1 hedge redundant 2 active boundary</p>	<p>F OUTLINE</p> <p>a linear /regular b non-linear/irregular</p> <p>G BOUNDARY TYPE</p> <p>1x Single Line Hedge 2x Double Line Hedge 3x Random Line</p> <p>x1 + Bank x2 + Wall x3 + Shelf</p> <p>xa + External Drain xb + Internal Drain xc + Internal Path, Track-way, etc. x0 None of the above features</p> <p>H BANK/WALL/SHELF SIZE</p> <p>a < 0.5m b 0.5 – 1 m c > 1m d not applicable</p> <p>I DRAIN SIZE</p> <p>1 not present 2 small (<0.5m) 3 medium (0.5 – 1m) 4 large (>1m)</p>	<p>J PROFILE</p> <p>a remnant b relict (derelict) c losing structure d boxed / A shape e overgrown f overgrown + outgrowth at base g top heavy/ undercut h straight sided</p> <p>K HEIGHT</p> <p>1 <1.5m 2 1.5 – 2.5m 3 2.5 – 4m 4 >4m</p> <p>L WIDTH</p> <p>a < 1m b 1– 2m c 2 – 3m d 3 m+</p> <p>M GAPPINESS</p> <p>1 complete 2 < 5 % gaps 3 5 – 10 % gaps 4 10 – 25 % 5 25 – 50 % 6 > 50 %</p> <p>N BASE</p> <p>a open b open + vegetation c scrawny + vegetation d dense e very dense</p>	<p>O BANK/WALL/SHELF DEGRADATION</p> <p>1 severely eroded 2 eroded in parts 3 bank intact 4 not applicable</p> <p>P TREES</p> <p>a none b few c scattered d abundant e line</p> <p>Q TREE AGE COMPOSITION</p> <p>1 all mature 2 young trees present 3 no trees</p> <p>R VERGE</p> <p>a < 1m b 1 – 2m c 2 - 4m d 4m + e none</p> <p>S FRUITING</p> <p>1 none 2 sparse flowers and fruit 3 average fruiting 4 heavy fruiting</p> <p>T OVERALL VIGOUR</p> <p>a poor b average c good</p>	<p>U MANAGEMENT</p> <p>a cut box profile b cut 'A' shape c cut on one side d cut on both sides e topped only f excavator g fully laid h laid in part i coppiced j short term unmanaged k long term unmanaged l infill planting</p> <p>V MANAGEMENT METHOD</p> <p>1 flail 2 circular saw 3 bar cutter 4 hand tools 5 excavator 6 other 7 unsure 8 not applicable</p> <p>W EVIDENCE OF LAYING</p> <p>a no evidence b past evidence c recent evidence</p> <p>X FENCING</p> <p>1 none 2 fixed to stems 3 electric 4 post & wire 5 sheep wire 6 timber fence</p>

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
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02																								
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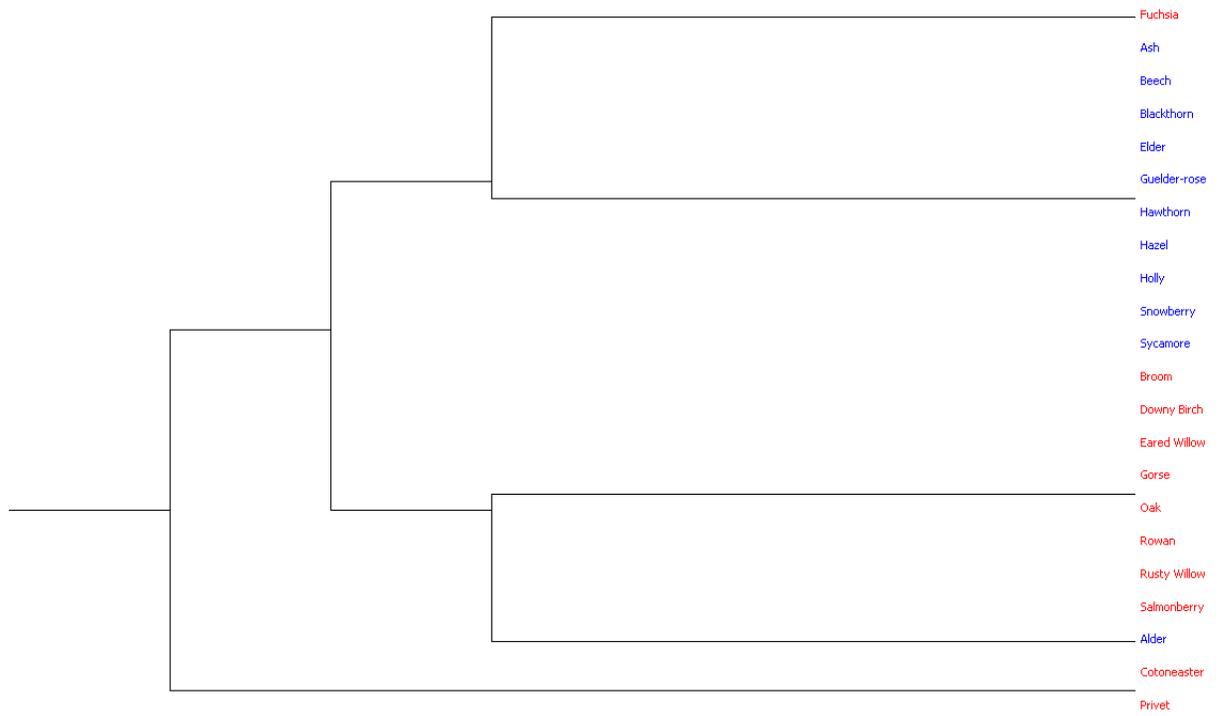
Appendix 4: TWINSPAN Analysis Results

Row	Mean	Median	Max	Min	Zeros	Non-zeros	% zeros	Variance
Alder	1.03922	0	65	0	94	8	92.1569	45.5628
Ash	3.9951	0	45	0	65	37	63.7255	73.7995
Beech	1.17157	0	50	0	95	7	93.1373	34.6064
Blackthorn	4.23039	0	60	0	85	17	83.3333	155.241
Broom	0.333333	0	12.5	0	96	6	94.1176	2.56601
Cotoneaster	0.803922	0	55	0	99	3	97.0588	35.5255
Downy								
Birch	0.926471	0	42.5	0	96	6	94.1176	27.4525
Eared								
Willow	1.86275	0	70	0	92	10	90.1961	74.6196
Elder	0.284314	0	10	0	96	6	94.1176	1.73025
Fuchsia	1.64216	0	55	0	96	6	94.1176	65.1603
Gorse	19.4657	0	92.5	0	53	49	51.9608	839.957
Guelder-								
rose	0.117647	0	5	0	99	3	97.0588	0.520676
Hawthorn	33.9118	30	100	0	24	78	23.5294	1021.65
Hazel	1.47549	0	50	0	88	14	86.2745	47.9276
Holly	3.19608	0	40	0	62	40	60.7843	40.2582
Oak	0.112745	0	7.5	0	99	3	97.0588	0.623301
Privet	0.857843	0	62.5	0	98	4	96.0784	40.1603
Rowan	1.22059	0	50	0	87	15	85.2941	29.9632
Rusty								
Willow	4.26471	0	35	0	69	33	67.6471	73.6916
Salmonberry	1.86765	0	80	0	95	7	93.1373	90.2422
Snowberry	0.995098	0	50	0	97	5	95.098	38.745
Sycamore	0.833333	0	15	0	87	15	85.2941	6.17987

Summary of the TWINSPAN data used in the TWINSPAN analysis

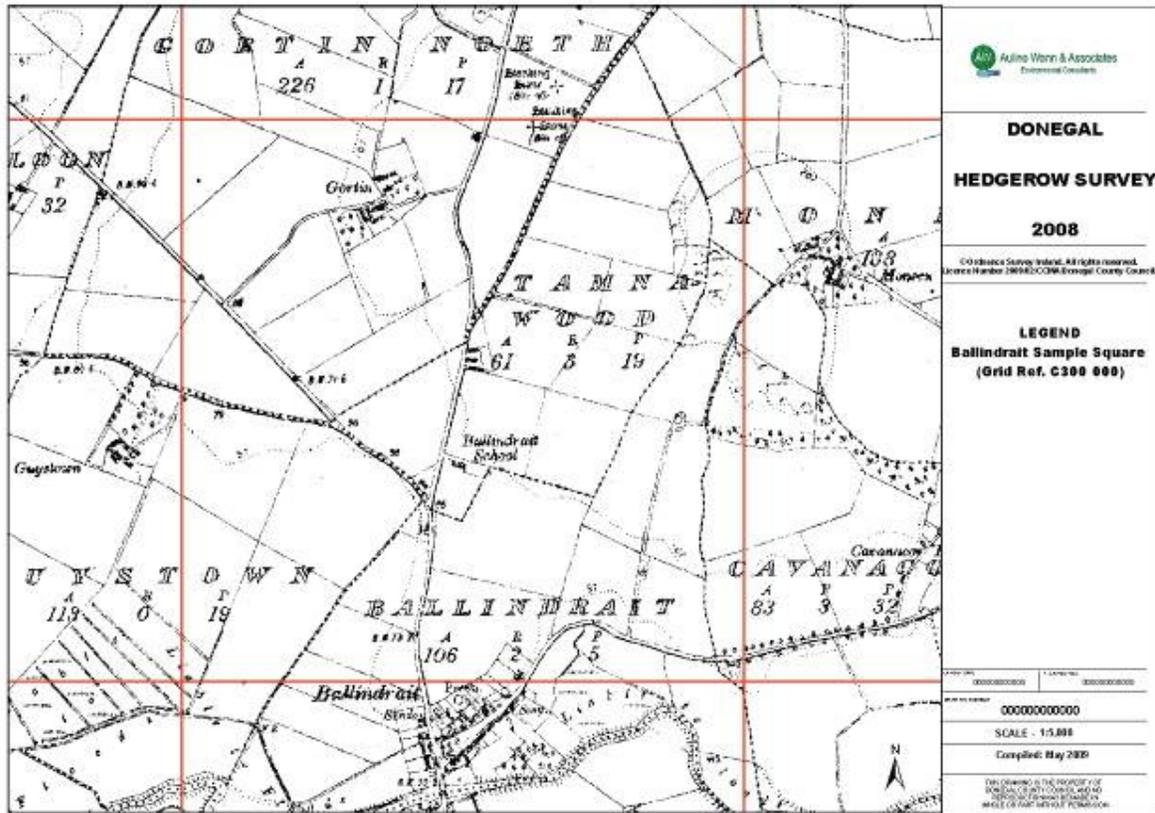


Dendrogram of Hedge Types Generated by TWINSpan



Species Dendrogram Produced by TWINSpan

**Appendix 5: Sample Ordnance Survey Map
Ballindrait Sample Square (C300 000)**



**Appendix 6: Sample Aerial Photograph
Ballindrait Sample Square (C300 000)**



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