The History, Ecology and Management of Partry House Estate Woodlands, Partry, County Mayo.

Lorraine Grimes, M.A.

This thesis was submitted in fulfilment of the requirements for the Master of Arts (by Research) degree

in

Heritage Studies,

Galway-Mayo Institute of Technology at Castlebar

Supervisor of Research: Dr. Seán Lysaght, Mr. John Tunney
Head of School: Dr. Barbara Burns
Submitted to the Higher Education and Training Awards Council

2007

I hereby declare that this thesis is my own work:

...Lorraine Grimes...........

GMIT

Galway-Mayo Institute of Technology

Declaration of Masters/PHD Thesis

I hereby declare that the work presented in this thesis is my own and that it has not been used to obtain a degree in this Institute of Technology or elsewhere.

Lorraine Grimes

Candidate Name

06/9/07

Date

Dr Seán Lysaght

Supervisor Name

6th September 2007

Date

Table of Contents **Page**

Acknowledgements

Sincere thanks to the following people for their work, guidance and support in helping me complete this thesis.

To the thesis supervisor Seán Lysaght.

To Chris and Lynda Huxley for their time and help.

To Lorraine O'Donoghue for granting me unlimited access to Partry House Estate and assisting me with my research.

To Pierce McDonnell for his expertise.

To the staff of the Institute Library.

To the administration staff of the Galway-Mayo Institute of Technology, Castlebar.

To Liz Ryder for the advice and information.

To my family and friends for their ongoing support of my studies through the years.

To Kenny for his love and support.

Partry House Estate by Lorraine O' Donoghue

This thesis is dedicated to the memory of my parents,
Maureen and Patrick Grimes.

Abstract

The history, ecology and management of Partry House Estate Woodlands situated on the shores of Lough Carra were examined by investigating their current ecology and structural development and contrasting this information with the historical evidence of their management. By combining the historical documentary evidence with the ecological data, the structural processes occurring in each of the woodlands were established leading to a greater understanding of the woodland development processes taking place. Also, valuable baseline data on species composition and diversity was gathered for the woodlands and vegetation maps were established.

Partry House Estate has a long history of establishment that has not been researched in the past and this study rectifies this. Using a combination of historical documents and sources, a chronology of events, management and ownership was ascertained.

As part of the study a deer exclusion experiment was set up in each of the woodlands to determine the effect of deer grazing on the vegetation layer and tree regeneration. The initial findings of the experiment indicate that excessive deer grazing is resulting in the loss of species diversity and regeneration. Their presence is influencing the natural successional processes in the woodlands which are negatively impacting upon the biodiversity value of Partry House Estate Woodlands.

The combined results of the field survey data and the historical data were used to guide the decision whether to manage the woodlands or not. It has been suggested that active adaptive management would be the most suitable approach to managing the woodlands of Partry House Estate and management prescriptions are outlined in a ten year management plan for these woodlands.

List of Figures **Page**

List of Plates

List of Tables

Appendix

1. Introduction

1 Introduction

Partry House Estate in Co. Mayo is situated idyllically on the shores of Lough Carra and has a long history of establishment. As part of its demesne it contains four separate woodland areas that have remained protected within its external walls and it is these woodlands which are the subject research in this thesis. They are important wooded habitats in a country that has the lowest percentage of woodland cover in Europe and it was the primary aim of this study to understand the ecology of the woodlands in terms of their history. In order to fulfil this aim it was necessary to combine the disciplines of historical and ecological research, an approach which is increasingly being used in the field of woodland ecology.

Historical woodland research is a well established discipline in Western Europe and is extensively used in Britain to establish the land use history of a study site. The woodlands of Ireland are often the result of a complex history and depending on the availability of sources it is sometimes possible to reconstruct their earlier landscapes and the history of their management. According to Rackham (1975) an evaluation of that history is necessary for the successful management of this resource. As a result the elucidation of the history of the woods has become a priority for their conservation and management (Bohan 1997) and that elucidation must examine individual woods, their past history and management and their ecological structure. However there are difficulties in establishing land use history in Ireland and historical records are rarely adequate to establish the degree of continuity of tenure by woodland of a particular site (Kelly & Kirby 1983:183).

According to Hall (1995:23-24) when reconstructing the history of a woodland one may use two sets of evidence; either the written record for forests found scattered throughout a range of contemporary historical documents or the record of woodland change left by trees and shrubs themselves as pollen grains preserved in peat bogs and lake sediments. The prime evidence for ancient woodland comes from pollen (Rackham 2006:77) and Ireland with its peaty landscape is very open to the field of pollen analytical studies which can be used to reconstruct the vegetation of past times.

However, Rackham (2006) and Hall (1997) both acknowledge that there are some drawbacks to pollen analysis. There are gaps in the fossil pollen assemblage and there is no direct link between the percentages of individual species and the area covered by that plant (Hall 1997:20). Rackham (2006:79) explains that different species of trees produce higher quantities of pollen and also that coppicing alters the ability of trees to produce pollen to varying degrees, with some species of trees recovering quicker and continuing to produce pollen while others may take up to ten years. Despite this, pollen analysis can contribute greatly when used alongside other interdisciplinary studies to gain a fuller understanding of woodland history.

Rackham (1990:106) suggests that as well as pollen analysis, documents, archaeology, woodland structure, place names, earthworks and vegetation may provide evidence as to the history of woodland and can be used to construct chronologies. He noted that the study of ancient woodland in Ireland should follow four principles: 1. fieldwork, 2. the recognition of exploitation of the woods, 3. the status of ancient trees and 4. the importance of demesnes (Rackham 1995:4). Historical sources are important in that they can be remarkably precise in time and can explain the present day ecological status of ancient woodlands. However historical references to woodlands are uncommon in early Irish texts and much documentation has been destroyed in the many wars and conflicts that have taken place on the island in the past thousand years. Reliable accounts and maps from the 16th and 17th centuries are very scarce as they were influenced by military and commercial interests when periods of unrest succeeded each other rapidly (Hall 1997:2).

Evidence of woodland may also be found in estate papers and surveys which can record when management practices took place as well as the motivation behind that management. Documents may not, however, be available for a specific site and in their absence cartography can be helpful. The Civil and Down Surveys carried out in the 1650s recorded many thousands of woods located by townland. Woodland is generally depicted where it occurs on parish maps but only sporadically on barony and county surveys (Bohan 1997: 35-36). The accuracy of these surveys have been questioned by both Forbes (1932:28) and Andrews 1985:72), with acreages found to be incorrect by 11.5-15%. Rackham (1995), on comparing the surviving records of the

Civil Survey with the Ordnance Survey maps of 1834-44, discovered that the 19th century woods are seldom in the same place as the 17th century woods. The quality and reliability of maps up until the first Irish Ordnance Survey of 1820s vary with the mapmaker and the commissioner of the map. The names of woodlands may well be indicative of their past history, but in Ireland few ancient names of big woods are known and even if woodland survives it seldom has a gaelic name today (Rackham 2006:169). Tree names were also incorporated in to place names and are evident today. Of the approximately 62,000 townland names in Ireland, 13,000 mention trees while 1,600 mention some derivation of *dair* (oak), such as dare or derry (The peoples millennium forest 2001). The Irish word for wood, *coill,* is also used in place names derived as kill or kyle, for example Kylemore. Information on woodland history may also be gleaned from surface features found in the field. However, boundary earthworks in woodlands such as the bank and ditch system are less a feature of Irish woods than of English and are relatively unhelpful in establishing woodland antiquity. Occasionally in stone-wall areas, particularly in the West of Ireland, they are replaced by walls (Bohan 1997:41). Charcoal-hearths are a feature found in Irish woodlands and are indicative of ancient woodland. Surviving charcoal hearths in woodlands are usually circular low platforms about 8m in diameter scooped out of a hillside (Rackham 1995:8). Beneath the leaf litter, the flat floor is usually covered with debris of charcoal, from which the species of wood used can be ascertained; mainly oak, hazel and birch (Cunningham 2005:24). Between 1600 and 1800 over 160 iron-making furnaces were known to have existed around Ireland (Cunningham 2005:24).

As suggested by Kelly & Kirby (1983) there were difficulties in establishing the land use history of the woodlands in Partry House Estate. This was mainly due to the absence of estate records and surveys which were destroyed in an unfortunate incident in the 1990s. The surviving descendants of the historical estate owners had very little knowledge of their ancestors and the ancestral home. To establish the management history of the estate it was necessary to rely on other sources of historical record including cartographic sources. The information gleaned from these was combined with the physical evidence of historical management that remains in the landscape of these woodlands.

The ecological element of this study was necessary to establish the woodland's current value and to appreciate its potential for improvement. The woodlands have not been studied prior to this survey so valuable baseline data has been collected and interpreted. Inventory lists of species have been created, the various habitats occurring have been identified and an evaluation of the diversity has been made. By combining the historical data with the present day ecological data, a greater understanding of the existing woodland structures and the processes that formed them has been achieved. This was an important aspect with regards to the classification of the various woodland types occurring in the woodlands. Woodland in Ireland is subdivided into two categories, semi-natural woodland and highly modified/non-native woodland. Semi-natural woodland is that which is spontaneous in occurrence but has been partly modified or partly determined by man or his animals. Highly modified/non-native woodland is woodland that has been planted or that contains tree species that are not native to Ireland and would not have naturally colonised as woodland without the interference of humans. Planting of exotics was commonly undertaken in estate demesnes in the 18th and 19th centuries and much of the remaining woodland in estates is semi-natural or planted. It was therefore important to establish the historical management of this estate in order to correctly classify the various compartments of woodland types occurring in each woodland. A further discipline that was incorporated in this study to help establish woodland history was dendro-chronology. Tree coring and annual ring counting was used to age the mature woodland trees, so a timeline for planting and the succession of species could be established. The historical and ecological information was combined to accurately create a vegetation map for each of the woodlands, which identified the various woodland habitats they contained.

The final part of the study aimed to create a management plan based on the data collected during the surveys. In order to guide the management decision on the deer population, a deer exclusion experiment was set up to gather some quantitative data on the effects of their grazing. This is a long-term experiment so it was too early to get any definitive results as yet. However the data did show that deer are negatively impacting on the herb and scrub layer and are a priority management concern. The information established during this survey has determined that active adaptive management is necessary in these woodlands in order for the full potential of their biodiversity value to be realised. In the absence of management these woodlands will continue to deteriorate losing valuable diversity and decreasing the conservation value.

1.1 Aims and Objectives of Thesis

The aims and objectives of this thesis are as follows:

- To establish the history and historical management of Partry House Estate Woodlands.
- To examine the vegetation composition of Partry House Estate Woodlands resulting in the collection of baseline vegetative data and species lists.
- To interpret the relationship between the ecological data and the historical management of the woodlands.
- To use both the historical and ecological data to complete a preliminary management plan for the woodlands.
- To create comprehensive vegetation maps for each of the woodlands.
- To establish the effects the presence of a deer population are having on the species diversity and structure of the woodlands.
- To help maintain and enhance the biodiversity and semi-natural characteristics of the woodlands.

2. Literature Review

Literature Review

2.1 The History of Irish Woodland

Woodland in Ireland has experienced a cataclysmic history, one of evolution through climatic change, followed by widespread destruction. Woodland represents the climax of nature's colonisation, which most of the countryside would revert to in the absence of human activity. Woodland history began some 12,000 years ago following the end of the last Ice Age when climatic conditions improved and trees and plants re-colonised Ireland from the European Continent through Britain, "moving across landbridges at rates depending on each species method of regeneration" (Aughney & van der Sleesen 2000:1). Compared with the rest of Europe, it was a restricted range of trees due to the inundation that separated Ireland from the Continent ten to twelve thousand years ago. Tree species such as Birch (*Betula*), Willow (*Salix*), Scots Pine (*Pinus sylvestris*), Hazel (*Corylus*), Elm (*Ulmus*), Oak (*Quercus*), Ash (*Fraxinus*), Alder (*Alnus*), Juniper (*Juniperus communis*), Whitebeam (*Sorbus hibernica*) and Holly (*Ilex aquifolium*) formed a dense forest cover over the country by ca 7,000 years ago (O'Connell 1999:25). According to pollen counts, this forest cover was virtually undisturbed up until 5,000 years ago (Mitchell & Ryan 1997), when human activity superseded climatic change as the leading influence on vegetation change. These natural or wild woodlands are all but extinct in Ireland. Some regenerated remnants of ancient woodland are to be found here and there, but there is some doubt that even these are truly natural. Some experts take the view that they are more likely to be the residue of medieval or later forests which were at one time cultivated (Neeson 1997:133).

In Ireland, the practice of clearing primeval woodland for agriculture developed after 4,000 BC with the arrival of the Neolithic farmers. Extensive areas were cleared by felling and this combined "with a shift to wetter climatic conditions led to the onset of forest depletion and to the spread of blanket bog over large areas particularly in the west of Ireland" (O'Sullivan 1999:2). Bronze Age prosperity in Ireland led to major and largely permanent woodland removal, due primarily to the increased sophistication of agricultural practices (Mitchell & Ryan 1997). Gradually people controlled and began to utilise the natural forest and woodland resources in Ireland for pasturage and agriculture, destroying forest land to make way for fields. This practice of free range grazing, which prevented tree regeneration, allowed the open spaces to prevail and accelerated the decline in forest cover. Some species of native trees had already died out including Elm and Scots Pine. The elm, a high forest species, suffered what Mitchell & Ryan (1997) describes as a catastrophic decline about the year AD 500. By the seventh century it had virtually disappeared. There is a difference of opinion about the disappearance of Scots Pine. Neeson (1997:136) claims that by AD 300 Scots Pine was gone or going and bogland was beginning to increase.

Unlike Britain, Ireland does not have a great deal of documentary evidence on woodland history as there are few statistics relating to Irish woodland before the middle of the seventeenth century. This makes it difficult to assert to what extent the island was forested when the Normans arrived in 1169. It is Neeson's (1997:136) opinion that the regenerative properties of the native forests were so great, that despite intensive clearance in the early Christian Period, that the greater part of the country was clothed in trees as late as the twelfth century. The seventeenth century was a time of great political instability and industrial development and the popular belief is that up until then, Ireland was a vastly wooded country, with extensive forests and surviving wildwood and that deforestation occurred due to its exploitation by the New English colonists. In the middle of the century clearance of timber took place due to insecurity of title when English landlords were anxious to extract the maximum amount of profit from their Irish possessions. O'Connell (1999), Aalen, Whelan and Stout (1997), Johnson (1998) and O'Sullivan (1999) use this explanation, that the seventeenth century despoliations is the main reason for the present day absence of Irish woodland. However, according to the earlier research by Forbes (1932:15-36) the woodland of Ireland *c.* 1600 was not as extensive as initially thought and covered no more than 1.5% of Ireland. Forbes (1932) reviewed the historical accounts of early writers and travellers such as Fynes Moryson who remarked in 1599 that "Ulster and the western parts of Munster yield vast woods. But I confess myself to have been deceived in the common fame that all of Ireland is woody, having found in my long journey from Armagh to Kinsale few or no woods by the way, except the great wood of Offaly, and some low scrubby places which they call glens" (Henry 1914). Rackham (1995:2) and Cross (1987) also hold with this opinion, although they maintain that this figure is certainly too small and Cross (1987) noted that the original woodland cover of the island had fallen to 1.7% by the mid 17th century. These academics claim that Ireland would have followed the fashion of Britain, in which the great wildwoods had disappeared in prehistory. Rackham's (1995) justification for this theory of a depleted woodland cover is that "the customary Irish belief is at odds with Ireland's long history of dense population and high civilisation, which is demonstrated by the presence of over 40,000 ringforts and raths dating to the Iron Age and Early Christian periods". Over 18,000 ringforts have been positively identified while a further 28,000 have been identified from cartographic sources and aerial photography (Aalen, Whelan & Stout 1997:44). Throughout all this time wood was part of daily life and an economic essential in a non-technical agricultural society and it is questionable to believe that these woodlands remained intact and unused until 400 years ago. Before the Norman period the Vikings also had a considerable timber trade from Ireland exporting timber to treeless Iceland and the Faeroe Islands, and shipbuilding was carried out extensively at their Irish settlements (Neeson 1997:136). According to Rackham (1995) the Irish woodland of the 17th century was not necessarily ancient and covered no more than 2.1%. Hall (1995:26) makes the point that up until the 17th century Ireland exported a range of agricultural products and that thriving agriculture and undisturbed woodland do not go hand in hand. Another contributing factor to Ireland's woodland clearance was the lack of woodland management. The Normans successfully introduced profitable forest management to England and many of Britain's woodlands still exist today because of their value as a renewable economic resource in medieval times. However, they did not have the same success when they tried to introduce it to Ireland. Ireland's turbulent history and instability of land ownership did not create an environment for long term woodland management schemes. The market for timber was so great at this time that it led to the "el dorado" aspect of Irish woodlands (Neeson 1997:139). It is therefore evident through the reasoning of the facts that the estimation that Irish woodlands were devastated after the 17th century to provide timber for shipbuilding is generally incorrect. This opinion is also held by McEvoy (1944), who claims that historical data leads to the conclusion that the process of deforestation was well advanced at the time of the Norman invasion, but was probably accelerated in the succeeding centuries and was fairly complete by the beginning of the 17th century.

The 17^{th} century was a time of great political instability and industrial advancement. England's national requirement of timber increased as it embarked on its explosion of colonisation, trade and statecraft. The exploitation and reduction of Irish woodlands was a natural consequence of the English military action and the policy of plantation that accompanied it (Neeson 1997:140). Clearance of timber took place due to insecurity of title when the English planters were anxious to extract the maximum amount of profit from their Irish possessions, before the land might be confiscated (Andrews 1954:140-141). So profitable was timber that it was often the case that the amount for which the estate was bought was recovered in full from the sale of the timber (McCracken 1971). While Irish forests were being despoiled and not replanted under the effects of the twin policies of profit and prevention of their use by native insurgents, profound political changes in England in the sixteenth and seventeenth centuries affected forests and economics. The extent to which timber was depended on for economic and industrial processes, and also power, is comparable to the present day reliance on oil resources. England's dependence on timber for ship building was to keep their political dominance on the sea. It was this need to preserve ship timber that prompted the introduction of forest policy in Ireland. In 1610 each planter was given two hundred good oaks to make timber for such building as he wished to erect (McCracken 1971). The exploitation of Irish woodlands did not stop here as from the mid-seventeenth century onwards industrial development using furnaces and huge quantities of timber began to reduce forests very rapidly. The iron industry was unquestionably the major industrial predator of Irish woodlands at this time (Neeson 1997:143) and according to Henry (1914) and McEvoy (1944) completed the ruin of much woodland. The forests that previously remained untouched on wilder mountainous regions and that were useless as farmland were now cleared to produce charcoal for iron-smelting. With the raw material costing so much less in Ireland, Irish iron could be marketed very competitively. There is a conflicting argument by Forbes (1932:25-26) who studied also the role of the iron industry in woodland destruction, that the bulk of the forests had disappeared centuries before and "the cutting of timber does not necessarily mean the permanent destruction of the woods in which it grew". However, according to McCracken (1959: 295) and Bohan (1997:13), the establishment of iron-works was recommended as a concerted effort to clear woodland during the 17^{th} century in order to prevent rebels from hiding within them and that there was no incentive to coppice these woods as they gave shelter to the displaced Irish.

2.2 Woodland Management and Forestry in Ireland

By the beginning of the 18th century the forest cover had reached such low levels that concern arose among the private landowners and the government of the time. In the period 1696-1711, Ireland ceased to be a timber exporting country and the government introduced measures to curb the decline (McCracken 1971:39). Between 1698 and 1791 seventeen Parliamentary Acts designed to encourage the planting of trees and the conservation of the existing resources were passed. An Act of 1698 noted that the late rebellion, as well as the iron-works had destroyed the timber of Ireland and as a result required that certain land-owners were obliged to plant trees such as oak, firr, elm, ash, walnut, popular, abeal or elder in some ditch or elsewhere on the said lands (Anderson 1944:7-10). It is generally assumed that these Acts produced few or no results but it is impossible to prove this (Forbes 1932:177). The Cromwellian and Jacobite wars had freed up lands, making them available to a new breed of entrepreneur or merchant adventurer, few of whom had any direct relationship with the older Gaelic or Norman landed families (Shaffrey 1985). On many of the large estates landowners became sufficiently secure and initiated large-scale private tree planting (McCracken 1971:136). According to McCracken (1971:135) the initial estate plantings before the end of the seventeenth century were shelter belts, orchards and avenues and consisted of recently introduced exotics: sycamore, beech, walnut, lime or horse chestnut. McEvoy (1944:34-35) considered that Beech and other exotics were probably introduced at the end of the 17th century and that Sycamore had been recorded since 1632. Along with this ornamental planting, hedgerow planting took place with landlords binding tenants to plant and maintain hedges around his holding. According to Neeson (1997:145) some Irish landowners also began to appreciate the importance of applying principles of forest management and so began elementary timber management. When hardwood coppice became uneconomic, many owners interplanted the coppice stools with Scots Pine and Larch. Edlin (1970:112) noted that coppicing was a widespread practice in Ireland at this period.

McEvoy (1944:178) refers to the 18th century as Ireland's "planting age" which he relates to the development and laying down of demesnes. From 1740 a more natural informal garden design unique to Europe and emanating from England was influenced by the great landscape designer "Capability Brown" (Grimes 2003:15). The ideal was now to surround the mansions with wide expanses of smooth, open turf dotted with clumps of noble trees, secluded from the outside world by plantation belts and perimeter walls (Aalen, Whelan & Stout 1997:201). Simultaneously with these landscape plantings the laying down of young plantations was also proceeding. Landowners started to spend money on their estates and the need to know more about planting saw almost thirty books concerned with woodlands published in England in the eighteenth century (Neeson 1991:92). The Royal Dublin Society formed in 1731 also encouraged tree planting and between 1766-1806 some 25 million trees were planted as a result of the encouragement of the society, which paid £90,000 in awards and medals (Neeson 1991:92). But this did little to reverse the overall trend of reduction of native woodland cover and the exploitation of centuries had left devastation too great to be repaired by private means. Neeson (1997:145) claims that by 1801 there were still only 132,000 acres of woodland in the country. By the 1830s, pre 17th century woodland covered approximately 0.2% of Ireland (Rackham 1995:3) and even after 80 years of planting the effects of the deforestation were obvious. A French visitor at this time wrote "The most striking thing on first sight of the Irish landscape is the total absence of trees of any kind. They are only seen in private parks" (Neeson 1997:142). In the 1840's the population of Ireland was 8.2 million and the demand for fuel and land put increased pressure on the dwindling woodland resources (O'Connell 1999:25). The year 1880 marked the end of woodland acreage and planting in private hands as Land Acts began to transfer land control from landlord to tenant (McCracken 1971: 141). Estate owners conscious of the insecurity of their land sold much of the existing timber (McCracken 1971:141), until woodland cover was reduced to 1% by the early 1900 (Neeson 1991).

The early part of this century witnessed "further exploitation of private woodlands and led to a reduction in woodland cover to 0.5%" (O'Sullivan 1999:3). Before the end of the nineteenth century conifers were accepted as more economically viable than broadleaves and would become the dominant tree crop (Neeson 1997:149). This trend in conifer planting was continued by the state into the 20th century and the vast majority of forest is presently in conifers, "with broadleaved woodland accounting for less than 1% of the land area" (Aalen, Whelan and Stout 1997:122). The state embarked on an active policy for afforestation with an emphasis on fast growing conifer trees and a minimum cover of 1 million acres of forest was the target set. In 1930 the establishment of forestry was under the control of the Land Commission and any land worth more than £4 per was considered to be too good for forestry (Ryder 2004:3). Areas given for planting were on bogs in remote areas (Neeson 1991:153) which left plantations of forests scattered, inaccessible and uneconomic. As peatland forestry expanded in Ireland many native woodlands were cleared or under-planted with conifers (RSPB 2004:5). Blanket peatland was regarded as ideal territory for the expansion of forestry, particularly because of its low agricultural value. The influential Cameron Report (FAO 1951) also encouraged planting of western peatlands on the grounds that it would "provide a great increase in attractiveness to tourists for large sections of Western Ireland by considerably improving the scenic and sporting amenities" (Johnson 1998:32). Planting on blanket bogland rapidly became commonplace, peaking in the mid 1980's with approximately 170,000 hectares of intact blanket bogland afforested (Johnson 1998:32). According to Viney (1966) the timber industry demands softwood and that hardwood would not grow on the kind of land that can be spared for forestry. By 1985 one single species, Sitka Spruce, accounted for almost half (49%) of state planting and broadleaved species were only 5% (Higgins, Martin and Perrin 2004:3). In more recent years Coillte Teoranta (the state forestry body) has moved away from planting on undamaged bogland partially in response to pressure from environmental concerns. According to Neeson (1991:149) few subjects have given rise in recent years to so much ill-informed controversy and comment as has forestry. In recent years there is evidence to suggest that large-scale conifer plantations can be detrimental to the environment. Conifer forests planted on bog or moorland threaten bird species such as red grouse, dunlin and Greenland white fronted goose by destroying their habitats (RSPB 2004:7). The biodiversity value of conifer plantations is also questionable, as the dense shade created by planting the trees close together excludes competing vegetation and any species which temporarily increase after initial planting tend to decrease or disappear. Today, private woodland and state forests account for only 8% of the land area of Ireland, one of the lowest percentages in Europe (Johnson 1998:34). Since the 1980s there has been a shift towards the planting of broadleaved species by Coillte, partially due to increasing public concern over the environmental effects of coniferous block planting and lobbying various environmental groups. Also Ireland's ratification of the Convention on Biological Diversity (CBD) in 1996 has influenced the increase in the proportion of broadleaved species planted. In 1999 it was estimated that 13,182 ha of the Coillte forests were under broadleaved species. Of this beech accounted for almost 30%, oak for 22.6% and ash for 17% (Higgins, Martin and Perrin 2004:3). Presently the remaining fragments of private native woodland are under severe pressure from development, grazing and invasive species. Many have no designated conservation status and are in need of sensitive management to secure their survival and long term regeneration.

2.3 Irish Native Woodland Vegetation.

Woodland is defined as "any area that is dominated by trees and where the canopy height is greater than five metres" (Fossitt 2000). Irish native tree species are generally seen to be those species that managed to arrive in a location naturally, without any human intervention (Coll, 2000). The main types of Irish broadleaved woodlands can be broadly categorised as follows (O' Sullivan 1999).

1. Remnants of the wildwood woodland largely confined to the poorest sites, greatly modified and abandoned siliviculturally 100-180 years ago.
2. Plantations, most of which are 150-200 years old on better sites, with some good quality timber. Exotic species such as beech are common and the native species may be of foreign provenance.
3. Secondary woodland on abandoned farmland, usually scrub like with the better quality timber often selectively removed.

The ages of natural and semi natural woodlands has been divided into the following groups by the Irish Native Wood Trust (2001):

1. **Virgin Forest** is natural woodland that has not been significantly influenced by man.
2. **Ancient Primary Woodlands** are those that have been wooded continuously since the original wildwood. They may have been managed or clear felled, but they have never been cleared for some other use and the ecosystem has remained substantially intact.
3. **Ancient Secondary Woodlands** developed before the seventeenth century on land that had formerly been used for something else, primarily agriculture.
4. **Secondary Woodlands** are those which have naturally grown up after the seventeenth century.

There are no virgin forests remaining in Britain or Ireland and the present existence of "ancient" woodland is widely debated by researchers in Ireland. This debate is frustrated by the lack of documentary evidence, which not only makes it difficult to locate possible ancient woodlands, but also to verify whether or not they are indeed ancient or secondary. Nonetheless, the current view is that some small pockets of woodland are "ancient" (Rackham 1995; Kelly and Fuller 1988; O'Sullivan 1999) and are found in remote places scattered around the country, the largest of which forms part of the Killarney National Park. According to O'Connell (1999:25) all that remains of Ireland's natural or wild woodlands are some regenerated remnants of ancient woodland and woodland scrub. Bradshaw & Hannon (1988) drew attention to the palynological literature which indicated a widespread reduction in the number of forest dominants due to human intervention in Ireland. They concluded that such was the influence of humanity on the Irish woods that it is questionable whether ancient woodland survived at all (Bradshaw & Hannon 1988:29). Willis (1993:428) also claimed that palynological investigation of sites has revealed that the modern stand is a poor analogue for the primeval forest. While examples of ancient woodland are of major significance, "national conservation efforts are aimed also at the secondary stands" (O'Sullivan 1999). Semi-natural vegetation is that which is spontaneous in occurrence, but has been partly modified or partly determined by man or his animals (Bohan 1997:3). It is considered to most resemble the potential natural vegetation.

Long established semi-natural woodlands have been demonstrated to be important both scientifically and historically. The scarcity of semi-natural woodlands renders the entire resource of potential conservation value in Ireland.

2.4 Classification of Native Irish Woodland

The classification of habitat types in Ireland has been recently produced by Fossit (2000), in an effort to simplify and standardize a scheme for describing habitats. This classification recognises seven categories of semi-natural woodland, five categories of highly modified/non-native woodland and five categories of scrub/transitional woodland. This standard has been adopted for general use in habitat description and conservation in Ireland. The categories identified in this survey of the woodlands in Partry House estate are briefly described.

2.4.1 Oak-ash-hazel woodland WN2

This second major woodland type occurs typically on base-rich soils, particularly in the Midlands and on limestone pavement in western parts (Cabot 1999:231). This type of woodland is typically dominated by Pedunculate Oak (*Quercus robur*), Ash (*Fraxinus excelsior*) or Hazel (*Corylus avellana*), or by various mixtures of some or all of these trees. Other trees may be present but should not be dominant (Fossit 2000:50). Limestone pavement that s not subject to browsing will tend towards hazel dominated scrub and sometimes to "high forest" (Kelly & Kirby 1983). These woods tend to be species rich, particularly in the herb layer, but are not particularly diverse in terms of bryophytes (Higgins, Martin & Perrin 2004:9).

2.4.2 Wet willow-alder-ash woodland WN6

This third major woodland type in Ireland is low woodland (less than 10m high) or scrub, typically growing on wet or permanently waterlogged sites that are dominated by willows (*Salix spp.*), Alder (*Alnus glutinosa*), or Ash (*Fraxinus excelsior*), or by various combinations of some or all of these trees (Fossit 2000:52). It includes woodlands on carr and along lakeshores and rivers. Many of these woodlands have persisted in these locations because the land there is of low agricultural value and the generally poor stature of the canopy species renders them unsuitable for timber use (Higgins, Martin & Perrin 2004:8).

2.4.3 (Mixed) broadleaved woodland WD1

This category of woodland classified is as highly modified and includes woodland areas with 75-100% cover of broadleaved trees and 0-25% cover of conifers (Fossit 2000:53). It should be used in situations where woodland stands cannot be classified as semi-natural as they include various stands of native and non-native trees that was planted. They may have been planted for commercial timber, energy production, landscaping, shelter or conservation. If more than one broadleaved species is present in significant amounts the term "mixed" is applied.

2.4.4 Mixed broadleaved/conifer woodland WD2

This category of woodland classified is as highly modified and includes woodland areas with mixed stands of broadleaved trees and conifers, where both types have a minimum cover of 25% and a maximum of 75% (Fossit 2000:54). Trees may be either native or non-native species.

2.4.5 Scrub/Transitional woodland WS1

This broad category includes areas that are dominated by at least 50% cover of shrubs, stunted trees or brambles. The canopy height is generally less than 5m and scrub frequently develops as a precursor to woodland (Fossit 2000:55). Common components include Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), small birches (*Betula spp.*) and Hazel (*Corylus avellana*). The field layer is often improvished but in some situations it may be similar to that of woodland (Fossit 2000).

2.4.6 Immature woodland WS2

Immature woodland includes areas that are dominated by young or sapling trees that have not yet reached the threshold height of 5m. These are areas of new woodland regeneration, where perhaps existing woodland is expanding its parameters or natural colonisation of an unwooded site is taking place.

2.5 Research in Irish Natural Woodlands

Much of the woodland research conducted in Ireland over the past thirty years is directed at understanding the conservation requirements of wildlife and attempts to provide guidelines for management purposes. Several monitoring studies have been designed to produce information over the time scale necessary to examine the natural processes relevant to habitat management. During the 1970s a number of research projects were begun, which were concerned with various aspects of oak wood ecology. In Ireland oak is a major component of the limited area of semi-natural woodland and oak regeneration is often conspicuous by its absence. In order to investigate the possible reasons for this lack of regeneration two monitoring projects, were set up in oak woods in Killarney National Park, Co. Kerry (Kelly 2002) and Glenveagh National Park, Co. Donegal. The primary objective of these projects was to research woodland dynamics in the absence of the damaging effects of grazing over a long period of time. Large fenced deer exclosures were set up and the vegetation within them was submitted to monitored experimental manipulation. The most comprehensive programme is co-ordinated by Daniel Kelly in Killarney with assistance from students of the Botany Department at Trinity College, Dublin and staff of the National Park. It received financial support from the National Parks and Wildlife Service.

After 25 years of research in Killarney National Park, the findings of the study has been published by Daniel Kelly in 2002 and provides significant information to guide the future survival and management of oak woodlands in Ireland. The regeneration success of Sessile Oak (*Quercus petraea*) was studied using various controlled experiments. The effect of light level, competition and nutrient supply on seedling success was investigated. Various management approaches such as weeding, creating gaps in canopy cover, application of fertilisers and removal of grazing were used and their success recorded. Seedling survival was greatly enhanced within the ungrazed exclosure even under canopy. The results of this study made the following findings:

- Oak regeneration is adversely affected by waterlogged, peaty soil.
- Oak is vulnerable to competition from a range of herb, shrub and tree species.
- Oak regeneration is virtually precluded where woods are subject to heavy grazing pressure; however a vital condition for the conservation of native oak is the achievement of sufficiently low densities of large herbivores.
- The use of fertiliser on oak seedlings is ineffective and is an inappropriate management option.
- Successful oak regeneration is to be expected only in unshaded or lightly shaded sites where grazing levels are low.

The history and phytosociology of Irish woodland on free-draining soils over limestone is treated in detail in Kelly & Kirby (1983). The structure of present day scrub and forest and their successional status in relation to other woodland communities are discussed. The dominant species of limestone woodland is usually Hazel (*Corylus avellana*) and Ash (*Fraxinus excelsior*) and mainly survive on free draining till on lake islands, headlands and eskers. As part of the study by Kelly & Kirby (1983) woodlands on exposed bedrock or glacial deposits over Carboniferous Limestone were studied in nine counties in the western half of Ireland. Five woodland sites around Lough Carra were included in the survey. Relevés measuring $200m^2$ were taken in sites that had continuous canopy cover over 4m, with no dominant alien species and that showed no evidence of water-logging. Data on woodland structure, ground-dwelling plants and bryophytes were recorded. The low stature of woodland on limestone pavement was found to be due to the sparse pockets of soil which are too scanty to support the growth of large trees. Stages in secondary succession on neglected land were observed to be governed by (i) the degree of grazing pressure, (ii) the nature of the substratum, (iii) the nature of the adjacent vegetation and (iv) the degree of wind exposure. The successional success and stages of various tree species was appraised. In the presence of grazing animals, spiny and thorny shrubs such as Hawthorn, Blackthorn and Bramble usually dominate the early stages of succession over limestone (Kelly and Kirby 1983:186). When grazing levels are low Hazel is capable of invading grassland communities and will persist in the understorey of forest trees as will Holly and Spindle. A number of tree and shrub species are frequent in limestone areas but are apparently unable to persist in closed forest: Whitebeam, Juniper, Buckthorn, Cherry and Strawberry tree. Ash was found to contrast with Oak in the profusion of its regeneration both under canopy and in open habitats. Growth of Oak seedlings is suppressed under woodland canopy and saplings are normally found only in clearings and around woodland margins (Kelly & Kirby 1983:188). Rhododendron was found to be locally abundant on leached soils over limestone, especially where woodland grades into bog.

Floristic and environmental data were recorded from wetland woods in all regions of Ireland by Kelly and Iremonger (1997). The study treated wetland woods in a broad sense to include all woodland on soils that are subject to waterlogging. Many of the woods in the survey are spontaneous secondary woodlands that have developed within the past 150 years. From this survey seven distinct categories of wetland woodland were recognised of which the richness and diversity had previously been underestimated (Kelly & Iremonger 1997:21). The study permitted for the first time an ecological characterisation of Irish wetland woods. The hydrological regime was found to be the over-riding determinant of vegetation type. The principal tree species of wetland woodland were Willow and Alder. Willow showed a positive correlation with liability to flooding and an experimental study confirmed that Willow seedlings were significantly more tolerant of soil saturation. Birch was the only species recorded in all seven groups and the study found this species to be usual dominant on acid peat, whether drained or waterlogged. Many Irish wetland woods appeared to show a succession towards Ash. This species avoids sites subject to prolonged flooding as well as strongly acid sites. Pedunculate Oak was locally dominant on sites where the upper soil becomes relatively dry in summer, notably in mature riparian woodland and drumlins. Kelly and Kirby (1983) assigned these woodlands to the association Corylo-Fraxinetum group classified by Braun-Blanquet and identified four sub-associations: (i) nekeretosum – this describes Hazel (*Coylus avellana*) scrub on shallow and stony limestone bedrock. (ii) veronicetosum – woodland on deep soils with mull humus and with bluebell (*Hyacinthoides non-scriptus*) in the field layer. (iii) typicum – woodland similar to that in (ii) but lacking the presence of moisture demanding species (e.g. Opposite-leaved Golden-saxifrage- *Chrysosplenium oppositifolium*). (iv) deschampsietosum – Ash (*Fraxinus excelsior*) is often the dominant tree species occurring on base-rich mineral soils which are waterlogged in winter but dry out in the summer (Higgins, Martin &Perrin 2004:10).

A comprehensive programme of monitoring and scientific research is being undertaken in the semi-natural oak wood at Brackloon, Co. Mayo. Brackloon wood, a typically moist "Atlantic" oakwood, is being used as a prototype site for the Irish Ecological Monitoring Network (Little, Boyle, Ryan and Farrell 2000). It has been a centre for monitoring activity by the Forest Ecosystem Research (FERG) group since 1991. It has become the most intensively studied semi-natural oak woodland ecosystem in Ireland (Cunningham 2005:4). The forest health programme monitors nutrient inputs from precipitation, soil water, foliage and forest litter. Additional financial support from COFORD has allowed the scope of monitoring to be broadened to include radioisotopes, soil fauna, flora, birds, bats and other mammals. This monitoring and research at Brackloon Wood aims to provide a basis for developing principles of sustainability and can contribute to the sustainable management of commercial, productive systems in agriculture, forestry and semi-natural terrestrial ecosystems (Little, Boyle, Ryan and Farrell 2000). It was the intention that surveying would be repeated every five to ten years. In order for monitoring to continue indefinitely at Brackloon, complementary management initiatives have been implemented to conserve the ecosystem. Over the past number of years, considerable efforts have been made to implement priority management, including the removal of exotic conifers, eradication of the invasive scrub *Rhododendron ponticum* and the reduction of grazing pressure through the erection of a stock proof fence and repair of sections of existing peripheral stone walls (Cunningham 2005:4). Other recommendations outlined in the conservation and management plan for Brackloon included the replanting of clearfells with native tree species, clarification of the legal status of the woodland, the conduction of a wide range of baseline surveys for future monitoring and the involvement of the local community through education and management initiatives. Presently many of these recommendations have and are being implemented. Vegetation surveys were carried out between March and September 1997. A core monitoring area was established containing sixteen permanent vegetation monitoring plots. The number of different kinds of plants and fungi identified at Brackloon Wood amounted to 775 species (Fox, Cullen, Little, Ciaurriz, Ryan, Dwyer and Boyle 2001). Brackloon was found "not to be exceptionally rich in relation to vegetation diversity when compared to Killarney oak woods, principally because the structural diversity of Brackloon has been much reduced by past human impact" (Little, Boyle, Ryan and Farrell 2000). In addition, the vegetation history of the wood spanning the entire 10,000 year period since the last Ice Age has been investigated through pollen analysis and radiocarbon dating (Cunningham 2005:5). The importance of this long-term monitoring and biodiversity research carried out at Brackloon is that it will be relevant to the management of similar woodland ecosystems. Recently the ecological and historical data recorded at Brackloon Wood have been drawn on to produce a book which explores the whole anatomy of Brackloon Wood.

An initial survey of vegetation, flora and fauna was completed at Oldhead Wood, County Mayo for the National Parks and Wildlife Service in 2005 (Huxley 2005). The aims of this study were (i) to map the major habitats and physical features, (ii) to provide an outline description of the vegetation, (iii) to produce a basic biodiversity inventory for flora and fauna and (iv) to assess the current status of the ecology of the reserve. They are similar to the current aims of this study of Partry House Estate woodlands. The site is designated a Nature Reserve having been identified as an Area of Scientific Interest in 1979. Although designated primarily as a relict Atlantic Oak Woodland, it was the finding of this survey that the Reserve actually consists of a complex mosaic of different woodland types, with only a relatively small proportion classifiable as semi-natural woodland dominated by sessile oak. The results of the survey also showed that the lack of active management was resulting in the loss of biodiversity. The major aspects of concern were the increased incursion of non-native tree and plant species which are leading to the structural and biological modification of the habitat. Based on the results of the survey, Huxley (2005:13) advocates the use of active adaptive management for the reserve, whereby certain management prescriptions are initiated, the effects monitored and subsequent management intervention adjusted accordingly. The results of the vegetation survey were used to produce a suggested 10 year management plan using adaptive management principles for the woodland area of the Reserve. The importance of differentiating between various woodland types was highlighted in order to set priorities for future management.

2.6 Research in British Natural Woodlands

Britain has a long history of woodland research and management in comparison to Ireland and has numerous woodlands which have been surveyed and studied over a long period of time. Such woodlands include Hayley Wood, Lady Park Wood, Brigsteer Park Wood and Gambley Wood. Old Hayley Wood has a recorded history of over 700 years and there are several distinctive types of woodland. It was bought in 1962 by the Cambridgeshire and Isle of Ely Naturalists Trust because of its reputation as the largest surviving semi-natural oak-ash wood in West Cambridgeshire. It was used for educational and research purposes. The historical woodland management at Hayley Wood has been interpreted by Rackham (1975) and this along with the results of experimental management practices and field surveys have been combined into a book. In 1963-4 an acre of wood was coppiced to show on the ground the effect of traditional cyclical coppice treatment and in 1974 eleven more coppice plots were formed. This was one of the earliest examples of conservation coppicing. In some years coppice growth was satisfactory and in terms of height reached in the first year, the fastest grower was sallow (*Salix cinerea*). In the years that coppice growth was disappointing a combination of deer browsing and the competition from herbaceous plants were deemed responsible. The browsed stools were affected by the shade of the tall vegetation. The food preference of deer in Hayley was recorded in a definite order; ash-sallow-hawthorn-hazel-maple-aspen. Coppicing was seen to increase the ecological variety of the Wood; however it was not compatible with the presence of deer. The effect of coppicing and the creation of open areas on the ground vegetation were marked by an increase in vigour and flowering of the existing ground vegetation and by the invasion of light demanding plants not previously growing on the site (Rackham 1975:140). As the underwood grows up again to form a new canopy, the light demanding plants disappear, while the permanent ground vegetation returns to its previous shaded state. Large increases in flowering plants of oxlip, primrose, anemone, violets, orchids and ground ivy were recorded in the earlier years after coppicing. Small permanent clearings were made in 1963 and overgrown rides were reopened. The vegetation of the rides was seen to be similar to species found on woodland margins and grassland. Hayley Wood is an important template for the research and management of woodland and this research at Hayley Wood is continuing today.

Lady Park Wood was designated as a research reserve in 1944 and the growth, mortality and regeneration of individual trees and shrubs have been recorded at irregular intervals for half a century (Peterken & Mountford 1995:205). The wood has been allowed to grow without management throughout this time and now parts have developed the large trees, accumulations of deadwood and patchy structure that is assumed characteristic of natural woodland. Human influences are minimised so that natural processes and states can be studied. Lady Park was not a virgin forest and had been coppiced for centuries. Two thirds of the forest was felled to contribute timber for the war effort, so the reserve now contains two age-classes, the young growth stands in the cleared area and old growth stands of mainly 19th and early 20th century trees (Peterken & Mountford 1995:207). The development of both growth stands has been monitored over the past 50 years and has afforded some insight into how native woods develop naturally. Of interest to this study is the experimentation on the effects of deer browsing on ground vegetation and regeneration that were set up in Lady Park. In 1989 the first of eight deer exclosures was erected after deer browsing appeared to be inhibiting regeneration of tree species. Today these are the only places where the ground flora remains ungrazed. Fallow deer have dramatically reduced the Bramble (*Rubus fruticosus*), which was dense enough to be difficult to walk through as late as 1993 – and still is within the exclosures – but which now survives outside exclosures only as hard-bitten remnants (Peterken & Mountford 2005:11). Damage to woody plants by deer was recorded during field surveys. It was noted that shoots 60-90cm height appeared the most vulnerable to browsing, while taller shots ≥1.5m were generally spared. The order of preference amongst the main tree species was oak – ash – beech – birch. Dogwood was the by far the most sought after subsidiary species followed by holly – maple – hazel – sallow (Peterken 1989:404). The effect of deer on regeneration was extremely variable as, for example, birch saplings were rarely browsed. Ash was a preferred species, but it was so abundant that despite browsing, enough remained to make a stand. The preference for oak saplings over beech or birch saplings handicapped the regeneration of oak in favour of beech and birch regeneration (Peterken 1989:404). The fallow deer and other species that are colonising the area are managed by culling (Peterken & Mountford 2005:11). It has been decided that fencing out of deer completely would be unnatural.

In Brigsteer Park Wood the effects of management on the ground flora of ancient woodland was recorded over an eighteen year period. It is widely assumed by conservation managers that regular rotational coppicing is appropriate for the maintenance of the flora and fauna of ancient woodlands of lowland Britain because such woods have survived due to their economic value under coppice-with-standards management throughout a period of 700 years or more (Barkham 1992:167). It also the argument that if organisms are present in previously managed woods, they must be well-adapted to the traditional management system and therefore management should be maintained (Barkham 1992:168). The study site is on an escarpment of Carboniferous limestone and supports a variety of woodland types. During this long-term survey data was collected yearly from fifty permanent $4m^2$ quadrats over an eighteen year period. The quadrats were placed in areas of the woodland that experienced various management approaches such as coppicing, clearing, replanting and non-interference. The results of this survey suggested that silvicultural operations had little effect on the constant composition of the ground vegetation. It was concluded that under continuing coppice management, significant losses from or gains to the ground flora are unlikely to occur (Barkham 1992:184). In the area that was planted with beech, larch, pine, sycamore and oak, minimal losses of species characteristic of the woodland shade flora were recorded. The species lost were tree seedlings and ruderal and grassland species that are the periodic result of secondary succession. In the unmanaged area of the woodland survey the conclusion was that the process of decline of shade tolerant ground flora in undisturbed woodlands will be slow or absent. No significant change in the ground flora was recorded over the eighteen year period.

2.7 Palynological Research in Ireland

Palynological research was introduced to Ireland by Knud Jessen the prominent Danish researcher, in the 1930s (Hall 2000:343). Early research availed of the profusion of lakes and bogs in the Irish landscape and contributed much to our understanding of the development and decline of the natural forests (Mitchell & Ryan 1997). During the 1980s a new approach was introduced to Ireland by Richard Bradshaw which relies on the analysis of pollen and charcoal preserved in organic deposits from small hollows in the woodland floor (O' Sullivan 1999:8). The high representation of pollen from local sources allows interpretation of woodland dynamics at the scale of the individual stand (Bradshaw 1988). The technique has proved useful for example in Killarney and Brackloon, where the response of tree species to disturbance and human activity has been described in some detail (O'Sullivan 1999:8). Furthermore Hall (1997) has been studying the evidence for historic landscape change in the documentary evidence and comparing it with pollen profiles from recent peat and lake sediments in Ireland. The status of woodland is traced through time, especially the pollen evidence for the great depletion of forest recorded in the texts written in the early seventeenth century. Landscape reconstructions based on pollen profiles dated by historic tephrochronology are sufficiently precisely-dated to allow temporal comparison with statements about the vegetated landscape in the documentary record (Hall 2000). The pollen evidence enhances the written record for woodland because tree species other than oak and to a lesser extent ash are poorly documented. However pollen evidence is not without bias as some plants produce more pollen than others and their presence can be over represented based on a pollen count. Furthermore the pollen produced by some plants is lighter than that produced by others and therefore can be transported greater distances, incorrectly suggesting the presence of a particular plant in an area (Cunningham 2005:10). This needs to be taken into consideration when interpreting pollen diagrams. Hall compared the veracity of documentary evidence for oak in Ulster with the pollen analysis in counties Down, Antrim and Derry. Records for land of the Lower Bann valley were described as wonderfully well-wooded in the seventeenth century. Pollen analytical investigations carried out by Hall shows that oak woods were never dense in this region at any time during the last thousand years.

There was strong pollen analytical evidence for major clearance in the ninth century in the Lower Bann valley which are said to be the sites of Jacobean clearances (Hall 2000:348). Moreover there is no telltale drop in oak pollen values which would support the claim that extensive woodlands were felled rapidly and irreversibly in the early years of the seventeenth century. The pollen results from each county show a landscape where there was some oak woodland but where hazel scrub was more common. After analysing the pollen records available for Irish counties Hall concluded that the great woodland clearances of the seventeenth century are not obvious from pollen diagrams, even though extensive felling is reported in the documentary evidence. However woodland regeneration in the mid seventeenth century was greatly depressed as farming practices changed and grasslands encroached onto cleared woodlands. The palynological record for sites throughout the country show that woodlands were under duress as tree pollen dwindles to its lowest values that millennium. From research by Hall in Correl Glen National Nature Reserve and in many isolated woodlands, Oak trees today were shown to have a start date of about 1850. The reason for this regeneration is associated with the population reduction after the Potato famine of the mid 1840s allowing oak to regenerate as pressure on the tree as a timber resource was reduced. This study by Hall highlights the potential of landscape reconstruction through the use of pollen analytical research not only for Irish prehistory but also for the historic period in Ireland.

2.8 Rhododendron Management Research

Introduced plant species now occur in virtually every inhabited part of the world. A small minority of such plants can become aggressively invasive and displace native species from their habitats (Milne & Abbott 2000:541). The alien *Rhododendron ponticum* has been widely planted in Ireland since its introduction from the Iberian Peninsula in the late 18th century, where it was valued for its attractive flowers in "beautifying" woodlands and for the shelter it provided for game (Cross 1982:209). Of the 250 or so alien plants now established in Ireland it is undoubtedly one of the most successful and one of the most threatening weeds (Cross 1982:219). Although there are hundreds of species of Rhododendron, it is only *Rhododendron ponticum* which is known to be a problem. Rhododendron invades areas both vegetatively and via seed. Established plants spread by lateral horizontal growth of branches, which when they touch the ground root and a single plant may eventually end up covering many metres of ground (Forest Research 2007). Their seeds are tiny and hence wind dispersed, with each flower head capable of producing several million seeds per year and each plant has the expected life span of 100 years (Esen, Zedaker, Kirwan & Mou 2004:237). Seedlings have difficulty becoming established in areas where there is already continuous ground cover from native plants and in studies in Turkey it was noted that rhododendron proliferates vigorously and exponentially in population size after disturbances (Esen, Zedaker, Kirwan & Mou 2004:237). The flowers of Rhododendron are very attractive to bumble-bees monopolising the attention of pollinating insects to the detriment of competing native vegetation (Forest Research 2007). Cross (1982) has established that *Rhododendron ponticum* occurs in Ireland in three major vegetation types: woods, heaths and bogs. It grows most successfully in woodlands preferring poorer, rocky acidic soils. It can also occur in limestone woodlands if there are strongly leached pockets of humus (Cross 1982:213). Rhododendron does not grow well in waterlogged soils, such as bogs and fen. However this resilient plant colonises relatively well drained sites such as ditches and turf banks in bogs and fens (Cross 1982). Its most serious impact on native Irish vegetation is to reduce the biological diversity by shading out the ground flora, preventing regeneration of trees and shrubs, reducing the variety of epiphytes and fungi, and destroying the habitat and food supplies for animals (Cross 1982:209). It has been shown to reduce the number of earthworms, birds, animals, plants and also the regenerative capacity of a site (Forestry Research 2007). The toxins in rhododendron make it unpalatable to most larger herbivores and probably to many invertebrates. Cross (1982:218) established that there was a serious lack of natural enemies associated with the plant, recording only 16 animal species, several of which were introduced. *Rhododendron* does not bear any palatable fruits or seeds and the litter is unattractive to soil dwelling organisms (Cross 1982:218). All of this means that the areas dominated by *Rhododendron* have an exceedingly impoverished fauna in comparison to native habitats, both in terms of species and biomass.

The management and removal of *Rhododendron* in habitat restoration schemes is notoriously difficult and expensive. Yet control is essential if the conservation value of some communities, such as oak woodland and lowland heath, are to be successfully maintained. Commonly used interventions are herbicide application, herbicide application post cut, and cutting (manual or mechanical) alone (Tyler, Pullin & Stewart 2006:513). The choice of control/eradication method can influence the recovery of the site and should be considered in any management projects. Tyler, Pullin & Stewart (2006) conducted a study on the effectiveness of management interventions to control invasion by *Rhododendron ponticum* as no definitive intervention has been established as the best control mechanism. They used a method of systematic reviews to locate data from published and unpublished sources on *Rhododendron* management and only studies which met the strict methodological criteria were used. Evidence from the primary studies was combined in a meta-analysis to determine the significance of the intervention method. Meta-analyses of captured data showed that postcut application of the herbicide Glyphosate or applying the herbicides Metsulfuron-methyl or Imazapyr (no cut) can effectively reduce a *Rhododendron ponticum* stand (Tyler, Pullin & Stewart 2006:516). In sensitive areas such as near water courses, where the use of herbicides is not safe, winching was deemed as highly effective with total eradication being reported in all studies (Tyler, Pullin & Stewart 2006:518). Cutting with the use of no herbicide was satisfactory in the short term, but growth might be promoted as adventitious buds will grow within a few weeks (Tyler, Pullin & Stewart 2006:518). According to the Forestry Commission in Scotland (2007) the removal of *Rhododendron* shoots before herbicide control will allow faster re-invasion of native plants, especially if coupled with ground disturbance. The humus layer that is left after *Rhododendron* removal prevents natural regeneration and is a seed store from which reinfestation can occur (Forest Research 2007). In Britain 'The Woodland Project' is part of an on-going program of woodland restoration. As part of the project an area of woodland in which *Rhododendron* had been removed two years previously was surveyed. The results of the survey revealed that removal of the rhododendron does result in an increase in biodiversity. The number of species in the area cleared of rhododendron two years previously in the pilot project was nearly double that in areas still covered in rhododendron. Mosses were particularly notable in the early regeneration phase. However, the recolonisation and recovery process is likely to take a long time. According to Cross (1982:219) if it continues to spread unchecked in Ireland it will ultimately dominate large areas of dried-out bog and heath, and very few native deciduous woodlands would remain unaffected. There is a need for more rigorous monitoring of interventions, as data on the effect of rainfall on the day of spraying needs to be measured. Also, when is the best month to manage rhododendron and does the habitat (bog, heath or woodland) on which the *Rhododendron* is growing affect the success of intervention? Further detailed studies will guide the success of future restoration projects.

2.9 Deer Management Research

There is increasing concern for the problems that deer create for woodland management. The increase in woodland area in Ireland, 200,000ha in past 20 years, is leading to conflict with certain mammal species as afforestation is resulting in a mosaic of plantations suitable for deer to colonise (O'Carroll 2005:4). The increasing populations of deer across Ireland are exacerbated by the introduction of non-native deer species to the wild. According to Rooney and Hayden (2002) deer are increasing in density and distribution across much of the Northern Hemisphere due to (i) an increase in woodland, (ii) an increase in food availability, (iii) lack of hunting, (iv) increased survival of adults and juveniles, (v) removal of predators and (vi) translocation by humans. There are three deer species in Ireland – red deer, sika deer and fallow deer, of which fallow are the most numerous and nationally widespread. The preferred habitat of the Irish deer species is woodland margins. Mounting evidence reveals that deer, if present at too high a density, will decrease the diversity of plants as well as the value of woodland as habitat for many birds, small mammals and invertebrates (Gill, Gurnell & Trout 1995:208). Heavy grazing pressure is a feature of many types of woodland in Ireland and this is a cause for serious concern given the very limited area of semi-natural woodland remaining in Ireland, estimated at covering 1.1% of the country (Higgins, Martin & Perrin 2004). Deer can be responsible for much damage in and around woodlands consisting of some or all of the following: bark stripping, browsing, fraying and trashing (Rooney & Hayden 2002). Browsing is the removal of buds and growing shoots of young trees and can delay growth, increase the likelihood of death or reduce the quality of timber resulting in stem deformation (Gill, Gurnell & Trout 1995:209). Established trees may be affected by bark stripping which most commonly occurs on young trees during the winter and spring months and will kill trees if the entire circumference is removed from the main stem below the crown. Fraying and trashing damage is caused when deer use young trees to clean the velvet tissue from growing antlers and to deposit scent by males during the build-up to the rut in autumn. Branches and foliage are often broken and young trees may suffer severe damage (Rooney & Hayden 2002). The amount of damage that deer can cause depends on three factors: population density, use of habitat and the choice of available foodstuffs (Gill, Gurnell & Trout 1995). The size, age and species composition of woodland can be greatly influenced by the browsing habits of deer. Deer are widely reported to reduce the size and number of regenerating seedlings and can result in the virtual elimination of all seedlings when browsing pressure is too high (Gill, Gurnell & Trout 1995:210). Browsing also affects the ground flora with bramble, honeysuckle, ivy and wild rose showing a decline in response to deer browsing. Preventive measures that may be employed include the use of repellents, habitat management, protective tree guards, fencing, trapping and population control regimes. The use of tree guards, fencing and repellent are effective but have the disadvantage of being costly and unsightly (Gill, Gurnell & Trout 1995). Perrin, Kelly & Mitchell (2006) used long term deer exclosures to study the effects of grazing by deer on the natural regeneration of yew-wood and oakwood habitats in Killarney National Park. They concluded after a 32 years that chronic heavy grazing in the Killarney woodlands strongly influences the natural regeneration of several tree species, chiefly *Ilex aquifolium, Fraxinus excelsior, Sorbus aucuparia* and *Quercus petrea.*

According to Rooney and Hayden (2002) humane culling is possibly the best method of reducing and maintaining deer numbers rapidly and effectively. The suggested target stocking density of five deer per hectare should be pursued and once achieved a maintenance cull of 5-20% would be needed (O'Carroll 2005:6). According to the Deer Alliance (2007) the primary objective of good deer management is to shoot enough deer to keep the herd in balance with the habitat available and deer populations need to be kept in balance with available supplies otherwise they can threaten natural habitats and agricultural incomes. There is a shooting season for wild deer in Ireland, where they may be shot under licence and with the appropriate firearm. Male deer may be shot September 1 to December 31 and female deer from November to February 28. However the numbers of deer culled during the hunting season is not enough to alleviate the deer problem. There is a consensus between landowners, forest managers, state organisations and environmental agencies that there is a need for some form of national deer population management. According to O'Carroll (2005), one of the main administrative causes of the growing deer problem is the lack of ownership and accountability among state departments and organisations. At present there is no integrated control policy in Ireland to reduce deer numbers to a sustainable level. It has been suggested by O'Carroll (2005) that Ireland should follow the example of Britain and Scotland and form a Deer Commission to manage the problem. The Deer Commission for Scotland is Non Departmental Public Body charged with furthering the conservation, control and sustainable management of all species of wild deer in Scotland. The DCS undertakes a wide range of activities advisory, regulatory, training, commission's research projects and works with other agencies on wider policy issues (Deer Commission of Scotland 2007). It is clear that if deer densities are left unchecked it will result in the loss of habitat for a wide range of invertebrates, birds and mammals.

2.10 Protection of Irish Woodlands.

Woodland awareness and appreciation has developed in line with Ireland's protection of important habitats under EU[1] legislation such as the EU Habitats Directive 1997 and international legislation such as the UN[2] Convention on Biological Diversity (Grimes 2004:7). Flora in general is protected under the provision of the Wildlife Act of 1976 and The Wildlife Amendment Act 2000. The Forestry Acts (1946, 1956 & 1988) primarily regulate commercial forestry activity (Johnson 1999). The process of designating lands for conservation is very active in Ireland at present. Since 1992, two designations are being introduced, namely Natural Heritage Areas (NHAs) and Special Areas of Conservation (SACs). These represent a major new development, in that most of the land in NHAs and SACs is privately owned (O'Sullivan 1999). NHAs will be covered by national legislation, which has not been introduced yet. SACs are proposed under the European Habitats Directive in order to create a network of protected wildlife sites in Europe and were passed in to Irish law in 1997. The

---

[1] EU — European Union
[2] UN — United Nations

development of the proposed NHA/SAC network is of major significance as it greatly expands the area of protected semi-natural woodland in this country.

Local authorities have responsibilities that relate to nature conservation such as the preparation of local biodiversity actions plans, the making of Tree Preservation Orders, and the control of development in designated areas or on sensitive landscapes (Doyle 2005). Despite the range of legislative mechanisms available to protect woodlands, the total area of protected woodland in Ireland to date is still relatively low. Of the estimated 100,000ha of Ireland's broadleaved woodland, not more than 6,000 ha are protected for conservation through ownership and/or legislation in National Parks and Nature Reserves (O' Sullivan 1999). In addition, in 1996 Ireland ratified the Convention on Biological Diversity. As a result, a National Biodiversity Plan has been produced which contains several actions that relate to woodland conservation including the establishment of the Native Woodland Scheme and a national survey of native woodlands.

In Irelands' *National Biodiversity Plan* (2002), native woodlands are deemed the rarest habitat type in Ireland and it is considered necessary to increase the area of semi-natural woodlands through the creation of new woodlands. The following actions were outlined in this plan:

1. Introduction of the Native Woodland Scheme comprising of two separate elements.
   - Native Woodland Establishment; target of 15,000 ha of new native woodland.
   - Native Woodland Conservation aimed at protecting and enhancing existing native woodlands; target 15,000 ha of existing native woodlands will be enhanced.
2. Encouragement, in conjunction with the Peoples millennium Forests Project of the planting and management of 600 ha of native Irish Broadleaf trees.
3. Develop a classification system and undertake an inventory of broadleaved woodlands in Ireland.

The Native Woodland Scheme is currently up and running and is funded by the Department of the Marine and Natural resources under the National Development Plan (Forest Service 2001). Funding was announced by Minister Joe Walsh of 1.3 million Euros for the Native Woodland Scheme for 2004. The scheme is aimed at encouraging the private native woodland owners to conserve and manage these habitats. Funding is available to landowners that join the scheme and a site-specific ecological survey and management plan is prepared.

An inventory of native woodland in Ireland is already underway. The native woodland survey comprised a two-tier approach. The first was to conduct a desk survey of all possible native woodland sites in Ireland, identifying and mapping every block of native woodland greater that one hectare in extent (Higgins, Martin & Perrin 2004). The second was to use this information to implement a systematic field survey of native woodland sites. This survey is the first step in a detailed and comprehensive investigation of the diversity of Irish woodlands and an appraisal of the applicability of current classification systems (Higgins, Martin & Perrin 2004). The survey also aimed to facilitate a systematic evaluation of the conservation value and regeneration status of Irish woodlands. This survey is still ongoing and will result in a precise map of native woodland in Ireland.

A further governmental initiative, which enhances the protection of native woodland on farmland, is the Rural Environmental Protection Scheme (REPs). This is the first environmental scheme for agricultural land and is acknowledged by conservation bodies as a valuable policy for the protection of wild species of flora and fauna and their habitats (The Heritage Council 1998). The Rural Environmental Protection Scheme includes management guidelines on farm woodland and implements a biodiversity awareness strategy for farmers; ensuring adherence to the guide of good farming practices (National Biodiversity Plan 2002).

3. Methodology

3 Methods and materials.

3.1 Introduction

This chapter sets out the materials and methods employed in examining the history, ecology and management of the Partry House Estate Woodlands. The approach is multidisciplinary combining historical and ecological research and using primary and secondary data sources. As a result a biological field survey has been allied with a survey of historical writings, archives and both contemporary and historical cartography. The different methods and materials employed are described with special reference to their temporal and qualitative information. A combination of both primary and secondary sources have been utilised during the research. Primary sources included fieldwork, surveys, manuscripts, maps, travel diaries, personal observation and interviews. The secondary sources were mainly comprised of books, journal articles, reports and unpublished theses.

3.2 Study Area

The study area is located in Partry, County Mayo in the west of Ireland and is part of the Partry House Estate demesne which dates back to 1667. The estate is owned privately and is situated six miles to the northwest of Ballinrobe town on the N84 (Figure 3.1). The woodlands are situated on the south-western shore of Lough Carra, one of Ireland's Great Western Lakes that forms part of a chain of lakes, which run from Killala Bay in the North to Galway Bay in the South. Lough Carra, which is hydrologially linked to Lough Mask, is one of the best examples in Ireland of a hard water marl lake. The general geological character of the area is Carboniferous limestone. The limestone within this site represents the northern limit of the limestones of Clare and Galway. This underlying geology results in a great diversity of habitats, which supports many scarce and rare plants and animals. In addition, the habitats surrounding these woodlands are of great conservation importance, including limestone pavement, dry calcareous grassland and heath, limestone scrub, fen, *Cladium* fen and the shallow marl lake of Lough Carra.

Figure 3.1 Location of Partry House Estate

Plate 3.1 Orthograph of Woodlands in Partry House Estate 2001

Partry Estate, once known as Cloonlagheen, comprises approximately 250 acres of land, of which generally 104 acres are woodland (Plate 3.1). The four woodlands subject to this research are all located within the Carra/Mask Special Area of Conservation (SAC). The woodlands Moynish (M 170/693), Bridgepark (M 163/685), Creggaun (M 171/698) and Leamnahye Island (M 171/700) are mixed broadleaved woodlands of varied size, age, composition and structure. Species of native trees and shrubs found in the woodlands include Alder Buckthorn (*Frangula alnus*), Aspen (*Populus tremula*), Blackthorn (*Prunus spinosa*), Common Alder (*Alnus glutinosa*), Common Ash (*Fraxinus excelsior*), Common Juniper (*Juniperus communis*), Crab Apple (*Malus sylvestris*), Elder (*Sambucus nigra*), Goat Willow (*Salix caprea*), Guelder Rose (*Viburnum opulus*), Hawthorn (*Crataegus monogyna*), Hazel (*Corylus avellana*), Holly (*Ilex aquifolium*), Irish Whitebeam (*Sorbus hibernica*), Oak (*Quercus robur*), Rowan (*Sorbus aucuparia*), Silver Birch (*Betula pendula*), Spindle (*Euonymus europaeus*) and Yew (*Taxus baccata*). The woodlands also contain some introduced and non-native species such as Common Beech (*Fagus sylvatica*), Scots Pine (*Pinus sylvestris*), European Larch (*Larix decidua*), Rhododendron (*Rhododendron ponticum*) and Sycamore (*Acer pseudoplatanus*).

3.3 Historical Sources

Historical sources are important in that they can be remarkably precise in time scale and can explain the present day ecological status of existing woodlands. In Ireland historical documents date from at least as far back as the fifth century A.D. Historical references to woodlands are uncommon in early Irish texts. Forbes (1932:25) commented that "little reference is made to Irish woods after the thirteenth century until the reign of Elizabeth, and then chiefly in connection with the objectionable practice the rebels had of entrenching themselves in the woods and fastnesses of the country". Much documentation has been destroyed in the many wars and conflicts that have taken place on the island in the past thousand years. The drawbacks of historical sources include their relative rarity and the difficulty of discovering information to a specific site. The surviving Irish Annals are an invaluable source for Irish history up until the 16th century. These ancient historical sources describe past events, people and places. The Annals of Loch Cé give us an insight into the history of Ireland and the West. These Annals were the main source of information used by J.F Quinn to write *The History of Mayo* (Quinn 1993 & 2000). This is an important source of information detailing the early history of all Mayo's parishes and townlands. One of the earliest historic documents available for County Mayo is The Strafford Inquisition of County Mayo 1635-37. This was translated by O'Sullivan in 1958 and contained the work of a jury which set out to describe in detail the ownership of land in County Mayo over the previous ten years (National Library 2007). However there was no reference to Cloonlagheen/Partry Estate in it. The Civil Survey commenced in June 1654 and was an essential preliminary to the Cromwellian confiscation. It was a survey carried out by inquisition not by mapped measurement and was carried out in all counties except Clare, Mayo, Galway, Roscommon, and Silgo, for which the Strafford Survey was available (National Library 2007). An important record of landownership in the 17th century is The Books of Survey and Distribution 1636-1703. They recorded the change which took place in the distribution of landownership in the seventeenth century. The books of which several survive, record parish by parish the pre-Cromwellian and post-Cromwellian holders of all the lands confiscated by the commonwealth. Simington summarised the information contained in some of the surviving books including The Book of Survey and Distribution for Co. Mayo in 1956. This was the first document available which described the land composition of Partry House Demesne. In a further volume Simington (1967) summarised the owners of Castles in Co. Mayo as was recorded in the Divisions of Connaught 1570, 1574. The owner of Cloonlagheen Castle (Partry House) was recorded. The Transplantation to Connaught 1654-1658 was also summarised by Simington in 1970. Details on where the transplanters came from and where they received lands were recorded. The amount of land at Lough Carra that was received by Sir Robuck Lynch was recorded, but no other details were present. The Tithe Composition Applotment Books 1823-1837 are a valuable source when establishing land cover in the 19th century. They provide a detailed account of the occupiers of land with the extent and value of their individual farms. The types of land cover and the acreage was recorded and can be compared to similar data collected in the Books of Survey and Distribution in the 17th century in order to record any landscape changes that may have occurred.

The first Ordnance Survey of Ireland took place for 1824-1848. The field books accompanying the surveys recorded useful details on the landowners, the translation of the placename and also on the main use of the land. Landed estate records are of immense importance when establishing the history of land use. They provide information on what occurred in a particular estate, the names of tenants, rents being paid, improvements being carried out on the estate and policy relating to the estate. Unfortunately no estate records have survived to date for Partry House Estate. However, a survey of another family estate was discovered in the Manuscript Department of the National Library. The survey of the estates of Sir Robert Lynch-Blosse lying in the Baronies of Carra and Clanmorris, Co. Mayo was compiled by Samuel Nicholson Civil Engineer and Land Valuator in 1844. This report gives a valuable insight into the management and landscape of the estates on the eve of the famine. Records of the Famine Relief Commission Papers 1845-47 are held in the National Archives. They provide a source of information detailing the efforts made to help tenants during the famine. Summaries of the contents of surviving papers are available on the National Archives website. The primary valuation of rateable property in Ireland otherwise known as Griffith's Valuation is another historic source which is comprehensive in its coverage. The valuation was carried out between 1848 and 1864 in order to determine liability to pay the Poor Rate. It provides the only detailed guide to where people lived in the mid-nineteenth century Ireland and to the property they possessed. However there was no description of the land recorded. Other sources of historic reference that were sourced included primary travel journals, early books and local historic journals.

3.4 Cartographic Sources

An effort has been made to source cartographic maps depicting the woodlands at Partry House Estate. In Ireland the principal map collection is in the National Library of Ireland (N.L.I.). The earliest maps indicating the presence of woodland in Ireland date to about 1580 (Rackham 1995:109). The Down and Civil Surveys of the 1650s are important sources of information for landuse history. The Civil Survey took the form of parish and barony descriptions of Ireland, while the purpose of the Down Survey was to divide the lands among Cromwell's soldiers and the adventurers who funded him (Fahy 1995:175). The information gathered in the Civil Survey was incorporated in the Down Survey 1654-1657, which William Petty was appointed to direct as an extension of the Civil Survey (Bohan 1997:35). The data produced by the Down Survey allowed the production of William Petty's *Hibernia Delineatio* of 1685. These maps have suffered unfavourably during their subsequent history and a large number of them have been lost. Due to the ongoing conservation works of historic maps at The National Library any surviving Petty Maps of Co. Mayo were not available for consultation. An important publication of the eighteenth century was George Taylor and Andrew Skinner's atlas of major roads in Ireland of 1798. A number of woods are shown on the maps which survive. However the woods are mainly recorded around the Landlord houses only. The quality and reliability of maps up until the great era of the Ordnance Surveys (1820s onwards) varies with the mapmaker and the commissioner of the map rather than with the period (Bohan 1997:36). The first Ordnance Survey of 6 inch and 25 inch to the mile maps were carried out in Ireland from 1824 and did not finish until the 1880s. The original 25 inch maps are available for consultation in the National Library. Greater amount of detail is given on these maps describing the type of vegetation that is present. This was the first descriptive map available of Partry House Estate. The area was also mapped in 1830 by William Bald. However the quality of this map is inferior in comparison to the Ordnance Survey Map. The last Ordnance Survey of Ireland was started in the early 20th century and Partry House Estate was mapped in 1914. The 25 inch map from this Ordnance Survey was used when mapping the woodlands (Appendix 1.1). With advances in technology early aerial photography can be used to assess landscape changes. An aerial photograph of the estate taken in 1973 was available for consultation. Also a more recent orthograph of the estate taken in 2001 has been acquired to demonstrate the present area of woodland (Plate 3.1).

3.5 Field Survey

The field survey methods can be divided into three sections: firstly, the description and general survey of the site, the description of quadrats for each vegetation community in the site; and thirdly, the determination of tree size, abundance and quality. Specially designed field survey sheets were used for recording at each site

(Appendix 1.2). The aspect (N, NE, E, SE, S, SW, W, or NW) – was recorded for the site as a whole. Site area (in acres) was derived from the 25 inch Ordnance Survey map of 1914. The predominant soil moisture regime observed at the site of survey was recorded using the following measures; Excessive; Free; Impeded; Strongly impeded; Prone to flooding. Soil depth readings were taken in each woodland using a rod to probe the ground until it was obstructed and measuring the depth it reached. An average soil depth was then calculated for each woodland. The surface cover of each site was noted. The categories assessed were rocks and mossy boulders; limestone pavement and grassland; bare soil; leaf litter and dead wood; herbs. The scale used was DAFOR (dominant, abundant, frequent, occasional, rare) (Kent and Coker 1992:45). Any evidence of management, both previous and current, in each wood was noted. This included planting, felling, amenity use and coppicing. Also the presence of earthen banks, walls, ditches and other manmade features were recorded.

Vegetation analysis was carried out throughout Partry House Estate woodlands. The fieldwork took place during the summers of 2005 and 2006 and required the utilisation of both qualitative and quantitative research methods to collect and analyse the data. Both Rose (1981) and Webb, Parnell and Doogue (1996) were the taxonomic guides used for plant identification in the field. Before starting the fieldwork various external factors needed to be considered to ensure consistency throughout the fieldwork process;

- Sampling design for vegetation description and analysis.
- Quadrat size.
- How large a sample is required — How many quadrats?
- How to record species abundance i.e. Braun-Blanquet cover abundance scale or as a percentage?

The qualitative data collected are simply inventories of the species occurring in each site/stand. The quantitative form of data consists of a species list in each stand, but with an abundance value of some kind added to it (Causton, 1988). A combination of regular/systematic sampling and stratified sampling were the chosen sampling designs for this survey. Systematic sampling involves the location of sampling points at regular or systematic intervals (Kent and Coker 1992). According to Causton (1988:16) regular sampling is virtually a necessity for description and mapping purposes, and there are no disadvantages in doing this. Care was taken during surveying that the sampling interval did not coincide with any pattern in the vegetation. The principle of stratified sampling is that the vegetation of the area under study is divided up before samples are chosen on the basis of obvious variations within it (Kent and Coker 1992:52). A combination of various field sampling methods; belt transect, line transect, point quadrat, quadrats and grid sampling, were applied accordingly in the different woodlands. A belt transect is where quadrats are laid out next to each other or contiguously along a transect line. Regularly spaced point quadrats were used to obtain data on canopy and understorey cover and involved recording the presence or absence of an individual at a point. A form of regular sampling is the grid system. This consists of a grid of regular spaced transects and is useful for mapping changes in vegetation. Belt transects, line transects and $10m^2$ quadrats were used to gather information on the stand composition and structure, and all living trees and shrubs with a diameter $\geq$ 5cm were recorded. The survey plots were defined using rope, poles and a measuring tape, creating a square box in the case of the $10m^2$ quadrat and a rectangular study area was created when using belt and line transects. Any plants falling outside the plot were rejected. The following information was recorded for all trees falling within the relevé plot.

- Species name
- The diameter was measured at breast height (dbh).
- Crown position relative to other trees was recorded: canopy (trees forming the canopy, understorey (trees in the lower canopy that receive some direct light from above) and scrub $\leq$ 3m.
- Height (to the nearest metre)
- Number of stems
- Presence of epiphytes
- Evidence of bark stripping
- Evidence of management

The regeneration status of a wood is an important indicator of its future status and data on the presence of regenerating stems was recorded. An assessment of tree regeneration was accomplished by recording all stems of tree and woody species considered to be 'regeneration' growing within the survey site. For the analysis the size classes were combined into two height categories: $\leq$ 15cm were considered seedlings; $\leq$ 2m were considered saplings.

Vascular plants and bryophytes were recorded using quadrats measuring $1m^2$ and their cover abundance within each quadrat assessed by eye and recorded as percentage cover. Although estimations by eye can be inaccurate (Goldsmith 1991), the same recorder carried out all the fieldwork and all methods used were consistent. The cover of a species is defined as the proportion of the ground occupied by the aerial parts of individuals of the species under consideration and is normally expressed as a percentage (Kent and Coker 1992). The percentage cover of bare ground, dead wood and leaf litter occurring within the quadrat was also estimated and recorded. As suggested by Causton (1988) percentage cover was estimated to the nearest 5% as it is more feasible than estimating to the nearest 1%. The total cover of all species does not always amount to 100% due to the layering of species in thick foliage. A $1m^2$ quadrat was chosen to facilitate comparison with other work. Species nomenclature used in this research is after Rose (1981) and Webb, Parnell & Doogue (1996) for vascular plants. Vegetation communities were classified using the system of Fossitt (2000). All samples were taken by the same person to ensure consistency throughout. Unidentified species were collected and identified off the field.

3.5.1 Bridgepark

A grid transect was used to sample the vegetation in Bridgepark. A transect of regular spaced $10m^2$ quadrats were taken across the width of the woodland in a south-westerly direction (Appendix 1.3). A distance of 35 metres was between each quadrat. Each subsequent line of transects crosscutting Bridgepark were recorded eighty metres away from the last transect. The distance between transects was measured using a measuring tape and a Global Positioning System (GPS). A total of eight transects were taken, recording forty-two $10m^2$ quadrats of the vegetation composition. Four floral quadrats were taken within the area of each $10m^2$ quadrat and one hundred and sixty eight $1m^2$ quadrats of floral composition were recorded in total. A GPS was used to record the location of each survey area. An area of wetland woodland was inaccessible and only a species list of trees in this area was compiled. The data recorded was divided into three zones; Zone 1: Recent transitional woodland on limestone grassland. Zone 2: The area of Bridgepark depicted as woodland on 1914 OS Map, and Zone 3: Wetland woodland beside Keel Bridge.

3.5.2 Moynish

To facilitate the surveying of this the largest woodland it was decided to stratify the woodland into zones. The woodland is naturally divided by three pathways which dissect it into five plots of woodland. Each of these plots were surveyed and allocated a zone number.

Zone 1

A line transect measuring 4m in width and 160m in length was taken through the centre of Zone 1 (Appendix 1.4). All canopy, understorey and scrub species were recorded. At intervals along the transect, floral quadrats measuring $1m^2$ were taken. The boundary of the woodland was surveyed using point quadrats taken every five metres. Two further transects of point quadrats and floral quadrats were taken to the east and west of the central line transect. In total twenty floral quadrats were documented and an area of $480m^2$ was surveyed in Zone 1.

Zone 2, 3 and 4.

The entire boundary of each Zone was surveyed using point quadrats taken every five metres. Four transects of point quadrats were taken across each zone running in an east to west direction. There was a distance of 5 metres between each point and a distance of 80 metres between the transects (Appendix 1.5, 1.6 & 1.7). Four quadrats were recorded in all zones measuring 5m x 10m and in each three floral quadrats were documented. Further floristic data was recorded using transects of quadrats. Each $1m^2$ quadrat was taken 20m apart and there was a distance of 80m between each transect.

Zone 5

This area of Moynish consists of young thick scrub growth, which made it very difficult to survey. Data on the vegetation structure and composition were recorded by taking point quadrats along the boundary of the zone. However, as the scrub was impenetrable no floral data was recorded.

3.5.3 Creggaun

A combination of surveying methods was incorporated to survey the vegetation of Creggaun woodland (Appendix 1.8). The boundary of the woodland was surveyed using point quadrats taken every five metres. The distance between each point was measured by pacing. Information on the canopy, understorey and scrub occurring at each point was recorded. Six transects of point and flora quadrats were taken across the woodland and recording data every 5 metres. In total, sixty-four floral quadrats were documented. The distance between each point was measured by pacing and the direction of the transect lines was east to west. Each transect of points were taken 40 metres apart. To record further data on canopy composition and structure nine quadrats measuring 5m x 10m were taken, three in each zone.

3.5.4 Leamnahye Island

A series of belt transects were used to examine the vegetation on Leamnahye island (Appendix 1.9). The belt transects were placed across the width of the island with a distance of ninety metres between the first three transects and sixty metres between belt transect 3 and 4. A total four belt transects were recorded and each consisted of three-four quadrats measuring 10m x 10m each. Information about stand structure and species composition was recorded in each belt transect. The flora data was surveyed using 1m^2 quadrats and a total of 64 were recorded.

Summary Table of Methodologies							
Woodland	**Grid Sampling**	**Point Transect**	**Belt Transect**	**Line Transect**	**10m^2 Quadrat**	**1m^2 Quadrat**	**5m x 10m Quadrat**
Bridgepark	X					X	X
Moynish							
Zone 1		X			X	X	
Zone 2		X				X	X
Zone 3		X				X	X
Zone 4		X				X	X
Creggaun		X				X	X
Leamnahye			X		X	X	

Table 3.1 Summary Table of Methodologies used in Field Survey

3.6 Vegetation Analysis

CAP (Community Analysis Package) a Windows program that offers a range of analytical techniques was used to examine the collected data. Both ordination and classification methods were used to explore, compare and analyse the community structure. The raw floristic data was stored using Microsoft Excel and sorted using TWINSPAN (Two way species indicator analysis). TWINSPAN is a somewhat complex divisive clustering method originally devised by Hill for vegetation analysis. TWINSPAN uses reciprocal averaging to classify samples (in this case quadrats) and then divides the dataset into 'positive' and 'negative' group, depending on the relative abundances of certain 'indicator' species in the samples (Higgins, Martin and Perrin 2004). The floristic data was then rearranged based on the TWINSPAN output using Microsoft Excel and a table was then produced showing species-by-site (quadrate or sample) relationships. This allowed for groups and associations to be formed (Pisces Conservation 2004). The raw data is available for analysis in attached CD.

3.7 Tree Coring

There are a number of methods which can be used to ascertain the age of the trees. The most accurate is to use a Pressler's Borer, which involves the removal of a core of wood from the stem of a tree using a hand held, hollow boring instrument. The Pressler borer, after the name if its inventor in 1867, is similar to a hollow corkscrew. In the absence of data on tree age, the Pressler borer makes it possible to rapidly determine the age of a tree with minimum damage, as well as its growth rate over an interval of time. The technique is based on the principles of dendrochronology which was discovered in the early part of the 20th century by A.E. Douglas from the University of Arizona. He discovered that the difference between winter and summer growth of wood established a ring making it possible to count annual rings. The number of annual rings and their distance apart will be seen on the core allowing an estimate of age to be deduced (Broad 1998). When coring a tree it is first examined to find the best place to remove a core. Areas where ring patterns are likely to be distorted such as near branches or on scarred bark are avoided (Stokes and Smiley 1996). The tip of the borer is pressed firmly against the bark at right angles to the axis of the trunk and the handles are turned clockwise until the borer is anchored in the wood. The tree is bored until it is thought that it has reached its centre. The extractor spoon is then inserted into the borer between the wood and the sides of the borer. The borer is then given a full turn counter clockwise to break the core and the extractor, carrying the core is then removed from the borer. The species of tree, the height, diameter of the tree and the chest height at place of coring were all recorded. Trees were marked for coring in sample areas during the field survey in each woodland. Where possible the same recorder bored the trees, however on larger hard wood trees assistance was needed. Depending on the quality of the core, counting of rings took place in the field. However this was not always possible and the core was then stored, labelled and counted off the field. It was found that it was easier to count certain tree species such as Scots Pine (*Pinus sylvestris)* and Larch (*Larix decidua*), than Beech (*Fagus sylvatica*) or Aspen (*Populus tremula*). In some core samples annual rings were not uniform in direction or were misshaped making it difficult to age. When this occurred any areas of the core where rings were legible were measured and the rings counted in these areas. An average age was calculated for 1cm and then multiplied by the radius to calculate the age of the tree.

3.8 Deer Exclusion Experiment

The effect that deer are having on the woodlands in this area has never been recorded and it was decided that quantitative data on their impact would be of considerable value to the preparation of management plans. An experiment to evaluate the impact of deer grazing on regeneration and the flora layer was implemented. It consisted of constructing fenced deer exclosures enclosing an area of woodland in Bridgepark, Moynish, Creggaun and Leamnahye. The sites for the experiment plots were identified by fieldwalking. The sites selected in each woodland were similar in species composition, surrounding vegetation, drainage and light composition. They also had to show evidence of recent grazing by deer. The exclosures and control plots were located in the same class of woodland, which was semi-natural broadleaved woodland categorised as Oak-ash-hazel Woodland WN2. The exclosures measured 5m^2 and were erected from wooden posts and sheep wire in February 2005 (Plate No. 3.2). The dimensions of the exclosure were kept small in order to deter the trespass of deer, as it is unlikely that they would break into such a confined area.

Plate No. 3.2 Creggaun Exclosure

A control plot in a similar area of woodland measuring 5m^2 was marked out using wooden posts in each of the woodlands (Plate No. 3.3). The hypothesis of the experiment was that vegetation would increase in the absence of grazing in the exclosures and that it would decrease or remain the same in the control plots. The exclosures and control plots were then submitted to monitored experimental manipulation and were surveyed in the summer of 2005 and again in the summer of 2006. The number of seedlings and saplings were identified and recorded. The entire vegetation layer occurring inside the exclosures and control plots was surveyed. The data was collected using a 1m^2 quadrat and 25 quadrats were recorded each year in the exclosures and control plots. Data on the height of vegetation, number of primrose plants and number of flowering species occurring was also gathered. The position of the experiments was recorded with a GPS and their location was mapped (Appendix 1.10-1.13). The raw data was stored in spreadsheets using Microsoft Excel (Appendix 3 – CD). Both ordination and classification methods were used to explore, compare and analyse the raw data. The flora data was organised into groups using TWINSPAN.

Plate No. 3.3 Creggaun Control Plot

To examine the data collected more closely an ordination method Multidimensional Scaling (MDS) was used to compare the vegetation recorded from each year in the exclosures and control plots. MDS is a technique for expressing the similarities between different objects in a small number of dimensions. The method attempts to place the most similar samples closest together. The ecological data collected in an exclosure or control plot in 2005 was grouped with the data collected from it in 2006. The complex set of inter-relationships of the data are summarised from the two years and are displayed in MDS Plot Models. The MDS Plot plots the data spatial. The samples that are closer together are more similar. Analysis of Similarity (ANOSIM) tests were also carried out on the floristic data. This test was developed by Clark in 1988 as a test of the significance of the groups that had been defined a priori (Pisces Conservation 2004). The ecological data collected in an exclosure or control plot in 2005 and the data collected from it in 2006 were defined as two individual groups and entered into the test. If the assigned groups are meaningful, samples within the groups should be more similar in composition than samples from different groups. If the value of P is significant you can conclude that there is evidence that the samples within groups are more similar than would be expected by random chance (Pisces Conservation 2004). If the P-value result of the test is between 0.001 - 0.005 then it is significant, meaning that the composition of the data is similar. Similarity Percentages (SIMPER) tests were also carried out on the data sets collected from the exclosures and control plots to calculate the similarity or dissimilarity between these sites. This analysis breaks down the contribution of each species to the observed similarity (or dissimilarity) between samples. It allows the species that are most important in creating the observed pattern of similarity to be identified. The method uses the Bray-Curtis measure of similarity, comparing in turn, each sample in Group 1 with each sample in Group 2. The Bray-Curtis method operates at the species level and therefore the mean similarity percentage between data collected in 2005 & 2006 can be obtained. These experiments were carried out on all exclosure and control plot results. As there is only one year between the collections of data it is not expected that a definitive result or change will be observed.

3.9 Breeding Bird Census

A Breeding Bird Census is being conducted in Partry House Estate since 2003. Data on all types of bird species is being collected each summer in order to establish species abundance and a species inventory for all the habitats in the area. The woodlands of Bridgepark, Moynish and Creggaun have been included in this survey. A set route is taken, at a set time of the year and at approximately the same time in the day. While walking this route at a continuous pace all birds that are visually seen are identified and recorded. Also bird calls are identified and counted. This census technique has been undertaken twice each year between May and July. Data from 2003-2006 was made available to this research and only the data on woodland specialist birds was used.

3.10 Global Positioning System and DMap Software

Global Position System (GPS) is a constellation of 27 earth-orbiting satellites. Twenty-four of these are in operation at any one time with three extras providing built in redundancy in case of failure (McDonnell 2006:18). The Navstar GPS satellites transmit data via high frequency radio waves back to Earth and, by locking onto these signals, a GPS receiver can process this data to calculate its precise location on the globe (McDonnell 2006:17). A GPS receiver uses four or more of these satellites to fix a position for an accurate reading. It calculates the distance to each, and uses this information to triangulate its own location. Since 2000 the accuracy of GPS receivers has improved considerably with the US increasing the number of satellites that are available for civilian use (McDonnell 2006:19). They can now locate their position up to ten times more precisely (within 10 to 20 meters). The accuracy of the location may also be affected by cloud cover or in the case of woodlands by foliage cover The GPS receiver was used during field surveying to record the position of survey sites, badger sets, paths, stone walls and stone buildings (Appendix 1.10-1.13). To aid with the mapping of vegetation the GPS receiver was used to record the various areas of vegetation and translated into a colour-coded map in the lab using the DMap software programme. The methods involved walking throughout the woodlands with the GPS hand-held receiver and marking out points as the vegetation changed. In total 438 points were recorded. A hand drawn sketch of each of the woodlands was also made on site and was very important when identifying the different areas of vegetation later during the creation of the woodland maps.

In order to download the data from a GPS receiver a software application was used that facilitated communication between the computer and the GPS device. A combination of the information collected during the field survey and the GPS readings were used with DMap software to produce various maps of the woodlands. DMAP (Distribution Mapping) is a mapping software application specifically designed for producing Distribution and Coincidence Maps. Distribution Mapping is a method used to indicate the distribution of species or features over a geographical area (McDonnell 2006). It shows how plentiful something is on a map overlaid with a grid. Species distribution maps show the existence of a particular species at each study location/grid square on a map. The GPS points were imputed into the DMap software programme where they were displayed as a series of connecting lines that outlined the various vegetation types in the woodlands. This information was laid on top of a digital 25 inch Ordnance Survey map and the location was in the form of Grid References. The maps were then exported to Paint where the various woodland types were in filled with colour. The vegetation was classified in terms of the stand types using Fossitt (2000) and once the map was produced a legend and a north arrow was added in, in Microsoft Word. A map of the positions of the survey sites and a feature map were also produced for each woodland.

3.11 Interviews

During the process of the research it was deemed necessary to interview a number of people who had useful information concerning the history and management of Partry House Estate. An individual set of interview questions was designed for each interviewee. The interviews were recorded using a dictaphone and transcribed fully.

4. History

4 History

4.1 The History of Partry House Estate

Lough Carra has a long history of occupation which is evident in the array of monuments, castles and archaeological remains found along its shores and on its islands. There are remains of prehistoric and early Christian sites, such as crannogs and ecclesiastical ruins, and also reminders of more recent historic events in the form of famine works. These archaeological features in and around Lough Carra attest to continual human impact from at least the early Bronze Age. The lake and its surroundings provided a wealth of resources to its inhabitants down through the centuries including shelter, fishing, hunting, wood, fertiliser, transport and farmland. Settlement around Lough Carra can be dated back to before 1069 BC. An oak sample from a causeway crossing the lake at Kilkeeran on the west to Ballycally on the east side was aged in the Palaeoecology Centre in the Queen's University of Belfast in 1991 (Brown 1991). Local residents through the generations were aware of the presence of the causeway referring to it as the 'Old Road'. The history and management of Partry House Estate is difficult to portray in the absence of estate records and surveys. However from other documentary and cartographic sources it is possible to somewhat trace this history and present an overview of how the estate has developed up to now. Partry House estate today is situated in the townland of Cloonlagheen, in the Parish of Ballyovey which is in the Barony of Carra. The estate was always referred to as Cloonlagheen up until sometime in the late 19^{th} century, when the name changed to Partry House. According to the Ordnance Survey fieldbook of 1836, Cloonlagheen means the 'half beautiful lawn or meadow'. However it has also been translated as 'little meadow of the lake'.

The earliest documented primitive inhabitants of Ballyovey parish in the annals were 'the Partraighe tribal clan' (Quinn 1993:259). According to Quinn (2000:105), Partraighe was the old name of Partry and although its old boundaries have been lost the name of this territory has not shared the same fate of many others which are locally lost. The O'Connors dominated Partry in the Middle Ages, with sub-tribes of O'Tierneys, O'Murrays, MacNeills and O'Gormghall (Quinn 1993:259). The O'Connors were ousted by the DeBurgos in ten years of vigorous fighting (1228-

1238) and Partry became MacTybotts country. In the *Four Masters* there is the following reference: "A.D. 1238 – The Barons of Ireland went to Connaught and commenced erecting castles in that province. They erected 'castles on this occasion in the Kilmaine Barony and in Ceara (Carra)" (Quinn 1993:269). These early castles were probably wooden structures with a defensive peripheral palisade with a bank and ditch construction and were later replaced with stone towers. Cloonlagheen Castle does not exist today, but it would possibly have been similar to the other castles surviving on the shores of Lough Carra. Castlecarra and Castleburke were built in the same time period as Cloonlagheen and their ruins remain still. They are tower houses popularly built by both the Gaelic and Norman Lords during the fifteenth and sixteenth centuries. They were small stone castles or keeps, three to four stories in height linked to walled enclosures or bawns (Aalen, Whelan & Stout 1997).

It was after 1238 AD that the Stauntons came upon the scene and the Barony of Carra, including Kilkeeren and Clyonlaghen (Cloonlagheen) Castles fell under their patrimony (Quinn 1993:259). The Stauntons, a powerful Anglo-Norman family ruled under the DeBurgos. Both tribes later changed their names after repudiating England with DeBurgo becoming Burke and Staunton becoming MacEnvilly (Quinn 1993:268). The next mention of Cloonlagheen Castle which is the present site of Partry House Estate is in the 1570-1574 Divisions of Connaught. The Abbé Mac Envile was recorded as occupying Cloynlagheen Castle. Quinn (1993) has surmised that the Abbé Mac Envile was probably the last Abbot of Ballintubber Abbey. He bases this on a Chancery Record taken at Conylin in 1606 that states 'that at the suppression in 1542 the last Abbot of Ballintubber, Walter MacEvilly, alias Staunton, surrendered the abbey and abbey lands to the Crown'. According to O'Donoghue (personal communication 2007) Mac Envile was a prince of the church which is why he lived like a lord at Cloonlagheen. The connotation Abbé was possibly because he was educated in France or Switzerland. In the years following the composition of Connaught the chiefs of the Burkes and Mac Envillys rebelled against the crown and their rebellion was followed by confiscation of their lands and castles (Quinn 1993:268). Cloonlagheen Castle fell in a battle about 1585 and left in ruin.

The next inhabitants of Cloonlagheen Castle were the Lynches of Galway. Sir Robuck (Robert) Lynch (2nd Baronet) of Currendullagh Castle was Mayor of Galway in 1635 and M.P. in 1639 (Berry 1910). In 1654, the Cromwellians petitioned the Lord Deputy that Irish Papists should be dispossessed of their lands and Sir Robuck was one of the many Anglo-Norman descendants whose lands were seized. Sir Robuck Lynch and his family were transplanted from Galway sometime after 1654 and were compensated with lands at Castlecarra, situated on the east shore of Lough Carra. According to Simington's (1970) records of the transplantation of Connaught, Sir Robuck Lynch (Knight and Baronet) was decreed 4,478 acres of land of which 3,862 were deemed profitable and this was recorded in the Headfort Book of Survey and Distribution 1650-1690. The first Lynch to come to Ireland from which the Lynches at Partry are descended was General Andrew Lynch from Lintz in Austria in 1172. His son John married a daughter of Strongbow the Norman ruler of Ireland and after settling in Galway built the Great Gate of Galway and adjoining walls in 1312 (O'Donoghue 2000:58). The first mayor of Galway was Pierce Lynch in 1485 and he was the first of 84 hereditary mayors who over the next 169 years were active in church, civilian and academic life. The family fell into disrepute when Mayor of Galway James Lynch FitzStephen hung his son Walter for murdering his sweetheart's Spanish lover in 1493. The judiciary refused to try the popular man, so Mayor Lynch allegedly hung his own son from the window of his mayoralty house in Lombard Street, Galway. This was the start of the Lynch family law – Lynching (O'Donoghue 2000:59). The Lynches control over Galway came to an end in 1654 with the dispossession of their lands by the Cromwellians.

When Sir Robuck died in 1667 his lands at Castlecarra passed on to his eldest son Henry Lynch. Sir Robuck's widow, Lady Ellis received through her eldest son Sir Henry of Castlecarra, in lieu of her dower, by letters patent from King Charles II, the lands at Cloonlagheen on the 18th of August 1667 (O'Donoghue 2000:59). It was recorded by Berry (1910), that the letters patent from King Charles II were not received until 1678. The land inherited by Sir Henry Lynch in the various townlands was recorded in the Books of Survey and Distribution 1650-1690. This included the lands of Cloonlagheen, which at the time of the survey were still in his name. It can be deduced that the survey occurred after the death of his father in 1667 and prior to the letters from King Charles II in 1678. This is the first description of the landscape of Partry Estate that is available. The profitable land comprising the townland of Cloonlagheen consisted of: (i) Arable – 62 acres, (ii) Shrubby and Rocky Pasture – 50 acres and (iii) Pasturable Bog – 10 acres. A total of 10 families were recorded as being tenants at Cloonlagheen. It is generally accepted that work began on the construction of Partry House in 1667. It was built on the ruined remains of Cloonlagheen Castle by Arthur Lynch, the third son of Sir Robuck, for his mother Lady Ellis. This was a fortified house in the style of the 17th century within the castles peripheral stone wall the remains of which are still to be found in the garden (O'Donoghue personnel communication 2007). During the renovation work to the house in 1996 remains of castle walls were unearthed. A number of slit windows were revealed at floor level of the second storey indicating that the levels of the floors are different to that of the original castle. Also a slit window was found on an interior wall signifying that this had been an old defensive wall of the earlier castle. When removing the collapsed dining room floor the wooden joisting was constructed out of ship timbers carved with roman numerals and thought to date to the 13th or 14th century. This would indicate that they once belonged to the structure of the castle. It was also discovered that the foundations of the house consisted of rubble thought to have been from the curtain wall, which was used to fill in a possible lower level (cellar or dungeon) of the castle (O'Donoghue personnel communication 2007). The remains of the curtain wall are thought to run through the centre of the house and on the west side of the house there are walls measuring five to six feet. Part of the old castle wall and old chimney pieces are also to be seen in the yard buildings behind the house. The original house was a rectangular stone structure and in subsequent years an east wing was built in 1902 and a west wing was built in 1948 on to the rear of the building. The house has been completely restored to its former glory (Plate No. 4.1) and is furnished with 18th century furniture.

Plate No. 4.1 Partry House

Arthur Lynch and his mother Lady Ellis built up their property at Cloonlagheen. Arthur Lynch married Jean Browne, eldest daughter of Sir John Browne of the Neale Estate. They had 15 sons and daughters. The eldest son Stephen enlisted in the Austrian army in 1690 and took a company of soldiers from Partry. He lost an eye at the battle of Cremona where his brother Robert was killed. He was subsequently knighted for his distinguished service and inherited the estate from his father. In his absence of 50 years a younger brother Joseph took possession of Partry. When Sir Stephen returned to reclaim his birthright around 1740 he filed a law suit but died shortly after (O'Donoghue 2000). From Joseph the lands passed on to his brother Michael Lynch and on to his son Joseph Lynch who died in 1785. From 1785-1823 Henry Blosse Lynch had possession of Partry House (O'Donoghue 2000). The additional surname 'Blosse' appeared after Robert Lynch of Castlecarra married the sole heiress of Tobias Blosse who inherited his entire estate. One of the conditions of her inheritance was that her husband should take the name 'Blosse'. The Partry Lynches took on Blosse as a Christian name to keep in touch with the senior element of the family and since 1760 have used it as a double barrelled surname 'Blosse Lynch' (O'Donoghue personnel communication 2007).

The information on the Lynch family and the estate is relatively scarce up until the 19th century. Henry Blosse Lynch was married to Elizabeth, daughter of Robert Finnis of Kent and served as a Major in the 73rd regiment under the Duke of Wellington in the Peninsular War in Iberia (O'Donoghue 2000). On his gravestone there is an inscription on how 'his gallantry at the siege of Ciedad Roderigo was mentioned in the dispatches of the Duke'. On his wife's Elizabeth's headstone it is inscribed that 'She was the mother of eleven sons, most of whom she lived to see distinguished in their several professions'. They are both buried in an old fort in the demesne of Partry House which was established as a graveyard by their surviving sons. Surrounded by trees and in deep seclusion this circular hollow or rath has become the families resting place since 1823 (O'Donoghue 2000). Prior to this, members to the family had in the past been buried in the Abbey of Ross near Headford and later in the cemetery at Kilkeeran on Lough Carra. Many of the ancestors of the Lynch family are buried in this ring-fort graveyard on the estate, where their achievements military, exploratory and humanitarian are noted on a large stone obelisk erected in 1853 (Plate No. 4.2).

Plate No. 4.2 Stone Obelisk in ringfort graveyard.

It is from the inscriptions on the obelisk that much information on the achievements and genealogy of the family can be learnt. Henry Blosse Lynch and his brother Thomas Kerr Lynch of Partry House were born in 1807 and 1818 respectively. They were the sons of Major Henry Blosse Lynch and grew up on the 1,500 acre Partry Estate (Museums of Mayo 2006). In 1823 Henry became a midshipman in the Indian Navy and served in the survey of the Persian Gulf where he was educated by the East India Company Navy in Arabic and Persian. He was promoted to the rank of lieutenant in 1829 and made interpreter to the Gulf squadron (Museums of Mayo 2006). It is inscribed on the obelisk that in 1834 in was appointed second in command of the Chesney expedition of the Tigris River and in 1837 he was placed in command of an Indian Naval Squadron and succeeded in the capture of Rangoon and the relief of Mantabau. He led an expedition that ascended the Tigris to Baghdad, a feat of navigation never before accomplished. He was joined by his brothers Thomas Kerr and Stephen and founded the Lynch Brothers Ltd which stayed in operations until after World War II (O'Donoghue 2000). Their company organised a direct steamer service of a fast sailing clipper between England and Basra. Henry was awarded by the shah to the highest class of the Order of the Lion and Sun of Persia for his expeditionary achievements. He was stationed in Baghdad until 1851 where he commanded a squadron of the Indian Navy during the second Burmese War. A letter by Prince Albert on behalf of Her Majesty in 1853 lists Henry Blosse Lynch of the Indian Army as one of the officers to be appointed to 'the Military division of the third Class or Companions of the Most Honourable Order of the Bath' (John Wilson Manuscripts 2007) (Appendix 2.1). Henry retired in 1856 and settled in Paris, where he was delegated to conduct peace negotiations as the end of the Persian War of 1856-7 which resulted in the signing of the treaty of Paris in March 1857 (Museums of Mayo 2006). Henry died in his Paris home in 1873 however his legacy in Asia was to live on as 'an ancient stone road that crossed Iran's Zagros Mountains between the Karun River and the city of Isfahan on the Persian plateau was named after the British concessionaire Henry Blosse Lynch'. In 1899 the Tigris-Euphrates Steam Navigation Company, a British firm out of Baghdad, restored this ancient stone road. There is also reported to be a street in Baghdad called Lynch's Corner (O'Donoghue personnel communication 2007).

Many of Henry's 10 brothers were also employed by the Indian Army and stationed in Persia. They included Robert (d.1836 aged 30), Edward Patrick (d. 1884 aged 75), William Michael (d. 1841 aged 30), George Quested (d.1848 aged 34), Arthur Noel Hill (d. aged 56) and Thomas Kerr (d. 1891 aged 73).Their achievements and ranks are recorded on the stone obelisk. The remaining brothers were Stephen, John Finnis, Frederick and Brownlow. Stephen was involved in the Lynches Steam Navigation Company in Baghdad and spent time in Asia but there is no record that he was in the Indian army. Frederick died in 1854 aged 12. John Finnis Lynch was distinguished a scholar and Barrister at Law and died in 1855 (Berry 1910). The final brother was Reverend Brownlow Lynch and he was the rector of Ballyheane until his death in 1854 aged 38.

The estate was the property of John Finnis Lynch after the death of his father Henry from 1823 to 1855. He is recorded as the owner in the Tithe Applotment Books recorded in 1830. The tithe composition applotment books provided a detailed account of the occupiers of land with the extent and value of their individual farms and the proportion of future tithe payable within the period 1823-1837. The types of land recorded as comprising Partry demesne included: (i) Arable – 36 acres (ii) Rocky and Scrubby – 38 acres (iii) Bottom – 17 acres and (iv) Bog – 8 acres. The total area of the demesne came to just over 120 acres and tithes of 3 pounds 19 shillings were calculated. The estate was also recorded in the field book accompanying the first Ordnance Survey of the country between 1824-1848. It was recorded in 1836 that the townland Cloonlagheen was the property of John Lynch Esq. It contained 404 acres and part of this townland was let at £40 per annum to tenants, all Catholics and the remainder of the land was held by Mr. Lynch as a demesne. It was shortly after this that the famine hit Ireland and the Lynch family were one of the landed households who made a considerable effort to help their starving tenants. The Lynches of Partry, the Brownes of Westport House and the Moores of Moore Hall organised a shipment to Westport of maize on the 'The Martha Wasington' to feed their tenants (O'Donoghue personnel communication 2007). There are two old cast iron pots used to cook cornmeal still in the garden of Partry House. Members of the family were involved in the organising of relief famine works in the Partry area. The famine causeway and also the limestone shore edging on the estate were part of the famine works sponsored by the Lynches. John Lynch was also recorded as the chairman of the Partry Relief Committee in the Famine Relief Commission Papers 1845-1847 (National Archives 2007). He wrote to the Famine Relief Commission on a number of occasions describing the state of the Partry district and reporting great distress amongst 226 out of 900 families. Another of the family members George Quested Lynch, a doctor in the Indian Army, returned home at the time of the famine and in his efforts to save the lives of others, fell victim to Typhus Fever.

After the death of John F. Lynch in 1855 it appears that the ownership of the land went to his brother Henry Blosse Lynch for a time. He is recorded as the owner of the demesne and the estate lands in Griffith's Valuations of the area 1855-57. Griffith's Valuation was a valuation of property holdings carried out in order to determine liability to pay the Poor Rate (for the support of the poor and destitute within each Poor Law Union) (National Library 2007). The area of Cloonlagheen was recorded as approximately 404 acres and was valued at £129 and 6 shillings. Also recorded was the names and property of the tenants of the Lynches living in Cloonlagheen and Sir Henry Blosse Lynch was the listed owner. A total of ten houses were recorded not including Partry House and adjacent offices. Leamnahye was recorded as one of the islands in Lough Carra owned by Sir Henry and covered just over 3 acres and was worth 50 shillings. As mentioned previously Henry Blosse Lynch died in Paris in 1873 and the estate was inherited by another brother Major Edward Patrick Lynch. He is recorded as the owner in a book entitled *The Landowners of Ireland* published in 1878. This book listed the owners of estates of 500 acres or £500 valuation and upwards. Major Edward Lynch was documented as owing 1237 acres valued at £500. It is inscribed on the family obelisk that he died in 1884. It is not recorded but it is most likely that the remaining brother who was based in London Thomas Kerr inherited the estate for a short while up until his death in 1891. The next generation of Lynches were now to continue the running of the family inheritance.

The estate was inherited by Henry Patrick Blosse Lynch born in 1856. He married Emily Gwendolyn daughter of Ogalvie Graham D.2 of Co. Down in 1898. Henry was gazetted to 54th foot in 1875, served with the Dorset Regiment throughout the South African War (1899-1902) taking part in the relief of Ladysmith and action at Spion Kop, Tangela Heights and Pieters Hill (O'Donoghue 2000). The east wing of the house was built in 1902. The Colonel retired from the army in 1906 and was High

Sheriff for Co. Mayo until 1911. Henry inherited the estate at a time when the whole fabric of the Irish landed society was totally transformed by economic, social and political developments. Home Rule and the Land League were to change forever the economic prosperity of the landed class. The Wyndham Land Act of 1903 promoted the sale of estates on a revolutionary scale. For many landlords it allowed them to retain enough demesne and untenanted land to retain their big house and to also continue their former lifestyles for the best part of a generation (Dooley 2001:274). At this time part of the family estate was sold but the demesne lands were retained. The death of General Henry Patrick Blosse Lynch was recorded in 1936. The estate then passed on to his son also named Henry Patrick Blosse Lynch who was born in 1899. Similar to the generations before him, Henry who was educated in Harrow and Sandhurst, was involved in the British army and commissioned into the Dorset Regiment serving throughout World War II. He married Louisa Burnley Blosse Lynch in 1931. She followed her husband's service career and became a Commander of the Red Cross during World War II. They retired to Partry after the war in 1947 and became involved in the local community, church affairs and country sports. In 1948 the west wing of the house was erected. Louisa had a vegetable and fruit business supplying Ashford Castle with supplies. They managed the estate until their deaths, Henry in 1982 and Louisa in 1989. The estate was left to their son Henry Charles Blosse Lynch and daughter Sheila Gwendolyn Yate Blosse Lynch who were educated in England. During the war they were sent to live with relations in South Africa. They sold Partry Estate in 1991 as they could not maintain it financially and so ended the 330 years in residence of the Lynch family.

4.2 The Historical Management of Partry House Estate

The effort to trace the historical management of Partry House Estate is somewhat exacerbating in the absence of the estate records and surveys that usually exist in connection with landed estates. In 1991 the estate records were destroyed by the owner prior to its sale. Therefore it is necessary to rely on information contained in state documents and surveys as well as the evidence of management that is apparent in the demesne today. Of special interest is the history and management of the woodlands in order to understand their present structure. The earliest evidence of woodland around Lough Carra is the oak stake that once formed part of a wooden causeway joining both sides of the lake. This oak dating to 1069 BC or later indicates that oak woodland was present on the shores of Lough Carra and was being used as a resource for settlement building. The construction of island settlements on Lough Carra, crannogs, which were constructed from timber and brushwood, also attests to the existence of a ready supply of wood resources nearby. Crannogs were built and used up until the arrival of the Normans in the 11th century. The earliest written reference to woodland in the Partry area was recorded in The Annals. In 1417 Giolla Iosa Mac Firbis writes about O'Dorcey, chief of Partry:

> 'O'Dorcey here of the lefty soul
> Has well defended Partry, land of heroes,
> A cantred full of knotty hazel trees.
> Long may he reign upon the bright Lough Mask.
> And tread the mountain with that noble stalk,
> Which marks the proudest chiefs in front of war,
> And the huge oak that shelters his brave tribe.' (Quinn 1993:267).

The significance of this verse is that it mentions two tree species, oak and hazel, indicating that there was some woodland present in the area in the 15th century. The area of a cantred is not known, as there is a diverse group of land measurements present in historic documents and their interpretation is problematic. Also the precise location that the poem refers to is not clear. The reference to Abbé McEnville and Cloonlagheen Castle in the Divisions of Connaught 1570 does not give a description of the lands contained within the estate. It is unknown what type of estate the Abbé McEnville oversaw in the 16th century, but as he was of Norman descent so it is likely that he had a landlord role overseeing the tenants' that worked his lands. Also the lands received by Sir Robuck Lynch are not described in the records of The Transplantation to Connaught 1654-58, only the acreage is given. The first written document that describes the holdings of Cloonlagheen townland (Partry House Demesne) is in the Books of Survey and Distribution 1650-1690. It recorded the proprietor of the land, the tenant's names and how many acres of land they rented. It also classified the various types and acreage of land in the landlord's possession and valued the land as profitable or unprofitable. Of interest was that there was no reference made to woodland in the townland of Cloonlagheen. If woodland existed it would have been recorded and a profit estimated for it. However three parcels of shrubby and rocky pasture, 50 acres profitable and 50 acres unprofitable were recorded. This was possibly referring to the rough limestone grassland of Moynish, Creggaun, Leamnahye and Bridgepark, as the arable land was the farmland to the rear of the house and still exists today. The significance of is description shrubby indicates that some tree and shrub species were present at this time. The reference made to bog is mostly likely the fen bog which borders Creggaun and part of Moynish connecting it to the mainland. There are also the remains of old stone walls on both Creggaun and Moynish indicating that for some time the land was grazed as pasture.

The question of how the estate was managed still remains. It can be assumed that down through the centuries the land of the demesne bordering the house was primarily farmland as the remains of old tree lined field enclosures and old stone farm buildings still exist today. These are large farm stables and out buildings to the rear of the house. The fine cut stone stable yard behind the main house, with belfry has been completely restored. The 120 acres of the Lynches estate at Cloonlagheen supported ten tenants and their families in 1670 so it fair to assume that all the land would have been needed for agriculture. No historic documentation or description of the estate has been located for the 18^{th} century. However the influence of the great landscape designer 'Capability Brown' is evident in the planting of large trees along the entrance and in the grounds to the fore of the house (Plate No.4.3).

Plate No. 4.3 Lynch's Grove

The trees are still present today and include Oak, Ash, Lime, Beech and Horse Chestnut. This area was recorded in the 1838 Ordnance Survey map as Lynch's Grove and was well established at this time. The only map showing Partry House from the 18th century is from the Taylor and Skinner Maps of the roads of Ireland completed in 1798 (Appendix 2.2). The positions of the houses of the landed gentry and the name of the estate owner were mapped along the main roads of Ireland however no other landscape details were included. The houses of the gentry were frequently mapped with symbols of trees indicating planting. On the map Partry House was referred to as Cloonlagheen and a small number of tree symbols were present. It can be concluded from this that the planting of the grove had taken place prior to 1798. Another feature of the demesne grounds is the remains of two dry stone archways, one is the gateway at the entrance to the estate (Plate No. 4.4) and the other is on the right of the driveway twenty metres from the entrance. The purpose of the second arch is unclear. It is possible that it was part of a building or of a surrounding stone wall that was removed. As part of this new landscape design 1750-1840 there was a move towards more naturalised parklands and many defensive walls and structures were removed as the turmoil and insecurity of the seventeenth century ceased. It is possible that this was a feature of a surrounding wall that was removed, but it is more likely to be the remains of a pleasure building or a piece of folly architecture.

Plate No. 4.4 Gateway Entrance to Partry Estate

Other features in Partry Estate of this landscape design phase are the gate lodge, walled garden and boathouse. The entrances to demesnes became important features and the construction of gate lodges became popular. Partry Gate Lodge was most probably built during this era. On the 1838 Ordnance Survey Map the gate house was present as was the walled garden and boathouse. The original gate lodge fell into disrepair in the 20th century and was recently rebuilt by the present owner after a tree fell through it in 1998. As part of this landscape style, flowers, fruit and vegetable were banished to walled gardens (Aalen, Stout, Whelan 1997). The walled garden at Partry covers an area of 2 acres and has been in use up until the present day. The dry and wet stone boathouse with pier would have been an attractive leisure area and is still in full working order after being restored by the present owner.

The documentary evidence of the estate and the landscape improves in the 19th century. A record of the land contained in the estate was recorded in the Tithe Applotment Books in 1830. The classifications of the land arable, rocky and scrubby and bog are the same as were recorded in the Books of Survey and Distribution in 1690. The only difference is that there is another category of land described as bottom. In other estates planting and woodland were categories of land use that were recorded. However there was no reference to woodland or planting recorded in the demesne. The estate is also recorded in Bald's Maritime Maps of Mayo 1830 (Appendix 2.3). The quality of this map is inferior and the landscape was recorded in greater detail eight years later in the Ordnance Survey Map of 1838 (Figure No. 4.1) and a description of the land cover of each of the present day woodlands is given. Moynish, spelt as Mynish, was described as woodland and is illustrated as almost entirely wooded. Creggaun although not named on the map was classed as brushwood and only a small area of tree symbols were illustrated on the northwest edge of the woodland. Leamnahye Island was not connected to land and was described as rocks and brushwood, but no tree symbols were shown. Leamnahye was recorded in the Ordnance Survey Field Book as 'Léim na hOidhche' meaning 'Leap of the night'. Finally Bridgepark also not named was classed as rocks and brushwood with two areas of conifer tree symbols shown along the road edge. It can be concluded that it was in the early half of the 19th century grazing pressure was reduced on the rocky, scrubby grassland allowing the colonisation process of woodland on Creggaun, Leamnahye and Bridgepark to begin. From the description of Moynish as woodland in 1838 it would seem that this is the oldest of the four woodlands and was well established at the time of the ordnance survey. It is questionable, therefore, how woodland was recorded on Moynish in 1838 yet it was not recorded in the Tithe Applotment Books in 1830. Perhaps the woodland on Moynish was not as established as indicated by the Ordnance Survey map in 1838 and it was recorded as rocky and scrubby in the Tithe Applotment Survey in 1830.

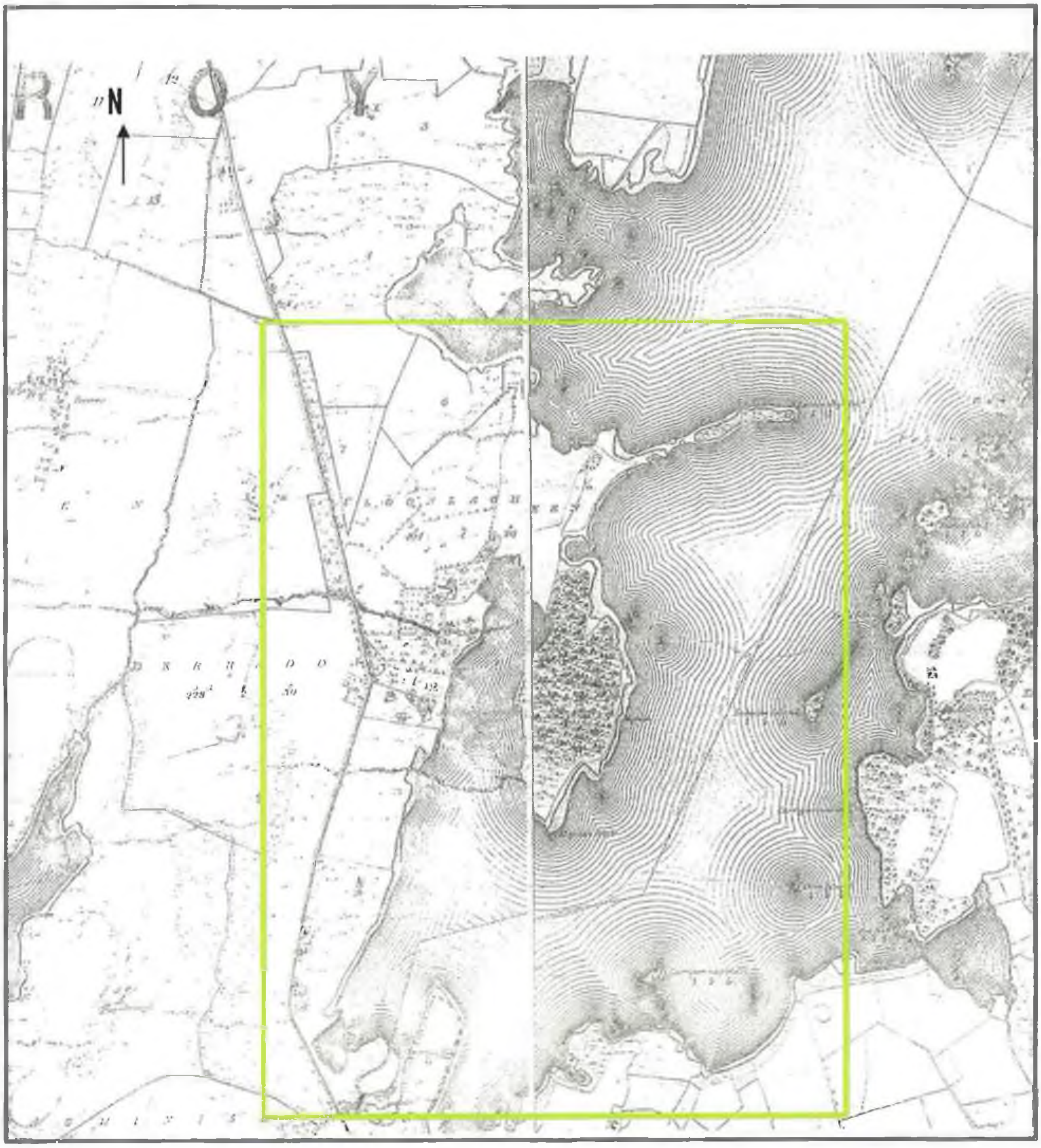


Figure No. 4.1 Ordnance Survey Map 1838

Evidence of estate management is most apparent from the famine years, as the family were prominent supporters of the Famine Relief Commission and sponsored numerous building projects on their estate supporting their struggling tenants. Many of these famine works are responsible for easier access to the woodlands on the estate. The land on Creggaun, Moynish and Leamnahye prior to the construction of the famine causeway would have been accessed across the fen bog which would have been prone to flooding. The access of Creggaun from Moynish was also improved by the development of a stone walkway referred to as the stepping stones. Access to Bridgepark was also improved by the construction of a smaller stone causeway at its entrance. The shore at Bridgepark was edged with large limestone blocks and another stone causeway was built at the southern end near Keel Bridge. There are the remains of an old stone quarry on the peninsula of Moynish where limestone blocks were quarried. The ruins of small stone huts and an old fashioned wooden crane still remain there today. It is most probable that this quarry was used to supply the stone used in the building of the various famine works. There is also evidence that some limestone was also removed from the woodland at Bridgepark. A number of hollows/pits which seem to be manmade are present on Creggaun and the purpose of which is not clear. Possible uses are pits for charcoal or lime burning. The theory of lime pits is possible as their presence around Lough Carra was mentioned in a survey by Samuel Nicholson in 1844. The theory of charcoal burning is compounded by the absence of any record of woodland or this industry in earlier historic documents of the estate. One possible reason for these pits is that soil and rock were removed and used to create the stone trackway that links Creggaun to Moynish. The area where the stepping stones are located was shown as an inlet of the lake on the Ordnance Survey Map in 1838. On the Ordnance Survey Map in 1914 this area was now land, making it possible that soil and stone were needed to infill the lake in order to construct the stepping stones.

The improved access to the land on Creggaun, Moynish and Bridgepark might have been the catalyst that inspired the family to undertake planting projects in each of the woodlands. The family members were well travelled so they would have been familiar with the popularity of planting exotic trees on estates. This land is rocky with shallow soil and so cultivation was not a possibility. Trees planted by the family included European Larch, Scots Pine and Beech. Some of these trees were aged using an increment borer and dendrochronology. Most of the oldest trees of Larch and Scots Pine recorded were approximately 150-160 years old which would tie in with the theory that they were planted as part of the famine works during the mid 19th century. The reason for planting the trees does not appear to have been an economic one and it is mostly likely that planting took place for its aesthetic value improving the vista of the demesne. Leamnahye Island is the only woodland that contains no planted trees and that developed naturally. This is most likely due to fact that it was an island up until some time in the 20th century and access to it was restricted. There is no firm evidence to support that any woodland management techniques such as coppicing or pollarding took place in the woodlands. However the survival of the woodland paths to this day attests to the continued maintenance of these pathways. In order to keep the paths open it would have been necessary to cut back encroaching trees and to remove fallen trees. Some evidence of this management was recorded in both Creggaun and Bridgepark. The midsection of large trees that had fallen blocking the paths were cut in order to reopen the path. The woodland path in Bridgepark could possibly have been a road at some time. There is evidence that the trackway was used by wheeled vehicles, carts, for some time, as there are groves worn into the underlying limestone. It is possible that this may have been part of the route to Ballinrobe in earlier centuries. From Taylor and Skinner's Map of the roads of Ireland in 1798 it is clear that the main road and entrance to the estate at that time are where they are today and that the use of this trackway in Bridgepark was abandoned prior to this.

In 1844 Sir Robert Lynch Blosse of Castlecarra, the Partry Lynches relation, commissioned a survey of his estates in the Barony of Carra. A report on the assets and management of the estate was completed by Samuel Nicholson. Of considerable interest is Nicholson's description of the woods and plantations of the demesnes of Castlecarra. Doon peninsula on the shore of Lough Carra, which is still wooded today, was described as consisting of shrub hazel, ash, some oak and holly and overrun with bramble and hawthorn. Nicholson (1844) advised that 'it aught be copsed and the ash and oak carefully protected' and also that planting should take place on waste lands which are too rocky to be cultivated. The planting of larch and fir was also recorded in Tourmacady, on the Glen of Cappaduff and in young plantations on the demesnes of Clogher and Carnacon. There was no mention, however, of Partry Estate. Nicholson (1844) also made reference to the supply of limestone and its uses: 'The chief supply of lime/limestone is from the opposite side of the lake where it is collected in boulders on the beach, boated across and calourised with turf on the townlands where it is to be applied. The opposite side of the lake is where Partry Estate is situated. He also mentions that old gravel pits are numerous around Lough Carra. The estate was recorded as being run by agents who neglect their duties and management of the estate. The relevance of this report is that it provides information on the management of an estate that was similar to Partry House Estate. It is possible that the management of Castlecarra was comparable to the management of Partry. Of interest is the reference to the lack of woodland management and the planting of larch and fir on rocky land in the area. This would back up the theory that planting took place in Partry Estate around 1845. The composition of Doon woodland is similar to the composition of the Partry woodlands, and the presence of oak there in 1844 may signify that oak is naturally present in Partry. Nicholson's description of the gravel pits in the area opens up the possibility that the pits on Creggaun were in fact used for lime burning. As many of the Lynches members were stationed abroad in the army it is probable that during their absence their estate was also managed by agents. As the estate records have been destroyed it is not known whether Nicholson ever conducted a survey of Partry House Estate. However it is feasible as many landlords commissioned similar reports in order to evaluate the running of their estate.

It is in the early 20th century that the first documentary evidence records the estate as Partry instead of Cloonlagheen. Both Berry (1910) and the Ordnance Survey Map of 1914 refers to the estate as Partry House Estate. The map shows well established woodland growing on Bridgepark, Moynish, Creggaun and Leamnahye. The stands of woodland are illustrated as mixed conifer and broadleaved. The area of land cover by trees was calculated for each woodland. Leamnahye is shown as still being an island with no land connection. From the beginning of the 20th century the woodlands were left to grow naturally with no further planting or management. A worker on the estate in 1960, Bridie Horan (personnel communication 2007) reported that the woodlands were not used to graze animals and that their main purpose was for recreational use. She described the Colonel Henry Lynch bringing out shooting parties of friends at that time to hunt wildfowl. This was also the purpose the woodlands were used for by the next owner David Shaw Smith in the early 1990s. For a short time the estate was managed as a gaming lodge organising fishing and hunting parties. This resulted in a depleted wildfowl population in the woodlands and the present owner Lorraine O'Donoghue turned the woods into a private bird sanctuary in the hope that their numbers will revive. Lorraine O'Donoghue has owned the estate since 1995 and since that time has restored the house and the surrounding farmlands which were in a neglected state. Partry House is now open to the public 60 days of the year and is advertised to visitors by the Museums of Mayo. However, the woodlands are not for public, as according to Lorraine (personnel communication 2007); "the very thing you want to protect suffers from the admiration of others". When the estate was acquired in 1995 there was planning permission for 25 houses on Bridgepark that had been applied for by the previous owner. Fortuitously the planning permission has been let lapse or else another piece of Irish woodland would have been lost to development. The farm holding of the estate is now 68 acres and has been established as an organic farm and is part of the Rural Environment Protection Scheme (REPS). Up until recently the present owner has not managed the woodlands preferring not to interfere with the natural processes. However the management of deer on the estate has been supported by the owner. At the end of 2006 the author supervised a number of management operations that were deemed necessary and they were funded by the Heritage Council. The management included the removal of Rhododendron and the opening up of some of the pathways.

5. Results

5 Results

5.1 Bridgepark

5.1.1 Description

Bridgepark woodland is located on the mainland to the southwest of Partry House and to the west of Lough Carra. The woodland is accessed by a manmade stone causeway which is prone to flooding during the winter. This stone causeway and the stone edging along the shore of Lough Carra are the vestiges of famine works, which were funded by the estate after the famine. The main road, N84, travels along the western boundary of Bridgepark. On the 1838 OS Map, Bridgepark was illustrated as predominantly rough grazing with two areas of conifer growth. However on the 1914 OS Map 22.3 acres are depicted as wooded. Presently it is almost entirely wooded except for an area of limestone grassland and paving which separates the woodland from the shore of Lough Carra. The dimensions of Bridgepark are approximately 780m in length, 220m in width at its widest point and cover an area of approximately 42 acres. Bridgepark was surveyed using regular sampling in the summer of 2005. These field methods were used to collect quantitative data in order to map the mosaic of woodland types existing in Bridgepark woodland. In total forty-two10m^2 quadrats were used to gathered vegetation data, which was stratified into three zones to facilitate interpretation of the data collected. Data collected in the areas of recent woodland on the limestone grassland were grouped together as Zone 1. Data collected through the main area of the woodland as recorded on the 1914 OS map was grouped as Zone 2. An area of wetland woodland was zoned as Zone 3.

5.1.2 Woodland Structure

Information about stand structure and species composition was recorded throughout the woodland. Trees species determined as over 5 metres in height were classed as canopy species and tree species less than 5 metres in height were classed as understorey species. The scrub layer was grouped as trees species less than 3 metres in height.

Zone 1

In total 14 tree species were identified and recorded in the field survey of Zone 1 and consisted of *Fraxinus excelsior, Fagus sylvatica, Prunus spinosa, Juniperus communis, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Larix decidua, Pinus sylvestris, Betula pendula, Sorbus aucuparia, Quercus robur* and *Euonymus europaeus*. The result of this survey is summarised in Figure 5.1. The dominant species in the canopy layer were *Corylus avellana, Fraxinus excelsior* and *Pinus sylvestris*. The principle understorey species were *Ilex aquifolium, Corylus avellana* and *Fraxinus excelsior. Juniperus communis* and *Pinus sylvestris* were the main species recorded in the scrub layer.

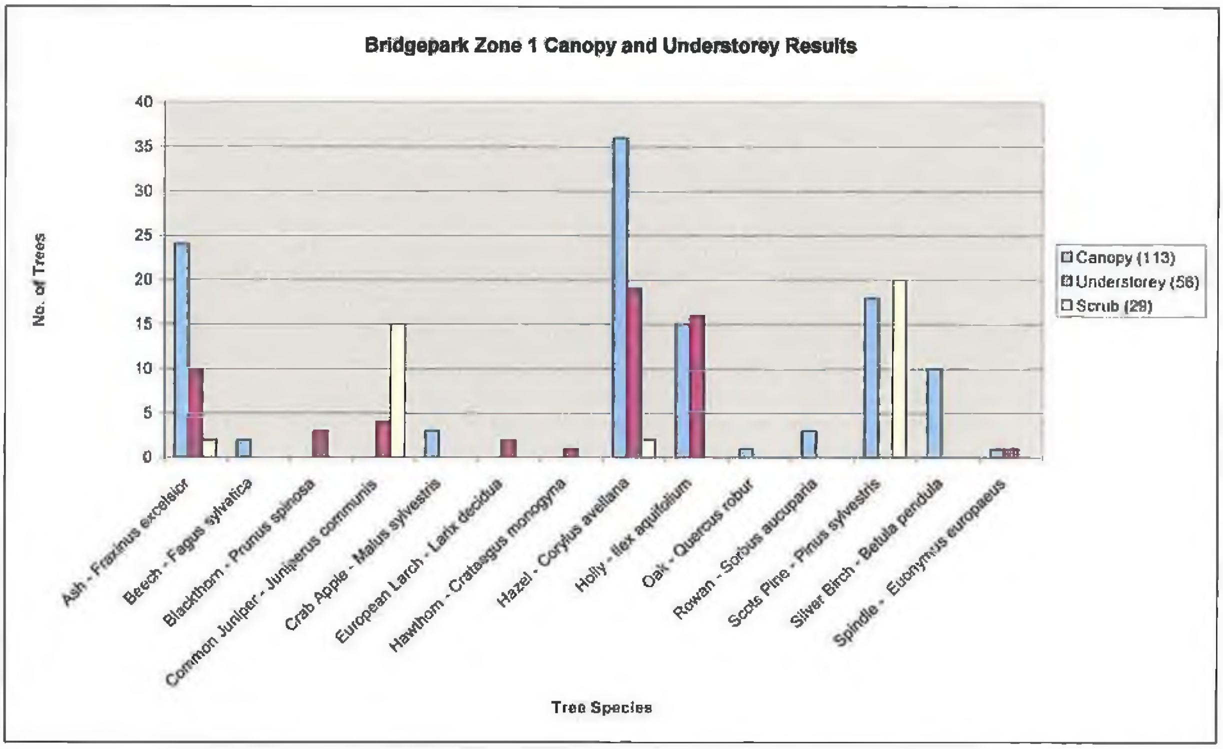


Figure 5.1 Bridgepark Zone 1 Canopy and Understorey Results

Zone 2

A total of 14 tree species were recorded in Zone 2 and included *Fraxinus excelsior, Fagus sylvatica, Prunus spinosa, Juniperus communis, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Larix decidua, Pinus sylvestris, Betula pendula, Sorbus aucuparia, Quercus robur* and *Euonymus europaeus* (Figure 5.2). The main components of the both the canopy layer and the understorey were *Fraxinus excelsior* and *Corylus avellana.* The following tree species were recorded in the scrub layer; *Fraxinus excelsior, Prunus spinosa, Crataegus monogyna, Corylus avellana* and *Ilex aquifolium.*

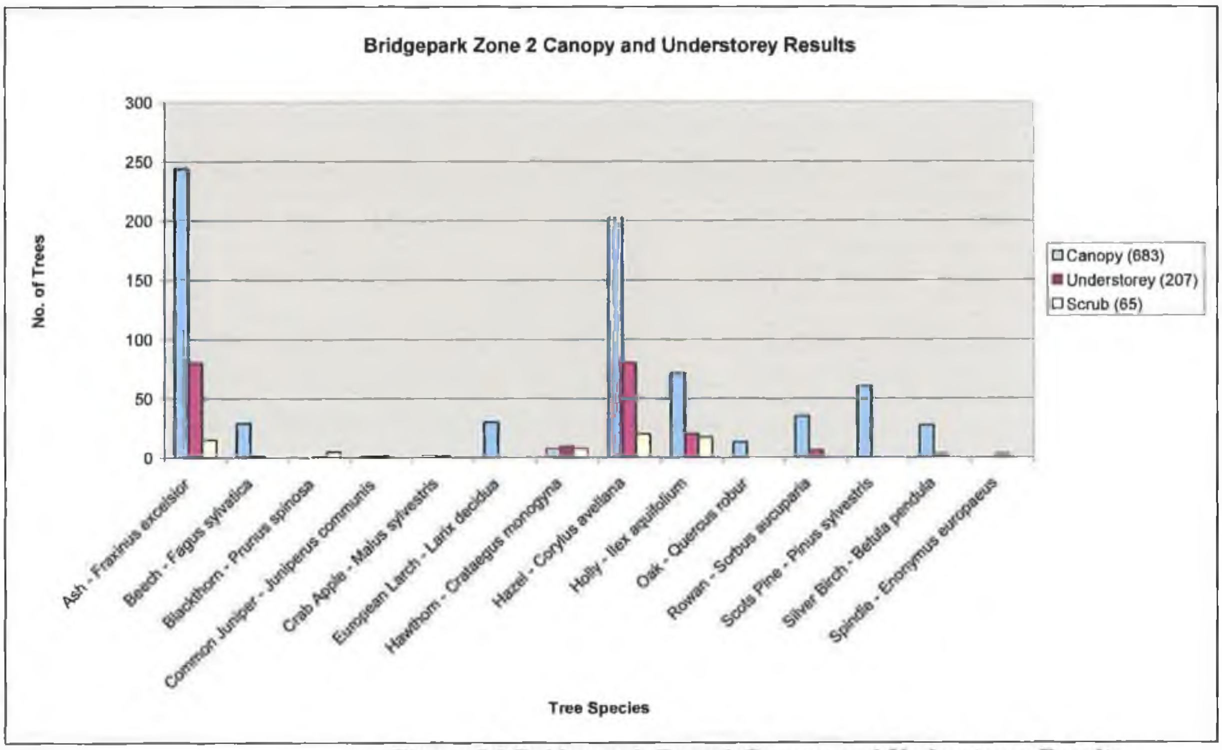


Figure 5.2 Bridgepark Zone 1 Canopy and Understorey Results

Zone 3

This area of wetland woodland at the southern end of Bridgepark was inaccessible and therefore no quadrats of the vegetation were taken. The tree species growing there were recorded and included *Alnus glutinosa, Salix caprea, Fraxinus excelsior, Corylus avellana, Crataegus monogyna, Prunus spinosa, Frangula alnus* and *Viburnum opulus.*

5.1.3 Woodland Classification and Mapping

The data from the vegetation survey was used to map the mosaic of woodland types that form Bridgepark woodland. GPS readings were taken during the survey and used in combination with Dmap to create an accurate map of the current vegetation (Figure 5.3). Each colour-coded polygon represents a different vegetation type and the information such as the classification of the vegetation type of each polygon type is contained in the legend table. For the most part the vegetation was classified according to Fossitt (2000).

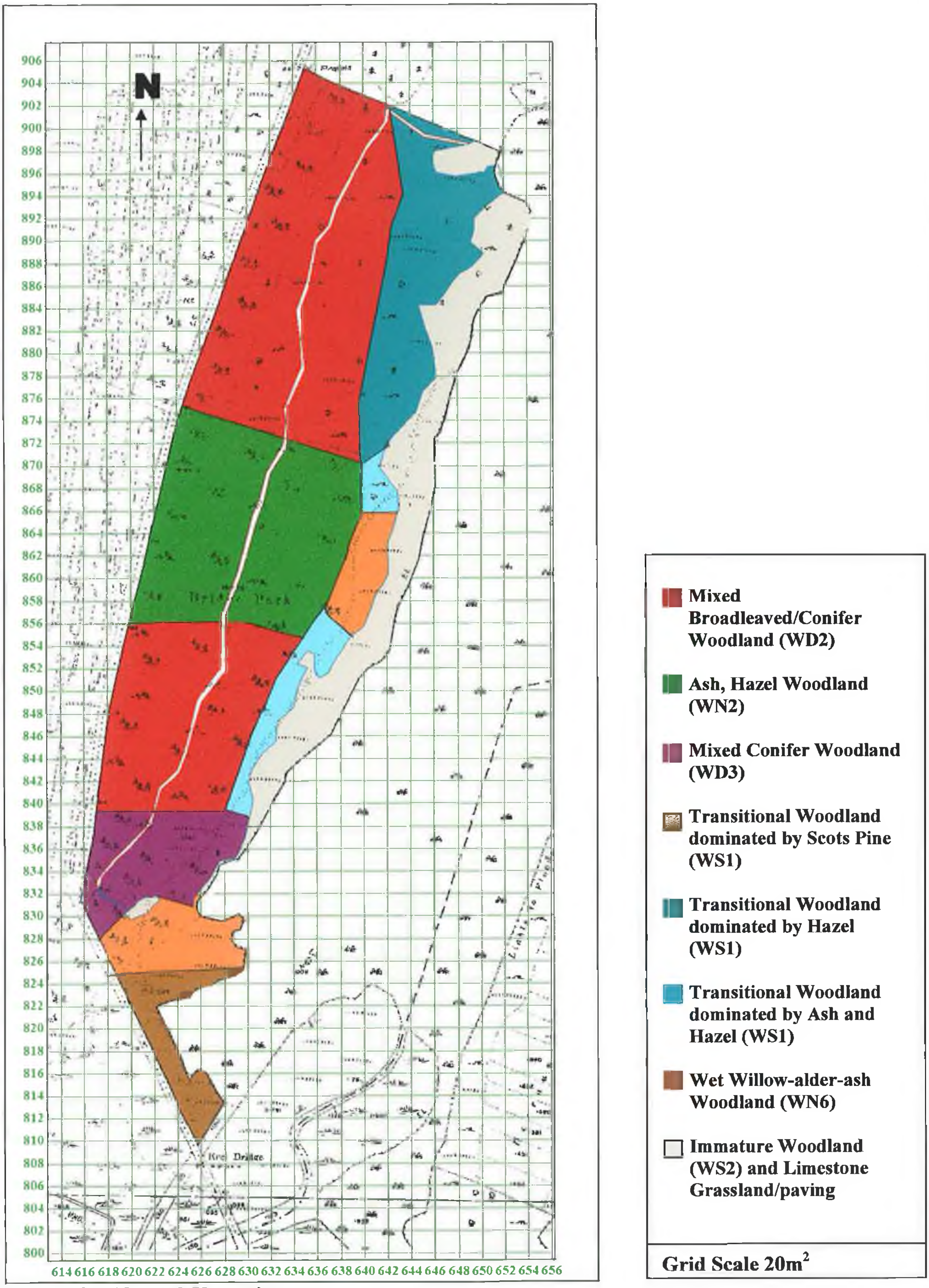


Figure 5.3 Bridgepark Vegetation map

5.1.4 Regeneration

An evaluation of tree regeneration in Bridgepark woodland was compiled by recording all stems of tree and woody species considered to be 'regeneration' that were growing in each $10m^2$ quadrat. For this analysis the size classes were combined into two height categories: $\leq$ 15cm were considered seedlings; $\leq$ 2m were considered saplings. A total of 11 tree species were recorded as regenerating to varying degrees in Zone 1 and included *Fraxinus excelsior, Prunus spinosa, Fagus sylvatica, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Quercus robur, Sorbus aucuparia, Pinus sylvestris* and *Betula pendula*. The seedlings and saplings results have been charted in Figure 5.4. *Ilex aquifolium* and *Fraxinus excelsior* were the main seedling species recorded. *Pinus sylvestris* was the principle sapling species regenerating in this area.

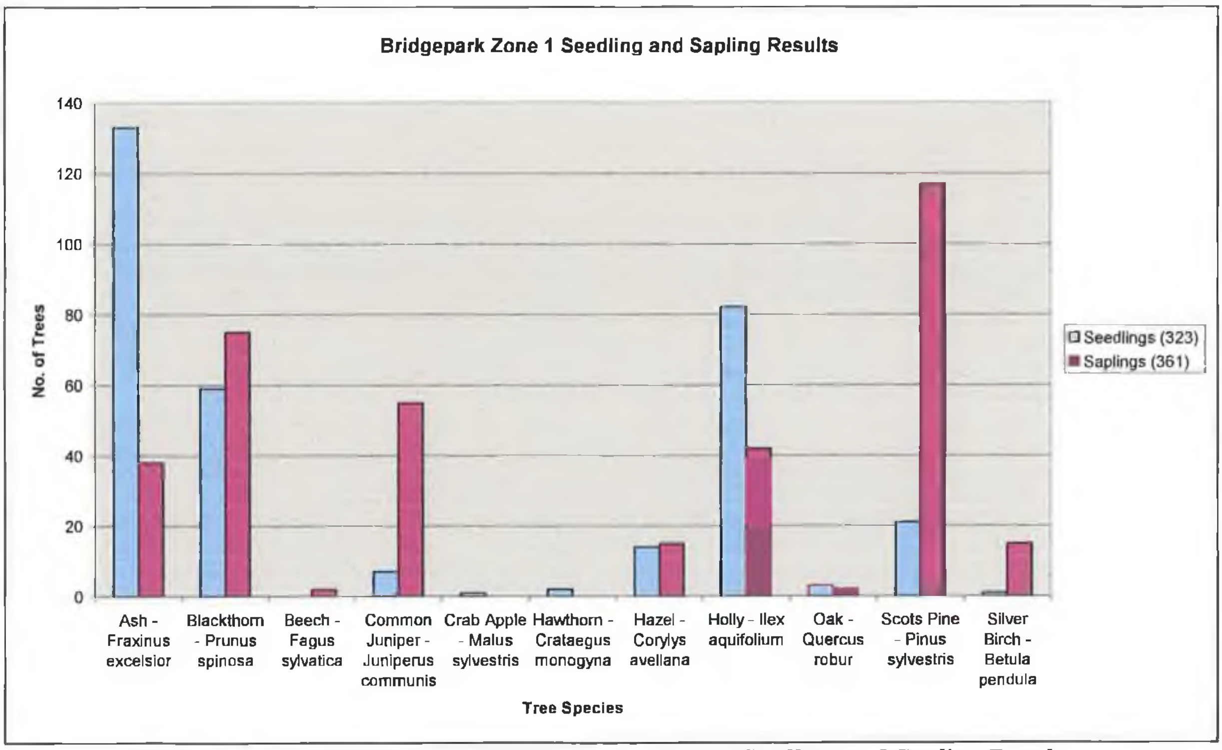


Figure 5.4 Bridgepark Zone 1 Seedling and Sapling Results

In Zone 2 the following 10 tree species were recorded as regenerating to varying degrees (Figure 5.5); *Fraxinus excelsior, Prunus spinosa, Fagus sylvatica, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Quercus robur,* *Sorbus aucuparia* and *Betula pendula.* The principle seedling species recorded were *Fraxinus excelsior* and *Ilex aquifolium. Ilex aquifolium* was also the most frequently recorded sapling species.

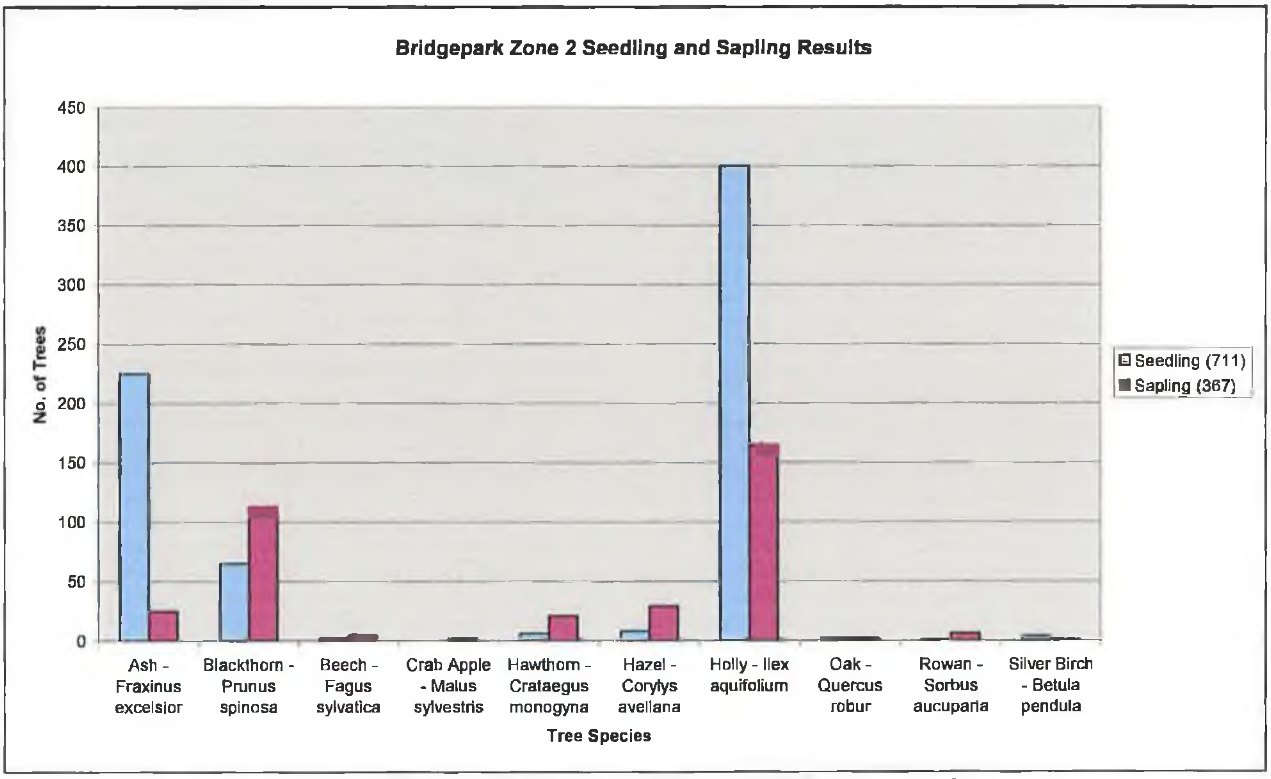


Figure 5.5 Bridgepark Zone 2 Seedling and Sapling Results

5.1.5 Tree diameters and age

The girth measurements of all tree species occurring within each quadrat were recorded in the field. The measurements of the stools were taken at chest height which measured between 1m-1.3m above ground level. All stems greater than 5cm were measured and recorded. To conform to modern international standards in tree measuring, girth is expressed in the register as diameter at breast height (dbh).

Zone 1

An examination of the results shows a wider variety of species in the lower diameter size classes below 25 centimetres in which *Fraxinus excelsior* occurs most frequently Figure (5.6). The only species which measured above 31 centimetres in diameter was *Pinus sylvestris.* No species was recorded with a diameter exceeding 50 centimetres.

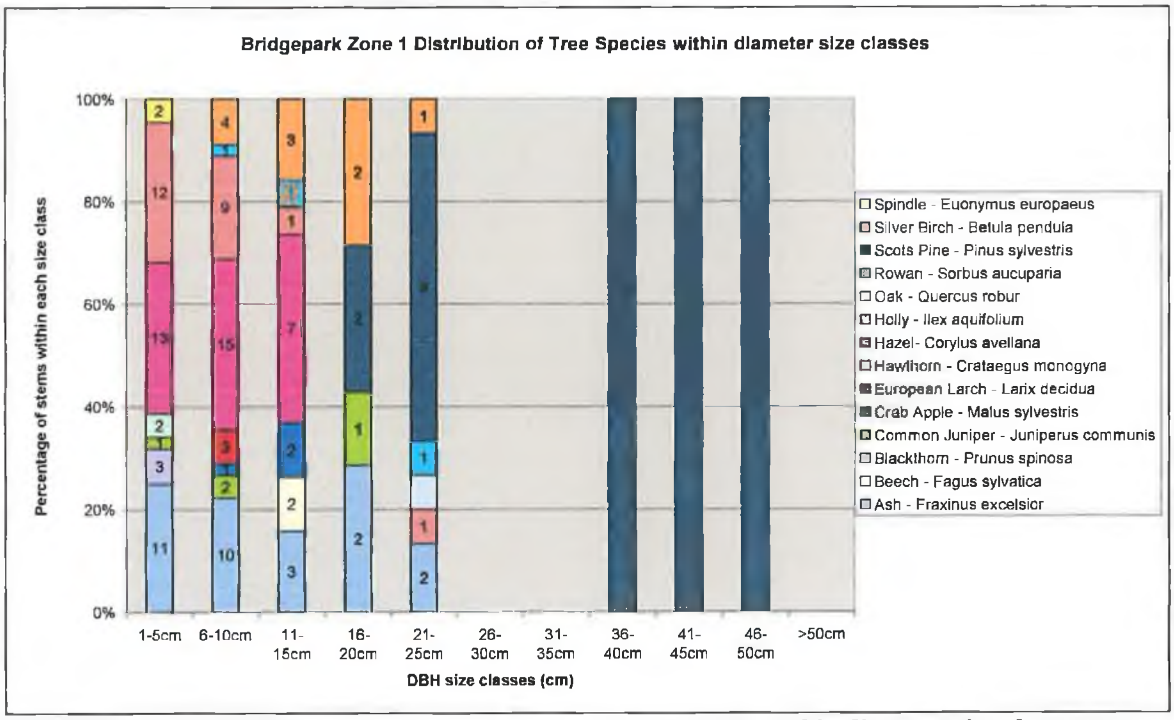


Figure 5.6 Bridgepark Zone 1 Distribution of tree species within diameter size classes

Zone 2

On analysing the results from Zone 2 there is a greater number of tree species recorded with diameters exceeding 31 centimetres and include *Pinus sylvestris, Fagus sylvatica, Malus sylvestris, Fraxinus excelsior, Quercus robur* and *Larix decidua* (Figure 5.7).

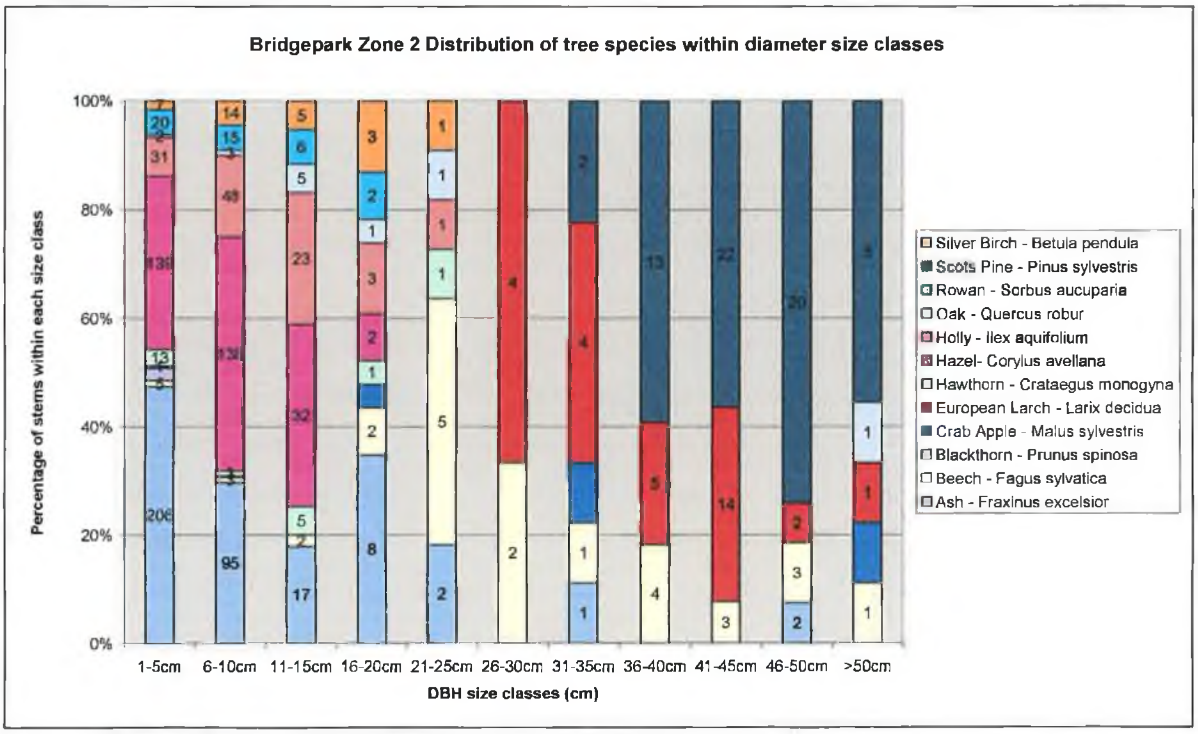


Figure 5.7 Bridgepark Zone 2 Distribution of tree species within diameter size classes

The age of a sample of trees was recorded using an increment borer. Of interest were the ages of the *Pinus sylvestris* and *Larix decidua* populations in Bridgepark (Table 5.1).

Bridgepark Coring Results			
Tree Species	**Girth(cm)**	**DBH(cm)**	**Age**
Ash – *Fraxinus excelsior*	**65**	**20.7**	**46**
Ash – *Fraxinus excelsior*	**80**	**25.48**	**57**
Ash – *Fraxinus excelsior*	**145**	**46**	**101**
Beech – *Fagus sylvatica*	**200**	**63.69**	**115**
Birch - *Betula pendula*	**40**	**12.74**	**54**
European Larch - *Larix decidua*	**136**	**43.31**	**120**
European Larch - *Larix decidua*	**73**	**23.25**	**60**
European Larch - *Larix decidua*	**123**	**39.17**	**90**
European Larch - *Larix decidua*	**140**	**44.58**	**118**
Holly - *Ilex aquifolium*	**77**	**24.52**	**80**
Scots Pine - *Pinus sylvestris*	**155**	**49.36**	**80**
Scots Pine - *Pinus sylvestris*	**200**	**63.69**	**87**
Scots Pine - *Pinus sylvestris*	**163**	**51.91**	**109**
Scots Pine - *Pinus sylvestris*	**103**	**32.8**	**60**
Scots Pine - *Pinus sylvestris*	**152**	**48.41**	**126**

Table 5.1 Bridgepark Coring Results

5.1.6 Epiphytes and Woody Climbers

Ivy Growth

The abundance of ivy on all trees surveyed was recorded. If ivy was present, it was recorded subjectively as 'profuse' or 'sparse'. In Zone 1 ivy growth was recorded on nine tree species in Bridgepark. However, ivy growth was most commonly recorded on *Pinus sylvestris* as profuse. Ivy growth was also recorded growing less commonly on *Fraxinus excelsior, Betula pendula, Malus sylvestris, Corylus avellana, Ilex aquifolium, Quercus robur, Sorbus aucuparia* and *Euonymus europaeus* (Figure 5.8).

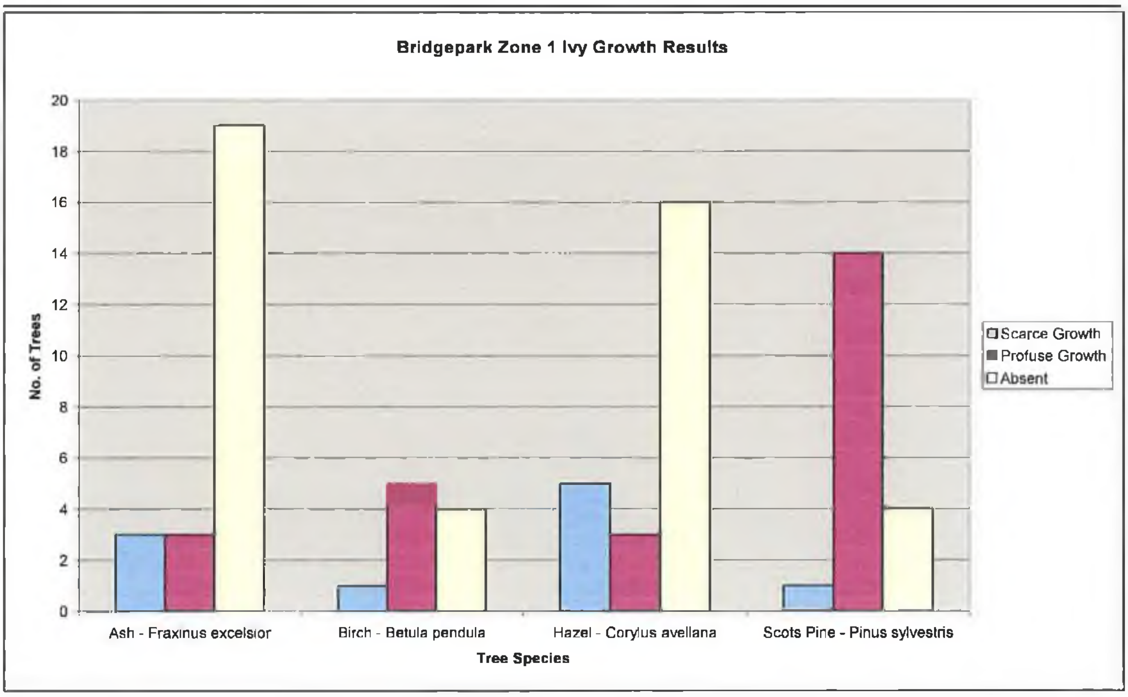


Figure 5.8 Bridgepark Zone 1 Ivy Growth

Zone 2

In Zone 2 ivy growth was most frequently recorded on *Fraxinus excelsior* and *Corylus avellana.* It was also recorded less often on the following species; *Fagus sylvatica, Betula pendula, Larix decidua, Crataegus monogyna, Ilex avellana, Quercus robur, Sorbus aucuparia* and *Pinus sylvestris* (Figure 5.9).

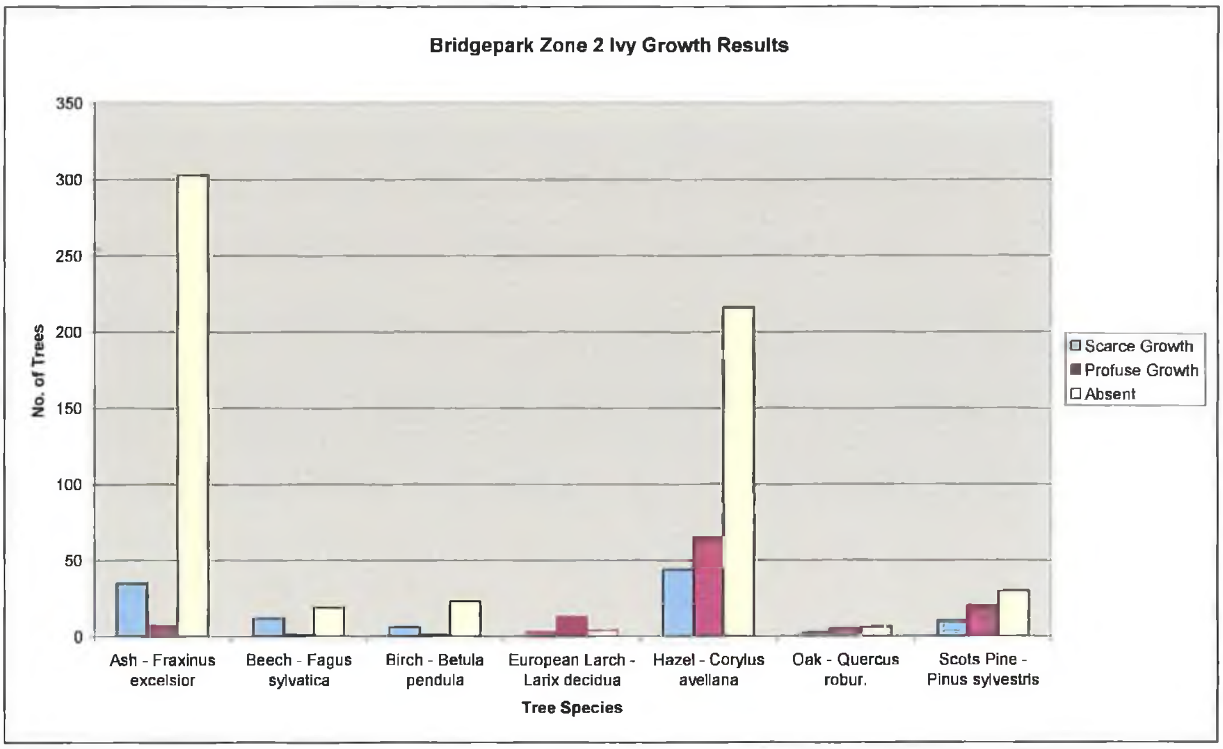


Figure 5.9 Bridgepark Zone 2 Ivy Growth Results

Honeysuckle Growth Results

Honeysuckle was recorded growing on a number of trees surveyed and the results are summarised in Table 5.2.

Bridgepark Honeysuckle Results	Zone 1	Zone 2
Ash – *Fraxinus excelsior*	**1**	**9**
Hawthorn – *Crataegus monogyna*	**0**	**2**
Hazel – *Corylus avellana*	**1**	**15**
Holly – *Ilex aquifolium*	**0**	**2**
Rowan – *Sorbus aucuparia*	**0**	**5**
Scots Pine – *Pinus sylvestris*	**2**	**0**
Silver Birch – *Betula pendula*	**0**	**2**

Table 5.2 Bridgepark Honeysuckle Results

Moss Growth Results

The abundance of moss on all trees surveyed was recorded. If moss was present, it was recorded subjectively as “profuse” or “sparse”. The absence of moss growth was also recorded. All tree species on Bridgepark were recorded to support bryophyte growth and the most common species have been graphed (Figure 5.10 & 5.11). However the principle tree species recorded most frequently with moss growth in both Zone 1 and Zone 2 were *Fraxinus excelsior, Corylus avellana* and *Ilex aquifolium.*

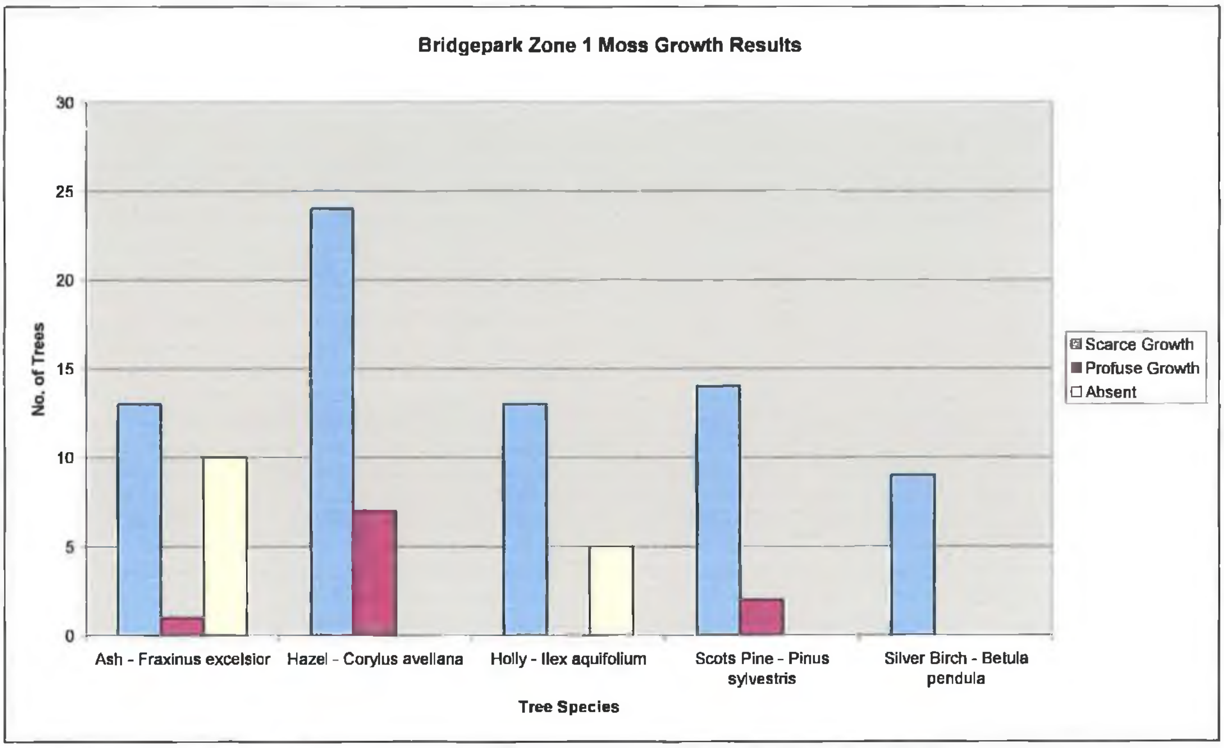


Figure 5.10 Bridgepark Zone 1 Moss Growth Results

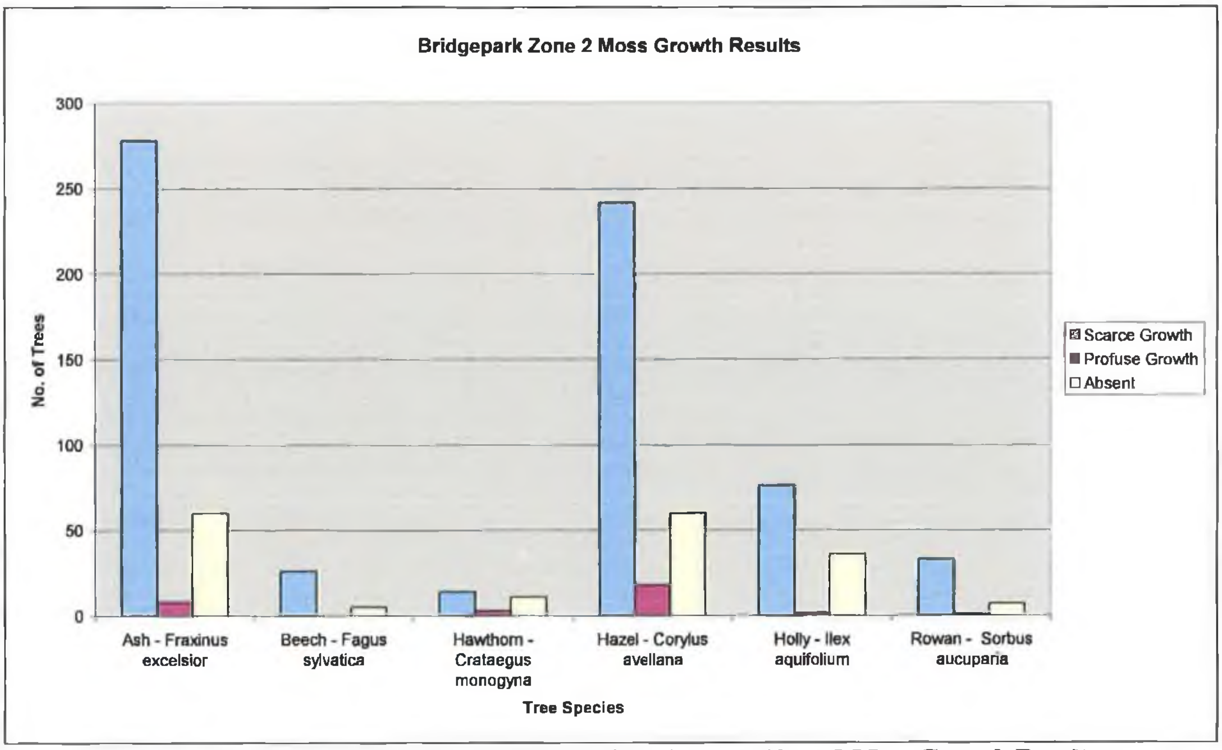


Figure 5.11 Bridgepark Zone 2 Moss Growth Results

5.1.7 Bark Stripping Results

Evidence of bark stripping and browsing of ground vegetation was recorded in all quadrats during the survey. Fraying and trashing damage was also recorded in Zone 1 during the rutting season. Immature growth of *Prunus sylvestris* and *Juniperus communis* were trampled and broken along the shore edge of Bridgepark. Evidence of bark stripping was recorded on *Fraxinus excelsior, Betula pendula Crataegus avellana, Corylus avellana, Ilex aquifolium, Quercus robur* and *Sorbus aucuparia* (Table 5.3). Bark stripping was most frequently recorded on *Ilex aquifolium, Fraxinus excelsior* and *Corylus avellana.*

Bridgepark Bark Stripping Results				
	Zone 1		Zone 2	
	No. of Trees	% of Trees	No. of Trees	% of Trees
Ash - *Fraxinus excelsior*	1	2.78%	41	17.6%
Birch - *Betula pendula*	0	0	1	4.76%
Hawthorn - *Crataegus monogyna*	0	0	2	33.33%
Hazel - *Corylus avellana*	5	8.77%	15	8.24%
Holly - *Ilex aquifolium*	9	29.03%	48	57.83%
Oak - *Quercus robur*	0	0	1	33.33%
Rowan - *Sorbus aucuparia*	0	0	2	7.14%
Spindle - *Euonymus europaeus*	2	100%	0	0

Table 5.3 Bridgepark Bark Stripping Results

5.1.8 Light Composition Results

The intensity of the light composition reaching the woodland floor was recorded in each $10m^2$ quadrat. It was measured using a scale of very bright to very dim (Table 5.4).

Bridgepark Light Composition Results Zone 1	
Scale	Quadrat No.
Very Bright	Q.1, Q.9,Q.10,Q11, Q.21, Q.22, Q.33, Q.38
Bright	Q.32
Moderate	Q.2, Q.12,Q.31
Dim	Q.19, Q.20
Very Dim	
Bridgepark Light Composition Results Zone 2	
Scale	Quadrat No.
Very Bright	Q.27
Bright	Q.3, Q.5
Moderate	Q.6,Q.8, Q.13, Q.29, Q.34, Q.37, Q.40, Q.41
Dim	Q.4,Q.7, Q.14, Q.15, Q.16, Q.17,Q.18, Q.23, Q.24, Q.25,Q.26, Q.28,Q.29, Q.30, Q.36, Q.39
Very Dim	Q.35, Q.42

Table 5.4 Bridgepark Light Composition Results

5.1.9 Percentage of canopy cover

The percentage of canopy cover over each 10m^2 quadrat was estimated during the survey of Bridgepark. The result of this information was calculated as an average percentage cover for each Zone in Table 5.5.

Percentage of Canopy Cover Bridgepark					
Zone 1	% cover	Aver %cover	Zone 2	% cover	Aver %cover
Quadrat 1	0	25	Quadrat 3	20	60.29
Quadrat 2	50		Quadrat 4	70	
Quadrat 9	5		Quadrat 5	35	
Quadrat 10	0		Quadrat 6	50	
Quadrat 11	0		Quadrat 7	70	
Quadrat 12	45		Quadrat 8	55	
Quadrat 19	70		Quadrat 13	50	
Quadrat 20	65		Quadrat 14	75	
Quadrat 21	10		Quadrat 15	80	
Quadrat 22	15		Quadrat 16	85	
Quadrat 31	55		Quadrat 17	70	
Quadrat 32	20		Quadrat 18	75	
Quadrat 33	10		Quadrat 23	65	
Quadrat 38	5		Quadrat 24	60	
			Quadrat 25	68	
			Quadrat 26	75	
			Quadrat 27	0	
			Quadrat 28	60	
			Quadrat 29	50	
			Quadrat 30	60	
			Quadrat 34	40	
			Quadrat 35	90	
			Quadrat 36	80	
			Quadrat 37	60	
			Quadrat 39	45	
			Quadrat 40	45	
			Quadrat 41	70	
			Quadrat 42	85	

Table 5.5 Percentage of Canopy Cover Bridgepark

5.1.10 Drainage Results

The method of recording drainage results that was used in this survey was taken from methodology used by the NPWS during the National Woodland Inventory Survey (2004). The geology of the island was recorded as well drained in every quadrat (Table 5.6).

Bridgepark Internal Drainage Results Zone 1	
	Quadrat No.
Excessive	
Free	**Q.2, Q.12, Q.19, Q.1, Q.9, Q11, Q.20, Q.21, Q.22, Q.31, Q.32, Q.33, Q.38**
Impeded	
Strongly Impeded	
Prone to Flooding	
Bridgepark Internal Drainage Results Zone 2	
	Quadrat No.
Excessive	
Free	**Q.3, Q.4, Q.5, Q.6,Q.7, Q.8, Q.13, Q.14, Q.15, Q.16,Q.17,Q.18, Q.23, Q.24, Q.25, Q.26, Q.27, Q.28, Q.29, Q.30, Q.34, Q.36, Q.37, Q.35, Q.39, Q.40, Q.41, Q.42**
Impeded	
Strongly Impeded	
Prone to Flooding	

Table 5.6 Bridgepark Internal Drainage Results

5.1.11 Soil Depth

The soil depth of each zone was assessed by probing the ground with a metal rod and measuring the depth the rod reached unhindered. Thirty readings were taken in each zone and the average depth calculated for each zone in Table 5.7.

Soil Depth Results Bridgepark	Zone 1	Zone 2
	cm	cm
Deepest Reading	18	35
Shallowest Reading	3	8
Average Depth	8.65	14.45

Table 5.7 Soil Depth Results Bridgepark

5.1.12 Ground Cover Results

The predominant ground cover was recorded in each quadrat. Limestone and Grass was the most frequently recorded surface cover in Zone 1. In Zone 2 both rocks and mossy boulders, and Leaf litter and dead wood were recorded most frequently (Table 5.8).

Bridgepark Ground Cover Results Zone 1	
	Quadrat No.
Rocks and Mossy Boulders	**Q.31,**
Limestone and Grass	**Q.1, Q.9, Q11,Q.21,Q.22,Q.32,Q.33,Q.38**
Bare Soil	**Q.19,**
Leaf Litter and Dead Wood	**Q.2, Q.12,Q.20,**
Covered with Plants	**Q.12,**
Bridgepark Ground Cover Results Zone 2	
	Quadrat No.
Rocks and Mossy Boulders	**Q.8,Q.16,Q.24,Q.25, Q.26,Q.28, Q.29,Q.34,Q.39,Q.40,Q.41,**
Limestone and Grass	
Bare Soil	**Q.23,Q.30,**
Leaf Litter and Dead Wood	**Q.6,Q.13,Q.14,Q.15, Q.17,Q.18,Q.36, Q.35,Q.37,Q.42**
Covered with Plants	**Q.3,Q.4,Q.5,Q.7, Q.27,**

Table 5.8 Bridgepark Ground Cover Results

5.1.13 Invasive Canopy and Shrub Species

During the survey of Bridgepark *Fagus sylvatica* was recorded growing in Zone 2. In quadrat 42 an area of 16 mature *Fagus sylvatica* was recorded. However the majority of *Fagus sylvatica* recorded were of recent growth and are spreading throughout the woodland. The species was also recorded as regenerating in both Zones. The garden escape *Buxus sempervirens* was recorded growing in the limestone grassland.

5.1.14 Breeding Bird Census

Bridgepark woodland was part of a survey route used to create a Breeding Bird Census for the area. The results of this surveys is summarised in Table 5.9. The results of only the woodland specialist species have been used. Twenty-four bird species were identified breeding in Bridgepark.

Bridgepark Breeding Bird Census 2003-2006					
Species	2003	2004	2005	2006	Total
Woodpigeon	17	1	6	10	46
Cuckoo			1		1
Wren	6	6	10	7	29
Dunnock		1		1	2
Robin	14	9	12	11	46
Blackbird	12	13	9	8	42
Song Thrush	2	6	5	4	17
Mistle Thrush	1	1	2	6	10
Whitethroat				1	1
Blackcap	2	4		1	7
Chiffchaff	2	1	2		5
Willow Warbler	17	13	12	11	53
Goldcrest	2	3	1	4	10
Long-tailed Tit			3		3
Coal Tit	2	3	4		9
Blue Tit	2	2	4	8	16
Great Tit	5		3	2	10
Treecreeper	1				1
Jackdaw	2				2
Hooded Crow	2		1	2	5
Starling	1	3	15		19
Chaffinch	10	9	18	7	44
Redpoll	2				2
Bullfinch		2		1	3

Table 5.9 Bridgepark Breeding Bird Census 2003-2006

5.1.15 Fauna

Fallow deer were commonly recorded grazing in both the woodland and on the limestone grassland at Bridgepark. Bridgepark is the main access point for the deer entering Partry Estate as it is situated beside the road. Young fawns were frequently found sleeping camouflaged in the long grasses of the limestone grassland. A badger sett was also noted and mapped on the south-eastern edge of the woodland. It is not certain if it is currently occupied.

5.1.16 Leaf Litter Results

Leaf litter cover was recorded by percentage cover in each $1m^2$ quadrat of the flora survey. The results of this survey is summarised below.

Frequency – 120 recordings out of 168

Species Frequency % - 71.43%

Total % - 4137%

Mean % Cover – 24.63%

5.1.17 Vegetation Classification

Sampling of the ground flora took place throughout the woodland in Summer 2005. In every $10m^2$ quadrat of vegetation, four $1m^2$ quadrats were taken of the flora. In total data from 168 $1m^2$ quadrats were collected during the field survey of summer 2006. 56 quadrats were recorded in Zone 1 and 112 in Zone 2. All ground-dwelling and saxicolous vascular plants were recorded by percentage cover estimated by eye. The floristic data was rearranged based on the TWINSPAN output using Excel and a table was produced showing species-by-site (quadrate or sample) relationships. This allowed for groups and associations to be formed (Pisces Conservation 2004). In total 29 flora species were recorded in the floristic survey and comprised of vascular plants from woodland and limestone grassland. The floristic composition of Bridgepark is displayed in Tables 5.10 and 5.11 and the raw data is in the Appendix 3. Species Frequency percentage and Mean Percentage Cover were calculated for each species.

Bridgepark Flora Results Zone 1	Total % Cover	Mean % Cover	Species Frequency out of 56	Species Frequency %
Limestone Grassland Species				
Tormentil - *Potentilla erecta*	38.75	0.69	10	17.86
Lesser Stitchwort - *Stellaria graminea*	11.25	0.2	4	7.14
Autumn Gentian - *Gentianella amarella*	7.5	0.13	3	5.36
Dandelion - *Taraxacum officinale agg.*	73.75	1.32	12	21.43
Cats Foot - *Antennaria dioica*	8.75	0.16	5	8.93
Devils Bit Scabious - *Succisa pratensis*	18.75	0.33	5	8.93
Grass of Parnassus - *Parnassia palustris*	28.75	0.51	7	12.5
Common Bird's-foot-trefoil - *Lotus corniculatus*	174.5	3.12	26	46.43
Lousewort - *Pedicularis palustris*	16.25	0.29	3	5.36
Greater Knapweed - *Centaurea nigra*	28.75	0.51	12	21.43
Harebell - *Campanula rotundifolia*	11.25	0.2	7	12.5
Selfheal - *Prunella vulgaris*	35	0.62	15	26.78
Oxeye Daisy - *Chrysanthemum leucanthemum*	54.5	0.97	22	39.28
White Clover - *Trifolium repens*	141.75	2.53	28	50
Lady's Bedstraw - *Galium verum*	116.25	2.07	23	41.07
Wild Carrot - *Daucus carota*	18.75	0.33	5	8.93
Common Milkwort - *Polygala vulgaris*	30	0.53	12	21.43
Creeping Buttercup - *Ranunculus bulbous*	22.5	0.4	11	19.64
Eyebright Sp. – *Euphrasia sp.*	58.5	1.04	18	32.14
Common Cat's-ear - *Hypochoeris radicata*	3.75	0.07	3	5.36
Common Sorrel - *Rumex acetosa*	13.25	0.24	5	8.93
Germander Speedwell - *Veronica chamaedrys*	12.5	0.22	6	10.71
Heather - *Calluna vulgaris*	92.5	1.65	10	17.86
Bracken - *Pteridium aquilinum*	81.25	1.45	10	17.86
Meadowsweet - *Filipendula ulmaria*	35	0.62	10	17.86
Wood Sage - *Teucrium scorodonia*	48.75	0.87	11	19.64
Grass Sp. - *Gramineae sp.*	2054.5	36.69	47	83.93
Burnet Rose - *Rosa pimpinellifolia*	28.75	0.51	7	12.5
Vetch Sp. – *Vica sp.*	12.5	0.22	5	8.93
Bramble - *Rubus fruticosus*	201.75	3.6	31	55.36
Uncommon Grassland Species				
Wild Cotoneaster - *Cotoneaster integerrimus*	27.5	0.49	2	3.57
Rough Hawkbit - *Leontodon hispidus*	17.5	0.31	2	3.57
Sliverweed - *Potentilla anserina*	8.75	0.16	2	3.57
Common Ragwort - *Senecio jacobaea*	3.75	0.07	2	3.57
Woodruff - *Galium odoratum*	6.25	0.11	2	3.57
Dog Rose - *Rosa canina*	10	0.18	2	3.57
Daisy - *Bellis perennis*	5	0.09	2	3.57
Hemp-agrimony - *Eupatorium cannabinum*	1.25	0.02	1	1.78
Spear Mint - *Mentha spicata*	3.75	0.07	1	1.78
Foxglove - *Digitalis purpurea*	1	0.02	1	1.78
Common Mouse-ear - *Cerastium holosteoides*	1.25	0.02	1	1.78
Common Quaking Grass – *Briza media L.*	48	0.86	1	1.78
Woodland Species				
Moss - *Musci sp.*	1100.75	19.66	39	69.64
Primrose - *Primula vulgaris*	10	0.18	4	7.14
Wood Sanicle - *Sanicula europaea*	6.25	0.11	3	5.36
Enchanters Nightshade - *Circaea lutetiana*	50	0.89	18	32.14
Ivy - *Hedera helix*	57.25	1.02	17	30.36

Wild Strawberry - *Fragaria vesca*	37	0.66	10	17.86
Common Dog Violet - *Viola riviniana*	75.5	0.13	18	32.14
Greater Wood-rush - *Luzula sylvatica*	10	0.18	3	5.36
Ground Ivy - *Glechoma hederacea*	41.25	0.74	10	17.86
Honeysuckle - *Lonicera periclymenum*	10.5	0.19	4	7.14
Uncommon Woodland Species				
Wood Sorrel - *Oxalis acetosella*	1.75	0.03	2	3.57
Male Fern - *Dryopteris filix-mas*	2.5	0.04	1	1.78
Lords and Ladies - *Arum maculatum*	3.75	0.07	1	1.78
Herb Robert - *Geranium robertianium*	2.5	0.04	1	1.78

Table 5.10 Bridgepark Flora Results Zone 1

Bridgepark Flora Results Zone 2	**Total % Cover**	**Mean % Cover**	**Species Frequency out of 112**	**Species Frequency %**
Woodland Species				
Herb Robert - *Geranium robertianium*	23.75	0.21	10	8.93
Lords and Ladies - *Arum maculatum*	11.25	0.1	4	3.57
Yellow Pimpernel - *Lysimachia nemorum*	26.75	0.24	6	5.36
Primrose - *Primula vulgaris*	61.25	0.55	12	10.71
Wood Sorrel - *Oxalis acetosella*	38.25	0.34	13	11.61
Bugle - *Ajuga reptans*	13.75	0.12	6	5.36
Wood Sanicle - *Sanicula europaea*	73.05	0.65	24	21.43
Enchanters Nightshade - *Circaea lutetiana*	154.75	1.38	66	58.93
Male Fern - *Dryopteris filix-mas*	12.5	0.11	7	6.25
Ground Ivy - *Glechoma hederacea*	149.5	1.33	27	24.11
Greater Wood-rush - *Luzula sylvatica*	97.5	0.87	31	27.68
Tutsan - *Hypericum androsaemum*	16.25	0.14	8	7.14
Wild Strawberry - *Fragaria vesca*	128	1.14	52	46.43
Woodruff - *Galium odoratum*	16.25	0.14	7	6.25
Burnet Rose - *Rosa pimpinellifolia*	31.2	0.28	9	8.03
Vetch Sp. – *Vica sp.*	7.5	0.07	3	2.68
Wood Sage - *Teucrium scorodonia*	88.25	0.79	11	9.82
Pignut - *Conopodium majus*	6.25	0.05	4	3.57
Bracken - *Pteridium aquilinum*	71.25	0.64	14	12.5
Honeysuckle - *Lonicera periclymenum*	48.75	0.43	17	15.18
Common Species				
Common Dog Violet - *Viola riviniana*	277	2.47	80	71.43
Ivy - *Hedera helix*	350.45	3.13	90	80.36
Moss - *Musci sp.*	4654.8	41.56	106	94.64
Bramble - *Rubus fruticosus*	440.75	3.93	92	82.14
Limestone Grassland Species				
Heather - *Calluna vulgaris*	10	0.09	1	0.89
Perforate St John's-wort - *Hypericum perforatum*	2.5	0.02	1	0.89
White Clover - *Trifolium repens*	10	0.09	2	1.78
Common Bird's-foot-trefoil - *Lotus corniculatus*	11.5	0.1	2	1.78
Common Milkwort - *Polygala vulgaris*	3.5	0.03	1	0.89
Germander Speedwell - *Veronica chamaedrys*	5	0.04	1	0.89
Harebell - *Campanula rotundifolia*	2.5	0.02	1	0.89
Eyebright Sp. – *Euphrasia sp.*	7.5	0.07	2	1.78
Marsh Thistle - *Cirsium palustre*	15	0.13	1	0.89
Tormentil - *Potentilla erecta*	78.75	0.7	15	13.39
Grass Sp. - *Gramineae sp.*	666.2	5.95	45	40.18
Common Nettle - *Urtica dioica*	36.75	0.33	4	3.57
Creeping Buttercup - *Ranunculus bulbous*	8.75	0.08	5	4.46
Dandelion - *Taraxacum officinale agg.*	5.5	0.05	2	1.78
Uncommon Species				
Hartstongue Fern - *Asplenium scolopendrium*	7.5	0.07	1	0.89
Selfheal - *Prunella vulgaris*	3.75	0.03	2	1.78
Common Twayblade - *Listera ovata*	5	0.04	2	1.78
Dog Rose - *Rosa canina*	6.25	0.05	2	1.78

Table 5.11 Bridgepark Zone 2 Flora Results

5.2 Moynish

5.2.1 Description

Moynish woodland is located to the east of Partry House and south of Creggaun Woodland. It is accessed by a manmade causeway built across the lake as part of the famine works that joins the woodland to the mainland. The northern part of the woodland is bordered by fen and limestone grassland, and the rest of the woodland is surrounded by Lough Carra. There is an area of limestone paving on the southern peninsula of the woodland, where the ruins of a limestone quarry still exist. Moynish is almost entirely wooded except for the area of limestone paving. It is shown as having supported woodland on the early OS map of 1838 and also Bald's Map of 1830 (Appendix 2.3). The dimensions of the island are approximately 710 metres in length and 365 metres at its widest part. At the causeway entrance to the woodland a path continues straight across in a west to east direction. A further two paths run in a north to south direction and join and all the paths naturally divide Moynish into four parcels of woodland. It was surveyed using regular and stratified sampling in the summer of 2006. These field methods were used to collect quantitative data in order to map the mosaic of woodland types occurring in Moynish woodland. The parcels of woodland were zoned 1-5 and each zone was surveyed. Both point quadrats and 5m x 10m quadrats were used to gathered vegetation data.

5.2.2 Woodland Structure

Information about stand structure and species composition was recorded in each zone. Trees species measuring over 5 metres in height were classed as canopy species and tree species measuring less than 5 metres in height were classed as understorey species. The scrub layer was classified as trees species measuring less than 3 metres in height.

Zone 1

A line transect was taken through the centre of the zone measuring 120 metres in length and 4 metres in width. All stems falling within the line transect were counted and measured. Point quadrats were taken along the boundary of the zone and also two point transects were taken either side of the line transect. In total 10 species of tree and shrub species were recorded in the point and line transects taken in the centre of the zone and the results are summarised in Figure 5.12. Both *Fraxinus excelsior* and *Corylus avellana* are dominant in the canopy layer. Also recorded in the canopy layer were *Fagus sylvatica, Crataegus monogyna, Ilex aquifolium, Quercus robur, Sorbus aucuparia, Betula pendula* and *Euonymus europaeus*. The dominant tree species in the understorey was recorded as *Ilex aquifolium*. Other tree species recorded as understorey consisted of *Fraxinus excelsior, Fagus sylvatica, Crataegus monogyna, Prunus spinosa, Betula pendula and Euonymus europaeus*. The invasive shrub *Rhododendron ponticum* was also recorded growing in the central area of Zone 1. The number of canopy trees recorded was far greater than the number of understorey trees.

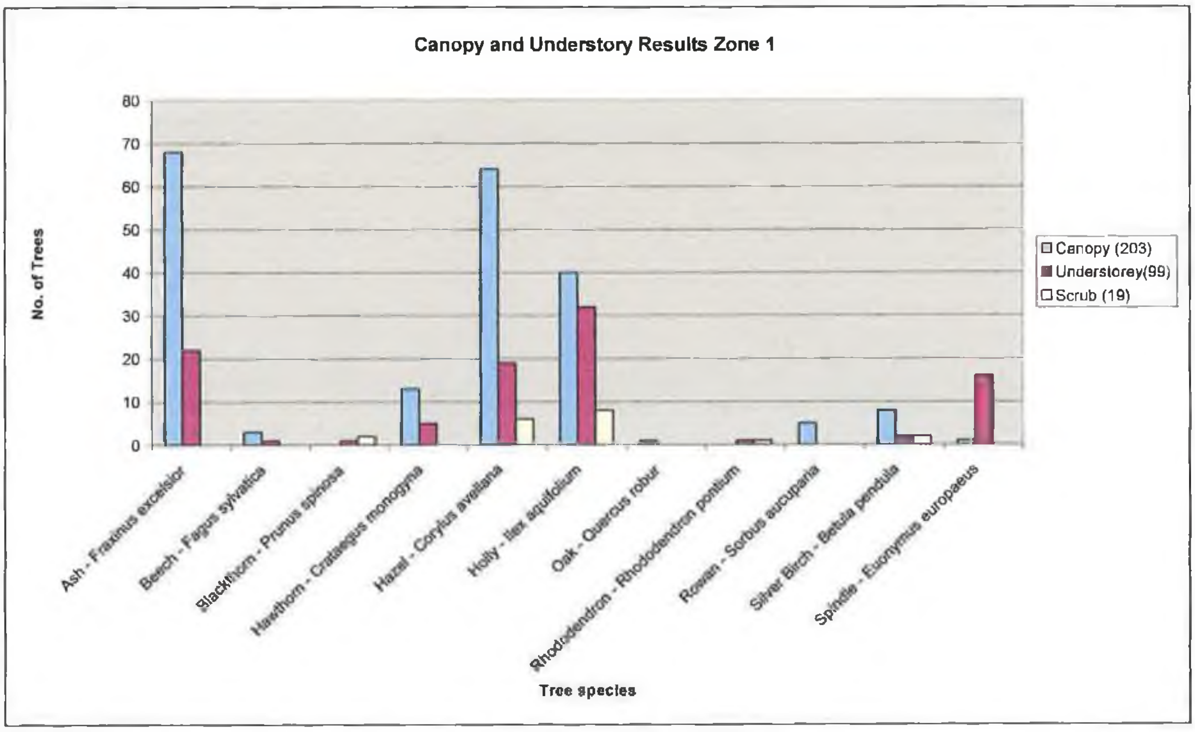


Figure 5.12 Moynish Canopy and Understorey Results Zone 1

The results of the boundary survey of Zone 1 are shown separately in Figure 5.13. Data on the canopy, understorey and scrub layers were recorded by point quadrat every five metres around the woodland edge. A total of 10 tree and shrub species were recorded *Corylus avellana* is dominant in the canopy layer. Species also recorded in the canopy were *Fraxinus excelsior, Fagus sylvatica, Quercus robur, Pinus sylvestris, Betula pendula* and

Acer pseudoplatanus. There is a noticeably dominance of *Betula pendula* in the understorey along the woodland margins of this zone and it is also the only area in the zone that *Pinus sylvestris* was recorded. Other species recorded in the understorey included *Fraxinus excelsior, Fagus sylvatica, Crataegus monogyna, Viburnum opulus* and *Corylus avellana.* The quantity of understorey trees was greater than the quantity of canopy trees.

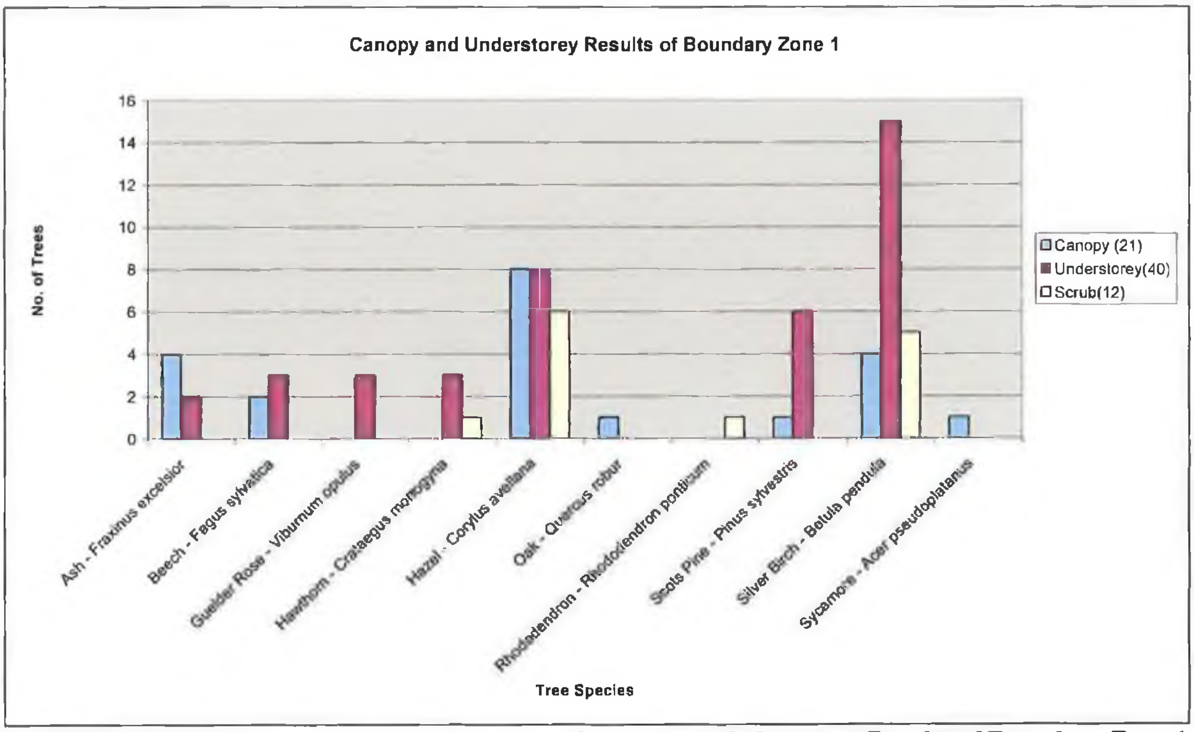


Figure 5.13 Moynish Canopy and Understorey Results of Boundary Zone 1

Zone 2

The vegetation in Zone 2 was sampled using transects of point quadrats, and quadrats measuring 5m x 10m. In total 15 tree species were recorded and the results are displayed in Figure 5.14. *Corylus avellana* and *Ilex aquifolium* are the principal components of the canopy layer. *Populus tremula, Larix decidua, Quercus robur, Sorbus aucuparia, Pinus sylvestris* and *Acer pseudoplantanus* were only recorded growing at canopy level. Other species recorded in the canopy include, *Fagus sylvatica, Fraxinus excelsior, Betula pendula* and *Crataegus monogyna.* The understorey was dominated by the growth of *Ilex aquifolium* and *Corylus avellana.* Also recorded in the understorey were *Fagus sylvatica, Fraxinus excelsior, Betula pendula, Prunus spinosa, Malus sylvestris, Crataegus* *monogyna* and *Euonymus europaeus*. The number of the canopy trees recorded in the survey was twice that of the understorey layer.

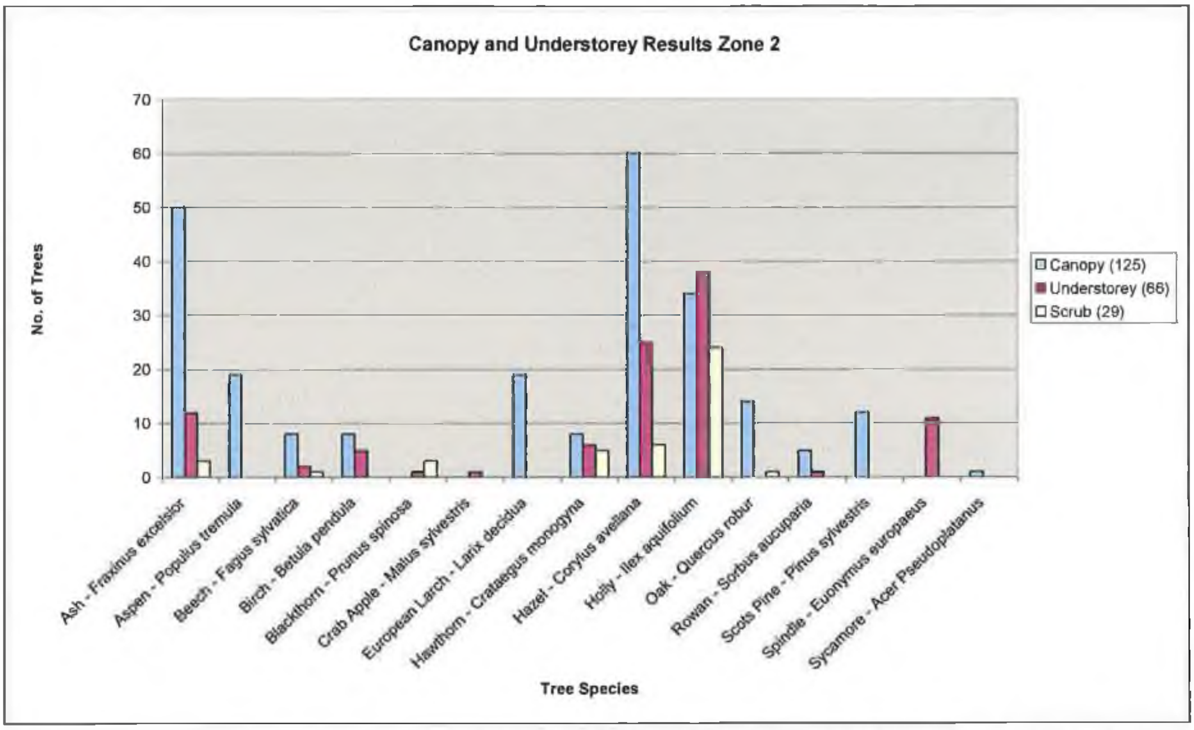


Figure 5.14 Moynish Canopy and Understorey Results Zone 2

The boundary edge of Zone 2 was surveyed and its results displayed separately in Figure 5.15. In total 16 tree and shrub species were recorded along the woodland periphery. Six tree species were recorded in the canopy layer and *Pinus sylvestris* was the main canopy species. Also recorded in the canopy layer were *Fraxinus excelsior, Populus tremula, Fagus sylvatica, Betula pendula, Crataegus monogyna, Ilex aquifolium and Quercus robur*. There were 11 species recorded in the understorey layer and consisted of *Frangula alnus, Fraxinus excelsior, Fagus sylvatica, Betula pendula, Viburnum opulus, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Quercus robur, Sorbus aucuparia* and *Pinus sylvestris. Betula pendula* was most frequently recorded in the understorey. Twelve tree species were recorded in the scrub layer and included *Frangula alnus, Fraxinus excelsior, Fagus sylvatica, Betula pendula, Prunus spinosa, Juniperus communis, Corylus avellana, Ilex aquifolium, Quercus robur, Pinus sylvestris* and *Salix caprea. Corylus avellana, Betula pendula* and *Pinus sylvestris* were recorded most frequently in the scrub layer and most of the trees recorded in the boundary survey were in the scrub layer.

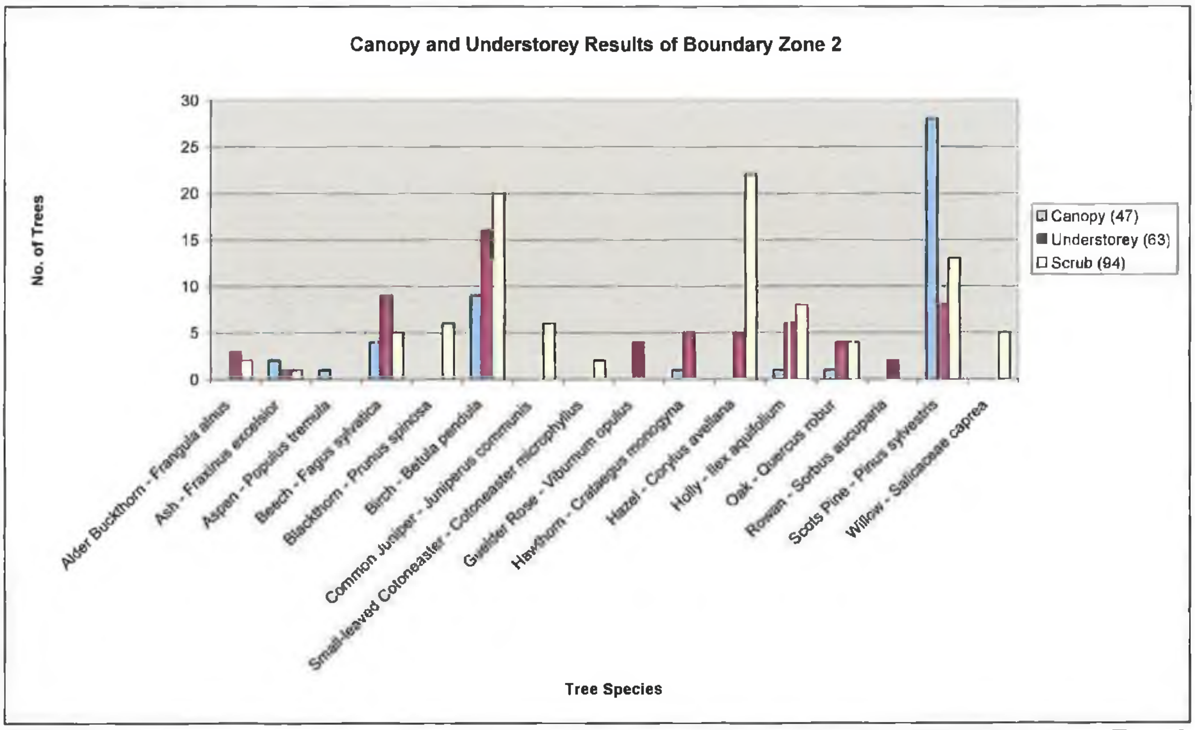


Figure 5.15 Moynish Canopy and Understorey Results of Boundary Zone 2

Zone 3

The vegetation in Zone 3 was sampled using transects of point quadrats, and quadrats measuring 5m x 10m. As Zone 3 was in the centre of the woodland no boundary/woodland edge survey was required. In total 18 tree and shrub species were recorded in the survey and the results are shown in Figure 5.16. Fourteen of these species were recorded in the canopy layer, which was dominated by *Corylus avellana* and *Fraxinus excelsior* growth. *Fagus sylvatica, Larix decidua, Quercus robur, Pinus sylvestris, Acer pseudoplatanus* and *Salix caprea* were only recorded growing in the canopy layer. There was 11 tree species recorded in the understorey layer, which consisted of *Fraxinus excelsior, Populus tremula, Betula pendula, Prunus spinosa, Malus sylvestris, Viburnum opulus, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Sorbus aucuparia* and *Euonymus europaeus*. *Corylus avellana* and *Ilex aquifolium* were the main species in the understorey layer. In the scrub layer seven tree species were recorded and *Ilex aquifolium* dominated this stratum. *Fraxinus excelsior, Prunus spinosa, Ulex europaeus, Crataegus monogyna, Corylus* *avellana* and *Sorbus aucuparia* were also recorded to a lesser extent in the scrub layer. The greatest population of trees were recorded growing in the canopy level.

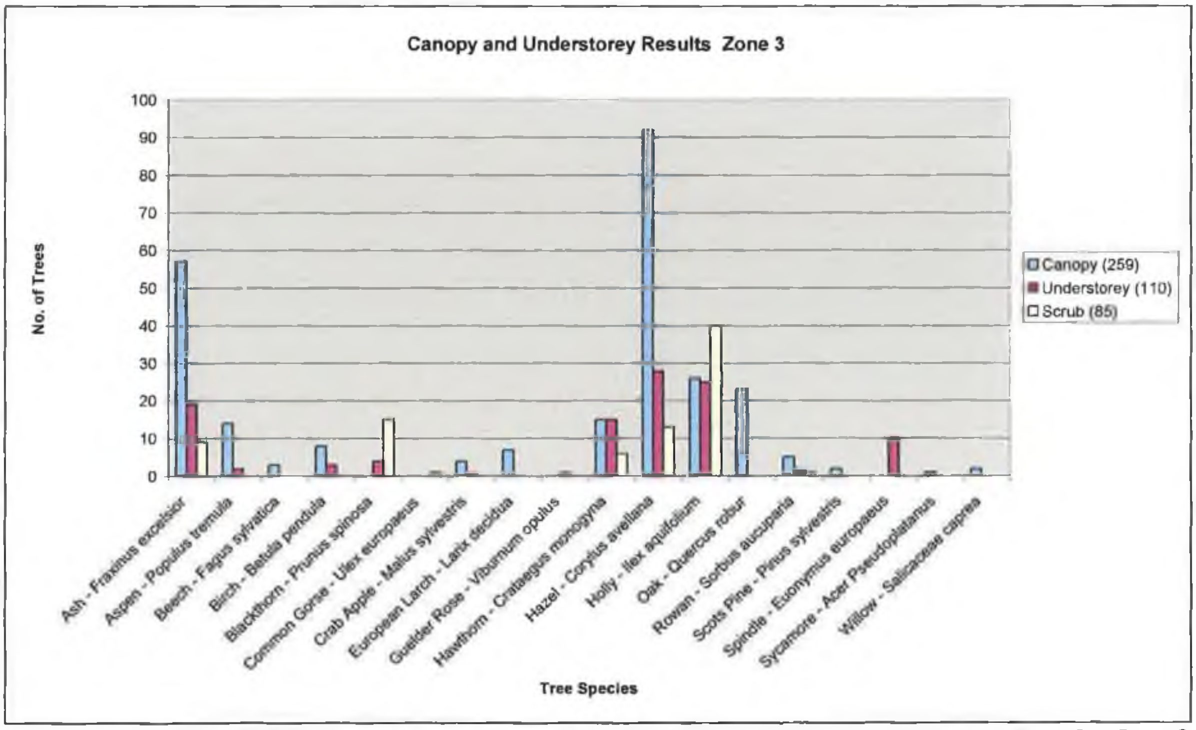


Figure 5.16 Moynish Canopy and Understorey Results Zone 3

Zone 4

The vegetation in Zone 4 was also sampled using transects of point quadrats, and quadrats measuring 5m x 10m. In total 16 tree species were recorded in this Zone (Figure 5.17). Thirteen of these species were recorded in the canopy, with *Malus sylvestris, Sorbus hibernica, Quercus robur and Sorbus aucuparia* only recorded growing in this layer. The most dominant canopy species recorded were *Fraxinus excelsior* and *Corylus avellana.* Also recorded in the canopy stratum were *Populus tremula, Fagus sylvatica, Crataegus monogyna, Ilex aquifolium, Betula pendula, Euonymus europaeus* and *Taxus baccata.* Eleven tree species were recorded in the understorey layer, which were identified as *Fraxinus excelsior, Populus tremula, Fagus sylvatica, Prunus spinosa, Crataegus monogyna, Ilex aquifolium, Corylus avellana, Betula pendula, Euonymus europaeus, Salix caprea* and *Taxus baccata. Corylus avellana, Fraxinus excelsior* and *Ilex aquifolium* were the main species in this stratum. A total of 10 species were recorded in the scrub layer, which was dominated by *Ilex aquifolium.*

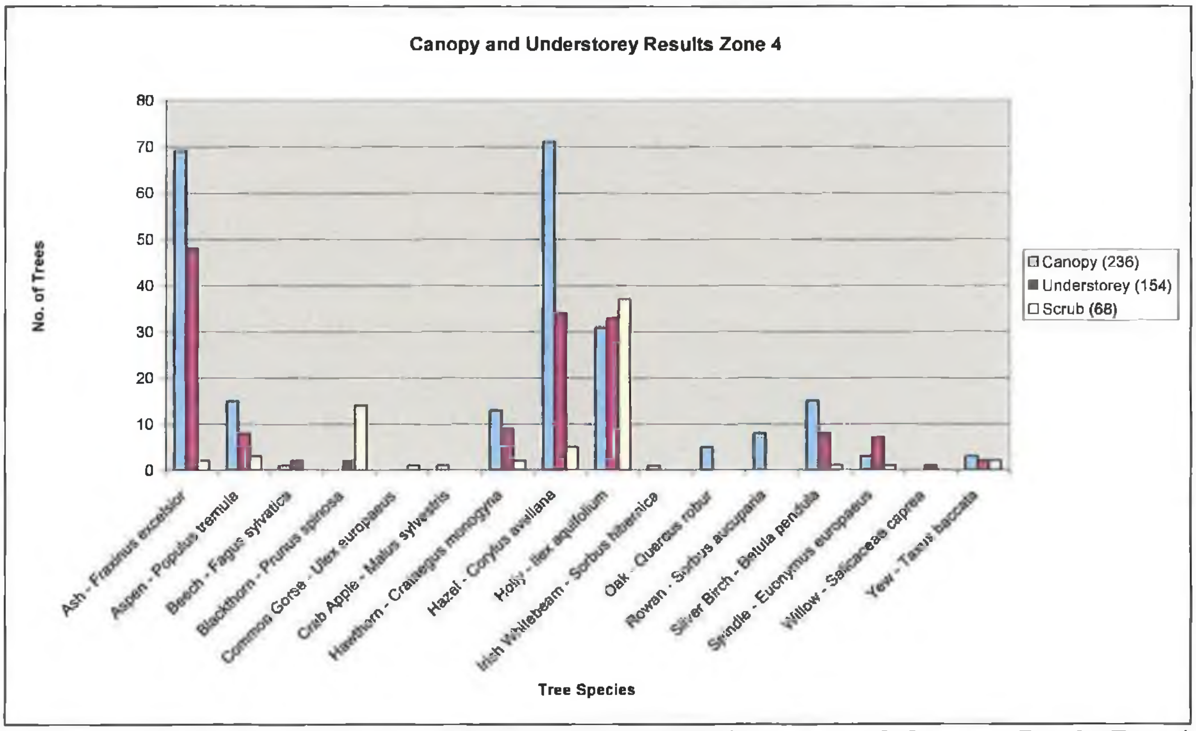


Figure 5.17 Moynish Canopy and Understorey Results Zone 4

The woodland edge of Zone 4 was surveyed separately using point quadrats and the results are displayed in Figure 5.18. A total of 16 tree and shrub species were identified growing in this area: *Frangula alnus, Fraxinus excelsior, Populus tremula, Betula pendula, Prunus spinosa, Juniperus communis, Malus sylvestris, Viburnum opulus, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Sorbus hibernica, Sorbus aucuparia, Pinus sylvestris, Prunus avium* and *Salix caprea.* *Betula pendula* and *Pinus sylvestris* were the main canopy species. *Corylus avellana* and *Betula pendula* were the dominant species in both the understorey and the scrub layers. *Malus sylvestris, Viburnum opulus* and *Salix caprea* were only recorded in the understorey stratum. *Frangula alnus, Prunus spinosa* and *Juniperus communis* were only noted growing in the scrub layer.

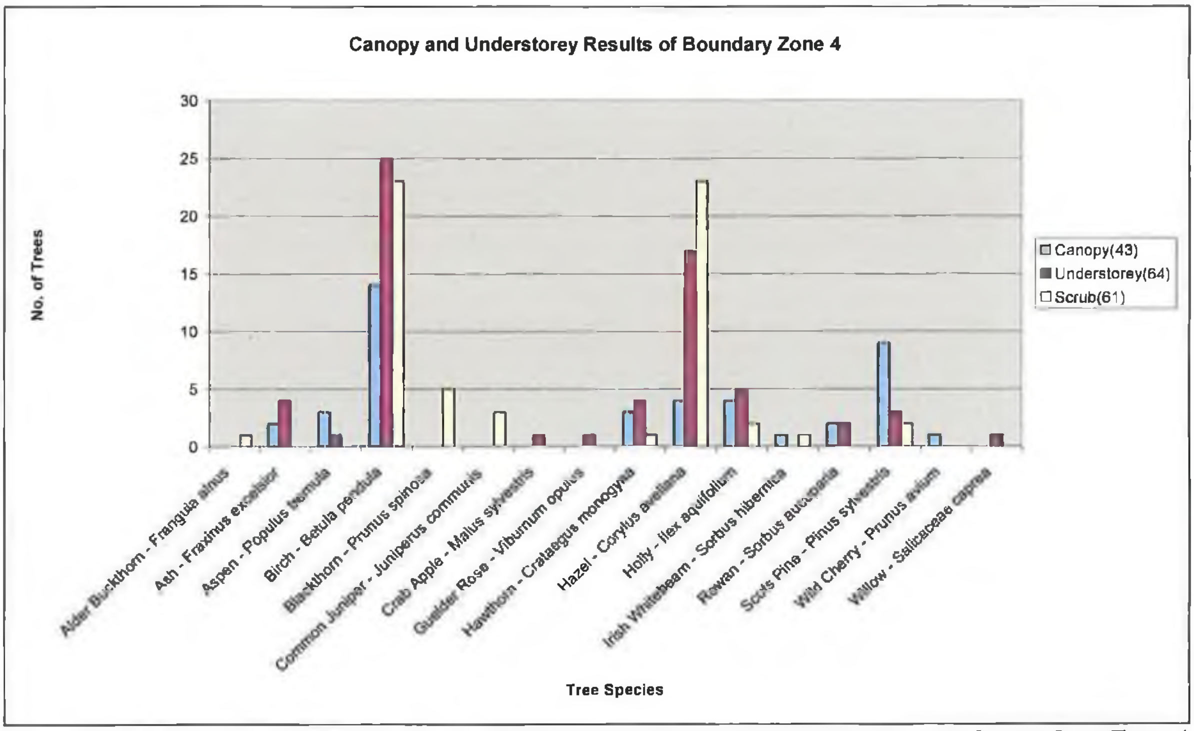


Figure 5.18 Moynish Canopy and Understorey of Boundary Zone 4

Zone 5

During the surveying of Zone 5 only the boundary edge of the zone was surveyed using point quadrats due to the impenetrable thick growth of this zone. Overall the following 19 tree and shrub species were recorded: *Frangula alnus, Fraxinus excelsior, Populus tremula, Prunus spinosa, Juniperus communis, Viburnum opulus, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Ulex europaeus, Sorbus hibernica, Quercus robur, Sorbus aucuparia, Betula pendula, Pinus sylvestris, Euonymus europaeus, Prunus avium* and *Salix caprea. Fraxinus excelsior* and *Betula pendula* were the main canopy species. The principal understorey species was *Betula pendula* and the main scrub species were *Prunus spinosa* and *Corylus avellana.*

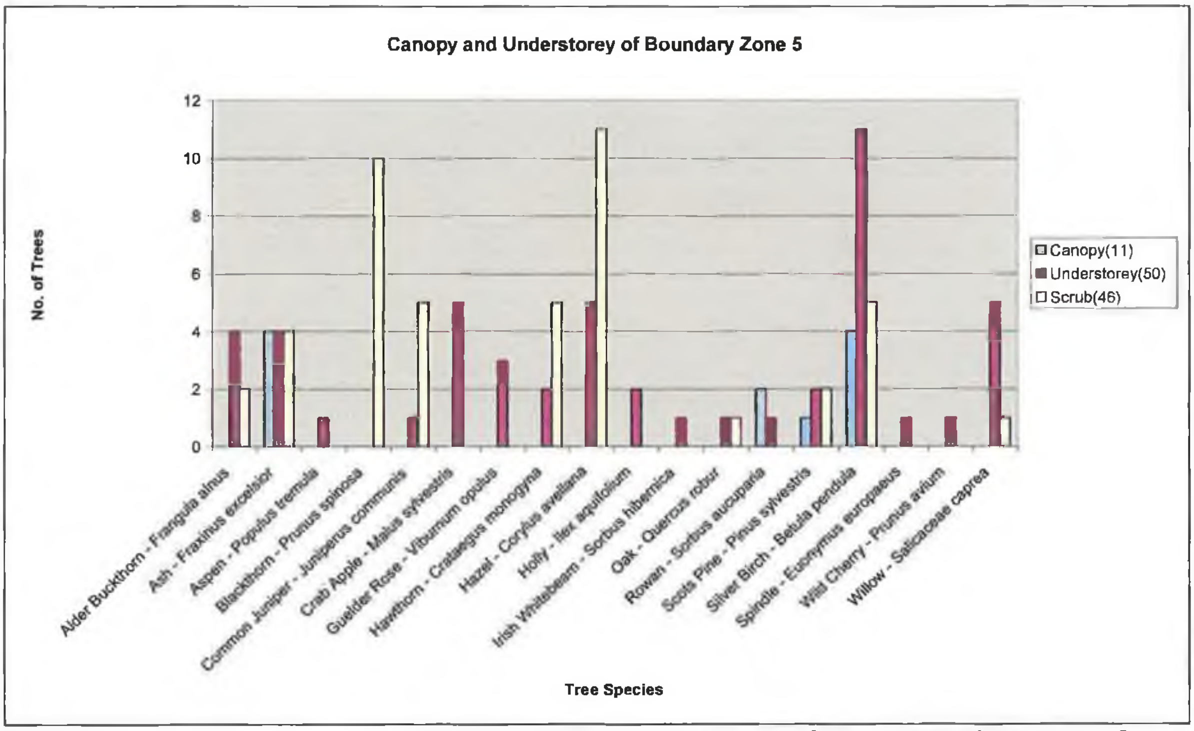


Figure 5.19 Moynish Canopy and Understorey of Boundary Zone 5

5.2.3 Woodland Classification and Mapping

The data from the vegetation survey was used to map the various woodland types that exist in Moynish woodland. GPS readings were taken during the survey and used in combination with Dmap to create an accurate map of the current vegetation Figures 5.20-5.25. Each colour-coded polygon represents a different vegetation type and the information such as the classification of vegetation type of each polygon type is contained in the legend table. A vegetation map was created for each zone. For the most part the vegetation was classified according to Fossit (2000).

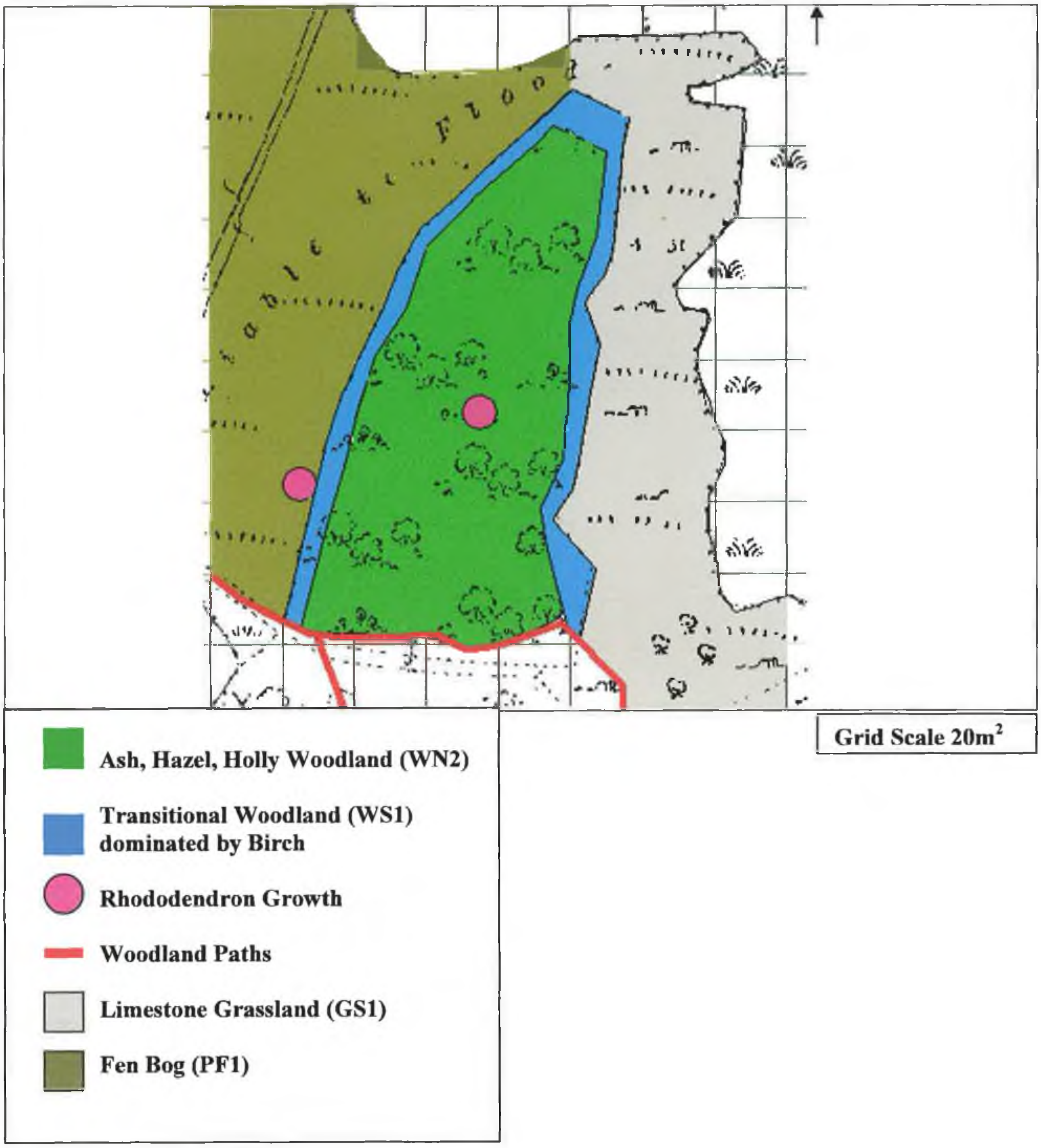


Figure 5.20 Moynish Vegetation Map of Zone 1

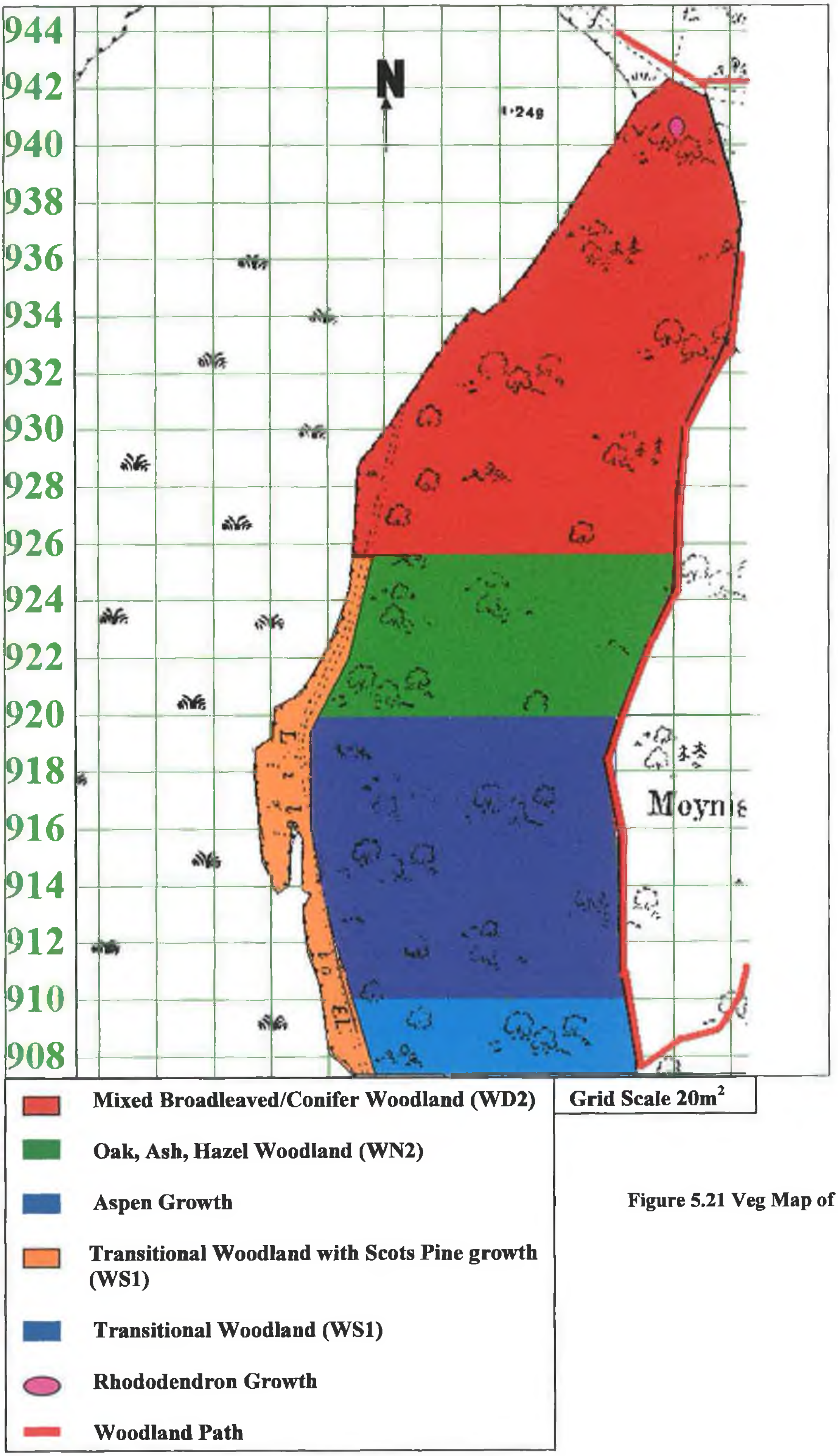
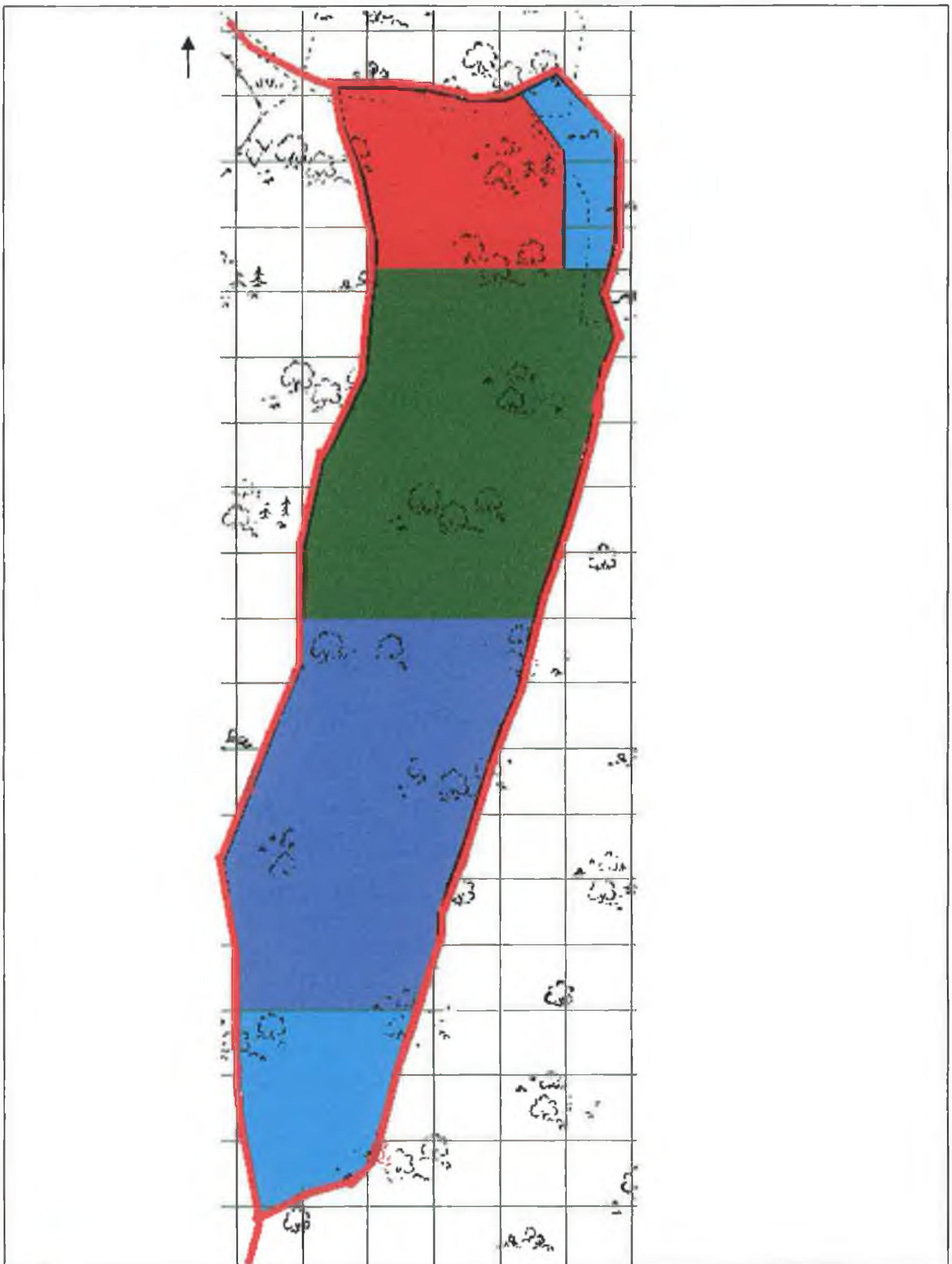
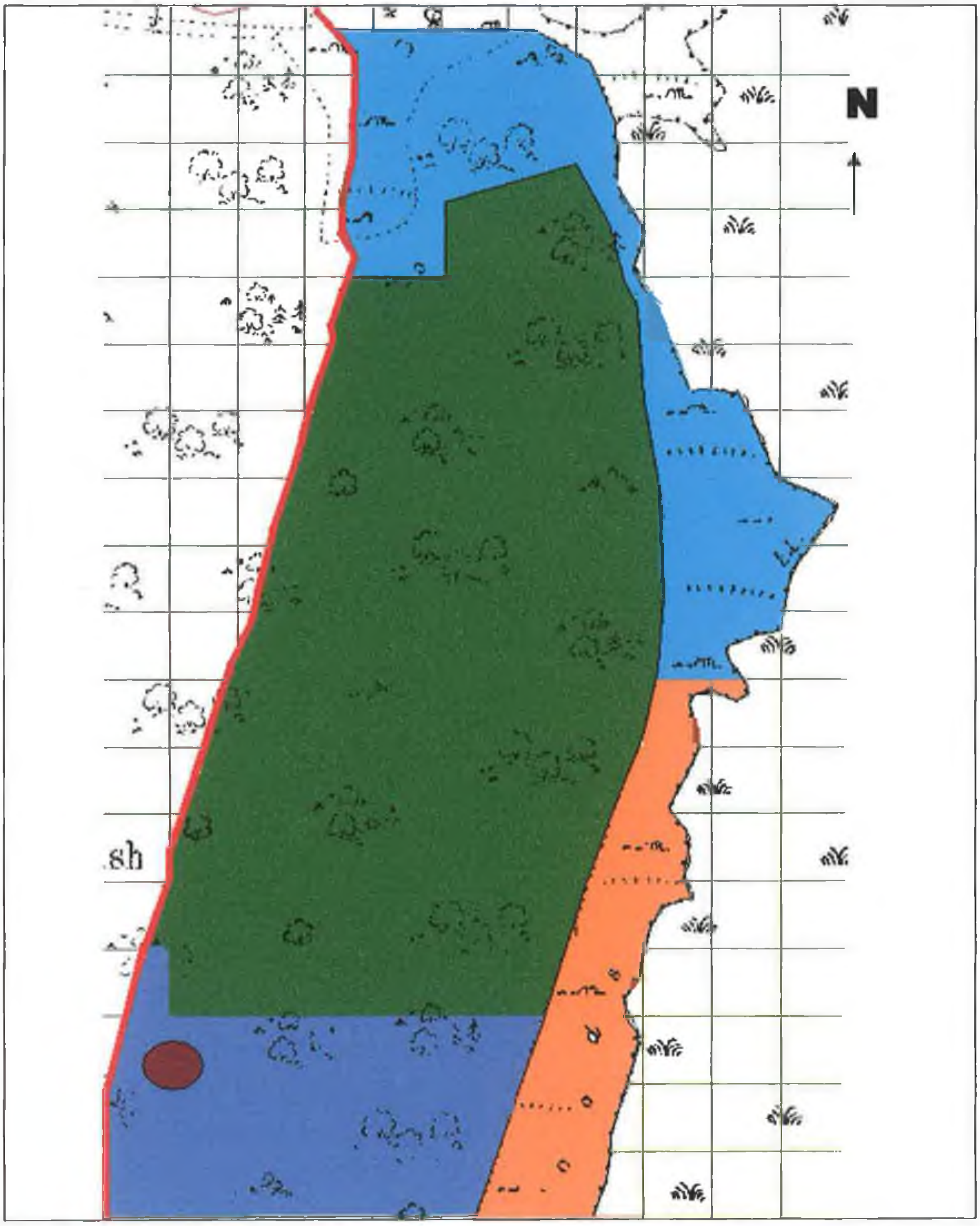


Figure 5.21 Veg Map of Zone 2



Mixed Broadleaved/Conifer Woodland (WD2)	Grid Scale 20m²
Oak, Ash, Hazel Woodland (WN2)	
Aspen Growth	
Transitional Woodland (WS1)	
Woodland Paths	

Figure 5.22 Moynish Vegetation Map Zone 3



Grid Scale 20m^2

Oak, Ash, Hazel Woodland dominated by Ash (WN2)

Transitional Woodland dominated by Birch ((WS1)

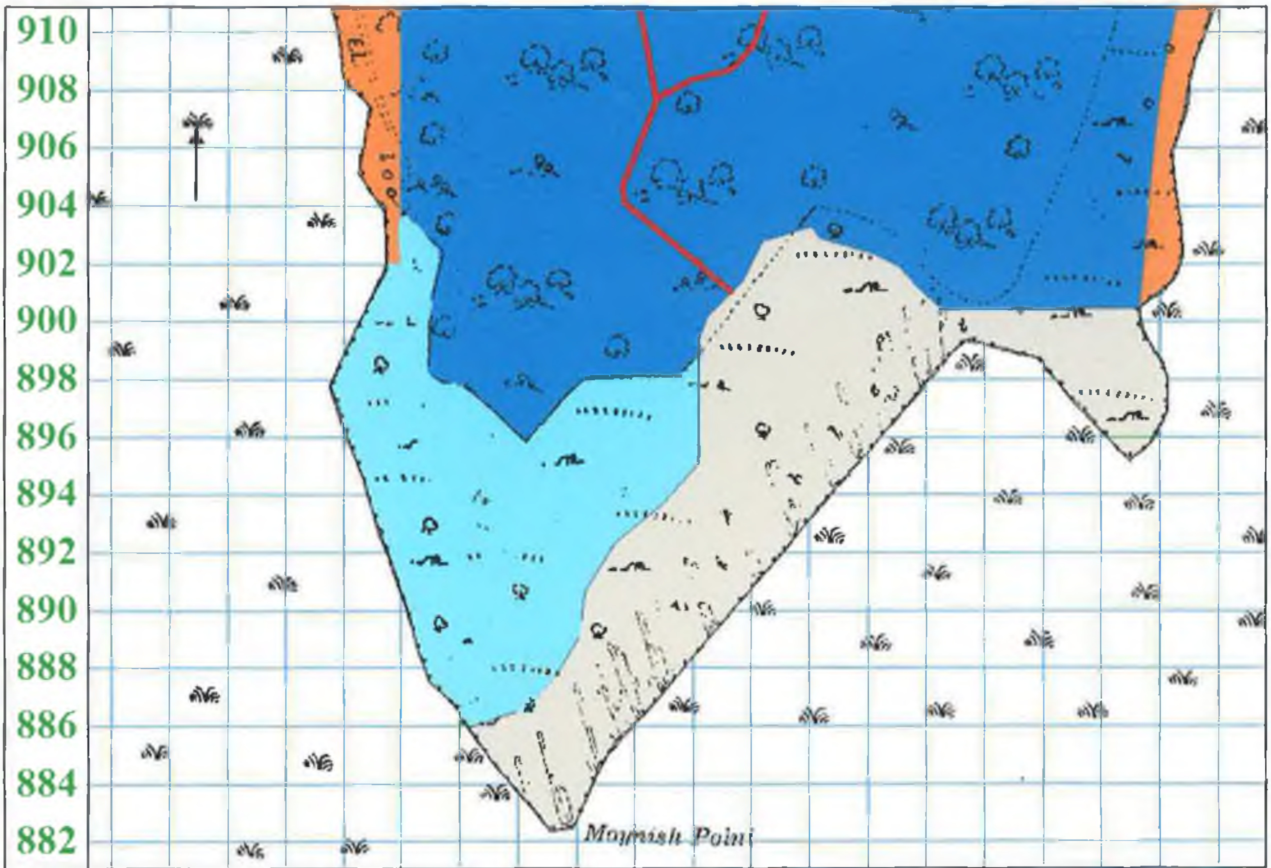
Transitional Woodland with Scots Pine growth (WS1)

Aspen Growth

Yew Growth

Woodland Path

Figure 5.23 Moynish Vegetation Map of Zone 4



Grid Scale 20m²

Transitional Woodland (WS1)

Transitional Woodland (WS1) and Immature Woodland (WS2)

Transitional Woodland with Scots Pine Growth (WS1)

Limestone grassland and Limestone paving (GS1)

Woodland Paths

Figure 5.24 Moynish Vegetation Map of Zone 5

5.2.4 Regeneration

An assessment of tree regeneration in Moynish woodland was accomplished by recording all stems of tree and woody species considered to be 'regeneration' that were growing in each 5m x 10m quadrat and also recorded in all $1m^2$ flora quadrats. For this analysis the size classes were combined into two height categories: ≤ 15cm were considered seedlings; ≤ 2m were considered saplings. A total of 5 tree species were recorded as regenerating in the woodland. The seedlings and saplings regenerating in each zone have been charted in graphs and discussed separately.

Zone 1

In Zone 1 all regeneration was recorded in the line transect taken through the zone and also in all floral quadrats that were recorded. The following tree species were recorded as regenerating in this zone: *Frangula alnus, Fraxinus excelsior, Fagus sylvatica, Prunus spinosa, Crataegus monogyna, Corylus avellana, Ilex aquifolium* and *Acer pseudoplatanus* (Figure 5.25). The principle sapling and seedling species recorded during the survey was *Ilex aquifolium*. *Fagus sylvatica* and *Corylus avellana* were only recorded as sapling growth.

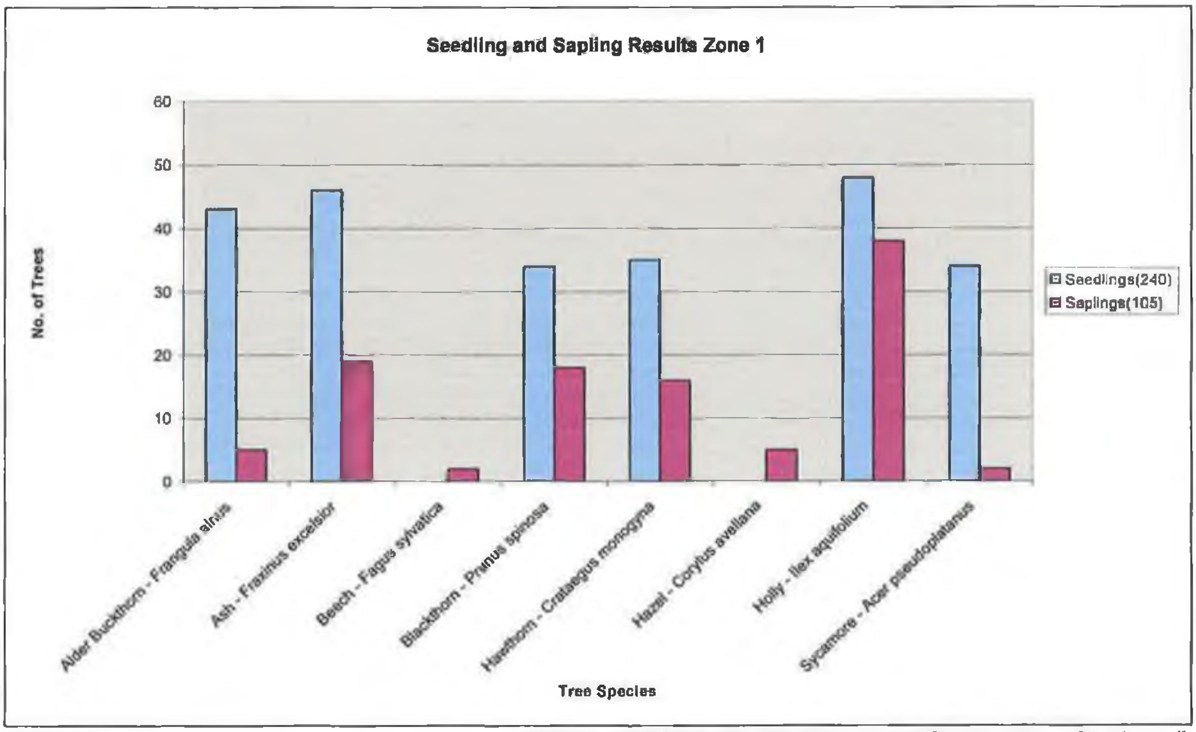


Figure 5.25 Moynish Seedling and Sapling Results Zone 1

Zone 2

Regeneration was recorded in the 5m x 10m quadrats and also in the 1m^2 floral quadrats. The following 12 species were recorded as regenerating: *Frangula alnus, Fraxinus excelsior, Populus tremula, Fagus sylvatica, Prunus spinosa, Crataegus monogyna, Ilex aquifolium, Sorbus aucuparia, Pinus sylvestris, Betula pendula* and *Acer pseudoplantanus.* The main sapling species recorded was *Ilex aquifolium*, and *Fagus sylvatica* and *Prunus spinosa* were only recorded as saplings. *Fraxinus excelsior, Populus tremula* and *Ilex aquifolium* were the dominant seedling species and *Acer pseudoplantanus* and *Crataegus monogyna* were only recorded as seedlings.

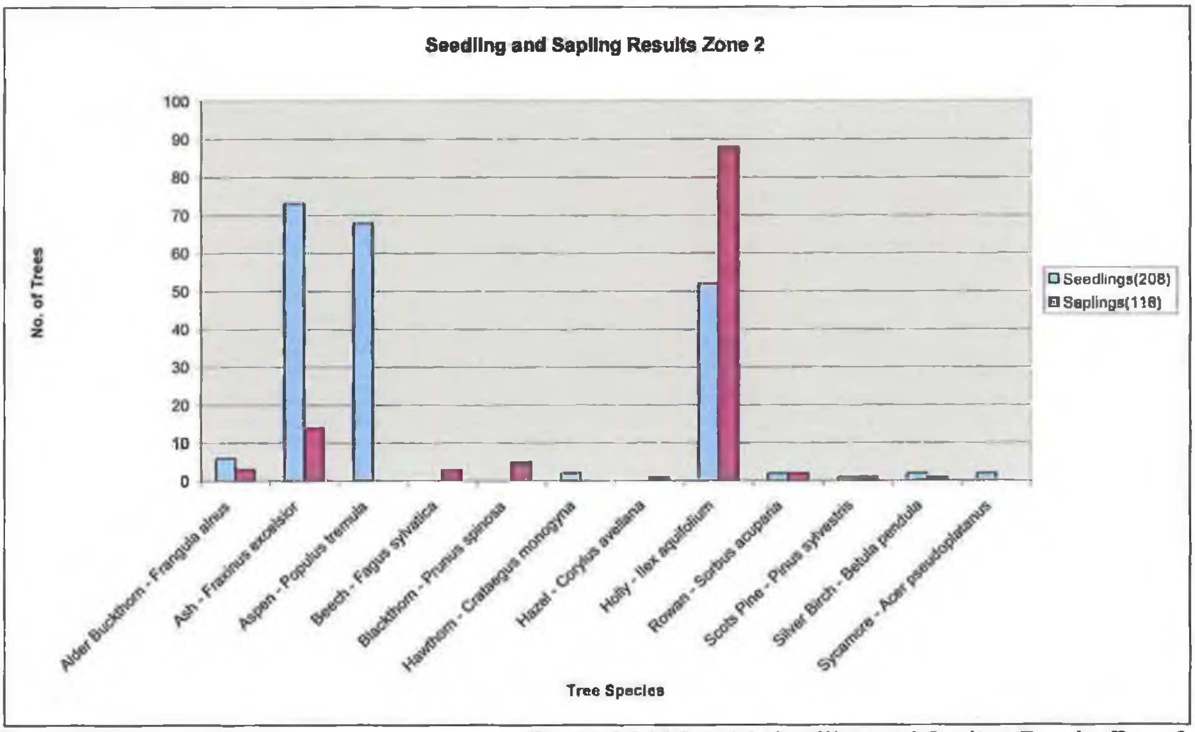


Figure 5.26 Moynish Seedling and Sapling Results Zone 2

Zone 3

The same method of recording regeneration in Zone 2 was used to survey Zone 3 and Zone 4. Overall 10 tree species were recorded as regenerating in Zone 3 (Figure 5.27) and consisted of *Frangula alnus, Fraxinus excelsior, Populus tremula, Fagus sylvatica, Prunus spinosa, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Quercus robur* and *Taxus baccata. Ilex aquifolium* was the most frequent sapling recorded and both *Fagus sylvatica* and *Quercus robur* were only noted as saplings. *Fraxinus excelsior* and *Populus tremula* dominated the seedling results.

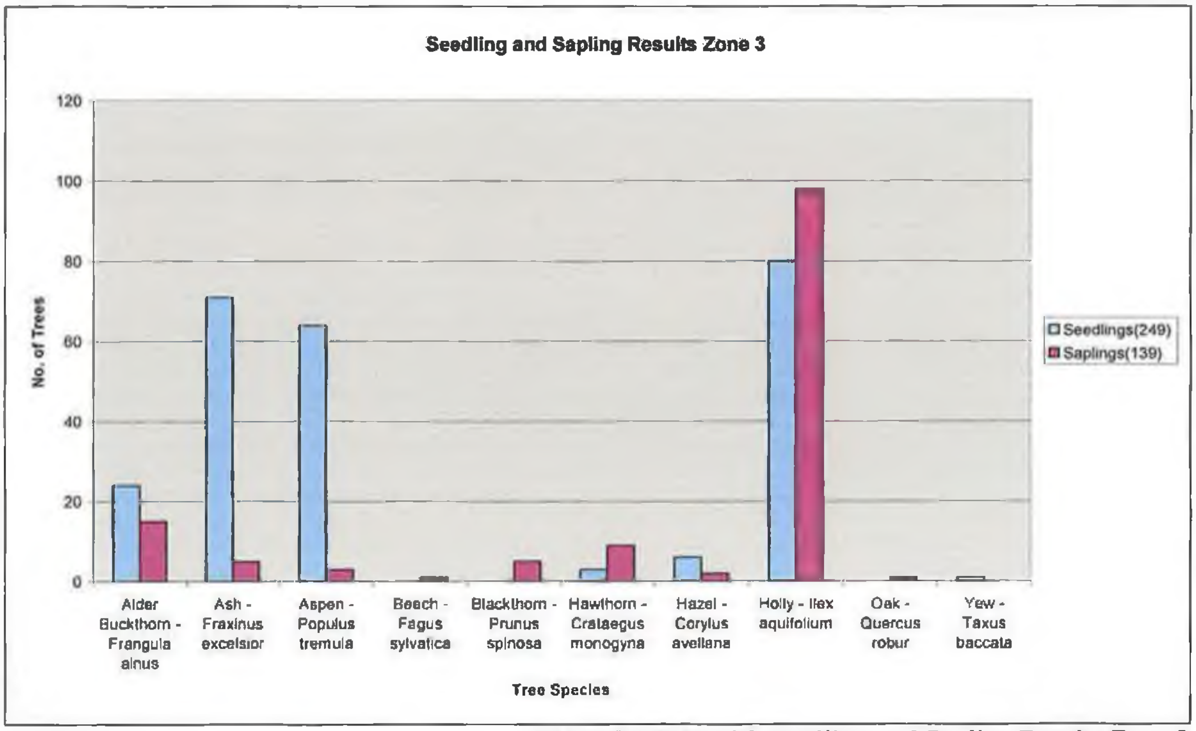


Figure 5.27 Moynish Seedling and Sapling Results Zone 3

Zone 4

In total 10 different tree species were recorded as regenerating in Zone 4 (Figure 5.28) and included *Frangula alnus, Fraxinus excelsior, Populus tremula, Betula pendula, Prunus spinosa, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Euonymus europaeus* and *Taxus baccata*. The main sapling regeneration recorded was by *Ilex aquifolium* and both *Euonymus europaeus* and *Taxus baccata* were only recorded as saplings. *Fraxinus excelsior, Populus tremula* and *Ilex aquifolium* were the principle seedling species recorded. Similar to previous results the number of seedlings recorded greatly outnumbered the number of saplings recorded.

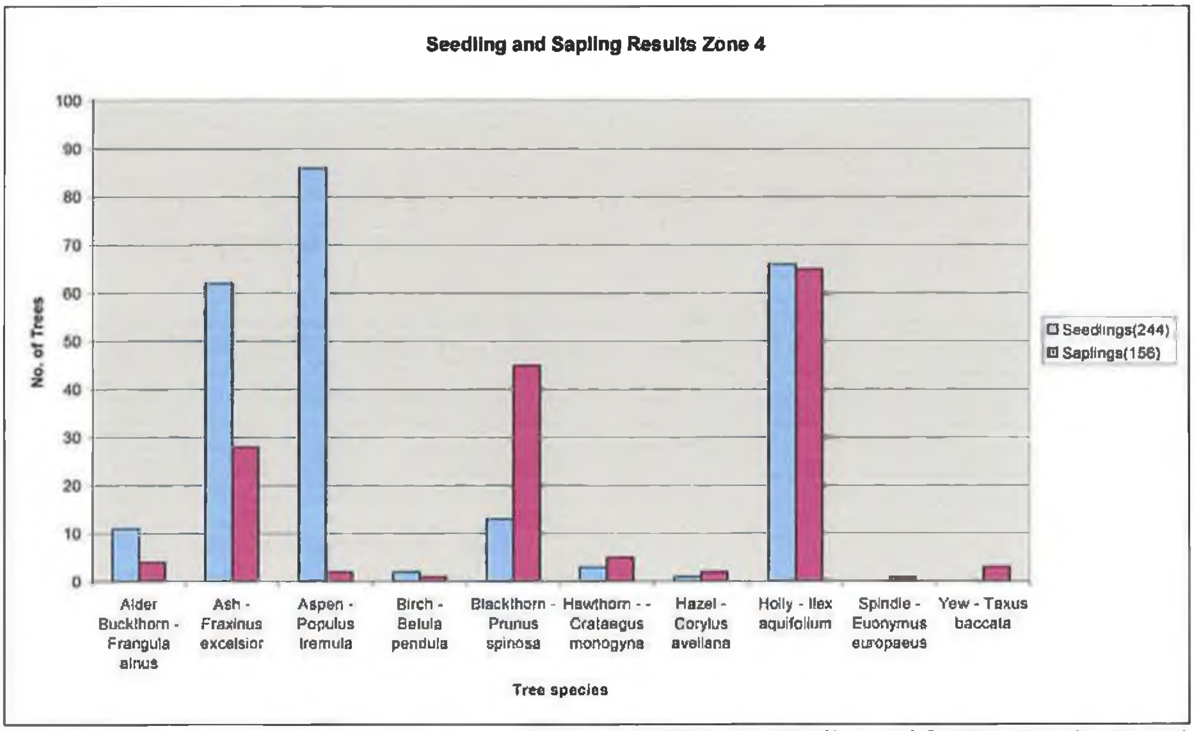


Figure 5.28 Moynish Seedling and Sapling Results Zone 4

5.2.5 Tree diameter and age

The girth measurements of all tree species occurring within each quadrat were recorded in the field. The measurements of the stems were taken at chest height which measured between 1m-1.2m above ground level. All stems greater than 5cm were measured and recorded. To conform to modern international standards in tree measuring, girth is expressed in the register as diameter at breast height (dbh) (girth divided by 3.14159, or pi), giving a mean of an infinite number of variable diameters (Miles, A. 1999).

Zone 1

Fraxinus excelsior dominated the larger size classes over 36centimeters in diameter. There is a greater variety of species occurring in the lower dbh class sizes and a noticeable absence of any species recorded with dbh between 20-35cm.

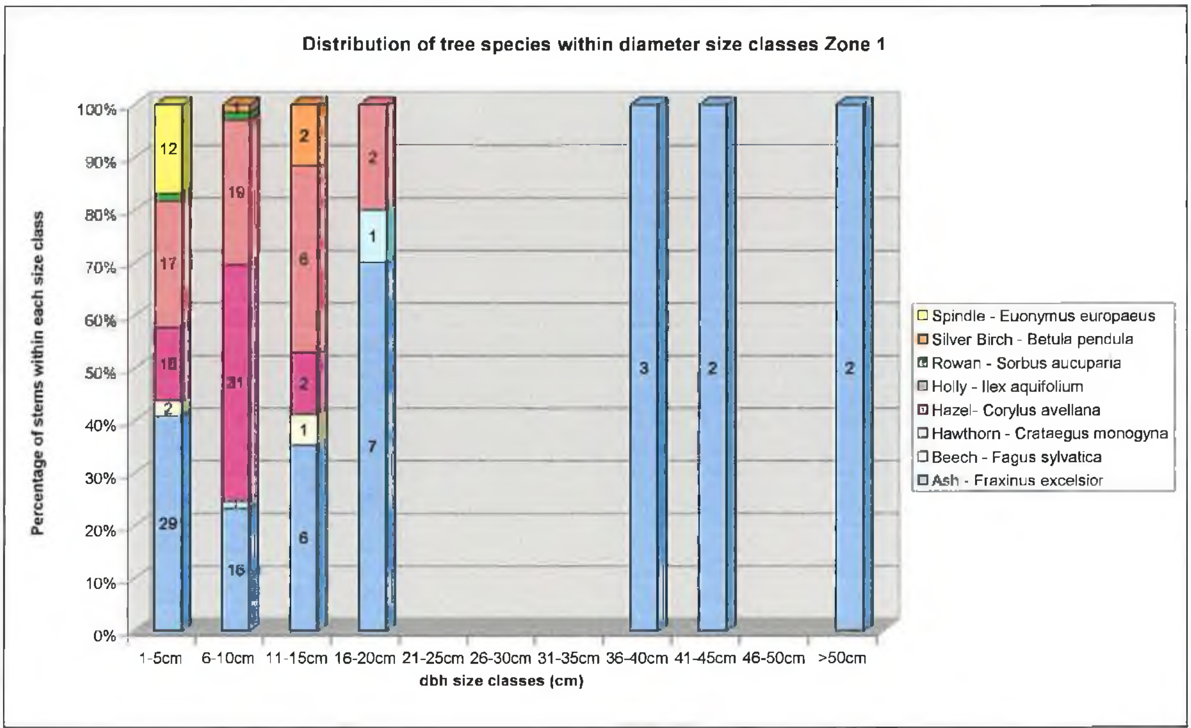


Figure 5.29 Moynish Distribution of tree species within diameter size classes Zone 1

Zone 2

In this area of Moynish there is a greater variety of tree species in the larger diameter size classes consisting of *Fagus sylvatica, Larix decidua* and *Pinus sylvestris*. *Quercus robur* was only recorded with a dbh greater than 50cm. There is a concentration of *Fraxinus excelsior* growth between 20 and 30cm.

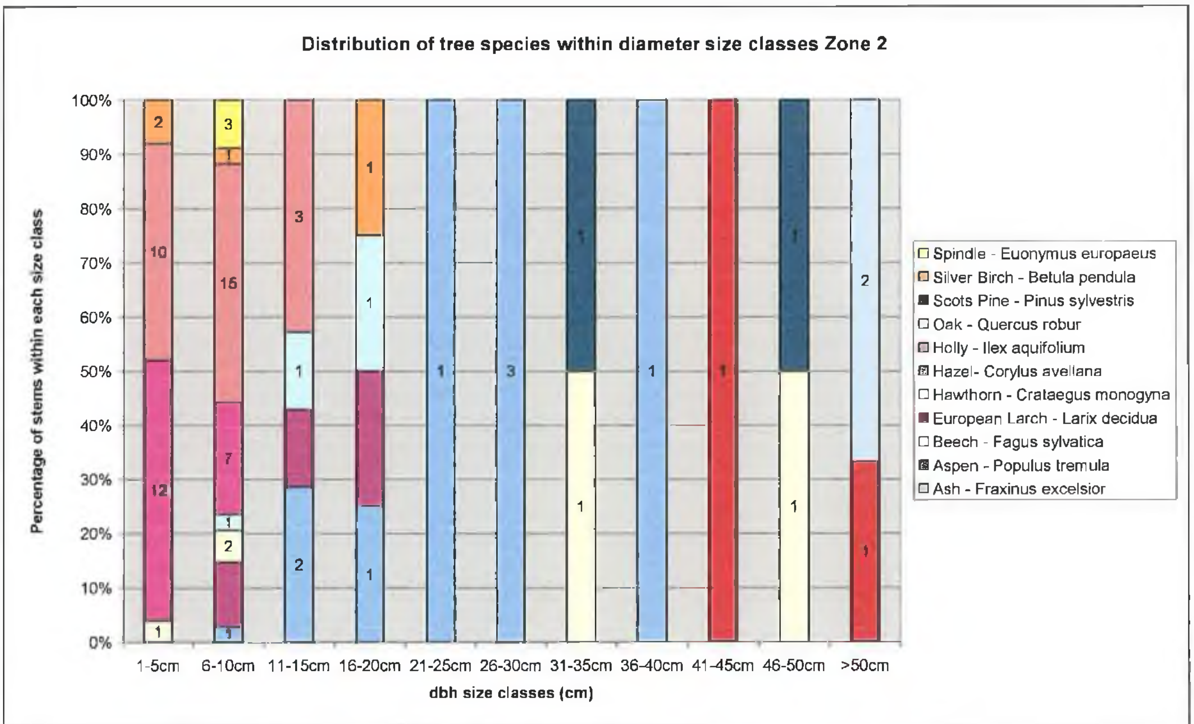


Figure 5.30 Moynish Distribution of tree species within diameter size classes Zone 2

Zone 3

In this zone five tree species were measured with a diameter greater than 20cm – *Fraxinus excelsior, Quercus robur, Pinus sylvestris, Larix decidua* and *Populus tremula.* There is a concentration of *Quercus robur* recorded in the larger size classes.

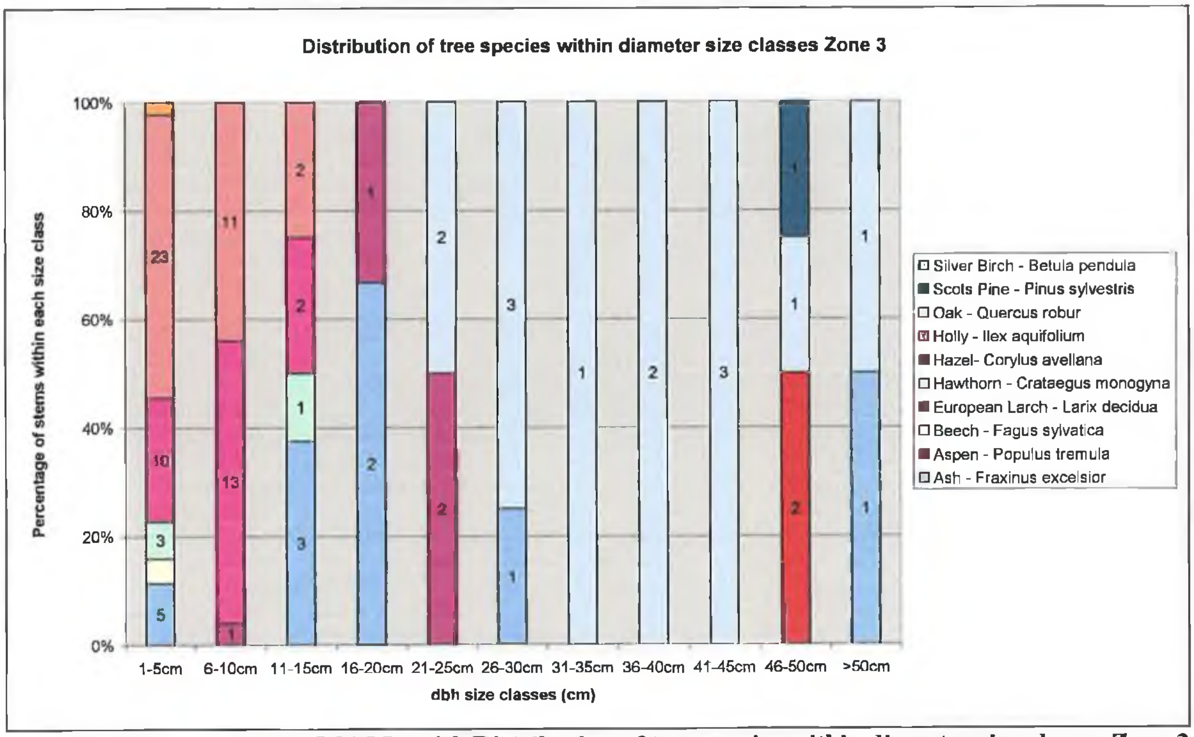


Figure 5.31 Moynish Distribution of tree species within diameter size classes Zone 3

Zone 4

During the survey of Zone 4 only two species were recorded with diameters greater than 20cm and they were *Quercus robur* and *Populus tremula*. The majority of the tree species in this zone measured less than 20cm in diameter.

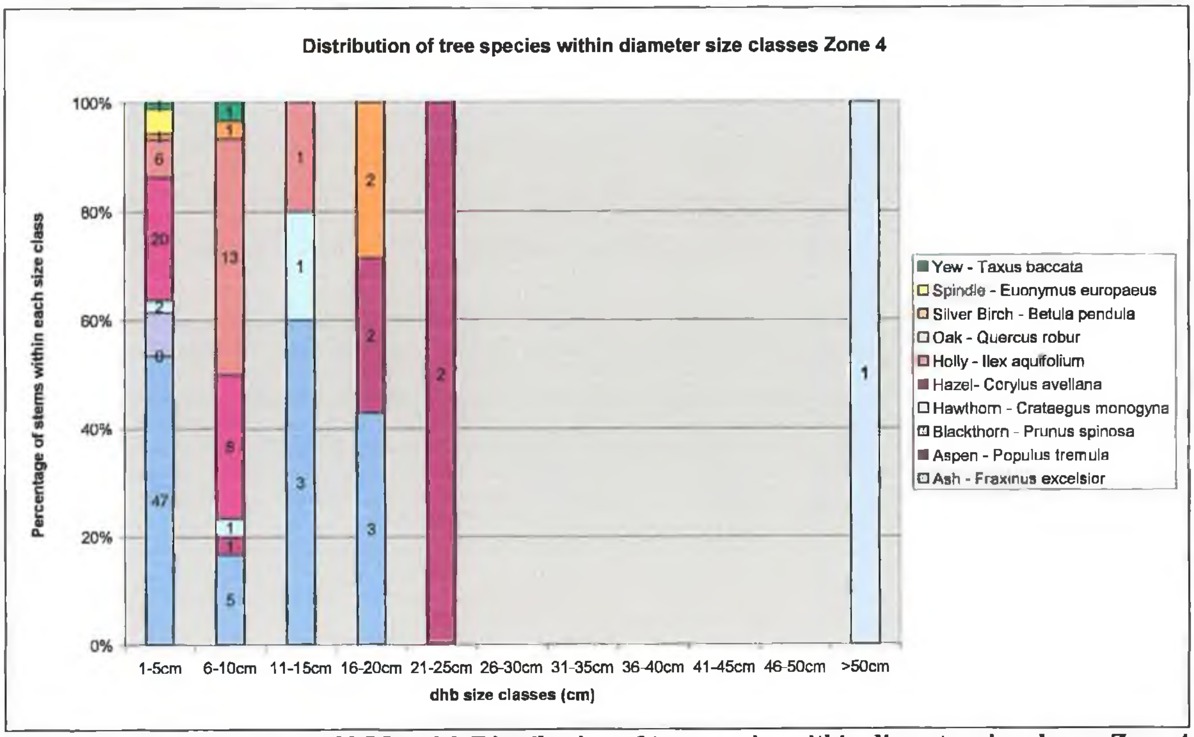


Figure 5.32 Moynish Distribution of tree species within diameter size classes Zone 4

The age of a small sample of trees was recorded using an increment borer. Of interest were the ages of the *Quercus robur, Pinus sylvestris* and *Larix decidua* populations on Moynish and also to establish when *Populus tremula* colonised the woodland. The results of this coring are displayed in Table 5.12

Moynish Tree Coring Results			
Tree Species	Girth (cm)	Diameter at Breast Height (DBH) (cm)	Age of Tree (yrs)
Scots Pine - *Pinus sylvestris*	**104**	**33.12**	**93**
Scots Pine - *Pinus sylvestris*	**160**	**50.95**	**146**
European Larch - *Larix decidua*	**142**	**45.22**	**112**
European Larch - *Larix decidua*	**158**	**50.32**	**111 - 120**
Pedunculate Oak -*Quercus robur*	**138**	**43.95**	**105 -120**
Pedunculate Oak -*Quercus robur*	**200**	**63.69**	**144 - 160**
Pedunculate Oak -*Quercus robur*	**150**	**47.77**	**148**
Common Beech- *Fagus sylvatica*	**200**	**63.69**	**143**
Sycamore - *Acer pseudoplatanus*	**140**	**44.58**	**50 - 60**
CommonAsh -*Fraxinus excelsior*	**160**	**50.95**	**96**
Common Ash - *Fraxinus excelsior*	**104**	**33.12**	**80**
Common Ash - *Fraxinus excelsior*	**63**	**20**	**48**
Common Ash - *Corylus avellana*	**53**	**16.88**	**78**
Aspen - *Populus tremula*	**75**	**23.88**	**50**

Table 5.12 Moynish Tree Coring Results

5.2.6 Epiphytes and Woody Climbers

The abundance of ivy on all trees surveyed within each zone was recorded. If ivy was present, it was recorded subjectively as "profuse" or "sparse". Ivy growth was recorded on 14 tree species on Moynish (Figure 5.33). However, ivy growth was most commonly recorded on *Fraxinus excelsior, Populus tremula, Corylus avellana, Crataegus monogyna, Ilex aquifolium* and *Quercus robur*. Ivy growth was also recorded growing on *Fagus sylvatica, Larix decidua, Pinus sylvestris, Sorbus aucuparia* and *Euonymus europaeus* but this growth was not significant enough to chart.

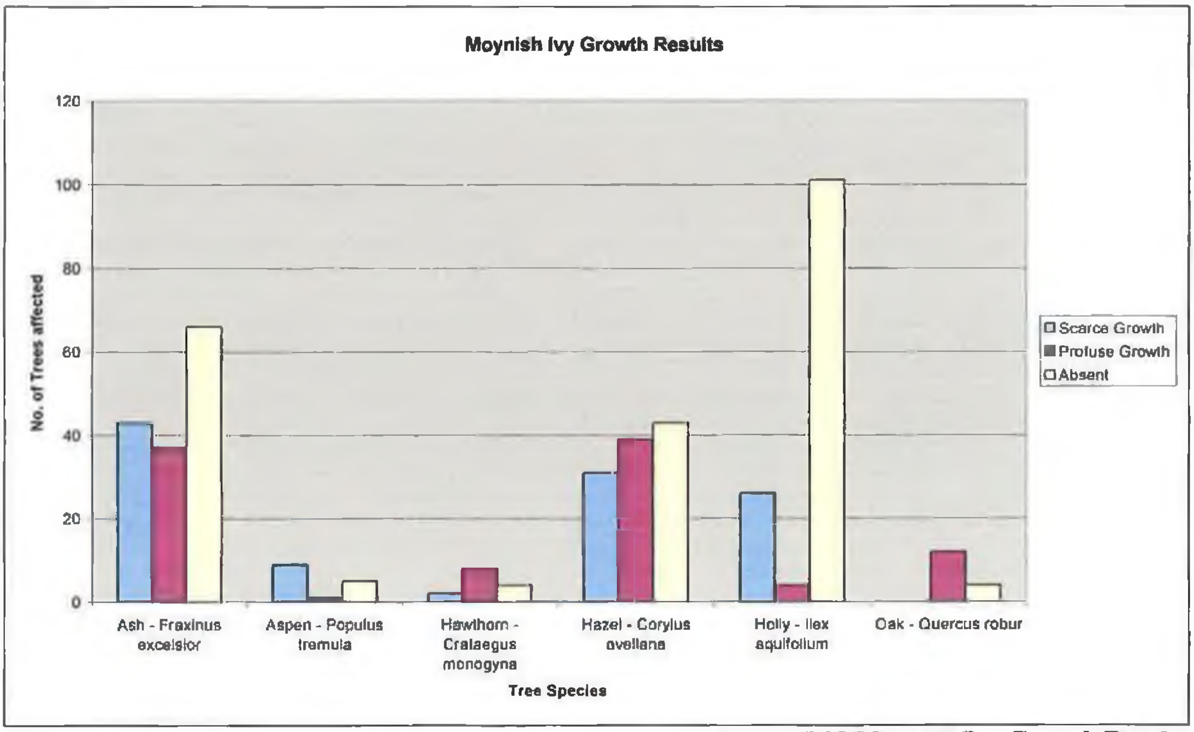


Figure 5.33 Moynish Ivy Growth Results

Honeysuckle Growth Results

Honeysuckle was recorded growing on two *Corylus avellana* trees, one in Zone 1 and Zone 3.

Moss Growth Results

The abundance of moss on all trees surveyed within each zone was recorded. If moss was present, it was recorded subjectively as 'profuse' or 'sparse'. The absence of moss growth was also recorded. All tree species on Moynish were recorded to support bryophyte growth and the results of the main species are shown in Figure 5.34. However the principle tree species recorded most frequently with moss growth were *Fraxinus excelsior, Populus tremula, Crataegus monogyna, Corylus avellana, Ilex aquifolium* and *Quercus robur.*

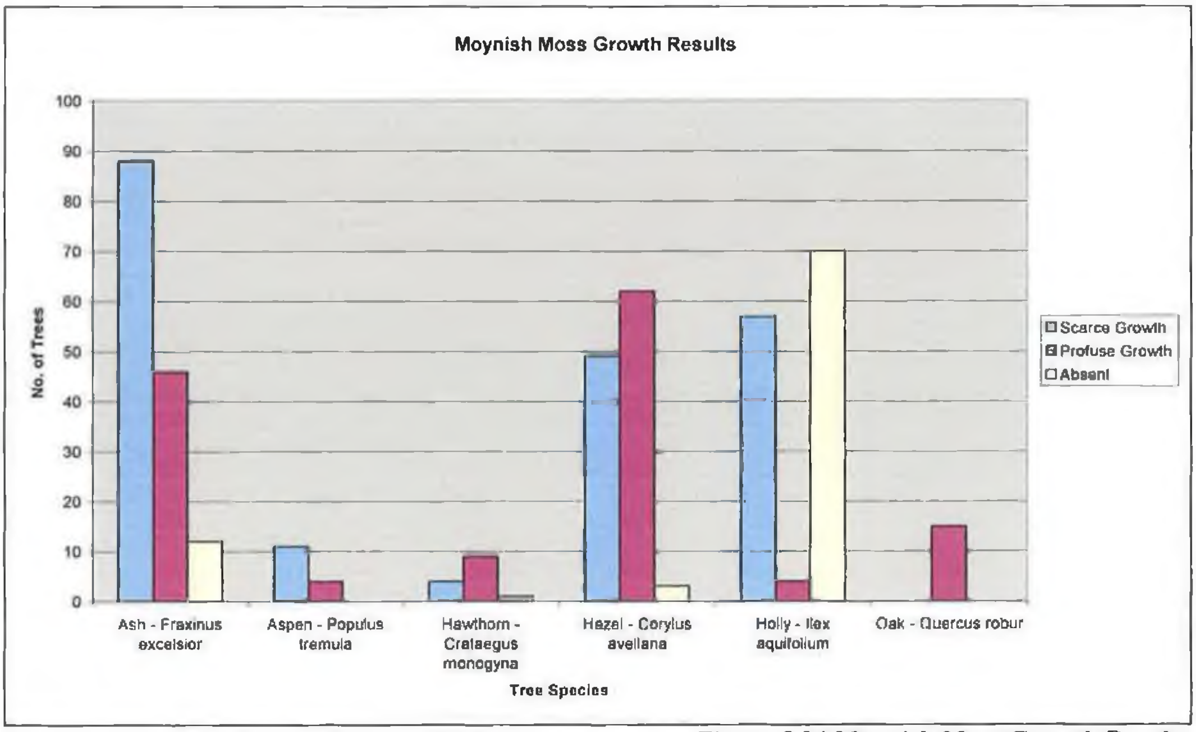


Figure 5.34 Moynish Moss Growth Results

5.2.7 Bark Stripping Results

Evidence of bark stripping was recorded in all zones during the survey and summarised in Table 5.13. Evidence of bark stripping was recorded on *Fraxinus excelsior, Betula pendula, Corylus avellana, Ilex aquifolium, Crataegus monogyna* and *Euonymus europaeus*. Bark stripping was most frequently recorded on *Ilex aquifolium.*

Moynish Bark Stripping Results		
Tree Species Affected	**No. Of Trees Affected**	**% of Trees Affected**
Ash - *Fraxinus excelsior*	**15**	**10.13%**
Birch - *Betula pendula*	**1**	**7.69%**
Hawthorn - *Crataegus monogyna*	**2**	**14.28%**
Hazel - *Corylus avellana*	**11**	**9.65%**
Holly - *Ilex aquifolium*	**31**	**24.03%**
Spindle - *Euonymus europaeus*	**16**	**80%**

Table 5.13 Bark Stripping Results

5.2.8 Light Composition Results

The intensity of the light composition reaching the woodland floor was recorded in each 5m x 10m quadrat. It was measured using a scale of very bright to very dim and the results are summarised in Table 5.14.

Light Composition Results Moynish					
Belt Transect No.	Very Bright	Bright	Moderate	Dim	Very Dim
Zone 1 Line Transect		**X**			
Zone 1 Line Transect			**X**		
Zone 1 Line Transect			**X**		
Zone 1 Line Transect		**X**			
Zone 2 Quadrat 1				**X**	
Zone 2 Quadrat 2				**X**	
Zone 2 Quadrat 3				**X**	
Zone 2 Quadrat 4			**X**		
Zone 3 Quadrat 5				**X**	
Zone 3 Quadrat 6					**X**
Zone 3 Quadrat 7					**X**
Zone 3 Quadrat 8			**X**		
Zone 4 Quadrat 9					
Zone 4 Quadrat 10		**X**	**X**		
Zone 4 Quadrat 11				**X**	
Zone 4 Quadrat 12			**X**		

Table 5.14 Moynish Light Composition Results

5.2.9 Percentage of canopy cover

The percentage of canopy cover over each 5m x 10m quadrat was estimated during the survey of Moynish. The result of this information was calculated as an average percentage cover for each zone.

Percentage of Canopy Cover Moynish				
Zone No. Quadrat. No	**% cover**		**Aver % cover**	
Zone 1 Line Transect	**35**	**Zone 1**	**42.5**	
Zone 1 Line Transect	**45**	**Zone 2**	**71.25**	
Zone 1 Line Transect	**60**	**Zone 3**	**75**	
Zone 1 Line Transect	**30**	**Zone 4**	**58.75**	
Zone 2 Quadrat 1	**75**			
Zone 2 Quadrat 2	**70**			
Zone 2 Quadrat 3	**80**			
Zone 2 Quadrat 4	**60**			
Zone 3 Quadrat 5	**75**			
Zone 3 Quadrat 6	**80**			
Zone 3 Quadrat 7	**85**			
Zone 3 Quadrat 8	**60**			
Zone 4 Quadrat 9	**40**			
Zone 4 Quadrat 10	**60**			
Zone 4 Quadrat 11	**75**			
Zone 4 Quadrat 12	**60**			

Table 5.15 Moynish Percentage Canopy Cover Results

5.2.10 Drainage Results

The geology of the island was mostly recorded as well drained. Impeded drainage was recorded in a number of areas that are prone to water logging in the winter months and remain moist during the summer months.

Internal Drainage Results Moynish					
Zone No. Quadrat No.	Excessive	Free	Impeded	Strongly Impeded	Prone to Flooding
Zone 1 Line Transect		X			
Zone 1 Line Transect		X			
Zone 1 Line Transect		X			
Zone 1 Line Transect		X			
Zone 2 Quadrat 1			X		
Zone 2 Quadrat 2		X			
Zone 2 Quadrat 3		X			
Zone 2 Quadrat 4		X			
Zone 3 Quadrat 5		X			
Zone 3 Quadrat 6		X			
Zone 3 Quadrat 7		X			
Zone 3 Quadrat 8		X			
Zone 4 Quadrat 9			X		
Zone 4 Quadrat 10		X			
Zone 4 Quadrat 11		X			
Zone 4 Quadrat 12		X			
Zone 5			X		
Zone 5		X			
Zone 5		X			
Zone 5		X			

Table 5.16 Moynish Internal Drainage Results

5.2.11 Soil Depth Results

The soil depth of each zone was assessed by probing the ground with a metal rod and measuring the depth the rod reached unhindered. Thirty readings were taken in each zone and the average depth calculated.

Soil Depth Results Moynish	Deepest Reading (cm)	Shallowest Reading (cm)	Average Depth (cm)
Zone 1	37	7	18.59
Zone 2	23	8	13.46
Zone 3	22	6	14.31
Zone 4	30	10	18.43
Zone 5	15	5	9.5

Table 5.17 Moynish Soil Depth Results

5.2.12 Ground Cover Results

A description of the main ground cover was recorded in every quadrat taken and the results are summarised in Table 5.18. The ground cover in Moynish was recorded most frequently as mossy boulders and heavy leaf litter. Plant cover was recorded as scarce and was principally found along the woodland margins and paths.

Moynish Ground Cover Results	
	Principal Ground Cover Description
Zone 1	**Mossy Boulders and Leaf Litter and Limestone Grasses**
Zone 2	**Mossy Boulders and Leaf Litter. Scarce Vegetation**
Zone 3	**Mossy Boulders and Leaf Litter. Scarce Vegetation**
Zone 4	**Mossy Boulders and Leaf Litter and Limestone Grasses**
Zone 5	**Limestone Grassland and Pavement**

Table 5.18 Moynish Ground Cover Results

5.2.13 Invasive Canopy and Shrub Species

The invasive introduced climax species *Fagus sylvatica* was recorded growing in each tree stratum and also regenerating in the woodland. Low numbers of *Fagus sylvatica* was recorded in all zones except Zone 5. It was recorded regenerating in insignificant numbers in all zones except Zone 4 and 5. Large mature *Fagus sylvatica* were recorded growing in Zone 2 and 3 and were aged to 143 years. During the fieldwork a total of three *Acer pseudoplatanus* were recorded growing in Zone 1, 2 and 3. Seedlings from this species were also recorded regenerating in Zone 1 and 2. The invasive garden escape *Rhododendron ponticum* has been mapped growing in three areas in Moynish. Two separate areas of growth have been identified in Zone 1 with a further area in Zone 2.

5.2.14 Breeding Bird Census

Moynish woodland was part of a survey route used to create a Breeding Bird Census. A census has been taken twice every summer between 2003 and 2006. The results of these surveys are summarised in table 5.19. The results of just the woodland specialist species have been used. Twenty-one bird species were identified breeding in Moynish. Species also identified during fieldwork but not in the census in Moynish were Bullfinch, Woodcock and Pheasant.

Moynish Breeding Bird Census 2003-2006					
Species	2003	2004	2005	2006	Total
Woodpigeon	7	5	5	8	25
Cuckoo	1				1
Meadow Pipit				1	1
Wren	4	4	4	5	17
Robin	10	11	13	10	44
Blackbird	9	6	11	4	30
Song Thrush	4	6	11	5	26
Mistle Thrush			2		2
Blackcap				1	1
Chiffchaff		1			1
Willow Warbler	8	10	12	11	41
Goldcrest	2	2	6	4	14
Coal Tit	4	2			6
Blue Tit	7	4	3	7	21
Great Tit	2	5	4	2	13
Treecreeper			2		2
Jay				2	2
Jackdaw				5	5
Starling				5	5
Chaffinch	6	3	9	1	19
Total	64	59	82	71	276

Table 5.19 Moynish Breeding Bird Census Results

5.2.15 Fauna

Similar to the other woodlands Fallow deer were commonly sighted in Moynish. Groups of female deer up to seven in number were recorded grazing together. On one occasion a male deer, a buck, was recorded during mating season with nine female deer entering the woodland from the fen bog. Two badger setts have been discovered and mapped on

Moynish. One was located on the eastern edge of the woodland and the other was located on the southern end near the limestone paving. Activity was recorded at the sett on the southern edge such as fresh bedding and footprints. The second sett may be subsidiary sett which is less often occupied. A fox was sighted on the woodland path in Moynish in 2006. The habitat of the fox is not restricted to residing in woodland and it may have been passing through. No obvious fox den was recorded in the woodland.

5.2.16 Leaf Litter Results

Leaf litter cover was recorded by percentage cover in each 1m^2 quadrat of the flora survey. The results of this survey is summarised below.

Frequency – 129 recordings out of 131

Species Frequency % - 98.47%

Total % - 5371.75%

Mean % Cover - 41%

5.2.17 Vegetation Classification

Sampling of the ground flora took place within each zone. In total data from 131 1m^2 quadrats were collected during the field survey of summer 2006. All ground-dwelling and saxicolous vascular plants were recorded by percentage cover estimated by eye. The floristic data was rearranged based on the TWINSPAN output using Excel and a table was produced showing species-by-site (quadrate or sample) relationships. This allowed for groups and associations to be formed (Pisces Conservation 2004). In total 39 floral species were recorded in the vegetation survey and comprised of vascular plants from woodland and limestone grassland. The floristic composition of Moynish is displayed in table 5.20 and the raw data is in Appendix 3. Species Frequency percentage and Mean Percentage Cover were calculated for each species.

Moynish Flora Results	**Frequency of Species**	**Species Frequency %**	**Total % Cover**	**Mean % Cover**
Woodland Species				
Woodruff - *Galium odoratum*	3	2.29	3.75	0.03
Enchanters Nightshade - *Circaea lutetiana*	6	4.58	8	0.06
Wood Anemone - *Anemone nemorosa*	2	1.53	2.75	0.02
Tutsan - *Hypericum androsaemum*	13	9.92	28.25	0.22
Dandelion - *Taraxacum officinale agg.*	4	3.05	8.75	0.07
Lords and Ladies - *Arum maculatum*	2	1.53	6.25	0.05
Primrose - *Primula vulgaris*	6	4.58	13.75	0.1
Selfheal - *Prunella vulgaris*	3	2.29	7.5	0.06
Ground Ivy - *Glechoma hederacea*	20	15.27	55	0.42
Wood Sedge - *Carex sylvatica*	3	2.29	9.75	0.07
Wood Sorrel - *Oxalis acetosella*	21	16.03	118.75	0.91
Wood Sanicle - *Sanicula europaea*	32	24.43	88.75	0.68
Honeysuckle - *Lonicera periclymenum*	34	25.95	64	0.49
Spear Mint - *Mentha spicata*	5	3.82	26.25	0.2
Bugle - *Ajuga reptans*	20	15.27	48.75	0.37
Wood Avens - *Geum rivale*	17	12.98	40	0.3
Yellow Pimpernel - *Lysimachia nemorum*	18	13.74	48.5	0.37
Male Fern - *Dryopteris filix-mas*	8	6.11	20	0.15
Wood Sage - *Teucrium scorodonia*	11	8.4	65	0.5
Common Group				
Moss - *Musci sp.*	127	96.95	4817.25	36.77
Ivy - *Hedera helix*	106	80.92	397.5	3.03
Bramble - *Rubus fruticosus*	101	77.1	383.75	2.92
Common Dog Violet - *Viola riviniana*	93	70.99	399	3.05
Wild Strawberry - *Fragaria vesca*	71	54.2	212.75	1.62
Limestone Grassland Group				
Bracken - *Pteridium aquilinum*	7	5.34	28.5	0.22
Creeping Buttercup - *Ranunculus repens*	2	1.53	6.25	0.05
Grass Sp. - *Gramineae sp.*	59	45.04	711.25	5.43
Burnet Rose - *Rosa pimpinellifolia*	7	5.34	22.5	0.17
Common Rush - *Juncus conglomeratus*	2	1.53	8.75	0.07
Ground elder - *Aegopodium podagraria*	1	0.76	2.5	0.02
Heather (Ling) - *Calluna vulgaris*	1	0.76	30	0.23
Meadowsweet - *Filipendula ulmaria*	4	3.05	29.5	0.22
Perforate St. John's-Wort - *Hypericum perforatum*	4	3.05	9.25	0.07
Tormentil - *Potentilla erecta*	3	2.29	5	0.04
Vetch Sp. - *Leguminosae sp.*	6	4.58	18.75	0.14
Uncommon Group				
Grass of Parnassus - *Parnassia palustris*	1	0.76	2.5	0.02
Common Nettle - *Urtica dioica*	1	0.76	3.75	0.03
Hard Fern - *Blechnum spicant*	1	0.76	1.25	0.009
Herb Robert - *Geranium robertianum*	1	0.76	1.25	0.009

Table 5.20 Moynish Flora Results

5.3 Creggaun

5.3.1 Description

Creggaun woodland is located to the north of Moynish and to the southwest of Leamnahye. The woodland is accessed from Moynish by way of stepping stones that join the two woodlands. This access to Creggaun floods in winter months. The island is bordered by fen bog to the west, an area of *Cladium fen* on the south and by Lough Carra to the north and east and covers an area of approximately 12 acres. The 1914 OS map shows the island with areas of mixed woodland and rough grazing. Creggaun is entirely wooded at present. The dimensions of the island are approximately 220 metres in length and 160 metres at its widest part. At the stepping stones entrance to the woodland a path dissects the wood through the centre and ends at the northern edge. It was surveyed using regular sampling in the summer of 2006. These field methods were used to collect quantitative data in order to map the mosaic of woodland types existing in Creggaun woodland. Both point quadrats and 5m x 10m quadrats were used to gather vegetation data.

5.3.2 Woodland Structure

Information about stand structure and species composition was recorded throughout the woodland. Trees species measuring over 5 metres in height were classed as canopy species and tree species measuring less than 5 metres in height were classed as understorey species. The scrub layer was classified as trees species measuring less than 3 metres in height.

In total 21 tree species were identified and recorded during the survey of Creggaun. Fourteen species were recorded in both the canopy and understorey layers, and nine species were recorded in the scrub layer. The result of the surveys of the central area of the woodland and the boundary edge are summarised in Figures 5.35 and 5.36. The dominant species in the central canopy layer were *Fraxinus excelsior* and *Corylus avellana*. Also recorded in this canopy layer were the conifer species, *Larix decidua* and *Pinus sylvestris*, and the broadleaved species, *Fagus sylvatica, Crataegus monogyna, Malus sylvestris, Rhododendron ponticum, Ilex aquifolium, Quercus* *robur, Betula pendula, Euonymus europaeus, Sorbus aucuparia* and *Salix caprea.* The principle understorey species in the centre of the woodland were *Ilex aquifolium* and *Corylus avellana.* The following understorey species were recorded less frequently; *Frangula alnus, Fraxinus excelsior, Alnus glutinosa, Juniperus communis, Crataegus monogyna, Rhododendron ponticum, Sorbus aucuparia, Pinus sylvestris, Betula pendula, Euonymus europaeus* and *Salix caprea. Fraxinus excelsior, Prunus spinosa, Juniperus communis, Crataegus monogyna, Taxus baccata* and *Ilex aquifolium* were all recorded in the scrub layer. The total number of canopy trees recorded was double the number of understorey trees.

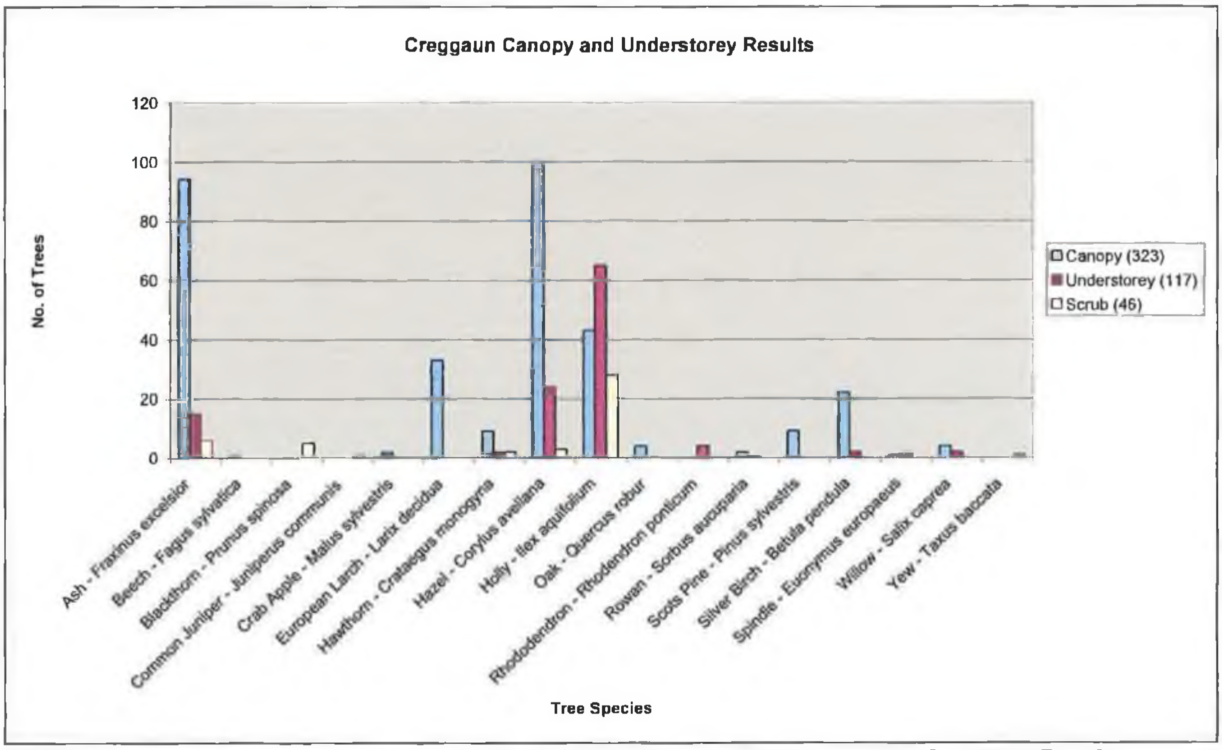


Figure 5.35 Creggaun Canopy and Understorey Results

The results of the boundary survey are presented in a separate graph Figure 5.36. The following 15 tree species were recorded growing in this area; *Frangula alnus, Fraxinus excelsior, Fagus sylvatica, Betula pendula, Prunus spinosa, Alnus glutinosa, Juniperus communis, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Sorbus hibernica, Rhododendron ponticum, Pinus sylvestris* and *Salix caprea.* The main canopy species recorded were *Betula pendula* and *Pinus sylvestris.* The understorey stratum was dominated by *Betula pendula* and *Corylus avellana* growth. In the scrub layer the principle species were *Betula pendula, Juniperus communis* and *Corylus avellana.*

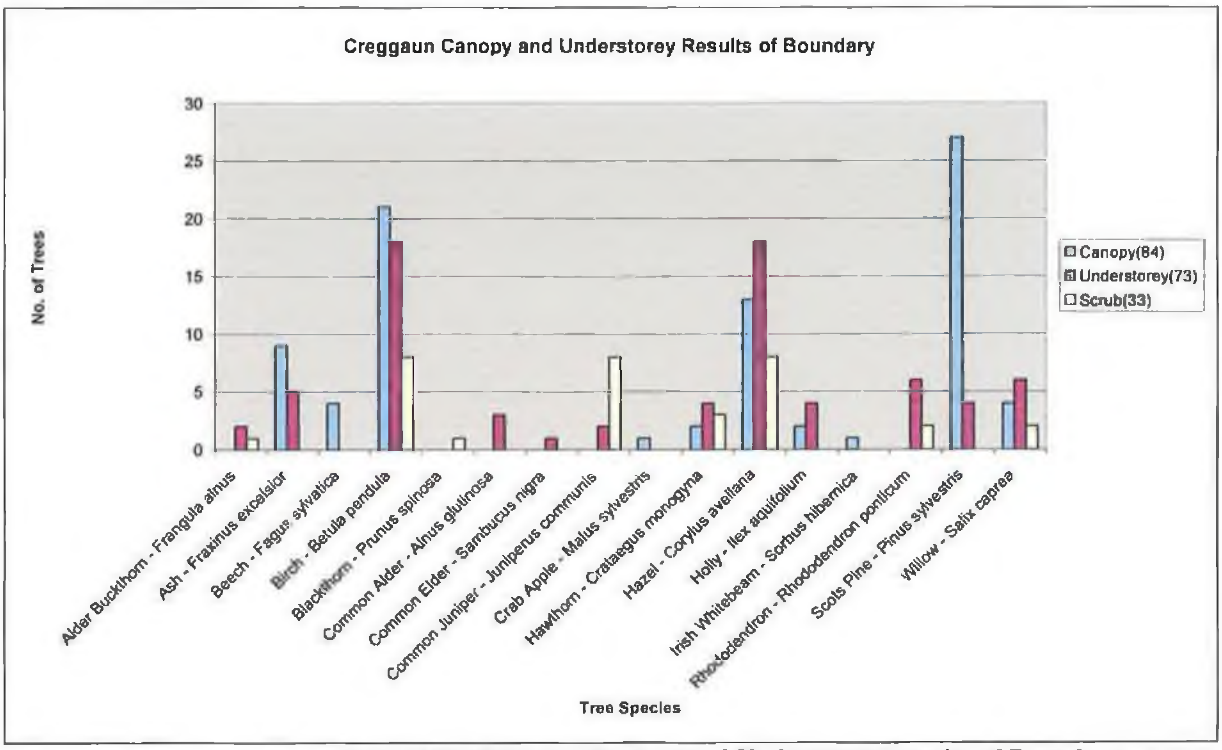
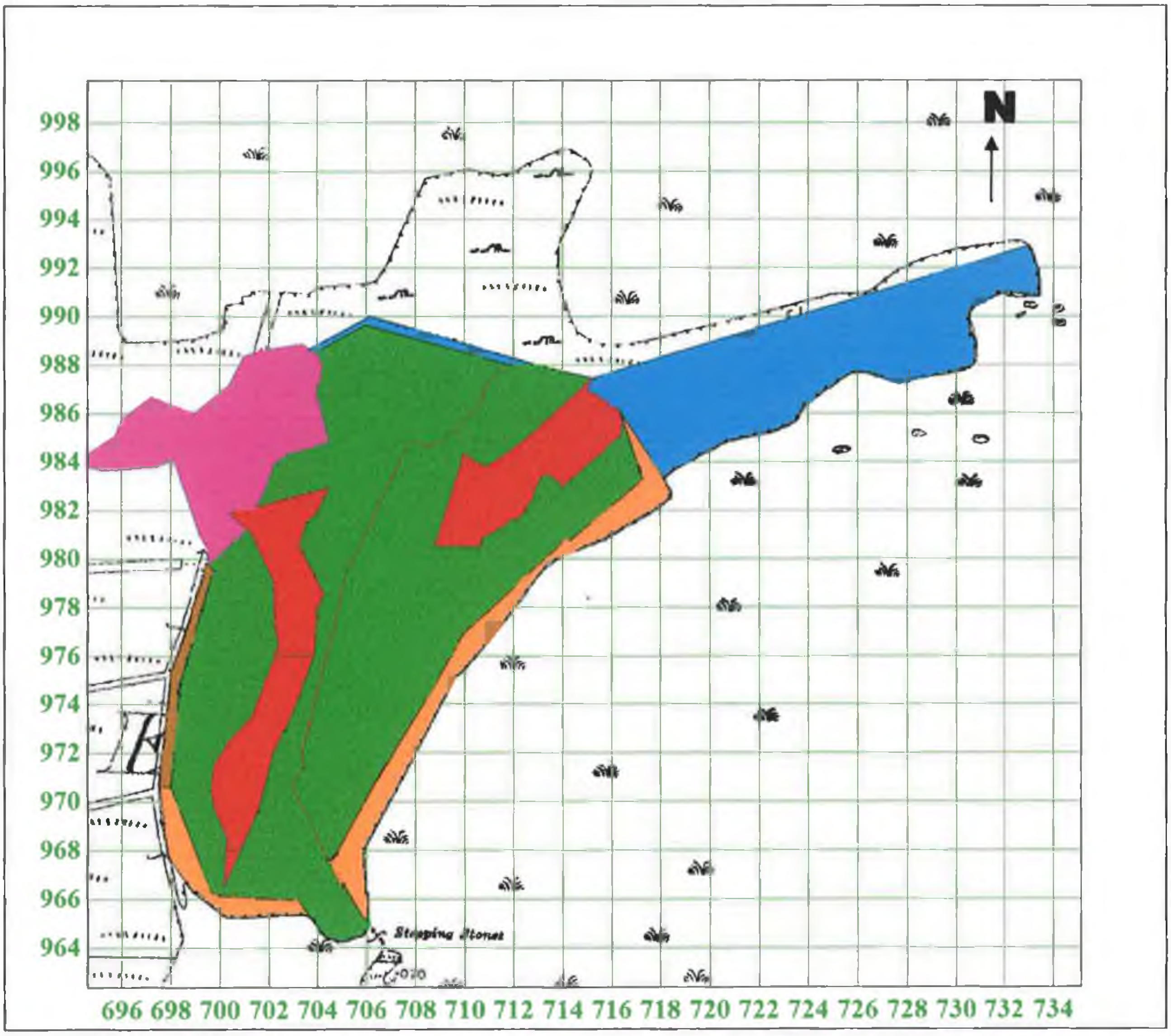


Figure 5.36 Creggaun Canopy and Understorey Results of Boundary

5.3.3 Woodland Classification and Mapping

The data from the vegetation survey was used to map the mosaic of woodland types that form Creggaun woodland Figure 5.37. GPS readings were taken during the survey and used in combination with Dmap to create an accurate map of the current vegetation. Each colour-coded polygon represents a different vegetation type and the information such as the classification of vegetation type of each polygon type is contained in the legend table. For the most part the vegetation was classified according to Fossitt (2000).



Oak, Ash, Hazel Woodland dominated by Ash (WN2)

Mixed Broadleaved/Conifer Woodland containing Larch (WD2)

Transitional Woodland containing Scots Pine (WS1)

Transitional Woodland dominated by Birch (WSN1)

Wet Willow-alder-ash Woodland (WN6)

Rhododendron Growth

Grid Scale 20m^2

Figure 5.37 Creggaun Vegetation Map

5.3.4 Regeneration

An assessment of tree regeneration in Creggaun woodland was completed by recording all stems of tree and woody species considered to be 'regeneration' that were growing in each 5m x 10m quadrat and also recorded in all $1m^2$ flora quadrats. For this analysis the size classes were combined into two height categories: < 15cm were considered seedlings; $\leq$ 2m were considered saplings. A total of eight tree species were recorded as regenerating to varying degrees in the woodland and included *Frangula alnus, Fraxinus excelsior, Prunus spinosa, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Sorbus aucuparia* and *Betula pendula*. The seedlings and saplings results have been charted in Figure 5.38. *Ilex aquifolium* and *Fraxinus excelsior* were the main seedling species recorded and *Ilex aquifolium* dominated the sapling results.

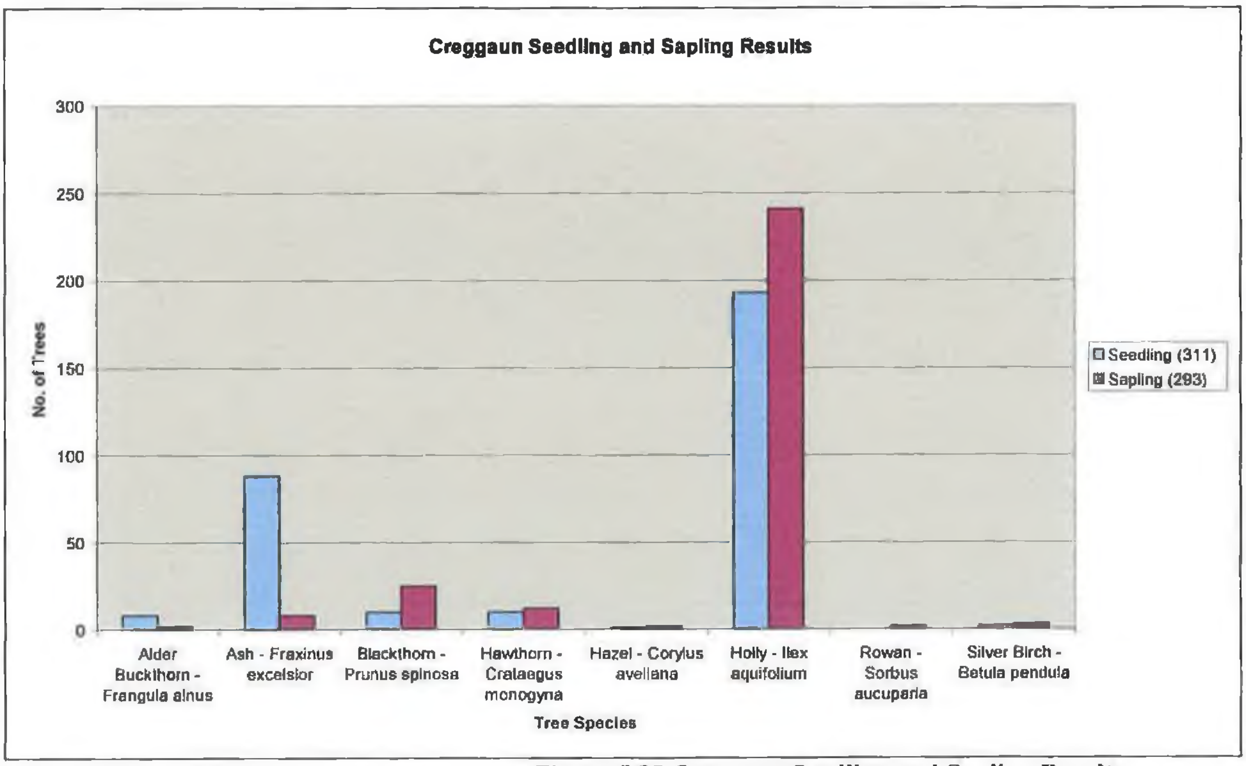


Figure 5.38 Creggaun Seedling and Sapling Results

5.3.5 Tree diameter and age

The girth measurements of all tree species occurring within each quadrat were recorded in the field. The measurements of the stems were taken at chest height which measured between 1m - 1.30m above ground level. All stems greater than 5cm were measured and recorded. To conform to modern international standards in tree measuring, girth is expressed in the register as diameter at breast height (dbh). On analysing the results there was a spread of *Fraxinus excelsior* occurring in most size classes. The main species which measured above 31 centimetres in diameter were *Larix decidua, Fraxinus excelsior, Quercus robur* and *Pinus sylvestris.*

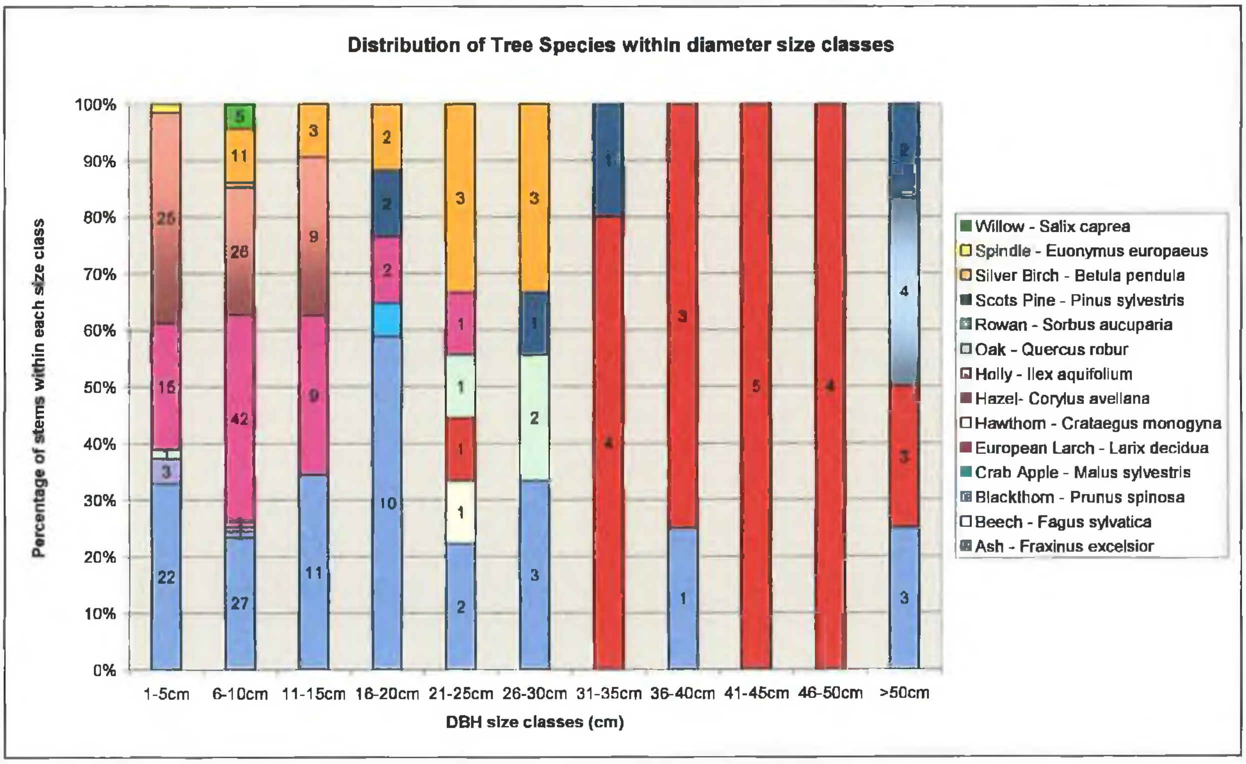


Figure 5.39 Creggaun Distribution of Tree Species within diameter size classes

The age of a sample of trees was recorded using an increment borer. Of interest were the ages of the *Fraxinus excelsior* and *Larix decidua* populations on the island and also to establish when *Rhododendron ponticum* colonised the island. The results of this coring are displayed in table 5.21

Creggaun Tree Coring Results			
Tree Species	**Girth(cm)**	**DBH(cm)**	**Age**
Ash – *Fraxinus excelsior*	**35**	**11.15**	**20**
Ash - *Fraxinus excelsior*	**54**	**17.19**	**35**
Ash - *Fraxinus excelsior*	**130**	**41.4**	**54**
Ash - *Fraxinus excelsior*	**55**	**17.52**	**45**
Ash - *Fraxinus excelsior*	**48**	**15.28**	**44**
Ash - *Fraxinus excelsior*	**85**	**27.07**	**30**
Ash - *Fraxinus excelsior*	**130**	**41.4**	**52**
Ash - *Fraxinus excelsior*	**250**	**79.62**	**180**
Beech - *Fagus sylvatica*	**73**	**23.25**	**53**
Birch - *Betula pendula*	**100**	**31.85**	**90**
Birch - *Betula pendula*	**32**	**10.01**	**28**
European Larch - *Larix decidua*	**150**	**47.77**	**118**
European Larch - *Larix decidua*	**126**	**40.13**	**93-103**
European Larch - *Larix decidua*	**137**	**43.63**	**149**
European Larch - *Larix decidua*	**98**	**31.10**	**86**
Hawthorn - *Crataegus monogyna*	**90**	**28.66**	**80**
Hazel - *Corylus avellana*	**60**	**19.11**	**70**
Hazel - *Corylus avellana*	**30**	**9.55**	**45**
Holly - *Ilex aquifolium*	**30**	**9.55**	**35**
Rhododendron – *Rhododendron ponticum*	**70**	**22.29**	**65**
Rhododendron – *Rhododendron ponticum*	**85**	**27.07**	**85**
Scots Pine - *Pinus sylvestris*	**230**	**73.25**	**88**
Scots Pine - *Pinus sylvestris*	**180**	**57.32**	**115**
Scots Pine - *Pinus sylvestris*	**100**	**31.85**	**45**
Scots Pine - *Pinus sylvestris*	**70**	**22.4**	**32**

Table 5.21 Creggaun Tree Coring Results

5.3.6 Epiphytes and Woody Climbers

Ivy Growth

The abundance of ivy on all trees surveyed was recorded and the results are summarised in Figure 5.40. If ivy was present, it was recorded subjectively as ‘profuse’ or ‘sparse’. Ivy growth was recorded on eight tree species on Creggaun. However, ivy growth was most commonly recorded on *Fraxinus excelsior* and

Corylus avellana. Ivy growth was also recorded growing on *Larix decidua, Pinus sylvestris, Crataegus monogyna, Quercus robur, Sorbus aucuparia* and *Salix caprea.*

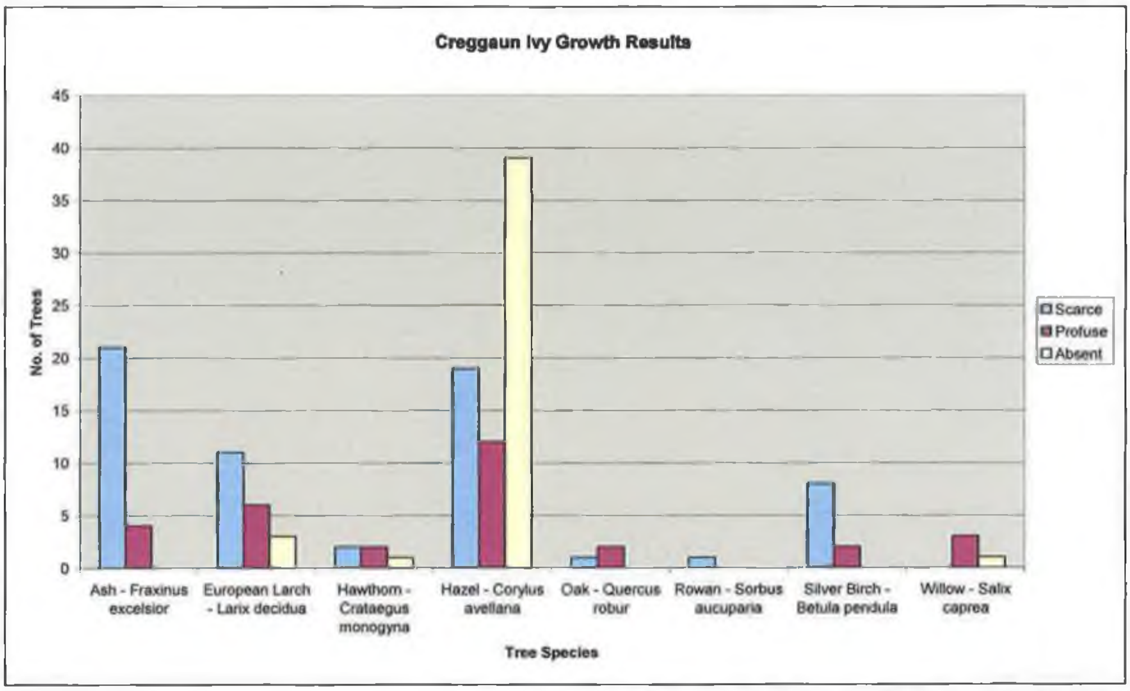


Figure 5.40 Creggaun Ivy Growth Results

Honeysuckle Growth Results

Honeysuckle was not recorded growing on any of the trees surveyed.

Moss Growth Results

The abundance of moss on all trees surveyed was recorded and the results are displayed in Figure 5.41. If moss was present, it was recorded subjectively as 'profuse' or 'sparse'. The absence of moss growth was also recorded. All tree species on Moynish were recorded to support bryophyte growth. However the principle tree species recorded most frequently with moss growth were *Fraxinus excelsior, Corylus avellana* and *Ilex aquifolium.*

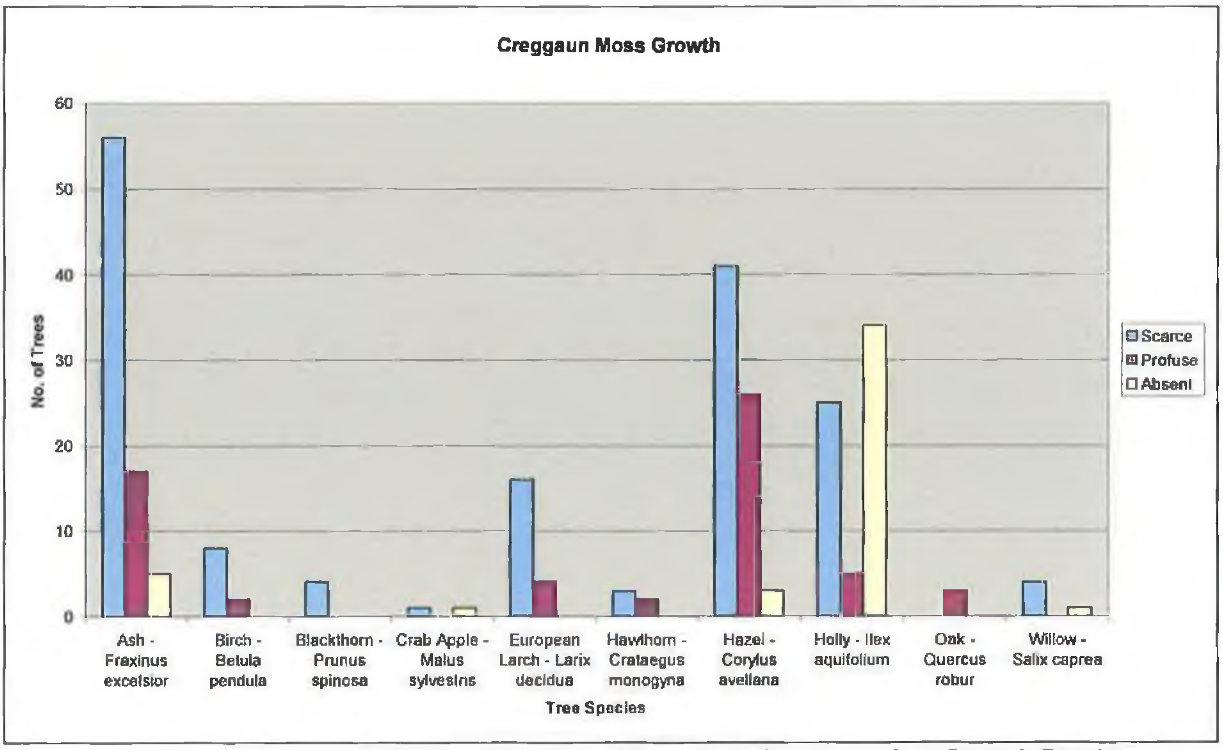


Figure 5.41 Creggaun Moss Growth Results

5.3.7 Bark Stripping Results

Evidence of bark stripping was recorded in all quadrats during the survey. Evidence of bark stripping was recorded on *Fraxinus excelsior*, *Prunus spinosa*, *Corylus avellana* and *Ilex aquifolium*. Bark stripping was most frequently recorded on *Ilex aquifolium*.

Creggaun Bark Stripping Results	No. of Trees Affected	% of Trees Affected
Ash - *Fraxinus excelsior*	13	16.67
Blackthorn - *Prunus spinosa*	1	25
Hazel - *Corylus avellana*	11	15.71
Holly - *Ilex aquifolium*	17	26.56

Table 5.22 Creggaun Bark Stripping Results

5.3.8 Light Composition Results

The intensity of the light composition reaching the woodland floor was recorded in each 5m x 10m quadrat. It was measured using a scale of very bright to very dim.

Creggaun Light Composition Results					
Quadrat No.	**Very Bright**	**Bright**	**Moderate**	**Dim**	**Very Dim**
Quadrat 1				**X**	
Quadrat 2			**X**		
Quadrat 3				**X**	
Quadrat 4			**X**		
Quadrat 5				**X**	
Quadrat 6			**X**		
Quadrat 7		**X**			
Quadrat 8			**X**		
Quadrat 9				**X**	

Table 5.23 Creggaun Light Composition Results

5.3.9 Percentage of canopy cover

The percentage of canopy cover over each 5m x 10m quadrat was estimated during the survey of Creggaun. The result of this information was calculated as an average percentage cover and shown in table 5.24.

Creggaun Percentage of Canopy Cover		
Quadrat. No	**% cover**	**Aver % cover**
Quadrat 1	**75**	**67.77**
Quadrat 2	**60**	
Quadrat 3	**85**	
Quadrat 4	**65**	
Quadrat 5	**85**	
Quadrat 6	**55**	
Quadrat 7	**40**	
Quadrat 8	**60**	
Quadrat 9	**85**	

Table 5.24 Creggaun Percentage Canopy Cover Results

5.3.10 Drainage Results

The method of recording drainage results that was used in this survey was taken from methodology used by the NPWS during the National Woodland Inventory Survey (2004). The geology of the island was mostly recorded as well drained (Table 5.25). Impeded drainage was recorded in one area on the western edge of the island, which borders the fen bog.

Creggaun Internal Drainage Results					
Quadrat No.	Excessive	Free	Impeded	Strongly Impeded	Prone to Flooding
Quadrat 1		X			
Quadrat 2		X			
Quadrat 3		X			
Quadrat 4			X		
Quadrat 5		X			
Quadrat 6		X			
Quadrat 7		X			
Quadrat 8		X			
Quadrat 9		X			

Table 5.25 Creggaun Internal Drainage Results

5.3.11 Soil Survey Results

The soil depth of the woodland was assessed by probing the ground with a metal rod and measuring the depth the rod reached unhindered. Sixty readings were taken throughout the woodland and the average depth calculated in table 5.25.

Creggaun Soil Depth Results	cm
Deepest Reading	101
Shallowest Reading	8
Average Depth	24.35

Table 5.25 Creggaun Soil Depth Results

5.3.12 Ground Cover Results

The ground cover in Creggaun was recorded most frequently as mossy boulders and heavy leaf litter. Plant cover was recorded as scarce.

5.3.13 Invasive Canopy and Shrub Species

A large area of *Rhododendron ponticum* have been mapped growing on the western edge of Creggaun woodland. This invasive garden escape is spreading on to the fen bog habitat that borders the woodland. It is also spreading further into the centre of the woodland. Using cross sections of *Rhododendron ponticum,* the initial growth was aged to approximately 85 years ago. The invasive introduced climax species *Fagus sylvatica* was also recorded growing in low numbers in Creggaun.

5.3.14 Breeding Bird Census

Creggaun woodland was part of a survey route used to create a Breeding Bird Census for the area. The results of this surveys is summarised in table 5.27. The results of only the woodland specialist species have been used. Seventeen bird species were identified breeding in Creggaun and are shown in table 5.27.

Creggaun Breeding Bird Census 2003-2006					
Species	2003	2004	2005	2006	Total
Woodpigeon	8	2		1	11
Wren	4	7	7	5	23
Robin	4	9	3	3	19
Blackbird	8	2	4	3	17
Song Thrush	1	8	6	4	19
Blackcap	3	3	2	3	11
Chiffchaff				1	1
Willow Warbler	3	5	1	4	13
Goldcrest	4	5	3		12
Long-tailed Tit	2				2
Coal Tit	1	1		2	4
Blue Tit	1	5	5	3	14
Great Tit	2	1		2	5
Treecreeper	1		2	1	4
Hooded Crow	1				1
Chaffinch	8	6	3	5	22
Bullfinch		1		2	3

Table 5.27 Creggaun Breeding Bird Census Results

5.2.15 Fauna

On Creggaun there is an active badger sett situated to the west of the deer exclosure. Regular activity has been recorded at the sett for the past three years. Signs of activity included fresh footprints and bedding around the entrances. There are numerous entrances to the sett which are dug into a bank of dry sandy soil. Badgers have been observed with young at this sett recently. Fallow deer have been resident in this woodland throughout the survey. Female deer were most commonly sighted and the woodland is easily accessed by way of the fen bog. Other evidence besides sightings included bark stripping, browsing, rutting, hoof prints and deer droppings. Although not sighted evidence of the presence of Pine Marten was recorded by way of droppings in Creggaun.

5.3.16 Vegetation Classification

Sampling of the ground flora took place throughout the woodland. In total data from 131 $1m^2$ quadrats were collected during the field survey of summer 2006. All ground-dwelling and saxicolous vascular plants were recorded by percentage cover estimated by eye. The floristic data was rearranged based on the TWINSPAN output using Excel and a table was produced showing species-by-site (quadrate or sample) relationships. This allowed for groups and associations to be formed (Pisces Conservation 2004). In total 29 flora species were recorded in the floristic survey and comprised of vascular plants from woodland and limestone grassland. The floristic composition of Creggaun is displayed in Table 5.28 and the raw data is in appendix 3. Species Frequency percentage and Mean Percentage Cover were calculated for each species.

Creggaun Flora Results	**Total % Cover**	**Mean % Cover**	**Frequency**	**Species Frequency %**
Common Group				
Ivy - *Hedera helix*	273.25	4.27	59	92.18
Moss - *Musci sp.*	1175	18.36	62	96.87
Wood Sorrel - *Oxalis acetosella*	285	4.45	43	67.19
Common Dog Violet - *Viola riviniana*	78.75	1.23	33	51.56
Bramble - *Rubus fruticosus*	194.75	3.04	32	50
Woodland Species				
Ground Ivy - *Glechoma hederacea*	54.25	0.85	20	31.25
Wild Strawberry - *Fragaria vesca*	50.25	0.78	21	32.81
Grass Sp. - *Gramineae sp.*	174.5	2.72	5	7.8
Bugle - *Ajuga reptans*	18.75	0.29	9	14.06
Wood Avens - *Geum rivale*	15	0.23	7	10.93
Yellow Pimpernel - *Lysimachia nemorum*	21	0.33	9	14
Male Fern - *Dryopteris filix-mas*	10	0.16	4	6.25
Wood Sage - *Teucrium scorodonia*	37.5	0.58	3	4.69
Wood Sanicle - *Sanicula europaea*	30	0.47	10	15.62
Bracken - *Pteridium aquilinum*	18.75	0.29	7	10.94
Honeysuckle - *Lonicera periclymenum*	10	0.16	6	9.37
Tutsan - *Hypericum androsaemum*	17.75	0.28	6	9.37
Enchanters Nightshade - *Circaea lutetiana*	11.25	0.17	6	9.37
Uncommon Species				
Burnet Rose - *Rosa pimpinellifolia*	2.5	0.04	1	1.56
Greater Wood Rush - *Luzula sylvatica*	2.5	0.04	2	3.12
Meadowsweet - *Filipendula ulmaria*	1.25	0.02	1	1.56
Early Purple Orchid - *Orchis mascula*	1	0.01	1	1.56
Lesser Celandine - *Ranunculus ficaria*	4.25	0.07	2	3.12
Lords and Ladies - *Arum maculatum*	6.75	0.1	2	3.12
Bird's-nest Orchid - *Neottia nidus-avis*	2.5	0.04	1	1.56
Primrose - *Primula vulgaris*	3.75	0.06	2	3.12
Common Twayblade - *Listera ovata*	10	0.16	2	3.12
Spearmint - *Mentha spicata*	6.25	0.97	1	1.56

Table 5.28 Creggaun Flora Results

5.3.17 Leaf Litter Result

Leaf litter cover was recorded by percentage cover in each 1m^2 quadrat of the flora survey. The results of this survey is summarised below.

Species Frequency – 63

Species Frequency % - 98.44%

Total % Cover – 3299.25%

Mean % Cover – 51.55%

Belt Transect 1

Belt transect 1 was taken across the western entrance of Leamnahye Island. This is the only edge of the woodland that is connected to land, as the rest of the woodland is surrounded by water. Belt transect 1 measured 10m x 30m covering an area of $300m^2$. The dominant canopy layer consists of two native tree species *Betula pendula* and *Pinus sylvestris* (Figure 5.42). Also recorded in the canopy layer was *Fraxinus excelsior*, *Fagus sylvatica*, *Malus sylvestris*, *Corylus avellana*, *Ilex aquifolium*, *Sorbus hibernica*, *Quercus robur* and *Sorbus aucuparia*. The understorey species were recorded as trees measuring less than 5m. The dominant tree species in the understorey was recorded as *Corylus avellana*. Other tree species recorded as understorey in Belt Transect 1 consisted of *Alnus glutinosa*, *Fraxinus excelsior*, *Fagus sylvatica*, *Ilex aquifolium* and *Betula pendula*. The number of understorey trees was far greater than the number of trees recorded in the canopy.

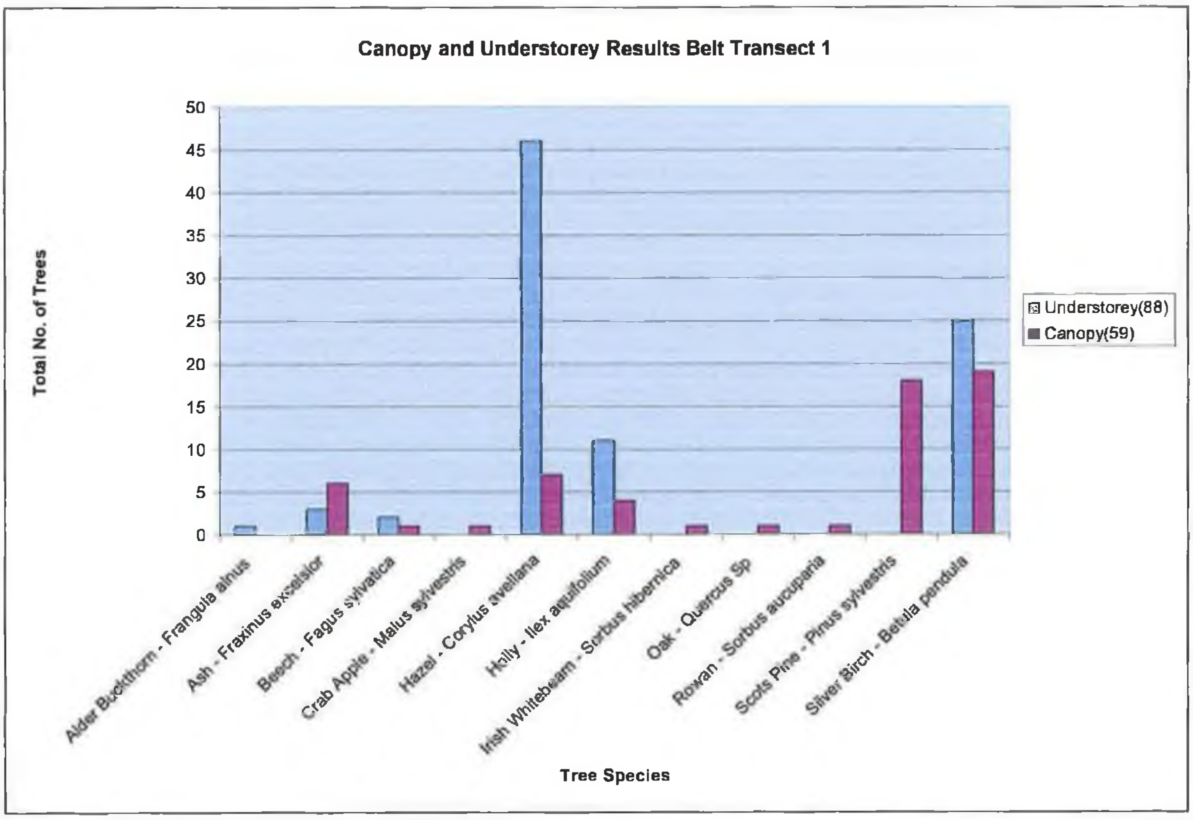


Figure 5.42 Leamnahye Canopy and Understorey Results Belt Transect 1

Belt Transect 2.

Belt transect 2 was taken 90m from belt transect 1 across the width of Leamnahye Island. Belt transect 2 measured 10m x 40m covering an area of 400m^2. It was located 10 metres to the west of an area of very dense scrub. This area of young growth covered an area of approximately 30 x 40m and supported *Corylus avellana*, *Ilex aquifolium* and *Fraxinus excelsior* growth (Figure 5.43). The dominant canopy species recorded in belt transect 2 consisted of two native tree species *Corylus avellana* and *Fraxinus excelsior.* Also recorded in the canopy layer was *Ilex aquifolium* and *Betula pendula* both of equal population. Other species recorded in lower numbers included *Quercus robur*, *Crataegus monogyna*, *Sorbus aucuparia*, and *Pinus sylvestris.* The dominant tree species in the understorey were recorded as *Corylus avellana* and *Ilex aquifolium.* Other tree species recorded as understorey in Belt Transect 2 were *Frangula alnus*, *Fraxinus excelsior*, *Juniperus communis*, *Crataegus monogyna*, *Sorbus hibernica* and *Betula pendula.* Similar to belt transect 1 the number of understorey trees in belt transect 2 was greater than the number of canopy trees.

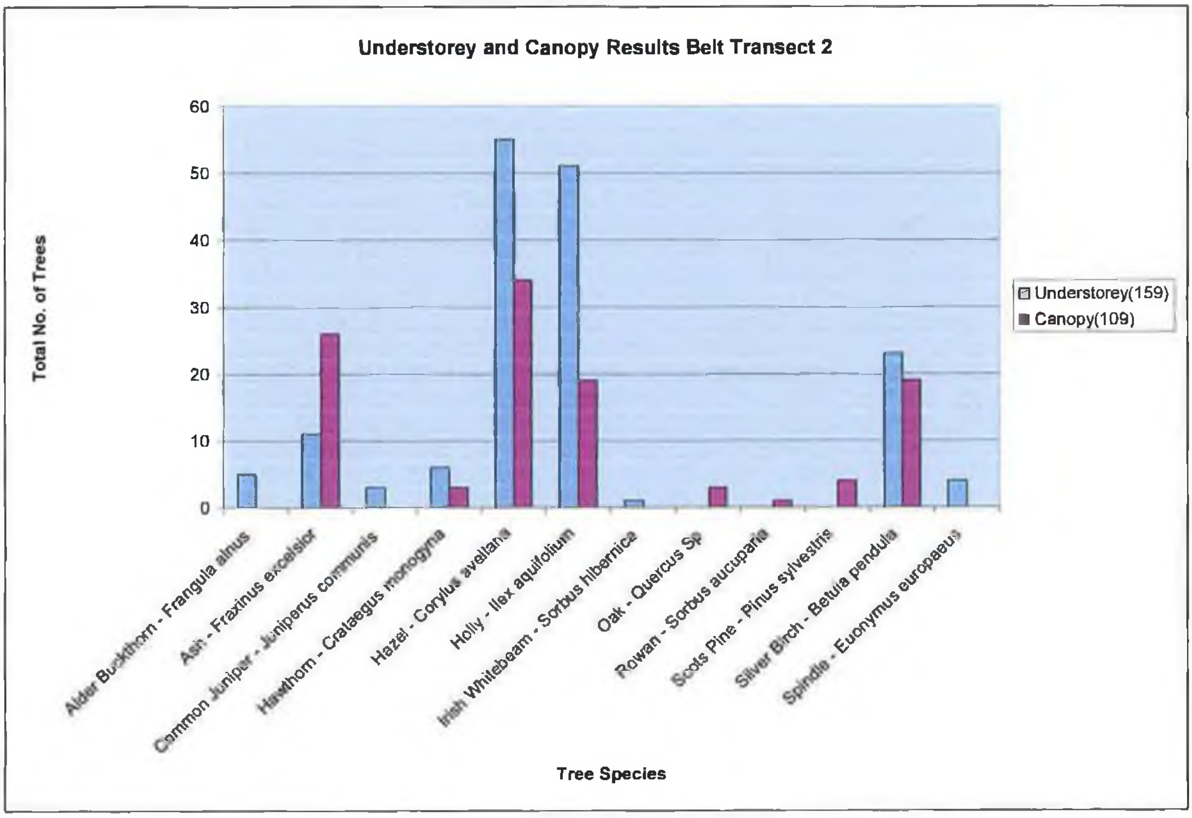


Figure 5.43 Leamnahye Canopy and Understorey Results Belt Transect 2

Belt Transect 3.

Belt transect 3 was taken across Leamnahye Island 90m from belt transect 2 and 200m into the centre of the woodland. Belt transect 3 measured 10m x 40m covering an area of 400m$^{2.}$ The dominant canopy layer consists of native tree species *Corylus avellana.* Also recorded in the canopy layer were *Fraxinus excelsior*, *Fagus sylvatica*, *Ilex aquifolium*, *Sorbus hibernica*, *Quercus robur*, *Sorbus aucuparia* and *Betula pendula* (Figure 5.44). The dominant tree species in the understorey were recorded as *Corylus avellana* and *Ilex aquifolium*. Other tree species recorded as understorey in Belt Transect 3 consisted of *Frangula alnus*, *Fraxinus excelsior*, *Malus sylvestris*, *Crataegus monogyna*, *Sorbus hibernica*, *Sorbus aucuparia* and *Betula pendula*. The number of canopy and understorey trees recorded was almost equal in this survey site.

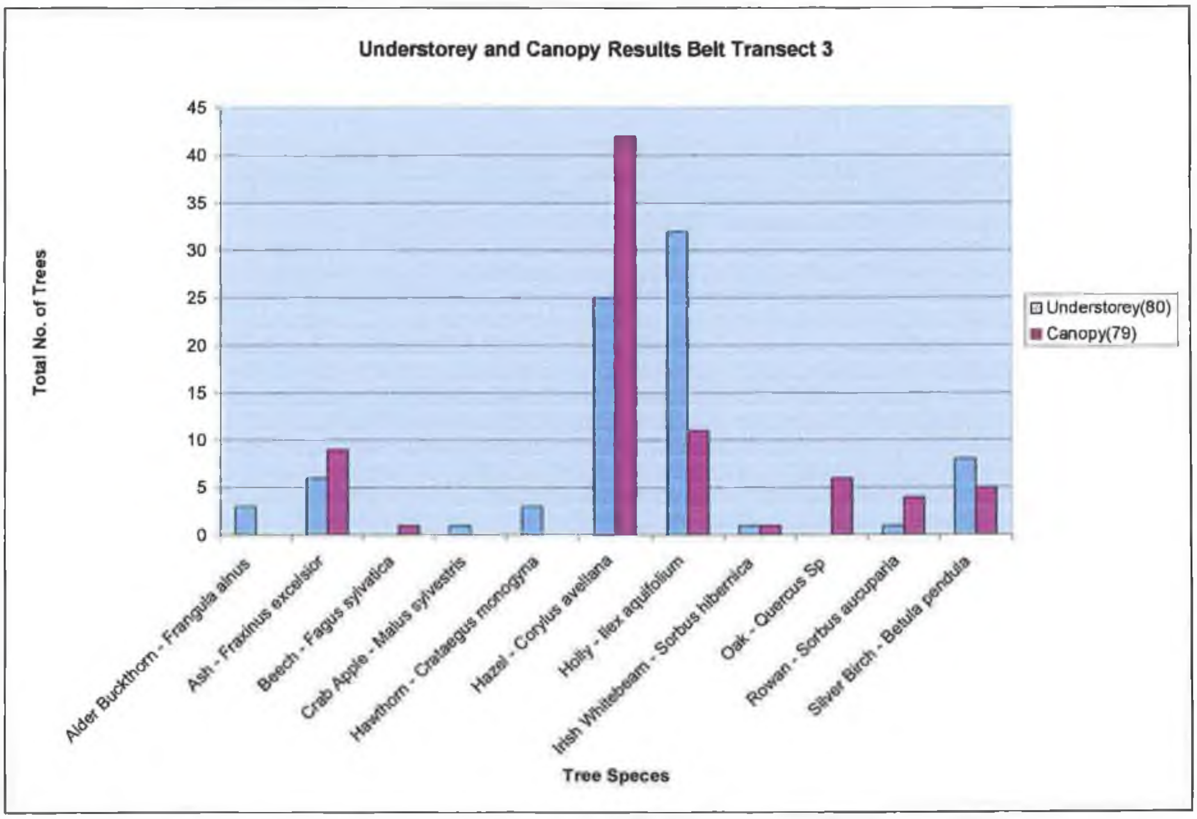


Figure 5.44 Leamnahye Canopy and Understorey Results Belt Transect 3

Belt Transect 4.

Belt transect 4 was taken across the eastern edge of Leamnahye Island, 60m from belt transect 3. Belt transect 4 measured 10m x 30m covering an area of $300m^2$. Equally dominant in the canopy layer was *Corylus avellana* and *Ilex aquifolium* (Figure 5.45). *Fraxinus excelsior* and *Betula pendula* were also recorded to a lesser extent. *Juniperus communis*, *Crataegus monogyna, Sorbus hibernica, Sorbus aucuparia*, and *Pinus sylvestris* are also present in the canopy layer. The dominant tree species in the understorey were recorded as *Corylus avellana* and *Ilex aquifolium*. Other tree species recorded as understorey in Belt Transect 4 consisted of *Frangula alnus*, *Fraxinus excelsior, Crataegus monogyna*, *Sorbus aucuparia*, *Betula pendula* and *Euonymus europaeus*. The number of understorey trees once again outnumbered the total quantity of trees recorded in the canopy.

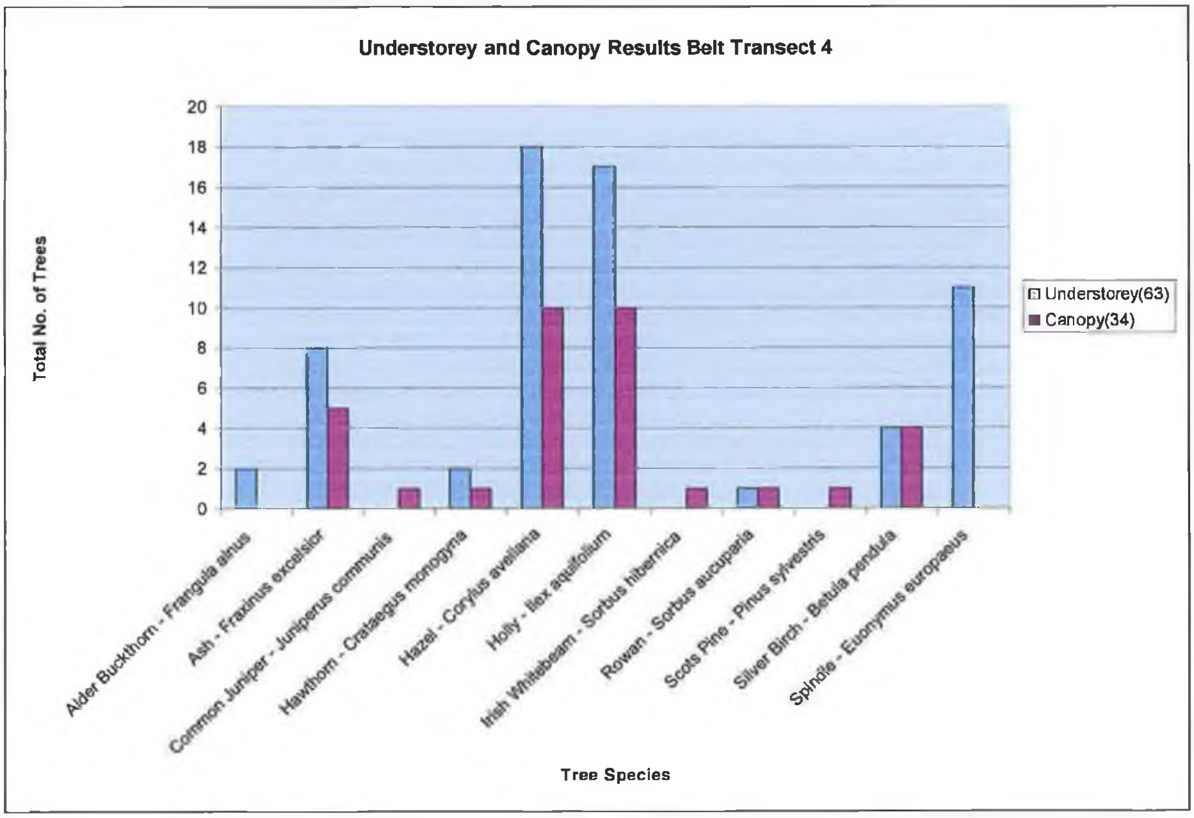


Figure 5.45 Leamnahye Canopy and Understorey Results Belt Transect 4

5.4.3 Woodland Classification and Mapping

The data from the vegetation survey was used to map the mosaic of woodland types that form Leamnahye Island woodland Figure 5. 46. GPS readings were taken during the survey and used in combination with Dmap to create an accurate map of the current vegetation. Each colour-coded polygon represents a different vegetation type and the information such as the classification of vegetation type of each polygon type is contained in the legend table. For the most part the vegetation was classified according to Fossitt (2000).

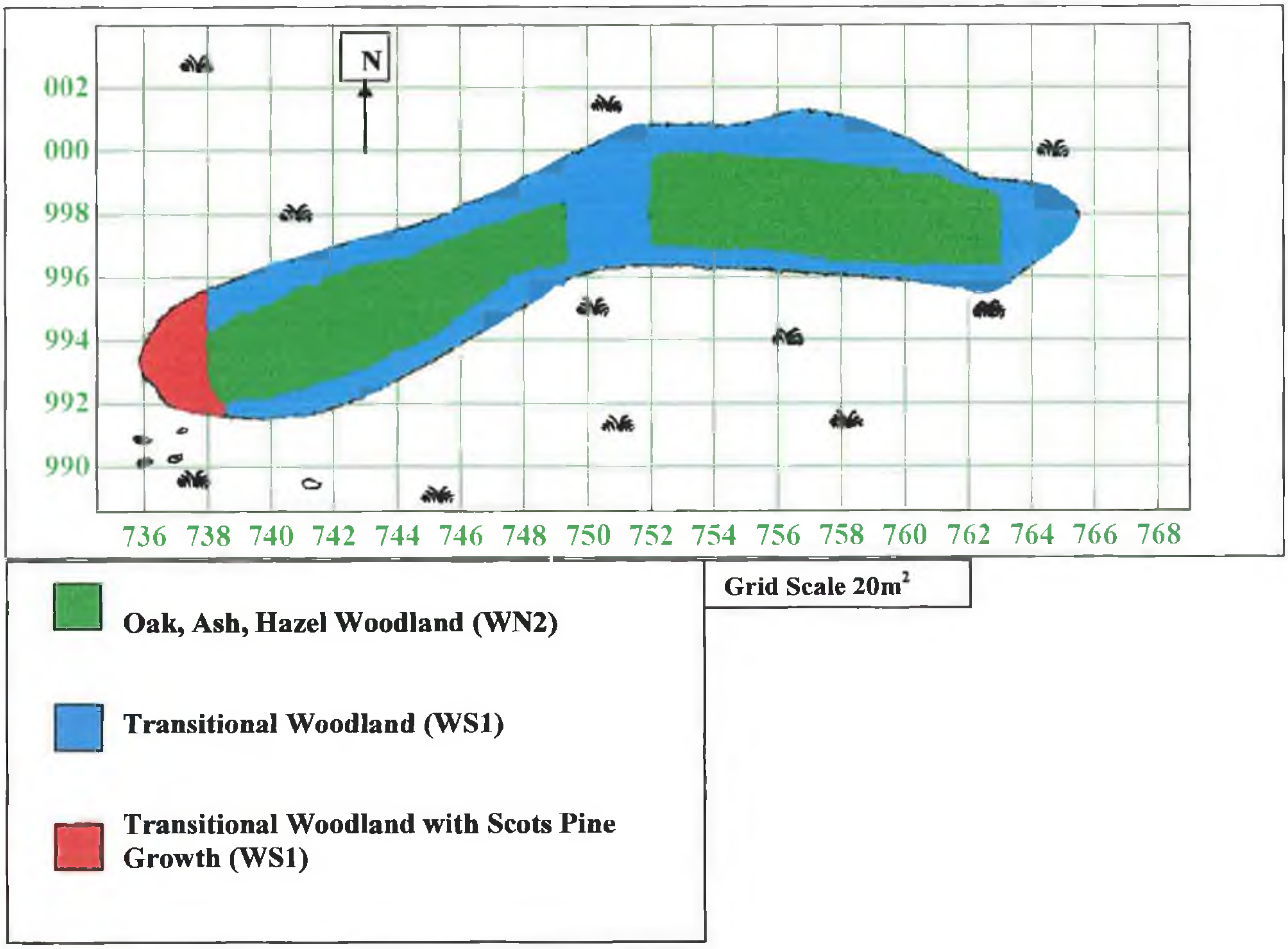


Figure 5.46 Leamnahye Island Vegetation Map

5.4.4 Regeneration

An assessment of tree regeneration on Leamnahye Island was accomplished by recording all stems of tree and woody species considered to be 'regeneration' that were growing in each belt transect. For this analysis the size classes were combined into two height categories: ≤15cm were considered seedlings; ≤ 2m were considered saplings.

Belt Transect 1

A total of seven tree species classed as seedlings were recorded in Belt transect 1 and the results are shown in Figure 5.47. They consisted of *Frangula alnus*, *Fraxinus excelsior*, *Juniperis communis*, *Corylus avellana*, *Ilex aquifolium*, *Sorbus hibernica*, *Betula pendula* and *Acer pseudoplatanus*. The most abundant seedlings recorded were *Fraxinus excelsior*, *Ilex aquifolium* and *Frangula alnus*. The remaining seedlings were less common. A total of five tree species classified as saplings were recorded in belt transect 1. These included *Prunus spinosa*, *Juniperis communis*, *Corylus avellana*, *Ilex aquifolium* and *Betula pendula*. The most abundant sapling species recorded was *Ilex aquifolium*. The number of seedlings recorded in this survey site was far greater than the number of saplings.

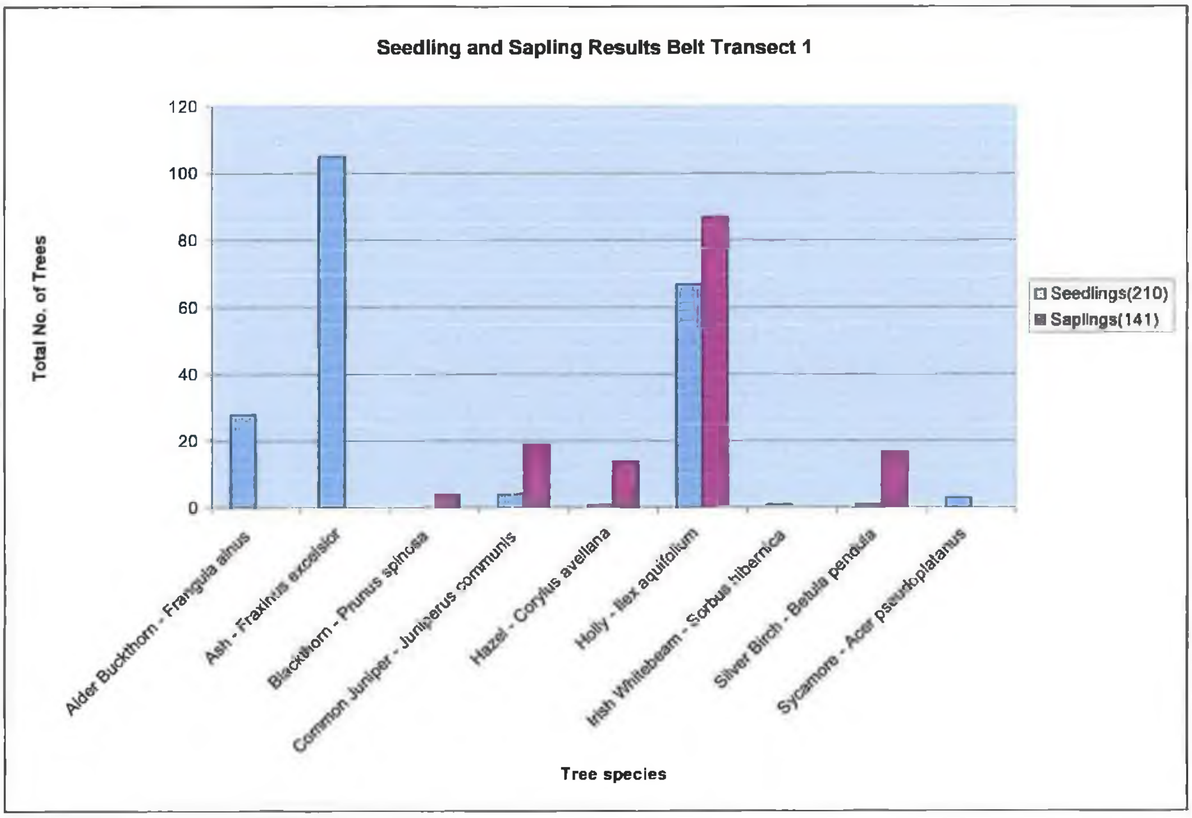


Figure 5.47 Leamnahye Seedling and Sapling Results Belt Transect 1

Belt Transect 2

A total of seven tree species classed as seedlings were recorded in Belt transect 2 and the results are summarised in Figure 5.48. These consisted of *Frangula alnus*, *Fraxinus excelsior*, *Juniperus communis*, *Crataegus monogyna*, *Corylus avellana*, *Ilex aquifolium* and *Betula pendula*. The most abundant seedling recorded was *Fraxinus excelsior*. There was occasional growth of the remaining seedlings. A total of seven tree species classified as saplings were recorded in belt transect 2. These included *Frangula alnus*, *Fraxinus excelsior*, *Juniperus communis*, *Corylus avellana*, *Ilex aquifolium*, *Sorbus hibernica* and *Betula pendula*. The most abundant sapling species recorded was *Ilex aquifolium*. The remaining saplings were less common. The total number of seedlings recorded significantly outnumbered the total number of saplings by almost four to one

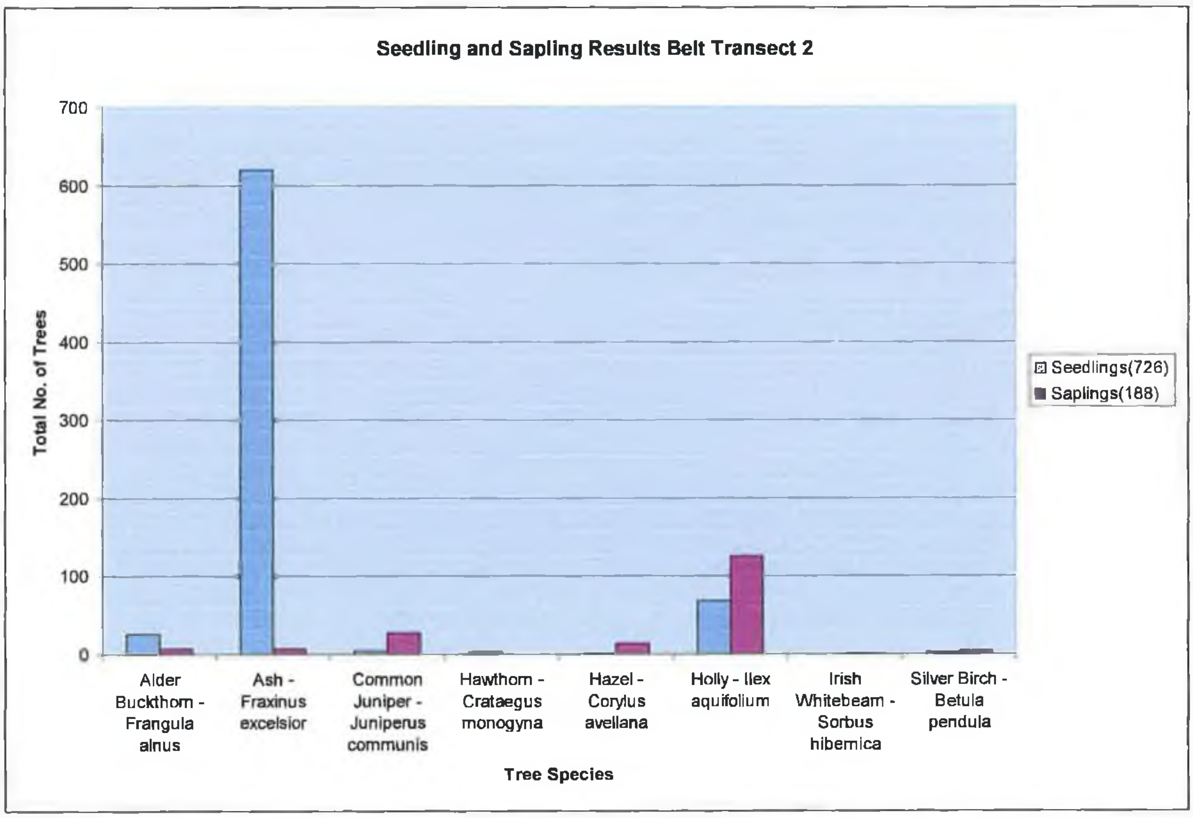


Figure 5.48 Leamnahye Seedling and Sapling Results Belt Transect 2

Belt Transect 3

A total of nine tree species classed as seedlings were recorded in Belt transect 3 and the results are displayed in Figure 5.49. These consisted of *Frangula alnus*, *Fraxinus excelsior*, *Sorbus spinosa*, *Juniperus communis*, *Crataegus monogyna*, *Corylus avellana*, *Ilex aquifolium*, *Sorbus hibernica*, *Sorbus aucuparia* and *Betula pendula*. The most abundant seedlings recorded were *Frangula alnus* and *Fraxinus excelsior*. The remaining seedlings were less abundant. A total of seven tree species classified as saplings were recorded in belt transect 2. These included *Frangula alnus*, *Fraxinus excelsior*, *Sorbus spinosa*, *Juniperus communis*, *Crataegus monogyna*, *Corylus avellana*, and *Ilex aquifolium*. The most abundant sapling species recorded was *Ilex aquifolium*. The remaining sapling species occurred less frequently. As in Belt transect 1 and 2 the number of seedlings was greater than the total number of saplings recorded.

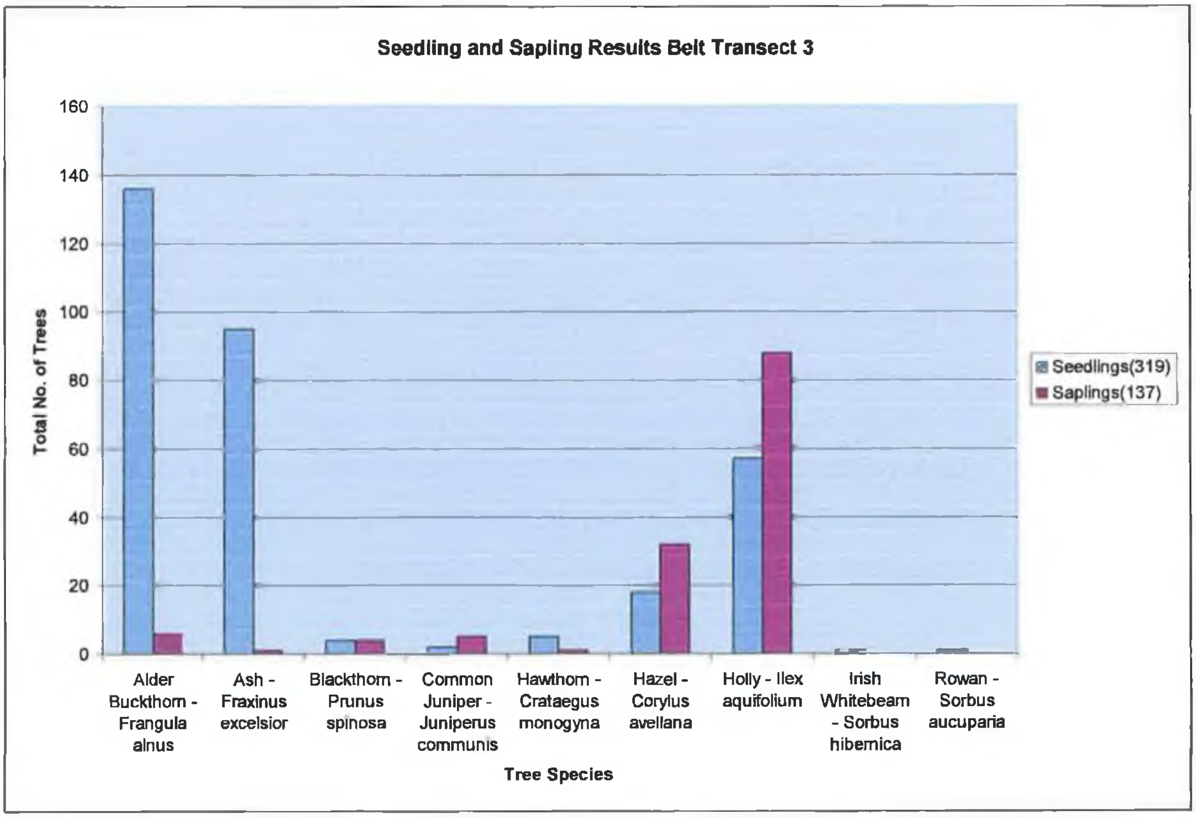


Figure 5.49 Leamnahye Seedling and Sapling Results Belt Transect 3

Belt Transect 4

A total of five tree species classed as seedlings were recorded in Belt transect 4 and the results are shown in Figure 5.50. These consisted of *Frangula alnus*, *Fraxinus excelsior*, *Juniperus communis*, *Corylus avellana*, and *Ilex aquifolium*. The most abundant seedlings recorded were *Frangula alnus* and *Ilex aquifolium*. The remaining seedlings were less common. Only four tree species classified as saplings were recorded in belt transect 4. These included *Frangula alnus*, *Fraxinus excelsior*, *Corylus avellana* and *Ilex aquifolium*. The most abundant sapling species recorded was *Ilex aquifolium*. *Frangula alnus*, *Fraxinus excelsior* and *Corylus avellana* were recorded occasionally. In this transect there was less of a gap between the total number of seedlings and saplings recorded.

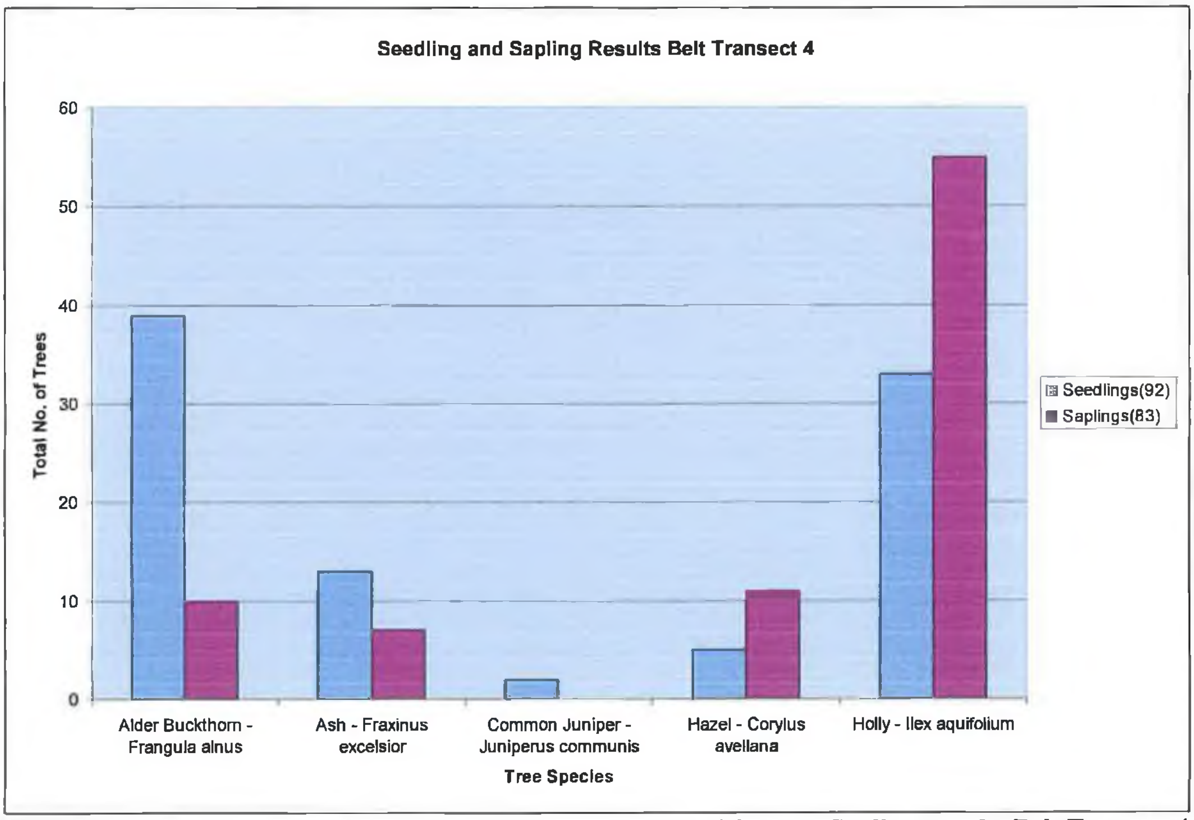


Figure 5.50 Leamnahye Seedling and Sapling Results Belt Transect 4

5.4.5 Tree diameter and age.

The girth measurements of all tree species occurring within each belt transect were recorded in the field. The measurements of the stems were taken at chest height which measured between 1m - 1.20m above ground level. All stems greater than 5cm were measured and recorded. To conform to modern international standards in tree measuring, girth is expressed in the register as diameter at breast height (dbh) (girth divided by 3.14159, or pi), giving a mean of an infinite number of variable diameters (Miles, A. 1999). There is a noticeable dominance of *Quercus robur* and *Pinus sylvestris* in the larger size classes over 31centimeters in diameter (Figure 5.51). There is a greater variety of species occurring in the lower dbh class sizes.

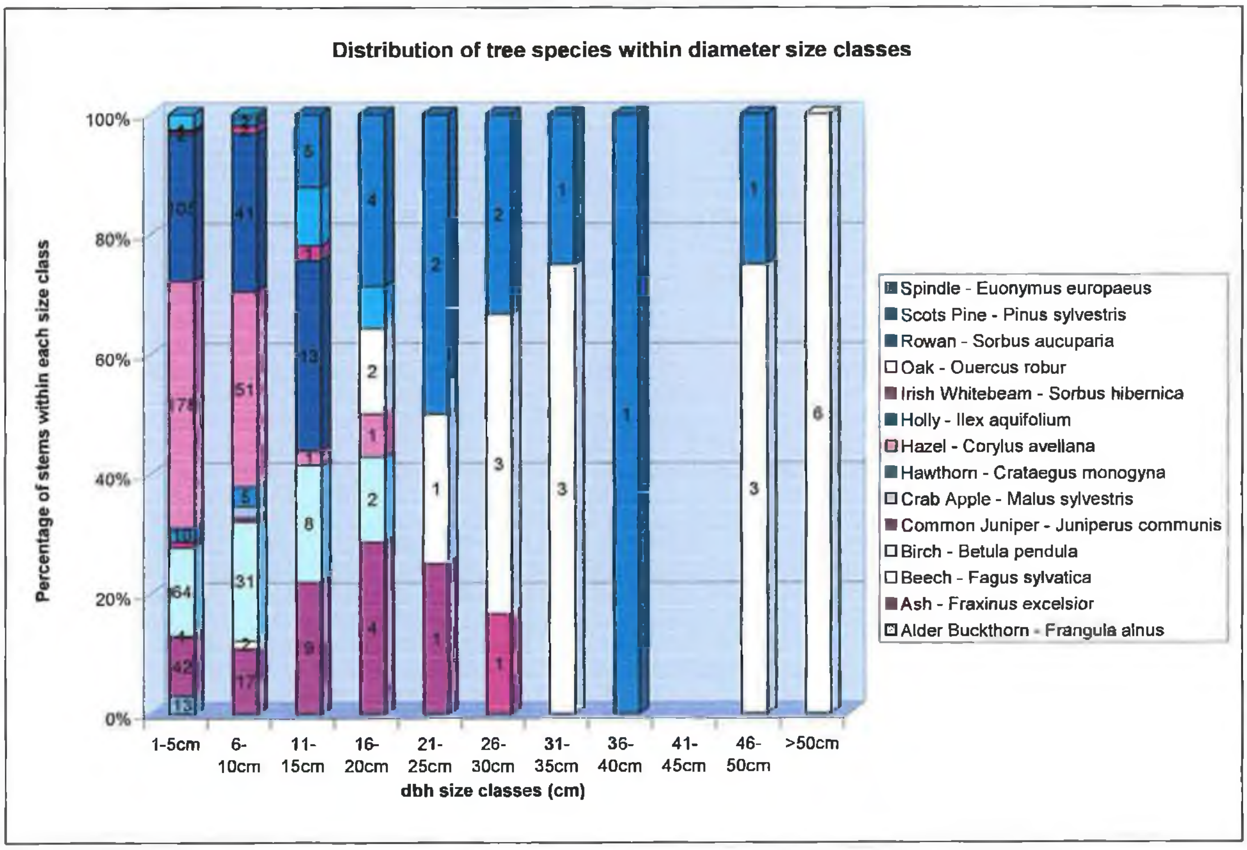


Figure 5.51 Leamnahye Distribution of Tree Species within diameter size classes

The age of a small sample of trees was recorded using an increment borer and the results are displayed in Table 5.29. Of interest was the age of the oak population on the island and also to establish when *Pinus sylvestris* and *Sorbus hibernica* colonised the island. The *Quercus* population was aged between 52 and 161 years of age. The oldest *Pinus* tree was aged 48 years of age and the oldest *Sorbus hibernica* was aged 36 years.

Leamnahye Tree Coring Results	Girth (cm)	Diameter at Breast Height (DBH) (cm)	Height (m)	Age of Tree (yrs)
Scots Pine - *Pinus sylvestris*	**90**	**28.66**	**9**	**35**
Scots Pine - *Pinus sylvestris*	**115**	**36.62**	**10**	**48**
Pedunculate Oak -*Quercus robur*	**50**	**15.92**	**8.5**	**52**
Pedunculate Oak - *Quercus robur*	**160**	**50.95**	**15**	**156**
Pedunculate Oak - *Quercus robur*	**90**	**28.66**	**14**	**100-120**
Pedunculate Oak - *Quercus robur*	**200**	**63.69**	**14**	**140-161**
Rowan - *Sorbus hibernica*	**90**	**28.66**	**8**	**36**
Ash - *Fraxinus excelsior*	**78.5**	**25**	**12**	**38**

Table 5.29 Leamnahye Tree Coring Results

5.4.6 Epiphytes and Woody Climbers.

Many of the trees bore epiphytic growth of mosses, lungwort and other lichens. The following woody climbers, ivy and honeysuckle, plants which grow on trees, were recorded. A bryophyte survey of *musci* and *hepaticae* groups was not carried out. However the abundance of *musci* growth was recorded.

Ivy Growth Results

The abundance of ivy on all trees surveyed within the belt transects was recorded. If ivy was present, it was recorded subjectively as "profuse" or "sparse". This approach of recording ivy was adopted from Huxley (2005). Scarce growth was ivy that was not as yet negatively affecting the growth of the tree. Profuse growth was ivy that was severe enough to affect the growth of the tree. If no ivy was present this was also documented. Ivy growth was recorded on all species of trees growing on Leamnahye Island. However ivy growth was most commonly recorded on the following species; *Fraxinus excelsior, Betula pendula, Corylus avellana, Ilex aquifolium* and *Quercus robur* (Figure 5.52).

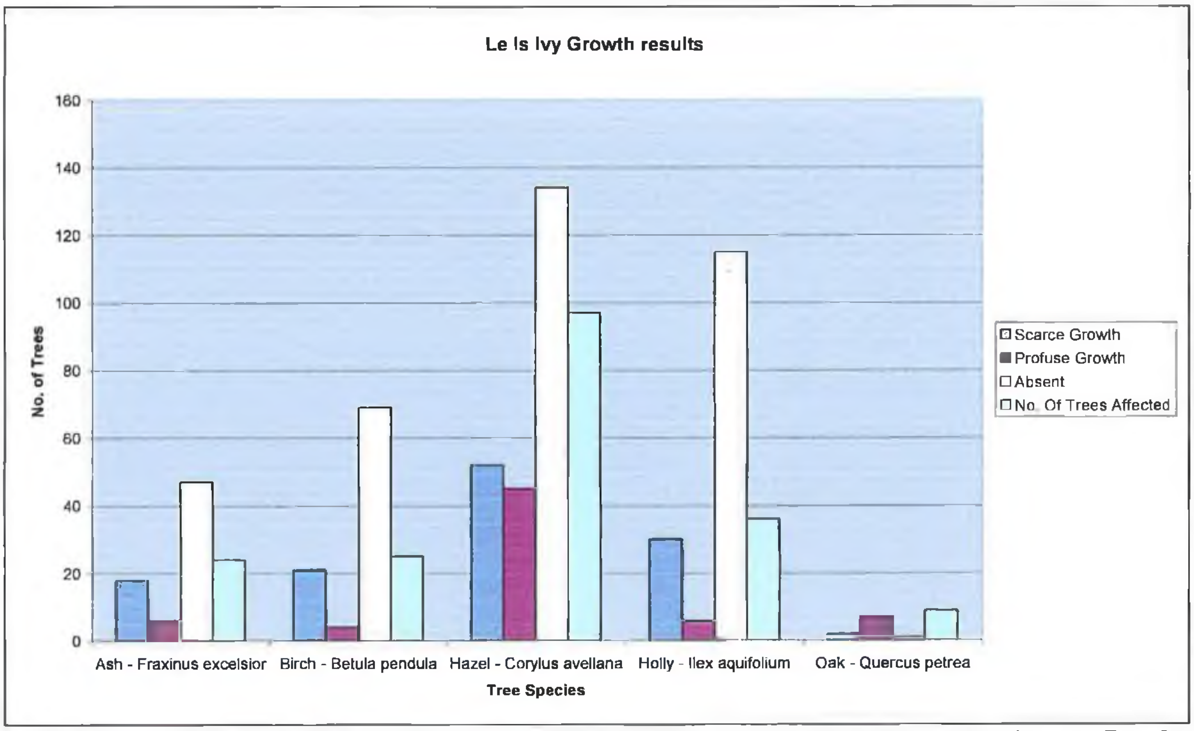


Figure 5.52 Leamnahye Ivy Growth Results

Honeysuckle Growth Results

The presence of honeysuckle growth was also recorded. During the survey honeysuckle was recorded growing on four *Corylus avellana* and one *Ilex aquifolium*. It was also recorded in the ground vegetation during the flora survey.

Moss Growth Results

The abundance of moss on all trees surveyed within the belt transects was recorded. If moss was present, it was recorded subjectively as "profuse" or "sparse". The absence of moss growth was also recorded. Moss growth was recorded on all tree species except *Euonymus europaeus* on Leamnahye Island. The main tree species with moss growth were *Fraxinus excelsior, Betula pendula, Corylus avellana, Ilex aquifolium* and *Quercus robur* (Figure 5.53).

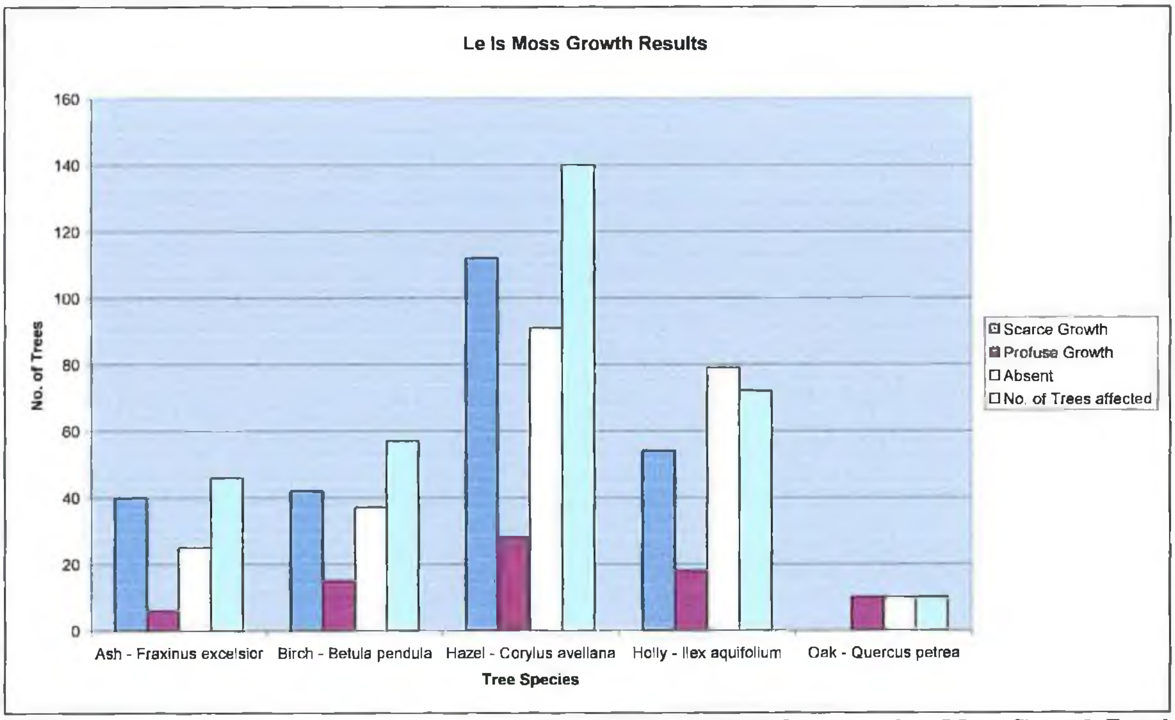


Figure 5.53 Leamnahye Moss Growth Results

5.4.7 Bark Stripping Results

Evidence of bark stripping was recorded during the survey and the results are summarised in Table 5.30. Deer remove bark for food and to gain access to softer tissues and sap underneath, whilst buds, shoots and leaves will be browsed as food. The main trees affected were *Ilex aquifolium*, *Corylus avellana*, *Frangula alnus* and *Euonymus europaeus*. Bark stripping was also recorded on *Fraxinus excelsior*, *Juniperus communis*, *Crataegus monogyna* and *Sorbus hibernica* species. There was no evidence of deer damage on any of the following tree species; *Fagus sylvatica, Betula pendula, Malus sylvestris, Quercus robur, Sorbus aucuparia* and *Pinus sylvestris*.

Leamnahye Island Bark Stripping Results	No. of Trees Affected	% of Trees Affected
Alder Buckthorn - *Frangula alnus*	**7**	**63.64**
Ash - *Fraxinus excelsior*	**4**	**5.63**
Common Juniper - *Juniperus communis*	**1**	**25**
Hawthorn - *Crataegus monogyna*	**5**	**33.33**
Hazel - *Corylus avellana*	**10**	**4.33**
Holly - *Ilex aquifolium*	**14**	**9.27**
Irish Whitebeam - *Sorbus hibernica*	**5**	**100**
Spindle - *Euonymus europaeus*	**7**	**46.66**

Table 5.30 Leamnahye Bark Stripping Results

5.4.8 Light Composition Results

The intensity of the light composition reaching the woodland floor was recorded in each 10m^2 quadrat comprising a belt transect and the results are shown in Table 5.31. It was estimated using a scale of very bright to very dim.

Leamnahye Is Light Composition Results					
Belt Transect No.	Very Bright	Bright	Moderate	Dim	Very Dim
Belt Transect.1 Q.1		X			
Belt Transect.1 Q.2		X			
Belt Transect.1 Q.3		X			
Belt Transect.2 Q.1				X	
Belt Transect.2 Q.2			X		
Belt Transect.2 Q.3				X	
Belt Transect.2 Q.4			X		
Belt Transect.3 Q.1			X		
Belt Transect.3 Q.2				X	
Belt Transect.3 Q.3			X		
Belt Transect.3 Q.4				X	
Belt Transect.4 Q.1		X			
Belt Transect.4 Q.2			X		
Belt Transect.4 Q.3		X			

Table 5.31 Leamnahye Light Composition Results

5.4.9 Percentage of canopy cover

The percentage of canopy cover was estimated for every $10m^2$ quadrat/area occurring in each belt transect and the results are shown in Table 5.32. The result of this information was calculated as an average percentage cover for the area of each belt transect.

Leamnahye Island Percentage of Canopy Cover Results			
Belt Transect No. Q. No	% cover		Aver % cover
Belt Transect 1 Q.1	45	Belt Transect 1	48.33
Belt Transect 1 Q.2	50	Belt Transect 2	72.5
Belt Transect 1 Q.3	50	Belt Transect 3	76.25
Belt Transect 2 Q.1	60	Belt Transect 4	38.75
Belt Transect 2 Q.2	80	Total Average	58.96
Belt Transect 2 Q.3	85		
Belt Transect 2 Q.4	65		
Belt Transect 3 Q.1	70		
Belt Transect 3 Q.2	90		
Belt Transect 3 Q.3	80		
Belt Transect 3 Q.4	65		
Belt Transect 4 Q.1	50		
Belt Transect 4 Q.2	60		
Belt Transect 4 Q.3	45		

Table 5.32 Leamnahye Percentage Canopy Cover Results

5.4.10 Drainage Results

The method of recording drainage results that was used in this survey was taken from methodology used by the NPWS during the National Woodland Inventory Survey (2004). The geology of the island was recorded as well drained in Table 5.33. However as this is an island it is likely that the edges of the woodland would be prone to flooding during the winter months.

Leamnahye Island Internal Drainage Results					
Belt Transect No.	Excessive	Free	Impeded	Strongly Impeded	Prone to Flooding
Belt Transect.1 Q.1		X			
Belt Transect.1 Q.2		X			
Belt Transect.1 Q.3		X			
Belt Transect.2 Q.1		X			
Belt Transect.2 Q.2		X			
Belt Transect.2 Q.3		X			
Belt Transect.2 Q.4		X			
Belt Transect.3 Q.1		X			
Belt Transect.3 Q.2		X			
Belt Transect.3 Q.3		X			
Belt Transect.3 Q.4		X			
Belt Transect.4 Q.1		X			
Belt Transect.4 Q.2		X			
		X			

Table 5.33 Leamnahye Internal Drainage Results

5.4.11 Soil Depth Results

Soil depth readings were recorded in each belt transect and the results summarised in Table 5.34.

Leamnahye Soil Depth Results	Deepest Reading (cm)	Shallowest Reading (cm)	Average Depth (cm)
Belt transect 1	18	7	11.25
Belt transect 2	23	10	17.2
Belt transect 3	22	15	14.75
Belt transect 4	16	6	8.79

Table 5.34 Leamnahye Soil Depth Results

5.4.12 Ground Cover Results

A general description of the ground cover was recorded for each $10m^2$ quadrat and the results are summarised in Table 5.35. The method of recording ground cover results was taken from the methodology used by the NPWS during the National Woodland Inventory Survey (2004).

Ground Cover Results in Leamnahye Island.					
Belt Transect No:	**Rocks and Mossy Boulders**	**Limestone and Grass**	**Bare Soil**	**Leaf Litter and Dead Wood**	**Covered with Plants**
BT.1 Q.1	X				X
BT.1 Q.2		X			X
BT.1 Q.3				X	X
BT.2 Q.1				X	
BT.2 Q.2				X	
BT.2 Q.3				X	
BT.2 Q.4	X	X			
BT.3 Q.1		X		X	
BT.3 Q.2	X			X	
BT.3 Q.3	X			X	
BT.3 Q.4		X		X	
BT.4 Q.1		X			X
BT.4 Q.2		X		X	
BT.4 Q.3					X

Table 5.35 Leamnahye Ground Cover Results

5.4.13 Invasive Canopy and Shrub Species

The invasive introduced climax species *Fagus sylvatica* was recorded growing on Leamnahye Island. In total three were recorded; one in the canopy layer and two in the understorey in belt transect 1. No regeneration of *Fagus sylvatica* was recorded during the sapling and seedling survey. No invasive shrub species or garden escapes such as *Rhododendron ponticum* were recorded in the survey of Leamnahye Island.

5.4.14 Breeding Bird Census

Leamnahye Island was not included as part of the Birding Bird Census that has been annually conducted in Partry House Estate since 2003. During fieldwork on the island Wood Pigeon, Jay and Coal Tit species were recorded.

5.4.15 Fauna

The fauna of Leamnahye was not surveyed at this time due to time constraints. However the main mammals noted on the island are Fallow deer. There presence was not as frequently recorded on the island during surveying and field walking as compared to the other woodlands. A Pine Marten was seen on the island during the summer of 2006. These elusive creatures are rarely seen during daylight hours.

5.4.16 Vegetation Classification

Sampling of the ground flora took place within the belt transect. In every 10m2 quadrat/area in each belt transect, four $1m^2$ quadrats were taken randomly and in total data from fifty six quadrats were collected during the field survey of summer 2006 and the raw data is available for consultation in Appendix 3. All ground-dwelling and saxicolous vascular plants were recorded by percentage cover estimated by eye. CAP (Community Analysis Package) a Windows program that offers a range of analytical techniques was used to examine the collected data. Both ordination and classification methods were used to explore, compare and analyse the community structure.

The raw floristic data was stored using Microsoft Excel and sorted using TWINSPAN (Two way species indicator analysis). TWINSPAN is somewhat complex divisive clustering method originally devised by Hill for vegetation analysis. TWINSPAN uses reciprocal averaging to classify samples (in this case quadrats) and then divides the dataset into 'positive' and 'negative' group, depending on the relative abundances of certain 'indicator' species in the samples (NPWS 2004). The floristic data was then rearranged based on the TWINSPAN output using Excel and a table was then produced showing species-by-site (quadrate or sample) relationships. This allowed for groups and associations to be formed (Pisces Conservation 2004). In total forty-seven floral species were recorded in the vegetation survey and comprised of vascular plants from woodland, limestone grassland and lakeshore habitats. The floristic composition of Leamnahye Island is displayed in Table 5.36.

5.4.17 Leaf Litter Results

Leaf litter cover was recorded by percentage cover in each $1m^2$ quadrat of the flora survey. The results of this survey is summarised below.

Frequency – 49 recording out of 56

Species Frequency % - 87.5%

Total % - 2476.25%

Mean % - 40.05%

Leamnahye Flora Results	Frequency	Species Frequency %	Total % Cover	Mean % Cover
Woodland Species				
Wild Strawberry - *Fragaria vesca*	9	16.07	19	0.34
Wood Avens - *Geum rivale*	9	16.07	30	0.53
Wood Sanicle - *Sanicula europaea*	22	39.28	137.25	2.45
Ground Ivy - *Glechoma hederacea*	8	14.28	21.25	0.38
Woodruff - *Galium odoratum*	3	5.36	6.5	0.12
Wood Sorrel - *Oxalis acetosella*	8	14.28	36	0.64
Enchanters Nightshade - *Circaea lutetiana*	8	14.28	22.7	0.41
Primrose - *Primula vulgaris*	9	16.07	21.5	0.38
Broad Buckler Fern - *Dryopteris austriaca*	3	5.36	7.5	0.13
Wood Anemone - *Anemone nemorosa*	3	5.36	7	0.12
Honeysuckle - *Lonicera periclymenum*	5	8.93	13.5	0.24
Tutsan - *Hypericum androsaemum*	3	5.36	8.8	0.16
Bracken - *Pteridium aquilinum*	3	5.36	12.5	0.22
Common Species				
Bramble - *Rubus fruticosus*	37	66.07	161.75	2.89
Grass Sp. - *Gramineae sp.*	52	92.86	850.25	15.18
Moss - *Musci sp.*	51	91.07	1271	22.69
Common Dog Violet - *Viola riviniana*	43	76.78	231.5	4.13
Ivy - *Hedera helix*	43	76.78	305.25	5.45
Limestone Grassland Species				
Burnet Rose - *Rosa pimpinellifolia*	16	28.57	82.25	1.47
Harebell - *Campanula rotundifolia*	4	7.14	13.5	0.24
Lesser meadow rue - *Thalictrum minus*	5	8.93	20.25	0.36
Carline Thistle - *Carlina vulgaris*	1	1.78	1.2	0.02
Common Milkwort - *Polygala vulgaris*	1	1.78	2.5	0.04
Dog Rose - *Rosa arvensis*	2	3.57	13	0.23
Grass of Parnassus - *Parnassia palustris*	1	1.78	2	0.03
Selfheal - *Prunella vulgaris*	2	3.57	5	0.08
Common Bird's-foot-trefoil - *Lotus corniculatus*	5	8.93	19.5	0.35
Silverweed - *Potentilla anserina*	1	1.78	2.5	0.04
Hemp-agrimony - *Eupatorium cannabinum*	2	3.57	8	0.14
Tormentil - *Potentilla erecta*	8	14.28	45.75	0.82
Vetch Sp. - *Leguminosae sp.*	7	12.5	22	0.39
Uncommon Species				
Lesser Celandine - *Ranunculus ficaria*	1	1.78	2.5	0.04
Maidenhair Fern – *Adiantum capillus veneris*	1	1.78	2.5	0.04
Yellow Pimpernel - *Lysimachia nemorum*	1	1.78	1.25	0.02
Male Fern - *Dryopteris filix-mas*	2	3.57	17.5	0.31
Wall Lettuce - *Mycelis muralis*	1	1.78	5	0.08
Perforate St John's-wort - *Hypericum perforatum*	1	1.78	1.25	0.02
Fragrant Orchid - *Gymnadenia conopsea*	1	1.78	2.5	0.04
Lady's Bedstraw - *Galium verum*	1	1.78	6.25	0.11
Germander Speedwell - *Veronica chamaedrys*	1	1.78	3.75	0.07
Meadowsweet - *Filipendula ulmaria*	2	3.57	4.75	0.08
Lords and Ladies - *Arum maculatum*	2	3.57	10.8	0.19
Wild Madder - *Rubia peregrina*	2	3.57	20	0.36
Bugle - *Ajuga reptans*	2	3.57	11.25	0.2
Common Twayblade - *Listera ovata*	1	1.78	3.75	0.07

Table 5.36 Leamnahye Flora Results

5.5 Deer Experiment Results

5.5.1 Bridgepark

In the deer exclosure on Bridgepark 3 tree species were recorded in seedling or sapling form (Table 5.37). The species regenerating were *Fraxinus excelsior, Corylus avellana* and *Ilex aquifolium.* The number of *Corylus avellana* remained static while the number of *Ilex aquifolium* saplings and seedlings increased. *Fraxinus excelsior* which was not recorded in 2005 was recorded in 2006 with almost 200 seedlings growing in the exclosure. The number of *Primula vulgaris* plants also increased in one year of excluded grazing. An increase in the average height of vegetation was also documented with an increase in the growth height of *Rubus fruiticosus* and *Luzula sylvatica.* Two flora species which did not flower in 2005 were recorded in bloom in 2006 and were *Viola riviniana* and *Fragaria vesca.* The flora data recorded in both surveys was organised in to groups using TWINSPAN and three groups of data was sorted (i) Common Species (ii) Woodland Species and (iii) Uncommon Species. Overall 22 flora species were identified between the two surveys and the data is summarised in Table 5.40. In general an increase in the percentage cover of most species was documented. The increases were mainly small however both *Lonicera periclymenum* and *Galium odoratum* recorded fair increases in percentage cover. There were some small decreases also recorded but the most noticeable was *Circaea lutetiana* dropping 2% in mean percentage cover. The reason for this decrease may be due to the fact that like in Moynish this exclosure was surveyed slightly earlier in 2006 and this species might not have developed fully. A number of limestone grassland species were also recorded in the exclosure and one species *Potentilla erecta* decreased in area in 2006. This is likely due to the increased competition from woodland species in the absence of grazing. Four new species were recorded in 2006 and included *Calluna vulgaris, Hypericum androsaemum, Glechoma hederacea* and *Geum rivale.* The MDS Plot plotted the most of the samples in one area illustrating spatial the similarity in composition (Figure 5.54). However there were a number of samples plotted away from the main group implying that some change has occurred between 2005-2006. The P-Value calculated by ANOSIM test was 0.001% which is significant and the SIMPER result of an average similarity was 83.47% are both indicative of a change in flora composition but it is not a definitive change. Overall the composition has remained similar from the first survey in 2005 to the second survey in 2006.

In the control plot on Bridgepark three tree and shrub species were recorded regenerating and included *Fraxinus excelsior, Crataegus monogyna* and *Ilex aquifolium* (Table 5.37). The number of *Crataegus monogyna* seedlings remained static however *Ilex aquifolium* seedlings which were recorded in 2005 were not recorded in 2006. *Fraxinus excelsior* was the dominant regenerating species and a profound increase of 424 seedlings was recorded in 2006. No saplings were documented in the area in the control plot. One *Primula vulgaris* plant was recorded in the control plot and there was no increase in numbers. The average height of the vegetation also increased in one year by 3.14 cm. This increase was mainly due to the increased presence of *Arum maculatum* which grew up to 25 cm in the control plot and was not observed to be grazed on by deer throughout the woodland (Plate No. 5.1)). There were no species recorded in flower in either survey.

Plate No. 5.1 *Arum maculatum* Growth in Bridgepark Control Plot 2006

Overall 13 flora species were recorded in the combined survey results and the results are shown in Table 5.41. The raw data is available for consultation in Appendix 3. In general the vegetation was observed to be decreasing in percentage cover. Only two species recorded an increase in percentage cover and the principal species was *Arum maculatum* which increased in mean percentage cover by almost 7%. The increased recording of this species was due to the slightly earlier surveying of the control plot in May in 2006. This is a spring flowering plant which dies off as the summer advances.

Two species *Fragaria vesca* and *Pteridium aquifinum* were only recorded in 2005. While two new species were recorded in 2006 and included *Listera ovata* and *Lysimachia nemorum.* The MDS Plot maps some overlap in the samples but there is mainly two groups of samples plotted (Figure 5.55). The P-Value calculated by ANOSIM test was 0.017% which is not significant and the SIMPER result of an average similarity was 71.82% are both indicative of a change in the flora composition but it is not a definitive change.

Bridgepark Exclosure & Control Plot Results 05-06 Tree Species	Exc 2005 Saplings	Exc 2006 Saplings	Exc 2005 Seedlings	Exc 2006 Seedlings	CP 2005 Saplings	CP 2006 Saplings	CP 2005 Seedlings	CP 2006 Seedlings
Ash - *Fraxinus excelsior*	0	0	0	199	0	0	33	457
Hawthorn - *Crataegus monogyna*	0	0	0	0	0	0	1	1
Hazel - *Corylus avellana*	4	4	0	4	0	0	0	0
Holly - *Ilex aquifolium*	8	16	0	13	0	0	3	0
	0	0	0	0	0	0	0	0
No. Of *Primula vulgaris*	2	5			1	1		
Average Height of Vegetation	16.78	21.38			12.30cm	15.44cm		
No. Of Flowering Species	0	2			0	0		

Table 5.37 Bridgepark Exclosure & Control Plot Results 2005-2006

Bridgepark Leaf Litter/Bare Ground Results of Exc & CP 2005-2006	Exc 2005	Exc 2006	CP 2005	CP 2006
Total % Cover	483	574	278	655
Mean % Cover	19.33	23	11.12	26.18
Frequency	20	25	21	25
Species % Frequency	80	100	84	100

Table5.38 Bridgepark Leaf Litter Results of Exclosure and Control Plot 2005-2006

Bridgepark	Exc 2005-2006	CP 2005-2006
ANOSIM Result	P-Value 0.001	P-Value 0.017
SIMPER Result	Ave Sim 83.47%%	Ave Sim 73.81%

Table 5.39 Bridgepark ANOSIM and SIMPER Results 2005-2006

Bridgepark Flora Results of Exclosure 2005-2006	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	2006 Species % Frequency
Common Species								
Bramble - *Rubus fruticosus*	110	115	4.392	4.58	23	25	92	100
Moss - *Musci sp.*	1442	1421	57.68	56.8	25	25	100	100
Common Dog Violet - *Viola riviniana*	94	91.3	3.76	3.65	22	20	88	80
Grass Sp. - *Gramineae sp.*	150	92.5	6.01	3.7	22	21	88	84
Woodland Species								
Honeysuckle - *Lonicera periclymenum*	33.3	49.6	1.33	1.98	14	15	56	60
Ivy - *Hedera helix*	36.5	45	1.46	1.8	18	19	72	76
Tormentil - *Potentilla erecta*	19.3	11.3	0.77	0.45	9	6	36	24
Greater Wood Rush - *Luzula sylvatica*	10.8	13.8	0.43	0.55	5	6	20	24
Bracken - *Pteridium aquilinum*	15.3	10	0.61	0.4	4	6	16	24
Woodruff - *Galium odoratum*	4.25	21.3	0.17	0.85	4	12	16	48
Yellow Pimpernel - *Lysimachia nemorum*	2.5	3.75	0.1	0.15	2	3	8	12
Enchanters Nightshade - *Circaea lutetiana*	53.3	2.5	2.13	0.1	17	2	68	8
Wild Strawberry - *Fragaria vesca*	39.8	30	1.59	1.2	16	13	64	52
Uncommon Species								
Vetch Sp. - *Leguminosae sp.*	2.75	1.25	0.11	0.05	2	1	8	4
Spearmint - *Mentha spicata*	1.25	2.5	0.05	0.1	1	1	4	4
Primrose - *Primula vulgaris*	2.25	1.25	0.09	0.05	2	1	8	4
Hartstongue Fern - *Asplenium scolopendrium*	1.25	2.5	0.05	0.1	1	1	4	4
Early Purple Orchid - *Orchis mascula*	0.25	1.25	0.01	0.05	1	1	4	4
Heather - *Calluna vulgaris*	0	1.25	0	0.05	0	1	0	4
Tutsan - *Hypericum androsaemum*	0	5	0	0.2	0	2	0	8
Ground Ivy - *Glechoma hederacea*	0	1.25	0	0.05	0	1	0	4
Wood Avens - *Geum rivale*	0	6.25	0	0.25	0	2	0	8

Table 5.40 Bridgepark Flora Results of Exclosure 2005-2006

Bridgepark Flora Results of Control Plot 2005-2006	**2005 Total % Cover**	**2006 Total % Cover**	**2005 Mean % Cover**	**2006 Mean % Cover**	**2005 Frequency**	**2006 Frequency**	**2005 Species % Frequency**	**2006 Species % Frequency**
Common Species								
Bramble - *Rubus fruticosus*	156.5	102	6.26	4.08	25	25	100	100
Enchanters Nightshade - *Circaea lutetiana*	177.8	90.8	7.11	3.63	25	22	100	88
Ivy - *Hedera helix*	58	38.8	2.32	1.55	22	19	88	76
Moss - *Musci sp.*	1761	1400	70.44	56	25	25	100	100
Lords and Ladies - *Arum maculatum*	20.75	183	0.83	7.3	7	23	28	92
Woodland Species								
Common Dog Violet - *Viola riviniana*	5.75	2.5	0.23	0.1	3	2	12	8
Grass Sp. - *Gramineae sp.*	37	7.5	1.48	0.3	7	4	28	16
Uncommon Species								
Honeysuckle - *Lonicera periclymenum*	1.75	2.5	0.07	0.1	2	2	8	8
Wild Strawberry - *Fragaria vesca*	2	0	0	0	2	0	8	0
Primrose - *Primula vulgaris*	1.5	3.75	0.06	0.15	1	2	4	8
Common Twayblade - *Listera ovata*	0	3.75	0	0.15	0	1	0	4
Yellow Pimpernel - *Lysimachia nemorum*	0	11.3	0	0.45	0	3	0	12
Bracken - *Pteridium aquilinum*	0.5	0	0.02	0	1	0	4	0

Table 5.41 Bridgepark Flora Results of Control Plot 2005-2006

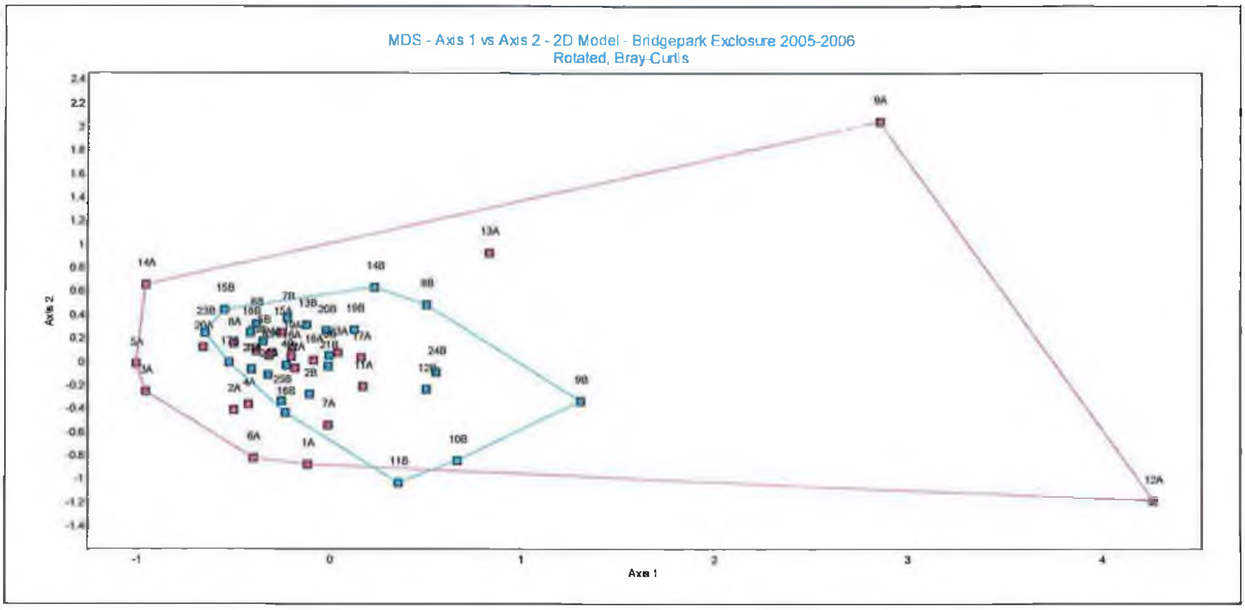


Figure 5.54 MDS Plot Bridgepark of Exclosure 2005-2006

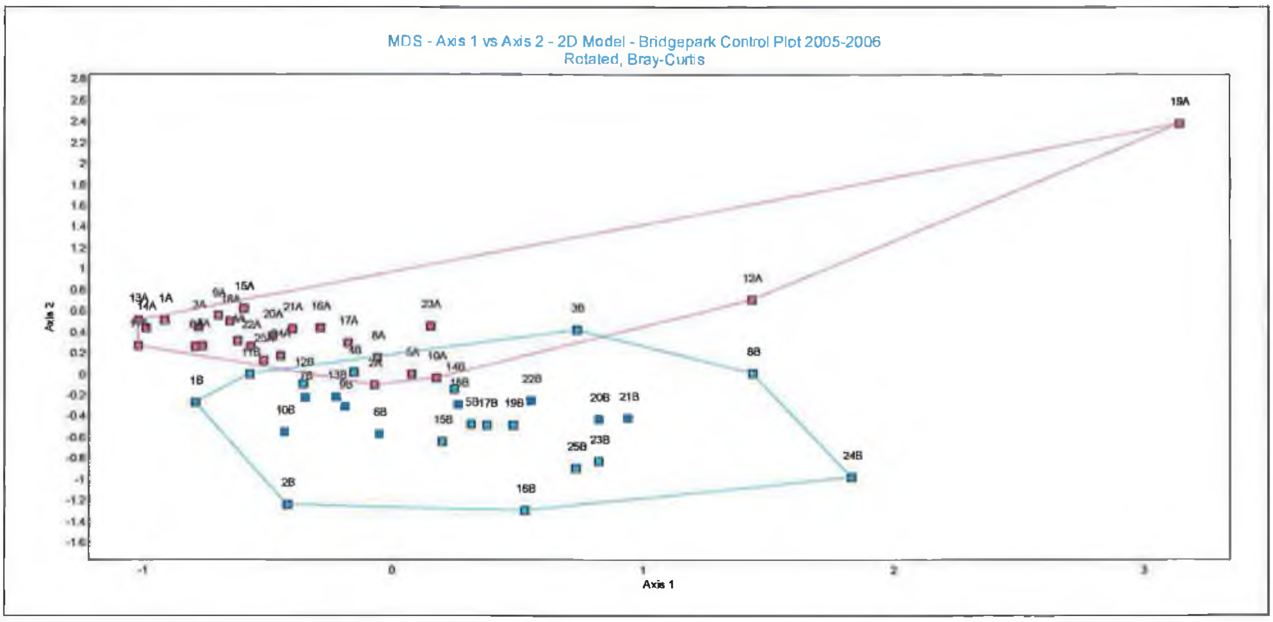


Figure 5.55 MDS Plot Bridgepark of Control Plot 2005-2006

5.5.2 Moynish

In the exclosure on Moynish 4 tree and scrub species were recorded as regenerating and included *Frangula alnus, Fraxinus excelsior, Crataegus monogyna* and *Ilex aquifolium* (Table 5.42). An increase in regeneration from 2005 to 2006 was recorded for all the species. The main regeneration was noted for *Fraxinus excelsior* of which there was an increase of 1380 seedlings in one year. The number of *Ilex aquifolium* seedlings decreased because they developed into saplings. There was no *Primula vulgaris* plants recorded in the deer exclosure during the survey. The average height in the exclosure greatly increased by 14.02 % and this increase was mainly due to the growth of *Rubus fruticosus* and *Gramineae sp.* Two species were recorded in flower only in 2006 and were *Viola riviniana* and *Fragaria vesca.* A total of 22 flora species were recorded in the herb layer of the exclosure 2005-2006 and the results are summarised in Table 5.45. These species were organised into groups using TWINSPAN: (i) Common Species (ii) Woodland Species (iii) Uncommon Species and the raw data is available in Appendix 3. The increases in growth from 2005 -2006 were very slight especially among the species in the common group. *Lonicera periclymenum* recorded the greatest increase in percentage cover from 2005-2006. There were a number of new species recorded in 2006 including *Oxalis acetosella, Glechoma hederacea* and *Leguminosae sp.* The most noticeable decrease of percentage cover was recorded for *Circaea lutetiana* which may be caused by the increase in competition. It is also likely that this decrease was because the exclosure was surveyed a few weeks earlier in 2006 than in 2005 and it may not have been fully established at the time of surveying. The percentage cover of *Musci sp.* was also down on the value recorded in 2005 but it coincides with an increase in the percentage cover of leaf litter and was probably less evident. The MDS Plot shows some overlap of the samples and the samples are grouped relatively near each other (Figure 5.56). A P-Value of 0.001 was established when the data from 2005 and 2006 were entered into the ANOSIM method. This is a significant value meaning that the composition of the samples is similar. The value of this similarity was calculated using SIMPER and was 81.06%.

The control plot on Moynish only recorded two regenerating tree species *Fraxinus excelsior* and *Ilex aquifolium* (Table 5.42). *Fraxinus excelsior* seedlings were only recorded in 2006. The number of *Ilex aquifolium* saplings remained static however the number of seedlings decrease by 50 %. Only one *Primula vulgaris* plant was recorded in both surveys. There was only a very slight increase in average height of the vegetation and no species were recorded flowering. In total 18 flora species were recorded in the ground layer within the control plot and the results are shown in Table 5.46. The data for 2005 and 2006 was arranged into groups using TWINSPAN and the same groupings as was used for the exclosure were used on this data. The percentage cover more frequently decreased in value than increased. All the common species recorded losses in the amount of percentage cover. Some species decreased so much that they were not present during the 2006 survey. These included *Sanicula europaea, Dryopteris filix-mas, Galium odoratum, Lonicera periclymenum* and *Oxalis acetosella.* There were also some new species that were only present in 2006 and they were *Ajuga reptans, Fragaria vesca* and *Fiplipendula ulmaria.* Their percentage cover and frequency were very low. *Orchis mascula* was present in this control plot and increased slightly in 2006. However it was not recorded in flower at the time of surveying unlike the exclosure in Creggaun. The percentage cover of *Musci sp* dropped in 2006 as the leaf litter and bare ground percentage cover of the area increased. The MDS Plot showed some overlap in the samples and some samples that were spatial significantly apart (Figure 5.74). The ANOSIM result comparing the data collected in 2005 and 2006 was P-Value 0.001 which is a significant similarity. The value of this similarity according to the SIMPER calculation is 72.44% which a relatively high degree of similarity.

Moynish Exclosure & Control Plot Results 05-06	**Exc 2005 Saplings**	**Exc 2006 Saplings**	**Exc 2005 Seedlings**	**Exc 2006 Seedlings**	**CP 2005 Saplings**	**CP 2006 Saplings**	**CP 2005 Seedlings**	**CP 2006 Seedlings**
Alder Buckthorn - *Frangula alnus*	6	7	0	10	0	0	0	0
Ash - *Fraxinus excelsior*	1	0	2	1382	0	0	0	13
Hawthorn - *Crataegus monogyna*	0	0	0	1	0	0	0	0
Holly - *Ilex aquifolium*	7	26	23	18	2	2	10	5
No. Of *Primula vulgaris*	0	0			1	1		
Average Height of Vegetation	9.78	23.8			5	5.17		
No. Of Species in Flower	0	2			0	0		

Table 5.42 Moynish Exclosure & Control Plot Results 2005-2006

Moynish Leaf Litter/Bare Ground Results of Exc & CP 2005-2006	**Exc 2005**	**Exc 2006**	**CP 2005**	**CP 2006**
Total % Cover	563.8	919.1	997.1	1446
Mean % Cover	22.55	36.76	39.88	57.84
Frequency	25	25	25	25
Species % Frequency	100	100	100	100

Table 5.43 Moynish Leaf Litter Results of Exclosure and Control Plot 2005-2006

Moynish	**Exc 2005-2006**	**CP 2005-2006**
ANOSIM Result	P-Value 0.001	P-Value 0.001
SIMPER Result	Ave Sim 81.06%	Ave Sim 72.44%

Table 5.44 Moynish ANOSIM and SIMPER Results 2005-2006

Moynish Flora Results of Exclosure 2005	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	2006 Species % Frequency
Common Species								
Bramble - *Rubus fruticosus*	102.8	105	4.11	4.2	24	24	96	96
Common Dog Violet - *Viola riviniana*	128.8	131	5.15	5.24	24	22	96	88
Ivy - *Hedera helix*	85	92.5	3.4	3.7	22	25	88	100
Moss - *Musci sp.*	1152	1029	46.08	41.16	25	25	100	100
Enchanters Nightshade - *Circaea lutetiana*	213.5	52.5	8.54	2.1	16	21	64	84
Wild Strawberry - *Fragaria vesca*	101.5	102.3	4.04	4.09	19	21	76	84
Woodland Species								
Male Fern - *Dryopteris filix-mas*	5	6.25	0.2	0.25	2	4	8	16
Honeysuckle - *Lonicera periclymenum*	44.5	60	1.78	2.4	13	18	52	72
Yellow Pimpernel - *Lysimachia nemorum*	22.75	11.25	0.91	0.45	8	4	32	16
Bugle - *Ajuga reptans*	19	22.75	0.76	0.91	8	8	32	32
Grass Sp. - *Gramineae sp.*	24.5	32.75	0.98	1.31	3	4	12	16
Wood Sorrel - *Oxalis acetosella*	0	11.25	0	0.45	0	3	0	12
Uncommon Species								
Perforate St. John's-Wort - *Hypericum perforatum*	9.75	10	0.39	0.4	2	2	8	8
Wood Sanicle - *Sanicula europaea*	15	18.25	0.6	0.73	2	2	8	8
Ground Ivy - *Glechoma hederacea*	0	2.5	0	0.1	0	1	0	4
Vetch Sp. - *Leguminosae sp.*	6.25	0	0.25	0	1	0	4	0
Wood Avens - *Geum rivale*	2.5	2.5	0.1	0.1	1	2	4	8
Early Purple Orchid - *Orchis mascula*	1.25	2.5	0.05	0.1	1	1	4	4
Lords and Ladies - *Arum maculatum*	1.25	6.25	0.05	0.25	1	2	4	8
Tutsan - *Hypericum androsaemum*	1.25	1.5	0.05	0.06	1	1	4	4
Burnet Rose - *Rosa pimpinellifolia*	0.25	1	0.01	0.04	1	1	4	4

Table 5.45 Moynish Flora Results of Exclosure 2005-2006

Moynish Flora Results of Control Plot 2005-2006	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	2006 Species % Frequency
Common Species								
Common Dog Violet - *Viola riviniana*	75.25	32.5	3.01	1.3	25	16	100	64
Enchanters Nightshade - *Circaea lutetiana*	66.75	30	2.67	1.2	25	14	100	56
Ivy - *Hedera helix*	91.95	47.5	3.68	1.9	25	19	100	76
Moss - *Musci sp.*	1196	867.8	47.84	34.71	25	25	100	100
Woodland Species								
Wood Anemone - *Anemone nemorosa*	12.75	30.75	0.51	1.23	6	12	24	48
Grass Sp. - *Gramineae sp.*	6.25	3.75	0.25	0.15	7	2	28	8
Bramble - *Rubus fruticosus*	8	2.5	0.32	0.1	6	2	24	8
Early Purple Orchid - *Orchis mascula*	9	15.5	0.36	0.62	3	6	12	24
Lords and Ladies - *Arum maculatum*	6.75	13.75	0.27	0.55	4	7	16	28
Wood Sanicle - *Sanicula europaea*	15.25	0	0.61	0	5	0	20	0
Uncommon Species								
Male Fern - *Dryopteris filix-mas*	1.75	0	0.07	0	2	0	8	0
Bugle - *Ajuga reptans*	0	3.75	0	0.15	0	2	0	8
Wild Strawberry - *Fragaria vesca*	0	3.75	0	0.15	0	2	0	8
Woodruff - *Galium odoratum*	3.5	0	0.14	0	1	0	4	0
Primrose - *Primula vulgaris*	0.75	1.25	0.03	0.05	1	1	4	4
Honeysuckle - *Lonicera periclymenum*	0.5	0	0.02	0	1	0	4	0
Wood Sorrel - *Oxalis acetosella*	8.25	0	0.33	0	1	0	4	0
Meadowsweet - *Filipendula ulmaria*	0	1.25	0	0.05	0	1	0	4

Table 5.46 Moynish Flora Results of Control Plot 2005-2006

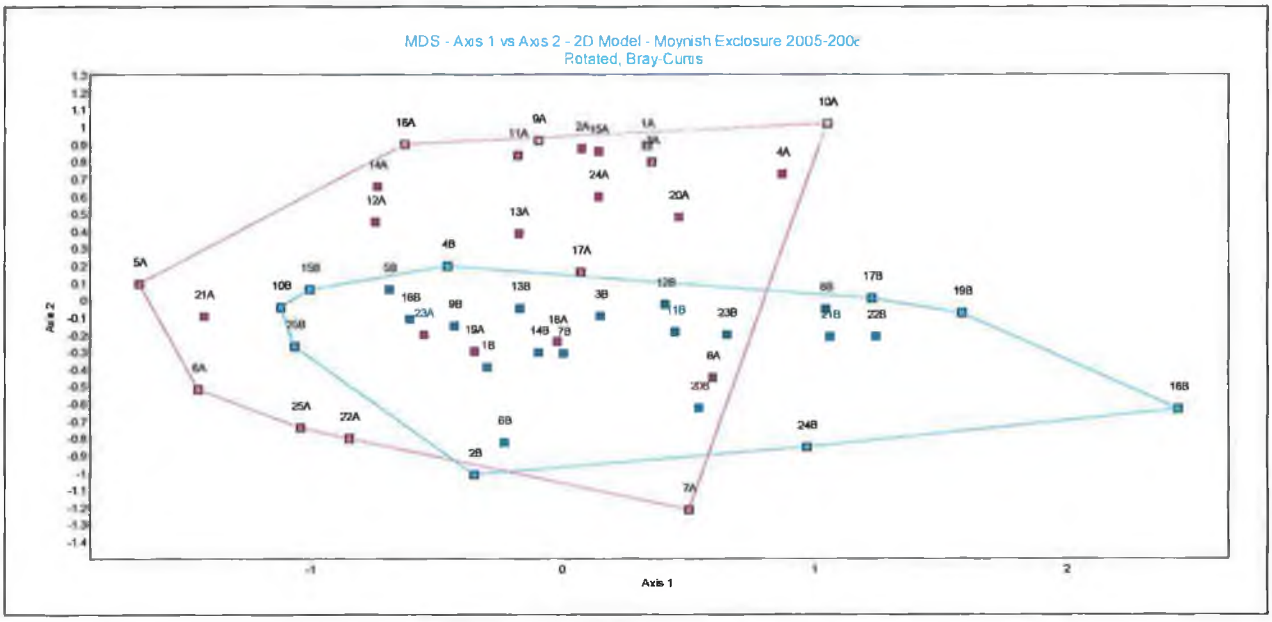


Figure 5.56 MDS Plot Moynish of Exclosure 2005-2006

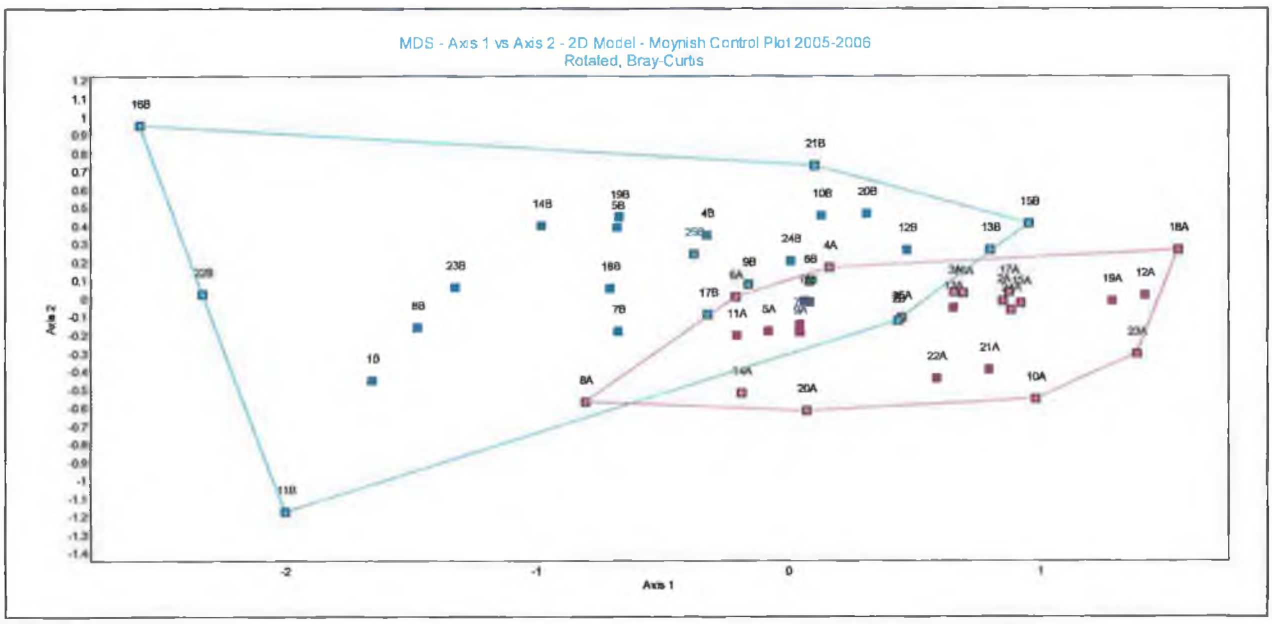


Figure 5.57 MDS Plot Moynish of Control Plot 2005-2006

5.5.3 Creggaun

In the deer exclosure on Creggaun 6 tree and shrub species were recorded regenerating (Table 5.47). The regeneration of *Prunus spinosa* and *Crataegus monongyna* increased slightly in 2006, while there was a dramatic rise in the number of *Fraxinus excelsior* seedlings. *Quercus robur* seedlings were recorded in both years and it will be interesting to monitor the success of their growth. The number of *Primula vulgaris* plants noted remained static and none were recorded at the time of surveying in bloom. The average height of the vegetation increased by almost 10 cm. This was mainly due to the flowering of *Orchis mascula* (Plate No. 5.2) which had tall stems and was recorded flowering in 2006 and again this year. In total 59 *Orchis mascula* plants were recorded with blooms and it was the only area in the woodland where they were recorded in flower. *Orchis mascula* plants directly outside the exclosure did not flower at the same time. Deer broke into the exclosure in spring of this year and ate the flowering *Orchis mascula* demonstrating their susceptibility to grazing.

Plate No. 5.2 Flowering *Orchis mascula* in Creggaun Exclosure 2006.

Also recorded flowering in 2006 was *Oxalis acetosella, Sanicula europaea* and *Viola riviniana.* The raw data was organised by TWINSPAN and is in Appendix 3. The data was divided into three groups (i) Common Species (ii) Woodland Species and (iii) Uncommon Species and the data is shown in Table 5.50. The Total Percentage Cover, Mean Percentage Cover, Frequency and Species % Frequency was calculated for each species and summarised in Table No. The flora survey identified 22 species when the results of 2005 and 2006 were combined. Both increases and decreases in percentage cover and frequencies were recorded from 2005 to 2006. *Geum rivale* which was not recorded in 2005 was present in 2006 and *Cirsium palustre* was not recorded 2006. The main species that an increase in growth was recorded for were *Oxalis acetosella, Orchis mascula, Arum maculatum, Ranunculus ficaria* and *Lonicera periclymenum.* There were slight decreases in some of the more common species such as *Hedera helix, Circaea lutetiana* and *Rubus fruiticosus.* There was also a decrease in the percentage cover of *Musci sp.* recorded, which may be linked to the increase in percentage cover of leaf litter. There were very few species which could be associated with limestone grassland in the exclosure. The ordination experiments demonstrated that the composition of both years is very similar and this similarity is visible clear in the MDS Plot (Figure 5.58) which plots the samples on top of each other. The ANOSIM result of P-Value 0.001 further denotes the similarity of the groups. The SIMPER result of an average similarity of 82.65 % is very high signifying that there has only being slight change in the flora of the exclosure. This indicates that the flora composition in the exclosure is stable.

In the control plot of Creggaun 5 species of tree and shrub were recorded regenerating (Table 5.47). There was slight an increase in the regeneration of *Fraxinus excelsior* but mainly there were decreases recorded. A *Fraxinus excelsior* sapling and four *Ilex aquifolium* saplings were not recorded in 2006 as they had died from browsing and bark stripping. This area had a good population of *Primula vulgaris* plants with 82 recorded in 2005. This figure had reduced to 79 in 2006 and no plant was recorded in flower. There was a slight increase in the average height of the vegetation and this was mainly due to the increase in *Arum maculatum* which was recorded up to 25 cm in height. Both *Ranunculus ficaria* and *Fragaria vesca* were recorded in flower in 2006. *Orchis mascula* was not recorded during the survey in the control plot. The raw data collected during the survey was organised using TWINSPAN and the same groups as assigned to the exclosure results were formed. In total 19 species were recorded in 2005 and 22 in 2006 and the results are shown in Table 5.51. The new species included *Dryopteris filix-mas, Conopodium majus* and *Ranunculus repens.* The majority of the species had decreases in percentage cover from 2005 to 2006. There were noticeable decreases in *Viola riviniana, Sanicula europaea, Oxalis acetosella, Hedera helix* and *Rubus fruticosus.* This may be partly associated with the increase in leaf litter and bare ground which increased by over 10 %. The MDS Plot showed the samples as two distinct groups with very little spatial overlap indicating that there is a marked difference between the samples taken in 2005 and 2006 (Figure 5.59). When the data was entered into the group test of ANOSIM a P-Value of 0.033 was established. This value is not significant indicating that there is not a major similarity between the two groups. The SIMPER result of average similarity was 76.32 % showing that there has been a slight change in the flora composition from 2005 to 2006.

Creggaun Exclosure & Control Plot Results 05-06	Exc 2005 Saplings	Exc 2006 Saplings	Exc 2005 Seedlings	Exc 2006 Seedlings	CP 2005 Saplings	CP 2006 Saplings	CP 2005 Seedlings	CP 2(Seedli
Ash - *Fraxinus excelsior*	0	0	8	188	1	0	4	9
Blackthorn - *Prunus spinosa*	1	1	0	1	0	0	0	1
Hawthorn - *Crataegus monogyna*	0	1	4	6	0	0	9	8
Hazel - *Corylus avellana*	0	0	1	1	1	0	1	0
Holly - *Ilex aquifolium*	4	4	1	1	28	25	16	16
Oak - *Quercus robur*	0	0	2	2	0	0	0	0
No. Of Primula vulgaris	12	12			82	79		
Average Height of Vegetation	8.67	18.52			8.95 cm	9.84 cm		
No. Of Flowering Species	0	4			0	2		
No. Of Flowering *Orchis mascula*	0	59			0	0		

Table 5.47 Creggaun Exclosure and Control Plot Results 2005-2006

Creggaun Leaf Litter/Bare Ground Results of Exc & CP 2005-2006	Exc 2005	Exc 2006	CP 2005	CP 2006
Total % Cover	345	3659.8	238	879.25
Mean % Cover	13.8	14.39	24.6	35
Frequency	25	25	25	24
Species % Frequency	100	100	100	96

Table 5.48 Leaf Litter Results of Creggaun Exclosure and Control Plot 2005-2006

Creggaun	Exc 2005-2006	CP 2005-2006
ANOSIM Result	P-Value 0.001	P-Value 0.033
SIMPER Result	Ave Sim 82.65%	Ave Sim 76.32%

Table 5.49 Creggaun ANOSIM and SIMPER Results 2005-2006

Creggaun Is Flora Results of Exclosure 2005	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	2006 Species % Frequency
Common Species								
Ivy - *Hedera helix*	243.3	234.5	9.73	9.38	24	25	96	10[illegible]
Moss - *Musci sp.*	1464	1379	58.56	55.16	25	25	100	10[illegible]
Wood Sorrel - *Oxalis acetosella*	206.6	263	8.26	10.52	24	25	96	10[illegible]
Enchanters Nightshade - *Circaea lutetiana*	59	33.75	2.36	1.35	21	15	84	6[illegible]
Early Purple Orchid - *Orchis mascula*	24.5	84	0.98	3.36	8	20	32	8[illegible]
Woodland Species								
Wood Sanicle - *Sanicula europaea*	7	10	0.28	0.4	5	6	20	2[illegible]
Common Dog Violet - *Viola riviniana*	27.75	31.25	1.11	1.25	13	13	52	4[illegible]
Common Twayblade - *Listera ovata*	16.75	17.5	0.67	0.7	8	6	32	2[illegible]
Lesser Celandine - *Ranunculus ficaria*	8.5	17.5	0.34	0.7	4	3	16	1[illegible]
Bramble - *Rubus fruticosus*	47.25	40	1.89	1.6	17	13	68	5[illegible]
Lords and Ladies - *Arum maculatum*	2	11.25	0.08	0.45	2	6	8	2[illegible]
Honeysuckle - *Lonicera periclymenum*	2	8.5	0.08	0.34	3	5	12	2[illegible]
Creeping Buttercup - *Ranunculus repens*	2.5	6.25	0.1	0.25	1	4	4	1[illegible]
Yellow Pimpernel - *Lysimachia nemorum*	1.25	6.75	0.05	0.27	1	3	4	1[illegible]
Grass Sp. - *Gramineae sp.*	19.75	17.5	0.79	0.7	6	4	24	1[illegible]
Male Fern - *Dryopteris filix-mas*	1.25	5	0.05	0.2	1	3	4	1[illegible]
Wood Avens - *Geum rivale*	0	4	0	0.16	0	3	0	1[illegible]
Uncommon Species								
Wild Strawberry - *Fragaria vesca*	6.25	5	0.25	0.2	2	2	8	[illegible]
Dandelion - Taraxacum *officinale agg.*	1.25	3.75	0.05	0.15	1	1	4	[illegible]
Ground Ivy - *Glechoma hederacea*	2.75	1.25	0.11	0.05	2	1	8	[illegible]
Marsh Thistle - *Cirsium palustre*	3.25	0	0.13	0	1	0	4	[illegible]
Primrose - *Primula vulgaris*	8.75	6.25	0.35	0.25	1	2	4	[illegible]

Table 5.50 Creggaun Flora Results of Exclosure 2005-2006

Creggaun Flora Results of Control Plot 05-06	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species Frequency %	2006 Species Frequency %
Common Species								
Ivy - *Hedera helix*	98.25	51.3	3.93	2.05	25	22	100	88
Moss - *Musci sp.*	1448	1003.5	57.9	40.14	25	25	100	100
Wood Sorrel - *Oxalis acetosella*	64.25	32.5	2.57	1.3	20	19	80	76
Ground Ivy - *Glechoma hederacea*	41.5	32.5	1.66	1.3	14	13	56	52
Woodland Species								
Wood Sanicle - *Sanicula europaea*	20.5	3.75	0.82	0.15	18	2	72	8
Honeysuckle - *Lonicera periclymenum*	8.5	2.5	0.34	0.1	4	2	16	8
Lords and Ladies - *Arum maculatum*	8.25	10	0.33	0.4	3	5	12	20
Wild Strawberry - *Fragaria vesca*	19.25	20	0.77	0.8	10	7	40	28
Common Dog Violet - *Viola riviniana*	41	16.25	1.64	0.65	18	12	72	48
Grass Sp. - *Gramineae sp.*	8	15	0.32	0.6	5	10	20	40
Bramble - *Rubus fruticosus*	41.25	17.5	1.65	0.7	13	10	52	40
Enchanters Nightshade - *Circaea lutetiana*	9.75	23.75	0.39	0.95	11	17	44	68
Lesser Celandine - *Ranunculus ficaria*	10.75	251.25	0.43	10.05	4	24	16	96
Primrose - *Primula vulgaris*	35.5	28.25	1.42	1.13	13	10	52	40
Yellow Pimpernel - *Lysimachia nemorum*	16	28.75	0.64	1.15	8	17	32	68
Creeping Buttercup - *Ranunculus repens*	0	27.5	0	1.1	0	16	0	64
Pignut - *Conopodium majus*	0	12.5	0	0.5	0	7	0	28
Uncommon Species								
Bugle - *Ajuga reptans*	1.75	2.5	0.07	0.1	1	2	4	8
Common Twayblade - *Listera ovata*	1.75	4	0.07	0.16	1	3	4	12
Male Fern - *Dryopteris filix-mas*	0	5	0	0.2	0	1	0	4
Woodruff - *Galium odoratum*	5.25	6.25	0.21	0.25	4	3	16	12
Early Purple Orchid - *Orchis mascula*	5.5	5	0.22	0.2	2	3	8	12

Table 5.51Creggaun Flora Results of Control Plot 2005-2006

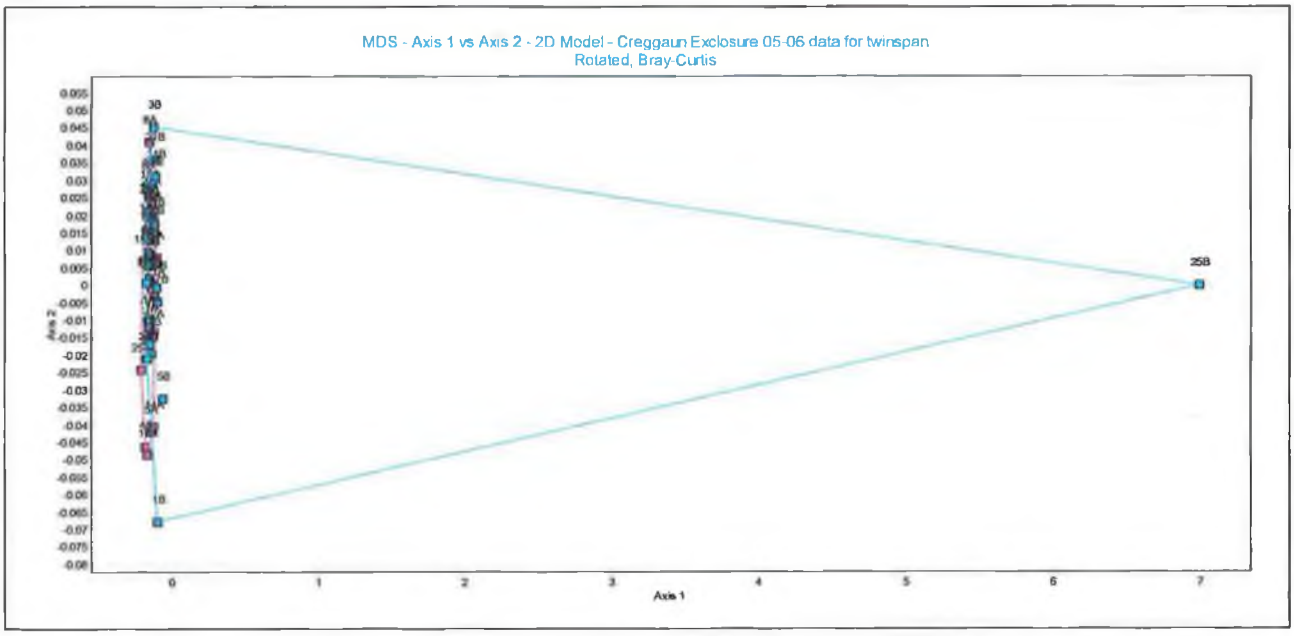


Figure 5.58 MDS Plot of Creggaun Exclosures 05-06

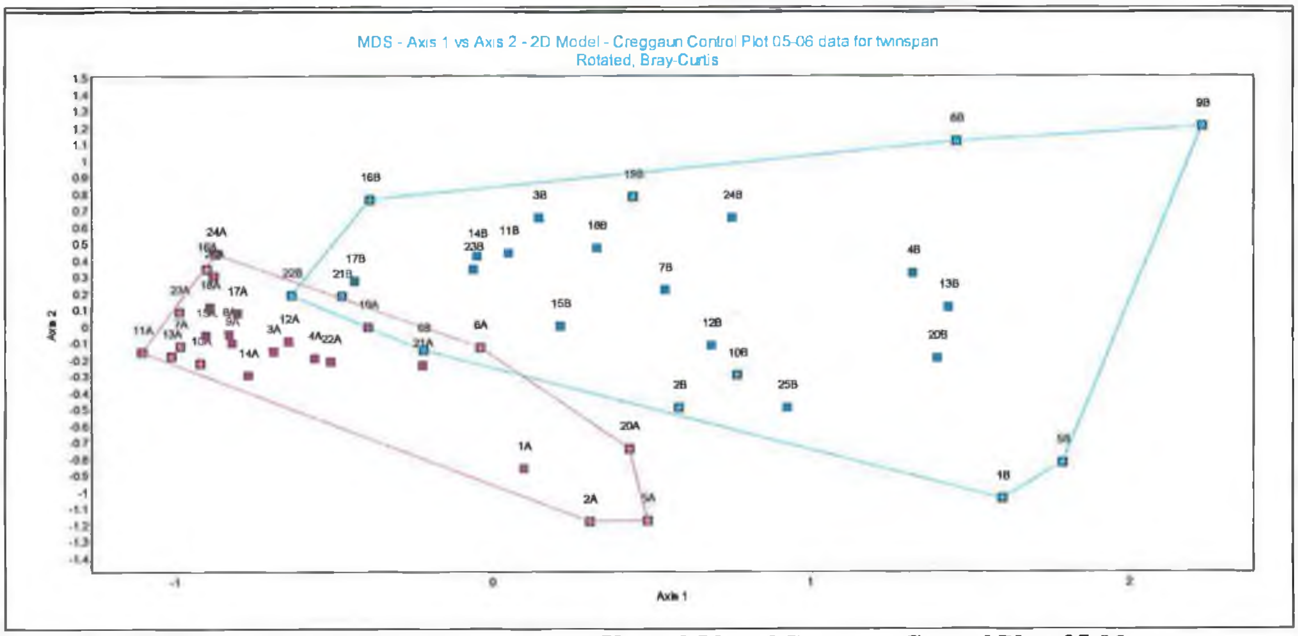


Figure 5.59 MDS Plot of Creggaun Control Plots 05-06

5.5.4 Leamnahye Island

In the deer exclosure on Leamnahye Island 6 tree species were recorded regenerating and included *Frangula alnus, Fraxinus excelsior, Prunus spinosa, Betula pendula, Crataegus monogyna* and *Ilex aquifolium* (Table 5.52). There was a slight increase in the numbers of *Prunus spinosa* and *Ilex aquifolium* from 2005 to 2006. A huge increase in *Fraxinus excelsior* seedlings was recorded in 2006 from only 2 seedlings in 2005 to 516 seedlings in 2006. The number of *Primula vulgaris* plants noted in the exclosure also increased from 1 in 2005 to 5 in 2006. The height of the vegetation in each quadrat was measured and an average height calculated. The average height increased by almost 4 cm after one year of exclusion from grazing. There was no flora species recorded in flower in 2005. In 2006 *Viola riviniana, Sanicula europaea, Glechoma hederacea* and *Conopodium majus* were all recorded in bloom. A total of 25 species were recorded in the herb layer, 24 in 2005 and 25 in 2006. *Galium verum* was only recorded in 2006. The raw data was organised by TWINSPAN and is in Appendix 3. The data was divided into three groups (i) Common Species (ii) Woodland Species and (iii) Uncommon Species and the results are shown in Table 5.55. The Total Percentage Cover, Mean Percentage Cover, Frequency and Species % Frequency was calculated for each species. In general there was a slight increase in the percentage cover and frequency of most species. A number of species decreased but this is to be expected as other species compete for space. Very few limestone grassland species were recorded as the exclosure is situated in the centre of the woodland under heavy canopy. The MDS Plot of the exclosure data from 2005 and 2006 showed the majority of the samples plotted close together signifying that the data from 2005 and 2006 is similar in composition and that their has been no astounding changes (Figure 5.60). This result was also recorded in the ANOSIM test. The results of which gave a P-Value of 0.002 which is significant. This means that there is a significant similarity between the data recorded in 2005 and in 2006. The similarity of the data was given a quantitative measure using the SIMPER test which recorded an average similarity of 66.13%. These collective results infer that although some change in the flora has occurred between 2005 and 2006 it is not a definitive change.

In the Control Plot on Leamnahye Island 4 tree species were recorded regenerating and included *Frangula alnus, Fraxinus excelsior, Prunus spinosa* and *Ilex aquifolium* (Table 5.52). Similar to the exclosure the number of *Fraxinus excelsior* seedlings increased in 2006 but not to the same extent. *Prunus spinosa* was only recorded in 2006 and the number of *Ilex aquifolium* seedlings decreased in 2006. There was no *Primula vulgaris* recorded in 2005 and in 2006 one plant was noted. The average height of vegetation slightly increased in the control area by 1.6 cm and this was mainly due to growth of *Conopodium majus* which was not present in 2005. This was also the only species recorded flowering in 2006. The data from the flora survey was divided into the same groups as the exclosure and the results are summarised in Table. 5.56. A total of 23 flora species were recorded between the two years. The number of species recorded in 2006 increased by 5 and included *Conopodium majus, Lysimacha nemorum, Rosa piminellifolia, Primula vulgaris, Lonicera periclymenum* and *Teucrium scorodonia.* There were both increases and decreases in the percentage cover and frequency of various flora species. The most noticeable increase was *Sanicula europaea* which over doubled in percentage cover. Both *Leguminosae sp* and *Fragaria vesca* decreased and were not recorded in 2006. The MDS Plot of the control data from 2005 and 2006 showed the samples plotted in two separate groups that are close together signifying that the data from 2005 and 2006 is similar in composition but that their has been some change (Figure 5.61). This result was also recorded in the ANOSIM test. The results of which gave a P-Value of 0.001 which is significant. This means that there is a significant similarity between the data recorded in 2005 and in 2006. The similarity of the data was given a quantitative measure using the SIMPER test which recorded an average similarity of 57.95%. These collective results infer that some change in the similarity of the flora composition has occurred between 2005 and 2006.

Leamnahye Exclosure & Control Plot Results 05-06	**Exc 2005 Saplings**	**Exc 2005 Seedlings**	**Exc 2006 Saplings**	**Exc 2006 Seedlings**	**CP 2005 Saplings**	**CP 2005 Seedlings**	**CP 2006 Saplings**	**CP 200 Seedlin**
Alder Buckthorn - *Frangula alnus*	1	0	1	1	0	1	0	5
Ash - *Fraxinus excelsior*	0	2	0	516	0	1	0	15
Blackthorn - *Prunus spinosa*	2	1	2	2	0	0	0	1
Birch - *Betula pendula*	0	1	0	1	0	0	0	0
Hawthorn - *Crataegus monogyna*	0	3	0	3	0	0	0	0
Holly - *Ilex aquifolium*	3	4	3	5	4	3	4	1
No. Of *Primula vulgaris*	1	5			0	1		
Average Height Of Vegetation	10.4	14.32			11 cm	12.6 cm		
No. Of Flowering Species	0	4			0	1		

Table 5.52 Leamnahye Exclosure & Control Plot Results 2005-2006

Leamnahye Leaf Litter/Bare Ground Results of Exc & CP 2005-2006	**Exc 2005**	**Exc 2006**	**CP 2005**	**CP 2006**
Total % Cover	1107	1359	1669	1742
Mean % Cover	44.28	54.36	66.76	69.68
Frequency	25	25	24	25
Species % Frequency	100	100	96	100

Table 5.53 Leaf Litter Results of Leamnahye Exclosure & Control Plot 2005-2006

Leamnahye Island	**Exc 2005-2006**	**CP 2005-2006**
ANOSIM Result	P-Value 0.002	P-Value 0.001
SIMPER Result	Ave Sim 66.13%	Ave Sim 57.95%

Table 5.54 Leamnahye ANOSIM and SIMPER Results 2005-2006

Leamnahye Flora Results of Exclosure 05-06	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	200 Species % Frequenc
Common Species								
Wood Sanicle - *Sanicula europaea*	64.25	115.8	2.57	4.63	12	24	48	9
Ivy - *Hedera helix*	132.8	116.3	5.31	4.65	22	25	88	10
Common Dog Violet - *Viola riviniana*	140.2	131.3	5.6	5.25	24	24	96	9
Moss - *Musci sp.*	445.3	210.4	18.81	8.42	23	23	92	9
Wood Sorrel - *Oxalis acetosella*	91.25	97.95	3.65	3.92	21	22	84	8
Woodland Species								
Grass Sp. - *Gramineae sp.*	107.3	85	4.29	3.4	14	17	6	6
Ground Ivy - *Glechoma hederacea*	32.25	27.5	1.29	1.1	14	14	56	5
Vetch Sp. - *Leguminosae sp.*	4.75	22.85	0.19	0.91	3	11	12	4
Enchanters Nightshade - *Circaea lutetiana*	89	41.6	3.56	1.66	19	18	76	7
Wood Anemone - *Anemone nemorosa*	71.5	64.1	2.86	2.56	19	12	76	4
Bramble - *Rubus fruticosus*	55	61.25	2.2	2.45	24	2	96	
Primrose - *Primula vulgaris*	9.25	11	0.37	0.44	3	5	12	2
Wild Strawberry - *Fragaria vesca*	51.5	21.6	2.06	0.86	19	11	76	4
Greater Wood Rush - *Luzula sylvatica*	45.25	47.25	1.81	1.89	13	12	52	4
Honeysuckle - *Lonicera periclymenum*	9.5	10	0.38	0.4	3	2	12	
Woodruff - *Galium odoratum*	23.5	18.75	0.94	0.75	11	10	44	4
Pignut - *Conopodium majus*	5.5	52	0.22	2.08	1	11	4	4
Wood Avens - *Geum rivale*	13.25	10	0.53	0.4	3	3	132	
Uncommon Species								
Lords and Ladies - *Arum maculatum*	5.5	15	0.22	0.6	1	3	4	
Burnet Rose - *Rosa pimpinellifolia*	0.5	1	0.02	0.04	1	1	4	
Tormentil - *Potentilla erecta*	2	4	0.08	0.16	1	1	4	
Tutsan - *Hypericum androsaemum*	1	2	0.04	0.08	1	1	4	
Yellow Pimpernel - *Lysimachia nemorum*	1.25	6.25	0.05	0.2	1	2	4	
Perforate St. John's-Wort - *Hypericum perforatum*	2.5	11.25	0.1	0.45	1	3	4	
Ladies Bedstraw - *Galium verum*	0	1.25	0	0.05	0	1	0	

Table 5.55 Leamnahye Flora Results of Exclosure 2005-2006

Leamnahye Flora Results of Control Plot 05-06	2005 Total % Cover	2006 Total % Cover	2005 Mean % Cover	2006 Mean % Cover	2005 Frequency	2006 Frequency	2005 Species % Frequency	2006 Species Frequency
Common Species								
Ivy - *Hedera helix*	42.25	48.75	1.69	1.95	22	21	88	84
Common Dog Violet - *Viola riviniana*	68.75	67.5	2.75	2.7	22	22	88	88
Moss - *Musci sp.*	469.3	399.5	18.77	15.98	25	21	100	84
Wood Sorrel - *Oxalis acetosella*	134.3	50	5.37	2	25	14	100	56
Wood Sanicle - *Sanicula europaea*	14	32.75	0.56	1.31	9	15	36	60
Bramble - *Rubus fruticosus*	11.5	51.25	0.46	2.05	9	22	36	88
Woodland Species								
Enchanters Nightshade - *Circaea lutetiana*	2.5	17.5	0.1	0.7	3	13	12	52
Grass Sp. - *Gramineae sp.*	30	23.25	1.2	0.93	13	10	52	40
Greater Wood Rush - *Luzula sylvatica*	1.25	5	0.05	0.2	1	2	4	8
Ground Ivy - *Glechoma hederacea*	6.75	5	0.27	0.2	5	3	20	12
Lords and Ladies - *Arum maculatum*	40.75	63	1.63	2.52	2	21	8	84
Wood Anemone - *Anemone nemorosa*	10	124	0.4	49.6	4	24	12	96
Pignut - *Conopodium majus*	0	50	0	2	0	18	0	72
Uncommon Species								
Vetch Sp. - *Leguminosae sp.*	0.5	0	0.02	0	1	0	4	0
Wood Avens - *Geum rivale*	0.5	2.5	0.02	0.1	1	2	4	8
Wild Strawberry - *Fragaria vesca*	2.5	0	0.1	0	2	0	8	0
Woodruff - *Galium odoratum*	1.25	5	0.05	0.2	1	2	4	8
Yellow Pimpernel - *Lysimachia nemorum*	0	1.25	0	0.05	0	1	0	4
Burnet Rose - *Rosa pimpinellifolia*	0	2.5	0	0.1	0	2	0	8
Primrose - *Primula vulgaris*	0	5	0	0.2	0	1	0	4
Honeysuckle - *Lonicera periclymenum*	0	3.75	0	0.15	0	1	0	4
Wood Sage - *Teucrium scorodonia*	0	1.25	0	0.05	0	1	0	4

Table 5.56 Leamnahye Flora Results of Control Plot 2005-2006

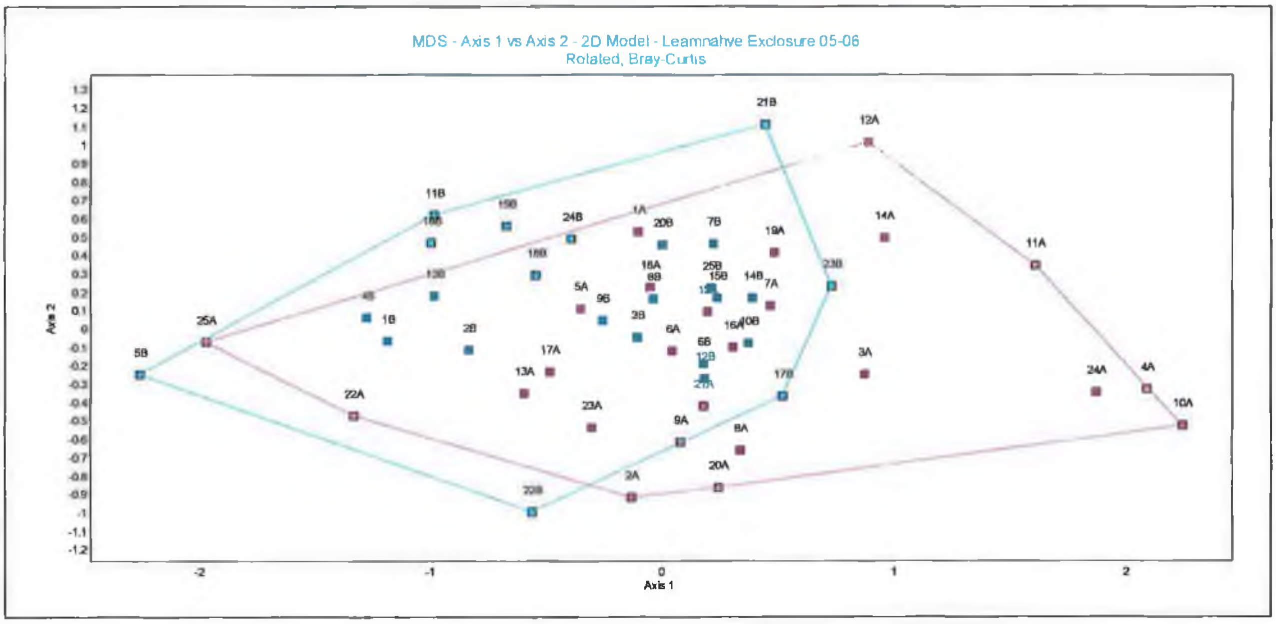


Figure 5.60 MDS Plot of Leamnahye Exclosure2005-2006

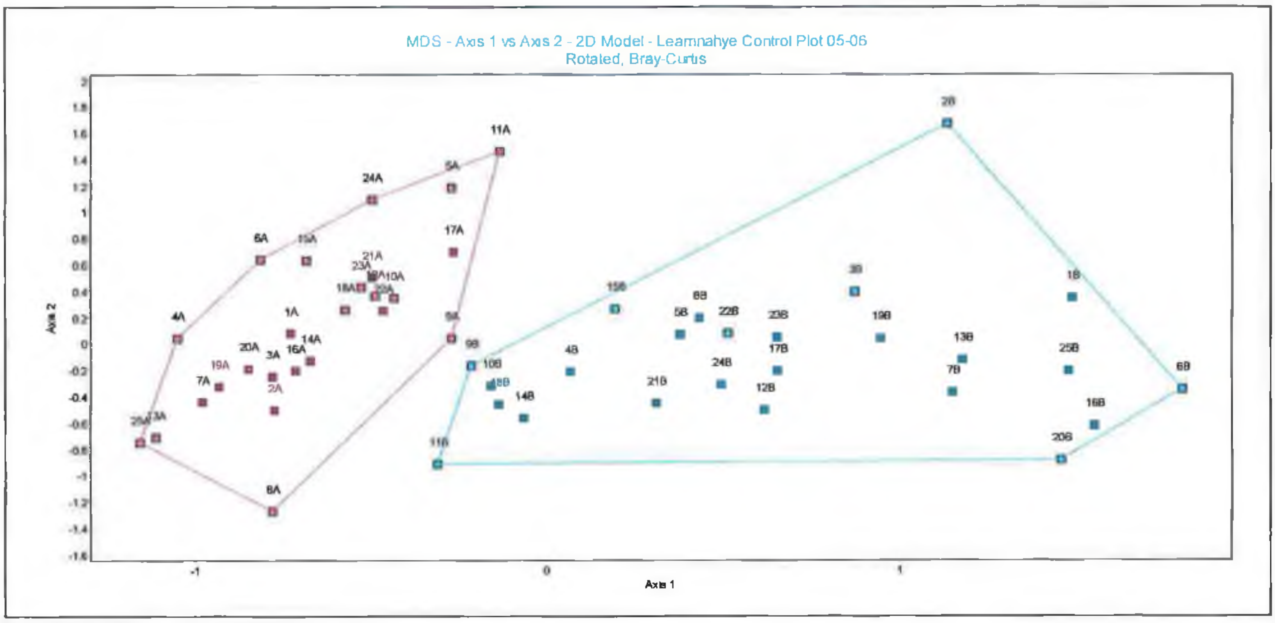


Figure 5.61 MDS Plot of Leamnahye Control Plot 2005-2006

6. Discussion

6 Discussion

6.1 Bridgepark: Woodland Structure and Classification

Bridgepark contains 18 species of trees and shrubs and there are both compartments of highly-modified mixed conifer and broadleaved woodland, and semi-natural broadleaved woodland and scrub. The woodland structure is also varied with mature, transitional and recent woodland areas. This area of Partry Estate was recorded in historic documents as rocky and shrubby pasture from 1690. However in 1838 the vegetation was recorded as rocks and brushwood signifying that there was a change in the grazing regime allowing secondary woodland to colonise this area. The development of woodland and its current structures were therefore very much influenced by the grazing management of the land. This colonisation process would also have been influenced by edaphic factors such as the shallow soil depth, climate and wind exposure. The planting of conifer species in the area has had a profound effect on the present day structure and composition of Bridgepark. *Pinus sylvestris* and *Larix decidua* were planted in Bridgepark since 1838 and one area of conifers was recorded on the Ordnance Survey map of that year. One of the advantages the presence of these species had on the development of woodland was that they were fast growing providing protection from wind throw to other regenerating species. Although these species may have helped with the development of Bridgepark, their presence denotes that areas of the woodland are not semi-natural native woodland and this reduces the conservation value of this habitat.

The ecological survey in 2005 identified 14 species of trees growing in the area of woodland that has colonised since 1914 and is referred to in this study as Zone 1. This area of new growth is mapped in Appendix 4. The species recorded included *Fraxinus excelsior, Prunus spinosa, Juniperus communis, Malus sylvestris, Crataegus monogyna, Corylus avellana, Ilex aquifolium,* Larix *decidua, Pinus sylvestris, Betula pendula, Sorbus aucuparia, Quercus robur* and *Euonymus europaeus.* These species are all present in the mature area of the woodland in Zone 2 and this transitional growth was colonised from there. In Zone 2 the structure of the woodland is mature with the same 14 tree species as in Zone 1 and is classed as Mixed Broadleaved woodland, Ash/Hazel woodland and Mixed Conifer/Broadleaved woodland. This area of Bridgepark dates from about the 1880s when planting of *Larix decidua, Pinus sylvestris* and *Fagus sylvatica* took place. Both zones were recorded as well drained which is due to the free draining nature of the soils over limestone pavement. The ground cover in Zone 1 was mostly frequently recorded as limestone grassland species which is a further indication of its recent colonisation. Leaf litter was only recorded in 37% of quadrats and had a mean percentage cover of 10.93%. These results further attest to the openness of the canopy and the lack of large forest trees in this area. In Zone 2 both rocks and mossy boulders, and leaf litter were the main types of ground cover recorded. Leaf litter was recorded in 99% of quadrats and had a mean percentage cover of almost 30%. In some quadrats under conifers and under *Fagus sylvatica* stands leaf litter was recorded at 100%. In both zones a ground cover of woodland plants was rarely recorded during the survey indicating that there is a depleted vegetation layer. The light composition of Zone 1 was mainly recorded as bright and the average percentage cover was calculated as 25%. This is as a result of the open and recent nature of the young growth in this area and a closed canopy has not yet developed. Zone 2 exhibited a closed canopy in areas that is typical of mature forest and the light composition was described as moderate to dim with an average percentage cover of 60.29% recorded. This is due to the more developed nature of this area and the presence of larger forest trees. Zone 3 consisted of wetland woodland and was not surveyed in full. This area beside Keel Bridge was not recorded as woodland in 1914. A species inventory of eight tree and shrub species was recorded. This was the only area that *Alnus glutinosa, Salix caprea, Frangula alnus* and *Viburnum opulus* were recorded. This site of native woodland was classed as Wet willow-alder-ash woodland WN6 and is associated with permanently waterlogged sites. There is a stone causeway between this woodland and the lake built as part of the famine works and it has facilitated the growth of this woodland by preventing drainage of the site.

Zone 1 consisted of transitional woodland that was dominated by *Fraxinus excelsior, Corylus avellana* or *Pinus sylvestris* and immature growth, while Zone 2 was classed as mainly Mixed Broadleaved woodland dominated by *Pinus sylvestris, Fraxinus excelsior* and *Corylus avellana. Corylus avellana* was recorded most frequently in both the canopy and understorey layers in both zones but there was little evidence of regeneration. *Corylus avellana* is freely grazed by livestock and deer but where grazing pressure is low it is capable of invading grassland communities and persisting as an understorey tree as forest develops (Kelly & Kirby 1983). It was the most commonly recorded tree, present in all the categories of woodland types growing in the sub-canopy under the larger forest trees of *Fraxinus excelsior, Pinus sylvestris* and *Larix decidua* in Zone 2. In Zone 1 it was mainly a canopy tree as larger forest trees have not developed yet. Its abundance attests to its colonising abilities and the present lack of regeneration may be attributed to the reoccurrence of grazing in the area by deer. *Corylus avellana* is notoriously difficult to age using tree coring, as any one stool has poles of a variety of ages and sizes as it self coppices, and the oldest are seldom more than 10cm in diameter (Rackham 1975). Also their stems increase in size up to a point, but it is possible that they then remain at the same size for many years, and almost certainly sometimes decrease in size by underground decay when old (Rackham 1975). Therefore it was not undertaken to core *Corylus avellana* in this woodland and in the area of Zone 1 it is known that most of the *Corylus avellana* has colonised since 1914. However *Corylus avellana* is well established in Zone 2 and it is probable that it has grown in this area even prior to 1838 when it was described as brushwood. When analysing the diameter at breast height (dbh) of *Corylus avellana* it was recorded in three size classes in Zone 1 and four size classes in Zone 2 indicating a variety of ages. The percentage of *Corylus avellana* stems recorded was evenly distributed in the size classes less than 15cm. Diameter at breast height of up to 20cm was only recorded in Zone 2. The height of the *Corylus avellana* canopy increases with increasing shelter, reaching up to 8m (Kelly & Kirby 1983). *Corylus avellana* trees of this height were recorded in Zone 2, but only reached a height of 6m in Zone 1 where it is more exposed. Ivy growth, honeysuckle and moss results on *Corylus avellana* were not significant in Zone 1. However in Zone 2 scarce and profuse ivy growth was most frequently recorded on *Corylus avellana.* According to Rackham (1975) ivy is often a precise indicator of secondary woods meaning that Bridgepark was once woodland in the past. Honeysuckle was also most frequently recorded on *Corylus avellana* in Zone 2. The success of honeysuckle and ivy growth is dependent on the absence of grazing. In the absence of grazing they are both more successful at becoming woody climbers and their presence on trees is an indicator of the maturity of the trees.

Fraxinus excelsior was one of the principal species recorded both in the canopy and understorey layers of Zone 1 and 2. There were pockets of woodland in Zone 1 classed as Transitional that was dominated by recent *Fraxinus excelsior* growth. In Zone 2 *Fraxinus excelsior* was the most frequently recorded species found growing alongside *Pinus sylvestris* and *Larix decidua* in the canopy. The success of *Fraxinus excelsior* is directly related to the shelter from westerly winds that the planted conifers offer. According to Cabot (1999) when a site on calcareous soils is sheltered from westerly winds hazel scrub will give way to a more pure ash woodland. An area of Zone 2 was classed as semi-natural Ash/Hazel woodland. No conifer species were recorded in this area and *Fraxinus excelsior* dominated the canopy with a *Corylus* sub-canopy and an understorey of *Ilex aquifolium.* Due to the light foliage of *Fraxinus excelsior* they are unable to dominate the site allowing *Corylus avellana* and *Ilex aquifolium* to grow well beneath. *Fraxinus excelsior* seedlings are plentiful and Kelly and Kirby (1983) observed that *Fraxinus excelsior* was the most abundant species on open limestone ground that is colonised directly by the tree species if grazing pressure is low. *Fraxinus excelsior* seeds itself very easily and will tolerate considerable shade in youth but will stagnate if not released within a few years (Joyce 1998). Under normal shade the seedlings grow a few inches high and then stop and in this suppressed state they can live for many years until it can take advantage of a gap in the canopy (Rackham 1975). This explains why it was noted in both Zones that the numbers of seedlings recorded far exceeded the number of saplings. *Fraxinus excelsior* needs overhead space and light for the development of a large crown to attain rapid growth of the stem and its rapid early growth enables it to outgrow competing ground vegetation (Joyce 1998). The successful regeneration of *Fraxinus excelsior* seedlings is influenced by both abiotic and biotic factors. Abiotic factors such as soil quality and depth, wind and shade all affect the regenerating abilities of *Fraxinus excelsior* seedlings. The main biotic factors are competing vegetation cover and deer as they tend to browse intensively on young plants. It was recorded in Lady Park Wood that *Fraxinus excelsior* is one of the preferred species of deer browsing. In Zone 1 the seedlings are in competition with other grassland species and the ground cover is much thicker. In Zone 2, competition with ground cover is not an issue and the seedlings are affected by the shade created by the canopy trees. A further factor influencing the success of regeneration is the presence of deer as browsing of *Fraxinus excelsior* seedlings was recorded in both Zones. Young *Fraxinus excelsior* trees were also damaged by deer in this area. Barking stripping was most frequently recorded on young growth in Zone 2. Because of the open nature of Zone 1 less browsing and bark stripping was recorded. On analysing the dbh results of the 359 *Fraxinus excelsior* trees surveyed in Zone 1 and 2, 352 of them had stems that measured less than 20cm, with the vast majority measuring 1-5cm. Only 7 specimens had a dbh greater than 20cm, with the largest dbh in Zone 1 measuring 25 cm. The greatest dbh of *Fraxinus excelsior* measured was 46cm and was in Zone 2. This tree was aged by tree coring and an approximate age of 101 years was recorded. This is the approximate age group of mature *Fraxinus excelsior* in Zone 2 which were recorded infrequently. Also recorded in Zone 2 was a *Fraxinus excelsior* stem measuring 25 cm in dbh, which was aged approximately 57 years. In Zone 1 a tree measuring 20 cm in dbh was aged approximately 46 years. Therefore based on these results it can be said that the vast majority of *Fraxinus excelsior* in Bridgepark has grown in the last 46 years. The major group of trees with dbh less than 5 cm were too small to core, however based on the coring results of other trees it can be estimated that this group is less than 20 years old. It is evident that despite the return of deer browsing over the last 30 years that *Fraxinus excelsior* regeneration was so abundant, enough remained to make a stand and its main growth in Bridgepark is recent. An example of this abundance is the recording of 113 individual *Fraxinus excelsior* trees with dbh all under 15cm in an area of $10m^2$. The development of these trees in close proximity means the quality of the growth is quite poor and *Fraxinus excelsior* stems are tall and spindly. These areas could benefit from some thinning management to improve the quality of the trees surviving. Ivy growth on *Fraxinus excelsior* was scarce, with few trees recorded with profuse growth and in total 10 trees were recorded with honeysuckle growth which is not significant. Bryophyte growth of moss was recorded as scarce frequently which is to be expected on young stands of trees.

The conifer species of *Pinus sylvestris* and *Larix decidua* were major components in the woodland composition of Bridgepark influencing the classification of large areas of woodland. These species were recorded growing in both zones but were more frequent in Zone 2. The presence of *Larix decidua* in Zone 1 was recorded in the understorey and canopy trees were mainly confined to the boundary edge of the main body of woodland. In Zone 2 it was primarily recorded in the canopy in the northern end of the woodland that is classed as Mixed Broadleaved Woodland. No current regeneration of *Larix decidua* was recorded in any zone however recent regeneration has taken place and a small area of young *Larix decidua* trees were recorded along the eastern boundary edge of transitional woodland in Zone 1 with a diameter at breast height (dbh) of 10cm. By using data collected from tree coring and the ages of *Larix decidua* it can be estimated that 1cm of growth represents 2.6 years. Using this data it can be estimated that the most recent growth of *Larix* was roughly 26 years ago. The planted mature *Larix decidua* was mainly recorded in Zone 2 and dbh measurements from 26cm to over 50 cm in dbh were recorded. A variety of ages from tree coring was established proving that regeneration of *Larix decidua* took place in the past. The oldest *Larix decidua* with a dbh of 43.31 cm was aged to 120 years. Seventeen trees had dbh over 40cm and most *Larix decidua* trees measured were in this size class. The next age group of *Larix decidua* recorded was 90 years with a dbh of 39.17 cm and a dbh of 23.25 was aged 60 years. These results demonstrate that the presence of *Larix decidua* in Bridgepark is not limited to the individuals planted 120 years ago and that it has continued to regenerate. According to studies in Britain the maximum age of *Larix decidua* is generally recorded as 150-180 years depending on the conditions of its growth. In Scandinavia, its place of origin, it can grow until 300 years and it has been recorded as growing to 230-240 years in Britain. Therefore the *Larix decidua* trees in Bridgepark will continue to be a feature of this woodland for sometime to come. No honeysuckle growth and very little moss growth were recorded on *Larix decidua* in Bridgepark. When ivy was recorded it was generally profuse and on mature trees. No bark scrapping was recorded on *Larix decidua* as conifer bark is not as palatable as some of the other species in the woodland. It was also observed that the majority of fallen trees and standing dead trees were *Larix decidua.* This may signify that the older individuals that were planted are nearing the end of their lifecycle and are dying off. This combined with the shallow rocky substrate and the impact of westerly winds is having an effect of naturally reducing the numbers of *Larix decidua* in Bridgepark.

Pinus sylvestris was the most populous of the two conifer species growing in Bridgepark and was present in both zones. In Zone 1 it was one of the most frequent and largest canopy species recorded and also dominated the scrub layer. Areas of transitional woodland were dominated by the *Pinus sylvestris* colonisation. In Zone 2 its growth was only recorded in the canopy and although it was not as common as *Fraxinus excelsior* or *Corylus avellana* it was a major element in the classification of some woodland areas as Mixed Broadleaved/Conifer woodland WD2. In Zone 1 *Pinus sylvestris* was the main sapling species that was recorded, encroaching further on the limestone grassland than any other species. There was not as many seedling species recorded as saplings and the scrub layer between 2-3m was also dominated by *Pinus sylvestris.* No recent regeneration of the species was occurring in Zone 2. In Zone 1 recordings of diameter at breast height (dbh) were between 16-50cm and it was the only species recorded with a diameter over 35cm. By combining the data collected on tree ages it can be estimated that 1 cm of diameter growth is equivalent to 1.88 years. Therefore is can be surmised that the oldest *Pinus sylvestris* in Zone 1 may date to 100 years and the trees with the smaller diameter of 16 cm are approximately 30 years old. In Zone 2 diameters of *Pinus sylvestris* were between 31-50cm with a few trunks measuring over 50cm. The oldest *Pinus sylvestris* recorded in Zone 1 was aged 126 years and had a dbh of 48.41 cm. Two trees with greater diameters dated were more recent; one tree with a diameter of 63.69 cm was aged 87 years and another tree with a diameter of 51.91 cm was aged 109 years. This indicates that a larger diameter does not always represent an older tree as diameter growth is also dependant on other biotic and abiotic factors. In Zone 2 *Pinus sylvestris* with diameters of approximately 30cm were aged 60 years. Therefore the stands of *Pinus sylvestris* in Zone 1 date between 30-100 years and in Zone 2 date to between 60-126 years. The maximum age of *Pinus sylvestris* (126 years) and *Larix decidua* (120 years) is similar placing the planting of Bridgepark to sometime in the 1880's. There was a significant number of *Pinus sylvestris* recorded with ivy growth in both Zones. The majority of *Pinus sylvestris* recorded in Zone 1 were recorded with profuse ivy growth and it mainly affected the older trees. The success of this profuse ivy growth is related to the openness of the canopy in Zone 1 as there is no competition for light. In Zone 2 half the *Pinus sylvestris* trees surveyed were recorded with ivy growth that was mainly profuse. As mentioned earlier the amount of ivy growth is an indicator of the maturity of woodland. Honeysuckle was only recorded on two trees in Zone 1 and is not significant. *Pinus sylvestris* was not recorded as a good bryophyte host and moss growth was rarely recorded. A number of *Pinus sylvestris* stems with diameters around 40 cm aged approximately 80 years were recorded as dead or dying in Zone 1. The cause of this may be because the shallow substrate in Zone 1 cannot support the growth of these mature trees. *Pinus sylvestris* has been recorded as growing up to 300 years in Scotland so their mortality was not caused by their longevity. No bark stripping was recorded on *Pinus sylvestris* stems. However, it was observed that considerable damage was caused to *Pinus sylvestris* scrub and saplings in Zone 1. This damage was caused by deer thrashing during rutting season which resulted in many saplings being trampled and broken.

It was also established that *Fagus sylvatica* was introduced to this woodland around 1880 and planted alongside *Pinus sylvestris* and *Larix decidua.* However its influence over the woodland structure of Bridgepark is not nearly as evident as the conifer species. *Fagus sylvatica* on limestone sites develops a highly plastic root system which penetrates deep into the fissures in search of moisture and nutrients and so grows well in the geology of this landscape (Read & Frater 1999). In Zone 1 only two *Fagus sylvatica* trees and two saplings were recorded and at present it does not play any role in the transitional woodland that is developing. In Zone 2 mature *Fagus sylvatica* was recorded in the canopy layer in areas along the western edge of the wood near the boundary wall of the main road. In these areas the plasticity of the crown development is so thick that no understorey was recorded underneath. The shade produced, combined with the heavy leaf litter of *Fagus sylvatica,* resulted in a depleted ground flora. Shade tolerant *Fagus sylvatica* has been regenerating in Zone 2 and young trees were recorded growing in the western area of the woodland and along the edges of the wood path. *Fagus sylvatica* was not frequently planted and the competition from fast growing conifers has slowed and limited the spread of this species to date in Bridgepark. This combined with the fact that the minimum seed bearing age of *Fagus sylvatica* is 50-60 (Read & Frater 1999) means that these planted trees have only been regenerating over the last 60 years. *Fagus sylvatica* can regenerate up until 160 years and therefore it is surmised that this species will have a fundamental effect on the structure of Bridgepark in the future and is a management consideration. On analysing the diameter results of *Fagus sylvatica* it was revealed that the diameters recorded were spread over a number of size classes that probably developed over the last 60 years. This suggests that a variety of age groups have developed in Zone 2 under the age of 60. There was some difficulty with the aging of *Fagus sylvatica* as the annual rings are very faint in its light coloured wood. However one of the mature *Fagus sylvatica* from Zone 2 was aged. The diameter at breast height of 63.69 cm was aged to approximately 115 years. This age is similar to the ages of the oldest conifers so confirming the conjecture that it was planted in the same period. The growth of ivy and moss recorded on *Fagus sylvatica* was infrequent and scarce. The smooth bark of this tree does not accommodate their growth. No bark scrapping of *Fagus sylvatica* was recorded in Bridgepark and although deer have been recorded browsing young *Fagus sylvatica* growth in other studies it was not apparent here. The life span of *Fagus sylvatica* is 350 years so it will remain a component part of this woodland for sometime in the absence of any management.

Ilex aquifolium was a common sub-canopy, understorey and scrub species recorded throughout Bridgepark and in a variety of woodland types. It was equally represented in the canopy and understorey layers of Zone 1. However its growth in Zone 1 was confined to the main stands of developing wood and it was seldom recorded in the open. It was recorded as canopy in Zone 1 as the forest canopies have not yet developed overhead. In Zone 2 its growth was similar to *Corylus avellana* in that it grows in the sub-canopy layer beneath the forest species reaching up to 8m in height. It was frequently recorded growing under the conifer species and it was the only tree species that was growing in the areas of *Fagus sylvatica.* In Zone 1 *Ilex aquifolium* was the second most common seedling recorded. Combined with its sapling results it is obvious that *Ilex aquifolium* is regenerating well in this area of Bridgepark. In Zone 2 *Ilex aquifolium* was the most abundant seedling and sapling species recorded demonstrating that they are resilient under shady canopies. Deer browsing was noted most frequently on young *Ilex aquifolium* saplings and bark scrapping was most numerous on the young trees in the scrub layer. Bark scrapping was recorded on more *Ilex aquifolium* than *Fraxinus excelsior* trees and this demonstrates that *Ilex aquifolium* is favoured by deer in this area. Diameter at breast height results were recorded up to 25 cm in both Zones. A core sample of an *Ilex aquifolium* in Zone 2 of 24.52 cm resulted in an age of 80 years, which represents its maximum recorded age in Bridgepark and means growth under 25 cm in dbh has occurred since the 1920's. Ivy growth was observed infrequently on *Ilex aquifolium* and bryophyte growth of mosses was recorded mainly as scare. Honeysuckle growth was noted growing poorly on two *Ilex aquifolium* which is of no significance.

Quercus robur was recorded in very low numbers (14 in total) in the canopy throughout Bridgepark during the survey and is not a principal species in this woodland. In total 5 seedlings and 4 saplings were recorded. The survival and growth rate of *Quercus* seedlings are diminished by the presence of competing vegetation, canopy shade and browsing by animals (Kelly 2002). *Quercus robur* trees were mainly recorded with dbh under 25 cm and only one was recorded in Zone 2 with a dbh above 50cm. There are no results for the ages of *Quercus robur* in Bridgepark. Ivy and moss growth were present on *Quercus robur* and both bark scrapping and honeysuckle growth were not recorded.

The remaining species recorded in Bridgepark consisted of *Prunus spinosa, Juniperus communis, Malus sylvestris, Crataegus monogyna, Betula pendula, Euonymus europaeus* and *Sorbus aucuparia.* These species were recorded dispersed throughout Bridgepark woodland. *Prunus spinosa* and *Juniperus communis* both scrub species were recorded regenerating in large numbers on the limestone grassland of Zone 1. This growth was classed as Immature Growth, the early stage of scrub development which may be followed by woodland succession. According to Kelly and Kirby (1983) in the presence of grazing animals, spiny and thorny shrubs usually dominate the early stages of succession and this is obviously occurring in Bridgepark. *Juniperus communis* in this area was mainly creeping Juniper but a number of uncommon upright trees were also recorded up to 4m in height in Zone 1. *Prunus spinosa* was also commonly recorded regenerating beneath the young stands of *Fraxinus excelsior* and along the woodland path in Zone 2. Low numbers of both *Betula pendula* and *Sorbus aucuparia* were recorded in the canopy layer of recent woodland areas and were regenerating in low numbers. Diameters at breast height of *Betula pendula* were recorded up to 25 cm. A core sample of this species measuring 12.74 cm in diameter was aged 54 years. When this figure is used to estimate the number of years 1 cm is equivalent to, it can be estimated that 25 cm is equal to 106 years approximately. Although this is a rough estimation of the age of mature *Betula pendula* in Bridgepark it does suggest that this species was a pioneer species and the numbers of this light demanding species may be declining as other species such as *Fraxinus excelsior* begin to dominate.

The woodland of Bridgepark is not the typical class of woodland that is commonly found in limestone areas and that have been studied by Kelly and Kirby (1983). Their findings were that a substantial proportion of the present day area of native woodland over limestone is scrub dominated by *Corylus avellana.* The rare cases of high forest in these areas in the west of Ireland usually consist of *Quercus robur* and to a lesser extent *Fraxinus excelsior.* It is evident that the planting of conifers and non-native trees in this area has altered the natural succession of woodland and consequently there are mixed and patchy assemblages of woodland types in this wood. The presence of *Pinus sylvestris* and *Larix decidua* have changed the natural colonisation and success of native trees especially *Fraxinus excelsior* which has thrived in the shelter offered by these species. The expected role of *Quercus robur* as a pioneer coloniser of recent limestone woodland has been prevented by the shade of the conifers and by the success of other species such as *Fraxinus excelsior.* Although there is a dominance of *Corylus avellana* in this wood it is mainly a sub-canopy species. Even in the areas of transitional woodland and recent growth, where it would be expected that *Corylus* would be the dominant colonising species, it is *Pinus sylvestris* that is the leading coloniser of this area. It is difficult to predict in woodland so altered by external factors how the woodland structure is going to develop. The knowledge of the natural succession of woodland cannot be relied on in the presence of non-native species. Also the outcome of succession in temperate forest is neither stable nor predictable in detail because disturbance is significant and not itself predictable (Peterken 1987). It is likely that *Pinus sylvestris* is going to remain a defining element in this woodland for sometime in the absence of active management, as it is regenerating freely and becoming a naturalised species of this woodland. *Fraxinus excelsior* will also continue to grow well in this conifer mix with its shade tolerant seedlings and fast growing abilities. However the quality of this growth so far is poor as the shade provided by the conifers increases the survival rate of weaker stems that would not have normally survived. The only possible drawback to its success is the presence of grazing deer. If their numbers increase beyond a manageable level it will negatively impact on *Fraxinus excelsior* growth. According to Perrin, Kelly & Mitchell (2006) *Fraxinus excelsior* as a highly palatable species is very resilient to browsing and able to compensate repeatedly for lost growth. They found that whilst *Fraxinus excelsior* seedlings are tolerant of canopy shade and may persist for many years they do not make effective height growth until the occurrence of a canopy gap. As of yet *Fagus sylvatica* is not a major component in this woodland and *Fraxinus excelsior* has an advantage over this more demanding light species. However it will continue to colonise open areas of ground left by fallen trees and take advantage of any disruption to the colonisation processes of other species. It is conjectured that in the future *Fagus sylvatica* if left unmanaged will become an influencing element of Bridgepark wood. The role of *Corylus avellana* and *Ilex aquifolium* will continue to be in the sub-canopy. However their numbers will likely decrease as the forest canopy develops.

6.1.1 Bridgepark: Vegetation Analysis

In Zone 1 a total of 55 ground cover species was recorded and divided into four groups; (i) Limestone Grassland Species. (ii) Uncommon Grassland Species. (iii) Woodland Species. (iv) Uncommon Woodland Species. There are few species of particular interest, although the plant community of the limestone habitat is of some considerable conservation value. The true woodland habitat does not have a very diverse or plentiful flora as the vegetation is depleted by deer browsing. The most diverse plant communities occur along the existing path. There are also wider assemblages of plant species in the ecotone area between the woodland and limestone habitats although many of the species here are not woodland specialists. According to Peterken and Mountford (1995) young growth stands almost always have more diverse species of trees, shrubs and herbs than older stands. Limestone Grassland Species dominated the flora results with 41 species recorded and only 14 woodland species were identified. This is not unexpected as woodland has recently colonised this grassland area and the arrival of woodland species can take some time to develop. According to Read and Frater (1999) it can take around 250 years for species such as *Primula vulgaris* and *Sanicula europaea* to appear in new woods. However, both of these species are already present in this woodland which suggests that this is secondary woodland. The dominant limestone ground cover was *Gramineae sp.* growth. The most commonly recorded species based on frequency values growing throughout the grassland included *Rubus fruticosus, Lotus corniculatus, Galium verum, Chrsyanthemum leucanthemum, Trifolium repens, Euphrasia sp.* and

Taraxacum officinale agg. However the mean percentage cover of most species was under 1% and was recorded in low numbers. Many orchid species also grow in this limestone area of Bridgepark and a recent survey of orchids on the shores of Lough Carra (Huxley 2007 personal communication) indicated that a combination of summer grazing by deer and the advancing woodland was having a negative impact on orchid species diversity and numbers in this limestone habitat. The most common woodland species in the ground layer was *musci sp.* recorded almost 70% of the time. All other species were recorded in less than 33% of the quadrats and had a mean percentage cover of less than 1%. The most frequently recorded woodland specialists were *Circaea lutetiana* and *Viola riviniana* however they were usually recorded as single plants and had a mean percentage cover of less than 1%. The poor performance of these species is somewhat surprising in this ecotone area of the woodland which only has a percentage cover of 25%, so it is not shade that is restricting their growth. It would have been expected that light loving species such as *Primula vulgaris* would be growing well in this forest edge area however it was only recorded on four occasions. A lot of this is due to the grazing pressure on the flora by deer, but also in this area these woodland species are in competition with grassland vegetation which is thick with the growth of sedges, heather and grasses.

In Zone 2 a total of 42 species was recorded. Similar to Zone 1 two groups of vegetation representing a different habitat was identified after the data was put through TWINSPAN. These groups were (i) Woodland Species. (ii) Limestone Grassland Species. (iii) Common Species. (iv) Uncommon Species. Species in the common group were the most frequently recorded species and essentially had the highest mean percentage cover. They included in order of density, *Musci sp, Rubus fruticosus, Hedera helix* and *Viola riviniana.* A further 20 woodland specialist species were also recorded some more frequent than others but overall the densities of these species are extremely low and insignificant. The woodland floor of Bridgepark is lacking in colour with no flowering plants. An explanation for such an underwhelming ground flora may be contributed to a number of factors. As already mentioned the continuous grazing of deer in this area is not allowing flora or scrub to recover and develop. Also this area if left to naturally develop would have been deciduous woodland like it had been prior to clearance and continuous shade is not a normal feature of deciduous woods. The woodland species that had survived in the area and started to recolonise it when it was brushwood would be acclimatised to growing under the conditions of deciduous trees and so therefore would not grow well under the year round canopy cover of conifers. Furthermore, Rackham (2006) quotes a German study that showed that the leaf litter of *Larix decidua* contains growth inhibitors which may explain why little grows under *Larix decidua* although it is deciduous. A total of 14 species characteristic of limestone grassland were recorded the most common of which was *Graminae sp.* These species were recorded infrequent yet their presence is a testimony of Bridgepark's past management as pasture.

6.2 Moynish: Woodland Structure and Classification

The woodland on Moynish is the oldest of the four woods and was recorded as woodland as far back as 1838 in the first Ordnance Survey. In total 25 tree and shrub species were recorded and the majority of the woodland was classed as native broadleaved woodland (WN). Seven woodland habitats were identified and mapped based on Fossit (2000) classifications of woodlands. Moynish has a similar management history to Bridgepark in that for a time it was managed as rough pasture and was later planted with *Pinus sylvestris, Larix decidua* and *Fagus sylvatica.* Its treatment as pasture was obviously relaxed sometime prior to 1838 allowing woodland species to colonise. The planting undertaken on Moynish has also influenced the woodland structure, but to a less extent than on Bridgepark. The majority of woodland on Moynish is more typical of the type of woodland native to limestone areas. The woodland structure varies from mature woodland to areas of scrub and immature growth. In Moynish the woodland was divided into five zones prior to surveying and each zone will be discussed separately.

In Zone 1 a total of 14 tree and scrub species were recorded including *Fraxinus excelsior, Fagus sylvatica, Viburnum opulus, Crataegus monogyna, Corylus avellana, Quercus robur, Rhododendron ponticum, Pinus sylvestris, Betula pendula, Acer pseudoplantanus Prunus spinosa, Ilex aquifolium, Euonymus europaeus* and *Sorbus aucuparia*. There was a dominance of *Fraxinus excelsior* and *Corylus avellana* in the canopy and of *Ilex aquifolium* in the sub-canopy and understorey. The woodland margin of this zone was recorded separately and its results showed that it was at a different development stage. The area was dominated by *Corylus avellana* and pioneer species such as *Betula pendula* were more populous in this area of the zone. This light demanding species is growing well in the present absence of canopy cover. The distribution of *Pinus sylvestris* and *Fagus sylvatica* was mainly limited to the ecotone area. *Pinus sylvestris* was only recorded in this area of the zone where it has regenerated naturally from the stands planted in Zone 2 and 3. *Fagus sylvatica* is also regenerating well on the edges of this zone and in time both species will dominate this area and the pioneer species of *Betula pendula* will gradually reduce in numbers. The main species regenerating in Zone 1 were *Ilex aquifolium, Fraxinus excelsior* and *Frangula alnus.* Although *Corylus avellana* is a major component of this zone there was little evidence of it regenerating in this area at this time. There were good numbers of *Frangula alnus* recorded throughout the zone. This is slightly unusual as this light-loving scrub species is usually found growing in woodland edges and not in high forest. The seedlings may be the result of a heavy crop of seeds, the success of which remains to be seen. These seedlings have browsing and heavy shade to contend with so it is likely that their success will be limited.

The non-native species *Acer pseudoplatanus* and *Rhododendron ponticum* were both recorded in this zone. *Acer pseudoplatanus* was only recorded growing in Moynish and its arrival is natural, likely seeding from the trees in Lynch's Grove. The largest *Acer pseudoplatanus* stem was aged to establish when it first arrived and it was aged between 50-60 years. The regeneration of this species was recorded mainly in seedling form in Zone 1 and there was no evidence that it is browsed by deer. In total only three individuals of *Acer pseudoplatanus* have established since its arrival 60 years ago. This low number and the lack of saplings suggest that there are factors other than browsing that are affecting its growth on Moynish. The shallow limestone soils of Moynish is most likely inhibiting its growth as it is a deep rooted species preferring moist base-rich soils. This is a positive outcome as the establishment of this non-native *Acer pseudoplatanus* in this woodland is not desirable. The presence of *Rhododendron ponticum* in Moynish is also natural and relatively recent, perhaps seeding from the more established area of growth on nearby Creggaun. Its growth was recorded in three areas on Moynish with the largest area in Zone 1. The majority of this growth has been removed by manual cutting and stump treated. However it will need continuous monitoring to prevent its re-establishment.

When analysing the diameter at breast height results, the majority of trees measured were under 20cm in diameter. Only seven *Fraxinus excelsior* trees were measured over 36cm in dbh. The oldest *Fraxinus excelsior* measuring 50.95 cm at dbh was aged 96 years. The average percentage of canopy cover recorded for this zone was 42.5% which was the lowest of all the zones. The amount of light reaching the woodland floor may be firstly attributed to the dominance of *Fraxinus excelsior* in the canopy, the light foliage of which allows more sunlight to reach the lower levels of the woodland stratum. Also this area of Moynish does not contain many large forest trees or conifers which would reduce light levels. The drainage of Zone 1 was recorded as free and the average depth recorded for this area of 18.59 cm was the deepest recorded out of all the zones.

The woodland structure and classes of both Zone 2 and Zone 3 were very similar. In Zone 2 20 tree and scrub species were recorded, 15 in the centre of the zone and 16 in the ecotone edge. In total 18 tree and scrub species were recorded in Zone 3. The planting of *Pinus sylvestris* and *Larix decidua* was only recorded in the northern ends of both these zones and is classed as Mixed Broadleaved/Conifer Woodland WD2. In this area *Corylus avellana* and young *Fraxinus excelsior* trees dominated in the sub-canopy and *Ilex aquifolium* dominated in the understorey under these species. The largest diameter reading for *Corylus avellana* of 16 cm at dbh was recorded in Zone 3. In all other zones the diameter of this species was less than 10 cm. As previously mentioned *Corylus avellana* is notoriously difficult to age using coring techniques. However the largest recorded stem was aged 78 years. It is likely that this species is much older as it stops producing rings as it matures. *Corylus avellana* was probably one of the earliest species to colonise Moynish and will continue to be a major component of the woodland structure for some time. On aging the conifer species in Moynish it was established that the oldest *Pinus sylvestris* was 146 years and the oldest *Larix decidua* was 120 years. This would indicate that planting of *Pinus sylvestris* took place first sometime in the 1860s and the planting of *Larix decidua* in the 1880s was of a similar time period as the planting in Bridgepark. Moynish had been recorded as woodland prior to this planting and would have been *Corylus scrub.*

Pinus sylvestris was also recorded as the principal canopy species along the boundary edge of Zone 2 with both planted and naturally regenerated stands of growth. There was no evidence of any recent regeneration of *Larix decidua* occurring in the woodland.

The presence of *Quercus robur* was also mainly recorded in these zones on Moynish growing alongside the planted conifers. The areas with no conifers and where the canopy was dominated by *Quercus robur* were classed as Oak, Ash, Hazel Woodland WN2, which according to Kelly and Kirby (1983) is a class of woodland usually recorded in limestone areas. A variety of age groups between 104 -160 years were established for *Quercus robur* by tree coring. Due to the constraints of coring some of the larger *Quercus robur* were not possible to age and may be slightly older. The oldest *Quercus* aged was situated on very shallow soil over limestone pavement in Zone 5 and would suggest that the presence of *Quercus robur* on Moynish is natural and not planted. Similar to Bridgepark was the presence of low numbers of mature *Fagus sylvatica* scattered throughout Zone 2 and 3. The oldest recorded age for this species of 143 years is similar to the oldest *Pinus sylvestris* and would imply that the planting of both these species occurred at the same time.

The presence of *Populus tremula* was confined to Moynish and was recorded in all zones except Zone 1. This species which is native to Ireland has been established on Moynish for at least the past 50 years. *Populus tremula* flowers infrequently and seed production is therefore occasional and sporadic. Its main method of reproduction is vegetative, with young suckers growing with great vigour off the roots of a parent tree. It could be questioned whether *Populus tremula* naturally colonised this woodland. According to Cosgrave (2005), the low rate seed production means that it is unlikely that *Populus tremula* will naturally colonise sites where it is absent. However a similar colonisation of *Populus tremula* took place in Hayley Wood which according to Rackham (1975) was a rare event. It was described as such because the conditions needed for *Populus tremula* seedlings to germinate are extremely exacting. For *Populus tremula* to grow from seed would require moisture within a week of seed fall and moisture every day through the summer in an open area. These wet conditions for its natural growth are very feasible in the west of Ireland as wet summers are not uncommon. Also a similar stand of mature *Populus tremula* is present in Carracastle on the east side of Lough Carra. Considering all the facts such as its growth in the already established woodland of Moynish and the information about the management of the estate at that time it is highly unlikely that it was planted. The presence of a nearby mature stand also indicates that its growth is due to natural colonisation. The diameter results of *Populus tremula* was between 5-25 cm. No stems were recorded under 5 cm signifying that there has been little recent growth of this species. Regeneration of *Populus tremula* in Moynish is almost entirely by suckers, which are being severely browsed by deer thus preventing its growth. Its regeneration by suckers would explain the distribution of *Populus tremula* when mapped to the southern areas of Zone 2-4 which borders the recent scrub growth of Zone 5. This quick growing species dominates the canopy where it grows and was recorded with *Fraxinus excelsior, Corylus avellana* and *Ilex aquifolium* in its sub-canopy and understorey. The fungi *Lecunum aurantiacum* (Red Aspen Bolete) which only grows on Aspen roots was also recorded in Moynish (Plate No.6.1). The previous history of planting in the estate does put into question the naturalness of this stand. However, since *Populus tremula* is recorded in limestone and because there is a neighbouring stand of similar age structure then its occurrence is likely similar to the rare event which took place in Hayley Wood.

Plate No. 6.1 *Lecunum aurantiacum* (Red Aspen Bolete)

The regeneration results were similar for both zones in that *Ilex aquifolium* seedlings and saplings were recorded most frequently many of which were browsed more than once. High numbers of *Fraxinus excelsior* seedlings but not saplings were recorded in these zones. This occurred also in Bridgepark and possible explanations for this were discussed earlier. The regeneration results of *Populus tremula* was mainly based on sucker numbers and very few seedlings were recorded. *Frangula alnus* regeneration was also recorded in both zones but principally in Zone 3. As mentioned when discussing Zone 1 its regeneration in the centre of the woodland is unusual and its success will be limited. The dispersal of this species may be bird-sown by a woodland specialist bird. Only one sapling of *Quercus robur* was recorded in these zones. Kelly (2002) claimed that shade and the presence of browsing diminished the survival and growth rates of regenerating *Quercus* species. Also the light demanding character of its seedlings indicates that *Quercus robur* should be considered as a'subclimax' species. This view is substantiated by the widespread tendency for Irish oakwoods to be invaded by the introduced *Fagus sylvatica,* a true climax species whose shade tolerant saplings grow freely under an oak canopy (Kelly & Kirby 1983). Both of these constraints are present in Moynish. However a number of young *Quercus robur* were recorded growing along the boundary edge of Zone 2 where light levels are greater and deer are discouraged by the lack of cover. The average percentage of canopy cover of these zones was also very similar: Zone 2 was 71.25 %. Zone 3 was 75%. The presence of conifer trees combined with the thick foliage of canopy trees such as *Quercus robur* and *Fagus sylvatica* have reduced the amount of light reaching the woodland floor. As mentioned the edges of Zone 2 had greater light levels and showed a higher diversity of species because habitats are available for species that need both closed forest and open habitats together. The drainage results of both zones were recorded mainly as free. However there was one area near the entrance path between the zones which was recorded as impeded and remains moist throughout the year. The average soil depths for both zones were also similar: Zone 2 was 13.46 cm. Zone 3 was 14.31 cm. This shallow soil depth is typical of the limestone geology of the area and it seems is still capable of supporting the growth of large forest species.

In Zone 4 there was no planted conifer species recorded and *Fraxinus excelsior* was the principal broadleaved canopy species. This was marginally the most diverse area of woodland in Moynish with twenty-one tree and scrub species recorded. The largest area was classed as Oak, Ash, Hazel Woodland WN2 in which *Fraxinus excelsior* was the principal canopy species and *Corylus avellana* dominated the sub-canopy. Similar to the other zones the shade tolerant species *Ilex aquifolium* dominated the understorey and scrub layers. The area of *Populus tremula* growth in Moynish continued into Zone 4 and had the same composition of trees as in Zone 2 and 3. Of distinct importance in this zone is the presence of *Taxus baccata.* This is one of Ireland's only native conifers and a small area in the centre of Zone 4 was recorded as growing and regenerating. This species has become rare in natural habitats and one of the only *Taxus baccata* woods in Ireland is found in Killarney National Park. It is usually recorded on rocky ground in the west and north of Ireland. Occasionally it is bird-sown from gardens elsewhere and this is the likely explanation for its arrival in Moynish. Species of thrush eat the berries and have been recorded in this woodland. *Taxus baccata* is recorded in Moore Hall which is situated on the eastern side of Lough Carra. Its growth here is not natural as it was planted in a children's graveyard but it is a possible seed source of the *Taxus baccata* growing in Moynish. This species grows naturally scattered in the understorey of woodlands and is shade tolerant which suggests it will continue to develop and increase in Moynish. However, its growth might be limited by the presence of deer. In the 25 year deer exclusion study in Killarney yew regeneration was found to be limited by deer, despite it being highly toxic to some animals yew foliage is freely eaten by deer (Perrin, Kelly & Mitchell 2006). Another species which is relatively rare as a native species in Ireland, *Sorbus hibernica,* was recorded in low numbers near and in the boundary area of Zone 4 and in the scrub area of Zone 5. This is a light-loving species unique to Ireland and is found in limestone areas. Similar to Zone 2 the boundary edge of this zone contained numerous shade intolerant and edge-preferring species not found in the centre of the wood. These species included *Communis juniperus, Frangula alnus, Viburnum opulus* and *Prunus avium. Pinus sylvestris* was also only recorded growing in the ecotone of Zone 4 where its growth is natural regeneration and was not planted. The regeneration results were similar to the other zones with the species of *Fraxinus excelsior, Populus tremula* and *Ilex aquifolium* most commonly recorded. The majority of diameters at breast height were less than 20 cm except for one *Quercus robur* tree which had a dbh over 50 cm. A core sample of a *Fraxinus excelsior* measuring 20 cm in dbh was aged approximately 48 years. This indicates that most of the *Fraxinus* growth in this zone has taken place in the past 50 years. The average percentage of canopy cover of Zone 4 was less than that recorded in Zone 2 and 3 at 58.75%. The reason for this result is the same as Zone 1 in that there was no conifer trees planted and the main canopy species is recent *Fraxinus excelsior* growth. Zone 4 was principally recorded as well drained. However there is an area of the zone on the northern edge which is prone to water-logging in the winter and is dominated by transitional woodland which has established since 1914. The soil depth of Zone 4 at 18.43 cm was also greater than Zone 2 and Zone 3 signifying its capabilities of supporting larger trees.

The woodland in Zone 5 was classed as Transitional Woodland and Immature Growth and has established in this area since 1914 and is mapped in Appendix 4. The growth of scrub species on the limestone pavement of Moynish is similar in composition to the gradual colonisation of the limestone grassland in Bridgepark. A total of 19 tree and shrub species was recorded in this area. The tree composition of this area is similar to the ecotone areas of the other zones where the percentage of canopy cover is low. It was observed that the composition of growth in the boundary edges of Moynish varied from the main body of the woodland in that it preserved many scrub species that are light-loving or pioneer species. Kelly and Kirby (1983) also recorded that species such as *Sorbus hibernica, Frangula alnus* and *Juniperus communis* while locally frequent in limestone areas were apparently unable to persist in closed forest. The average soil depth of Zone 5 was 9.5 cm. This area of Moynish still preserves its limestone species as the shallow soil cover and limestone paving prevents the entire area establishing as woodland.

The epiphyte and woody climber results of all zones were combined together. Ivy and moss growth was most frequently recorded growing on *Corylus avellana* and *Fraxinus excelsior* stems, but was recorded as profuse mainly on *Corylus avellana* and *Quercus robur*. Honeysuckle was only recorded on two *Corylus avellana* trees and is not a common woody climber in Moynish. Similar to Bridgepark this species was recorded in the ground flora but the presence of grazing animals has prevented its accent into the tree canopies. When the bark stripping results were combined together a total of five tree species were recorded with bark damage caused by deer. *Ilex aquifolium* was the most frequently recorded with bark stripping. Younger saplings and trees were mainly targeted and bark stripping frequently resulted in the mortality of the tree affected. *Euonymus europaeus* was infrequently recorded, growing poorly in the understorey of all zones. Almost half of this species was recorded with bark stripping in Moynish indicating a preference for this species. Based on the results the order of species preference is *Euonymus europaeus* > *Ilex aquifolium*>*Fraxinus excelsior* >*Corylus avellana* > *Crataegus monogyna* > *Betula pendula.*

6.2.1 Moynish: Vegetation Analysis

The vegetation data recorded in each of the zones was combined together to get an overall view of the existing flora composition and also to produce the first species list of the ground cover. In total 131 $1m^2$ quadrats were sampled and 39 flora species were identified. Similar to Bridgepark, Moynish had an extremely impoverished vegetation layer which is severely reduced by overgrazing. Browsing was recorded in almost all of the quadrats. The ground cover in each of the zones was most frequently described as mossy boulders and heavy leaf litter with scarce plant growth. Leaf litter and bare ground was recorded as having a mean percentage cover of 41%. Vegetation was principally found along the edges of the paths or in the ecotone edges of the woodland were the light composition is enhanced. Of the 39 species identified 25 were woodland species and 14 were limestone grassland species. The TWINSPAN programme ordered the species that most frequently occurred together and a number of groups were identified: (i) Woodland Species. (ii) Common Group. (iii) Limestone Grassland Group. (iv) Uncommon Group. A common group of species was identified based on the percentage frequency of their recording. These species also had higher mean percentage cover values when compared with the other herbs. *Musci* species dominated the ground cover carpeting the wood floor. Kelly and Kirby (1983) observed that although the diversity of *Musci* (bryophyte) species is generally much less in limestone woodlands that ground cover is often high especially where the limestone is at or near the surface. The rocky nature of the substrate in Moynish is facilitating the dominance of bryophyte cover. The other common species *Hedera* *helix, Rubus fruticosus, Viola riviniana* and *Fragaria vesca* were frequently recorded but their cover was extremely low for common species. All other woodland species that were recorded had a mean percentage cover of less than 1%. Limestone woodlands are usually characterised among Irish woodland communities by a wealth of broad-leaved herbs. The lack of species diversity and cover of the woodland species recorded here in Moynish is a testimony to the devastating affects of overgrazing.

Kelly and Kirby (1983) undertook some research on the phytosociology of Irish native woodlands over limestone defining the floristic communities into a number of groups. The species listed in each group was compared to the floristic data collected on Moynish and it was found that there was character species present that are associated with two of the groups: (i) *Querco-Fagetea and Fagetalia sylvaticae* Group. (ii) *Corylo-Fraxinetum* Group. There were more character species recorded of the *Querco-Fagetea and Fagetalia* Group and they included *Galium odoratum, Circaea lutetiana, Anemone nemorosa, Arum maculatum, Carex sylvatica, Sanicula europaea, Geum rivale* and *Viola riviniana,* which are usually shade tolerant herbs. The species recorded that were associated with the *Corylo-Fraxinetum* Group were *Primula vulgaris, Fragaria vesca, Hypericum perforatum* and *Geranium robertianum,* which are prevernal/vernal herbs that flower before the canopy foliage is expanded. It is not surprising that there are species present from both groups as Moynish is made up of various woodland types. The reason that more species from these groups were not recorded may be down to the presence of planted conifer trees which have changed the nature of the habitat in Moynish. Of some interest is the presence of *Anemone nemorosa* which according to O'Connell (1999), Van der Sleesen (2000) and Rackham (2006) is often indicative of older woodland as it is not sensitive to clearance and has been found as a relict of woodland cleared for hundreds of years. Daniel Kelly considers *Galium odoratum* which was also recorded in Moynish, an indicator of woodland that has existed in one place for a long time (Van der Sleesen 2000). These species associated with ancient forest are generally those which have poor rates of colonisation due to poor dispersal of seeds or clones and ancient forest species are seen as stress-tolerant while new forest is postulated to be a likely invasion site for ruderal or competitive species (Van der Sleesen 2000:51). The accuracy of translating the method of ancient indicator species in Irish woodlands is not well researched as of yet. In the case of Moynish it has been established that this is mainly a secondary woodland site and therefore the presence of *Anemone nemorosa* and *Galium odoratum* indicates that this was once an ancient woodland site. The limestone grassland species recorded were mainly confined to the ecotone and transitional woodland areas where the light composition is bright. There presence shows that grassland species can persist in secondary woodland for some time.

6.3 Creggaun: Woodland Structure and Classification

In Creggaun 21 species of both native and non-native tree and shrub species were recorded. This area was described as rocky and shrubby pasture in 1690, as rocks and brushwood in 1838 and in 1914 areas of both woodland and rough pasture was recorded. Today the once island of Creggaun is dominated by forest and understorey trees of which six woodland types were identified. This woodland was also planted with *Pinus sylvestris* and *Larix decidua* and it is these areas of planting that were mapped in 1914 which is available in Appendix 4. Unlike Moynish and Bridgepark *Fagus sylvatica* was not planted here and its natural growth in this woodland is recent and mainly confined to the woodland edges. The woodland development in areas recorded as rough pasture has taken place naturally in the past 93 years.

The areas were conifer planting has taken place have been classed as Mixed Broadleaved/Conifer Woodland WD2. Mature *Larix decidua* was more numerous in this area than *Pinus sylvestris* and the oldest with a diameter at breast height (dbh) 43.63 cm was aged approximately 149 years. This would place the planting of this species sometime in the late 1850s which is of a similar time as the planting of *Pinus sylvestris* in Moynish. *Larix decidua* is a light loving deep rooted deciduous conifer which grows well on calcareous soils. It was the main species recorded with diameters in excess of 31 cm. A number of other ages were also recorded for this species: Dbh of 47.77 cm was aged 118 years. Dbh of 40.13 cm was aged 93-103 years. Dbh of 31.10 cm was aged 86 years. The range of diameters and ages recorded would suggest that more planting of this species took place or that some regeneration of this species took place naturally up until 86 years ago when light levels would have been reduced as the forest cover increased. There was no evidence that this species is regenerating at present. The earlier planted *Larix decidua* was the principal species that was recorded as standing dead or as dead wood on the woodland floor. The mortality of this species may be due to its maturity or perhaps the shallow substrate could not support this species anymore. Mature *Pinus sylvestris* were not as commonly planted in Creggaun as *Larix decidua* and its principal growth as a canopy species along the woodland edges is natural regeneration from the planted stands. A range of ages and diameters were recorded for *Pinus sylvestris* the oldest of which was 115 years. This would suggest that planting of *Pinus sylvestris* did not take place as early as *Larix decidua* and is of a similar time as the planting of *Larix decidua* in Moynish in the 1880s. The regenerated stands on the woodland edge were aged between 32-88 years. No recent regeneration of *Pinus sylvestris* was recorded.

The principal area of Creggaun was classed as Oak, Hazel, Ash Woodland (WN2) where *Fraxinus excelsior* dominated the canopy and *Corylus avellana* dominated the sub-canopy. *Ilex aquifolium* was the principal species recorded growing in the understorey and as scrub under both conifer and broadleaved species. The area of this woodland type was recorded as unwooded on the Ordnance Survey map of 1914. Therefore it is secondary woodland that has naturally colonised since then. Both *Fraxinus excelsior* and *Ilex aquifolium* were the main regenerating species recorded during the survey. *Fraxinus excelsior* was mainly in seedling form at present but young trees were recorded growing in the understorey. *Ilex aquifolium* was mainly recorded in sapling form however there was evidence of repeated browsing on many of these young stems. *Corylus avellana* regeneration is not taking place at the moment in Creggaun. On analysing the results of tree coring and diameter measurements for *Fraxinus excelsior* the presence of this species on Creggaun can be established as far back as 180 years. There was a number of mature *Fraxinus excelsior* measuring over 50 cm in diameter at breast height and they were situated growing alongside the conifer stands. It is apparent that the shelter offered by these fast growing conifers helped this species to establish. The majority had diameters of between 6-10 cm and the smallest diameter of *Fraxinus excelsior* aged was 11.15 cm and an age of 20 years was determined. This result shows that the majority of *Fraxinus excelsior* recorded developed in the past twenty years. Stems between 17 cm and 45 cm in diameter were aged between 30 and 54 years. The majority of both *Corylus avellana* and *Ilex aquifolium* stems measured 6-10cm in diameter. *Corylus avellana* in this diameter size class was aged from a cross section to 45 years and *Ilex aquifolium* was aged 35 years. So the main population of these species are under 45 years. As already mentioned there is a difficulty with aging *Corylus avellana* as it self coppices and even though the oldest stem recorded was 70 years it likely that this species has been present on Creggaun much longer. Some mature *Crataegus monogyna* were recorded growing in the sub-canopy of Creggaun. A particularly large stem of this species was aged to approximately 80 + years. This species is a light-loving semi-shade species that grows well on calcareous soils. This was a likely pioneer species of the abandoned pasture on Creggaun and like *Corylus avellana* is still able to survive under forest canopy.

During the survey of Creggaun a large area of *Rhododendron ponticum* was identified and mapped. It was determined from a cross section of one of its largest stems that it has been growing on Creggaun for at least the past 80 years. Based on its location it is unlikely that *Rhododendron ponticum* was purposely planted in this area and it would have naturally colonised here. It is located on the western edge of the woodland which borders fen bog and is currently spreading very vigorously westwards on to the fen and eastwards into the woods. When surveyed it roughly covered an area of one hectare and was estimated as growing up to eight metres in some areas. In December 2006 some removal and treatment of this *Rhododendron ponticum* stand was undertaken and approximately one third of its growth was removed. Further management is needed to remove the remaining growth and this will be discussed in the management plan for Creggaun.

The boundary of Creggaun was surveyed separately to examine the variation in the composition of its vegetation. The main species recorded in its canopy were *Betula pendula, Pinus sylvestris* and *Corylus avellana* was mainly in the sub canopy. Two types of Transitional Woodland and an area of Wet willow-alder-ash woodland were identified around the edges of Creggaun. A section of transitional woodland was dominated by *Pinus sylvestris* which has naturally regenerated and a variety of species were recorded in its understorey. The transitional woodland that was dominated by *Betula pendula* comprised various broadleaved trees and scrubs of which *Corylus avellana* was frequently recorded. A large percentage of *Betula pendula* stems measured between 6-10 cm in diameter at breast height and an age of 28 years was recorded for a diameter of 10 cm. The oldest *Betula pendula* stem aged 90 years was recorded in the centre of the woodland were there is a natural clearing and a number of this species are still growing well in the absence of a higher forest canopy. This indicates that this pioneer species began to colonise unwooded areas in Creggaun shortly after they were recorded in 1914. It was recorded regenerating mainly in the scrub layer of the ecotone edges and the evidence of recent seedlings was very scarce. An area of wetland woodland has established on the edge of Creggaun in a wet area beside the fen bog. This is a relatively small area and has been colonised mainly by *Salix caprea* and *Alnus glutinosa.* One *Sambucus nigra* tree was recorded growing in this area. Its presence was only recorded on Creggaun of which it has only recently colonised and was likely bird sown. This is a light loving species which grows well on moist, humus rich sites, so its growth will be limited to the area it has established in on the boundary edge.

Ivy was the only woody climber recorded in Creggaun and was growing on eight tree species. It was principally recorded on *Fraxinus excelsior* and *Corylus avellana* where it was deemed to be scarce. Profuse growth was more commonly recorded on mature canopy trees such as *Quercus robur* and *Larix decidua* where it has had more time to become established. The amount of bryophyte growth was also recorded and it was shown that different tree species are better hoists. For example moss growth was not frequently recorded as profuse on conifers such as *Pinus sylvestris* or on very smooth bark such as *Fagus sylvatica* or *Ilex aquifolium.* Similar to ivy growth moss was most frequently recorded as profuse on mature stems of *Corylus avellana* or mature *Quercus robur.* There was evidence of deer browsing throughout the woodland and groups of deer were frequently recorded grazing in Creggaun. The deer can access the wood easily by crossing the fen which they graze in the early morning retreating to the cover of Creggaun in daylight hours. Bark stripping was recorded on four tree species and the order of preference was established by looking at the species most affected by bark stripping: *Ilex aquifolium* > *Fraxinus excelsior* > *Corylus avellana* > *Prunus spinosa.* The order of tree preference is similar to Moynish except that *Euonymus europaeus* was rarely recorded in Creggaun and so was not affected.

The average percentage cover of the canopy in Creggaun was estimated at 67.77% which would allow a moderate amount of light to reach the woodland floor. Areas of conifer growth were generally regarded as dim areas and *Pinus sylvestris* had thicker canopy foliage than *Larix decidua.* The areas of transitional growth were mainly on the woodland edges and percentage of canopy cover was much reduced. The one exception to this is the area of *Rhododendron ponticum* which has extremely heavy foliage blocking light both from shining down from above and also from entering the woodland floor from the side. The drainage of Creggaun was generally recorded as free draining throughout the woodland except on the western edge of the woodland. This area borders fen bog and is prone to flooding in the winter when the lake level rises. This is where the wetland woodland species are located. The average soil depth of 24.35 cm is deeper than any of the other woodlands. Creggaun is slightly mound shaped and has a deeper sub-strate in the centre than on the edges.

6.3.1 Creggaun: Vegetation Analysis

The herb layer in Creggaun was divided into three groups after the data was organised by TWINSPAN. The groups include (i) Common Species, (ii) Woodland Species and (iii) Uncommon species. A sum of 29 flora species was recorded in Creggaun. The ground floor of Creggaun was generally described as having a good leaf litter layer over mossy boulders which had sparse plant cover. Leaf litter had a mean percentage cover of 51.55% and was recorded in nearly every quadrat. The main difference of the species recorded in Creggaun when compared to the other woodlands is that there is no obvious limestone species recorded. Possible remainders of its pasture past include *Rosa pimpinellifolia* and *Gramineae* species. A reason for the lack of surviving grassland species is that the ecotone areas of Creggaun mainly border the fen bog on one side and the lake on the other and it was in the periphery areas in Bridgepark and Moynish that limestone species were mainly recorded. The common group of species established were similar to both Moynish and Bridgepark with bryophyte growth being the commonest ground species recorded. The mean percentage cover of both *Hedera helix* and *Rubus fruticosus* were greater in Creggaun and *Hedera helix* was recorded nearly 100% of the time. However, their ground cover was still extremely low given how frequently they were recorded. They are both shade tolerant species so it would be expected that they would have proficient growth levels in this type of woodland. There is a natural clearing in the centre of the woodland with good light levels. It would normally be expected that this area would have profuse flora growth but as deer grazing is present this area is no richer in plant life than the rest of the woodland. *Oxalis acetosella* was also recorded relatively frequently throughout the woodland. This shade resistant plant grows its leaves in autumn and photosynthesises for most of the year and it is the type of species that is expected to dominate under forest canopy. It was mainly recorded growing at the base of mature trees and in scrubby areas in the transitional areas where it is somewhat protected from grazing. The mean percentage cover of the woodland species recorded was similar to the other woodlands and was less than 1%. The composition of the woodland species was also similar to Moynish in that there were species belonging to two of the plant groups (*Querco-Fagetea and Fagetalia sylvaticae* and *Corylo-Fraxinetum territorial* groups) determined by Kelly & Kirby (1983) as associated with limestone woodlands. The reason that the species present do not slot into one group is that this woodland is not typical of natural limestone woodland having been irreversibly altered by planting. There is also a lack of fern species recorded throughout the woodlands with only three species, *Pteridium aquilinum, Dryopteris filix-mas* and *Asplenium scolopendrium,* recorded infrequently in Creggaun. This species group usually grows abundantly in the shaded humid environment of the woodland. However, the soils over limestone are well drained and the lack of moisture is not as suitable for fern growth as other woodlands which are over heavier soils. In Creggaun the most species belonging to the *Orchidaceae* (Orchid) family were recorded and included *Neottia nidus-avis, Listera ovata* and *Orchis mascula.* Of distinct interest is the presence of *Neottia nidus-avis* which according to Praeger (1934), Kelly and Kirby (1983), is essentially an old forest species in Ireland and its presence certifies that this is secondary woodland which has grown on previously wooded land. Only one specimen was recorded during the flora survey of 2006. However in the Orchid Survey of Lough Carra in 2007 which is presently taking place eight specimens were recorded (Huxley 2007 personal communication). This orchid is entirely honey coloured growing only in woodlands in deep leaf litter. The colour of this species has a camouflage quality and can be quite difficult to see against the background of leaf litter which perhaps saves it from browsing. Both *Listera ovata* and *Orchis mascula* were recorded infrequently in Creggaun and were in the uncommon group of species. The basal leaves were all that remained of both species having been grazed on by deer. However in Creggaun large numbers of *Orchis mascula* were recorded in full bloom in the deer exclosure. This will be discussed later. In comparison to the other woodlands Creggaun may have been less diverse in species but this was due to the absence of limestone grassland species. However it had a similar number of woodland species to Moynish and Bridgepark.

6.4 Leamnahye Island: Woodland Structure and Classification

The woodland structure of Leamnahye Island was the simplest of all four woodlands and more characteristic of limestone woodland. This narrow island was described as rocky and shrubby pasture in 1690, as brushwood and pasture in 1838, in 1914 only the centre area of the island was shown as wooded (approximately 1.5 acres mapped in Appendix 4) and today it is entirely wooded. The distribution of trees on the island is that larger canopy trees such as *Quercus robur* are confined to the centre which has deeper soils while the edges are principally dominated by light-loving scrub and pioneer trees. This is the only woodland in Partry Estate that was not affected by planting and so its development is entirely natural. The most frequently recorded species on Leamnahye were *Corylus avellana, Ilex aquifolium* and *Betula pendula. Corylus avellana* dominated both the sub-canopy and understorey through out the island. In the centre area it was recorded growing well alongside *Ilex aquifolium* under the heavy canopy of mature *Quercus robur* and also dominated the transitional woodland with *Betula pendula.* The transitional woodland along the island edges had a greater diversity of species and *Juniperus communis, Sorbus hibernica, Frangula alnus* and *Malus sylvestris* were only recorded growing in this area. There was also an area of transitional woodland running across the centre of the woodland 30 metres in length. This area had no mature or large canopy trees and was dominated by recent *Corylus avellana* and *Ilex aquifolium* scrub which is almost impassable. Leamnahye has a good population of mature *Quercus robur* which was probably one of the primary colonisers of this island after grazing management was neglected in the 1800s. Some of the mature *Quercus robur* trees were aged to approximately 156-161 years which is the same as those found on Moynish. The minimum age established for this species was 52 years which is probably around the time other species became more populous and canopy cover increased preventing further regeneration. There was no evidence of any *Quercus robur* regeneration at present. There was one aspect to some of the *Quercus robur* growth of interest and that was some of these trees were multi-stemmed while those on Moynish were mainly comprised of just one stem. One tree was recorded with nine stems. *Quercus robur* natural growth tendency is to have a single standard stem. Coppice management of young *Quercus robur* can cause the tree to grow with numerous stems. However, grazing by domestic or wild animals on young *Quercus robur* saplings can also produce this affect and is the most likely reason for these multi-stemmed *Quercus robur* on Leamnahye.

Although Leamnahye was not planted the effects of this planting have reached its shores. Both *Pinus sylvestris* and *Fagus sylvatica* were both recorded growing on the island. There growth is natural having colonised this island recently. The largest stem of *Pinus sylvestris* was located with a dbh of 36.62 cm and aged to 48 years. All other stems of this species had smaller diameters so it is fair to assume that *Pinus sylvestris* has only colonised this island in the past 50 years. *Sorbus hibernica* which is not a common woodland species was also established by tree coring to have colonised this island approximately 36 years ago. Similar to its growth on Moynish and Creggaun it was mainly recorded growing in the boundary edges. The growth of *Fraxinus excelsior* was not as abundant on Leamnahye Island as it was in the other woodlands. Its growth was mainly young with tall thin stems growing up to 12 metres in the canopy and also in the understorey. The maximum age recorded for this species was 38 years. It was also one of the main species regenerating in the woodland which was also the finding in the other woodlands. Similarly *Ilex aquifolium* was the most abundant sapling species recorded in the scrub layer. *Frangula alnus* was also commonly recorded regenerating in seedling form throughout the woodland and especially in Belt Transect 3 where over 100 seedlings were recorded. *Frangula alnus* was recorded growing in the understorey along the island edge and so there is a ready seed source to explain this regeneration in Leamnahye. In the other woodlands *Frangula alnus* was not frequently recorded and its regeneration was thought to be bird sown.

Woody climbers, ivy and honeysuckle were recorded on a number of trees in Leamnahye. Ivy was most commonly recorded growing on *Corylus avellana* and *Quercus robur.* The extent of its growth on trees was mainly scarce with profuse growth recorded occasionally. Honeysuckle growth was very uncommon and was only recorded on two tree species. Moss growth was also most frequent and profuse on *Corylus avellana* and was not as extensively recorded on other species. Eight tree species were recorded which had evidence of bark stripping and included *Frangula alnus, Fraxinus excelsior, Juniperus communis, Crataegus monogyna, Corylus avellana, Ilex aquifolium, Sorbus hibernica* and *Euonymus europaeus.* Based on the amount of damage recorded the species preference seems to be *Euonymus europaeus* > *Frangula alnus* > *Ilex aquifolium* > *Corylus avellana* > *Sorbus hibernica* > *Crataegus monogyna* > *Fraxinus excelsior* > *Juniperus communis.* The order of preference is similar to that ascertained in the other woods except there is a greater number of species recorded with bark stripping damage. The seclusion and undisturbed location of Leamnahye Island has obviously facilitated this result. The light composition of Leamnahye Island varied between bright and dim depending on the woodland structure. The edges of the woodland were generally brighter and had a lower percentage canopy cover because of its species composition. The average percentage canopy cover for the entire woodland was estimated as 58.96 % and reflects its varied composition. The drainage of the island was described as free and there was no evidence of impeded drainage during the field research. Soil depths of between 7-23 cm were recorded with rocks near the surface in many places. A combination of ground cover descriptions were recorded and depended on the location of the quadrat being described. Plant and grass cover was mainly recorded along the periphery of the island while the centre was covered with mossy boulders, leaf litter and had scarce plant cover. Leaf litter and dirt had a mean percentage cover of approximately 40% which makes it the principal ground cover component.

6.4.1 Leamnahye Island: Vegetation Analysis

In total 45 flora species were recorded during the vegetation survey of Leamnahye Island. These species were split up into four groups: (i) Woodland Species. (ii) Common Species. (iii) Limestone Grassland Species. (iv) Uncommon Species. These groupings are the same as were discerned for Moynish and Bridgepark. The species occurring in the common group were the same that were recorded in the other woodlands with moss dominating the ground cover. Grass was also frequently recorded but its growth was mainly confined to the woodland edges which have preserved some of the limestone grassland species. None of the flora species recorded in this group had exceptionally high mean percentage cover but they were the most frequently recorded species. Similar to the other woodlands the species listed in the woodland species group were relatively scarce and had mean percentage covers of less than 1%. The exception to this was *Sanicula europaea* which was the most frequent woodland species with a mean percentage cover of 2.45 %. It is a frequent shade tolerant species with a preference for limestone areas. Only the basal leaves of this species were recorded with no evidence of it flowering. The possible ancient woodland indicators *Galium ordoratum* and *Anemone nemorosa* were also recorded on Leamnahye although in low percentages. The relevance of their association with ancient woodland has not yet been adequately researched in Ireland to make any assumptions about the ancientness of this site. But it can be used as a sign that this area has had a previous woodland history. The composition of the woodland species in Leamnahye was also similar to Moynish and Creggaun in that there were species belonging to two of the plant groups (*Querco-Fagetea and Fagetalia sylvaticae* and *Corylo-Fraxinetum territorial* groups) determined by Kelly & Kirby (1983) as associated with limestone woodlands. Limestone grassland species were commonly recorded around periphery edges of the island. *Rosa pimpinellifolia* was recorded most frequently and was not only recorded along the edges but was also recorded growing in the centre of the woodland. The Orchid species of *Listera ovata* and *Gymnadenia conopsea* were both recorded during the survey and *Neottia nidus-avis* was recorded growing during the Orchid Survey of Lough Carra. Both *Listera ovata* and *Neottia nidus-avis* are woodland orchids but *Gymnadenia conopsea* is a limestone grassland species. The overall results of the Leamnahye Island flora survey depict a woodland habitat that has a severely depleted herb layer. Both limestone species and woodland specialists are equally affected. It has been shown that even shade tolerant species are not growing well in this environment so the only explanation for this minimal woodland flora is the presence of grazing. Grazing has long been a natural part of the woodland ecosystem but it is evident that uncontrolled levels of grazing are detrimental to woodland biodiversity.

6.5 Breeding Bird Census

During the Breeding Bird Census 2003-2006 25 woodland specialist species was identified in Partry Estate. Creggaun had 17 species, Moynish had 21 species and Bridgepark had 24. Most of the birds recorded are very common birds in Ireland and their distribution is widespread. Some of the species recorded are resident birds while others are summer visitors. The woodlands were used for gaming in the early nineties and many species of birds were wiped-out or severely depleted. The disturbance of gaming would have caused some species not to return to this habitat. However the woodlands are now a designated Wildfowl Refuge and no hunting is permitted. The Breeding Bird Census results generally show a gradual increase in the numbers and diversity of species residing in the woodlands. Woodlands are very important habitats for birds, providing shelter from the weather and predators, a secure place to build their nests and a source of food to sustain them. They have a very three-dimensional structure and different species of bird are found at different heights which can be linked to their food preferences (Read & Frater 1999). Blackcap species were recorded in all of the woodlands and was most abundantly noted in Creggaun. This species is a summer visitor which breeds in broadleaved woodlands with good ground cover and is not quite as common in Ireland as the other species. The Whitethroat species is a summer resident whose numbers have been declining in parts of Ireland, was recorded in Bridgepark in 2006. It prefers scrub areas for nesting which is available on the limestone area of Bridgepark. Another warbler species the Willow Warbler which is a summer visitor was abundantly recorded in each woodland. Competition from Goldcrests has meant their densities in Irish oak woodlands especially in Killarney are low, but this does not seem to be the case in Partry Estate as the Willow Warbler out numbered the Goldcrest in all of the woods. Many of the species recorded are benefiting from the presence of conifers in the woodlands such as the Coal Tit, Treecreeper, Goldcrest, Redpoll and Willow Warbler. Both the Chiffchaff and Great Tit which are widespread throughout Ireland prefer broad-leaved habitats and were found nesting in each woodland. The mixed nature of each of these woodlands is obviously beneficial to the diversity of bird species that occupy them. Another woodland specialist who was only recorded in 2006 in Moynish is the Jay. This exotic-looking crow has only been recorded west of the Connaught lakes since

1958 and is still extending its range in Co. Mayo (Cabot, 1999). It has been recorded in both coniferous and broad-leaved woodlands and was also recorded during the field survey in Leamnahye. Although not recorded during the breeding survey a Woodcock was spotted in Moynish during field surveying. This species is a popular gaming species and its population in Partry Estate would have been severely depleted when hunting was permitted. According to Cabot (2004) there are only 1,750-4,500 breeding pairs in Ireland and they occur in both coniferous and broadleaved habitats. Perhaps in time the numbers of this species will again increase in Partry Estate. Bridgepark had the greatest diversity of bird species despite its mixed nature and young growth. One advantage Bridgepark has over the other woodlands is that it has scrubby undergrowth and long grasses in the limestone area which is the preferred nesting area for some species such as the Blackcap, Chiffcaff and Whitethroat. Moynish had the second highest number of bird species and the presence of *Quercus robur* has attracted Jays who feed on the acorns. Creggaun had the least number of species and perhaps the presence of *Rhododendron ponticum* and a lack of undergrowth have influenced this. Overall it is encouraging that numbers of bird species are gradually increasing in Partry Estate. However the presence of grazing is preventing the establishment of any type of thick undergrowth such as briar patches or bracken thickets which are important areas for nesting and feeding birds. Yet the attractiveness of these woodlands to new species will be dependent on its diversity of habitats and the richness of its undergrowth and ground flora.

6.6 Fauna

The fauna of Partry Estate was not recorded in full during this survey however some information was recorded on a few species. The most common and largest species recorded was the Fallow deer whose presence was observed to be continual in every area of Partry Estate. The effect of their activity will be discussed subsequently. Badgers activity was noted in both Creggaun and Moynish and a badger sett was recorded in Bridgepark. Badgers are one of Ireland's most common large mammals and require habitats that are suitable for digging and that are remote. Setts are most commonly found in woodland habitats and as they are omnivorous they are not dependant on a rich herb layer. Pine marten was also recorded as residing in Party Estate. The numbers of this species seriously declined in the 17th century with the deforestation of the country which destroyed its habitat (Cunningham 2005). Pine marten was quite rare until recently and its numbers are recovering with the increase of woodland habitat. This mammal is regarded as threatened in Ireland and may be found in 'The Irish Red Data Book No. 2' and is considered category 2 or as an internationally important species (Rooney & Hayden 2002). Its preferred habitat is deciduous woodland with a thick canopy cover where it feeds on the fruit of ivy. It has been suggested that the presence of Pine marten is an indicator of ancient forest. However there is not enough known about the accuracy of this assumption.

6.7 Deer in Partry House Estate

It is evident from the results of both the vegetation and flora survey that deer are having an extreme impact on the biodiversity and structural development of the woodland habitats in Partry House Estate. The species of deer present in Partry Estate is fallow deer which are the most numerous and national species of deer in Ireland (Deer Alliance 2007). Fallow deer were first introduced to Ireland in the 13th century by the Normans who kept deer parks for hunting. Many park herds escaped or were released to the wild at the beginning of the 20th century and these supplemented the already wild fallow population in Ireland which is now widespread (Rooney & Hayden 2002:24). The presence of fallow deer in the Lough Carra/Mask area is due to their release from a Teagasc farm outside of Ballinrobe. Since then the population of deer has continued to increase in the absence of predatory and management controls. The fallow deer from the farm have a brown coat with black colouring on the hind quarters and these are the deer that have populated Partry House Estate. The preferred habitat of fallow deer consists of deciduous or mixed woodlands with a good understorey and interspersed grassy openings (Rooney & Hayden 2002:26) all of which are present in Partry Estate.

Sixteen years ago the population of deer in the Lough Carra/Mask area was 300-500 and has been gradually reduced by culling to 200 which has remained static for the past number of years. The population of deer in Partry is currently 30-35 deer, which increases up to 50+ during the summer (Daly personal communication 2006). This herd in the Partry area is mainly comprised of doe's and has two bucks. Population management of the herds has been ongoing for the past eighteen years and is organised by the local people and farmers. The effect of this culling has gradually reduced the population of deer but it has also caused the herds to spread out over a larger area as when threatened in their habitat deer move to another one. In the area up to 60 deer are culled a year and the main aim is to control the female population. Weaker bucks and doe's are also culled to create a stronger herd but the killing of trophy bucks and stronger doe's by hunters is hindering this process (Daly personal communication 2006). The suggested target stocking density of deer is 5 deer per 100 hectares (202 acres) and once achieved a maintenance cull of 15-20% would be needed (O'Carroll 2005:6). A local hunter in the area Jim Daly who has been mainly responsible for the culling in the area claimed that there is not enough of a market for the meat of the wild deer he kills and so there is no incentive to cull. The quality of meat from wild deer in not guaranteed and is tougher than the meat from farmed deer. There are also few carcass handling facilities, as few exist due to increasing regulations and the low profit margins from sales. These factors do nothing to promote the up take in culling deer. The area of woodland in Partry Estate is approximately 104 acres and at any time a percentage of the 35 deer in the Partry area may be grazing in these woodlands. During surveying and field-walking deer were recorded on almost all occasions and up to 20 deer have been recorded in the same day spread throughout the woodlands. According to O'Carroll's optimum target stocking density of deer, Partry woodlands can only feasibly support a population of 2-3 deer and is currently being grazed by up to ten times this figure. It is obvious that this high density of deer is seriously impacting on the diversity of species in Partry Estate and needs to be rectified before more diversity is lost. The deer population needs to be kept in balance with available supplies.

Evidence of their impact was recorded throughout the woodlands and each woodland was equally affected by browsing and poaching of herbs and regenerating species. Plant cover in all the woodlands was scarce and patchy, leaving a ground cover that is dominated by mossy boulders, leaf litter and dirt. The decrease in the diversity of plants reduces the value of the woodlands as habitats for many birds, small mammals and invertebrates. The growth of bramble in the understorey is not developing into thickets a favoured nesting area and source of food for many bird species because of deer browsing. Deer prefer cover and browsing and bark stripping were more commonly recorded in the interiors of the woodland. Bordering areas between woodland and open ground known as edge habitats or ecotones were also favoured feeding habitats for deer in Partry Estate. Deer were frequently sighted grazing on the limestone grassland of Bridgepark and the fen bog bordering Moynish and Creggaun. The presence of grazing deer can greatly influence the developing woodland structure as deer are widely reported to reduce the size and number of regenerating seedlings and the effect increases with increasing animal density (Peterken 1989, Kelly 2002, Perrin, Kelly & Mitchell 2006). Not only are seedlings affected but also young trees and saplings are prone to damage by deer. Bark stripping was recorded throughout the woodlands and it was noticed that younger tree species were mainly targeted for bark stripping. Some older trees, mainly *Ilex aquifolium,* showed signs of past bark stripping of which the scars still remain and deform the stem growth (Plate No. 6.2). The bark stripping results also showed the deer preferred different tree species and some species were not affected by bark stripping. The pattern in preference in Partry Estate was *Euonymus europaeus* > *Ilex aquifolium* > *Fraxinus excelsior* > *Corylus avellana* > *Frangula alnus* > *Crataegus monogyna* > *Sorbus hibernica* > *Juniperus communis* > *Sorbus aucuparia/Betula pendula* > *Quercus robur/Pinus sylvestris/Prunus spinosa.* Deer stripping was responsible for the death of many young trees in the woodland as some species do not recover as well such as *Pinus sylvestris* (Plate No.6.2).

Plate No.6.2 Bark Stripping on *Ilex aquifolium*. Bark stripping causing death of *Pinus Sylvestris*

Experimental deer exclosures and control plots were set up to evaluate and quantify the effect of deer grazing on the vegetation of the woodlands in Partry Estate. This approach has been used for some time in the field of ecology and long-term monitoring programmes of deer exclosures have taken place in Killarney woods (Kelly 2002, Perrin, Kelly & Mitchell 2006), Lady Park Wood (Peterken 1989) and Hayley Wood (Rackham 1975) to name a few. These experiments generally found that heavy grazing pressure distort the natural ecology of woods favouring the regeneration of unpalatable species and also the canopy dominance of long-lived trees such *Quercus* species. The results from the deer exclusion experiment used in this study are only the preliminary findings and the experiment will need to be continued for some time in order to record some definitive changes in the vegetation and flora. The results from the exclosures and control plots confirm the conviction that the lack of flora diversity observed in the vegetation survey is caused by the overgrazing of the woodlands by deer. The hypothesis of the experiment was that vegetation would increase in the absence of grazing in the exclosures and that it would decrease or remain the same in the control plots, and this was proved true in all the exclosures. Increases in the mean percentage cover of most species were recorded and the average height in vegetation increased and was generally greater than vegetation recorded in the control plots. Height increases of 4.28 – 14.02 cm were recorded in the exclosures in 2006. Some height increases were also recorded in the control plots but this was mainly due to the presence of one species *Arum maculatum* which was recorded more frequently due to the earlier surveying of the experiment sites. The number of regenerating tree species in the exclosures generally increased in the year while some species were lost from control plots. The increase in regeneration was mainly recorded for *Fraxinus excelsior* in both the exclosures and control plots. Moynish exclosure recorded the greatest increase of 1380 seedlings and the same increase was not recorded in the nearby control plot. Marked increases in *Fraxinus excelsior* regeneration in the event of stock exclusion was also recorded in the exclosure experiment in Killarney woods (Perrin, Kelly & Mitchell 2006). *Ilex aquifolium* also increased in density in the exclosures and in the Killarney experiment impenetrable holly thickets have formed in many of the exclosures (Perrin, Kelly & Mitchell 2006). It was also found that the height growth of *Ilex aquifolium* was checked indefinitely by heavy browsing to form a low scrub less than 50 cm high (Perrin, Kelly & Mitchell 2006). Browsing on *Ilex aquifolium* was frequently recorded in the control plots leading to the loss of saplings and seedlings in both Creggaun and Moynish.

There was a noticeable increase in the flowering of species in the exclosures especially in Creggaun. The abundant flowering of *Orchis mascula* was only recorded in this area of the woodland and their growth is obviously affected by browsing as individuals directly outside of the fencing did not flower even though they were growing in the same environment. The appeal of these flowers to deer is such that in spring 2007 the exclosure was broken into and *Orchis mascula* growth was eaten. As part of the experiment the growth and flowering of *Primula vulgaris* is being observed. In the exclosures in Hayley Wood Oxlip growth was monitored in the absence of grazing. It was found that deer were almost entirely responsible for the frequent failure of oxlip to flower even in areas where coppicing had taken place and also for the reduction in oxlip numbers (Rackham 1975). The number of *Primula vulgaris* where present increased in one year but did not flower. The control plot in Creggaun with a good population of *Primula vulgaris* plants recorded a reduction in density in just one year. It is too early in the experiment to claim that deer are solely responsible for the lack of flowering *Primula vulgaris* plants but it seems that there presence may be a contributing factor as other plants rarely seen flowering in the woodlands recovered enough in one year to flower in the exclosures. In general increases in the mean percentage cover of species within the exclosures were more frequent than in the control plots. The reduction in some species within the exclosures may be caused by the increased competition for space and light by recovering species. Species diversity increased in the exclosures as new species were recorded that were not present in 2005. The ordination and group techniques used to compare the data from 2005 and 2006 did not show any definitive change occurring in the composition of the vegetation. The data from the surveys in the exclosures indicated that the composition was very similar and that some change had occurred. The data from the control plots was also shown as similar in composition but when compared to the average similarity results of the exclosures more of a change had taken place. The composition of the exclosures is more stable than the control plots because of the exclusion of deer. It is too early in the experiment for these calculations to give any definitive answers but they can be used as a tool and show that some change has occurred but not of a great extent.

There is no question in the light of all the evidence that deer are impacting negatively on the biodiversity value of Partry Estate Woodlands and there is an obvious need to address this matter. The present management of the deer in the area is population management by culling. This is deemed the most effective approach to deer management however the present levels of culling are not enough to reduce the population to innocuous levels. Other management approaches such as erecting deer proof fencing are not as cost effective and have associated problems such as injuring deer. According to Perrin, Kelly & Mitchell (2006) the complete cessation of grazing via fencing is undesirable except as a short term measure in heavily degraded areas. The sudden absence of grazing benefits established tree seedlings but the development of dense ground vegetation can prevent subsequent seedling establishment (Perrin, Kelly & Mitchell 2006). It is difficult to make a case for preserving the deer which are exotic mammals but grazing has been present within Irish woodlands as an integral part of the ecosystem and there would be nothing natural about the complete cessation of grazing in woodland. So ideally the woodlands should remain grazed but at a level that does not affect their biodiversity. The main problem with the growing deer problem is the lack of ownership of the problem and accountability among State departments. Coillte has developed deer management plans for its state owned forests but this does not help the private land owners. There is need for a statutory body to oversee deer management practice and research in Ireland similar to The Deer Commission of Scotland or The Deer Alliance in England. With regards to the woodlands in Partry the only feasible action at present is to increase the numbers of deer culled each year until the government bodies finally accept responsibility and some form of strategic management is implemented.

6.8 Summary of Survey Findings

Summary of Survey Findings.	
Bridgepark	▪ Varied woodland structure with mature, transitional and recent woodland compartments. ▪ Planting of *Pinus sylvestris, Larix decidua* and *Fagus sylvatica* in the 1880s had a profound effect on vegetation structure and composition. ▪ *Fraxinus excelsior* is the main species regenerating throughout the woodland. Its initial colonisation of the site was aided by the shelter offered from the planted trees. Most of its growth has taken place in the past 20 years. ▪ 55 flora species were recorded in Zone 1 and categorised as (i) Limestone Grassland Species, (ii) Uncommon Limestone Grassland Species, (iii) Woodland Species and (iv) Uncommon Woodland Species. ▪ 42 flora species were recorded in Zone 2 and categorised as (i) Woodland Species, (ii) Limestone Grassland Species, (iii) Common Species and (iv) Uncommon Species. ▪ Bridgepark has a depleted ground cover, which is species poor due to the overgrazing of the woodland by deer and also the presence of conifer species.
Moynish	▪ It is the oldest of the four woodlands with a wooded history that can be traced back to at least 1838. ▪ Seven different woodland compartments were identified, consisting of both semi-natural broadleaved woodland and highly modified woodland of varying stages in structure - mature, transitional, scrub and immature. ▪ Planting of *Pinus sylvestris* and *Fagus sylvatica* was dated to 1860s and *Larix decidua* was dated to 1880s.

	▪ The presence of *Quercus robur* is natural on Moynish and has been established for at least 160 years. ▪ It is the only woodland that has a stand of *Populus Tremula* and it has been growing on Moynish for at least 50 years. Its natural colonisation is a rare event and was in doubt due to the previous history of planting in the woodland. However, it is most likely that this growth is natural as there is a similar stand of trees in a neighbouring woodland. ▪ The woodland edges had greater light levels and showed a higher diversity of species because habitats are available for species that need both closed forest and open habitats together. ▪ A total of 39 flora species were identified and the results of the survey demonstrated that Moynish had an extremely impoverished vegetation layer which is severely reduced by overgrazing. ▪ The TWINSPAN programme ordered the species that most frequently occurred together and a number of groups were identified: (i) Woodland Species. (ii) Common Group. (iii) Limestone Grassland Group. (iv) Uncommon Group. ▪ The species *Anemone nemorosa* and *Galium ordoratum* that are considered to be indicators of relict or ancient woodland were recorded on Moynish.
Creggaun	▪ Creggaun consists of parcels of both semi-natural and highly modified woodland of which six woodland types were classified and mapped. ▪ The planting of *Larix decidua* was established as taking place in the late 1850s and *Pinus sylvestris* was slightly later in the 1880s. ▪ There is a large area of *Rhododendron ponticum* growth on Creggaun that has been dated as at least 80 years old. Some removal and stump treatment of this stand took place in December 2006 and further management is planned. ▪ The 29 flora species identified on Creggaun were grouped as (i) Woodland Species, (ii) Common Species and (iii) Uncommon Species. Unlike the other woodlands limestone species were scarcely recorded. ▪ Of distinct interest is the presence of *Neottia nidus-avis* which according to Praeger (1934), Kelly and Kirby (1983), is essentially an old forest species in Ireland and its presence certifies that this is secondary woodland which has re-established on land that was once wooded.
Leamnahye	▪ The woodland structure of Leamnahye Island was the simplest of all four

Island	woodlands, more characteristic of limestone woodland and was mainly classed as Oak Ash Hazel Woodland WN2 . ▪ No planting took place on Leamnahye, but both *Pinus sylvestris* and *Fagus sylvatica* have naturally established on the island seeding from neighbouring growth on Creggaun. ▪ Mature stands of *Quercus robur* were recorded and aged to approximately 160 years. ▪ Bark stripping damage was most frequently recorded on Leamnahye which is due to its undisturbed and secluded location. ▪ In total 45 flora species were recorded during the vegetation survey of Leamnahye Island. These species were split up into four groups: (i) Woodland Species. (ii) Common Species. (iii) Limestone Grassland Species. (iv) Uncommon Species which are the same groupings as Bridgepark and Moynish. ▪ The possible ancient woodland indicators *Galium ordoratum, Neottia nidus-avis* and *Anemone nemorosa* were also recorded on Leamnahye although in low percentages. ▪ The overall results of the Leamnahye Island flora survey depict a woodland habitat that has a severely depleted herb layer. Both limestone species and woodland specialists are equally affected by the presence of overgrazing by deer.
Breeding Bird Census 2003-2006	▪ During the Breeding Bird Census 2003-2006, 25 woodland specialist species was identified in Partry Estate. ▪ Creggaun had 17 species, Moynish had 21 species and Bridgepark had 24. Most of the birds recorded are very common birds in Ireland and their distribution is widespread. ▪ The species diversity of birds were affected by past gaming in the estate, but the census shows that numbers are now increasing gradually.
Deer in Partry Estate	▪ The current population of deer in Partry is 35-40 fallow deer. ▪ Culling management of the deer is currently taking place. However, the uptake in culling is hindered by the lack of handling facilities and the quality of meat. ▪ The optimum target stocking density of deer Partry woodlands can feasibly support is a population of 2-3 deer and it is currently being grazed by up to ten times this figure. ▪ The pattern in species preference for bark stripping in Partry Estate was

	Euonymus europaeus > Ilex aquifolium > Fraxinus excelsior > Corylus avellana > Frangula alnus > Crataegus monogyna > Sorbus hibernica > Juniperus communis > Sorbus aucuparia/Betula pendula > Quercus robur/Pinus sylvestris/Prunus spinosa. ▪ The overgrazing of the woodlands was found to have greatly reduced the species biodiversity and is altering the structure of woodland growth. The decrease in the diversity of plants reduces the value of the woodlands as habitats for many birds, small mammals and invertebrates. ▪ **Preliminary findings of Deer Exclusion Experiment:** (i) Increases in the mean percentage cover of most species were recorded in the exclosures and the average height in vegetation increased and was generally greater than vegetation recorded in the control plots. (ii) The number of regenerating tree species in the exclosures generally increased in the year while some regenerating species were lost from the control plots. (iii) There was a noticeable increase in the flowering of species in the exclosures especially in Creggaun where the abundant flowering of *Orchis mascula* was only recorded. (iv) The reduction in some species within the exclosures may be caused by the increased competition for space and light by recovering species. (v) Species diversity increased in the exclosures as new species were recorded that were not present in 2005. (vi) The ordination and group techniques used to compare the data from 2005 and 2006 did not show any definitive change occurring in the composition of the vegetation. However, the readings suggested that the composition of the exclosures is more stable than the control plots because of the exclusion of deer.

Table 6.1 Summary of Field Survey Findings

6.9 Management of Partry Estate Woodlands

Management for preservation of conserved ecosystems such as woodland is receiving increased attention. The opinion on whether to manage or not to manage for the purpose of conservation is still divided and is really dependent on the individual circumstances of each woodland. However, ever increasing research on the uses of management in woodlands are supportive of it and are proving that managed woodlands are more likely to survive than unmanaged woodland. There are various types of management such as active management, adaptive management, minimal intervention and non-intervention. Active management includes the use of coppicing, pollarding, felling, thinning, planting trees and grazing. This type of management may be necessary to remove non-native and exotic species that are threatening the natural environment. In Britain it is widely assumed by conservation managers that active management in the form of regular rotational coppicing is appropriate for the maintenance of the flora and fauna because such woods have survived due to their economic value under coppice-with-standards management for over 700 years (Barkham 1992:167). Barkham's (1992) research over 18 years in the mixed conifer/broadleaved woodland in Brigsteer Park Wood studied the effects of active management on ground flora and established that light demanding perennial herbs do increase in coppiced areas. It was also established that the process of decline of shade tolerant flora in undisturbed parts of the woodland will be slow or absent. Therefore the use of coppice management must be based on the individual objectives of the management plan. Thinning an active management prescription is when some trees are felled so that those remaining have enhanced growth. Thinning allows light to reach the previously shaded forest floor and seeds in the seed-bank can germinate and it encourages a herb layer to develop with more habitats for wildlife and enhances the nature conservation value of the forest. Felling of trees in woodlands may be a necessary action if exotic species are present and the management objective is to restore the natural woodland. This is often necessary in woodlands that have been interplanted with conifers or non-native broadleaved species. Brackloon Wood in County Mayo has been the focus of a planned management programme since 1998 that aims to restore and conserve the semi-natural status of the wood. In order to achieve this objective planted conifers and non-native broadleaved species such as

Acer pseudoplantanus and *Fagus sylvatica* have been removed to encourage natural regeneration of native woodland. The importance of this long-term monitoring and biodiversity research in Brackloon is that it will guide the management of similar woodland ecosystems in Ireland. Grazing is another form of active management used in woodland habitats. As mentioned earlier grazing has been a historical part of the Irish woodland ecosystem and there is nothing natural about woodland that is not grazed by large herbivores. Grazing at low levels is beneficial in most woods, keeping some plants in check, enabling a variety of ground flora to survive. According to Read & Frater (1999) grazing at low levels may even stimulate the natural regeneration of some trees as it keeps competing vegetation under control. An 80 year study in an oak-beech woodland in Denmark comparing managed and unmanaged areas indicated that leaving the forest without management decreased the floristic diversity and litter decomposition rates (Strandberg, Kristiansen & Tybirk 2005). The non-managed plots succeeded into dark beech-oak forest with drastic decreases in understorey species. The managed areas of the woodland indicated that grazing, at least as a temporary forest treatment, is likely to reverse oak forest aging by maintaining the forest in a species rich open stage. Strandberg, Kristiansen & Tybirk (2005) supported the theory that grazing management was necessary to conserve oak woodland and understorey vegetation. However as grazing pressure increases, the field and shrub layers gradually reduce in height and tree regeneration declines.

The principle of adaptive management is to continually review the effects of active management intervention and adjust activities accordingly. Active and minimal management approaches may be implemented but the effects of this management are closely monitored. This is the type of management which has been proposed for the management of the woodland at Old Head Reserve in County Mayo. Minimal intervention may be considered appropriate in woodlands that do not need much active management in order to maintain them and is often a good policy to employ in terms of nature conservation (Read & Frater 1999). This approach to management has been implemented in Lady Park Wood in Britain since 1944. Non-management was decided on in order to study the natural processes taking place there. After 60 years of study Peterken & Mountford (2005) concluded that it was impossible to create natural woodland by protecting it from intervention. Their experience was that the woodland could not be insulated from its surroundings which are not natural. The main problem they incurred was the presence of a large population of deer which were non-native and seriously impacting on the regeneration and successional changes taking place. They concluded that although the fencing-out of deer would be unnatural, the population of deer is also deviant in the absence of predators that would have also been part of the natural woodland ecosystem.

One of the objectives of this study of Partry Estate Woodlands was to use the historical and ecological data recorded to guide possible management decisions to enable their future conservation. The baseline ecological study, the deer exclusion experiment and the establishment of Partry Estate's historical management facilitated the drawing up of a management plan in an abridged format that will guide the future writing of a comprehensive management plan. Rackham (2006) criticises the writing up of management plans that are not properly researched or implemented and that are based on management plans from other woodlands just because they are similar. He advises that what makes the woodland different should be identified and clear objectives should be maintained throughout. Based on the research undertaken and the findings of studies in other woodlands an adaptive management approach is deemed the best option for this woodland. The presence of wild deer make the effect of certain management techniques unpredictable so constant monitoring of the situation will be necessary. A combination of both active management and non-intervention in areas will be incorporated. This is a private woodland so the amount of management that is feasible is restricted for economic reasons unlike many of the studies which were in national reserves. Some priority management has been implemented in the woodlands in December 2006, which was funded under the Heritage Council's Biodiversity Fund. The management of these woodlands, Moynish, Bridgepark and Creggaun was under taken to meet a number of specific objectives:

- To eliminate stands of *Rhododendron ponticum*.
- Re-open existing tracks and paths in order to encourage the herb layer and ecotone and to increase overall diversity.
- Create woodland glades by coppicing hazel.
- Eliminate young growth of beech.

The funding enabled the employment of a specialist tree surgeon company to undertake the management work over a five day period and their work was supervised by the author. The removal and treatment of *Rhododendron ponticum* was made a priority because of its aggressive growth. In Moynish two areas of growth were removed and the stumps treated with a brushwood killer to prevent its regrowth. In Creggaun a stand of *Rhododendron ponticum* extending to approximately 1 hectare was targeted for management. This area of growth is extensive and grows on the boundary of woodland bordering the fen bog. It had been decided that the winter months were the most suitable time for the woodland management techniques that were to be undertaken. By managing the woodlands in the winter there would be fewer disturbances caused to the bird and fauna populations and also to the vegetation. However flooding in Creggaun at the time of Rhododendron treatment prevented its complete removal and about one third of the area was cleared and treated. Some work on the re-opening of paths and removal of young beech was undertaken in Bridgepark and Creggaun. However there is a need for the management work undertaken in 2006 to be continued and extended. These management actions have significantly reduced the growth of *Rhododendron ponticum* and the re-opening of pathways will encourage the growth of herb and shrub flora with a consequent increase in the faunal component. The abridged management plan will stipulate how the woodland should be managed and outline future management actions and can be consulted in Appendix 5.

Plate No. 6.3 Rhododendron Clearance in Creggaun 2006

7. Conclusion

7 Conclusion

By using a combination of historical and ecological surveying techniques the historical management of Partry House Estate has been established. The detail of this history is not as informative as it was initially hoped as the lack of valuable estate records somewhat hindered this process. However, the lineage of ownership of the estate dating back to 1574 was established up to the present day. There were frequent changes of landlords during the ownership of the Lynch family and most of the heirs spent time abroad in the Indian Army and were not always present to manage the estate. From historical descriptions of the demesne land it was determined that the woodland sites were rough pasture from at least 1690 until a change in grazing management in the early 19th century allowed the re-establishment of secondary woodland to occur. From the mid 19th century planting of non-native trees took place in three of the woodlands. This was part of the landscaping fashion at that time and considerably altered the natural structure of these woodlands. The woodlands are still part of Partry House demesne and a minimal intervention approach has been taken towards their management in recent years.

The findings of the survey established that the woodland composition of Bridgepark is not the typical class of woodland that is commonly found in limestone areas and that areas of its natural structure have been greatly altered by the management's planting of species that would not naturally occur in this area. In saying that there are still areas of valuable semi-natural ash/hazel woodland and scrub developing since the early part of the 19th century in Bridgepark and which are typical of this limestone environment. However, the development of the woodland structure has been largely influenced by the presence of planted trees, and the success of *Fraxinus excelsior* over the growth of *Quercus robur* may be largely due to their existence in Bridgepark. It is also predicted that these species will continue to alter the natural successional processes of the woodland structure with both *Fagus sylvatica* and *Pinus sylvestris* increasing in population and invading the semi-natural areas. By compiling the management history of the estate it has been established that this is an area of secondary woodland that was once managed as pasture before reverting back to its natural disposition as woodland. The woodland is comprised of compartments of mature, transitional and scrub development, which have varied woodland structures and composition. The considerable diversity of trees and flora species identified are mainly associated with the areas of semi-natural secondary woodland and the presence of the limestone habitat. Poorer ground flora and understorey diversity was chiefly associated with the conifer areas. However the main finding of the flora survey was that the overgrazing of the area has resulted in an extremely depleted plant cover that is lacking in the diversity and abundance of vascular plants which is usually associated with broadleaved woodlands. This grazing has also prevented the establishment of a scrub layer which is an important woodland habitat for many species of fauna. One possible advantage of the presence of conifer species is that they are another source of food and shelter for bird species with the potential to attract specialist birds that feed on its fruit. The management of Bridgepark is mainly concerned with at least curbing the impact these introduced species are having on the natural structure and development of this woodland. By completely removing these planted species it is predicted that the woodland would revert to its character semi-natural state which is of higher conservation value. It is not possible to precisely predict what affect their removal would have on the overall diversity of the area, but it assumed that the biodiversity value of the area would increase.

The historical data confirmed that Moynish is the oldest of the four woodlands in Partry Estate with its history of woodland establishing sometime prior to 1838. It was recorded as pasture in historical documents from 1690 so this is secondary woodland like Bridgepark. It has also been partially altered in nature and structure due to the planting of conifers and *Fagus sylvatica* in approximately the 1860s. The effect of this planting has not been as obstructive to the high development of limestone woodland as in Bridgepark. Semi-natural woodland had already prominently developed on Moynish prior to planting and that is why there is a valuable population of colonising mature *Quercus robur* in the areas of semi-natural woodland. A mosaic of woodland types at various stages in development and composition were identified and mapped, with the majority of the woodland cover identified as semi-natural. It was determined that the forest edges and scrub areas of the woodland had a higher diversity of species than the forest interior because habitats are available for species that need both closed forest and open habitats together. An interesting population of *Populus tremula* was established to have naturally colonised in the woodland. The natural colonisation of this species does not often occur because of the exacting conditions required for its germination and according to Rackham (1975) it is a rare event. Another tree species of interest that has naturally colonised this area is *Taxus baccata* which is rarely recorded in natural habitats. The success of its growth as an understorey species is very much dependant on the reduction of grazing pressure and it is difficult to predict what future effect its presence could have on the structure and diversity of the woodland. *Fraxinus excelsior* was abundantly recorded and especially dominated the areas of semi-natural woodland. Its regeneration and present population suggest that it will continue to be a component part of this woodland for some time. The planting of *Pinus sylvestris* has significantly impacted on the structure of transitional woodland along the border edges. In the areas not affected by the natural colonisation *Betula pendula* was found to be the primary coloniser. However it now has competition from this introduced species which will effectively distort the natural successional processes of woodland in these areas. The results of the flora survey were similar to all the other woodlands with a greater diversity of limestone and woodland species recorded in the forest edges and mainly woodland species recorded in the interior. The grazing by deer is also seriously impacting on the diversity and abundance of flora species resulting in woodland that has no shrub layer and is dominated by bryophyte cover. There were a number of woodland indicator species recorded that are reputed to signify the presence of woodland prior to clearance, thus confirming that this is secondary woodland. The future structure of the woodland as mainly semi-natural is somewhat under threat by the colonisation of the introduced species and there is a need for some active management to be applied.

The woodland on Creggaun was found to be the most modified by planting primarily because of its smaller dimensions. The semi-natural area of the woodland was also reduced by the extensive area of *Rhododendron ponticum* that has naturally colonised and is aggressively spreading further into both the woodland and *Cladium* fen habitats. The planting of primarily *Larix decidua* took place in a similar period to Moynish and has altered the natural development of woodland on this site. There were both areas of mature and transitional semi-natural woodland identified in this woodland which varied in structure and composition. It was also found that *Pinus sylvestris* regeneration along the forest edges has significantly altered the natural successional processes in these areas. The historical management of Creggaun was the same as the other woodlands in that rough pasture started to be recolonised by secondary woodland sometime prior to 1838. The flora survey did not record as many limestone species as was found in the other woodlands and woodland flora of low abundance was mainly recorded in the semi-natural habitats and was even less abundant in the modified areas. The results of the survey revealed that grazing was negatively affecting both the diversity and abundance of species in the flora and shrub layers. Some management of *Rhododendron ponticum* growth in the woodland has been initiated but further priority management of this area is needed to restore this woodland back to semi-natural growth.

The findings of the survey indicate that Leamnahye Island is the most natural of the four woodlands and its woodland structure has not been modified by planting. Its survival as an island up until the 20^{th} century and its small area most likely protected its natural status and deterred the planting of non-native species. The woodland types on this island are all semi-natural and characteristic of native limestone woodland. The island has a valuable population of mature *Quercus robur* which colonised the island approximately 160 years ago. The forest edges were classified as transitional woodland which was populated with light loving trees and shrub species. The only area of Leamnahye Island affected indirectly by the planting regime is the western edge where some natural colonisation of *Pinus sylvestris* has taken place in the past 50 years. To date this growth has not impacted on the general structure of the woodland but its growth needs to be monitored. There are also a number of young *Fagus sylvatica* colonising along the forest edges and their growth is in need of management. The flora on Leamanhye was representative of both woodland and limestone grassland habitats and although relatively diverse the growth was not abundant. The effects of deer grazing have also impacted negatively on the diversity of the flora and scrub layers of this island. As this is the most natural woodland in the estate it has been advised that a minimal management approach to the island would be best suited. This would allow the natural successional processes to develop and to be observed.

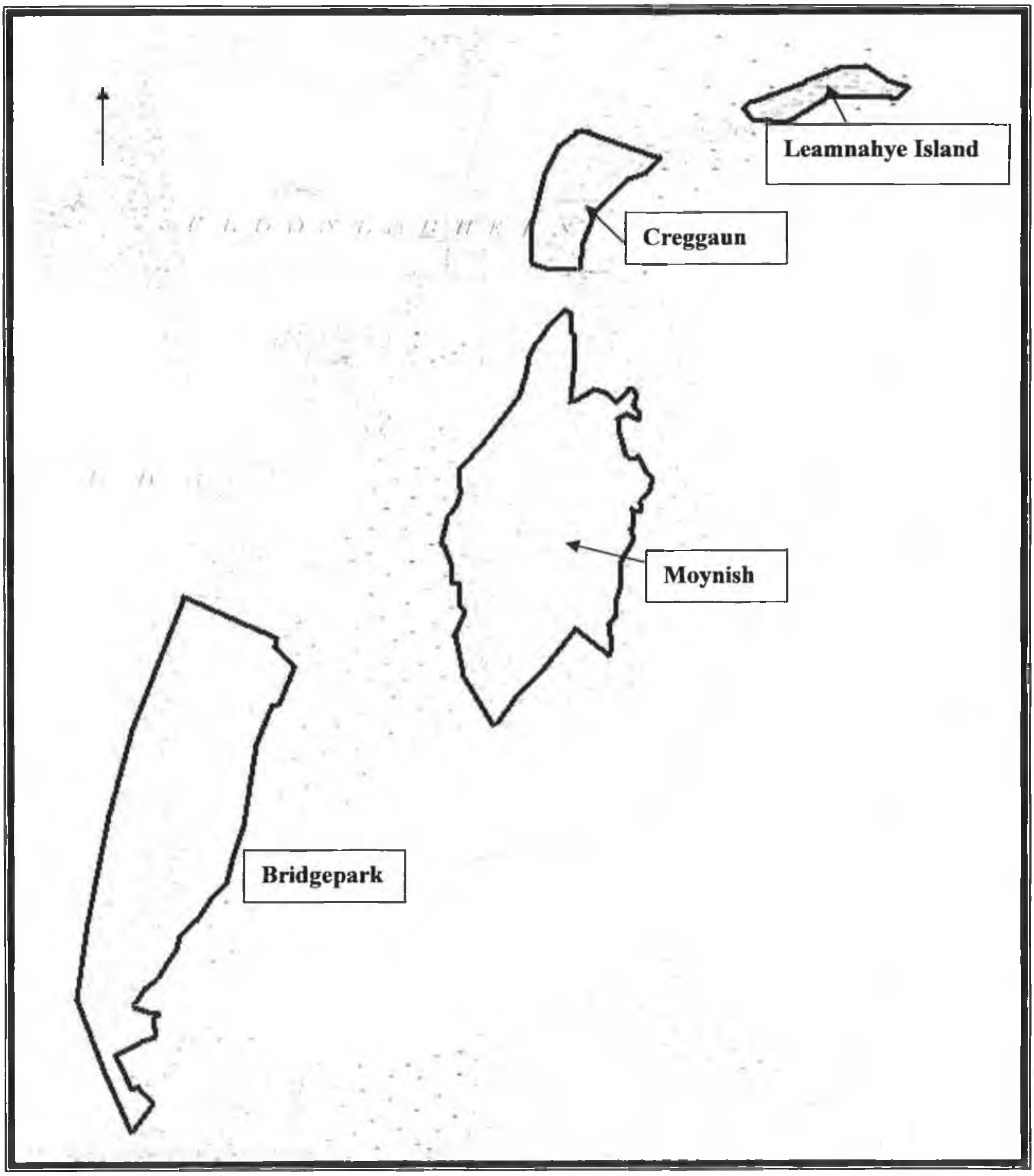
As mentioned throughout the study the presence of fallow deer in the woodlands is of great concern. The overgrazing is decreasing the biodiversity of the habitats and threatening the conservation value of these woodlands. It was calculated that 10 times too many deer are presently grazing these habitats year round which is preventing the development of a scrub layer and decreasing the diversity and abundance of flora species in the herb layer. This has resulted in a species poor habitat for birds and mammals. The initial findings of the long-term deer exclusion experiment confirm the hypothesis that grazing is the main reason for loss of diversity in the woodlands of Partry House Estate. Regeneration of species improved somewhat in the exclosures and also the diversity of species and the height of vegetation increased. Species were recorded in flower in the exclosures after just one year of deer exclusion. These findings are encouraging and indicate that when grazing pressure is alleviated the woodland species will recover and increase in diversity.

Based on the findings in this study it has been decided that an active adaptive management approach should be adopted for the management of these woodlands. The semi-natural characteristic of the woodlands has already been somewhat altered by past management which has altered both the natural structure and diversity of the woodland compartments in these sites. Therefore sensitive management is now needed to somewhat rectify the modification of these semi-natural habitats. In the absence of management further loss of diversity and naturalness will be experienced. The management of the growth of exotic species is one of the most pressing concerns and if left unsupervised further natural habitats will be altered. The management of fallow deer is also a priority but it is not a straight forward matter. There are many issues concerning population control which need to be rectified in order to advance their countrywide management. Through sensitive management techniques they have the potential to develop into diverse semi-natural woodlands that are of considerable conservation value.

The study of Partry House Estate Woodlands has been an informative and rewarding undertaking. As with most research there are constraints and unforeseen difficulties that must be overcome and that teach valuable lessons. Looking back it seems that the ambitious study load and inexperience may have compromised some decisions on surveying methodologies as time restraints dictated the change of surveying techniques. Also the unforeseen loss of the valuable historical records of the estate greatly reduced the content and scope of the historical research. However the study has established that Partry Estate Woodlands are valuable woodland habitats comprising of a mosaic of woodland types that have an interesting woodland history. Only the surface of the full ecological potential of these woodlands has been examined in this research and they are worthy of further investigation. It would be beneficial for surveys to be conducted on the bryophyte and fungi communities in the woodlands. A study of the invertebrate community should also be undertaken and further studies on the fauna populations would advance the knowledge of these sites. It has been established that palynological research has contributed much to our understanding of the development and decline of the natural forests in Ireland. Hall (1997) has been using pollen analysis research to study the evidence for historic landscape change in the documentary evidence and comparing it with pollen profiles from recent peat and lake sediments in Ireland. This study by Hall highlights the potential of landscape reconstruction through the use of pollen analytical research not only for Irish prehistory but also for the historic period in Ireland. The location of the Partry House Estate Woodlands beside both bog and lake habitats lends itself to the possible future study of its pollen deposits which would greatly extend the knowledge of its landscape prehistory and history. The habitats of the limestone grassland and *Cladium* fen bog were not surveyed in this study and species inventories for both habitats should be undertaken in the future. Both these habitats are affected by deer grazing and it would be interesting to establish to what extent their presence is influencing the diversity and development of these habitats.

Appendices

Appendix 1



Appendix 1.1 25 inch Ordnance Survey Map 1914

Quadrat Sheet ($10m^2$)

Woodland:____
Quad No:____
Date:____
Slope:____
Aspect: ____
G.P.S. No. ____
Evidence of brousing____

Evidence of Human Activity:____

Trees overhead: ____

Ground Cover:	4. Leaf litter and dead wood
1. Rocks and Mossy Boulders	5. Covered with plants
2. Limestone and grass	
3. Bare soil	

Internal drainage:	4. Strongly impeded
1. Excessive	5. Prone to flooding
2. Free	
3. Impeded	

Light:	4. Dim
1. Very bright	5. Very Dim
2. Bright	
3. Moderate	

Saplings recorded					
Tree species	**Height cm**	**Other info**	**Tree Species**	**Height cm**	**Other info**

Appendix 1.2 Field Surveying Sheets

Seedlings recorded					
Tree species	**Height cm**	**Other info**	**Tree Species**	**Height cm**	**Other info**

Appendix 1.2 Field Surveying Sheets

Flora Sampling Sheet

Date:________________________ **Recorder:**________________________________

Sampling design:________________ **Woodland:**______________________________

Aspect:________________________ **Slope:**__________________________________

Size of Quadrat:________________ **Drainage:**______________________________

Description of site & Surveying:____

____

____

Light Composition:______________ **G.P.S. No.** _____________________________

Height of Vegetation:____________ **Ground Cover:**__________________________

Quadrat No.	**% Cover**	**Quadrat No.**	**% Cover**	
Species		**Species**		
Species Name	**% Cover**	**Species Name**	**% Cover**	
Quadrat No.		**Quadrat No.**		

Appendix 1.2 Surveying Sheets

Tree Survey Sheet:

Woodland:_______________ G.P.S. No._______________

Date:_______________ Percentage Cover.__________

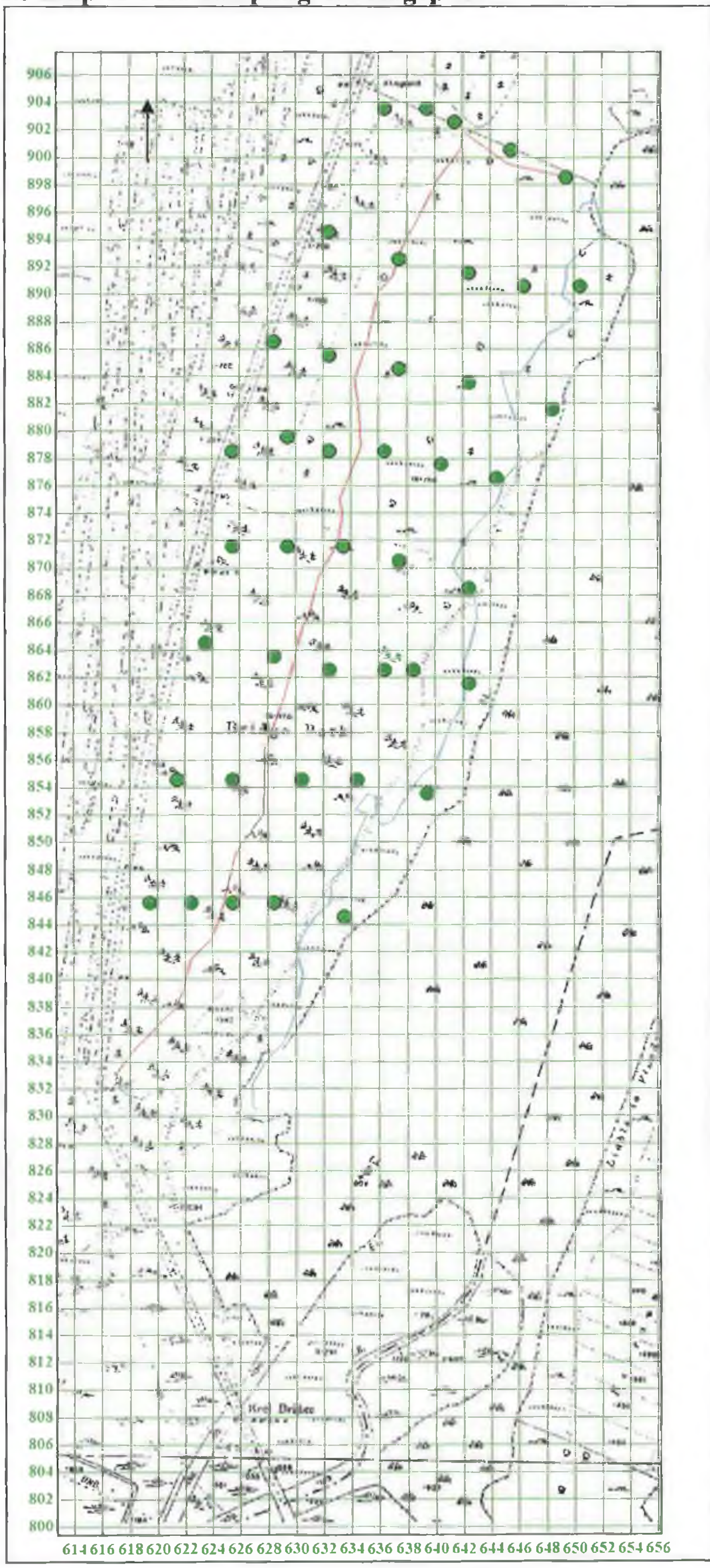
Quadrat No._______________

Tree Species:	
Tree number:	
Girth:	
Diameter:	
Tree height:	
Canopy/ Understorey/Scrub	
Observations on condition etc	
Bark Scrapping: Yes/no	
Epiphytes/woody climbers	
No. of Stems	
Management:	
Regeneration	

Tree Species:	
Tree number:	
Girth:	
Diameter:	
Tree height:	
Canopy/ Understorey/Scrub	
Observations on condition etc	
Bark Scrapping: Yes/no	
Epiphytes/woody climbers	
No. of Stems	
Management:	
Regeneration	

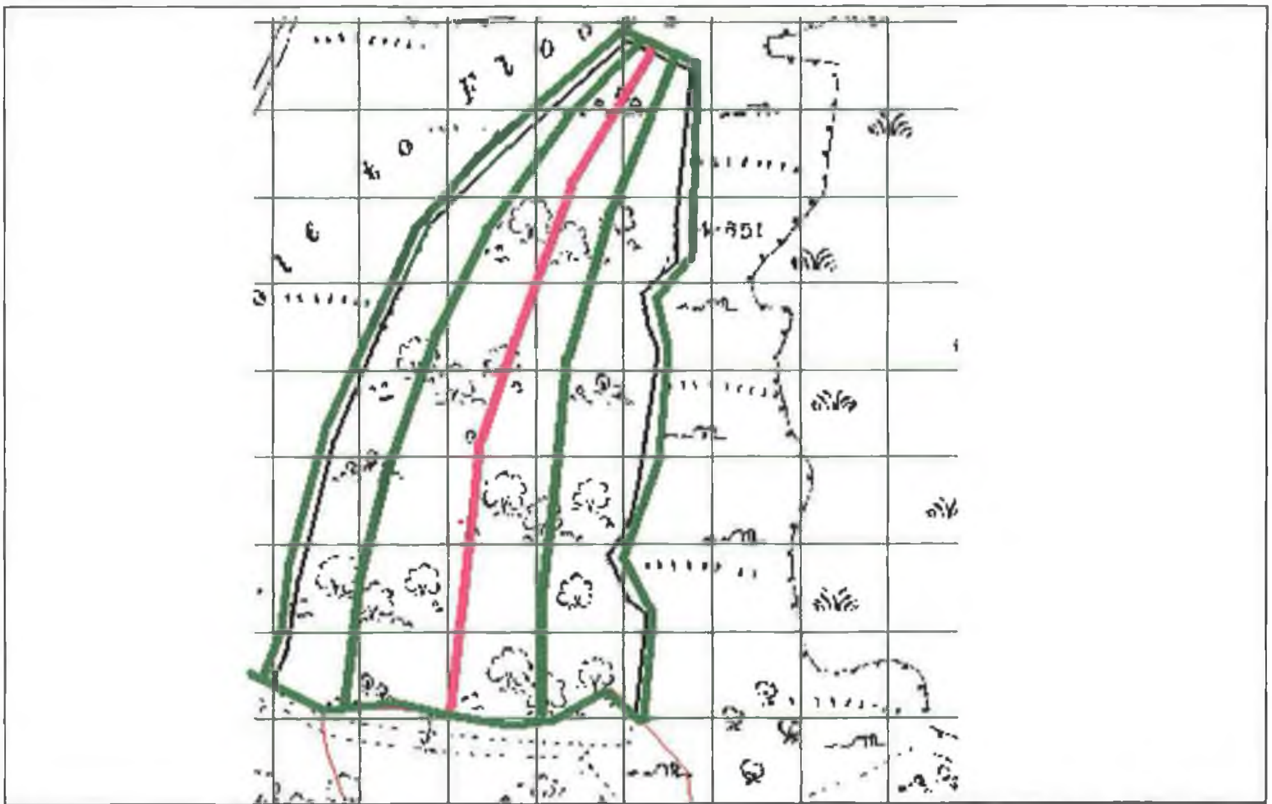
Appendix 1.2 Field Surveying Sheets

Appendix 1.3 Map of Grid Sampling in Bridgepark



Grid Scale 20m^2

Appendix 1.4



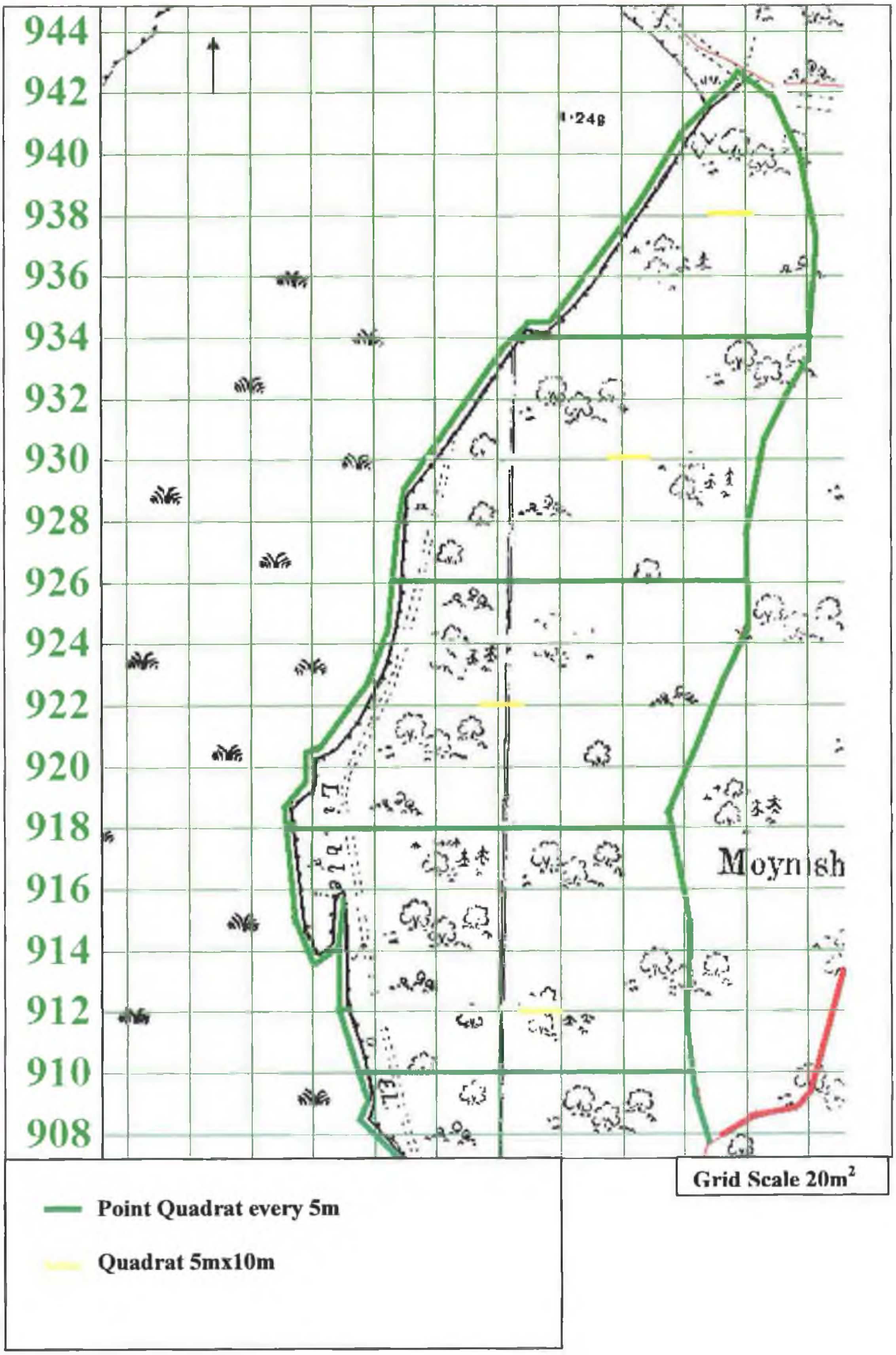
Grid Scale $20m^2$

Line Transect 160m x 4m

Point Quadrat every 5m

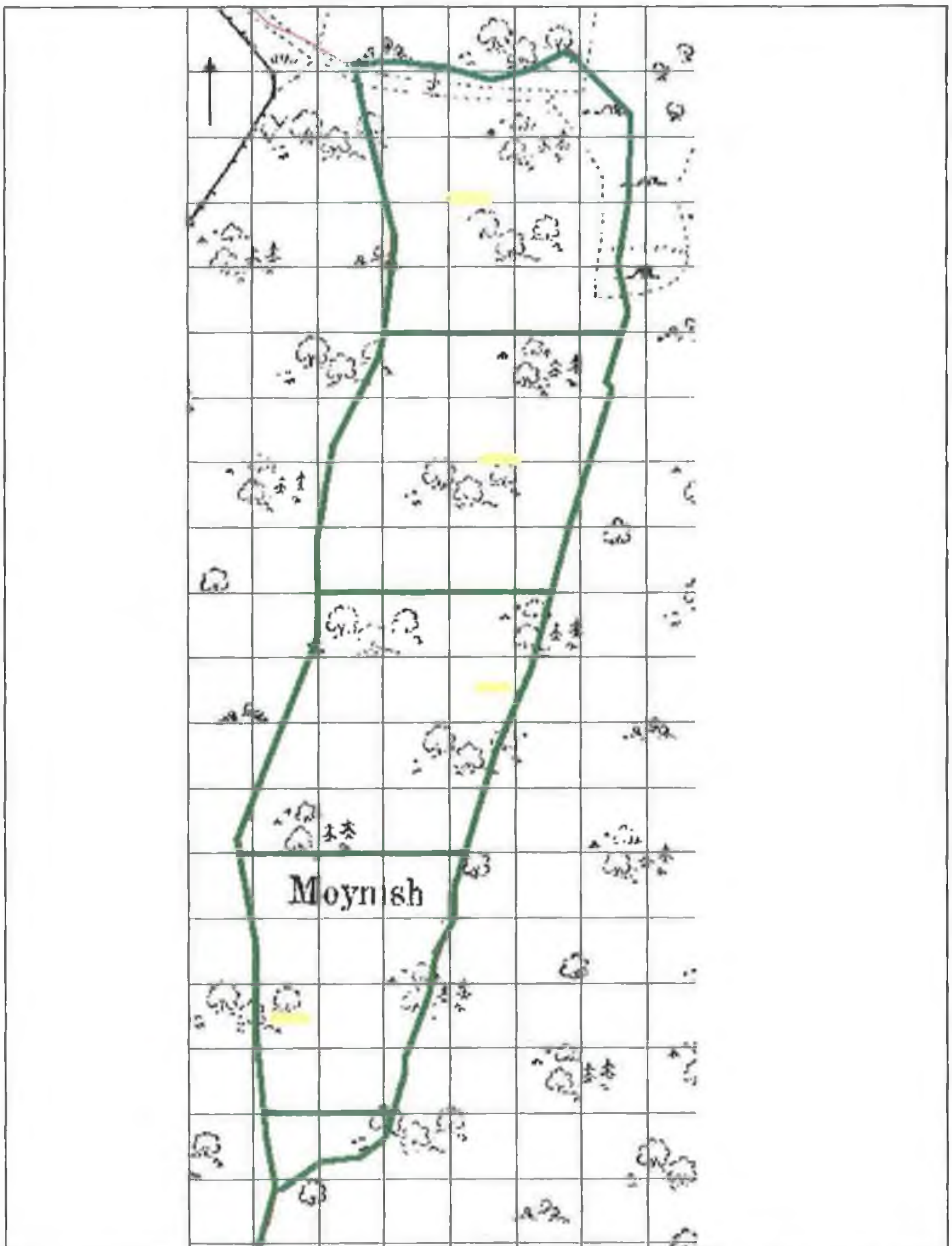
Surveying of Moynish Zone 1

Appendix 1.5



Surveying of Moynish Zone 2

Appendix 1.6



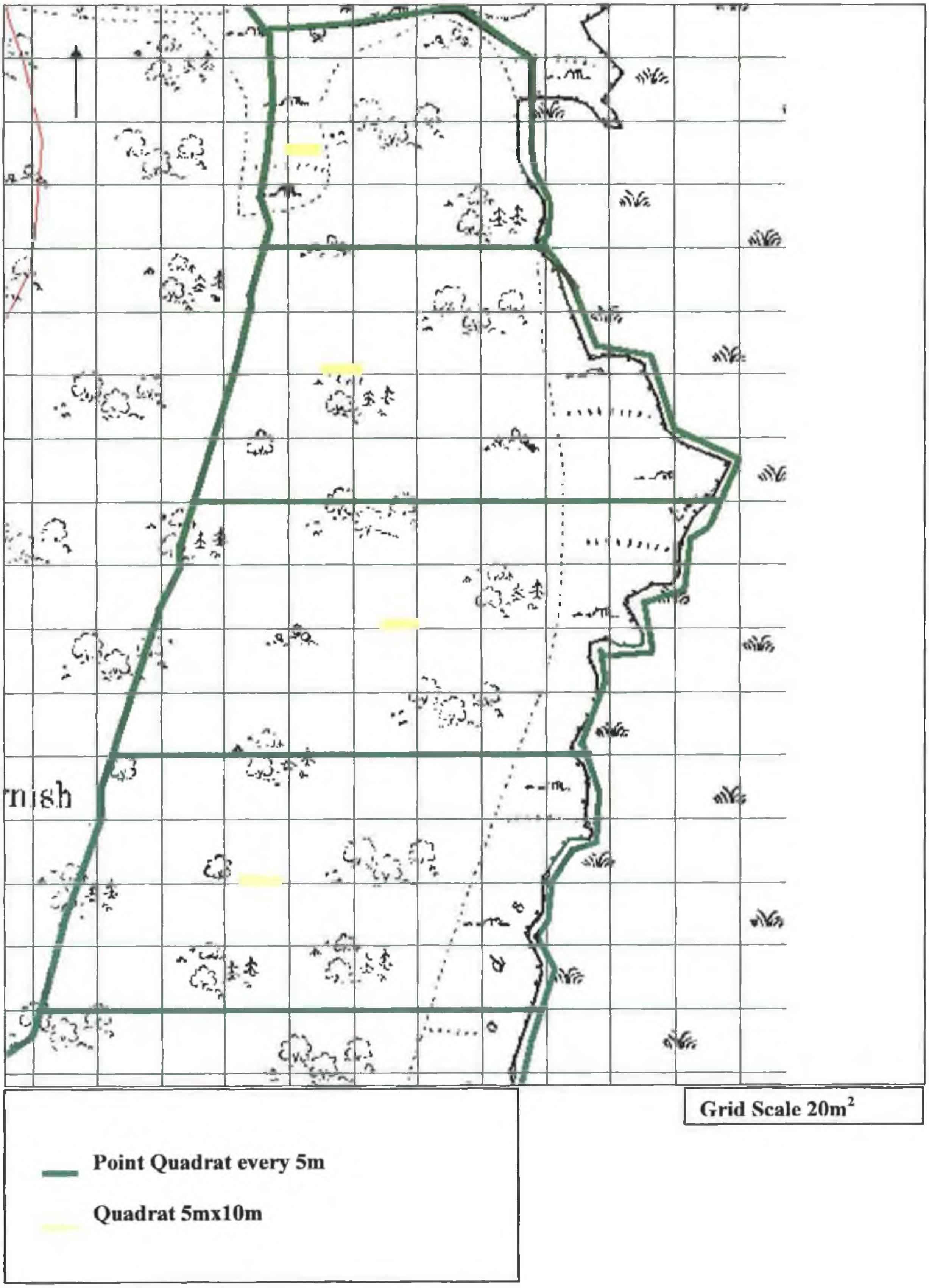
Point Quadrat every 5m

Quadrat 5mx10m

Grid Scale 20m^2

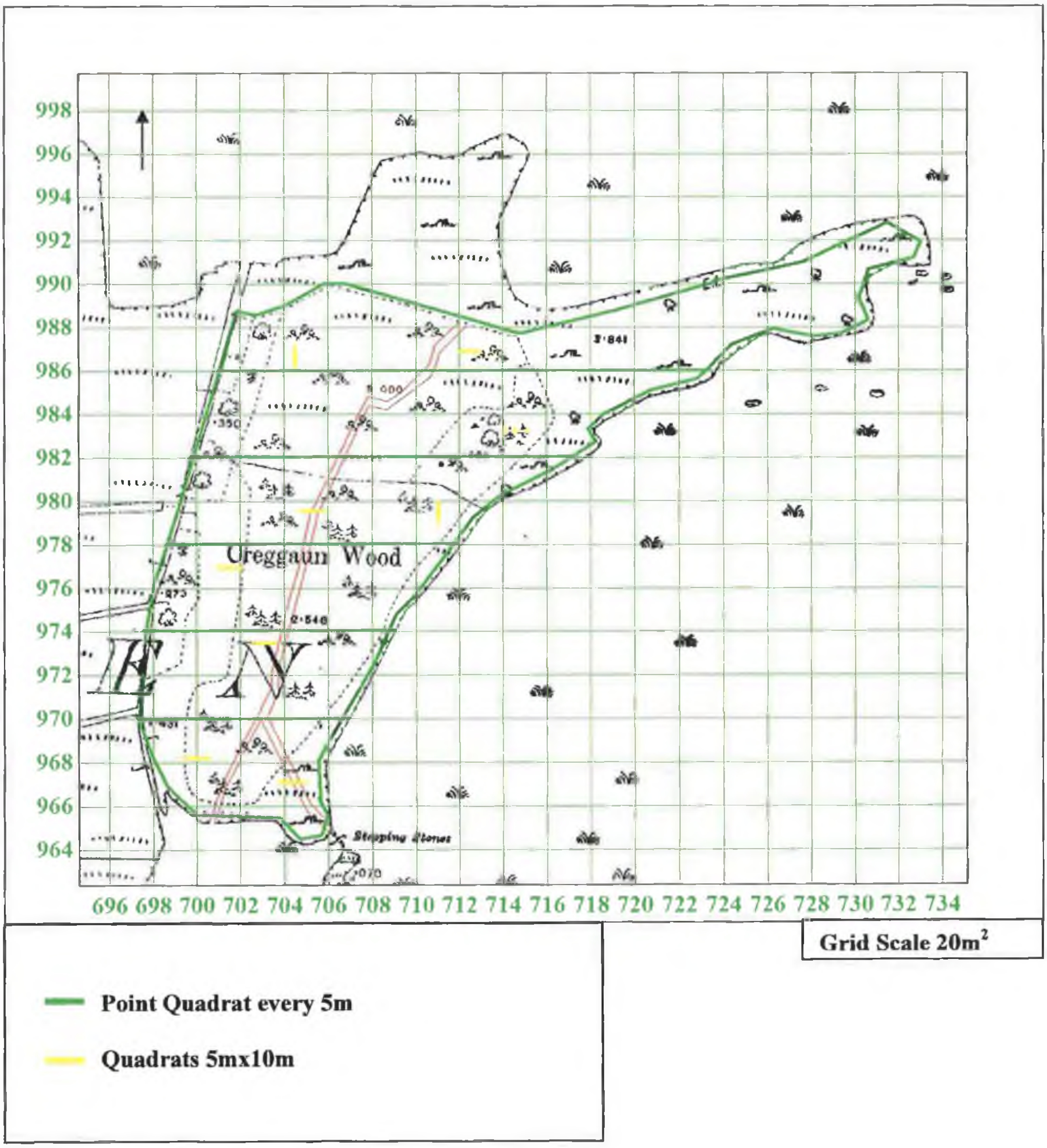
Surveying Moynish Zone 3

Appendix 1.7



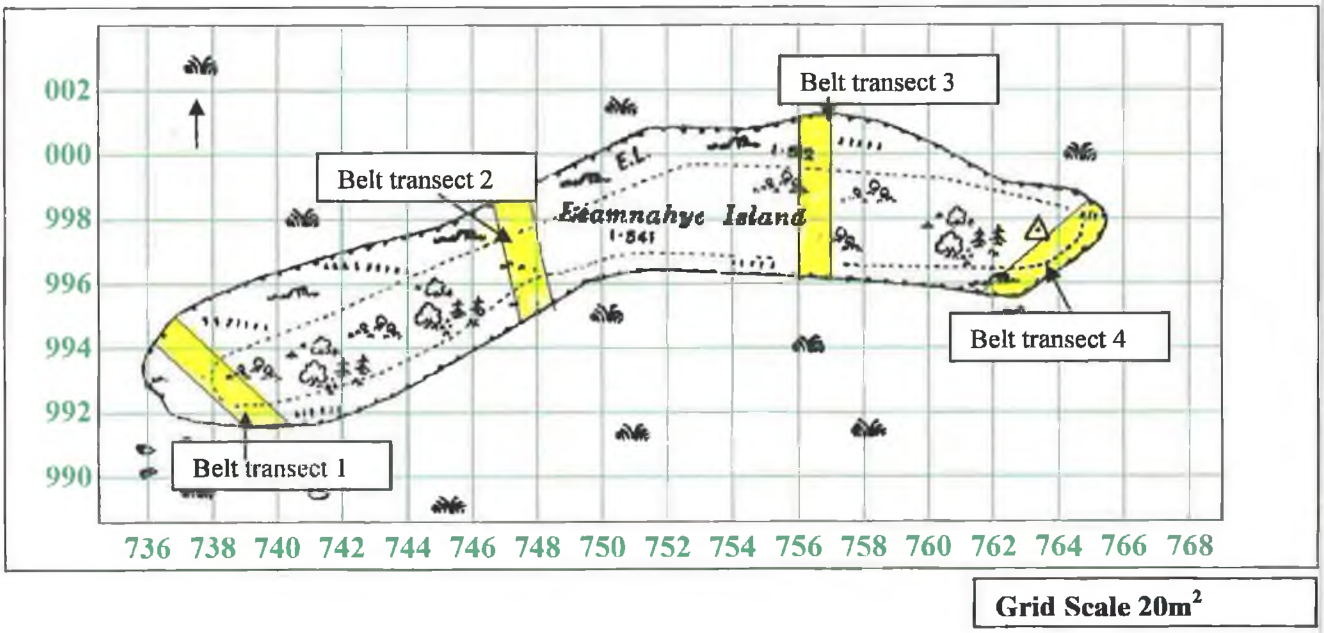
Surveying of Moynish Zone 4

Appendix 1.8

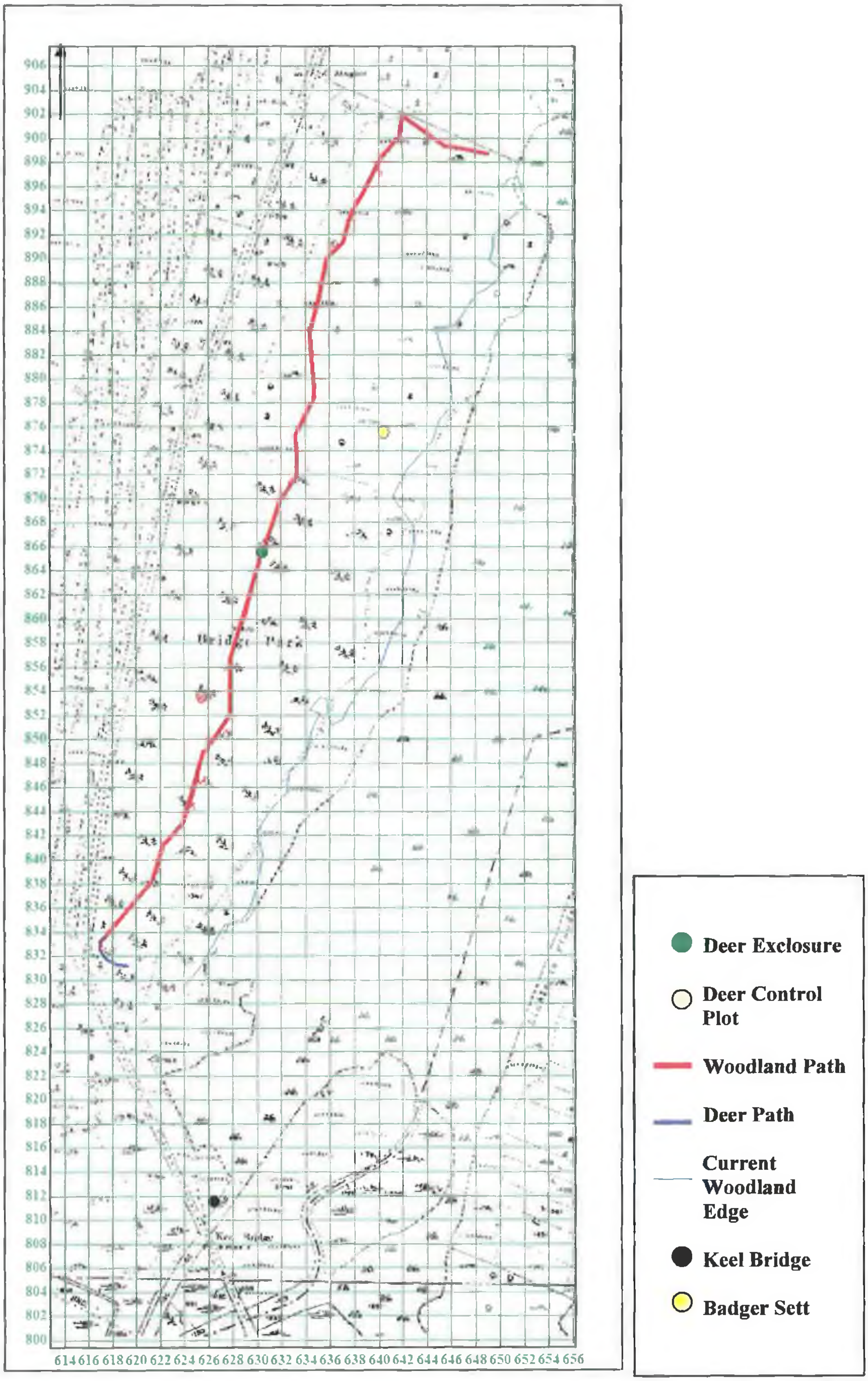


Surveying of Creggaun

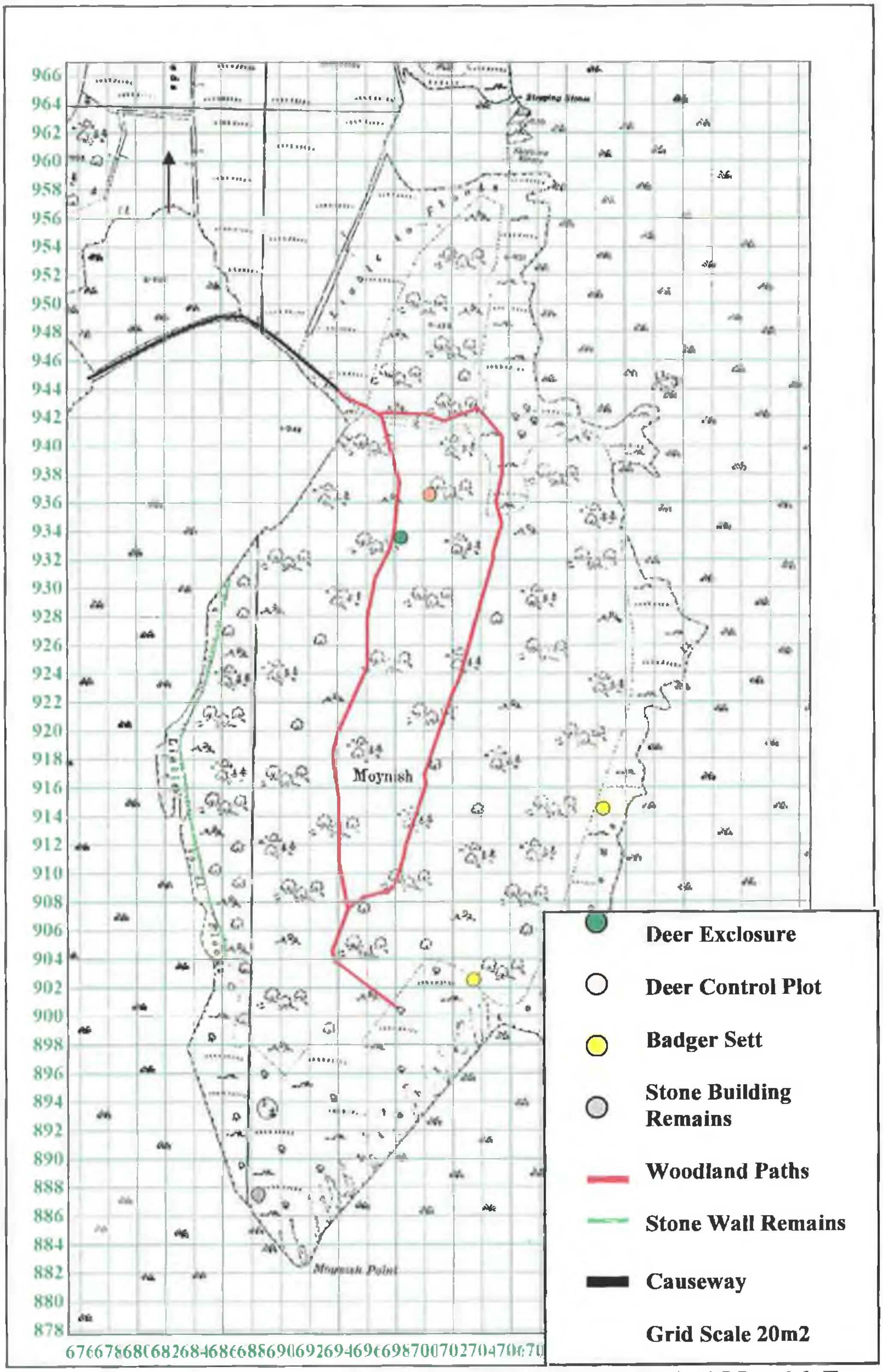
Appendix 1.9



Surveying of Leamnahye Island

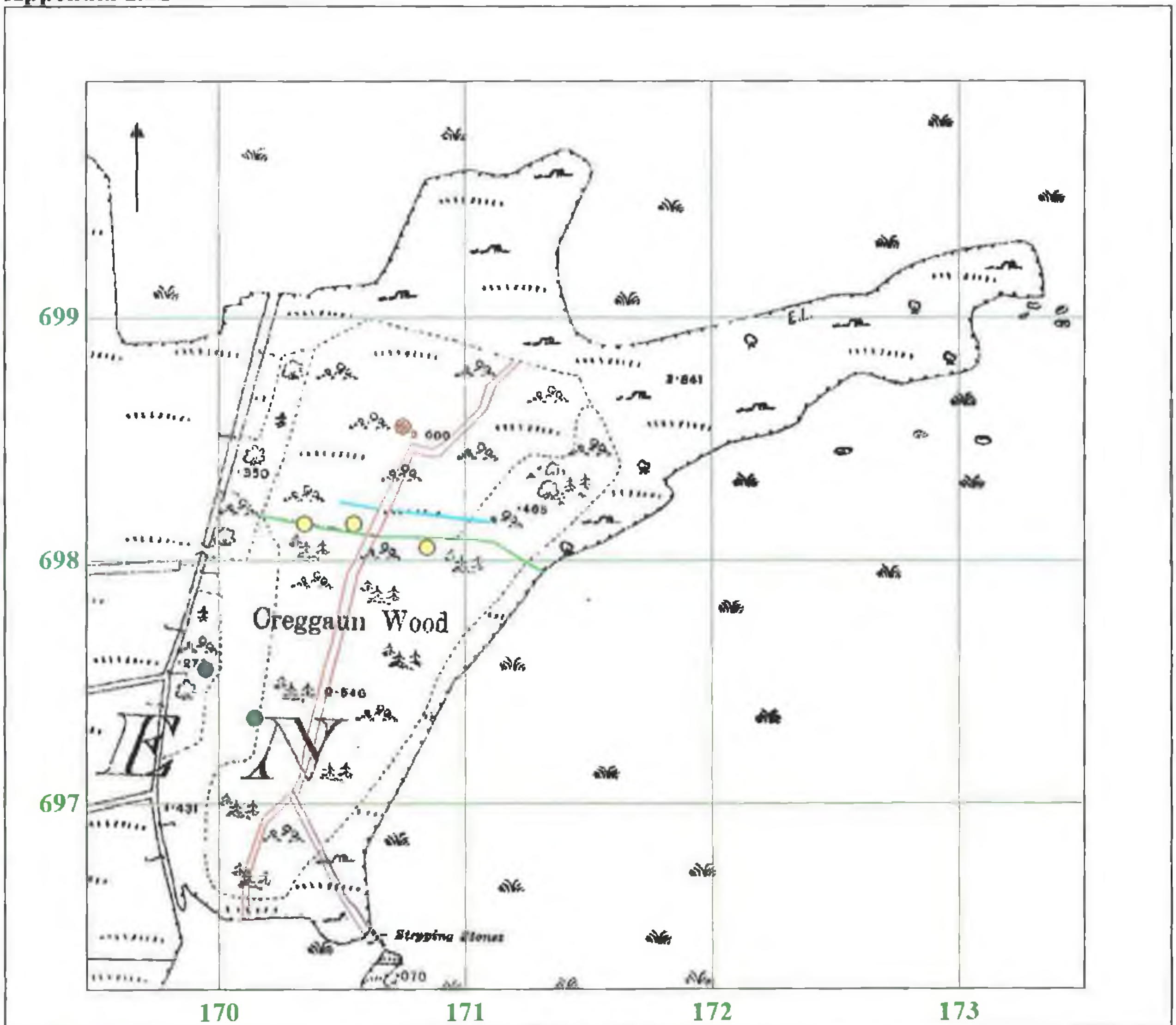


Appendix 1.10 Bridgepark Feature Map



Appendix 1.11 Moynish Feature Map

Appendix 1.12



Deer Exclosure

Deer Control Plot

Pits

Badger Set

Woodland Path

New Woodland Path

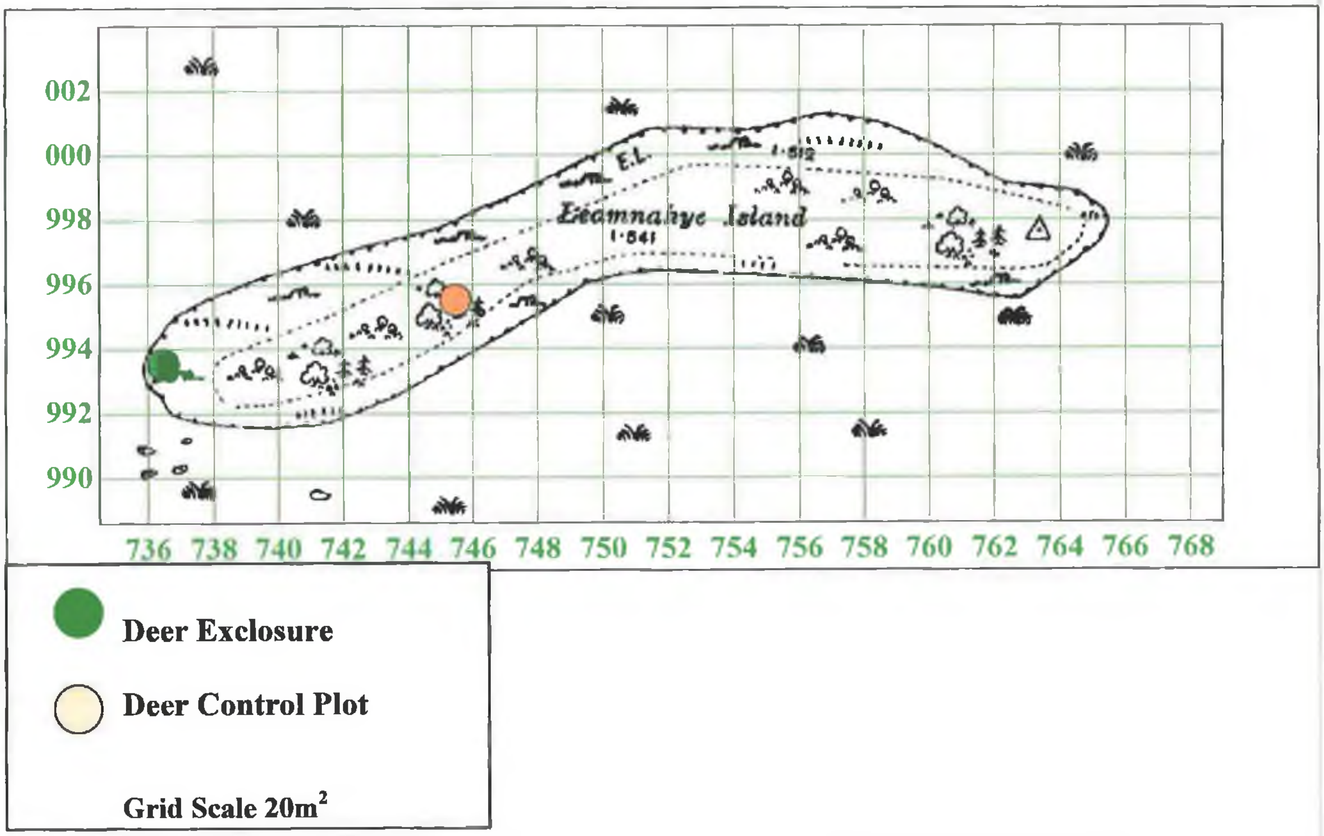
Stone wall on 1914 OS Map

Present Remains of Stone wall

Grid Scale 20m2

Creggaun Feature Map

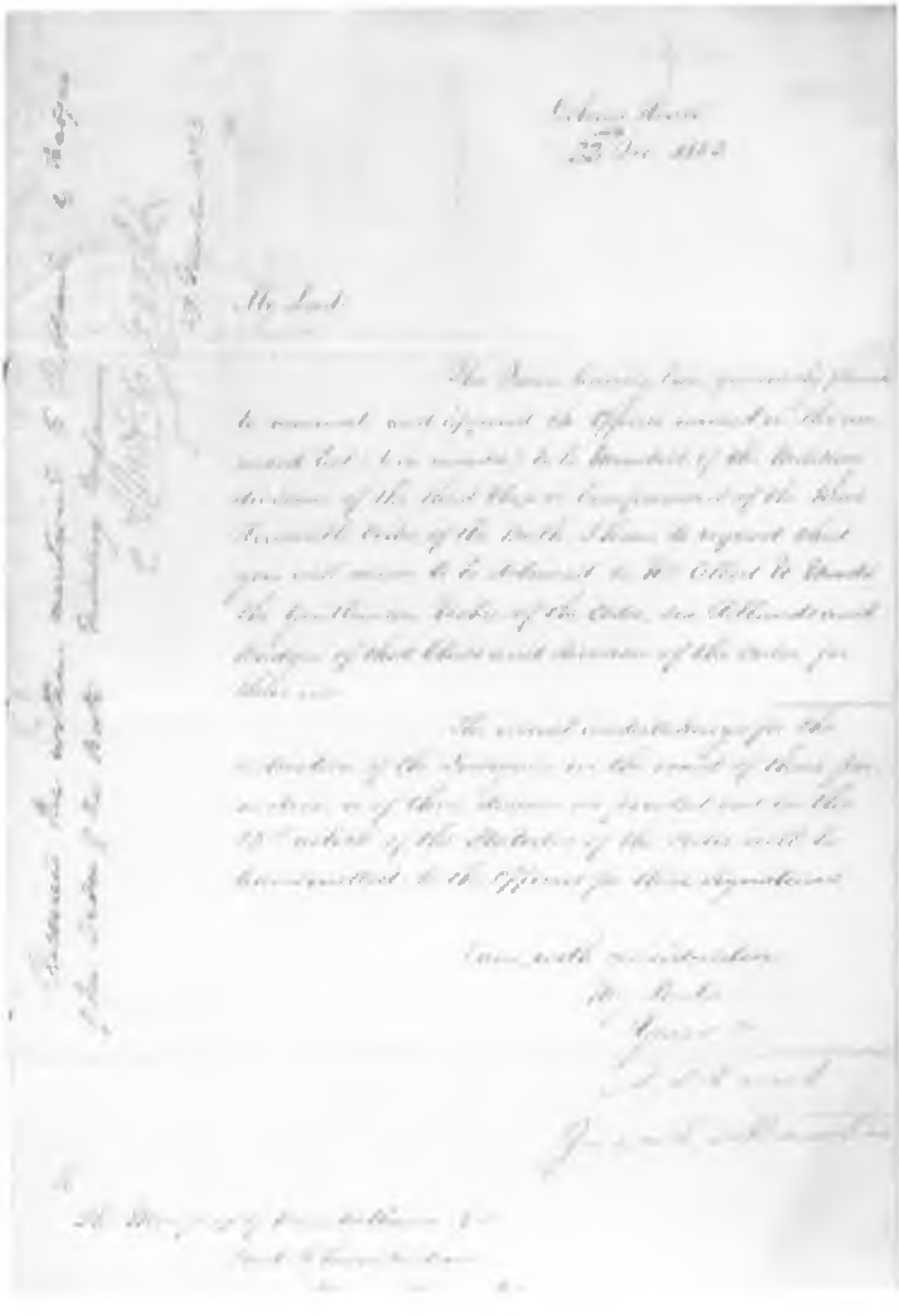
Appendix 1.13



Leamnahye Feature Map

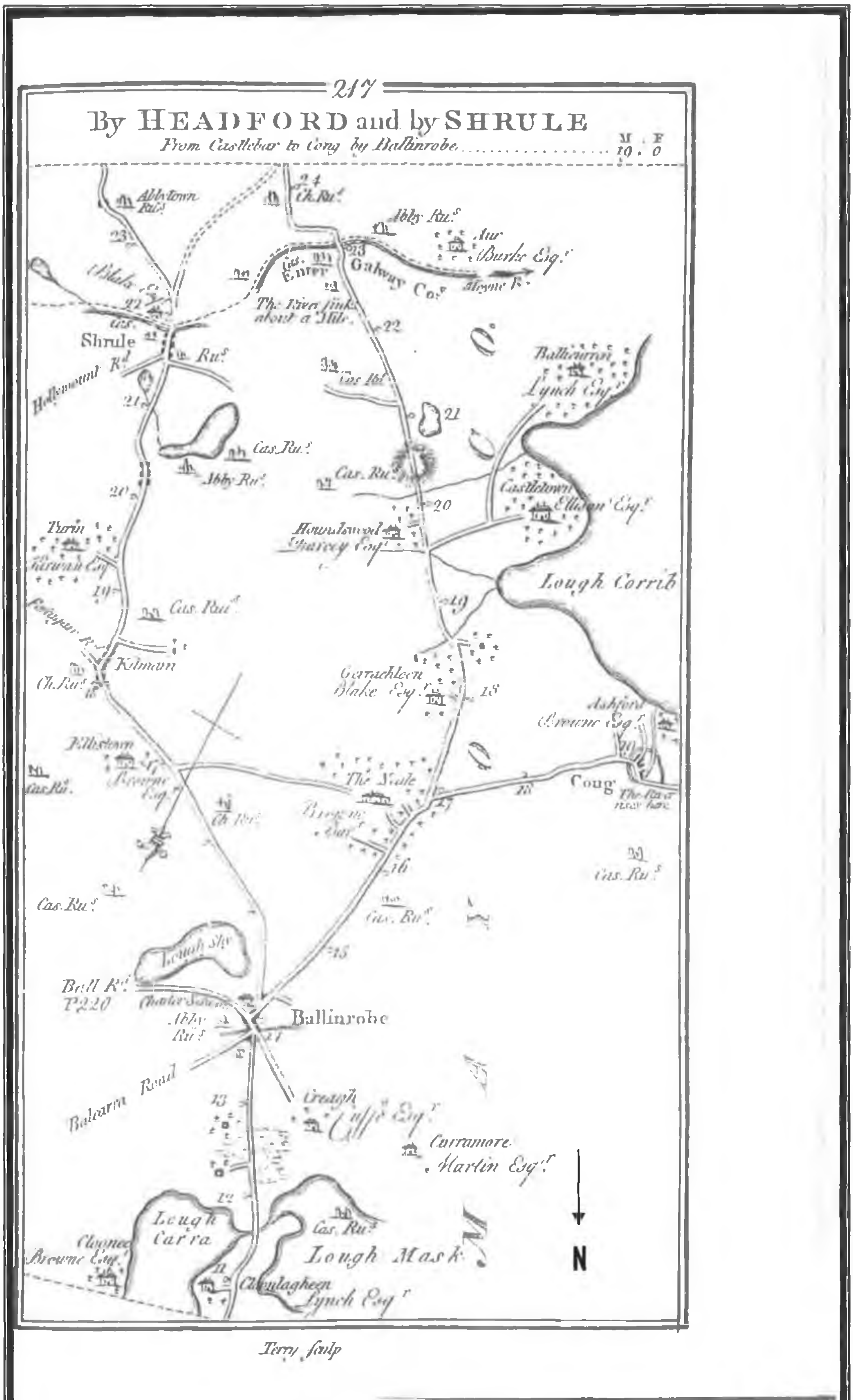
Appendix 2

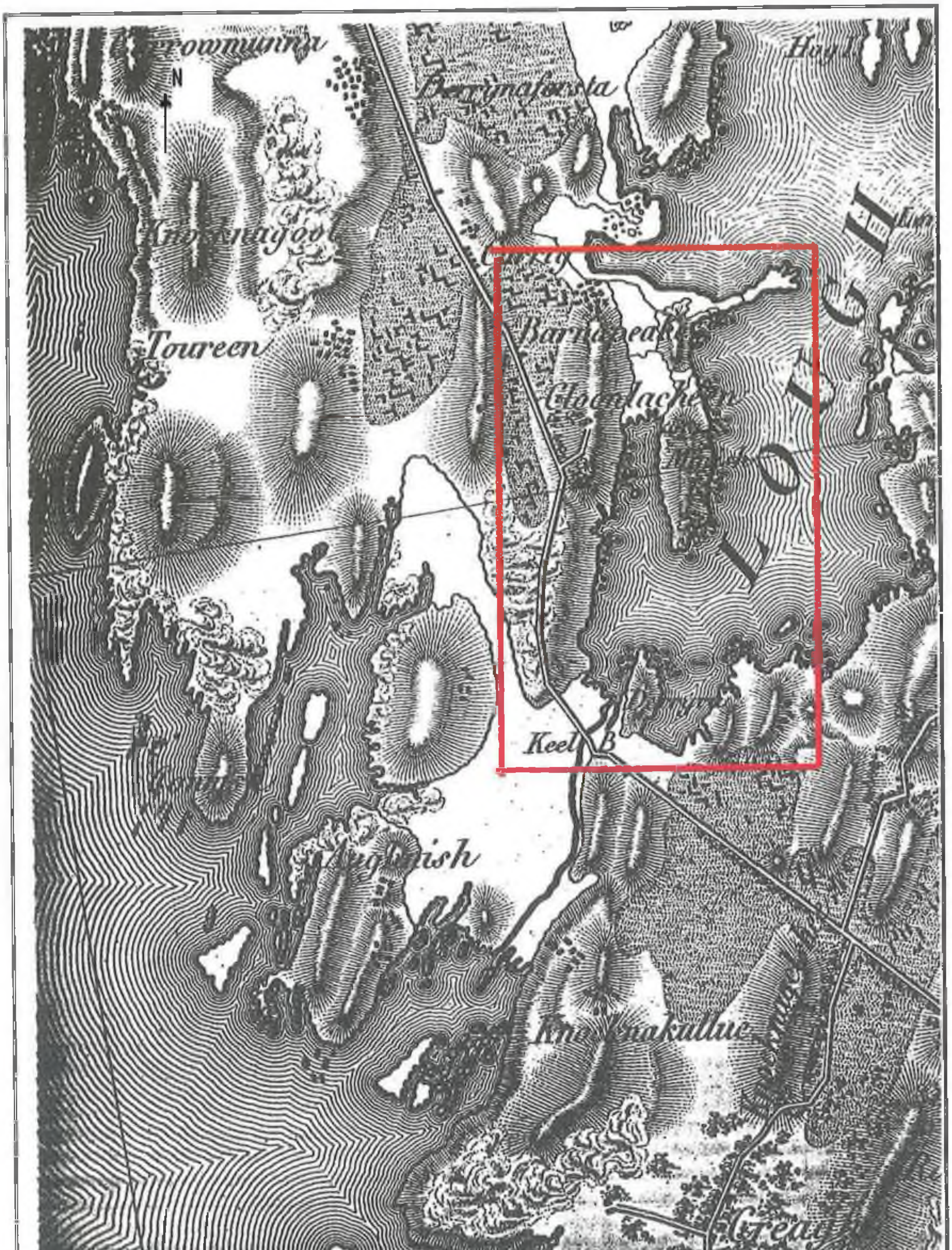
Appendix 2.1



Prince Albert Letter 1853

Appendix 2.2 Taylor and Skinner Map of Irish Roads 1798.

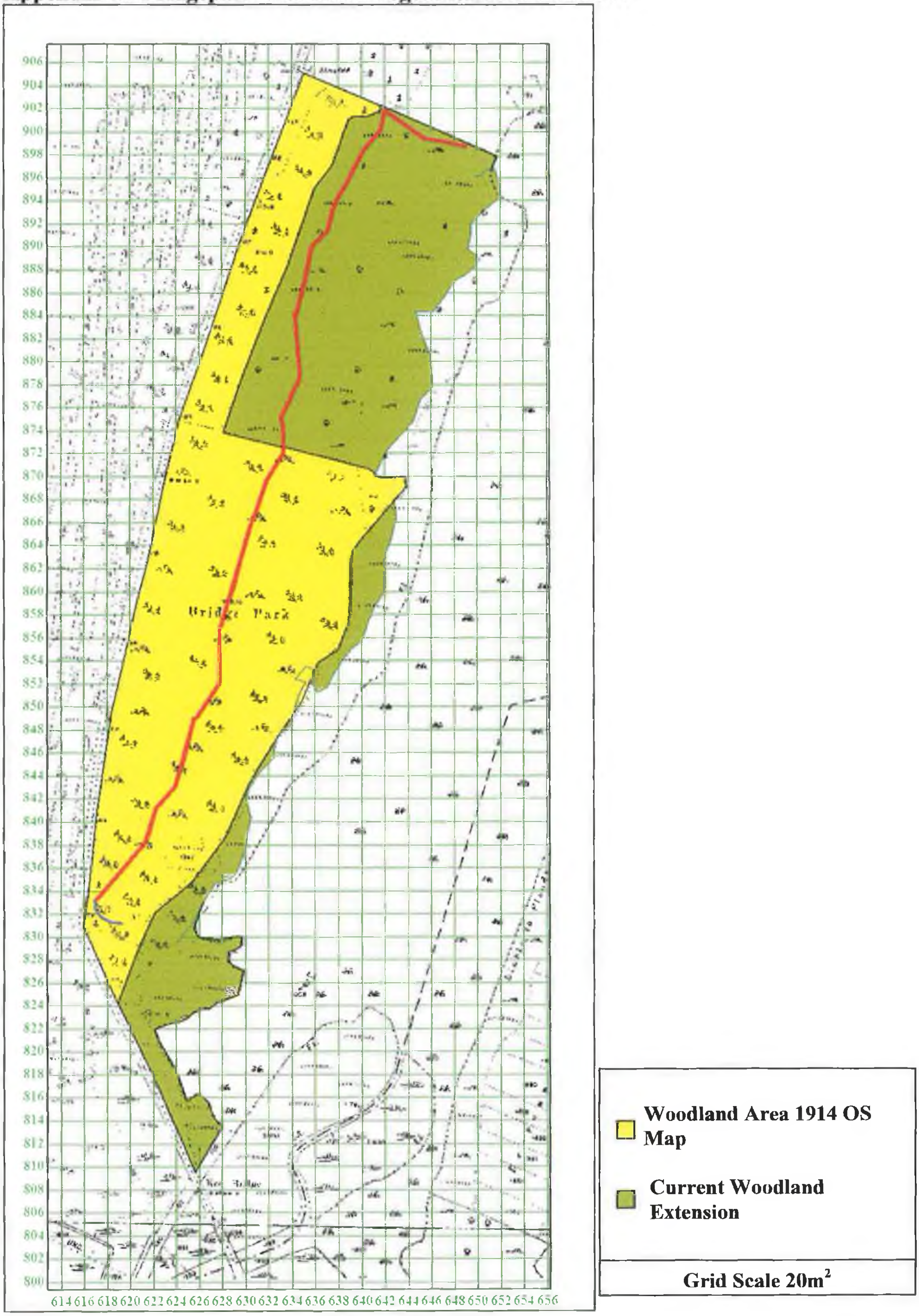




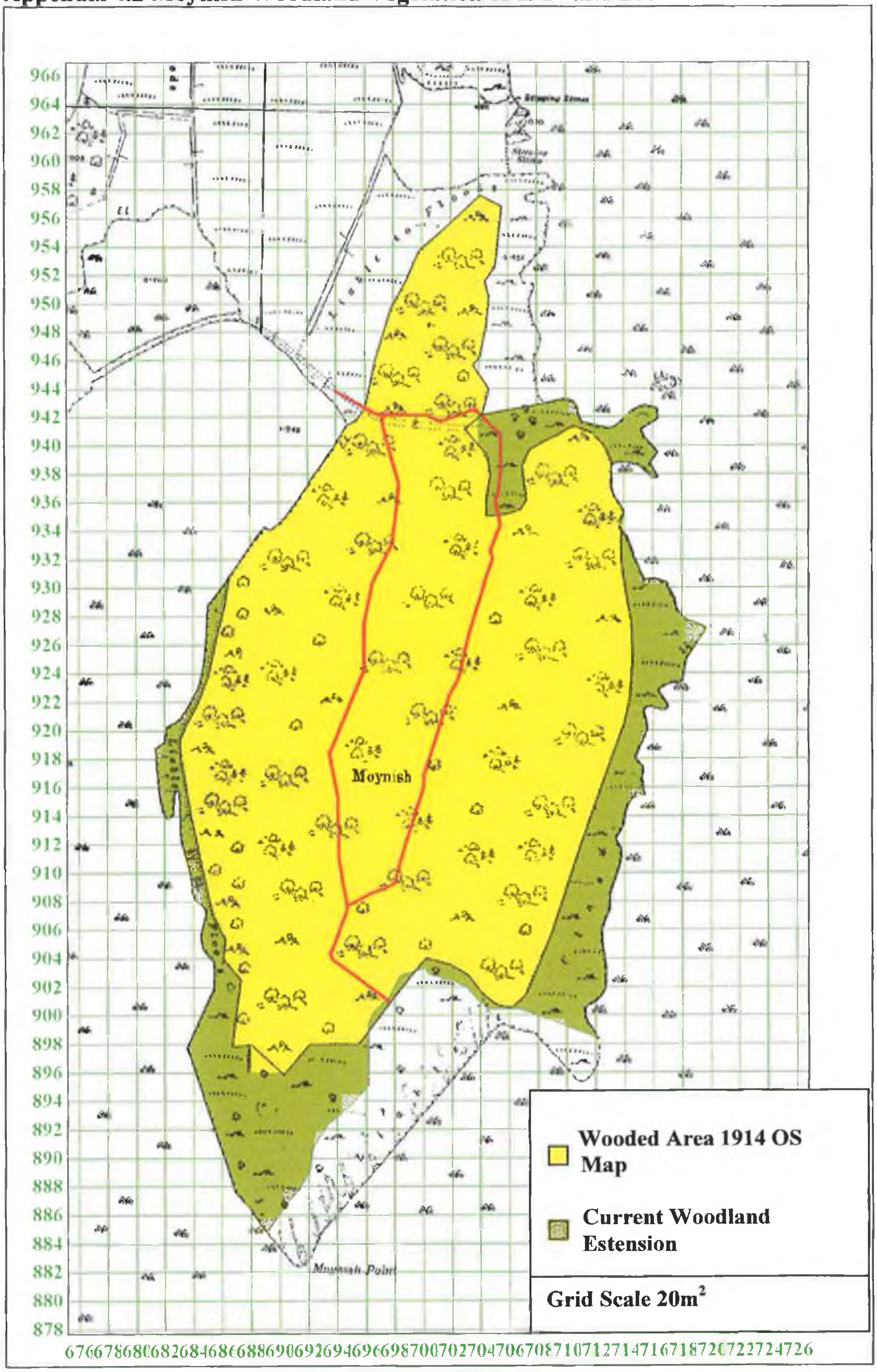
Appendix No. 2.3 Bald's Map of Maritime Mayo 1830

Appendix 4

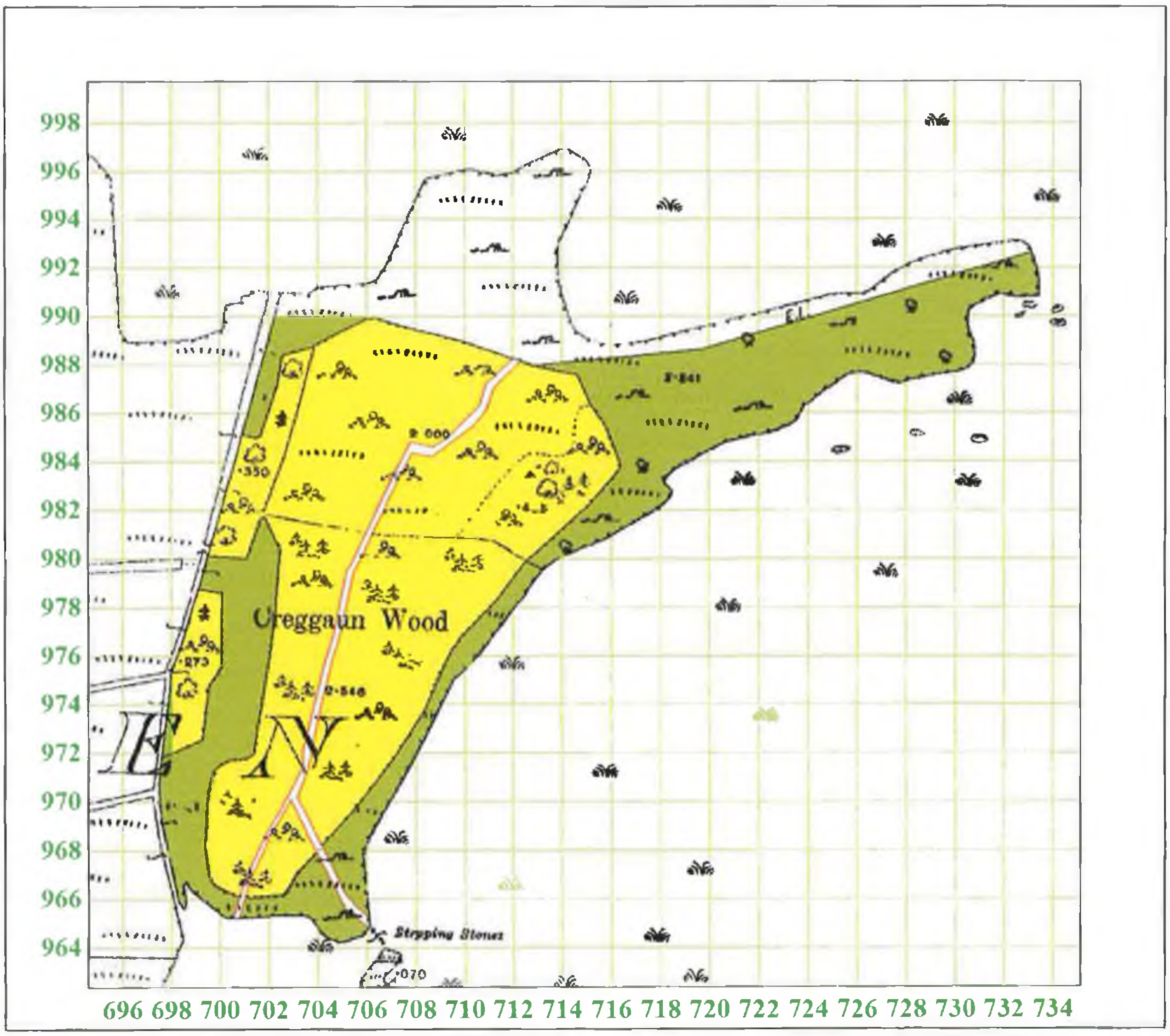
Appendix 4.1 Bridgepark Woodland Vegetation 1914 and 2007



Appendix 4.2 Moynish Woodland Vegetation of 1914 and 2007



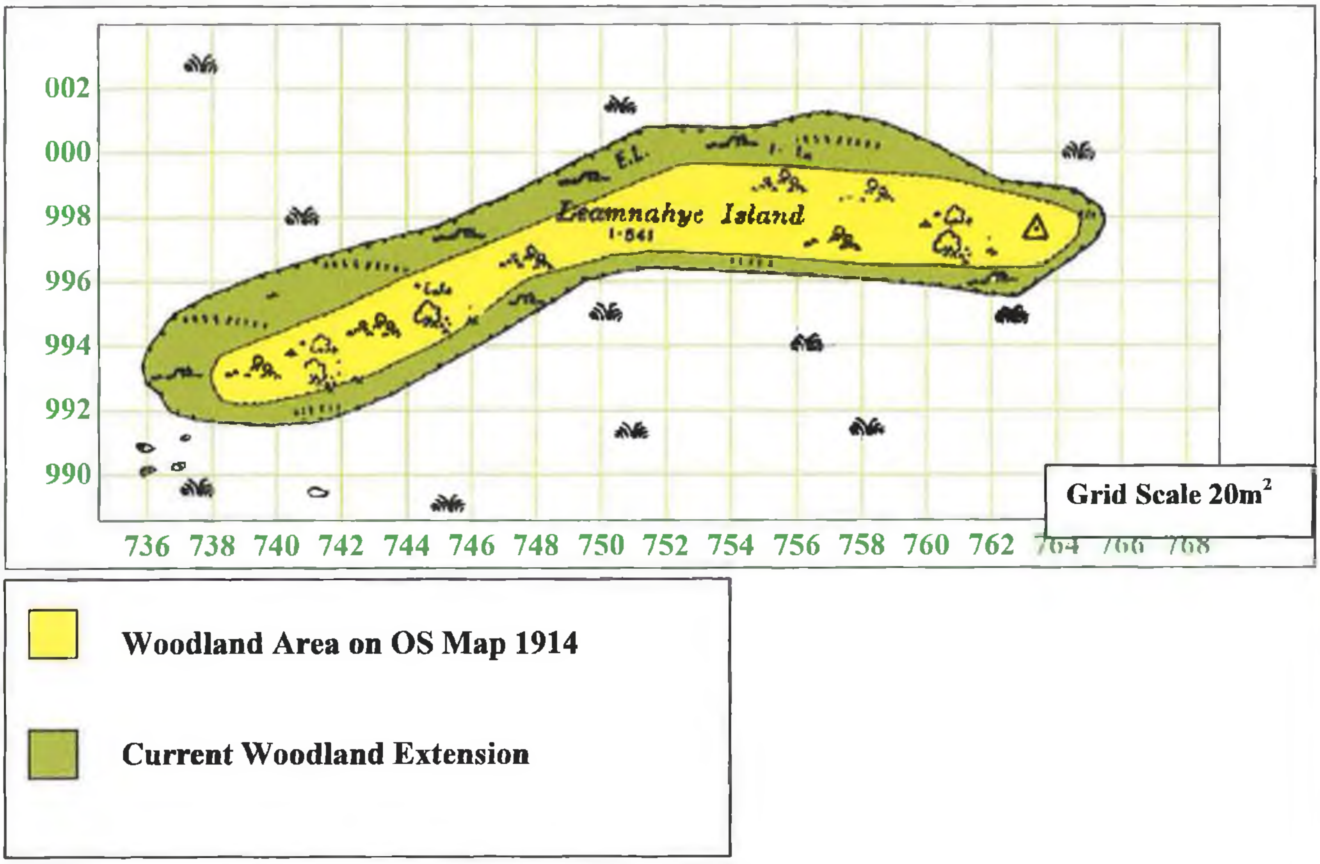
Appendix 4.3 Creggaun Woodland Vegetation in 1914 and 2007



Yellow	Wooded Area on 1914 OS Map
Green	Current Woodland Extension

Grid Scale $20m^2$

Appendix 4.4 Leamnahye Island Vegetation of 1914 and 2007



Appendix 5

Appendix 5 Management Plan for Partry Estate Woodlands

This management plan is given in an abridged format to put the results of the ecological and historical survey work in a management context.

5.1 Site Description

Partry House Estate Woodlands are located in Partry, County Mayo in the west of Ireland. The estate dates back to 1667 and is situated six miles to the northwest of Ballinrobe town on the N84. The woodlands are situated on the south-western shore of Lough Carra, one of Ireland's Great Western Lakes that forms part of a chain of lakes, which run from Killala Bay in the North to Galway Bay in the South. Lough Carra, which is hydrologically linked to Lough Mask, is one of the best examples in Ireland of a hard water marl lake. The Estate comprises approximately 250 acres of which generally 104 acres are woodland. The four woodlands subject to this management are all located within the Carra/Mask Special Area of Conservation (SAC). The woodlands Moynish (M 170/693), Bridgepark (M 163/685), Creggaun (M 171/698) and Leamnahye Island (M 171/700) are mixed broadleaved woodlands of varied size, age, composition and structure.

5.1.1 Physical characteristics

The woodlands are situated on the western shore of Lough Carra. Three of the woodlands, Moynish, Creggaun and Leamnahye Island, were at one time islands on Lough Carra. The development of fen off the western sides of Moynish and Creggaun joined these islands to the mainland over three hundred years ago. The access to these woodlands was improved when a stone causeway crossing from the mainland to Moynish was erected as part of the Famine works in the 19^{th} century. Leamnahye Island was still detached from the mainland at the beginning of the 20^{th} century and was recorded as such in the 1914 Ordnance Survey Map. Since that time the water levels have dropped in the lake and Leamnahye Island is now attached to Creggaun. The landscape of these woodlands is relatively flat with 4-7 metres recorded between the lowest and highest points and ranging in altitudes from approximately 16.9m to 24.9m. Bridgepark is bordered by the main road to the west which is demarcated by a stone wall and Lough Carra to the east. Part of the farmland borders the woodland on the north and is separated by sheep wire fencing and Keel Bridge and river mark the end of the woodland to the south. Moynish, Creggaun and Leamnahye as past islands are mostly surrounded by water. Moynish and Creggaun both border onto fen to the west. Leamnahye is linked to Creggaun by way of a landbridge to the southwest. The climate is wet and mild, with a mean annual rainfall of approximately 1143.3 mm in 2006 (Met Eireann 2007). This total is spread throughout every month of the year with drier weather recorded from April–July. Temperatures recorded in the area for 2006 ranged from 5.2 – 16.5°C with annual mean temperature of 8.9°C recorded. The prevailing winds are from the west and are sufficiently strong during winter months to fell large trees such as *Larix decidua.*

5.1.2 Legal status

The woodlands are owned privately and have been under the ownership of the present owner for the past twelve years. The estate is a designated Special Area of Conservation (SAC) and is a site in the larger Lough Mask/Carra Complex (Site code: 001774). Lough Carra and its lakeshore habitats are also designated as a Natural Heritage Area (NHA), a Special Area of Protection (SPA) and a Wildfowl Refuge. Six habitats in this area are on the Annex 1 of the EU Habitats Directive and four these occur in Partry House Estate: Limestone pavement, limestone grassland, *Cladium* fen and woodland. There is no current management plan for this SAC area. The woodlands have also been designated as bird sanctuaries by the present owner and no hunting of game is permitted. Partry House is open to the public sixty days of the year but no access to the woodlands is permitted.

5.1.3 Geology and soils

The general geological character of the area is Carboniferous limestone. The limestone within this site represents the northern limit of the limestones of Clare and Galway. This underlying geology results in a great diversity of habitats, which supports many scarce and rare plants and animals. In addition, the habitats surrounding these woodlands are of great conservation importance, including limestone pavement, dry calcareous grassland and heath, limestone scrub, fen, *Cladium* fen and the shallow marl lake of Lough Carra. The drainage was recorded as free in most areas of the woodlands with impeded drainage only occurring in Bridgepark beside Keel Bridge and on the western edge of Creggaun bordering the fen. Soil depths in the woodlands varied from a minimum average of 8.65 cm to a maximum average of 24.35 cm.

5.1.4 Vegetation/habitats

The woodlands in Partry Estate consist of a complex mosaic of different woodland types with classifiable areas of both semi-natural woodland and modified mixed broadleaved woodland. A baseline vegetation survey was conducted during the summers of 2005 and 2006, the results of which have been discussed in an earlier chapter. Vegetation maps of the various woodland types were created for each of the woodlands and the different categories of habitat were classified according to the standard work of Fossitt (2000). Other habitats that occur alongside the woodlands include limestone pavement, limestone grassland and *Cladium* fen. However most of Bridgepark, Moynish, Creggaun and Leamnahye comprises of woodland which is vegetation dominated by trees with a height of more than 5m or 4m in wetland areas. Also in these wooded sites are areas of transitional woodland, scrub and immature growth. The woodlands of Bridgepark, Moynish and Creggaun have been planted in the 19th century with conifers and *Fagus sylvatica,* which has profound implications for the management and conservation value of parts of the woodlands. Therefore it is important to distinguish between the various parts of the woodlands in order to set priorities for future management.

In Bridgepark six categories of woodland were identified and mapped and included Mixed Broadleaved Woodland WD1, Ash Hazel Woodland WN2, Mixed Broadleaved/Conifer Woodland WD2, Transitional Woodland dominated by Scots Pine/Ash/Hazel WS1, Wet willow-alder-ash woodland WN6 and Immature Woodland WS2. The modified areas of the woodland, Mixed Broadleaved Woodland WD1 and Mixed Broadleaved/Conifer Woodland WD2 were areas that were planted with *Pinus sylvestris* and *Larix decidua* in the 19th century. In the mixed broadleaved area *Larix decidua* dominated the canopy while the mixed broadleaved/conifer stand was dominated by planted *Pinus sylvestris.* These areas had a mixed understorey of tree and shrub species which was mainly dominated by *Ilex aquifolium, Corylus avellana* and *Fraxinus excelsior.* The semi-natural sites in the woodland covered a greater area than the modified areas and were dominated by *Fraxinus excelsior* and *Corylus avellana* in the canopy layers and had a rich understorey including abundant *Ilex aquifolium* and *Corylus avellana* and occasional *Sorbus aucuparia, Crataegus monogyna, Betula pendula, Fagus sylvatica* and *Prunus spinosa.* The area of immature growth on the limestone grassland is dominated by the natural regeneration of *Pinus sylvestris* and to a lesser extent *Juniperus communis.* There are number of other shrub species such as *Malus sylvestris, Prunus spinosa, Crataegus monogyna* and *Corylus avellana* also growing in small numbers in this area. The shrub and herb layer of Bridgepark is extremely depleted. The overgrazing by deer of the area prevents the development of shrub layer and plant growth is patchy. The main species regenerating in the wooded areas are *Fraxinus excelsior* and *Ilex aquifolium.* The ground cover is dominated by bryophyte growth and decomposing leaf litter. The flora layer is especially poor under the growth of the conifers and *Fagus sylvatica.* The greatest diversity of species were recorded growing along the pathway and in the ecotone areas of the woodland edge where both limestone grassland and woodland species were recorded growing. An area of wet-willow-alder- ash woodland was recorded growing at the southern end of Bridgepark beside Keel Bridge. *Corylus avellana, Frangula alnus, Crataegus monogyna, Prunus spinosa, Malus sylvestris* and *Viburnum opulus* were also recorded growing in this area.

Moynish woodland contained both areas of semi-natural and modified woodland. Similar to Bridgepark planting of *Pinus sylvestris, Larix decidua* and *Fagus sylvatica* took place in the 19th century and have altered the naturalness of the site. Categories of woodland habitats identified included Oak, Ash, Hazel Woodland WN2, Ash Hazel Holly Woodland, Transitional Woodland WS1, Mixed Broadleaved Woodland WD1, Immature Woodland WS2 and Aspen Woodland. The majority of the woodland is dominated by semi-natural growth. *Pinus sylvestris* dominated the canopy in the area of Mixed Broadleaved Woodland WD1 and also recorded in the canopy were *Quercus robur, Fraxinus excelsior, Fagus sylvatica* and *Larix decidua. Ilex aquifolium* was the principal species recorded in the understorey with occasional *Crataegus monogyna.* The semi-natural areas of the woodland were dominated by different broadleaved species including *Quercus robur, Fraxinus excelsior* and *Populus tremula.* The sub-canopy in these areas was dominated by *Corylus avellana. Ilex aquifolium, Crataegus monogyna* and *Euonymus europaeus* were recorded in the understorey and shrub layers. An area of *Taxus baccata* was recorded regenerating in an area of semi-natural woodland. Areas of transitional woodland were dominated *Pinus sylvestris, Betula pendula* and *Fraxinus excelsior.* Other tree and shrub species were also recorded in these areas including *Euonymus europaeus, Corylus avellana, Crataegus monogyna, Malus sylvestris, Ulex europaeus, Juniperus communis, Prunus spinosa, Fagus sylvatica, Frangula alnus* and *Sorbus aucuparia.* The area of immature growth is dominated by low growing *Juniperus communis.* The shrub and herb layer of Moynish was similar to Bridgepark. The grazing pressure on the woodland flora has resulted in a ground cover that is dominated by bryophyte growth with scarce vegetation. The areas of greatest diversity were recorded along the woodland paths and the forest edges.

Creggaun woodland contains similar classes semi-natural and modified woodland including, Oak Ash Hazel Woodland WN2, Mixed Broadleaved/Conifer Woodland WD2, Transitional Woodland dominated by Scots Pine/Birch WS1, Wet willow-alder-ash woodland and Rhododendron growth. This woodland was also planted with conifers in the 19th century. *Larix decidua* is the dominant canopy species in the area of modified woodland which is interspersed with *Fraxinus excelsior* and *Corylus avellana* in the sub-canopy and *Ilex aquifolium* recorded growing beneath it. Some mature *Pinus sylvestris* were recorded and the natural regeneration of this species has taken place in the transitional areas in the forest edges. The area designated as oak ash hazel Woodland contains a number of mature oak and ash stands. The dominant canopy species in this area is *Fraxinus excelsior* which is generally recent in nature. The sub canopy and understorey are dominated by *Corylus avellana* and *Ilex aquifolium.* What remains of a shrub layer is generally populated by regenerating *Ilex aquifolium.* A site of *Rhododendron ponticum* approximately 1 hectare in area is growing aggressively on the western edge of the woodland reaching up eight metres in height and devoid of any understorey or herb layer. A small area of wet willow alder ash woodland was identified during surveying growing alongside the Rhododendron stand. It is growing in area of water logging on the edge of the fen bog. The herb layer in Creggaun is generally species poor with only patchy growth of plants recorded. The principal area of flora diversity was recorded along the path edges.

Leamnahye Island is the only woodland that was not modified by planting in the past and so is classed as semi-natural. Three types of woodland were classified on the island and included Oak, Ash, Hazel Woodland WN2, Transitional Woodland dominated by Birch WS1 and Mixed Broadleaved Woodland WD1. The canopy of the woodland was mainly dominated by mature *Quercus robur,* with young *Fraxinus excelsior* growing alongside it. *Corylus avellana* and *Ilex aquifolium* were the principal species in the sub-canopy and understorey layers. *Betula pendula, Crataegus monogyna* and *Euonymus europaeus* were occasionally recorded in this area. A small area of woodland was categorised as Mixed broadleaved woodland because of the presence of naturalised *Pinus sylvestris* growth. This species has colonised the island in the last century. An area of transitional growth was identified growing mainly around the periphery of the island and was dominated by light loving species such as *Betula pendula. Sorbus hibernica* was also occasionally recorded in this area also. Other species recorded occasionally on the island included *Frangula alnus, Juniperus communis, Prunus spinosa, Fagus sylvatica* and *Sorbus hibernica.* The main regenerating species on the island were *Fraxinus excelsior* and *Ilex aquifolium.* Similar to the other woodlands Leamnahye has a depleted herb layer that is overgrazed. Numerous woodland and limestone species were recorded growing throughout the woodland but their growth was patchy and poor.

5.1.5 Flora

The results and discussion of the flora survey is available in previous chapters and the raw data is included in the Appendix 3.

5.1.6 Fauna

Fauna information has been presented and discussed in the previous chapters.

5.1.7 Other taxa

No research of the other taxa in the woodlands was undertaken during this survey. Further survey is needed to compile a comprehensive inventory of the invertebrates, fungi, lichens and bryophytes occurring in these woodlands.

5.1.8 History

The history of the estate and the woodlands has been discussed in an earlier chapter.

5.2 Evaluation

5.2.1 Conservation/ecological value

The conservation and ecological value is assessed according to the following criteria.

5.2.2 Size

The entire area covered by woodland in Partry House estate is 104 acres and is divided into four separate woodlands of varied acreage. In absolute terms this is not a large site and there is no continuity between these wooded sites which are only partly semi-natural. However in the context of established limestone woodlands in the west of Ireland the relative size becomes significant.

5.2.3 Diversity

There is considerable diversity of habitats, woodland types, plant communities, flora and fauna in the Partry House Estate. There are two priority habitats, limestone pavement and *Cladium* fen which are responsible for its designation as an SAC. Some of the diversity results from the fact that it was planted in the past with conifer species which is attracting specialist flora and fauna diversity. The semi-natural areas of woodland are diverse in nature varying in age, structure and composition. There is natural growth of *Populus tremula* and *Taxus baccata* in Moynish that is not common in this area. Both the semi-natural and modified areas of the woodlands add to the diversity. Therefore management prescriptions need to be formulated carefully to strike a balanced between the imperative of maintaining and enhancing natural woodland and maintaining diversity.

5.2.4 Naturalness

The naturalness of the woodland varies considerably. Moynish, Bridgepark and Creggaun all have areas that were planted with conifers and *Fagus sylvatica* in the 19^{th} century which has altered the natural composition of the woodlands. However in each there are considerable areas of semi-natural growth that has been developing prior to 1838, when Creggaun and Bridgepark were described as brushwood and Moynish was recorded as deciduous woodland. The development of these woodlands was probably due a relaxation of the grazing regime. These islands would have been wooded prior to 1690, which is when the first historical description of the land is available and was described as rocky and shrubby. There are woodland species such as *Anemone nemorosa, Neottia nidus-avis* and *Galium odoratum* which are indicators of the prior existence of woodland. Further establishment of natural woodland has taken place since 1914 and is mapped in Appendix 4. Leamnahye is the most natural of the four woodlands. This area was not modified by direct planting. It survived as an island for a longer period of time than the other woodlands so it is less altered. The composition of the woodland is mainly semi-natural limestone woodland. However there is one area of natural *Pinus sylvestris* colonisation. Although it has colonised naturally its growth is as an indirect result of planting and would not have grown otherwise. It is clear that parts of the woodlands have a very low level of naturalness as they contain significant quantities of non-native species that have been planted or in the case of *Rhododendron ponticum* and *Acer pseudoplantanus* have colonised naturally. However the greatest area of growth is semi-natural and exhibits a relatively high level of naturalness.

5.2.5 Rarity

Pine marten was recorded as residing in Party Estate and this mammal is regarded as threatened in Ireland and may be found in 'The Irish Red Data Book No. 2' and is considered category 2 or as an internationally important species (Rooney & Hayden 2002). Pine marten was quite rare until recently and its numbers are recovering with the increase of woodland habitat. The natural growth of *Taxus baccata,* one of Ireland's only native conifers, was recorded growing and regenerating in Moynish. This species has become rare in natural habitats and has not been growing naturally in other habitats around Lough Carra. *Sorbus hibernica* is rare as a national species and its occasional growth is confined mainly to the calcareous soils of the west. This species was recorded growing in Moynish, Leamnahye and Creggaun. Two of the habitats in the estate limestone pavement and *Cladium* fen are considered priority habitats and are relatively rare.

5.2.6 Fragility

At present the overgrazing of the woodlands by fallow deer is seriously impacting on the biodiversity value, regenerative abilities and the woodland structure in the estate. The presence of several invasive and aggressive alien plant species (including *Fagus sylvatica, Rhododendron ponticum* and *Acer pseudoplantanus*) increases the potential fragility of the system. Although a native species to Ireland *Pinus sylvestris* is threatening the future survival of the limestone grassland and pavement habitat in Bridgepark. It is aggressively colonising this area which is not desirable. A stand of poor growing *Pinus sylvestris* would not have the same biodiversity value and is not a priority habitat like the limestone habitat. Management prescriptions must take this into account.

5.2.7 Recorded history

There is no recorded scientific history of the woodlands and this is the first comprehensive ecological survey to be completed that appraised the habitat potential. At the time of writing some other long term studies such as bird, moth, butterfly and orchid surveys are being conducted in the area.

5.2.8 Intrinsic appeal

There is a unique combination of habitats types occurring in the estate on the shores of Lough Carra which is intrinsically appealing. This natural landscape supports an array of both flora and fauna and is of considerable biodiversity value.

5.2.9 Potential for improvement

There is considerable scope for improvement of the woodlands in several respects. Appropriate management at an adequate scale would be likely to increase the proportion of mature and transitional woodland dominated by native species that are characteristic of limestone woodland. The current state of the woodland is such that some areas are dominated by planted conifers which are not natural in this habitat. Also the regeneration of *Pinus sylvestris* that is taking place is threatening the survival of limestone grassland in Bridgepark. The removal of these conifers and the management of this regeneration will increase the conservation of this site. Secondly the growth of the invasive exotic *Rhododendron ponticum* is a threat to the diversity of the woodlands. Further removal and treatment of this growth would greatly improve the value of the woodlands and encourage natural successional processes. The diversity of the habitats and species could be increased through active management and manipulation of certain parts of the woodlands. Further clearance along paths, the creation of woodland glades and the thinning of young growth stands would greatly improve the diversity of species and the structure of the woodland. The management of fallow deer in the woodlands would allow the depleted herb and shrub layers to recover from the successive years of overgrazing and create new habitats increasing the flora and fauna diversity. Overall it is clear that the site has significant potential for improvement through carefully targeted management.

5.2.10 Potential for damage/degradation

The potential for damage and/or degradation is also substantial if left unmanaged. The major aspect of concern is the loss of diversity caused by the extensive grazing of the woodlands by non-native fallow deer. The woodlands have already been damaged by the present population of deer. However this degradation could increase if future population levels rise and would result in the further loss of species diversity. Another aspect of concern is the possibility of increased incursion and proliferation of the present non-native species and the invasion by other exotic species leading to structural and biological modification of the habitat. There is already evidence of the first concern with the regeneration of *Fagus sylvatica* recorded in all the woodlands. Furthermore the spread of *Pinus sylvestris* into areas of transitional woodland and also on to limestone grassland is threatening the natural structure of the semi-natural stands of woodland. The spread of the invasive alien species *Rhododendron ponticum* in Creggaun and Moynish is of some concern and may become more of a serious threat if no action is taken. Lack of active management in a large area of pristine habitat with a full complement of biodiversity might not be a problem. However in the small areas of woodland present in Partry Estate that have been partly modified such neglect can lead to significant loss of diversity and semi-natural habitats. The diversity of species was richer along the paths in the woodlands. The neglected management of these paths can lead to further loss of species diversity. Overall there is significant potential for damage to the woodlands, degradation of the habitats and loss in diversity.

5.2.11 Conservation Objectives

The conservation objectives for the woodlands are derived from relevant legislation, the Statutory Instrument designating the site, overall Irish Government and NPWS policy, the landowner and local or regional policy specific to either the region or the site itself.

The principal goal for the conservation of Partry House Estate Woodlands is:

> "To protect and improve the limestone woodland, other woodland habitats and component habitats and to conserve the overall biodiversity of the Estate."

This goal will be realised in the long term through the achievement of the following specific objectives:

- To maintain and enhance those areas of the woodland currently dominated by native broadleaved species as areas of semi-natural habitat.
- To increase the naturalness of the habitats in the estate and to enhance their ecological value.
- To protect the regeneration of the woodland.
- To control and progressively eliminate non-native plant species from the estate.
- To protect and improve the biodiversity of the estate, especially those species associated with limestone woodland by creating new wildlife habitats.
- To protect and reduce the overgrazing of the woodland by fallow deer.
- To create a secure habitat for birds and animals.
- To preserve the woodland for future generations.

5.3 Constraints

5.3.1 Legal constraints

The land in the estate is designated as part of a SAC and this includes the woodlands in this management plan. This protection places certain legal constraints on management. The main constraints in respect to this management plan relate to the grazing and felling of trees. Such activities require the consent of the Minster for the Environment, Heritage and Local Government.

5.3.2 Physical constraints

Access to Moynish is not an issue during summer months and it can be reach by way of a stone causeway. However, in the winter months which is ideally when management operations should be undertaken, it is prone to flooding as the lake level rises during heavy rainfall periods. There is no difficulty accessing Bridgepark which may entered by a number of routes such as from the main road or the bordering farmland. At present the main entrance to the woodland is via a small stone causeway which also floods in winter. To access Creggaun it is necessary to cross the fen bog or travel through Moynish to reach the stepping stones that link the woodlands. This area also floods during the winter months. If large machinery were necessary for the removal of trees or exotic plants they would not be able to access the woodland unless the fen bog was dry enough for them to cross. Leamnahye is only accessible through Creggaun. It is linked on the east side of Creggaun by means of a narrow landbridge.

5.3.3 Ecological factors

The main ecological factor affecting management intervention is the lack of understanding of the dynamics of the habitats under the conditions that exist in the Estate. Very little is known of how the woodland has developed and what effect the present grazing regime has had on its natural expansion. It is difficult to predict how the woodland will respond to the different management procedures. For this reason, this plan proposes a system of 'active adaptive management' whereby certain management prescriptions are initiated, the effects monitored and subsequent management intervention adjusted accordingly. There are also external factors that cannot be predicted or controlled and need to be considered such as climate change, tree diseases, or changes in water levels. It is not possible at this stage to formulate a management plan that takes possible changes into account. However over the time span of this plan evidence of likely changes can be gathered and incorporated into future management planning.

5.3.4 Limitation of resources

The current state of the habitats in the Reserve, especially in relation to the presence of invasive alien plant and mammal species, is such that substantial economic resources would be required to fund the necessary management intervention at the scale that is required to resolve the majority of the problems set out in this plan. The woodlands are privately owned so funding for the management is dependant on the owner or on grants like the Heritage Council's Biodiversity Fund, which is awarded for the improvement of biodiversity in natural habitats. Therefore it is necessary to set priorities for management such as the removal of Rhododendron and the improvement of the semi-natural areas.

5.4 Operational Objectives and Management Options

In order to structure the management of the estate woodlands in the most effective manner each woodland will be discussed separately and site specific management interventions will be put forward. A vegetation map of the woodlands is available for consultation in a previous chapter. Table 6.1 provides an outline description of the habitats and vegetation in the woodlands and accords a provisional conservation priority (on a scale of five - from very low to very high).

Woodland	Habitats	Description	Conservation priority
Creggaun Bridgepark Moynish	WD2	Mixed broadleaved/conifer woodland with *Larix decidua* or *Pinus sylvestris* growth which was planted in the 19th century? Intermixed with deciduous species such as *Fraxinus excelsior, Corylus avellana, Fagus sylvatica* and *Quercus robur. Ilex aquifolium* is the principal understorey and shrub species. *Fraxinus excelsior* seedlings recorded in ground cover. Ground flora is poor with patchy growth of *Hedera helix, Rubus fruticosus* and *Viola riviniana.* Heavy litter of pine needles on woodland floor. Some recent natural regeneration recorded in Bridgepark.	Very low
Leamnahye Moynish Creggaun	WN2	Oak ash hazel woodland with mature *Quercus robur. Fraxinus excelsior* and *Corylus avellana* recorded in sub-canopy. Principal understorey species is *Ilex aquifolium.* Regeneration of mainly *Fraxinus excelsior* and *Ilex aquifolium* recorded. Ground flora of woodland species that is relatively diverse but not abundant.	Very high
Moynish Bridgepark	WN2	Ash hazel holly woodland dominated by mature *Fraxinus excelsior. Corylus avellana* recorded in sub-canopy. Principal understorey species is *Ilex aquifolium.* Regeneration of mainly *Fraxinus excelsior* and *Ilex aquifolium* recorded. Ground flora of woodland and limestone grassland species that are relatively diverse but not abundant.	High
Leamnahye Creggaun	WS1	Transitional woodland dominated by *Betula pendula.* Recorded along forest edges with good light exposure. Other tree and shrub species recorded include *Corylus avellana, Juniper communis, Sorbus hibernica, Malus sylvestris, Frangula alnus, Fraxinus excelsior* and *Sorbus aucuparia.* Ground flora dominated by limestone grassland species.	Medium
Moynish	WS1	Transitional woodland of scrub nature growing on limestone paving with good light exposure. Tree and shrub species recorded include *Corylus avellana, Juniper communis, Sorbus hibernica, Malus*	Medium

		sylvestris, Frangula alnus, Fraxinus excelsior, Betula pendula, Populus tremula, Viburnum opulus, Ilex aquifolium, Quercus robur, Salix caprea, Ulex europaeus, Crataegus monogyna and *Sorbus aucuparia.* Ground flora dominated by limestone grassland species such as *Calluna vulgaris, Potentilla erecta* and *Rosa pimpinellifolia.*	
Moynish Bridgepark Creggaun Leamnahye	WS1	Transitional woodland dominated *Pinus sylvestris, Corylus avellana or Fraxinus excelsior.* Forest edges of recent growth with *Betula pendula, Corylus avellana* and *Fraxinus excelsior* recorded in all layers. In shrub layer are light loving species such as *Juniper communis, Prunus spinosa, Crataegus monogyna, Sorbus hibernica* and *Frangula alnus.* Ground flora of both woodland and limestone grassland species recorded.	Medium
Moynish	WN	Aspen woodland dominated by *Populus tremula* with interspersed growth of *Fraxinus excelsior. Corylus avellana, Ilex aquifolium, Crataegus monogyna, Taxus baccata* and *Euonymus europaeus* recorded in understorey and shrub. *Populus tremula* regeneration by suckers is taking place. Ground flora of woodland species diverse but not abundant.	High
Bridgepark	WD3	Mixed conifer woodland dominated by *Pinus sylvestris* which was planted in 19^{th} century. Mature planted *Fagus sylvatica* recorded in this area. Also growing was *Fraxinus excelsior* and *Corylus avellana* in the understorey. *Ilex aquifolium* is the principal understorey and shrub species. Ground flora is poor with patchy growth of *Hedera helix, Rubus fruticosus* and *Viola riviniana.* Heavy litter of pine needles on woodland floor	Very low
Bridgepark Creggaun	WN6	Wet-willow-alder-ash woodland dominated by *Alnus glutinosa* and *Salix caprea.* Also recorded in these water logged areas were *Fraxinus excelsior, Corylus avellana, Frangula alnus, Prunus spinosa, Viburnum opulus, Malus sylvestris* and *Crataegus monogyna.* Ground cover of brambles, sedges and grasses.	Medium
Bridgepark	WS2	Immature woodland recorded on the	Very low.

Moynish		limestone grassland and pavement. Regeneration of *Prunus sylvestris* and *Juniperus communis* invading limestone habitat in Bridgepark. Mainly *Juniperus communis* growing on limestone pavement in Moynish. Ground flora of limestone species.	
Creggaun Moynish	WS3	Rhododendron growth recorded in both woodlands but more extensive in Creggaun. Spreading onto fen bog. Species poor ground flora.	Very low.

Table 6.1 Description of Vegetation Types in the woodlands

The following operational objectives refer to each specific woodland type.

Mixed broadleaved woodland WD1

- To allow the habitat to develop as woodland, encouraging growth of native species but reducing the risk of non-native trees spreading to other woodland types
- To enhance the diversity of flora and fauna

Oak ash hazel woodland WN2

- To maintain and enhance the semi-natural woodland habitat
- To enhance the diversity of flora and fauna

Ash hazel holly woodland WN2

- To maintain and enhance the semi-natural woodland habitat
- To enhance the diversity of flora and fauna

Transitional woodland WS1

- To encourage the development of semi-natural woodland and encourage the process of ecological succession
- To enhance the diversity of flora and fauna

Mixed broadleaved/conifer woodland WD2

- To allow the habitat to develop as woodland but reducing the risk of non-native trees spreading from these areas
- To enhance the diversity of flora and fauna

Aspen woodland WN

- To allow the natural development and maintenance of the habitat
- To enhance the diversity of flora and fauna

Wet-willow-alder-ash woodland WN6

- To allow the natural development and maintenance of the habitat

Immature woodland WS2

- To maintain and enhance the natural limestone habitat
- To prevent the development of *Pinus sylvestris* woodland

Rhododendron growth WS3

- To prevent the spread of alien plant species
- To encourage the natural development of semi-natural woodland
- To enhance the diversity of flora and fauna

In addition the following operational objective applies to the existing woodland pathways:

Woodland paths

- To maintain existing paths and enhance biodiversity value.

5.5 Prescriptions

The following prescriptions address the operational objectives specified above:

5.5.1 Bridgepark

- **A1:** Progressively eliminate the regrowth of *Fagus sylvatica* throughout the woodland. Seedlings, saplings and understorey trees should be removed from the semi-natural areas first and then gradually extending management into the modified areas. Focus initially on young specimens and monitor the impact. If deemed necessary to control the regeneration of this species some mature trees may be selected for felling.
- **A2:** Continue the re-opening and widening of trackway through centre of woodland to encourage the herb layer to increase in diversity. *Corylus avellana* should be coppiced along the path edge. The trackways are to be monitored for fallen or overhanging trees or the growth of saplings.
- **A3:** To improve the structure of the woodland areas of young *Fraxinus excelsior* individual stems are to be thinned in the areas that recent growth dominates. Trees should be felled up to 10 metres apart. Thinning allows light to reach the previously shaded forest floor encouraging the herb layer to develop and enhancing the nature conservation value of the forest. It will help to maximise the full potential of *Fraxinus excelsior* trees in these areas.
- **A4:** The limestone grassland and pavement of Bridgepark is currently under threat from the early development of *Pinus sylvestris* scrub. This is a priority habitat with a rich diversity of plant species. The development of *Pinus sylvestris* in this area would mean that an important habitat would have been replaced by another that is not as species rich or of any great conservation value. Grazing management combined with the physical removal of young plants in this area could slow or eliminate the advance of this species. The introduction of winter grazing of appropriate cattle breeds will improve the diversity of this area and it is suggested that it will encourage the diverse growth of orchid species in the spring/summer months. Cattle should be prevented from entering the forest area using electric fencing and the area

grazed for short periods of time between October-February. The effect of this grazing will need to be closely monitored for any unforeseen impacts.

- **A5:** Ideally the areas of planted conifers should be completely removed to allow the development of semi-natural woodland that is characteristic of this area. Bridgepark is one of the woodlands where access for the necessary machinery to fell these stands is feasible. However the resources needed for such an operation may not be available during the lifetime of this management plan. Meanwhile the regeneration of both *Larix decidua* and *Pinus sylvestris* should be removed and the site monitored for further regeneration.
- **A6:** The creation of woodland rides and glades should be established to improve the diversity of flora species. Use alien tree clearance to create open areas by felling mature *Larix decidua, Pinus sylvestris* and *Fagus sylvatica.*
- **A7:** Monitor for the invasion of alien species and reestablishment of removed exotics.
- **A8:** Survey vegetation of deer exclosure and control plot in May/June to monitor the effects of grazing.

5.5.2 Moynish

- **B1:** Progressively eliminate the regrowth of *Fagus sylvatica* and *Acer pseudoplantanus* throughout the woodland. Seedlings, saplings and understorey trees should be removed from the semi-natural areas first and then gradually extending management into the modified areas. Focus initially on young specimens and monitor the impact. There are only a few *Acer pseudoplantanus* trees in the woodland which will be felled. The success of this seedling management should be monitored continuously. There is a number of mature *Fagus sylvatica* throughout the woodland and if deemed necessary to control the regeneration of this species some mature trees may be selected for felling.
- **B2:** The removal and treatment of *Rhododendron ponticum* is of high priority. The two areas that have already been manually removed are to be retreated and rigorously monitored to eliminate any regrowth. A further area of growth

that has not been managed will be removed and stump treated using Metsulfuron-methyl herbicide.

- **B3:** No path management has take place for some time in Moynish and it is time for it to be re-established. Remove fallen trees from the path and cut back tree growth along the edges. The paths should be widened to up to 10m where possible in some sections where there is a lot of understorey growth by coppicing.
- **B4:** Planted conifers should be removed from the mixed broadleaved stand to allow the development of semi-natural woodland that is characteristic of this area. The area's bordering the good stands of *Quercus robur* should be targeted first.
- **B5:** The creation of woodland rides and glades are to be established to improve the diversity of flora species. Use alien tree clearance to create open areas by felling mature *Larix decidua, Pinus sylvestris* and *Fagus sylvatica.*
- **B6:** Monitor for the invasion of alien species and reestablishment of removed exotics.
- **B7:** Survey vegetation of deer exclosure and control plot in May/June to monitor the effects of grazing.

5.5.3 Creggaun

- **C1**: The removal and treatment of *Rhododendron ponticum* is of high priority in this woodland. Some of the extensive growth has already been manually removed and treated. The remaining area of growth should be removed and stump treated using Metsulfuron-methyl herbicide. These areas of clearance are to be retreated and rigorously monitored to eliminate any regrowth.
- **C2:** The creation of woodland rides and glades should be established to improve the diversity of flora species. Use alien tree clearance to create open areas by felling mature *Larix decidua* and *Pinus sylvestris.*
- **C3:** The path management that has already been implemented should be retained and monitored, removing fallen trees and cutting back overhanging branches.

- **C4:** Monitor for the invasion of alien species and reestablishment of removed exotics.
- **C5:** Survey vegetation of deer exclosure and control plot in May/June to monitor the effects of grazing.

5.5.4 Leamnahye Island

Only minimal intervention methods are required for the management of this woodland.

- **D1:** Remove the small population of young *Fagus sylvatica* from the woodland and monitor the woodland for its regrowth.
- **D2:** The natural stand of *Pinus sylvestris* is to be monitored and any regeneration removed. If this stand impacts on the natural structure of this limestone woodland then it will be removed.
- **D3:** Monitor for the invasion of alien species.
- **D4:** Survey vegetation of deer exclosure and control plot in May/June to monitor the effects of grazing.

5.5.5 Management of deer

One of the major management issues affecting the woodlands in Partry Estate are the presence of fallow deer as discussed in the previous chapter. No management prescriptions were drawn up for their management as it is largely outside of the control of the owner. The owner is not willing to put up deer proof fencing which is very expensive and it may not succeed in keeping deer out of the woodlands as they could gain access to them by swimming. Culling has been proven to be the best approach to population control and has been implemented by volunteer and leisure hunters in the area for the past eighteen years. The overpopulation of deer has been slightly alleviated by this approach but the population is still too substantial for the woodland habitats. The culling needs to be intensified and in order to do this the government must create incentives to facilitate the management of deer.

5.6 Work Plans

Table 6.2 outlines the work plan for each prescriptive activity. The scale of work undertaken for each of these management interventions can be adjusted to the level of resources available. For this reason no attempt is made in this plan to prescribe the time to be spent on each activity. However, priorities have been indicated so that if resources are inadequate to complete the work the most important interventions can be targeted. In the table below the main priorities are indicated in red. The operational costs to undertake the work prescribed will vary from year to year. Prescriptions that are labour intensive, such as rhododendron removal, clear felling and coppicing that require the hiring of specialist services will cost more than the monitoring prescriptions. It is unlikely that the total cost of this management plan will be met by the private owner and funding from other sources will be required. Further funding from the Heritage Council's Biodiversity Fund could be sought to complete some of the priority management recommendations such as Rhododendron removal.

Procedure	Yr1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Y 10
Bridgepark										
A1			X	X					X	
A2	X				X					X
A3		X	X					X		
A4	X	X			X	X			X	X
A5									X	X
A6						X	X			
A7	X			X			X			X
A8	X	X	X	X	X	X	X	X	X	X
Moynish										
B1		X	X					X		
B2	X	X			X			X		

B3	X	X			X				X	
B4				X	X	X				
B5										
B6			X				X			
B7		X			X			X		
B8	X	X	X	X	X	X	X	X	X	X
Creggaun										
C1	X	X								
C2			X	X						
C3					X			X		
C4				X			X			X
C5	X	X	X	X	X	X	X	X	X	X
Leamnahye										
D1	X			X			X			
D2		X				X				X
D4	X				X				X	
D5	X	X	X	X	X	X	X	X	X	X

Table 6.2 Ten Year Management Work Plan

5.7 Monitoring and Review of Plan

The principle of adaptive management is to continually review the effects of management intervention and adjust activities accordingly. Therefore an overall monitoring programme needs to be established. After each management intervention has taken place an effort should be made to monitor the impact of this activity. Quantitative data should be recorded and evaluated to decide if modification of the plan is required. Also the progress of the plan should be monitored to assess whether the objectives of the plan are being met or whether too little is being achieved. Finally a comprehensive review should be initiated near the end of the ten year plan to assess whether or not the plan has been implemented and what the overall impact has been on the woodlands, its habitats, flora and fauna.

5.8 Research

There is a need to establish and maintain a research programme in the woodlands in order to understand fully the ecological processes taking place and to guide the management of the site and its component habitats. A baseline survey of the vegetation has been completed but there are other fields of research that are yet to be undertaken. Species inventories of invertebrates, bryophytes, lichens and fungi need to be compiled for the woodlands. Also neighbouring priority habitats such as *Cladium* fen and limestone grassland need to be studied and managed. A deer exclusion experiment to study the impact of deer grazing has been set up but needs to be continued over a long period to produce any quantitative information.

Bibliography

Bibliography

Manuscript and Printed Primary Sources

- Anon (1830). *Tithe Applotment Books 1830, Co. Mayo*. Mayo County Library, Microfilm.
- Anon (1836). *Ordnance Survey Field Books: Parish of Ballyovey No.16.* Ordnance Survey Ireland. Dublin.
- Anon (1844). *General Valuation of Ireland – Co. Mayo.* Dublin. Office of the General Advisor.
- DeBurgh, Hussy, U.H. (1878). *The Landowners of Ireland. An Alphabetical List of the Owners of Estates of 500 acres or £500 valuation and upwards.* Dublin. Hodges, Fosters and Figgis.
- Griffith, R. (1855). *Griffith Valuation – General Valuation of Rateable Property in Ireland.* Dublin. Her Majesty's Stationary Office.
- Kierans, J. (1901). Census of Ballinrobe and Partry – Names, Ages and Occupations. Irish Government.
- Nicholson, S. (1844). Photostat copy of a report upon the estates of Sir Robert Lynch Blosse lying in the baronies of Carra. Ms.2725. National Library of Ireland. Dublin.
- O' Sullivan, W. (Ed.) (1958). *The Strafford Inquisition of County Mayo 1635.* Irish Manuscripts Commission. Dublin.
- Simington, R.C. (Ed.) (1956). *Book of Survey and Distribution Vol. 2 1636-1703.* Irish Manuscripts Commission. Dublin.
- Simington, R.C. (Ed.) (1967). *Book of Survey and Distribution Vol. 4 1636-1703.* Irish Manuscripts Commission. Dublin.
- Simington, R.C. (Ed.) (1970). *The Transplantation to Connaught 1654-58.* Irish Manuscripts Commission. Dublin.

Secondary Sources

- Aalen, F.H.A, Whelan, K. and Stout, M. (Eds) (1997). *Atlas of the Irish Rural Landscape,* Cork University Press, Cork.
- Aas, G. and Riedmiller, A. (2001). *Trees of Britain and Europe,* HarperCollins, London.
- Andrews, J.H. (1985). *Plantation Acres,* Ulster Historical Foundation, Omagh.
- Andrews, J.H. (1978). *Irish Maps,* Eason's Irish Heritage Series No.18, Dublin.
- Andrews, J.H. (1954). 'Notes on the historical geography of the Irish Iron Industry', *Irish Geography,* 3, 139-149.
- Anon (2002). *National Biodiversity Plan,* Department of Arts, Heritage, Gaeltacht and the Islands, Dublin.
- Anon (1998). *Impact of Current Forestry Policy on Aspects of Ireland's Heritage,* Report to the Heritage Council, Kilkenny.
- Anon (1994). *Ireland's Forested Future – A plan for forestry and the environment,* The Royal Society for the Protection of Birds, Belfast.
- Alexander, K., Butler, J. and Green, T. (2006). 'The value of different tree and shrub species to wildlife', *British Wildlife,* 20, 18-28.
- Aughney, T. and van der Sleesen, S. (2000). *The Rich Habitat of Balla,* Balla Town Park Ltd, Castlebar.
- Baille, M.G.L. and Brown, D.M. (1995). Some deductions on ancient Irish trees from dendrochronology. In *Wood, Trees and Forests in Ireland,* (Ed. By Pilcher, J.R. and Mac An Tsaor), Royal Irish Academy, Dublin, 41-49.
- Barkham, J.P. (1992). 'The effects of management on the ground flora of ancient woodland, Brigsteer Park Wood, Cumbria, England', *Biological Conservation,* 60, 167-187.
- Berry, H.F. (1910). 'The Partry Private Cemetery, Townland of Cloonlagheen, and Parish of Ballyovey', *Journal of the Association for the Preservation of Memorials for the Dead in Ireland.* 8, The Office of Publics Works, Dublin.
- Bohan, R. (1997). '*The Historical Ecology of the Woodlands of Ireland, Western Scotland and The Isle of Man*' (Unpublished PhD Thesis. Philosophy Department, Trinity College, Dublin).

- Bradshaw, R.H.W. (1988). Spatially precise studies of forest dynamics. In: *Handbook of vegetation science, Volume 2: Vegetation History,* (Ed. By Huntley, B. and Webb, T.), Junk, Dordrecht.
- Bradshaw, R.H.W. and Hannon, G.E. (1988). Human influence in the decline of the Irish forest ecosystem. In: *Human Influence on Forest Ecosystems Development in Europe* (Ed. By F. Salbitano), ESF FERN-CNR, Pitagora, Editrice, Bologna, 21-30.
- Broad, Ken. (1998). *Caring for Small Woods,* Earthscan Publications Ltd, London.
- Brooks, A. (1988). *Woodlands: A Practical Handbook,* British Trust for Conservation Volunteers, Britain.
- Brown, D. (1991). Report on Oak sample from Lough Carra, Co. Mayo. Queens University Of Belfast. Belfast.
- Cabot, D. (2004). *Irish Birds,* HarperCollins Publishers, London.
- Cabot, D. (1999). *Ireland,* HarperCollins Publishers, London.
- Campbell, K. (1999). Time to 'Leap the Fence'. Historic parks and gardens. In: *Managing Historic Sites and Buildings,* (Ed. By Chitty, G. and Baker, D.), Routledge, London, 127-139.
- Causton, D.R. (1988). *Introduction to Vegetation Analysis,* Unwin Hyman, London.
- Coll, M. (Ed.) (2000). *Our Trees: A Guide to Growing Ireland's Native Trees in Celebration of a New Millennium,* The People's Millennium Forests.
- Cooke, A.S. (1996). Muntjac deer and woodland reserve management. In: *Deer or the New Woodlands?* (Ed. By Jones, M., Rotherham, I.D. and McCarthy, A.), Wildtrackpublishing, Sheffield, 47-51.
- Coroi, M., Skeffington, M.S., Giller, P., Smith, C., Gormally, M., and O'Donovan, G. (2004). 'Vegetation diversity and stand structure in streamside forest in the south of Ireland', *Forest Ecology and Management,* 202, 39-57.
- Cosgrave, P., Amphlett, A., Elliott, A., Ellis, C., Emmett, E., Prescott, T. and Watson Featherstone, A. (2005). 'Aspen: Britain's missing link with the Boreal Forest', *British Wildlife,* 17, No. 2, 107-115.
- Cross, J. (1987). 'Status and value of native broadleaved woodland', *Irish Forestry,* 44, 81-88.

- Cross, J.R. (1982). The invasion and impact of *Rhododendron ponticum* in native Irish vegetation. In *Studies on Irish vegetation,* (Ed. By White, J.), Royal Dublin Society, Dublin, 209-220.
- Cunningham, D. (2005). *Brackloon. The Story of an Irish Oak Wood,* Coford, Dublin.
- Dooley, T. (2001). *The Decline of the Big House in Ireland,* Wolfhound Press, Dublin.
- Doyle, C. Ed (2005). *Ireland's Native Woodlands. Abstracts of conference papers*, Woodlands of Ireland, Dublin,
- Eldin, H.L. (1970). *The New Naturalist a Survey of British Natural History, Trees, Woods and Man,* Collins, London.
- Esen, D., Zedaker, S.M., Kirwan, J.L. and Mou, P. (2004). 'Soil and site factors influencing purple-flowered rhododendron (*Rhododendron ponticum L.*) and eastern beech forests (*Fagus orientalis*) in Turkey', *Forest Ecology and Management*, 203, 229-240.
- Fahy, C. (1995). *Treasures from the National Library of Ireland,* (Ed. By Kissane, N.), Alpine Fine Art Collection, London.
- Felix, J. (2000). *Birds of Great Britain and Europe. A bird spotter's guide,* Caxton Editions, London.
- Fitzgerald, R. and Jackson, M.W. (2005). 'Telling the trees from the wood in Killarney', *British Wildlife,* 17, No.2, 83-92.
- Forbes, A.C. (1932). 'Some legendary and historical references to Irish woods, and their significance', *Proceedings of the Royal Irish Academy*, 41B, 15-36.
- Forest Service (2001). *Native Woodland Scheme*, Department of the Marine and Natural Resources, Wexford.
- Fossitt, J.A. (2000). *A Guide to Habitats in Ireland,* The Heritage Council, Dublin.
- Fox, H., Cullen, M., Little, D.J., Ciaurriz, P., Ryan, D., Dwyer, R. and Boyle, M. (2001). *Vegetation monitoring and botanical survey of Brackloon Wood, Westport, Co. Mayo*, Forest Ecosystem Research Group Report No. 31, University College Dublin, Dublin.
- Fowler, J., Cohen, L. and Jarvis, P. (1998). *Practical Statistics for Field Biology,* John Wiley & Sons, Chichester.

- Gill, R.M.A., Gurnell, J. and Trout, R.C. (1995). Do woodland mammals threaten the development of new woods? In *The ecology of woodland creation,* (Ed. By Ferris Kaan, R.), John Wiley & Sons Ltd, Chichester, 208-217.
- Goldsmith, F.B. (1991). *Conservation Biology Series. Monitoring for Conservation and Ecology,* Chapman and Hill, London.
- Grimes, L. (2004). *An Ecological Survey and Site Management Plan of Carrarevagh Woodland, Liscarney, Westport, Co. Mayo,* (Unpublished BA Dissertation, Heritage Department, Galway-Mayo Institute of Technology, Castlebar).
- Grimes, L. (2003). *Heritage Conservation versus Development? A Critical Analysis of the Development of the Demesne of Westport House Estate Co. Mayo,* (Unpublished Report, Heritage Department, Galway-Mayo Institute of Technology, Castlebar).
- Guyer, C.F. and Edwards, C.J.W. (1989). 'The role of farm woodland in Northern Ireland: An Appraisal', *Irish Geography,* 22. Part.2, 79-85.
- Hall, V. A. (2000). 'A comparative study of the documentary and pollen analytical records of the vegetational history of the Irish landscape, 200-1650 AD', *Peritia,* 14, 342-371.
- Hall, V.A. (1997). 'The development of the landscape of Ireland over the last two thousand years; Fresh evidence from historical and pollen analytical studies', *Chronicon*, 1, 1-22.
- Hall, V.A. (1997). 'Recent landscape change and landscape restoration in Northern Ireland: a tephra-dated pollen study', *Review of Palaeobotany and Palynology,* 103, 59-68.
- Hall, V. A. (1995). Woodland depletion in Ireland over the last millennium. In *Woods, trees and forests in Ireland* (Ed. By Pilcher, J.R. & Mac An tSaoir, S.S), Royal Irish Academy, Dublin, 23-33.
- Henry, A. (1914). 'Woods and Trees of Ireland', *County Louth Archaeological Journal,* 3, 237-45.
- Higgins, G.T., Martin, J.R. and Perrin, P.M. (2004). *National Survey of Native Woodland in Ireland*, (Unpublished Report, BEC Consultants, Dublin.)
- Howley, J. (1993). *The Follies and Garden Buildings of Ireland,* Yale University Press, New Haven and London.

- Huxley, C. (2005). *Old Head Wood Nature Reserve: Ten Year Management Plan 2006-2015*, (Unpublished Draft Plan, National Parks and Wildlife Service.)
- Johnson, G. (1998). *Archaeology and Forestry in Ireland. Towards Policies for Ireland's Heritage,* The Heritage Council, Kilkenny.
- Joyce, P.M. (1998). *Growing Broadleaves,* Coford, Dublin.
- Kelly, D.L. (2002). 'The Regeneration of Quercus petraea in southwest Ireland: a 25-year experimental study', *Forest Ecology and Management*, 166, 207-226.
- Kelly, D.L. & Iremonger, S.F. (1997). 'Irish wetland woods: the plant communities and their ecology, *Proceedings of the Royal Irish Academy,* 97B, 1-32.
- Kelly, D.L. & Fuller, S. (1988). Ancient woodland in central Ireland: does it exist? In *Human Influence on Forest Ecosystems Development in Europe* (Ed. By F. Salbitano), ESF FERN-CNR, Pitagora Editrice, Bologna, 363-369.
- Kelly, D.L. and Kirby, E.N. (1983). 'Irish Native Woodlands over Limestone', *Journal of Life Sciences*, 3,181-199.
- Kent, M. and Coker, P. (1992). *Vegetation description and analysis: A practical approach,* Belhaven Press, London.
- Kirby, K.J. (1984). *Focus on Nature Conservation No.8. Forestry Operations and Broadleaf Woodland Conservation,* Nature Conservancy Council, England.
- Little, D.J., Boyle, G.M., Farrell, E.P. and Ryan, D. (2001). *Intensive Monitoring of an Oak Woodland in Western Ireland,* Coford, Dublin.
- McCracken, E. (1971). *The Irish Woods since Tudor times,* David & Charles Newton Abbot, Queens University Belfast.
- McCracken, E. (1959). 'The woodlands of Ireland circa 1600', *Irish Historical Studies,* 11, 269-296.
- McDonnell, P. (2006). *Using Information Technology to enhance Ecological Research,* (Unpublished Masters Thesis, Department of Computing. Institute of Technology Sligo).
- McEvoy, T. (1944). 'Irish Native Woodlands: their present condition', *Irish Forestry,* 1, 27-35.
- Miles, A. (1999). *Silva: The Tree in Britain,* Ebury Press, Great Britain.

- Milne, R.I. and Abbott, R.J. (2000). 'Origin and evolution of invasive naturalized material of *Rhododendron ponticum L.* in the British Isles', *Molecular Ecology,* 9, Issue 5, 541- 547.
- Mitchell, F. and Ryan, M. (1997). *Reading the Irish Landscape,* Town House, Dublin.
- Mountford, E, P. (2001). 'Natural Developments in a Minimum Intervention Area in Buckholt Wood, part of the Cotswolds Commons and Beechwoods National Nature Reserve', *Nat-Man Working Report 10,* Nat-Man Project, Denmark, 1-18.
- Neeson, Eoin (1997). Woodland in History and Culture. In *Nature in Ireland,* (Ed. By Foster Wilson, J.), Lilliput Press, Dublin, 133-156.
- Neeson, E. (1991). *A History of Irish Forestry*, Lilliput Press, Dublin.
- O'Carroll, J. (2005). *Protecting Ireland's Forest- the threat from deer. Post-seminar action plan.* (Unpublished Report, Coford, Dublin).
- O' Conor-Nash, P. (1991). The Great Houses: How to breastfeed a dinosaur in the late 20th century. In *Environment and Development in Ireland,* (Ed. By Feehan, J.), University College Dublin, Dublin, 114-117.
- O' Connell, Catherine (1999). *Wild Woods of Ireland: Field Studies Guide,* Irish Peatland Conservation Council, Dublin.
- O' Donoghue, L. (2000). 'Partry House', *Partry: The place we call home,* Ballinrobe.
- O'Kane, F. (1997). The demesne landscape of the eighteenth century. In *Irish Landscape Forum – The Second Landfall,* (Ed. By O'Regan, T.), Landscape Alliance Ireland, Dublin, 20-21.
- O' Sullivan, Aileen (1999). *Natural Forests in Ireland*, Duchas, Dublin,
- Perrin, P.M., Kelly, D.L. and Mitchell, F.J.G. (2006). 'Long-term exclusion in yew wood and oakwood habitats in southwest Ireland: Natural regeneration and stand dynamics', *Forest Ecology and Management*, 236, Issues 2-3, 356-367.
- Peterken, G.F. and Mountford, E.P. (2005). 'Natural Woodland Reserve: 60 years of trying at Lady Park Wood', *British Wildlife*, 17, No.1, 7-16.
- Peterken, G.F. and Mountford, E.P. (1995). 'Lady Park Wood: The first fifty years', *British Wildlife*, 6, 205-213.
- Peterken, G.F. (1989). 'Forty years of change in Lady Park Wood: the young-growth stands', *Journal of Ecology,* 77, No. 2, 477-512.

- Peterken, G.F. (1987). 'Forty years of change in Lady Park Wood: the old-growth stands', *Journal of Ecology,* 75, No. 2, 477-512.
- Pilcher, J. and Hall, V. (2001). *Flora Hibernica: The Wild flowers, Plants and Trees of Ireland,* The Collins Press, Cork
- Pilcher, J.R. (1979). 'Application of dendrochronological techniques to the investigation of woodland history', *The Irish Naturalists' Journal,* 10, No. 11. 377-380.
- Praeger, R.L. (1934). *The Botanist in Ireland,* Hodges Figgis, Dublin.
- Putman, R.J., Duncan, P. and Scott, R. (2005). 'Demographic changes in a Scottish red deer population (*Cervus elaphus L.*) in response to sustained and heavy culling: an analysis of trends in deer populations of Creag Meagaidh National Nature Reserve 1986-2001', *Forest Ecology and Management*, 206, Issues 1-3, 263-281.
- Quinn, J.F. (1993). *History of Mayo - Volume 1,* Quinn Publishing, Ballina.
- Quinn, J.F. (2000). *History of Mayo - Volume 4,* Quinn Publishing, Ballina.
- Rackham, O. (2006). *Woodlands*, HarperCollins, London.
- Rackham, O. (1995). Looking for ancient woodland in Ireland. In *Woods, trees and forests in Ireland* (Ed. By Pilcher, J.R. & Mac An tSaoir, S.S), Royal Irish Academy, Dublin, 1-12.
- Rackham, O. (1990). *Trees and Woodland in the British Landscape: The Complete History of Britain's Trees Woods & Hedgerows,* Phoenix Press, London.
- Rackham, O. (1986). *The History of the Countryside,* J.M. Dent & Sons Ltd, London.
- Rackham, O. (1975). *Hayley Wood; Its History and Ecology,* Cambridgeshire and Isle of Ely Naturalists' Trust Ltd, Cambridge.
- Read, H.J. and Frater, M. (1999). *Woodland Habitats,* Routledge, London.
- Rooney, S. and Hayden, T.J. (2002). *Forest Mammals – management and control,* Coford, Dublin.
- Rose, R. (1981). *The Wild Flower Key,* Penguin Books Ltd, England.
- Ryder, E. (2004). *A Vegetation Study of Merlin Park Woodland, Co. Galway in Relation to Management Objectives,* (Unpublished BSc Dissertation, Environmental Science Department, National University of Ireland, Galway).
- Shaffrey, M. (1985). *Irish Countryside Buildings,* The O'Brien Press, Dublin.

- Simington, R.C. (1970). *The Transplantation to Connaught,* Irish Manuscripts Commission, Dublin.
- Simington, R.C. (1967). *The Books of Survey and Distribution,* Irish Manuscripts Commission, Dublin.
- Stokes, M.A. and Smiley, T.L. (1996). *An Introduction to Tree-ring Dating,* The University of Arizona Press, Arizona.
- Strandberg, B., Kristiansen, S.M. and Tybirk, K. (2005). 'Dynamic oak-scrub to forest succession: Effects of management on understorey vegetation, humus forms and soils', *Forest Ecology and Management*, 211, 318-328.
- Sutherland, W.J. (Ed.) (1996). *Ecological Census Techniques. A Handbook,* Cambridge University Press, Great Britain.
- Tyler, C., Pullin, A.S., and Stewart, G.B. (2006). 'Effectiveness of management interventions to control invasion by *Rhododendron ponticum*', *Environment Management,* 37, No. 4, 513-522.
- Van der Sleesen, A. (2000). *Galway's Woodlands: inventory, social context and prospects for the future,* (Unpublished PhD Thesis, School of Engineering, Galway Mayo Institute of Technology, Galway).
- Viney, M. (1966). Forestry, *The Irish Times*, 12 October 1966.
- Walker, R. (1996). Deer or the New Woods? – The need for an acceptable deer management policy. In *Deer or the New Woodlands?* (Ed. By Jones, M., Rotherham, I.D. and McCarthy, A.), Wildtrackpublishing, Sheffield, 64-69.
- Webb, D.A., Parnell, J. & Doogue, D. (1996). *An Irish Flora,* Dundalgan Press Ltd, Dundalk.
- Willis, K.J. (1993). 'How old is ancient woodland?' *Tree,* 8, 427-428.

Websites

- Deer Alliance (www.deeralliance.ie)
- The Deer Initiative (www.the deerinitiative.co.uk)
- Deer Commission of Scotland (www.dcs.gov.uk)
- Forest Research - The Research Agency of the Forestry Commission in the UK (www.forestresearch.gov.uk)
- Heritage Council - National Biodiversity Plan (www.heritagecouncil.ie)
- National Archives – Famine Relief Commission Papers 1845-1847. Items 2846, 4234, 5312. (www.nationalarchives.ie)

- Met Eireann (www.meteireann.ie)
- John Wilson Manuscripts Ltd (www.manuscripts.co.uk/)
- Museums of Mayo- History of Partry House Estate. (www.museumsofmayo.com)
- National Library of Ireland (www.nli.ie)
- Irish Native Wood Trust - (http://www.nativewoodtrust.ie)
- Pisces Conservation Ltd – (www.pisces-conservation.com)