Management & Evaluation of a Range of Forest Species for Use as Cut Foliage

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ABSTRACT

This project explored the possibility of harvesting marketable foliage stems in addition to producing timber from plantations of *Larix leptolepis*, *Cupressus macrocarpa* 'Goldcrest' and *Tsuga heterophylla*. Data recorded from trial sites included both growth parameters, in the form of height and diameter increments, and production parameters in the form of foliage stem yields. Results varied with species and site type. In many cases, results achieved appear to have been influenced more by the biology of the trees than by the treatments alone. Trials were also established to investigate methods of managing old or over grown *Abies procera* Christmas tree plantations for forest foliage production. Shelf life testing and market research into the domestic trade of forest foliage were also conducted over the course of the project. Recommendations for managing forest plantations for foliage production as well as a general discussion on the industry are presented in this report.

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ABBREVIATIONS

COFORD - the Programme of Competitive Forestry Research for Development (formerly National Council for Forest Research and Development) - is based in the Research Division of the Irish Department of Agriculture, Fisheries and Food. COFORD is responsible for the development of national forest research and development policy and priorities, the formulation and implementation of programmes that address these priorities, and transferring the knowledge generated into practice.

EAFRD - European Agricultural Fund for Rural Development

FSC – Forest Stewardship Council

MPS - Milieu Project Sierteelt (Floriculture certification scheme)

NWFP – Non Wood Forest Product

R.S.I. – Repetitive Strain Injury

SFM – Sustainable Forest Management

Stem(s) – The word stem as it appears in this document does not refer to tree stocking, instead it relates to a graded branch or twig removed from trees for use in the foliage trade. For example stems/ha refers to the number of foliage stems removed from a hectare of woodland. It does not refer to the number of trees per hectare.

Teagasc – The Agriculture and Food Development Authority

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1.0 INTRODUCTION

Since its inception, the focus of commercial forestry in Ireland has primarily been on the production of timber. It is only recently that interest has been shown in the other products and services found in afforested areas. As landowners have to wait until their crop matures to gain returns and with little income being derived from thinnings, the possibility of generating revenue from other non-wood forest products has never been so appealing. The National Council for Forest Research and Development (COFORD) study "Markets for Non Wood Forest Products" (Collier et al., 2004) examined the main categories of NWFPs and identified forest foliage as having the greatest potential to generate income. Recommendations from that study suggested further research into the management of forest species for foliage production. This thesis comprises the first body of work undertaken to implement these recommendations.

Cut foliage refers to the green vegetation used in conjunction with flowers in the preparation of bouquets and other floral arrangements (Whelton, 1995). Currently the EU market for cut flowers and foliage is worth approximately €12 billion of which foliage accounts for 8-10% (Collier et al., 2004). The influence of fashion permeates the industry and there is a constant need for new, innovative ideas. The current trend for all things natural has ensured that there is a clear demand for foliage from wild and woodland species. The selection criteria for new foliage species include interesting colours, leaf shapes and forms, a long vase life and being economically viable to produce (Arthy & Bansgrove, 2003). Research has also established that the way foliage is graded and presented is of utmost importance (Kelly, 1997).

To date, forest foliage production in Ireland relates mainly to *Abies procera* (Noble fir) with smaller harvests of *Betula pendula* (Silver birch) and *Pinus contorta* (Lodgepole pine). However due to the absence of solid scientific research, harvesting

operations are often based on mistreatment rather than management. While a limited amount of research exists on the effect of harvesting foliage from Noble fir, much of this work recorded results on a weight basis (Keane & Horgan 2000). Due to changes in the way foliage is marketed, the majority of flower packers will now only accept graded stems of specified lengths and shapes. *Larix leptolepis* (Japanese larch), *Cupressus macrocarpa* 'Goldcrest' (Monterey cypress Goldcrest) and *Tsuga heterophylla* (Western hemlock) have been suggested as good candidates for foliage production. Foliage stems from these species display favourable form, colour and scent characteristics. As these varieties are not well known in the flower trade, there is little if any research available on the effect of foliage removal.

With greater emphasis on the concept of multifunctional use forestry, the possibility of growing trees for timber in association with generating income from forest foliage is examined in this report. Once the final timber crop is identified, the premise that trees normally removed, at a later stage, during thinning operations may be alternatively managed for foliage production is investigated.

2.0 AIMS and OBJECTIVES

In terms of managing forest species for cut foliage production, the aims of the project include:

- To determine the potential of harvesting cut foliage from a range of forest species, without affecting the crop's ability to produce timber.
- To develop a set of management recommendations for production of cut foliage from *Larix leptolepis*, *Cupressus macrocarpa* 'Goldcrest' & *Tsuga hererophylla*.
- To investigate methods of managing overgrown *Abies procera* Christmas tree plantations for forest foliage production.

Regarding the evaluation of selected forest foliage species, the project has the following objectives:

- To carry out seasonal shelf life tests on the spring stems of Japanese larch foliage.
- To carry out market research into the Irish florist trade.
- To seek feedback from flower designers and foliage buyers.
- To present research findings at a seminar promoting development of the Irish forest foliage industry.

3.0 LITERATURE REVIEW

3.1 Non Wood Forest Products

3.1.1 Introduction to NWFPs

While the capacity of forests to produce timber is well recognised, woodland areas also provide a range of other attractive, interesting and often underrated goods. The term non-wood forest product (NWFP) is used to describe these products and it refers to numerous individual and unique items.

Box 1: NWFP Definition.

Non wood forest products or NWFPs are defined as 'products of biological origin other than wood derived from forests, wooded land and trees outside of forests' (FAO, 1999)

The United Nations Food and Agriculture Organization maintain that at least 150 non-wood products are found in international markets (FAO, 1995). Examples include foodstuffs such as berries and fungi, medicinal plants and decorative items including forest foliage. Indeed the range of products and services has expanded to include non-tangible items such as water quality, erosion control and scenic beauty.

The FAO definition of non-wood forest products presented in box 1 is perhaps the most recognised among researchers. However, there has been much debate about the suitability of this description and many commentators choose to use other terms to describe NWFPs or their related processes. According to Mantau et al (2007) "the use of the 'non' element signifies a comparative term because it defines the resources of interest by opposition or comparison with other products rather than directly describing what they are". Secondary forest products, special/speciality forest products, forest by-products, non timber forest products, forest farmed products and minor forest products are a just a few of the additional terms employed (Hill, 1998).

Consequently, this lack of a clear terminology poses difficulties for those involved in the sector, especially in the transfer of knowledge. One group of European researchers suggest that all forest resources are important and propose a more holistic approach to the analysis of forest resources and their management. Mantau et al. (2007) state "perhaps it is time to work towards banishing all 'non-terms' from forestry to create scientific clarity and remove all negative connotations from forest resources, giving them all equal attractiveness and presenting them as a broad variety of attractive goods and services". This may be something to consider in the future.

According to the FAO's Global Forest Assessment (2006), "the value of wood removals is decreasing while the value of NWFPs is increasing and is underestimated". While the social and economic importance of NWFPs in unindustrialised countries has been well documented, developed countries are starting to realise the potential of these goods within their own forest resources. As stated by Mohammed (1999), "Development of NWFPs may provide several benefits, including local employment, opportunities for better resource stewardship, and fuller use of the forest land base". Pettenella et al. (2006) suggest that there are three main driving forces behind the growing interest in NWFPs across Europe. These are; the decreasing price of wood products, the rising demand for environmentally friendly produce and rural development policies.

Although the benefits of encouraging NWFP production have been identified, there are few researchers claiming expertise in the area. As conventional forest management is based mostly around the production of timber, the study of NWFPs has long been over shadowed by the study of managing forests for timber and wood. Consequently, the amount of scientific research available in this area is quite limited.

3.1.2 NWFPs in Ireland.

Unlike European countries, recent years have seen very little NWFP gathering in Ireland. At the beginning of the 20th century, forests covered only 1% of the land area. While this has expanded to 10%, the majority of Irish forests are plantations of exotic species (National Forest Inventory, 2007). However, Ireland was once covered in forests and people used them for many purposes. In addition to tangible products such as wood, food items and medicinal plants, previous generations of Irish people turned to the forest for inspiration as well as spiritual and religious reasons.

Trees and forests were once revered and so called "sacred trees" are well documented in Irish lore. According to Milner (1992) the term sacred tree is used to describe a tree that is "treated with a certain reverence which normally protects them from wilful damage or cutting". Specific categories of Irish sacred trees include trees sited at the places where ancient chieftains or kings of Ireland were inaugurated, trees associated with saints, trees associated with funerals, trees at holy wells and lone bushes or fairy trees (Lucas, 1962 cited in Milner, 1992). Specific folklore beliefs were attached to individual tree species. For example, *Sorbus aucuparia* (Rowan or Mountain ash) was believed to keep "the dead from rising, helped to speed the hound, prevented fire charming when hung in the house, and generally protected the home, milk and the dairy" (Nelson & Walsh, 1993).

Trees have always been a source of inspiration for authors, poets and other artists. From the poets and bards of early Christian Ireland to literary greats like Joyce and Yeats, trees have featured in the work of a wide rage of Irish writers. The role of trees and forests in the work of two contemporary poets is discussed by author and priest Fr. Pat Moore in Appendix 1.

As well as being a source of inspiration, Irish forests were once providers of many tangible NWFPs. The bark of *Quercus* spp. (Oak) was valued for tanning leather until

recent times. Oak bark and acorns were also used to dye cloth black (Nelson & Walsh, 1993). Stems of *Ulex europaeus* (Gorse) were used in many parts of Ireland to clean chimneys and the blossoms were used to make a yellow dye (Danaher, 1964). *Sambucus nigra* (elder) was once regarded as a medicinal plant. According to Danaher, (1964) "The wood cured warts, the leaves made a poultice, clay from the roots cured toothache and berries were fermented to make a palatable wine which was a good cough cure". Many food items were also sourced from trees and woodlands. Stems of *Urtica dioica* (Nettle) were gathered for detoxifying nettle soup each Easter. In July, before the potatoes were ready for eating, leaves from *Tilia spp.* (Lime) were used to flavour cabbage for a dish known as "Iúil na cabáiste" Moore (2008). In autumn, berries were gathered from wild bushes of *Rubus fruticosus* (blackberry), an activity still carried out today.

Although the above examples indicate that Irish people were once collectors of NWFPs, the extent and variety of items gathered appears to be less than in other European countries. There are several suggestions as to why this may be the case.

- "The Fairies"

As the well known poem by William Allingham begins "Up the furry mountain, down the rushy glen, we dare not go a hunting for fear of little men". In Ireland, there was once a widespread belief in a hidden race of people known as "the fairies" or "little people" who lived in or near fairy trees. Disrespecting the fairies by cutting down certain trees would lead to dire consequences. Many beliefs surrounding the fairy folk related to trees. "A cradle made from elder wood was deemed a dangerous thing, for the fairies could more easily steal the baby and leave a changeling in its place" (Nelson & Walsh, 1993). It has been suggested that this belief in fairies may have deterred people from gathering NWFPs (Moore, 2008). While fairy lore has all but

died out, many people still believe cutting branches of *Crataegus monogyna* (Hawthorn) is bad luck.

- Rats

Oral tradition recounts the fear Irish people had of rats. Rats according to Danaher (1964) were "dirty and poisonous". The story is told in Co. Kerry of a man who was partial to eating hawthorn berries from a wild tree until one moonlit night revealed the tree violently shaking due to the large number of rats in its branches. This story was told as a warning to children to deter them from the red berries.

- Poison

People had a great fear of poison. As a result many harmless plants were thought to be poisonous and therefore were avoided (Danaher, 1964). Of all the wild fungi only field mushrooms were eaten. All other fungi were regarded as poisonous and not many people could identify the edible varieties.

In the past Irish people had a close affinity with nature. The behaviour of trees was monitored and used to make weather predictions. Through oral tradition, many of these beliefs have survived. For example it is said that when Hawthorn blossoms are plentiful, the coming winter will be a bad one. Another well-known rhyme relating to rainfall is "The ash before the oak makes an awful soak. The oak before the ash makes for a splash" (Moore, 2008).

Forest Management

Since the formation of the Irish republic and the development of commercial forestry, the emphasis in forest policy has been on timber production. With landowners having to wait decades for any return from their investment coupled with a decline in timber prices, attention is once again being paid to NWFPs. In addition, managing plantations for tangible non-wood forest products often compliments the management of other non-wood values such as wellbeing of the population, biodiversity, wildlife habitat and maintenance of clean air and water. These values are becoming increasing important in Irish forestry.

3.1.3 Forest Foliage as a NWFP

Beyond the confusion over the definition of NWFPs, there is a need for clarity in relation to the harvesting of materials for decorative purposes. While researching available literature on the subject of forest foliage various terms are used to describe the processes and products involved. These include: cut foliage production (Whelton, 1995) decorative greens (FAO, 1998), floral and greenery products (Thomas and Schumman, 1993) ornamental forest products (Natural Resources Canada [NRCan], 2007), boughs (FAO, 1998), brush and tip harvesting (Lilley & Holmes, 1991). While there are many examples of forest materials being harvested for decorative purposes, it is proposed that one term be employed to describe this process. An attempt to define the term forest foliage is presented in Box 2.

Box 2: Definition of Forest Foliage

Forest foliage refers to decorative plant material that may be removed from trees, shrubs or ground vegetation found in the forest environment.

Globally, there are a huge range of forest foliage products, from species like *Eucalyptus* spp. common in bouquets, to artisan items like birch bark used in basket making (Wetzel et al., 2006). Even plants considered nuisance weeds can become valuable forest foliage merchandise. As Mohammed (1999) states "in the Pacific Northwest, the Salal plant (*Gaultheria shallon*), historically a notorious weed on forest sites, now enjoys new popularity as a result of its decorative, long-lived foliage". In the U.K., *Viscum album* (Mistletoe) is another such pest species. Without harvesting for the foliage trade, massive infestations of up to 30 clumps of mistletoe can develop on small apple trees, ultimately killing both host and parasite (Briggs, 1995). A further example is the species *Rhododendron ponticum.* While it is a noxious weed in many Irish forests, foliage from this plant is highly sought by buyers in the floral trade.

In Ireland, there are an estimated three companies involved in forest foliage production, all based in the south of the country. All foliage is harvested by hand with workers paid on a piece level arrangement. (Ní Dhubháin et al., 2005). The main forest species sold as forest foliage are *Rhododendron ponticum*, *Pinus* spp., *Abies procera*, *Myrticia gale* (Bog myrtle), *Hedera helix* (Ivy) and *Betula* spp. (Bord Glas, 2002).

The following table presents a selection of attractive forest foliage products found in Irish forests. As many are unknown in the trade, much of the information presented below was gleaned from florists, designers, foliage buyers, marketeers, researchers and foliage producers.

Table 1: Forest Foliage Species

Forest Foliage Item	Product Features (as discussed with industry experts)	Author's Comments
Alder 	Striking product due to the presence of both female cones and catkins on the same stems. Not commercially available as yet.	Currently not known in the marketplace. May have potential as a new twig item. Research is needed to test suitability for painting. Needs to be promoted to buyers.
Birch 	Attractive, finely branched stem. Reddish brown colour. Harvested during the winter months. Irish birch has an excellent reputation in comparison to birch produced on the continent due to its bushy form.	Highly suitable for painting and glittering. Excellent example of value added product. Became a £1 million product for Marks and Spencers before the market became oversupplied by eastern European produce. Still an important forest foliage species (Boers, 2008).
Bog myrtle 	Another twig product. Very popular due to the presence of small brown buds. Also suitable for painting and glittering. In its natural state, twigs have a unique scent.	In 1996, 600,000 stems were exported from Scotland (Milliken & Bridgewater, 2001). Scottish producers no longer supply the forest foliage market to this level possibly because Irish produce is recognized by some buyers as being better quality. However, Bog myrtle remains a very important NWFP in Scotland. Boots chemists have developed a range of skincare products containing Scottish bog myrtle. Also Carlsberg are developing a beer flavoured with bog myrtle (Anon, 2008).
Cones 	Cones from spruce, pine and other species are well known in the trade. They are of various sizes, on wires, sticks or loose. "Used in floral, wreath, and potpourri products. Also used in gift and fragrance items, as ornaments and table decorations, and in a variety of small niche markets such as jewellery, bird feeders, etc." (Thomas & Schumann, 1993)	Highly competitive market. Alder and hemlock cones are also harvested in the U.S.A. for use in the production of potpourri. According to Thomas & Schumann (1993) the Lodgepole pine cone is one of the largest selling cones worldwide due to its availability.

Laurel	Large leaved, glossy, dark green foliage suitable for [illegible] floral	Laurel grows well under shade. Previous research has [illegible] variety 'etna' as being especially suitable due to its upright stem and

Forest Foliage Item	Product Features (as discussed with industry experts)	Author's Comments
Ferns 	Several varieties of ferns are used in the trade. *Rumohra adiantiformis* or Leatherleaf fern is perhaps the most recognizable. Available year round, it has an excellent shelf life and does not wilt easily. It is very popular in supermarket bouquets but is regarded by many florists as "common". Other species include *Asparagus virgatus* (known as Tree fern although not a true fern) and *Stickerus flabellatus* (Umbrella fern) from Australasia.	Florida is the main producer of ferns and it is believed that the industry there dates back to 1896. Much research has been carried out by the University of Florida's Central Florida Research and Education Center who offer a research and training facility to the industry (see http://www.pvns.net/fern/main.htm). Not known if any of the Irish fern varieties are suitable for forest foliage. The following species has been suggested for further research: *Osmunda regalis* (royal fern), *Polystichum setiferum* (Soft shield fern), *Polystichum aculeatum* (Hard shield fern), *Polypodium vulgare* (Common polypody) and *Blechnum spicant* (Hard fern.)
Grasses 	Numerous grasses are used to add texture to floral arrangements. *Xerophyllum tenax* or Bear grass is native to north America and is very popular in the floral trade. Described by the flowers and plants association as "very narrow, strong grey-green leaves, up to a metre long. Like silver grass. Very suitable for modern arrangements" (see www.flowers.org.uk). Another important grass is *Xanthorrea Australis* (Steel grass).	Little is known if grass varieties growing in Ireland are useful in terms of forest foliage. *Ammophila arenaria* (Marram grass) although protected in its natural environment has a very attractive form and may be worth cultivating. The potential of other grass species including *Molinia caerulea* (moorgrass) should also be investigated.
Hazel 	*Corylus avellana 'Contorta'* Contorted or corkscrew hazel is valued by florists for it's architectural form. While it adds structure to arrangements and bouquets, contorted hazel can be used on it's own to create a natural centerpiece. It is also popular with interior designers.	Contorted hazel is a popular forest foliage product; although there may be questions regarding growth rates Has been included in new species trials conducted as part of this project.
Heather 	Many heather species (*Erica & Calluna* spp) have attractive stems, which can be used to great effect especially in traditional basket arrangements. Very popular for mother's day market.	The Mediterranean tree heathers such as *Erica arborea* and *Erica lusitanica* grow well in the south west of Ireland. Site selection and soil type have been identified as essential for successful production of heather foliage. (Whelton, 1995).

Forest Foliage Item	Product Features (as discussed with industry experts)	Author's Comments
Lodgepole pine 	Very popular and highly scented Christmas foliage. Lush green needles with good volume. Main competition is from *Pinus strobus* from Denmark and Germany. However, one flower designer believes, Lodgepole pine is a superior product as it is has a more upright stem and tends to be better quality (Boers, 2008).	Irish producers introduced Lodgepole pine foliage to the industry in 1996 when 125,000 stems were exported to British and Dutch markets (Perry, 1997). The market has grown substantially since then and marketeers believe that the demand is increasing. The main constraint is labour as the harvesting season is short and the work is quite demanding, producers often find it difficult to attract cutters.
Monterey cypress 	*Cupressus macrocarpa*, or *C. leylandii* are well known in the floral trade and are often referred to as "palm". These varieties have a bad reputation in Ireland as being low value foliage and are often associated solely with funeral work and wreaths. Many florists report that they harvest cypress from their own gardens. However the yellow coloured, lemon scented, *Cupressus macrocarpa* Goldcrest is very well received in the market and is suitable for a variety of purposes.	Other interesting varieties of *Cupressus* are being examined in the new species section of this project. Producers should move away from the more "common" varieties as the market is already oversupplied.
Moss 	Moss is used for many purposes, in hanging baskets, flowers arrangements and wreaths. There are a number of different varieties on the market. As well as preserving moisture, moss adds texture to arrangements.	There is a huge market for moss products. In the USA, Moss sales are estimated to be between U.S. $6 million and $165 million per year (Muir, 2004). There is concern worldwide about inappropriate and illegal harvesting of moss. Ecological research on moss harvesting is needed. Also research into more environmentally friendly packaging materials for moss products is required.
Noble fir 	Very popular Christmas foliage. Desirable properties of this species include durability, density and colour of foliage, symmetrical branching and excellent needle retention (Murray and Crawford, 1982). Also foliage is highly scented.	Seasonal product, perhaps best known forest foliage species in Europe. Denmark is the main producer of Noble fir in Europe. Irish producers have differentiated themselves by offering graded stems as opposed to roughly cut bundles.

Forest Foliage Item	Product Features (as discussed with industry experts)	Author's Comments
Oak 	In Germany, foliage from the North American red oak *Quercus rubra* is available for sale in floral markets (Ciesla, 2002). Preserved oak leaves are also common in the market and are used in seasonal arrangements.	Market appears to be well supplied from eastern Europe. *Quercus palustris* 'Rubra' has been included in current new species trials (Whelton, 2008)
Rhododendron 	Unique and highly desirable foliage product. Lush dark green leaves on an upright stem. Used as a filler where it adds volume to bouquets. Popular in both the supermarket and florist trades.	Due to its association with *Phytophthora ramorum* disease, key production sites in Ireland have been shut down to foliage harvesting. Consequently very little is now being harvested and exported. Scotland and northwest England are now supplying markets previously serviced by Irish produce.
Rushes 	Design product, has upright non-pliable stems. Harvested in bunches with damaged or brown stems removed. Adds structure and a natural look to an arrangement or bouquet.	Niche product, very attractive when graded. However stiff competition comes from steel and bear grass, which are already well known in the market.
Salal 	Popular, versatile and long lasting is used in all aspects of floral design. As Cocksedge, (2001) states "the dark green, leathery leaves are highly attractive and will last six months if properly stored. The branches are harvested from within forests where the size, growth form, colour, and quality of the leaves and branches are preferred by purchasers and their customers in the florist industry."	Hugely important NWFP in Canada and the U.S.A. Has naturalized in parts of south Kerry, where excellent quality, blemish free stems have been seen.

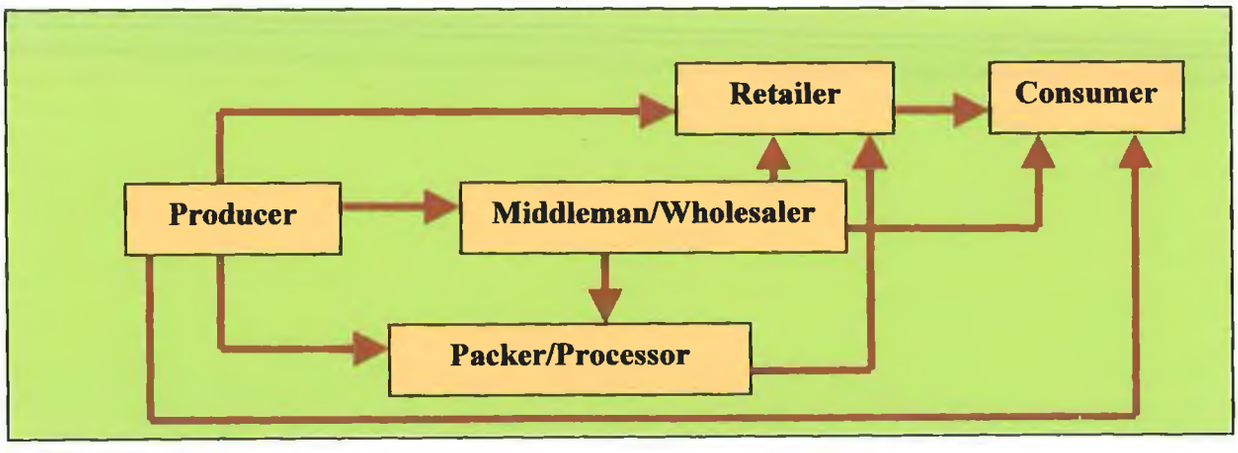
Forest Foliage Item	Product Features (as discussed with industry experts)	Author's Comments
Western hemlock 	Attractive, fine-needled foliage, bright green colour which works well in Christmas bouquets and contrasts nicely with blue Noble fir foliage. Seasonal product, although with proper promotion may be used at other times, would work very well with spring flowers.	Not long in the market and has not received as much attention as Noble fir. However, positive feedback has been received from designers.
Western red cedar 	Very attractive product, lacy, flat spray type foliage with two tone colour. Popular in the USA and Canada for wreath production. The foliage is very aromatic and has a "woody" scent.	As well as being an attractive forest foliage species, western red cedar provides other non-wood benefits. "Oil from the leaves and branches has been produced by steam distillation and sold in British Columbia since 1987. The leaf oil has an aromatic fragrance and is used as a base in manufacturing perfumes and toiletries. Oil from western red cedar heartwood residue is also produced on a small scale by steam distillation". (Gonzalez, 1997).
Willow 	Numerous different species, catkin types very popular in spring while contorted willow is used year round. Adds structure to flower arrangements, also willow twigs are used on their own in interior design.	Huge variety of willow species on the market, including contorted stems and twigs with catkins. Trials carried out in Ireland examined the potential of a range of different willow varieties. It was noticed that some varieties did not develop as many catkins as willow grown on the continent. However, it is believed this work may need to be revisited Whelton, A. (2007, pers. comm.).

3.2 Markets for Forest Foliage

There are no official data on EU foliage consumption. As foliage consumption is strongly linked to cut flower consumption, it is presumed that the relative size of the leading foliage markets is similar to the size of the cut flower market. The leading cut flower markets, according to their share in total EU consumption in 2007, were the UK (21%), Germany (21%), France (14%), Italy (11%), The Netherlands (7%), Spain (6%), Belgium (3%) and Poland (3%) (CBI Market Survey: The EU Market for Foliage, 2009).

There are different channels through which forest foliage producers can sell their goods. The auction houses in Holland are synonymous with the international floriculture trade. While they dominate the trade in flowers and are responsible for setting market prices, many forest foliage producers by pass the auctions and deal directly with wholesalers or packers. Figure 1 outlines the principle ways foliage is traded.

Figure 1: Forest Foliage Product Chain



Forest foliage provides an integral part of many floriculture products. Consequently, demand for foliage is affected by demand for other floral products. Research has shown that the forest foliage market is growing (Dyke & Primrose (2002), Collier et al. (2004)).

According to Pearson, (2007) the key issues for foliage buyers are "Availability, reliability, flexibility, quality".

The following table devised by Bord Glas (2003) outlines factors affecting the selection of flowers by supermarket buyers. The criteria discussed would also apply to foliage products.

Table 2: Retail Multiple Buyer Decision Considerations for Fresh Cut Flowers. Source: Bord Glas 2003.

Product	
Variety	Does it have strong consumer appeal — as most supermarket purchases are impulse buys? Is it new or distinctively different from a competitor or previous offers?
Freshness	Will vase life exceed customer expectations and supermarket guarantee periods?
Specification	Is it compliant with agreed standards for dimensions, blemish free and at the right stage of growth and development? Clearly agreed specifications are important where management control of the procurement process is delegated by local stores to central buyers.
Volume	Is there sufficient supply volume to satisfy the needs of the consolidated outlets? Buyers require large volumes of product to exploit the opportunities created by retail multiple outlets.
Price	Does it fit within predictable retail price points? Is it defensible when compared with competitors? Will it facilitate an acceptable mark-up?
Time	Can the product offering meet schedules with confidence? Frequent distribution — little & often shelf space replenishment? Is there responsive order processing — fast re-stocking?
Service	Post harvest management – does supplier have cool chain facilities? Shorter supply chains – with lower cost? Reliable and consistent (quality assured)? Environmentally defensible?

Key marketing trends for forest foliage are discussed below.

- Success in the floral trade generally requires emphasizing diversity and avoiding overdependence on seasonal products. However, as stated by Thomas & Schumann (1993) "it is critical to coordinate the timing of the harvest with the requirements of the buyers". Akin to the flower trade, demand for foliage produce in Europe is based around three peak times. These are Valentines Day, Mothers Day and most importantly for forest species, the period surrounding Christmas. For many supermarket buyers, preparation for these times is often carried out months in advance. It is important that growers provide product samples when required.
- Market research has identified that buyers are seeking novelties to take over some of the market (Profound Ltd. & Lanning, 2001). According to Dyke & Primrose (2002), "Demand exists for new ideas yet buyers are not specific about what new ideas they were looking for." Interviews carried out with key market informants in 1997, also highlighted the need for new ideas (Kelly, 1997).
- There has been a dramatic increase in demand for natural products including NWFPs (Hammett & Chamberlain, 1998). The demand for environmentally friendly products is also increasing (Lober & Misen, 1995).
- Fashion permeates the forest foliage business. Endorsements from television programmes and media personalities can affect demand for foliage goods. Research carried out by Dyke & Primrose (2002) identified "the influence of television shows such as "Changing Rooms" in creating a design aware marketplace where individuals were interested in designing rooms with a natural feel to them". An American producer of metal rings for wreaths maintains that

sales of his produce increased significantly after one of his products was used in a lifestyle television programme. He refers to it as "the Martha Stewart effect" (Staryzk, 2008).

- Scent has been highlighted as a key driver for foliage products (Boers, 2007; Pearson, 2007). As many flower species are no longer fragranced, foliage products are often used as the aromatic component in flower bouquets.
- The potential to add value is an important issue for forest foliage producers. By concentrating on value-added products, which command a higher price, developers may be able to earn more with less plant biomass, and further, there may be greater buffering against sharp decreases in demand for bulk supplies (Mohammed, 1999). Painting, glittering, drying and preserving forest foliage can increase profitability. Mater (2000) mentions that preserving florals with glycerine can increase profit margins by up to 300%.

3.3 The Role of Forest Foliage in Sustainable Forest Management

The concept of Sustainable Forest Management has evolved over recent years. While it is difficult to explicitly define SFM, it generally denotes a more holistic perspective of forests and their functions. The definition of SFM presented in Box 3 was laid down at the second Ministerial Conference on the Protection of Forests in Europe held in Helsinki in 1993.

Box 3: SFM Definition

Sustainable forest management is defined as the stewardship and use of forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems.

NWFPs have been identified as having a role to play in SFM. By complementing wood-based management, forest goods such as foliage offer a basis for managing forests in a more sustainable way and are recognised globally as an important tool in the development of SFM. (Duchesne & Wetzel, 2003; FAO, 1995). According to Staddon (2006), "The harvesting and trade of NWFPs have a potential role to play in delivering these outcomes of multiple-use and sustainability; being able to contribute economically, socially and environmentally".

Ireland made a formal commitment to sustainable forest management at the third Ministerial Conference in Lisbon in 1998. Following on from this, the Irish National Standard, Code of Best Forest Practice and Environmental Guidelines were published. While these publications did not directly address the role of NWFPs, the Code of Best forest practice (2000) states "the successful production of non-wood material within forests grown primarily for commercial timber production will require changes in conventional forest practices and operations, and specific plans will be necessary.

3.3.1 Economic Significance

Forest foliage production constitutes a novel industry with opportunities for further development. As products are closely connected with flowers and cultivated foliage, it can be difficult to evaluate economic contributions specifically from forest foliage species.

The world flower and foliage trade is estimated to be worth $20 billion with foliage accounting for $1 billion of this sum (Kelly & Whelton, 2004). The EU market for cut flowers and foliage is worth approximately €12 billion of which foliage accounts for 8-10% (Collier et al., 2004). According to Pearson (2007), Irish foliage is worth approximately £6 million per annum in the UK. During Christmas 2006, Kerry based Forest Produce Ltd sold 4.2[1] million forest foliage stems (Costello, 2007). Noble fir and Lodgepole pine foliage attain the highest market price of all Irish foliages and demand for these species at Christmas time far outweighs supply.

In North America, the New York Times Newspaper reported that in the Pacific Northwest, mosses, ferns and other plants have sustained the commercial floral products industry and contributed more than $125 million to the regions economy (Goldberg, 1996). Salal (*Gaultheria shallon*) is used in various types of floral and greenery arrangements, and generates millions of dollars in annual revenues (de Geus, 1995). In 1997, the sale of Salal stems generated $42-45 million (Can) in British Colombia (Wills and Lipsey, 1999). According to Walter (2005), a quarter of decorative foliage produced in the North West province is exported to Europe.

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[1] **This figure does not account for foliage harvested from cultivated species.**

Forest foliage is harvested from fir species for the production of wreaths and other Christmas arrangements. In countries such as Denmark, where this industry is well developed it is generating in the order of £18 million in revenue for the forestry sector (O'Reilly et al., 1997). In Minnesota, which is the largest supplier of bough and wreath products in the U.S.A., wreath sales are worth at least US$10 million annually (Preece, 1999). In New Brunswick, Canada, the Christmas tree and wreath industry had a wholesale value of $14 million in 1996, of which over $8 million was attributed to wreath sales. These were mostly composed of Balsam fir (Mohammed, 1999).

In addition to natural products, a survey of the U.S. market reported that the wholesale value for dried flowers and foliage is $295.7 million annually, and for preserved foliage is $177.6 million (Mitchell and Associates, 1997).

The production of forest foliage can contribute to local and regional economies and can be an important component in rural development. One paper from Canada suggests that the fairest way to evaluate the financial worth of NWFPs is to compare the number of workers or families that industries such as forest foliage allow to remain in rural communities rather than amount of income alone (Titus et al., 2004). In today's world, efforts to support small industry in rural communities may contribute to economic stability (Atwood, 1998).

3.3.2 Ecological Significance

As with other land use activities, environmental considerations are at the forefront of forest foliage and other NWFP production. Around the world, researchers are looking at ways of improving harvesting practices to ensure that nature is not diminished and that

any industry is sustainable. Unfortunately, in many cases, the harvesting of forest foliage has been based on exploitation rather than consideration.

The commercial harvesting of moss for the floral trade is big business. However, illegal harvesting has given the industry a bad reputation and undermines those who carry out moss harvesting in a sustainable and legal manner. Large scale, illegal and irresponsible harvesting is apparently on the rise. In Scotland, there were two convictions in 2003 for illegal collecting (Slee et al., 2005). As well as moss harvesting, the removal of other forest foliage products is often carried out in an unscrupulous manner. The popular press has even picked up on the unsavoury aspects of forest foliage harvesting (see Boxes 4 & 5).

Box 4: Press Article on Moss Harvesting - Scotland

Gangs steal moss to fund crime – THE SCOTSMAN
Wednesday 15th Dec 2004
James Reynolds Environmental Correspondent

"Illegal gangs dealing in drugs and other organised crime are now turning to the countryside to make money with devastating effects on Scotland's native habitats, The Scotsman has learned.
Police Officers working with Scottish Natural Heritage (SNH) have found that work parties often involving illegal immigrants and asylum seekers, are being bussed north of the border by criminal drug gangs to pick sphagnum moss, which is then sold to garden centres.
Large tracts of endangered peat bogs are being ripped up and irreparably damaged for the black market trade in moss used in Christmas wreaths and for hanging baskets."

Box 5: Report from Seattle on Illegal Forest Foliage Harvesting

The Seattle Times - Local News: Tuesday, June 06, 2006
A war in the woods
By Craig Welch

"Near Hood Canal, five people were caught last year stealing $28,000 in salal from private land. In Eugene, Oregon, a man was sent to prison for pilfering $250,000 in beargrass. In early May, eight illegal salal pickers were arrested in the Olympic National Forest, accused of chasing off legal competitors. A few weeks ago, Forest Service patrol officers came across nearly 150 80-pound bales of moss that had been swiped from the Mount St. Helens National Volcanic Monument…..

It's impossible to tabulate how much brush is stolen. In a 2004 study, Oregon State University Professor Patricia Muir estimated that just the commercial sale of moss, presumed to be worth $5.5 million a year, could actually be $165 million because of poaching."

To combat the often negative image of forest foliage production, many producers have adopted their own self-imposed environmental standards. Booth Moss & Foliage (based in Wales) gather mosses in Scotland over a two month period each year under a sustainable harvesting strategy where only mosses over five inches long are collected from sites which are harvested at two to three year intervals (Milliken & Bridgewater, 2001).

Regarding foliage harvesting, there is an argument that the current market requirement for graded stems plays a role in the sustainability of the industry as only saleable foliage material is removed. One Irish producer maintains that this is a pivotal reason why he has been able to harvest foliage from the same plantations of Noble fir and Lodgepole pine annually for the past 10 years (Costello, 2007).

In recent years foliage plantations have been established under polythene mulch, which acts as a means of controlling weed development and also retains soil moisture. This system reduces the amount of residual chemicals needed for crop protection (Houlihan, 2004).

Codes of Conduct

In addition to the above, other tools have been used to address environmental issues surrounding NWFP harvesting. One such tool is the development of "codes of conduct". These provide guidelines for collecting NWFPs in a sustainable and considerate manner. In Scotland, the following codes of conduct are presented on the Forest Harvest website (www.forestharvest.org.uk):

- The Scottish Moss Collection Code (2007)
- The Scottish Bulb Collection Code (2007)
- The Scottish Wild Mushroom Code (2003)

In Canada, a code has been devised for the collection of *Taxus canadensis* (ground hemlock), a plant used as a source of raw material for the production of taxanes for medical use (Anon, 2002).

It should be noted however, that many of these "codes" are based on opinion rather than scientific research. While available literature acknowledges that such guidelines provide a useful starting point, there is still a need for further ecological research. As a recent project carried out on moss identified "The forthcoming 'code of conduct' for moss harvesting is welcomed but studies to determine the ecological sustainability of the harvest are needed." (Staddon, 2006). The research being carried out into ground hemlock production is an excellent example of the level of follow up required once a "code of conduct" has been devised. Since initial guidelines were provided in 1999, work has been ongoing to ensure recommendations are backed up with ecological research. The fifth draft of guidelines published in 2002 incorporates significant changes from previous versions[2].

[2] See the following website for further information http://www.canyew.org/sustainable_guidelines.htm

Certification

The notion of certification can also be used to encourage environmentally conscious foliage production. Certification is defined as a "procedure by which assurance is given that a product, process or service is in conformity with certain standards" (Dankers, 2002). A certification logo or label enables potential customers to differentiate products, based on the social and environmental merits of the item they decide to buy. Certification of forests and their products ensures that they have been sustainably managed.

As with other products, labeling and certification schemes in the floriculture trade can reassure consumers. However, there is often confusion regarding which environmental issues are most important. An article published in the New York Times posed the following question "Should flowers be organic — that is, grown without synthetic or toxic pesticides? Or should the emphasis be on fair trade, meaning that the workers who grow and cut them are safe and well paid? Or should consumers favour flowers grown locally, not flown or trucked over long distances? In other words, what, exactly, is a green flower?" (Navarro, 2008).

While the food industry has been quite successful in marketing and achieving significantly higher prices for organic produce, the floral trade has been slow to recognize the merits of environmentally friendly production. The New York Times (2008) also reports the following "The Organic Trade Association says organic food and beverages had $17 billion in sales in 2006. Flowers, a $21 billion a year industry, brought in $19 million in organic sales". Jackie Stephen, former head floral buyer for UK supermarket giant Tesco recalls a promotion the company ran some years ago on certified roses. Each bouquet was supported with literature outlining the certification process. The range was not deemed a success for the company possibly because consumer interest in certification

or sustainability was not as great as it is today (Stephen, 2007). In the year 2008, it is a different story. In February, Tesco supermarket announced its decision to cut imports by half and the first Irish Tesco Eco opened in October in Tramore. Industry experts have also recognized that while audits of environmental issues are not barriers to immediate entry, they will most certainly be required in the near future (Pearson, 2007, Kelly & Whelton, 2004). In addition, market research has shown that many supermarkets now require producer compliance with the MPS certification scheme (Kelly and Whelton, 2004).

MPS is a Dutch based, international certification organisation, which assesses and certifies environmental, quality and social aspects of the floriculture industry. It was established in response to consumers' growing concerns about the way flowers and plants were being produced and to improve the sector's generally poor image. Participating growers must keep a record of the amounts of crop protection agents and fertilizers used, the energy consumed, and the amounts of waste produced. Growers are awarded an environmental qualification every quarter. The rating system used is one in which crop protection agents make up 40%, energy use 30%, fertilizers 20%, and waste 10% of the total. Participants are awarded points according to which they are classified in environmental class A, B or C. Those awarded the grade 'A' use the most environmentally friendly cultivation methods and have kept records for the previous consecutive 12 months at the least.

While the MPS system is used in the floriculture trade, perhaps the most recognized woodland certification scheme is the one provided by the Soil Association under the FSC. Unfortunately, the costs and expertise involved in achieving FSC certification tend to be prohibitive for individual NWFP producers. It may be more practical for a cooperative of

producers to apply for FSC certification as a collective. As stated by Dyke and Primrose (2002), "Group certification schemes would appear to be sensible to share the costs". This is certainly an area for further research.

As stated by Mallet & Karmann (2000) "Certification is only one tool among many to move towards more sustainable production systems. It will take further refinement of certification programs to meet local realities, more producers and harvesters willing to test the certification market, and increased demand by consumers for certified products" before the full benefits of NWFP certification are felt.

It appears certain that consumer concerns over environmental issues will remain a crucial factor for the production and marketing of forest foliage. These concerns will increasingly affect demand and will oblige producers to comply with best practice.

3.3.3 Social Significance

Many rural areas are going through a period of transition as more traditional resource based activities are declining. Communities are searching for ways to increase employment as well as their social and economic stability through diversification of their economic base. For many people, NWFPs like forest foliage can offer such an alternative source of income. It therefore makes sense that the role of NWFPs is considered in rural development and forest management practices where the needs of rural communities are taken into account (Titus et al, 2004).

Foliage harvesting procedures are not mechanised and operations tend to be carried out manually using secateurs or other hand held tools. Different groups of people are involved in the industry from large-scale enterprises to casual collectors and farmers supplementing their income. Further employment exists in packaging and processing

activities. In New Brunswick, Canada, the Balsam fir foliage industry creates jobs for 4,500 people including harvesters and wreath makers (Bell, 2003). While large-scale forest foliage enterprises such as this provide significant levels of employment, the majority of work created is seasonal in nature. There is a case that forest foliage production may provide employment in the winter months for people working in the tourism industry (Whelton, 2005).

Atwood (1998) states, "it would be easy to dismiss the botanical industry because of its relatively low economic contribution. However, for those living a modest lifestyle the income generated from secondary forest products is sufficient to support them in their local communities."

As well as having the potential to generate income, NWFPs when incorporated into forest management can often provide the following social benefits:

- Community goodwill leading to support for other forest management practices.
- Additional forest resources (the preference to keep land in forestry).
- Appreciation of forested landscape by harvesters. (Emery & Zasada, 2001)

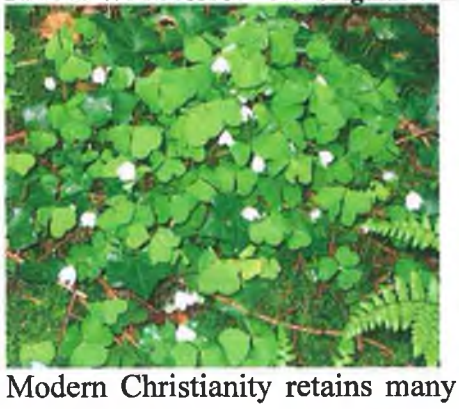
In addition, it is often the case that forest foliage species possess high amenity values and plantations would be suitable for recreation activities.

Harvesting of forest foliage for religious or spiritual reasons has also taken place for centuries. From yew branches hung outside the home of a dead person in ancient Greece, to the use of ivy trails in the wedding celebrations of today, forest foliage has formed the basis of many rituals and customs. During pre-Christian times, both *Quercus* spp. and *Viscum album* were involved in almost all Celtic-Druid ritual ceremonies (Lust, 1990). Wreaths containing forest foliage are still used for different purposes throughout the

world. Door and grave wreaths are used, especially at Christmas time, to symbolize the never-ending cycle of life.

In Ireland there are many examples of forest foliage being used in traditional culture. Each year in parts of Munster, the May bough is cut to celebrate the ancient summer festival of Bealtine. This is a small branch of a newly leafed tree that is usually brought into the house and placed over the door, on window sills or over the fire (Milner, 1992). In early Christian times, forest foliage played a role in spreading the new religion. Examples include the national emblem of Ireland - the shamrock and the St. Bridget's Cross which is made from woven rushes. Some people believe that *Oxalis acetosella* (Wood sorrel) may have been the original shamrock used by St. Patrick.

Plate 1: Wood sorrel – the Original Shamrock?



Modern Christianity retains many customs based around forest foliage. Every year on Palm Sunday (the Sunday before Easter Sunday) palm fronds are used in Christian services worldwide. Where palm cannot be easily obtained other species are used. In Ireland branches from *Cupressus leylandii* are commonly used for this purpose, hence many Irish people incorrectly refer to this species as "palm". Traditionally, the remains of living palm fronds blessed on Palm Sunday are burnt to make the ashes used in church services the following Ash Wednesday. The advent wreath, made from coniferous foliage also plays an important role in pre Christmas Christian church services.

3.4 Management of Forests for Foliage Production

For the most part, forest management practices in developed countries are based on the production of timber. Very little regard is given to foliage or other NWFPs. In America, Chamberlain et al. (2002) interviewed state forest managers to convey their ideas about NWFP management. From the comments received from this research, the following key issues were identified:

- Lack of knowledge about the biology and ecology of the flora from which products originate.
- Diverse nature of the products and of the collectors.
- Lack of market knowledge.
- Insufficient personnel and fiscal resources to assign to NWFP management.

As a result of issues such as those identified above, forest managers tend to have little input into the production of NWFPs like forest foliage. Consequently, harvesting these products has too often been based on exploitation rather than management.

Without appropriate management structures, foliage producers are often individualistic which can make it difficult for new players to enter the market. Harvesting of forest foliage tends to be carried out by external contractors. As a result the forest owner does not always receive the full financial benefits of foliage harvesting. Titus et al. (2004) quote the following example "A good Salal site in the Pacific North West can have a value of ~ $1000/ha/year, but is commonly leased at 5-8% of it's value, or $50 to $80/ha/year." It may seem obvious but the more involved forest owners are in foliage harvesting operations, the more they will be financially rewarded. Forest Produce Limited in Kerry currently pay foliage growers on a per stem basis. Rates differ in relation to grower involvement. Lowest prices are paid for the crop standing. If the owner co-

ordinates harvesting procedures and is involved in processing activities, they then receive a significantly higher price per stem (Costello, 2007).

Co-operation and good relations between all parties in a foliage enterprise can influence the success of the venture. The foundation of grower or producer associations has been found to improve the value of NWFP business activities. In Minnesota, "Forest owners and bough harvesters are coming together at a state level to maximize both timber and non timber values through the Balsam Bough Partnership by developing relevant policies and coordinating opportunities for bough harvesters to work with forest companies for timely access to boughs" (Titus et al., 2004). The establishment of producer associations or co-ops often leads to the development of trademarks, which may be used to strengthen success on the international market. One such example is the "Original Nordmann" - Christmas trees from Denmark (Helles and Thorsen, 2005).

Often conflict can occur between the production of non-wood products and general forest management practices. One example of this is the harvesting of *Rhododendron ponticum* foliage stems from forests in Ireland. With the threat of *Phytophthora ramorum* to native oak stocks, the government has issued a ban on *Rhododendron* foliage harvesting from key locations. Foliage harvesters maintain that if certain procedures are adhered to, foliage harvesting operations will not encourage the spread of the disease (Clancy, 2006). Currently no agreement has been reached between those concerned.

3.4.1 'Bough and Tip' Production

Generally speaking, bough or tip production refers to the harvesting of forest foliage from firs and other coniferous species for the manufacture of Christmas decorations especially wreaths.

In the Pacific Northwest, foliage is harvested from *Abies amabilis, Abies lasiocarpa, Abies procera, Pinus contorta, Pinus monticola, Pseudotsuga menziesii, Juniperus* spp., *Calcocedrus decurrens* and *Thuja plicata* (Thomas and Schumann 1993). *Abies procera* accounts for about 75% of the *Abies* foliage harvested in this region. In eastern North America, *Abies balsamea* and *Pinus strobus* are popular forest foliage species.

With "dense and beautifully coloured foliage, symmetrical branching, and excellent needle retention", Noble fir is recognized as a valuable conifer species for forest foliage production (Douglass, 1975). Consequently, Noble fir foliage has been the subject of several research projects. The majority of this work has been carried out in Denmark, to date the main European producer of Noble fir foliage. Danish Noble fir research cited in Von Hagen et al., (1996) includes investigating the effect of different cutting intensities on bough yields (Bang, 1979) the effect of fertilization and herbicides (Holstener – Jorgensen and Johansen, 1975) and irrigation (Holstener- Jorgensen, 1973) on bough yields. According to Keane & Horgan (2000), there are over 3000 hectares of Noble fir in Ireland and many of these stands have supplied foliage to the European market. The manufacture of Noble fir wreaths in Ireland dates back to the 1960s (Collier et al., 2004). A previous COFORD project examined the effect of thinning, cutting methods and fertilisation on Noble fir foliage (Keane & Horgan, 2000).

Regarding Balsam fir, an extract from the guidelines prepared by the University of Maine Co-operative Extension is presented in Box 6. This note gives practical information for

growers and many of the suggestions could be applied to managing Noble fir for foliage production.

Box 6: Recommendations for the Production of Balsam Fir Foliage.

Source: The University of Maine Cooperative Extension

Growing a Continuous Supply of Balsam Fir Wreath Brush

Fact Sheet #4, University of Maine Cooperative Extension Bulletin #7089.

"Spacing the crop trees will insure adequate sunlight to all branches and produce thicker, rounded tips. The balsam fir should be thinned to a spacing of eight to 10 feet apart (approximately 500 trees/acre). This spacing gives room for the trees to branch out and receive full sunlight on all sides. The spacing also makes it easier for tip pickers to gather the tips. When thinning, eliminate the poorer or weaker trees, such as trees that are off-colour or severely damaged by insects or disease. If this thinning is done during the wreath-making season, tips from the cut trees can be used. To keep the tree short, you should prune all tops that start to turn up every other year. This will cause the tree to brush out, and concentrate its growth into branches and tips rather than height.

One strategy is to harvest tips from 1/3 of the managed trees each year. This will provide for a three-year cycle of harvesting that will allow the trees to recover from harvesting before the next crop is picked from the tree."

3.4.2 The Effect of Foliage Harvesting on the Growth of Forest Species

There has been limited research carried out to assess the effects of removing foliage from forest species. The following is a summary of available research.

- In relation to sustainable foliage production, research carried out in western Washington indicates that bough harvesting in Noble fir plantations can be successfully carried out in a commercial timber forest. Bough harvests can begin

when the plantation is eight years old and can be sustained for up to 25 years. The same paper reports a study in Denmark where a 21-year-old stand of Noble fir harvested for 13 years for boughs, gave annual yields of 1.8kg per tree. (Murray & Crawford 1982).

- Also in the U.S.A., a cooperative study known as "The Kilburn Wreath Study" examined the effect of harvesting Balsam fir "tips" for wreath production. A series of experiments were carried out in an ex Christmas tree plantation. While the intensity and frequency of tipping did not seriously affect height and diameter growth of the trees, the amount of tips available from one year to the next was affected. At medium and high frequencies of harvest the amount of "tips" available declined substantially following the third and second years of the study respectively (Bell, 2003).
- As of yet, there has been no research conducted to examine the effect of harvesting foliage from Monterey cypress Goldcrest, Japanese larch or Western hemlock. The closest comparison is in pruning research. One experiment carried out in British Columbia examined the effect of pruning on stands of coastal Western hemlock. Significant growth reductions appeared below a threshold of about 50% retained crown ratio for both height and diameter measurements (De Montigny, 2001). As foliage harvesting is not as severe an operation as pruning, it could be tentatively suggested that removal of graded foliage stems should have no affect on growth of Western hemlock.

3.4.3 Co- management of Forests

Much work had been done in the USA and Canada on the concept of managing forests for both timber and NWFP values. Titus et al. (2004) use the term compatible management to describe management regimes that consider these different values. This group of researchers propose that compatible management opportunities exist along a continuum from inactive compatibility (taking advantage of existing forest management tools to increase NWFP values) to active compatibility (applying specific forest management practices to benefit both timber and NWFP production). In addition there are coincident scenarios where management of forest for one value happens to benefit the other, even though this was not an initial objective. Using this model, Table 3 outlines how management practices used in forest foliage and timber production can interact.

Table 3: Co-management of Forests

Inactive Management	**Co-incident Management**		**Active Management**
Existing management tools which benefit foliage production	**Timber management happens to benefit foliage production**	**Foliage management happens to benefit timber production**	**Management for both foliage and timber production**
Roads Maps - species - topographical Aerial photographs Gates & fencing	Species selection Inspection paths Thinning Vegetation control Fertilisation Pest control	Brashing Pruning Pre commercial thinning Harvesting of invasive species	Selective pruning Vegetation control Fertilisation Additional Roads Timing of timber harvest

Case studies for each compatible management scenario are presented in Tables 4-7.

Table 4: Inactive Management

Inactive Management – Case Study	
Management Tool	Aerial photographs
Forest foliage product	Lodgepole pine
Description	Harvesting of Lodgepole pine foliage for European markets took place in parts of Sligo and Mayo by local company West Coast Forestry. Managing Director Fergus McCaffery used aerial photographs to identify gaps in overgrown plantations. This provides: 1. access for foliage harvesters 2. better quality foliage due to light exposure. McCaffery, F. (2007) pers. comm.

Table 5: Co-incident Management – Timber Benefits Foliage

Co-incident Management– Case Study 1. Timber management happens to benefit foliage production	
Management Practice	Vegetation Control
Forest Foliage Product	*Vaccinium* spp. Huckleberry
Description	In coastal British Columbia, huckleberry plants are sometimes mechanically cut when they overtop conifers and hinder growth in young plantations. Some Huckleberry species can be harvested for the floral industry. When the objective of cutting the species is vegetation management, silvicultural workers can collect and sell suitable stems (Titus et al., 2004).

Table 6: Co-incident Management – Foliage Benefits Timber

Co-incident Management– Case Study 2. Foliage management happens to benefit timber production	
Management Practice	Pruning
Forest Foliage Product	Salal (*Gaultheria shallon*)
Description	"In the Pacific North West, Salal pickers will sometimes prune trees for free, if they have a long term lease on secure land and can therefore benefit from the practice. As commercial quality Salal is found in the semi-shade it is often best closer to tree trunks in young plantations, and hence can be intertwined in low branches. Pruning is carried out in one forest on Vancouver Island, British Columbia, to increase the accessibility to this Salal, to improve light conditions for Salal growth, and to reduce the potential danger to pickers of facial and eye injuries from tree branches." (Titus et al., 2004)

Table 7: Active Management

Active Management – Case Study	
Management Practice	Delayed Clearfell
Forest Foliage Product	Balsam fir foliage.
Description	Mickman Brothers, one of the largest wreath makers in the U.S.A. works in cooperation with the Blandin Paper Company and Hibbing Taconite Company. Leasing rights allow licensed harvesters to prune branches from *Abies balsamea* due for felling (Mickman, 2002).

As the above examples show, there are numerous ways foliage production can be incorporated into commercial forest management.

3.5 Critical Issues for the Forest Foliage Industry

- Industry Awareness

According to Adepoju & Salau (2007), the NWFP sector has traditionally been neglected by governments and the general forestry community. The capacity to promote sustainable use of NWFPs including forest foliage is consequently low. In Ireland, awareness of the forest foliage industry remains low amongst forest managers and landowners. For the sector to grow, further promotion will be necessary.

- Quality Control

A wastage level of 5% is generally the maximum permissible and any produce deemed unsuitable after this will result in a claim (Pettenella et al., 2006). Claims can have a profound effect on enterprise profitability so to avoid this, producers need to operate on a cut to order basis and should not carry stock for long periods of time. The imposition of strict quality controls on the forest floor and in the warehouse would also ensure that only foliage of the highest quality is shipped.

- Human resources and social capital

The availability of qualified staff may be problematic in rural areas where specific skills are needed to develop a successful forest foliage enterprise. Recruiting such qualified people in marginal areas can often prove difficult. Personnel may need to be trained, or expert consultants from outside the area may be required to help stabilize the business (Pettenella et al, 2007). In addition, work involved in foliage harvesting operations is physically demanding and may not suit every person.

- External Risks

While certain threats may be controlled or influenced by competent planning, other factors can potentially devastate forest foliage production. Poor weather can seriously affect the production of NWFPs such as foliage (Pettenella et al, 2007). This is especially relevant during the Christmas period when bad weather can affect workers productivity and transportation of foliage. Adverse conditions can lead to the cancellation of ferry services, which delays foliage deliveries to European customers. In addition, outbreaks of disease can have a detrimental effect on forest foliage enterprises as is currently the case with *Rhododendron ponticum* and its association with the disease *Phytophtora ramorum*. Research can often provide solutions for disease or pest outbreaks. A few years ago, *Eucalyptus* plantations grown for foliage production were threatened with destruction from a psyllid (*Ctenarytaina eucalypti*) infestation. After a timely and comprehensive research project, the pest was controlled with an introduced biological control (Purvis et al., 1998).

- Critical Mass

Many of the large supermarket packers demand good quality foliage in large volumes. Market research conducted by Kelly and Whelton in 2003 found that Marks and Spencer,

the English supermarket, need as many as 10,000 stems of foliage per week over a period of 8 weeks. Also, Tesco demand for *Rhododendron* foliage at Christmas alone is 700,000 stems (Kelly & Whelton, 2004). Feedback from buyers indicates that retailers do not want to constantly change suppliers (Pearson, 2007). To retain business it is therefore important that producers have access to large areas of suitable forest species.

- Logistics

As Ireland is an island on the periphery of Europe, logistics can greatly affect the viability of a NWFP export enterprise, particularly where fresh produce is involved. With higher transport costs and delivery taking more time, producers have to ensure foliage is harvested and packed in an economical way. Rapid delivery channels and appropriate storage facilities such as refrigeration can play an important role in ensuring perishable products are received by the customer in good condition (Pettenella et al, 2007).

3.6 Previous Foliage Research

While the production of foliage is still an emerging industry, Ireland has been proactive in conducting applied research with a strong commercial focus. To oversee the orderly development of the sector, a co-coordinating group, Foliage Ireland was established. This group is comprised of the main development agencies, including COFORD, Teagasc and Enterprise Ireland, as well as company representatives and other industry experts.

The following projects have been carried out by the Foliage Ireland group over the last number of years.

- Eucalyptus for cut foliage – Teagasc End of Project Report 1999 No. 4078
- The Cut Foliage Industry – Teagasc End of Project Report June 2003 Service No 13

- Control of Eucalyptus Psyllid (*Ctenarytaina eucalypti*) with introduced parasite (*Psyllaephagus pilosus*) 1999-2002
- Improving the quality of transplants for supply to the cut foliage industry 1998-2001
- Pruning & Nutrition of cut foliage crops 1998 - 2001
- An investigation of weed problems in the emerging foliage industry 1998-2004
- Extraction and characterization of eucalyptus oil from waste Eucalyptus cut foliage 1998-2001
- The effect of foliage harvesting on *Pinus* and *Ilex* 1999-2001
- Evaluation of a range of 'new species' for suitability for the cut foliage industry 2000-2004
- Pruning studies of Rhododendron 1999-2001
- Pruning and density study on *Ozothamnus rosmarinafolia* 'Silver Jubilee' 2001-2002
- Pruning studies on *Viburnum tinus* 'Purpureum' 2002/03
- Shelf Life trials on range of cut foliage species – Ongoing

In addition to the above[3], COFORD funded a report on foliage production from Noble fir stands (Keane & Horgan, 2000).

[3] For further information on any of these project, contact Andy Whelton, Cut Foliage Officer, Teagasc, Email: Andy.Whelton@teagasc.ie

3.7 Justification of Current Research

The following reasons indicate the necessity of this research.

- Recent market research suggests that there are opportunities for the development of foliage as a sub sector of forestry. A recommendation for technical research has already been proposed to develop the industry (Collier et al., 2004).
- Currently there is no research available on the possibility of using forestry species for the production of both high quality timber and foliage. The notion that trees otherwise removed in thinning operations might instead be used for foliage production requires investigation.
- The climate in southern Ireland is milder than other countries involved in forest foliage production. Much of the existing research comes from Canada and the U.S.A. where factors such as species, soil type and duration of growing season are substantially different to those in Ireland. Hence management protocols designed specifically for Irish conditions are required.
- Unlike other countries, where foliage is sold on a weight basis, the current market for Irish forest foliage is for graded stems of a specific length and quality. Consequently any unsuitable foliage such as short or poor quality stems is not harvested. The effect of such selective foliage harvesting on growth and recovery needs to be assessed.
- As many forest foliage species are still unknown in the trade, there is a need for shelf life testing of all new products. This is especially true of Japanese larch, which has a very delicate appearance, and buyers may question the longevity of cut stems.

- Due to the fashion orientated nature of the business, there is a constant need for market research to receive feedback (Kelly & Whelton, 2004). Currently there is no recent information available on the potential of forest foliage in the domestic market. A marketing survey to determine the attitudes of Irish florists towards forest foliage products is therefore required.

4.0 METHODOLOGY

After consultation with members of the project team, work on existing forest foliage species was divided into three separate areas:

- 4.1 Management of Japanese Larch, Western Hemlock, and Monterey Cypress (Goldcrest) for Timber and Foliage Production.
- 4.2 Management of Overgrown Noble Fir Christmas Tree Plantations for Foliage Production.
- 4.3 Evaluation of Forest Foliage Species.

A general overview of each of the species examined is presented in Appendix 2.

4.1 Management of Japanese Larch, Western Hemlock, and Monterey Cypress (Goldcrest) for Timber and Foliage Production.

4.1.1 Site Descriptions

For each species, trials were set up in established plantations of various age and site type. Site descriptions are provided in Tables 8-10. Location maps are found in Appendix 3.

Plate 2: Japanese Larch / Monterey Cypress Goldcrest Plantation.

Table 8: Site Description – Japanese Larch.

LARCH – *Larix leptolepis*	
Owner	Mr. Robert O Connell
Location	Foulksmills, Co. Wexford
Map Reference	OS Ireland East 286 119
Soil type	Acid brown earth
Exposure	Low
Crop Age	4 years
Health Status	Very vigorous growth. Trees are fully furnished and have healthy green foliage.
Trial Established	May 2005

Table 9: Site Description – Monterey Cypress Goldcrest.

Monterey cypress (Goldcrest) – *Cupressus macrocarpa* 'Goldcrest'	
Owner	Mr. Robert O Connell
Location	Foulksmills, Co. Wexford
Map Reference	OS Ireland East 286 119
Soil type	Acid brown earth
Exposure	Low
Crop Age	4 years
Health Status	Located in same site as Larch trial, however to date does not seem to have shown the same vigour. The owner maintains that this may be due to the use of poor planting material.
Trial Established	May 2005

Table 10: Site Description – Western Hemlock.

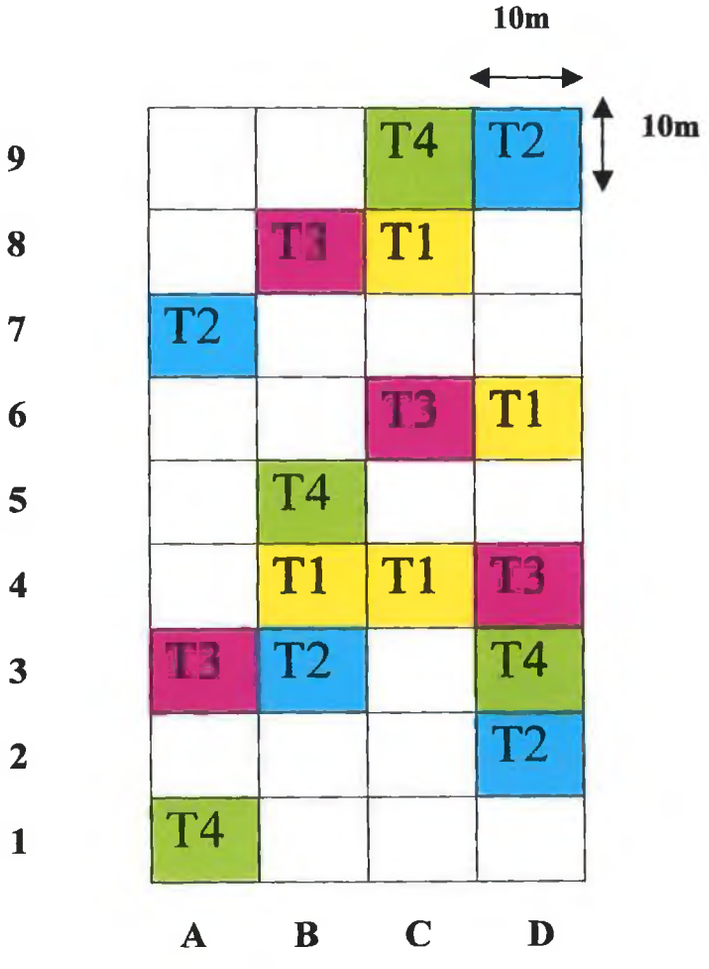
Western Hemlock – *Tsuga heterophylla*	
Owner	Coillte teo.
Location	Clogheen, Co. Tipperary
Map Reference	OS Ireland South 198 112
Soil type	Shallow peat over old red sandstone
Exposure	Moderate
Crop Age	6 years
Health Status	Poor site. Associated vegetation includes large areas of *Rhododendron ponticum* and *Calluna vulgaris*. Bark stripping by deer evident throughout the plantation.
Trial Established	January 2006

4.1.2 Experimental Design

For the three species being examined, trees were initially planted in straight lines at a spacing of 2m X 2m. A total of 36 plots of 100m² were fenced off within the experimental area for Japanese larch and Monterey cypress Goldcrest while the experimental area for Western hemlock contained 27 100m² plots. For each of these species the crop was deemed uniform enough to utilize a randomized block design. Sample blocks were randomly selected and three treatments along with a control were imposed and replicated at least 3 times.

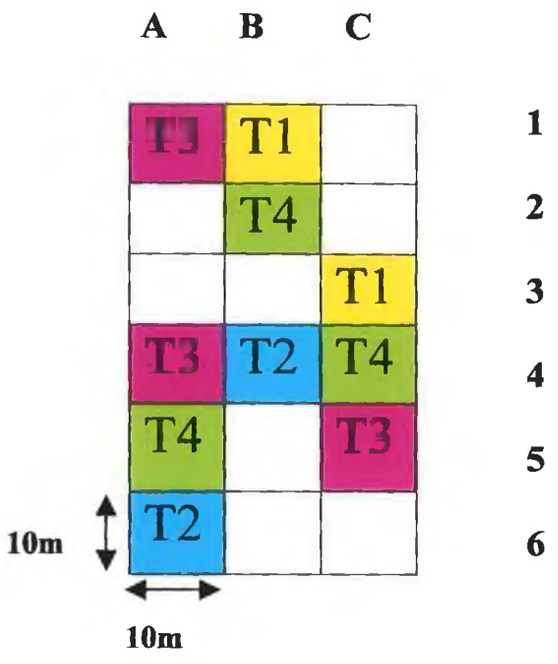
Figures 2-4 display the layout of each trial. Treatment descriptions relevant to each species are given in Tables 11-13

Figure 2: Layout of Japanese Larch Trials.



GATE

Figure 3: Layout of Monterey Cypress Goldcrest Trials.



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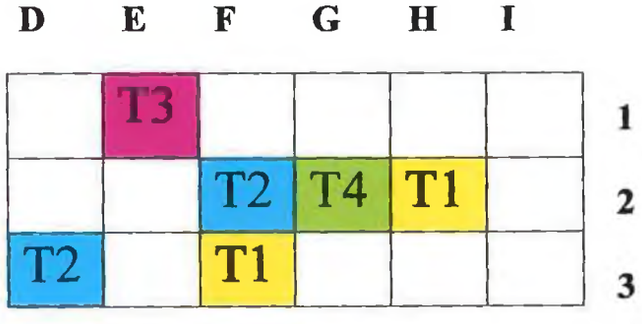


Figure 4: Layout of Western Hemlock Trials.

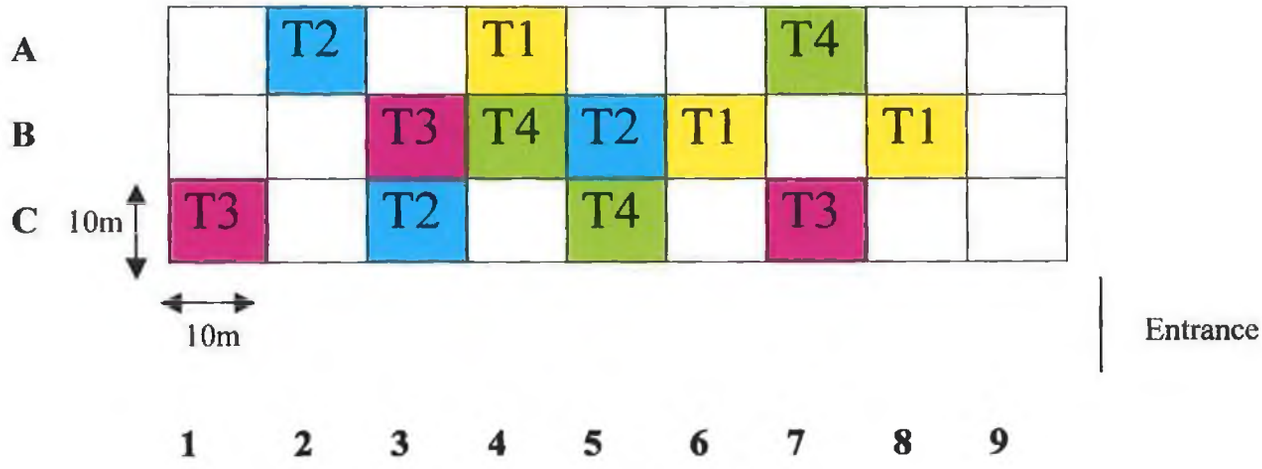


Table 11: Treatments Investigated in Japanese Larch Trials.

Treatment	Description
T1	Control
T2	Remove commercial standard foliage stems* from all sample trees. For this treatment, the foliage and timber crop are not treated separately.
T3	Remove commercial standard foliage stems* from all sample trees. In addition to removing foliage, prune trees selected for the final timber crop**. Reduce the height of foliage crop trees by cutting trunk at 2.3m*** above ground level.
T4	Remove commercial standard foliage stems* from all trees. In addition to removing foliage, prune trees selected as the final timber crop**.At a height of 1.8m***, scar foliage crop trees by removing approximately 70% of the bark around the trunk.

Table 12: Treatments Investigated in Monterey Cypress Goldcrest Trials.

Treatment	Description
T1	Control
T2	Remove commercial standard foliage stems* from all sample trees in plot. For this treatment, the foliage and timber crop are not treated separately.
T3	Remove commercial standard foliage stems* from all sample trees. In addition to removing foliage, prune trees selected for the final timber crop**. Reduce the height of foliage crop trees by cutting trunk at 2m*** above ground level.
T4	Remove commercial standard foliage stems* from all trees. In addition to removing foliage, prune trees selected as the final timber crop**.At a height of 1.5m***, scar foliage crop trees by removing approximately 70% of the bark around the trunk.

*** Commercial standard foliage stems – see section 4.1.4**
**** Final timber crop trees – see section 4.1.3**
***** This height was determined by the age, height and condition of each species growing in these conditions.**

Table 13: Treatments Investigated in Western Hemlock Trials.

Treatment	Description
T1	Control
T2	Remove commercial standard foliage stems* from all sample trees in plot. For this treatment, the foliage and timber crop are not treated separately.
T3	Remove commercial standard foliage stems* from all sample trees. In addition to removing foliage, prune trees selected for the final timber crop**. Reduce the height of foliage crop trees by cutting trunk at 2.3m*** above ground level.
T4	Remove commercial standard foliage stems* from all trees. In addition to removing foliage, prune trees selected as the final timber crop**. Basal prune foliage trees by using a chainsaw to scar the bottom of each trunk.

*** Commercial standard foliage stems – see section 4.1.4**
**** Final timber crop trees – see section 4.1.3**

4.1.3 Selection of Timber Trees

For treatment T2, the crop is treated as both a foliage and timber crop. In this case foliage harvesting should continue until light becomes an issue. The site will then require thinning to produce the timber crop. For treatments where the foliage and timber crop are treated differently (T3 & T4), instead of carrying out thinning operations as in conventional forest management, trees that would normally be removed will remain in the forest and be treated as the foliage crop. For these treatments it is suggested that foliage may be harvested for several years until the timber crop eventually smothers those trees dedicated solely for foliage production. It was decided by the project team, every second line was to be dedicated to foliage production instead of being removed. From the

remaining line, every second tree was marked and clearly identified as being the final timber crop. Thus, the final crop spacing was approximately 4m x 4m (See Figure 5). In the Western hemlock trials, a large proportion of trees had multiple leaders, possibly due to grazing by deer. These were reduced to one main stem for trees selected for timber production

INDIVIDUAL PLOT

X = Foliage Tree
O = Timber Tree

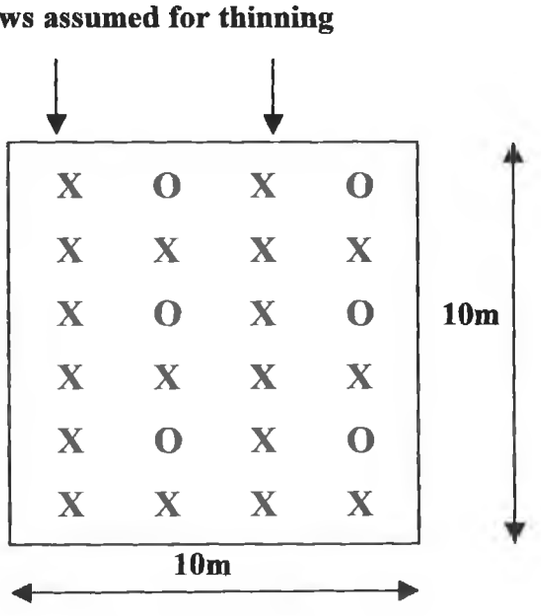


Figure 5: Individual Plot Layout

4.1.4 Selection of Commercial Standard Foliage Stems

As the market will only pay premium prices for high quality foliage stems, only stems, which meet commercial standard, are selected. To achieve commercial standard, foliage stems must fulfil specific criteria as outlined in Tables 14-16. Examples of both commercial standard foliage stems and unsuitable stems are presented in Plates 3-10.

Table 14: Commercial Standard for Japanese Larch Foliage

Species	Criteria for Commercial Standard
Japanese Larch	**1. Stem Length of 55cm.** **2. Spray type stems only, minimum of 3 breaks - no single stems.** **3. No bent stems.** **4. Lead shoot not to exceed 25cm in length.** **5. Must be blemish free with no damaged or decaying foliage.** **6. Clean handle of 15cm.** **7. Must possess adequate bulk or volume.**

Plate 3: Commercial Standard

Plate 4: Rejected Foliage Stem (Too light)

Plate 5: Rejected Foliage Stem (Too light and bent)

Table 15: Commercial Standard for Monterey Cypress Goldcrest Foliage

Species	Criteria for Commercial Standard
Monterey cypress Goldcrest	1. Stem Length of 50cm. 2. Must possess adequate bulk or volume – no light stems 3. No bent stems 4. "Spindly" tips to be pinched off. 5. Must be blemish free with no damaged or decaying foliage. 6. Clean handle of 15cm.

Plate 6: Commercial Standard

Plate 7: Rejected Foliage Stem (bent stem)

Table 16: Commercial Standard for Western Hemlock Foliage

Species	Criteria for Commercial Standard
Western hemlock	1. Stem Length of 55cm. 2. Bushy, spray type stems only, minimum of 3 breaks - no single stems. 3. No bent stems. 4. Lead shoot not to exceed 20cm in length. 5. Must be blemish free with no damaged or decaying foliage. 6. Clean handle of 15cm.

Plate 8: Commercial Standard

Plate 9: Rejected Foliage Stem (single stem)

Plate 10: Rejected Foliage Stem (no handle)

4.1.5 Harvesting Procedure

Guidelines from the industry recommend not to harvest foliage from the top two whorls (Keane & Horgan, 2000). This was taken into account when removing foliage.

Equipment

The following equipment was used to carry out foliage harvesting:

- Secateurs
- Measuring tape
- Bamboo or other straight stick
- Elastic bands

Procedure

1. Bamboo/stick was cut to specified length (different for each species).
2. Good quality foliage stems were selected on the tree and cut to length using the bamboo as a guide.
3. A handle of 10-15cm was created by removing shoots at the bottom of the stem.
4. Ten foliage stems were gathered together with each stem being turned inwards to create a neat bunch.
5. An elastic band was placed around one stem and pulled up to where the handle ends.
6. The elastic band was wrapped around the bunch tightly and looped back on one stem.
7. Finally five bunches of 10 stems were tied together.

4.1.6 Parameters Measured

Data recorded from the trial sites included both growth parameters, in the form of height and diameter increments, and production parameters in the form of foliage stem yields. Height measurements were taken for each sample tree at the start and end of each growing season with height growth recorded as the difference between the two measurements. Diameter growth was also assessed for each sample tree as the difference between start and end of season measurements. For treatments where the foliage crop was separated from the final timber crop, measurements for both were recorded separately (T3 &T4). Due to the project being granted an extension in May 2007, an additional data set (after two complete growing seasons) was collected from the Japanese larch, Monterey cypress Goldcrest and Western hemlock trial sites. Field measurements were entered into MS Excel and statistically analyzed to compare the effects of treatments applied against each other and against controls.

To assess potential foliage yields and regrowth capability, all available commercial foliage stems were harvested and recorded for each 100m² plot. It was decided to record foliage yields on a per area basis as the availability of suitable foliage stems varied greatly between individual trees. This may have been due to variations in tree size, vigour, and branching habit. For treatments where the foliage and timber crops were separated the total number of commercial standard foliage stems harvested was recorded. This includes foliage harvested from both foliage and timber trees including any harvested during pruning operations.

As well as the above, an observational assessment of the amount of commercial foliage stems per individual tree was carried out. A number of trees outside the main experimental area were felled and the proportion of suitable foliage stems to waste material was estimated. This was done by first weighing the total amount of foliage material removed and then weighing the amount of commercial standard foliage stems.

4.2 Management of Overgrown Noble Fir Christmas Tree Plantations for Foliage Production.

4.2.1 Site Description

Trials were established in an overgrown Christmas tree plantation in Co. Kerry. A brief site description is provided in Table 17.

Table 17: Site Description – Noble Fir

Noble fir – *Abies procera*	
Owner	Mr. Jim Costello
Location	Brosna, Co. Kerry
Map Reference	Discovery Series 72, 113 116
Soil type	Mineralized peat over gley
Exposure	Low to Moderate
Crop Age	10 years
Health Status	Originally a Christmas tree plantation, although stocking levels at the commencement of trial work indicated that not many trees were removed. The crop was deemed relatively uniform as those trees already removed were evenly dispersed throughout the site and there were no gaps or open spaces. Majority of trees had grown into each other with many branches suffering from lack of light. In particular, lower branches had shed most of their needles. Overall though, trees appeared to have vigorous growth rates and foliage exposed to adequate light appeared to be good quality, blue/green colour. No evidence of needle necrosis or disease was noted.
Trial Established	March 2006

4.2.2 Experimental Design

As Noble fir is not regarded as a timber producing species in Ireland, trials were established to examine the potential of this species solely in terms of foliage production. It was decided by the project team to implement a pre-treatment where the experimental area was respaced to approximately 25% of initial stocking. This was achieved by removing every second line and selectively respacing the remaining line. The experimental area was then fenced off and subdivided to create 30 100m² plots. Three different harvesting treatments were explored. Treatment descriptions are provided in Table 18.

Table 18: Harvesting Treatments Investigated in Noble Fir Trials.

Treatment	Description
Harvest A	Each tree is harvested for foliage as follows; Branches below 2m, material may only be removed if a distance of 60cm from lateral tip to trunk (bearing capacity) is maintained after harvesting. Branches above 2m, material may only be removed if after harvesting the stem retains a bearing capacity of at least 30cm. Remaining stem must also have a least 2 lateral shoots. Once these criteria are satisfied all commercial standard foliage material* is harvested and the yield recorded per plot.
Harvest B	As Harvest A except deferred by one year.
Harvest O	Unmanaged scenario. All commercial standard foliage material is removed with no regard for future growth and development of the crop.
Control	Crop is untouched.

***Commercial standard foliage material – see section 4.2.3**

Two separate experiments were carried out to address the following key areas:

- Foliage yields and potential regrowth rates.
- Height control.

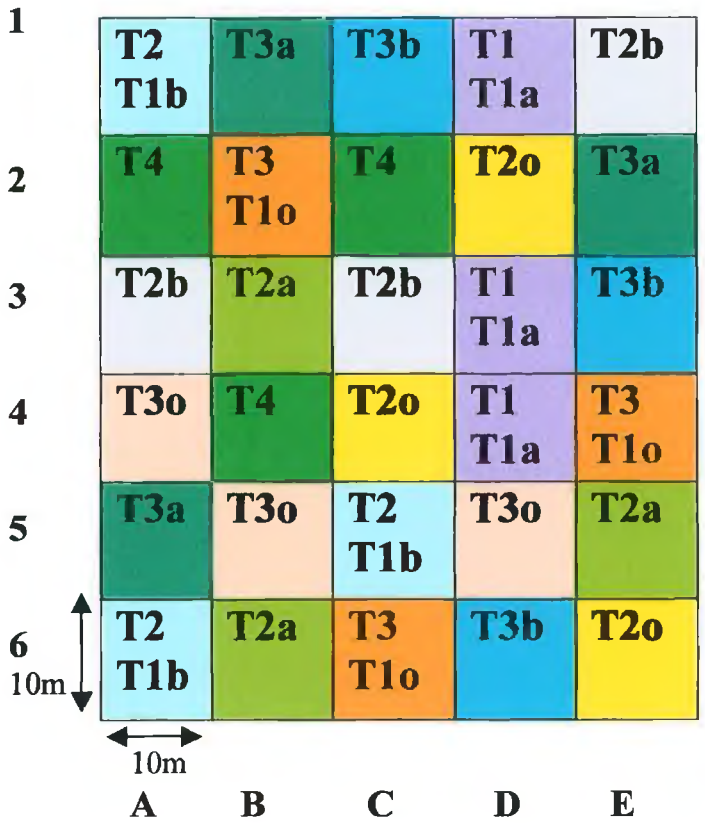
As there was a level of overlap between the two experiments, a number of the plots were used for both. Table 19 provides an overview of the experimental design. The trial layout is presented in Figure 6.

Table 19: Noble Fir Experimental Design

Experiment	Treatments	Treatment Descriptions*	# Replications
Yield Assessment	T1	Harvest A	3
	T2	Harvest B	3
	T3	Harvest O	3
	T4	Control	3
Height Control	T1a	Harvest A with no height control (Control)	3
	T2a	Harvest A base of tree scarred using chainsaw	3
	T3a	Harvest A leader scarred using penknife	3
	T1b	Harvest B with no height control (Control)	3
	T2b	Harvest B base of tree scarred using chainsaw	3
	T3b	Harvest B leader scarred using penknife	3
	T1o	Harvest O with no height control	3
	T2o	Harvest O base of tree scarred using chainsaw	3
	T3o	Harvest O leader scarred using penknife	3

***See table 18 for more details**

Figure 6: Layout of Noble Fir Trial.



ENTRANCE

4.2.3 Selection of Commercial Standard Foliage Material

Current market requirements indicate a demand for graded stems (used in bouquet design) and short pieces (used in wreath manufacture).

Exact specifications for both foliage products are outlined in Table 20. Plates 12-19 display examples of commercial standard Noble fir foliage stems. Plates 20-27 contain examples of rejected foliage stems.

Table 20: Commercial Standard for Noble Fir Foliage.

Foliage Product	Criteria for Commercial Standard
Graded Stems	**1. 55cm in length.** **2. Triangular shape, central shoot with 2 "wings".** **3. Handle of 15cm.** **4. Blue green colour, no yellow or discoloured foliage.** **5. Firm upright needles, no flat, floppy material.** **6. Leader not to exceed 20cm.** **7. Yield recorded as number of stems.**
Short Pieces	**1. Length not to exceed 40cm** **2. Uncleaned (no handle) pieces** **3. Blue-green in colour** **4. Firm, upright needles, no flat floppy material** **5. Yield recorded by volume (bag).**

Plate 11: Comparison between Good and Poor Quality Noble Fir Needles

Plate 12: Acceptable Noble Fir Stem

Good blue colour, triangular shape, good quality, upright needles. Cleaned handle 15cm.

Plate 13: Acceptable Noble Fir Stem

Although more green in colour. This stem has good form and blemish free upright needles.

Plate 16: Acceptable Noble Fir Stem

Excellent colour.

Plate 17: Acceptable Noble Fir Stem

Again green colour, also slightly misshapen but overall volume and needle quality is good.

Plate 14: Acceptable Noble Fir Stem

Good blue stem, plenty volume.

Plate 15: Acceptable Noble Fir Stem

Ideal. Good colour and shape with well cleaned handle.

Plate 18: Acceptable Noble Fir Stem

Slight flaw in lead shoot but overall quality is good.

Plate 19: Acceptable Noble Fir Stem

Borderline. Perhaps handle was cleaned too high up. However, good quality needles & stem form.

Plate 20: Reject Noble Fir Stem

No "wings". Known as slender. Occasionally, a market exists for stems like this.

Plate 21: Reject Noble Fir Stem

Break is too far down on stem. No room for handle.

Plate 24: Reject Noble Fir Stem

Too short.

Plate 25: Reject Noble Fir Stem

Poor quality needles, form, and colour.

Plate 22: Reject Noble Fir Stem

Misshapen stem with poor quality, flat needles. Often occurs when branch does not receive enough light.

Plate 23: Reject Noble Fir Stem

Misshapen stem, no obvious leader.

Plate 26: Reject Noble Fir Stem

Dirty foliage.

Plate 27: Reject Noble Fir Stem

Bent and misshapen stem.

4.2.4 Harvesting Procedure

Equipment

The following equipment was used to carry out foliage harvesting:

- Secateurs
- Extendable loppers
- Measuring tape
- Bamboo or other straight stick
- Elastic bands

Procedure

1. Bamboo/stick was cut to length of 55cm using secateurs.
2. All branches within reach were harvested first.
3. Good quality foliage stems were selected on the tree and then cut to length using the bamboo as a guide (see Plate 28).

Plate 28: Cutting Noble Fir Stem to Length

4. A handle of 10-15cm was created by removing shoots at the bottom of the stem (see Plate 29)

Plate 29: Making a Handle on Noble Fir Stem

Plate 30: Harvesting High Noble Fir

5. A bunch of 10 foliage stems were gathered together and an elastic band was wrapped around the handle to hold the bunch together.
6. Two bunches were then banded together to make a bunch of 20 stems.
7. Using extendable loppers foliage growing higher up on the trees was roughly cut (see Plate 30).
8. Stems were then graded to 55cm using the bamboo and steps 4-6 were then repeated.

4.2.5 Parameters Measured

Height Control Experiment

To assess the treatments carried out in this experiment; leader growth achieved for each sample tree was measured and recorded both one year and two years after the trial was established.

Field measurements were then entered into MS Excel and statistically analyzed to compare the effects of treatments applied against each other and against controls.

An observational test was also carried out on a number of trees outside the experiment area to assess the effect of cutting back the height to 1.8m.

Yield Assessment Experiment

As for the species examined in Section 4.1, all available commercial foliage was harvested and recorded for each 100m² plot. For this experiment, two different foliage products were assessed:

- Number of 55cm foliage stems.
- Number of bags of short pieces (see Table 20 for product descriptions).

As well as the above, an observational assessment of the amount of commercial foliage stems per individual tree was carried out. A number of trees outside the main experimental area were felled and the proportion of suitable foliage stems to waste material was estimated. This was done by first weighing the total amount of foliage material removed and then weighing the amount of commercial standard foliage stems (see Plate 31).

Plate 31: Weighing Noble Fir

- Labels – indicating start date and treatment imposed
- Secateurs (cleaned with alcohol or methylated spirits)

After harvesting, stems were placed in water in cool conditions (8°C) for 24 hours and then into two different environments: processing shed and 'kitchen/living room' conditions. Tap water was used to top up vases when necessary.

Treatments

1. Dry storage - processing shed
2. Low level water - processing shed
3. High level water - processing shed
4. Low level treated water (CHRYSAL) - processing shed
5. High level treated water (CHRYSAL) - processing shed
6. Low water level, stems recut every 3-4 days – processing shed
7. Dry storage - 'kitchen/living room' conditions
8. Low level water - 'kitchen/living room' conditions
9. High level water - 'kitchen/living room' conditions
10. Low level treated water (CHRYSAL) - 'kitchen/living room' conditions
11. High level treated water (CHRYSAL) - 'kitchen/living room' conditions
12. Low water level, stems recut every 3-4 days - 'kitchen/living room' conditions

Plate 32: Japanese Larch Shelf Life Trial

4.3.2 Market Research

Market research has already been identified as a key factor in the development of the foliage industry (Collier et al., 2004). As there is little information available on the market for forest foliage in the domestic florist trade, a marketing survey into this sector was proposed. After discussions with members of the project team, the following areas were identified for investigation:

- Awareness of forest foliage
- Importance of grading
- Current foliage usage
- Attitudes to forest certification
- Interest in value added products e.g.: wreaths, painted forest foliage
- Interest in training/workshops focused on forest foliage

A questionnaire was drafted and dispatched to 100 Irish florists by post. Along with photographs of the various forest foliage species, a stamped addressed envelope was included for replies. The full questionnaire along with the covering letter is presented in Appendix 4. Results of the survey are found in section 5.6.

4.3.3 Extension

To promote awareness of the project and of the forest foliage industry a range of extension activities were carried out during the allocated timeframe.

- Press articles were published in 'Today's Farm', and 'The Farmer's Journal'. A pull out supplement published in 'The Examiner' newspaper, March 2006 highlighted the foliage industry and detailed work being carried out under the project.
- Several on site meetings were held with members of the project team and other interested individuals.
- Numerous telephone and email enquiries were answered.
- At the invitation of Dr. Aine Ni Dhubhain U.C.D, the primary researchers involved in this project were participants in COST Action E30 ' Economic Integration of Urban Consumers' Demand and Rural Forestry Production'. In addition the keynote address at the final meeting in January 2006 in Viterbo, Italy was on the subject of forest foliage production.
- In association with COFORD staff, a two-day seminar and field visit program was organized in October 2007. This involved arranging venue and conference facilities, securing industry leading international speakers & floral designers, procuring live samples of forest foliage products and organizing field visit to trial sites.
- An information note for forest owners/managers has been published in the COFORD Connects series.

5.0 RESULTS and ANALYSIS

This section presents results and analysis of data from work described in the methodology section. The order of presentation of these results is as follows

- 5.1 Results of Japanese Larch Trials.
- 5.2 Results of Monterey Cypress Goldcrest Trials.
- 5.3 Results of Western Hemlock Trials.
- 5.4 Results of Noble Fir Trials
- 5.5 Shelf Life Testing Results
- 5.6 Questionnaire Results

The presentation of findings for each of the above is immediately followed by a discussion of the results. Conclusions are then drawn for each section, which incorporates individual recommendations. A general discussion on the project's findings is carried out in Section 6.

5.1 Results of Japanese Larch Trials.

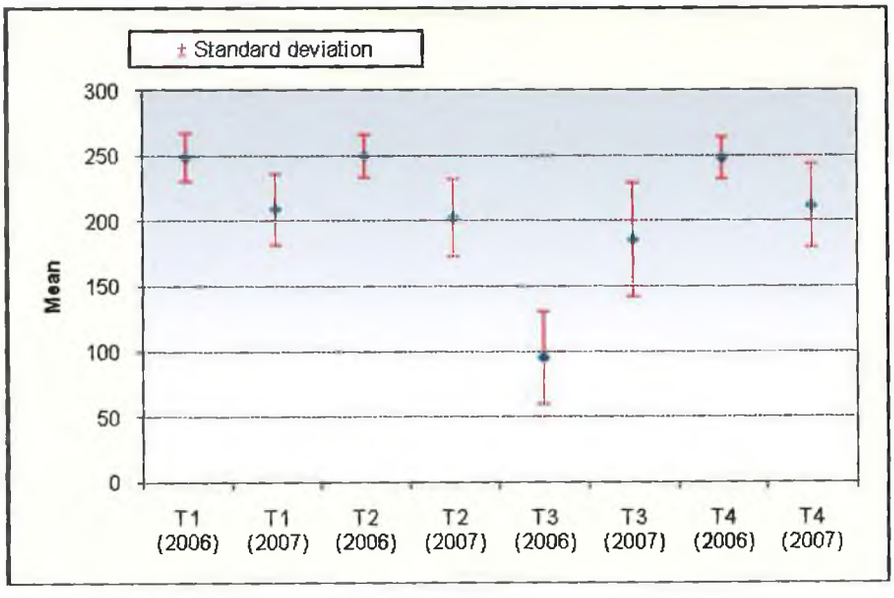
5.1.1 Effect of Foliage Harvesting on Growth Parameters for Japanese Larch

Mean height growths achieved during the 2006 and 2007 growing seasons for each treatment imposed on Japanese larch foliage trees are displayed in Table 21 and Figure 7.

Table 21: Height Growth of Japanese Larch Foliage Trees

Treat.	# Sample Trees	Mean Height Growth (cm) 2006	Mean Height Growth (cm) 2007
T1	108	248.27	208.80
T2	110	249.27	202.04
T3	78	94.75	185.32
T4	96	247.76	211.17

Figure 7: Mean Height Growth Japanese Larch Foliage Trees



Analysis of Height Growth Data – Foliage Trees

As treatment T3 involved cutting back the tree tops, height growth was obviously affected. Consequently, available data was analysed both including and excluding this treatment. As expected, analysis of data including T3 found a significant difference between this and the other treatments for both years.

2006 data: $F_{(3,385)0.05} = 989.72$ **significant**

2007 data: $F_{(3,385)0.05} = 10.50$ **significant**

When T3 was excluded, analysis of variance after one year indicated no significant difference between T1 (control),T2 (removing graded foliage stems) and T4 (removing foliage and scarring trees).

2006 data: $F_{(2,307)0.05} = 0.199$ **not significant**

Analysis of variance carried out on data collected after the 2007 growing season again found no significant difference between the control and treatments T2 and T4.

2007 data: $F_{(2,307)0.05} = 2.66$ **not significant**

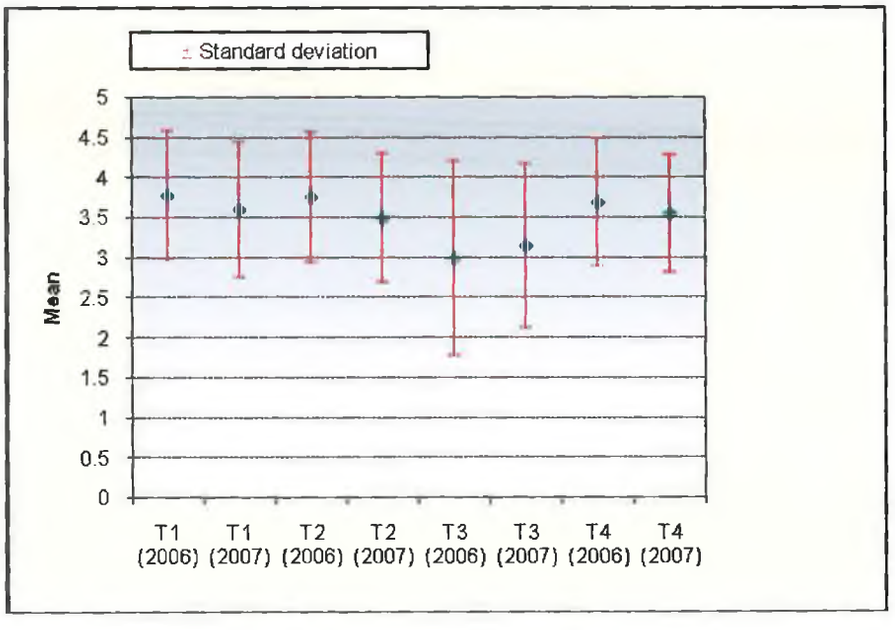
Therefore it can be suggested that foliage harvesting does not affect height growth of Japanese larch trees of this age grown in these conditions.

Mean diameter growth achieved during the 2006 and 2007 growing seasons for each treatment imposed on Japanese larch foliage trees is displayed in Tables 22 and Figure 8.

Table 22: Diameter Growth of Japanese Larch Foliage Trees

Treat.	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1	108	3.77	3.60
T2	110	3.75	3.49
T3	78	2.98	3.14
T4	96	3.69	3.55

Figure 8: Mean Diameter Growth of Japanese Larch Foliage Trees



Analysis of Diameter Growth Data – Foliage Trees

As was the case with height growth, diameter data was analysed both including and excluding T3. When T3 was included in the analysis, a significant difference was found between this and the other treatments in both the 2006 and 2007 data sets.

2006 data: $F_{(3,385)0.05} = 14.82$ significant

2007 data: $F_{(3,385)0.05} = 4.95$ significant

When T3 was excluded, analysis of variance after one year indicated no significant difference between T1 (control),T2 (removing graded foliage stems) and T4 (removing foliage and scarring trees).

Analysis of data excluding T3 found no significant difference between T1 and treatments T2 and T4 for both years.

2006 data: $F_{(2,307)0.05} = 0.282$ not significant

2007 data: $F_{(2,307)0.05} = 0.525$ not significant

Therefore it can be suggested that foliage harvesting does not affect diameter growth of Japanese larch trees of this age grown in these conditions

Data collected from trees designated for timber production is used to assess the effect of pruning operations on height and diameter increments.

Mean height increments are presented in Table 23 and Figure 9 for pruned and control trees. Mean diameter increments are presented in Table 24 and Figure 10 for pruned and control trees.

Table 23: Height Growth of Japanese Larch Timber Trees

Treatment	# Sample Trees	Mean Height Growth (cm) 2006	Mean Height Growth (cm) 2007
T1 (Control)	23	249.30	205.33
T3 (Pruned Trees)	23	230.92	193.61
T4 (Pruned Trees)	24	212.39	190.01

Figure 9: Mean Height Growth of Japanese Larch Timber Trees

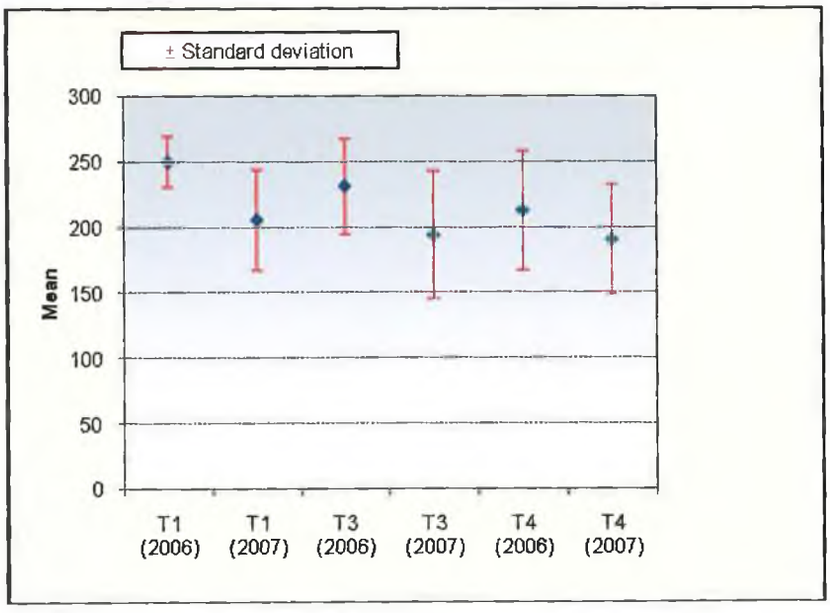
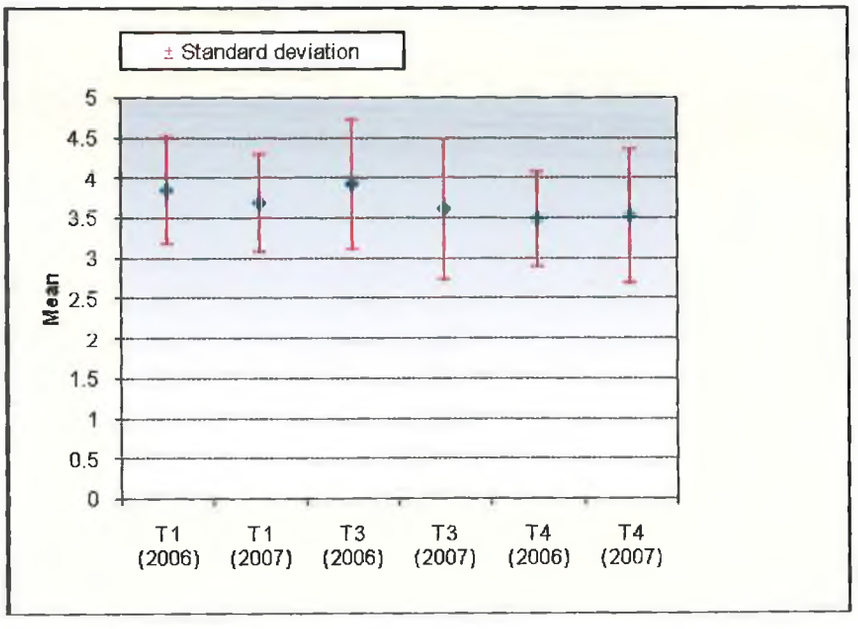


Table 24: Diameter Growth of Japanese Larch Timber Trees

Treatment	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1 (Control)	23	3.85	3.69
T3 (Pruned Trees)	23	3.92	3.61
T4 (Pruned Trees)	24	3.48	3.52

Figure 10: Mean Diameter Growth of Japanese Larch Timber Trees



Analysis of Height Growth Data – Timber Trees

After one year, analysis of data found that there was a significant difference between T1 and T4.

2006 data: $F_{(2,69)\ 0.05} = 6.27$ significant

Two years after imposing the treatments, analysis of data found no significant difference between the control (T1) and the pruned trees (T3 & T4).

2007 data: $F_{(2,69)\ 0.05} = 0.801$ not significant

This might indicate that although height growth was affected one year after pruning, the crop recovered with time. Also, due to their biological nature, individual responses to pruning may have differed between trees.

Analysis of Diameter Growth Data – Timber Trees

After one year, no significant difference was found between the control treatment (T1) and pruned trees (T3 & T4).

2006 data: $F_{(2,69)\ 0.05} = 2.67$ not significant

However a significant difference was found between T4 and T3 which were essentially the same. This may have been due to individual variations between trees.

After two years no significant difference was apparent between treatments

2007: $F_{(2,69)\ 0.05} = 0.266$ not significant

The above results suggest that the Japanese larch crop recovered from pruning after two years. Again it is suggested that individual tree response to pruning contributed to these results.

5.1.2 Foliage Yields for Japanese Larch

Table 5 displays mean foliage yields per plot for each treatment. As T1 is a control treatment, the crop was untouched and no foliage harvesting was carried out. To compare T1 and the other treatments, the number of potential stems was estimated and recorded. In Table 5, values in red type were those estimated for T1 while those in black were actually harvested. For all treatments, higher foliage yields were achieved in the second harvest (2006) than during the initial removal of stems (2005). A further increase in the number of foliage stems was recorded in 2007 for all treatments with the exception of T3.

Table 25: Foliage Yields from Japanese Larch Trial Plots.

Treatment	Mean Stems/Plot '05	Mean Stems/Plot '06	Mean Stems/Plot '07	Mean Stems/Plot/Year
T1	192.75	248.75	316.25	252.58
% Change		+29.1%	+27.1%	
T2	249.75	261.75	298.00	269.83
% Change		+4.8%	+13.8	
T3	198.75	282.50	242.50	241.25
% Change		+42.1%	-14.2%	
T4	196.75	292.25	303.00	264.00
% Change		+48.5%	+3.7%	

The estimated proportion of commercial standard foliage per tree was estimated for 15 individual trees. Results are presented in Table 26.

Table 26: Amount of Commercial Standard Foliage Stems per Tree – Japanese Larch

Tree No.	No. Of Stems	Tot. Stem Wt. (g)	Mean Wt./Stem (g)	Tot. Fol. Wt. (g)	% Com. Std. Foliage
1	7	848	121.1	6927	12.2
2	0	0	0	0	0
3	8	464	58.0	5973	7.8
4	9	712	79.1	6201	11.5
5	14	1425	101.8	5873	24.3
6	6	557	92.8	6098	9.1
7	9	763	84.8	6547	11.7
8	10	983	98.3	6971	14.1
9	7	687	98.1	7238	9.5
10	9	627	69.7	6492	9.7
11	11	1024	93.1	7458	13.7
12	4	345	83.6	6273	5.5
13	15	1123	74.9	6870	16.3
14	8	611	76.4	6520	9.4
15	6	572	95.3	5908	9.7

Based on the above data, the mean % of commercial standard foliage per tree is 10.96%. Therefore it is estimated that for Japanese larch trees of this age and growing in these conditions, foliage harvesting removes approximately 11% of the live crown.

5.1.3 Conclusions – Japanese Larch

While general management recommendations are presented in section 6, the following applies to foliage production from Japanese larch;

- Final timber crop should be identified early on in the rotation; remaining trees should then form the foliage crop.
- For Japanese larch growing under these conditions, it is proposed that foliage harvesting should commence once trees have achieved a height of 2m.
- Foliage trees should be topped to control height growth.
- From data collected after 2 growing seasons, harvesting all available 55cm graded foliage stems does not significantly affect height and diameter growth for Japanese larch growing under similar conditions to those in the trial site.
- On average foliage harvesting removes approximately 11% of the live crown.
- When only commercial standard stems are removed, Japanese larch growing under similar conditions should produce approximately 2400 foliage stems/ha/year for a least a three-year period.
- On completion of foliage operations, the final timber crop should consist of approximately 600 high quality trees/ha.

5.2 Results of Monterey Cypress Goldcrest Trials.

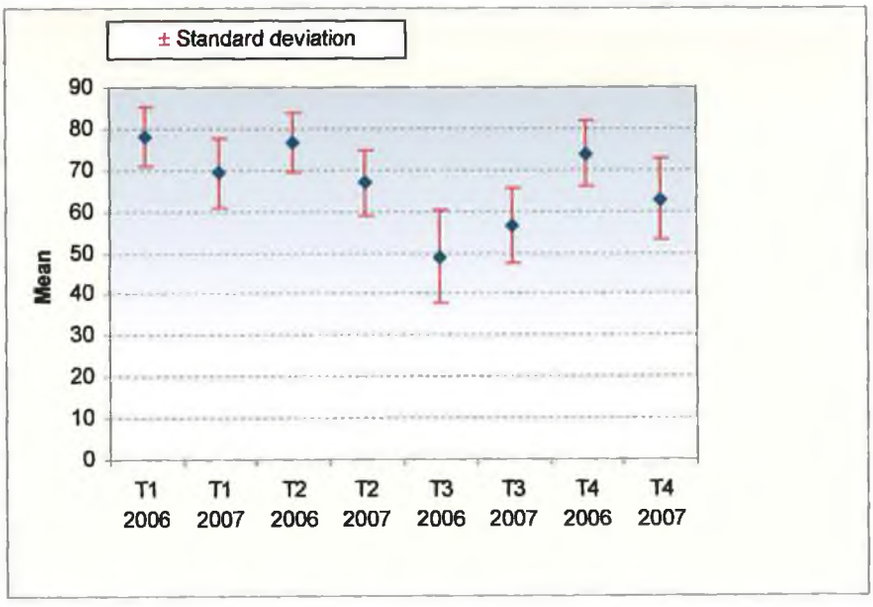
5.2.1 Effect of Foliage Harvesting on Growth Parameters for Monterey Cypress Goldcrest

Mean height growth achieved during the 2006 and 2007 growing seasons for Monterey cypress Goldcrest foliage trees are displayed in Table 27 and Figure 11.

Table 27: Height Growth of Monterey Cypress Goldcrest Foliage Trees

Treat.	# Sample Trees	Mean Height Growth (cm) 2006	Mean Height Growth (cm) 2007
T1	96	77.95	69.38
T2	111	76.40	66.85
T3	85	48.98	56.47
T4	81	73.95	62.93

Figure 11: Mean Height Growth Monterey Cypress Goldcrest Foliage Trees



Analysis of Height Growth Data – Foliage Trees

As for the Japanese larch trial, treatment T3 involved cutting back tree tops and height growth was again obviously affected. Available data was analysed both including and excluding this treatment. As expected, analysis of data including T3 found a significant difference between this and the other treatments for both years.

2006 data: $F_{(3,369)\ 0.05} = 229.11$ significant

2007 data: $F_{(3,369)\ 0.05} = 37.61$ significant

When T3 was excluded, analysis of variance after one year showed a significant difference between treatments.

2006 data: $F_{(2,284)\ 0.05} = 6.34$ significant

Further analysis found that while there was no significant difference between the control (T1) and removing foliage (T2), there was a significant difference between treatment T4 (bark scarring) and the other treatments.

Analysis of variance after two growing seasons found a significant difference between treatments.

2007 data: $F_{(2,284)\ 0.05} = 12.64$ significant

Again, there was greater variation between T1 and T4 than T1 and T2. Further analysis also found a significant difference between T2 and T4.

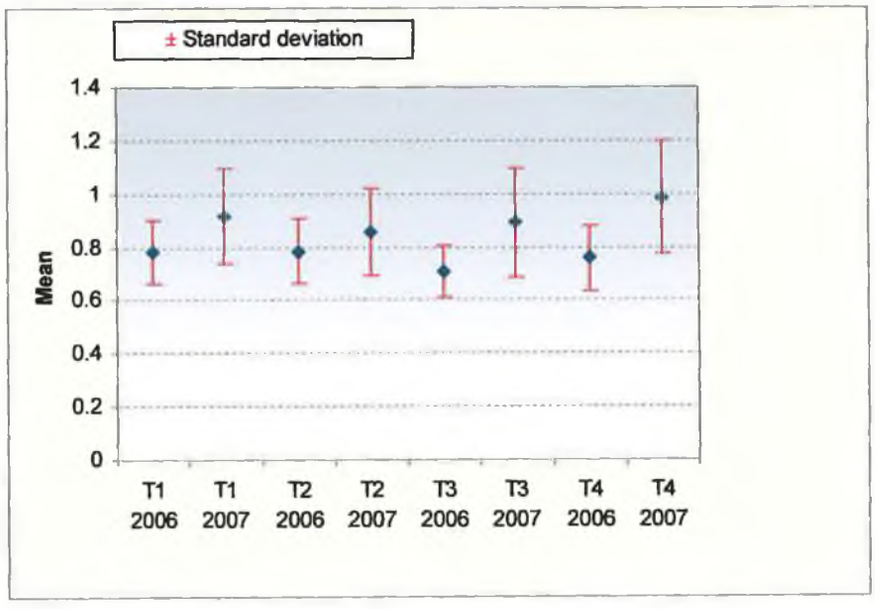
The above results indicate that bark scarring in addition to removing foliage affects height growth greater than simply removing foliage stems from Monterey cypress trees grown in these conditions.

Mean diameter growth achieved during the 2006 and 2007 growing seasons for Monterey cypress Goldcrest foliage trees are displayed in Table 28 and Figure 12.

Table 28: Diameter Growth of Monterey Cypress Goldcrest Foliage Trees

Treat.	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1	96	0.78	0.92
T2	111	0.78	0.86
T3	85	0.71	0.89
T4	81	0.76	0.99

Figure 12: Mean Diameter Growth of Monterey Cypress Goldcrest Foliage Trees



Analysis of Diameter Growth Data – Foliage Trees

Analysis of variance one year after treatments were imposed found a significant difference in diameter growth between T3 (topping trees and removing foliage) and the other treatments.

2006 data: $F_{(3,369)\ 0.05} = 8.64$ significant

Further analysis showed that there was no significant difference between T1 (control), T2 (removing foliage stems) and T4 (removing foliage stems and bark scarring).

Analysis of variance after two years again found a significant difference between treatments

2007 data: $F_{(3,369)\ 0.05} = 7.697$ significant

Further analysis of data found no significant difference in diameter growth between T1 and T3 but there was between T1, T4 and T2. Again, there was greater variation between T1 and T4 than T1 and T2. There was also significant difference between T2 and T4 but not between T2 and T3. As these results are somewhat curious, it is thought that biological factors such as individual tree variation may be involved.

The above results may indicate that while cutting back tree tops affected diameter growth after one year, the crop recovered after two years. It also appears that T3 (cutting tree tops and removing foliage) and T2 (removing foliage) have a less severe effect on diameter growth than T4 (bark scarring and removing foliage) on Monterey cypress Goldcrest trees growing in these conditions.

Data collected from trees designated for timber production is used to assess the effect of pruning operations on height and diameter increments.

Mean height increments are presented in Table 29 and Figure 13 for pruned and control trees. Mean diameter increments are presented in Table 30 and Figure 14 for pruned and control trees.

Table 29: Height Growth of Monterey Cypress Goldcrest Timber Trees

Treat.	# Sample Trees	Mean Height Growth (cm) 2006	Mean Height Growth (cm) 2007
T1 (Control)	20	77.79	61.46
T3 (Pruned Trees)	20	74.10	64.89
T4 (Pruned Trees)	19	73.46	63.23

Figure 13: Mean Height Growth Monterey Cypress Goldcrest Timber Trees

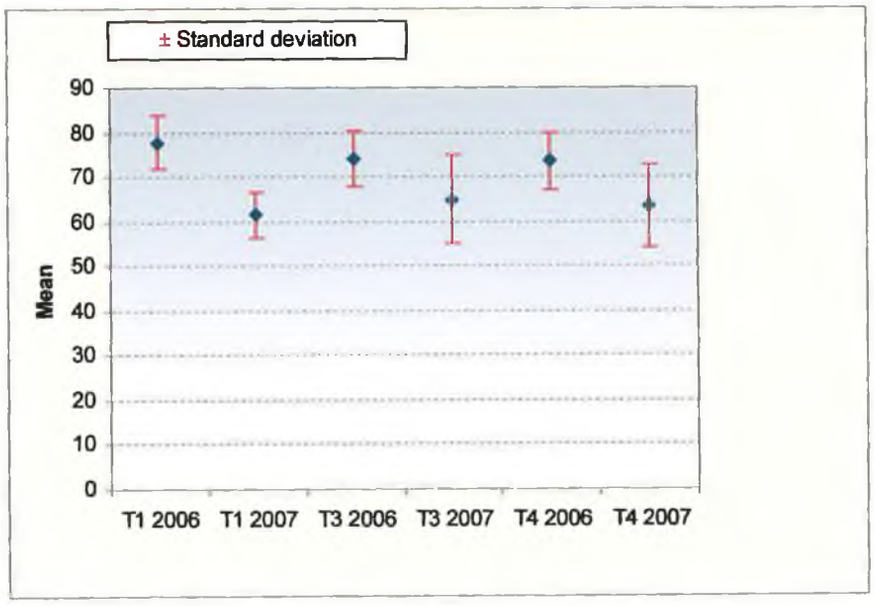
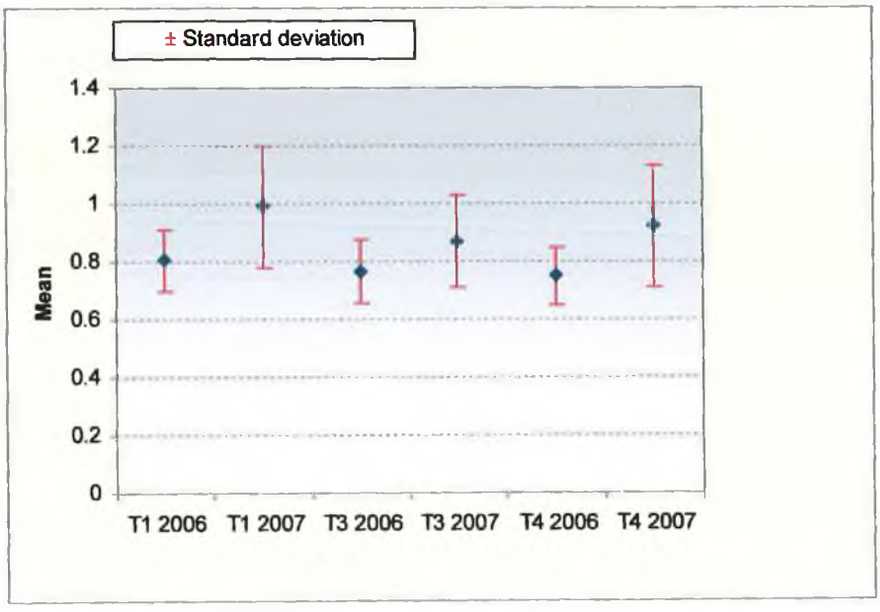


Table 30: Diameter Growth of Monterey Cypress Goldcrest Timber Trees

Treatment	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1 (Control)	20	0.80	0.99
T3 (Pruned Trees)	20	0.77	0.87
T4 (Pruned Trees)	19	0.75	0.92

Figure 14: Mean Diameter Growth of Monterey Cypress Goldcrest Timber Trees



Analysis of Height Growth Data – Timber Trees

Analysis of variance one year after treatments were imposed found a significant difference in height growth between T1 and T4 but not between T1 (control) and T3 (pruning) or T3 and T4 (pruning).

2006 data: $F_{(2,58)\ 0.05} = 2.76$ significant

These results are possibly due to individual tree response to pruning.

Analysis of 2007 data found no significant difference in height growth between control and pruned trees.

2007 data: $F_{(2,58)\ 0.05} = 0.83$ not significant

Analysis of Diameter Growth Data – Timber Trees

Analysis of variance after one year found no significant difference in diameter growth between treatments.

2006 data: $F_{(2,58)\ 0.05} = 1.40$ not significant

Analysis of data collected after the 2007 growing season found a significant difference in diameter growth between T1 and T3.

2007 data: $F_{(2,58)\ 0.05} = 2.03$ significant

No significant difference was found between T1 and T4 and T3 and T4.

As T3 and T4 are the same treatment (pruning), it remains difficult to say whether pruning affects diameter growth of Monterey cypress Goldcrest trees of this age and growing in these conditions. It is suggested that biological variations within trees may have affected their response to pruning.

5.2.2 Foliage Yields for Monterey Cypress Goldcrest

Mean foliage yields per plot for each treatment are presented in Table 31. Values in red type were estimated; those in black were actually harvested.

Table 31: Foliage Yields from Monterey Cypress Goldcrest Trial Plots

Treatment	Mean Stems/Plot '05	Mean Stems/Plot '06	Mean Stems/Plot '07	Mean Stems/Plot/Year
T1	288.25	908.25	859.50	685.33
% Change		+215.1%	-5.4%	
T2	287.00	847.25	681.25	605.17
% Change		+195.2%	-19.6%	
T3	414.00	636.00	549.75	533.25
% Change		+53.6%	-13.6%	
T4	391.75	546.00	519.50	485.75
% Change		+39.4%	-4.9%	

The estimated proportion of commercial standard foliage to waste was estimated for 15 individual trees. Results are presented in Table 32.

Table 32: Amount of Commercial Standard Foliage Stems per Tree – Monterey Cypress Goldcrest

Tree No.	No. Of Stems	Tot. Stem Wt. (g)	Mean Wt./Stem (g)	Tot. Fol. Wt. (g)	% Com. Std. Foliage
1	16	642	40.1	3542	18.1
2	19	1432	75.4	5337	26.8
3	25	1198	47.9	4994	24.0
4	4	209	52.3	2967	7.0
5	14	661	47.2	3849	17.2
6	6	468	78.0	4973	9.4
7	14	843	60.2	3387	24.9
8	17	726	42.7	4681	15.5
9	12	786	65.5	3685	21.3
10	9	391	43.4	3879	10.1
11	17	755	44.4	3679	20.5
12	22	1324	60.2	4590	28.8
13	11	504	45.8	4266	11.8
14	8	471	58.9	4325	10.9
15	20	1260	63.0	5235	24.1

Based on the above data, the mean % of commercial standard foliage per tree is 18.03%. Therefore it is estimated that for Monterey cypress Goldcrest trees of this age and growing in these conditions, foliage harvesting removes approximately 18% of the live crown.

5.2.3 Conclusions – Monterey Cypress Goldcrest

The following applies to foliage production from Monterey cypress Goldcrest trees;

- Final timber crop should be identified early on in the rotation; remaining trees then form the foliage crop.
- For Monterey cypress Goldcrest trees growing under these conditions, it is proposed that foliage harvesting should commence once trees have achieved a height of 1.5m. It is important that trees are healthy and vigorous prior to foliage harvesting.
- The optimal way to control height of trees designated for foliage production appears to be cutting back the tree tops.
- From these trials, harvesting 50cm graded foliage stems appears to have minimal effect on height and diameter growth for Monterey cypress Goldcrest trees. Results achieved appear to have been influenced by the biology of the trees rather than the actual treatments imposed.
- Bark scarring in addition to foliage harvesting has a greater effect on growth parameters and would not be recommended for trees designated for timber production.
- On average, foliage harvesting removes approximately 18% of the live crown.
- The highest foliage yield was recorded during the second harvest. Yields decreased in year 3 across all treatments including the control. This may be due to lack of light as branches became overcrowded.
- When only commercial standard stems are removed, Monterey cypress Goldcrest trees growing under similar conditions should produce approximately 5300 stems/ha/year[4] for a least a three year period.

[4] Estimated from yields measured for T3 treatment, where foliage and timber crops are treated separately and foliage trees topped to control height.

- Once foliage operations have ceased, the remaining timber crop should consist of approximately 600 trees/ha of high value, pruned trees.

5.3 Results of Western Hemlock Trials.

While collecting data after the 2007 growing season, it was noticed that the fence surrounding the trial area had been interfered with. Data was collected as per previous years; however it must be cautioned that a level of discrepancy may exist as plots were no longer clearly marked and the level of interference, if any, is unknown. A number of sample trees that had died or suffered excessive damage (possibly due to site conditions and browsing by deer) were not included in the final analysis, as they may have introduced an element of bias to the results.

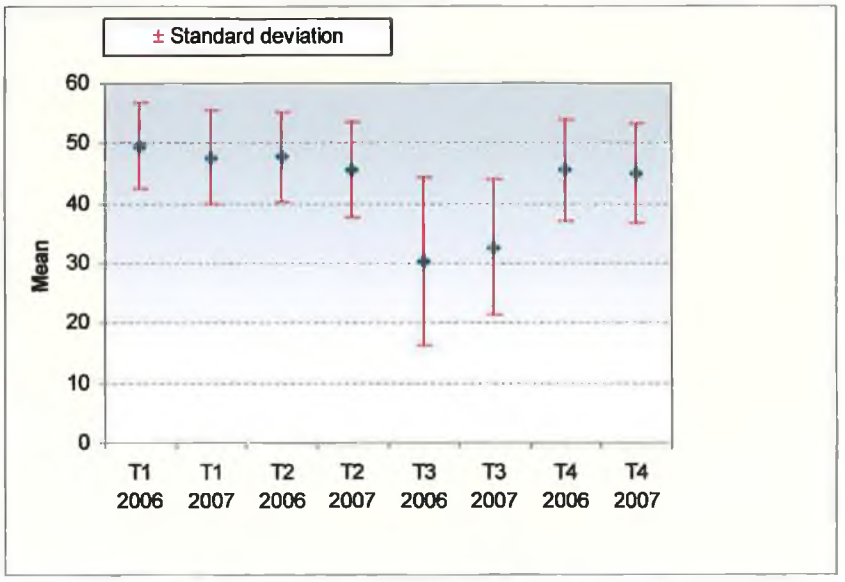
5.3.1 Effect of Foliage Harvesting on Growth Parameters for Western Hemlock

Mean height increments for each treatment after the 2006 and 2007 growing seasons are presented in Table 33 and Figure 15.

Table 33: Height Growth Western Hemlock Foliage Trees

Treat.	# Trees	Mean Hth Growth (cm) 2006	Mean Hth Growth (cm) 2007
T1	77	49.55	47.61
T2	74	47.73	45.59
T3	56	30.37	32.71
T4	58	45.51	45.11

Figure 15: Mean Height Growth of Western Hemlock Foliage Trees



Analysis of Height Growth Data – Foliage Trees

As with the other species examined in this section, treatment T3 involved removing tree tops and consequently had an obvious effect on height growth. As expected analysis of variance found a significant difference between this and the other treatments.

Analysis of 2006 data excluding T3 showed a significant difference in height growth between treatments.

2006 data: $F_{(2,207)\ 0.05} = 4.50$ significant

Further analysis of data found a significant difference between T1 (control) and T4 (removing foliage & scarring with chainsaw). However there was no significant difference between T1 (control) and T2 (removing foliage) or between T2 and T4.

Analysis of variance of 2007 data found no significant difference between treatments.

2007 data: $F_{(2,207)\ 0.05} = 1.92$ not significant

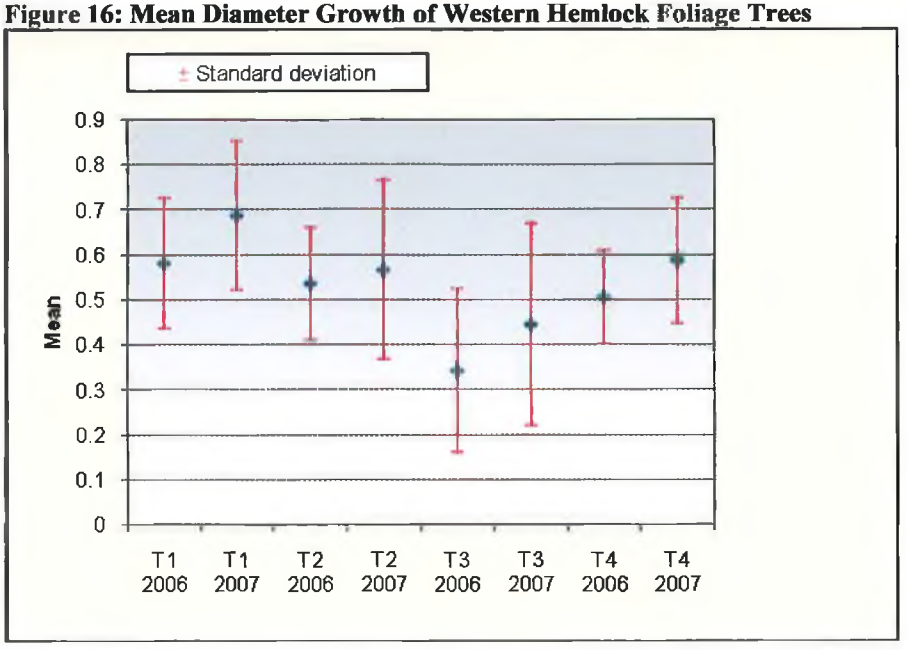
The above results indicate that harvesting foliage from Western hemlock trees growing in these conditions does not affect height growth. Scarring trees using a chainsaw affected height growth after one year but trees seemed to recover after a further growing season.

Mean diameter growth for each treatment is presented in Table 34 and Figure 16.

Table 34: Diameter Growth of Western Hemlock Foliage Trees

Treatment	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1	77	0.58	0.69
T2	74	0.54	0.57
T3	56	0.34	0.44
T4	58	0.51	0.59

Figure 16: Mean Diameter Growth of Western Hemlock Foliage Trees



Analysis of Diameter Growth Data – Western Hemlock Foliage Trees

Analysis of variance one year after treatments were imposed found a significant difference between T1 (control) and the other treatments.

2006 data: $F_{(2,208)\ 0.05} = 5.96$ significant

Analysis of 2007 data again showed a significant difference between the control and other treatments.

2007 data: $F_{(2,208)\ 0.05} = 10.49$ significant

Further analysis found that a greater difference occurred between T1 (control) and T3 (removing foliage and cutting back tree tops) than between T1, T2 (removing foliage) and T4 (removing foliage and scarring base with chainsaw).

The above results indicate that harvesting foliage over two consecutive years affects diameter growth of Western hemlock trees growing in these conditions.

Tables 35 and 36 and Figures 17 and 18 present mean height and diameter increments measured from trees designated for timber production. This data is used to assess the effect of pruning on tree growth and development.

Table 35: Height Growth of Western Hemlock Timber Trees

Treatment	# Sample Trees	Mean Height Growth (cm) 2006	Mean Height Growth (cm) 2007
T1 (Control)	18	50.01	48.37
T3 (Pruned Trees)	17	43.19	42.31
T4 (Pruned Trees)	16	45.48	40.90

Figure 17: Mean Height Growth of Western Hemlock Timber Trees

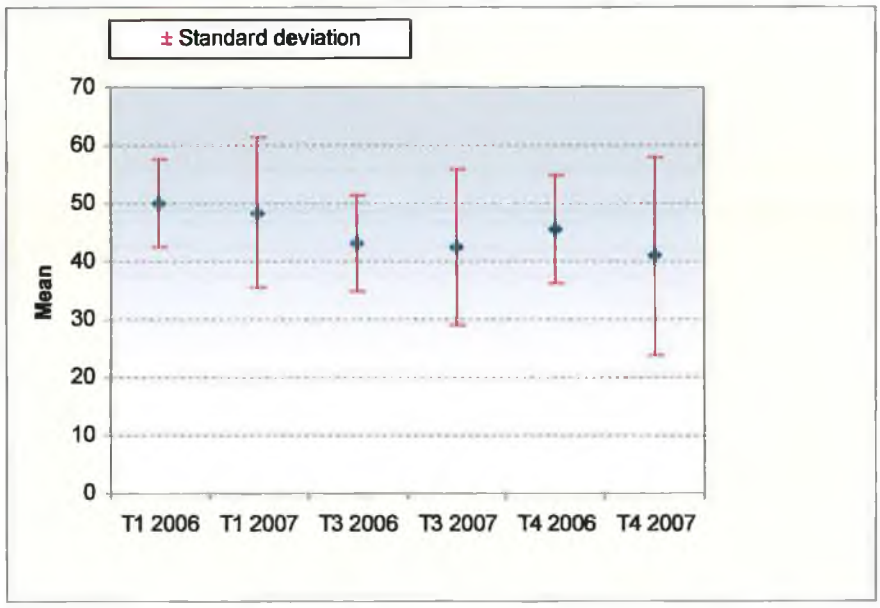
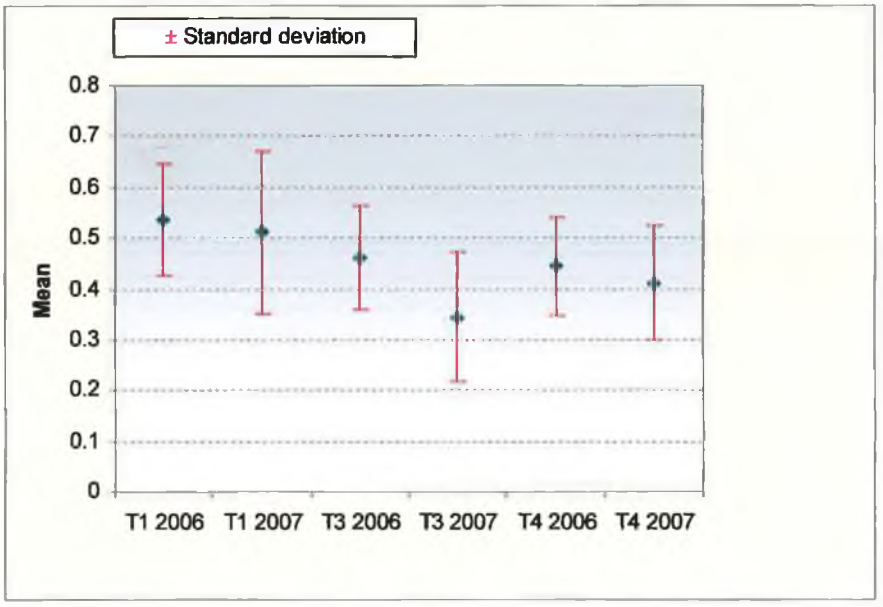


Table 36: Diameter Growth of Western Hemlock Timber Trees

Treatment	# Sample Trees	Mean Diameter Growth (cm) 2006	Mean Diameter Growth (cm) 2007
T1 (Control)	18	0.54	0.51
T3 (Pruned Trees)	17	0.46	0.34
T4 (Pruned Trees)	16	0.44	0.41

Figure 18: Mean Diameter Growth of Western Hemlock Timber Trees



Analysis of Height Growth Data – Timber Trees

Analysis of variance one year after treatments were imposed found a significant difference in height growth between T1 and T3 but not between T1 (control) and T4 (pruning) or T3 and T4 (pruning).

2006 data: $F_{(2,50)\ 0.05} = 2.99$ significant

These results are possibly due to individual tree response to pruning.

Analysis of 2007 data found no significant difference in height growth between control and pruned trees.

2007 data: $F_{(2,50)\ 0.05} = 1.30$ not significant

Analysis of Diameter Growth Data – Timber Trees

After one year, analysis of variance for differences in tree diameter showed a significant difference between T1 (unpruned) and T3/T4 (pruned trees).

2006 data: $F_{(2,50)\ 0.05} = 3.73$ significant

Analysis of the 2007 data found the same result.

2007 data: $F_{(2,50)\ 0.05} = 6.69$ significant

This indicates that pruning has a significant effect on diameter growth of Western hemlock trees growing in these conditions.

5.3.2 Foliage Yields for Western Hemlock

Table 37 presents the mean number of foliage stem per plot for each treatment investigated.

Table 37: Foliage Yields from Western Hemlock Trial Plots.

Treatment	Mean Stems/Plot '05	Mean Stems/Plot '06	Mean Stems/Plot '07	Mean Stems/Plot/Year
T1	226.67	239.33	304.00	256.67
% Change		+5.6%	+27.0%	
T2	276.67	234.33	99.33	203.44
% Change		-15.3%	-57.6%	
T3	310.67	204.67	90.67	201.00
% Change		-35.1%	-55.0%	
T4	231.67	204.67	76.33	170.89
% Change		-11.7	-62.7%	

The number of available foliage stems decreased annually for all treatments with the exception of control plots. For the three harvesting treatments examined, the most severe decline in yield was noted after the 2007 growing season where less than half the previous two years yields were achieved.

The estimated proportion of commercial standard foliage per tree was estimated for 14 individual trees. Results are presented in Table 38.

Table 38: Amount of Commercial Standard Foliage Stems per Tree – Western Hemlock

Tree No.	No. of Stems	Tot. Stem Wt. (g)	Mean Wt./Stem (g)	Tot. Fol. Wt. (g)	% Com. Std. Foliage
1	12	783	65.25	5093	15.37
2	4	178	44.50	4367	4.08
3	6	405	67.50	6094	6.65
4	7	564	80.57	5463	10.32
5	12	892	74.33	4482	19.90
6	4	287	71.75	5190	5.53
7	2	156	78.00	4783	3.26
8	9	645	71.67	5342	12.07
9	10	609	60.90	4378	13.91
10	6	404	67.33	4901	8.24
11	7	431	61.57	3562	12.10
12	6	351	58.50	4612	7.61
13	4	245	61.25	4198	5.84
14	8	613	76.63	5356	11.45

Based on the above data, the mean % of commercial standard foliage per tree is 9.74%. Therefore it is estimated that for Western hemlock trees of this age and growing in these conditions, foliage harvesting removes approximately 10% of the live crown.

5.3.3 Conclusions – Western Hemlock

The following applies to foliage production from Western hemlock trees;

- Final timber crop should be identified early on in the rotation; remaining trees then form the foliage crop.
- For Western hemlock trees growing under these conditions, it is proposed that foliage harvesting should commence once trees have achieved a height of 2.0m.
- It appears that the optimal way to control height growth is to top Western hemlock trees.
- Harvesting all available 50cm graded foliage stems over two consecutive years does not have a significant effect on height growth of Western hemlock trees growing under similar conditions.
- Harvesting all available 50cm graded foliage stems over two consecutive years had a significant effect on diameter growth of Western hemlock trees. On sites similar to the one used in the trial, it is suggested that foliage harvesting should only be carried out every two years to allow the crop sufficient time to recover.
- On average foliage harvesting removes approximately 10% of the live crown.
- When only commercial standard stems are removed, Western hemlock trees growing under similar conditions should produce approximately 2010 stems/ha/year[5] for at least a three year period. However, as mentioned above, it is recommended that Western hemlock trees growing under these conditions should be subjected to foliage harvesting operations every two years as opposed to annually. This is proposed as diameter growth and stem recovery rates in this trial appeared much slower than other species examined possibly due to poor site conditions.

[5] Estimated from yields measured for T3 treatment, where foliage and timber crops are treated separately and foliage trees topped to control height.

- Once foliage operations have ceased, the remaining timber crop should consist of approximately 600 pruned trees/ha.

5.4 Results of Noble Fir Trials

Treatment descriptions are found in Tables 18 and 19 in the methodology section (page 60 and 61).

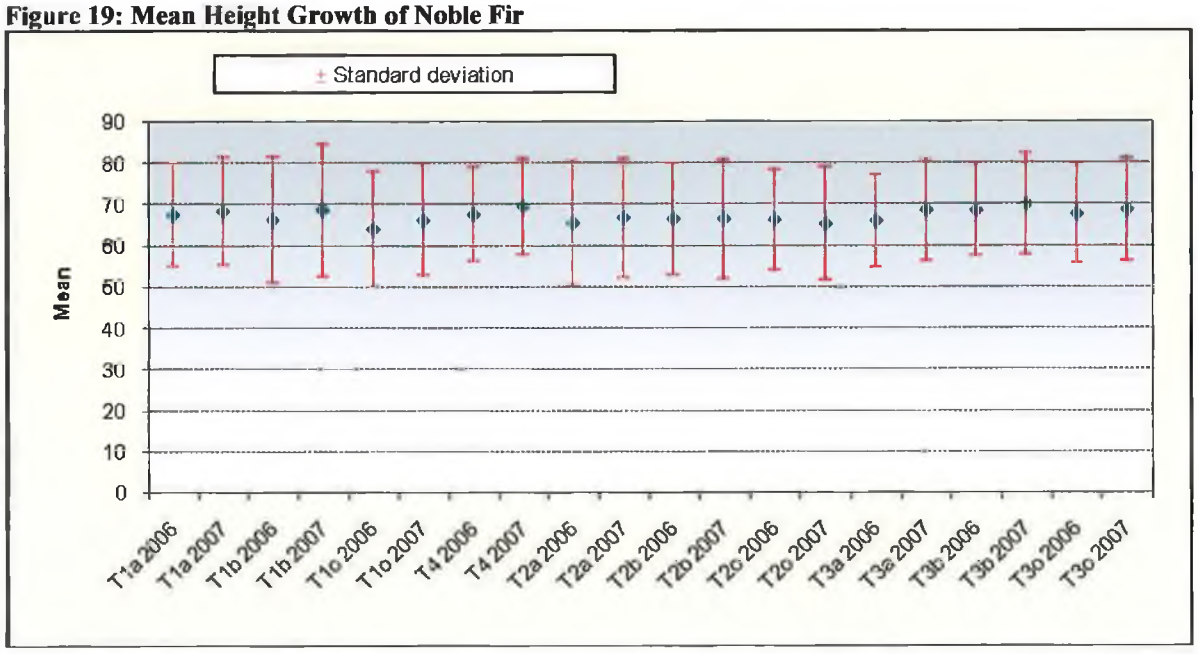
5.4.1 Height Growth

Table 39 and Figure 19 outline mean height increments recorded for each treatment after the 2006 and 2007 growing seasons.

Table 39: Height Growth of Noble Fir Trees

Treatment	No. of Sample Trees	Mean Height Growth 2006	Mean Height Growth 2007
T1a	68	67.48	68.40
T1b	70	66.23	68.85
T1o	65	64.00	66.16
T4 (control)	66	67.62	69.65
T2a	65	65.51	66.79
T2b	65	66.45	66.49
T2o	64	66.31	65.24
T3a	63	65.99	68.67
T3b	71	68.57	70.14
T3o	65	67.69	68.72

Figure 19: Mean Height Growth of Noble Fir



As can be seen from the above graph, mean height increments appear uniform across all treatments. Analysis of variance for differences in tree height between treatments showed no significant difference between treatments

$F_{(9,661)\ 0.05} = 0.693$ not significant

Analysis of data after a second growing season again found no significant difference between the control and other treatments.

$F_{(9,661)\ 0.05} = 0.969$ not significant

These results show than none of the treatments explored had an effect on height growth of Noble fir trees growing in these conditions.

5.4.2 Foliage Yields

Table 40 presents mean foliage yields/year for each of the treatments examined. Figures in red print are estimated amounts; figures in black were actually harvested.

Table 40: Estimated Yields from Noble Fir Trials.

Treatment	Mean Stems/Plot 2006	Mean Bags/Plot 2006	Mean Stems/Plot 2007	Mean Bags/Plot 2007	Mean Stems/Plot 2008	Mean Bags/Plot 2008
Control	85	2.03	238.33	2.17	420.33	3.03
% Change			+180.4%	+6.9%	+76.4%	+39.6%
Unmanaged Harvest	112.78	1.9	183.89	2.18	30.89	1.82
% Change			+63.1%	+14.6%	-83.2%	-16.3%
Managed Harvest A	53.89	2.74	185.22	3.32	104.44	2.21
% Change			+243.7%	+21.1%	-43.6%	-33.5%
Managed Harvest B	69.56	2.57	230.44	3.74	186.33	2.37
% Change			+231.3%	+45.9%	-19.1%	-36.8%

The estimated proportion of commercial standard foliage per tree was estimated for 12 individual trees. Results are presented in Table 41.

Table 41: Amount of Commercial Standard Foliage Stems per Tree – Noble Fir

Tree #	# Stems	Tot. Stem Wt. (g)	Mean Wt./Stem (g)	Tot. Fol. Wt. (g)	% Com. Std. Fol.
1	6	958	159.67	4094	23.4
2	4	601	150.25	6005	10.0
3	12	2695	224.58	9084	29.7
4	10	2540	254.00	12420	20.5
5	8	2260	282.50	7945	28.4
6	6	1605	267.50	9070	17.7
7	8	1335	166.88	5610	23.8
8	14	2937	209.79	7536	39.0
9	6	1648	274.67	7738	21.3
10	3	976	325.33	8296	11.8
11	10	1733	173.30	12952	13.4
12	8	1882	235.25	10173	18.5

Based on the above data, the mean % of commercial standard foliage per tree is 21.4%. Therefore, it is estimated that for Noble fir trees of this age and growing in these conditions, foliage harvesting removes approximately 21% of the live crown.

Plate 33: Noble Fir - Commercial Stems Versus Waste

5.4.3 Conclusions – Noble Fir

- Controlling height growth continues to pose a problem for Noble fir foliage production. It now appears that a more severe management practice is necessary to slow down canopy closure and prolong foliage harvesting. The small number of trees cut back to 1.8m for observation seem to have recovered well. While a proportion of the side shoots started to turn up, trees seemed to produce good volumes of saleable foliage (especially smaller pieces for wreath production). It is suggested that branches that start to turn up be pruned every two to three years to allow trees to concentrate on lateral growth. Further research into cutting tree tops back is now required.
- From observation, it appears that foliage harvesting removes approximately 21% of the live crown.
- Foliage yields increased across all treatments in the second year. A decrease in foliage yields was recorded in the third year for all treatments except the control.
- It is recommended for trees of this size, foliage harvesting should be carried out every 2 years to allow the crop sufficient time to recover.

5.5 Results of Shelf Life Testing

For shelf life testing of Japanese larch foliage, observational assessments were made at 9, 20 and 27 days from set up date.

The following scale of 1-6 was used to grade foliage quality.

Table 42: Shelf Life Testing – Assessment Scale

Grade	Description
1	Healthy with good colour
2	Evidence of tips and buds/needles beginning to dehydrate and change in colour
3	First sign of shoot/needle curling and first needle drop evident
4	Severs needle discolouration (yellowing) and shedding occurring
5	Totally shrivelled, severe yellowing and 90% needle/bud drop
6	Presence of fungal/bacterial disease – unsuitable

Results are presented in Tables 42-44.

Table 43: First Shelf Life Test of Japanese Larch Foliage 15-March

Treatment	1st Observation 24-March (9 days)		2nd Observation 04-April (20 days)		3rd Observation 11-April (27 days)	
	Grade	Comments	Grade	Comments	Grade	Comments
1.	4	'dead' branch – no further growth from buds.	4	Needles shedding, white mould like substance seems to be developing.	6	Presence of botrytis on stem (see Plate 34).
2	1.	Needle extension continues, attractive appearance	2	Further needle development, tips of new growth display slight signs of wilting. Also, white mould seems to be developing.	6	As above.
3.	1.	As above.	2	As above.	6.	As above.
4.	1.	As above.	2	As above.	6.	As above.
5.	1.	As above.	2	As above.	6.	As above.
6.	1.	As above.	2.	As above but deterioration not as noticeable as other treatments.	6.	As above.
7.	4	'dead' branch – no further growth from buds. Needles starting to shed	4	Needles shedding.	6.	As above.
8.	1	Needle extension continues, attractive appearance.	2	Further needle development, tips of new growth display slight signs of wilting, also appears to have developed fungal disease.	6.	As above.
9.	1.	As above.	2	As above.	6.	As above.
10.	1	As above.	2	As above.	6.	As above.
11.	1	As above.	2	As above.	6.	As above.
12.	1	As above.	2	As above but deterioration not as noticeable as other treatments, also has white mould developing.	6.	As above.

The average temperature recorded in the processing shed was 10°C. The average 'kitchen/front room' temperature was 19°C.

Table 44: Second Shelf Life Test of Japanese Larch Foliage 13-April

Treatment	1st Observation 22-April (9 days)		2nd Observation 03-May (20 days)		3rd Observation 10-May (27 days)	
	Grade	Comments	Grade	Comments	Grade	Comments
1.	4	'dead' branch – no further growth from buds.	4	Needles shedding.	5	All needles shedding.
2	1	Stems appear to be in good health, lovely lime green foliage.	2	Very slight deterioration noticed.	3	Some needles shedding, for the most part, stems still an overall healthy colour.
3.	1	As above.	2	As above.	2	Slight deterioration in quality.
4.	2	Generally good health, a few needles seem to be curling.	2	As above.	3	Some needle shedding.
5.	1	Stems appear to be in good health, lovely lime green foliage.	2	As above.	2/3	As above but noticeably less needles being shed.
6.	1	As above.	½	As above but deterioration not as noticeable as other treatments	2	As above.
7.	4	'dead' branch – no further growth from buds. Needles starting to shed	4	Needles shedding.	5	All needles shedding.
8.	2	Needle extension continues, a few needles seem to be curling.	3	New growth displaying signs of wilting, some needles shedding.	3	Noticeable colour change, further needle shedding.
9.	1	Appears healthy.	2/3	As above.	3	As above.
10.	2	Needle extension continues, a few needles seem to be curling.	3	As above.	3	As above
11.	1	As above.	2/3	As above.	3	As above
12.	1	As above.	2	As above but deterioration not as noticeable as other treatments.	3	Colour change not as evident as previous treatments.

Table 45: Third Shelf Life Test of Japanese Larch Foliage 02-May

Treatment	1st Observation 11-May (9 days)		2nd Observation 22-May (20 days)		3rd Observation 29-May (27 days)	
	Grade	Comments	Grade	Comments	Grade	Comments
1.	4	'dead' branch – no further growth from buds.	4	Needles shedding.	5	All needles shedding.
2	1/2	Lime green foliage, very attractive product.	2/3	New growth displaying slight signs of wilting.	3	Needle shedding noted. Still retains good colour.
3.	1	As above.	2	As above.	3	As above.
4.	2	As above.	2	As above.	3	As above.
5.	1	As above.	2	As above.	3	As above.
6.	1	As above.	2	As above.	3	As above.
7.	4	'dead' branch – no further growth from buds.	4	Needles shedding.	5	All needles shedding.
8.	2	Lime green foliage, very attractive product.	3	Needle drop noticed however retains good colour.	3/4	Further needle shedding noted. Stems appear more shrivelled than those in processing shed.
9.	2	As above.	3	As above.	3/4	As above.
10.	2	As above.	3	As above.	3/4	As above.
11.	1	As above.	3	As above.	3/4	As above.
12.	1	As above.	3	As above.	3/4	As Above.

5.5.1 Observations – Shelf Life Testing

First Test 15th March

- The main observation from this test is the presence of a white mould like substance on the foliage stems (see Plate 34). As it was visible across all treatments, it is thought that stems may have been contaminated prior to harvesting.
- It was noted at this stage of bud development that larch foliage continues to grow while stored in either treated or untreated water.
- The addition of flower food, in this test, showed no extra benefit over untreated water
- Generally speaking there did not appear to be any difference between foliage stored in the processing shed and foliage stored in a home environment, this may be because the temperature was not high or low enough to affect longevity.
- Recutting stems seemed to improve stem quality in both shed and home environments.

Plate 34: Botrytis on Japanese Larch Foliage

Second Test 13th April

- Dry storage is not appropriate to Japanese larch foliage at this stage of development.
- There appears to be a difference between stems stored in the processing shed and home conditions.
- Stems seemed to drink a lot of water; all wet treatments required topping up with tap water.
- The addition of flower food, in this test, showed no extra benefit over untreated water
- Recutting stems also seemed to improve stem quality in both shed and home environments.
- On the whole, very attractive product and perhaps the best stage for Japanese larch foliage.

Third Test 2nd May

- As per previous test, dry storage is not appropriate.
- It is worth noting that as stems started shedding needles in this test, there was quite a lot of litter generated indoors. This may be disadvantageous in comparison to other foliage species.
- Stems lasted better in cold storage than in a home environment at this stage.
- Overall, needles in the home environment seemed to dehydrate faster in this test than in the previous ones.

5.5.2 Shelf Life Testing - Conclusion

After carrying out the above shelf life tests it is suggested that Japanese larch foliage will last a minimum of 9 days when kept in water and longer in most cases. It is proposed that harvesting should be carried out over a 6-8 week period, commencing just as new growth starts to emerge.

5.6 Questionnaire Results

A total of 47 completed questionnaires were returned. Results are presented in the following series of pie charts (Figures 20-29). Additional comments received are presented in Box 1.

Figure 20: Response to Question 1.

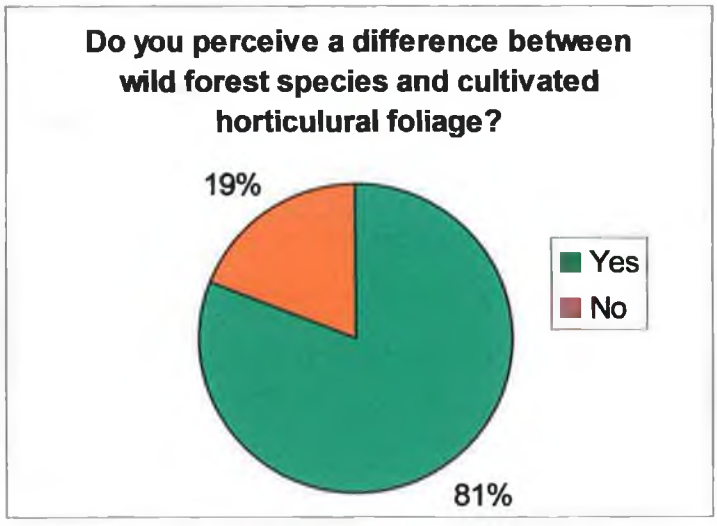


Figure 21: Response to Question 2.

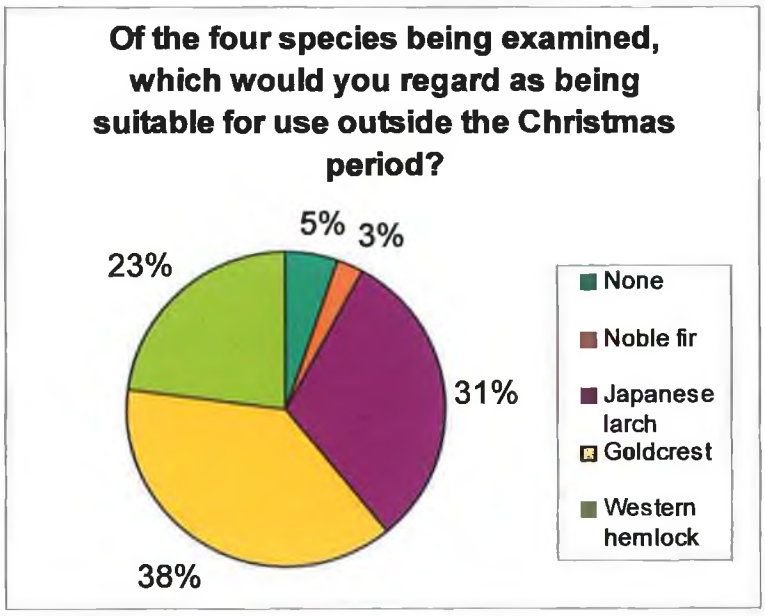
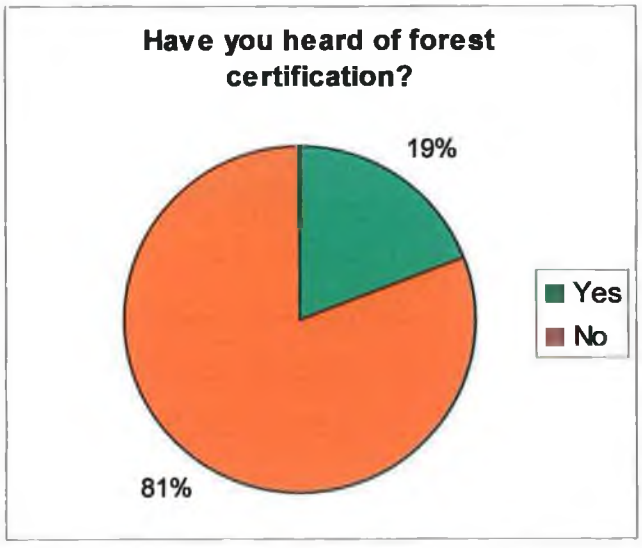


Figure 22: Response to Question 3.



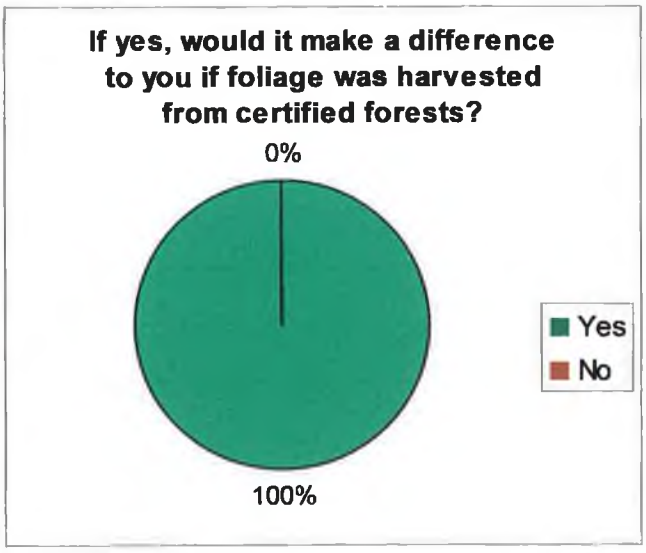


Figure 23: Response to Question 4

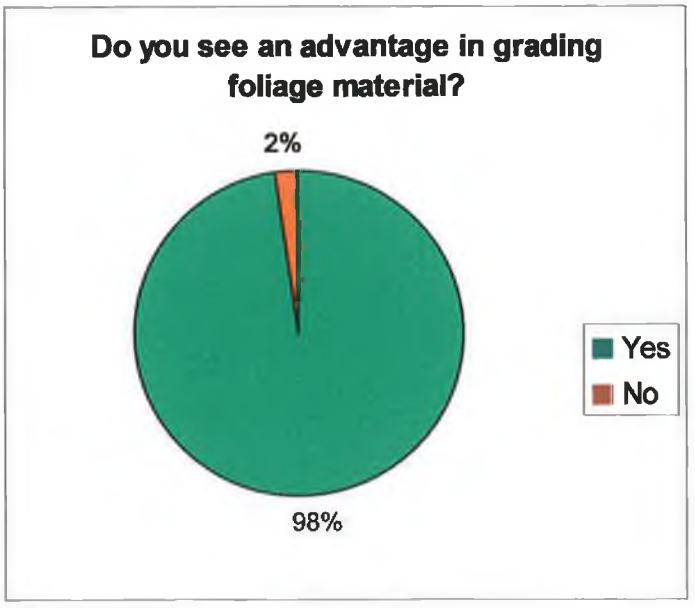


Figure 24: Response to Question 5.

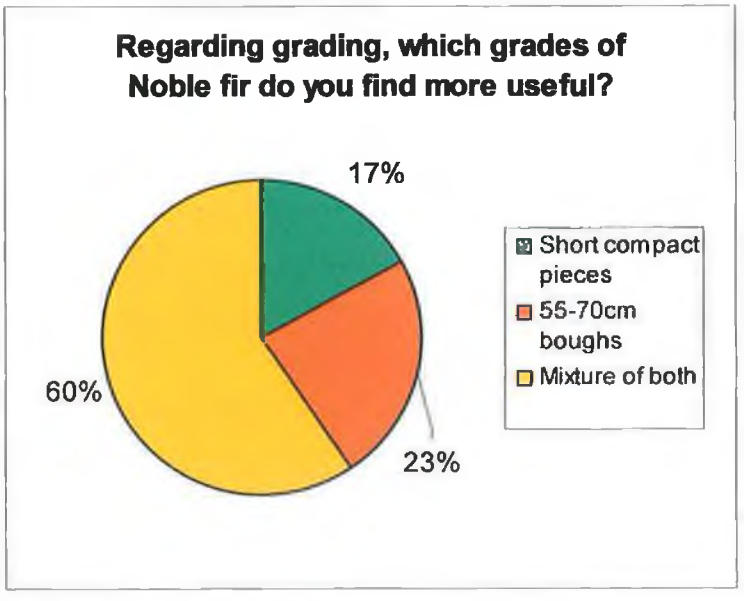


Figure 25: Response to Question 6.

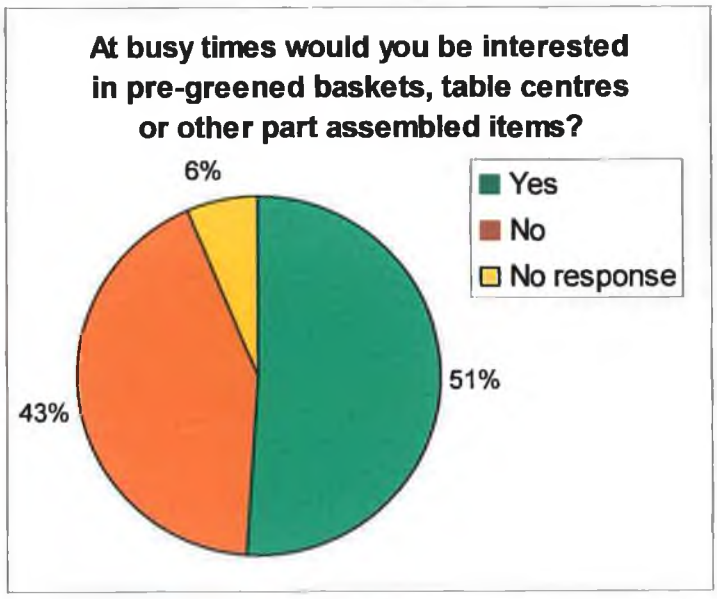


Figure 26: Response to Question 7.

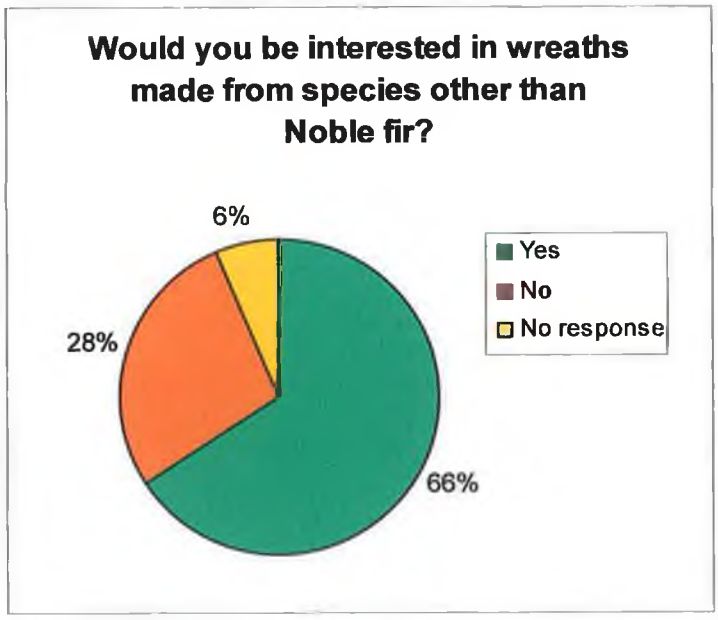


Figure 27: Response to Question 8.

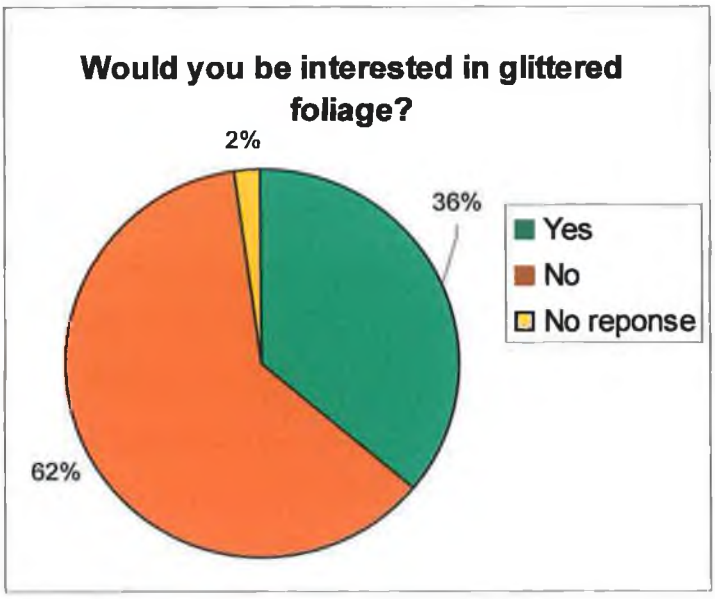


Figure 28: Response to Question 9.

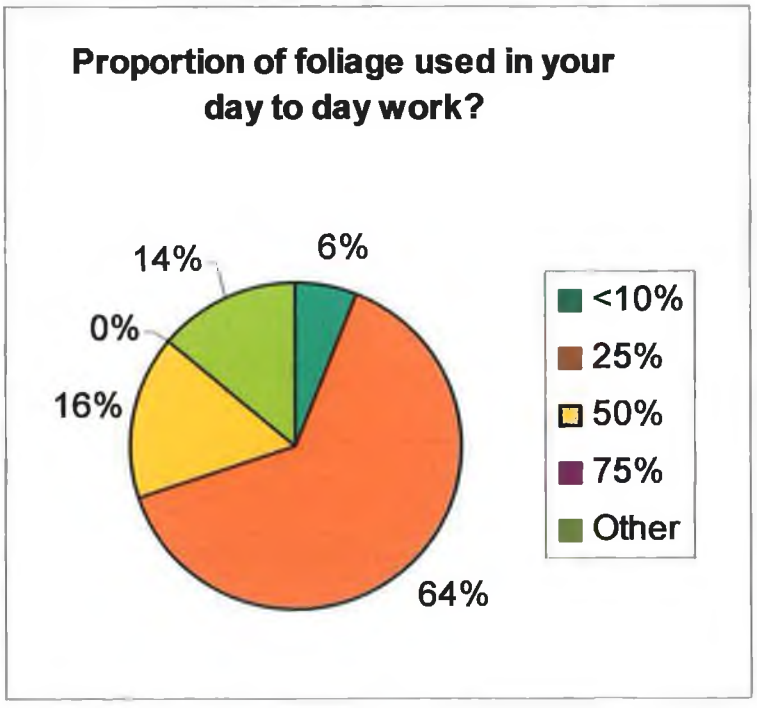
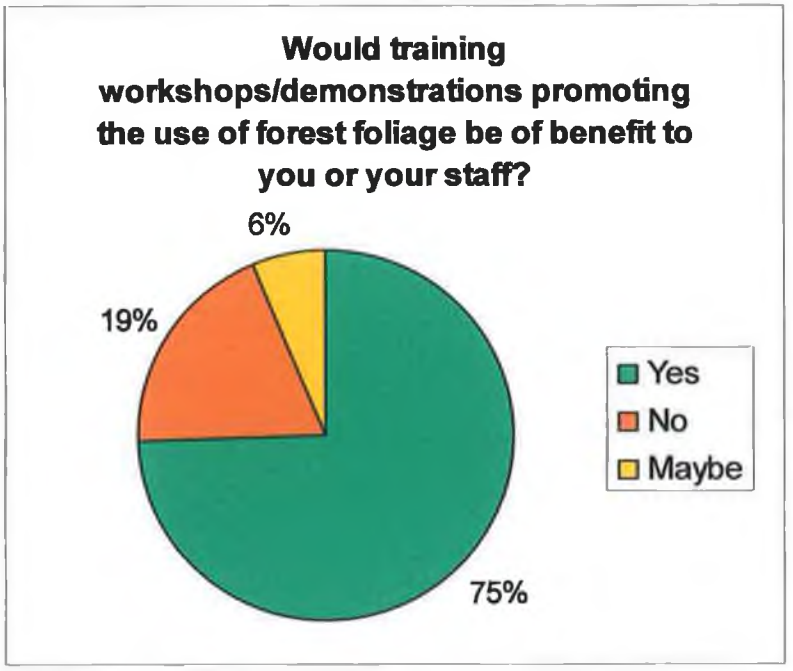


Figure 29: Response to Question 10.



Box 7: Comments Received from Florists

- 'A supply of green, fresh moss, not bagged but boxed, clean and not scrappy & muddy like the bagged fresh moss. I don't use it anymore as there is no supply.'
- 'We spend 19% of our total flower budget on greenery.'
- 'Price is all important as we are still educating Irish people re cost of greenery as they think it is for nothing.'
- 'Japanese larch would be a very pretty fresh foliage to use in hand ties etc – but will it drink water and last well?'
- 'Laurel would be another forest foliage I believe is underused in Ireland.'
- 'Mixed wreaths made with varied foliages eg. Noble fir, goldcrest & say bog myrtle but specifically not ordinary cupressus'
- 'Foliage choices could be expanded in Ireland.'
- 'With regards to glittered foliage and pre-greened baskets, would have to see live sample before deciding on purchase. This also applies to wreaths. Not sure on forest certification – I presume it gives permission for the cutting of foliage, trees etc. I would not like to purchase foliage if it was "stolen" from forests.'
- 'I think that the varieties are too similar. There needs to be a more varied selection of textures eg: glossy leaves, various shapes and sizes.'
- 'To Q8: Not glittered foliage such as Noble fir but glittered twigs.'
- 'Buxus sempervireus is a very nice foliage which can also grow in forest and is not really used in Ireland, pity.'
- 'As an Irish florist and shop owner with a horticultural diploma if I could buy competitively more foliage, flowers and environmentally friendly wrapping materials, produced in Ireland, I would. Purple pittosporum, cherry blossom, photinia red robin, cornus, alba siberica, variegated ivy – large leaf and small leaf trailing varieties, phormium – many varieties.'
- 'We used a lot of pulver (Eucalyptus) a couple of years ago..about 75%. Then the crop failed..after that we were stuck. We found salal and since then we use at least 80/90% salal. We like a variety of greenery, it adds to the texture of bouquets.'
- 'Foliage for funeral work needed'
- 'I think foliage should be kept natural (that's my own opinion!)'

5.6.1 Questionnaire - Conclusions

Response to the questionnaire was quite high with 47% of questionnaires being returned. Key findings include

- 81% of florists perceive a difference between forest and cultivated foliage.
- 98% of florists see an advantage in grading forest foliage.
- 81% of florists have not heard of forest certification.
- Of those that have heard of forest certification, 100% said it would make a difference to them.
- 75% of florists would be interested in attending training/workshop promoting forest foliage.

Plate 35: Designer Richard Haslam Demonstrating the Use of Forest Foliage to a Group of Florists

6.0 DISCUSSION

6.1 General Recommendations

While individual recommendations for each of the trial species are presented in the results section, key management considerations for forest foliage production are discussed below. The Code of Best Forest Practice produced by the Forest Service should be consulted at all times especially in relation to the final timber crop.

6.1.1 Access

Good access to plantations is essential for any commercial forestry venture. This is especially relevant for sites managed for forest foliage production. Not only is a good quality road network necessary to facilitate establishment and maintenance operations, it is also important for haulage of foliage products.

It is worth considering the following; a 20 stem bundle of Noble fir foliage can weigh between 3 and 5 kilograms. If an average harvester cuts 1000 Noble fir stems over the course of a day, this equates to between 150 and 250 kilograms of foliage, which would then need to be hauled out of the forest. Without a high quality road network to facilitate extraction, prohibitive costs involved in getting the product to the roadside may affect the profitability of a forest foliage enterprise.

6.1.2 Species Selection

While the majority of forest foliage species are recognized as Christmas items, it is worth paying attention to species that may be marketed outside the Christmas period.

The following other factors should be considered when choosing a species for forest foliage production:

Market Requirements

As previously mentioned, the market demand for foliage products is very much affected by trends and fashions. While a clear demand exists for Christmas species such as Noble fir and Lodgepole pine, it can be difficult to coordinate large-scale harvests of these products due to the difficulty in recruiting and training harvesters for a short period of time. Consequently, attention should be given to forest species suitable for use outside the Christmas period. Along with existing species such as birch and larch, new species trials conducted as part of this project play an important role in identifying new foliage candidates. Market research can also play a role in determining what species to plant. Recently, buyers have indicated that scent is a key factor in selecting foliage products. This may be attributed to the fact that many flowers are no longer fragrant. (Pearson, S. 2007). Another emerging trend is for bouquets to indicate seasonality Harris (2007, pers. comm.). This is a trend which may encourage greater use of forest species. For example, the use of species with catkins or buds in spring or berried stems and twigs in autumn.

Site Conditions

As for any afforestation program, species should be matched to individual site conditions. As foliage removal may reduce the crops photosynthetic ability, it is recommended that good quality, well-drained sites be selected for forest foliage production.

Establishment Costs

Many successful forest foliage species have a higher establishment cost than species usually grown for timber production. For example, the Coillte nurseries website quotes prices for 2 year old Sitka spruce seedlings as 61.67 cent/tree and 74.89 cent/tree for Western hemlock seedlings. Currently, nurseries producing Monterey cypress Goldcrest plant for forest foliage production charge €1 for a 2 year old plant.

Foliage Yields

Species selected for foliage production should possess good branching habit and fast growth rates. Attractive species, desired by the market may not be the most financially viable if yields/tree are low. This was found by foliage growers to be the case with one variety of Eucalyptus. *Eucalyptus pulverulenta* is a very attractive foliage. It is highly scented, has attractive circular leaves and adds volume to bouquets. However the amount of foliage produced per tree is substantially less than other Eucalyptus species, thus returns to the grower may be lower. New species trials play an important role in identifying high yielding varieties.

Amenity Values

Many forest foliage species possess high recreation and amenity values. Numerous opportunities exist for growers to develop their foliage enterprises into complementary ventures. Multi award winning Woodlands Caravan Park in Tralee, Co, Kerry have used commercial forest foliage species to provide an attractive landscape for their visitors. During the off peak season, the owners have operated a depot selling Christmas trees, wreaths and other locally produced crafts.

6.1.3 Monitoring Forest Foliage Crops

After establishment, crops should be monitored as outlined in the Code of Best Forest Practice. Once the plantation is well established and at the stage where foliage production is being considered, it is recommended that a minimum of five annual site inspections be carried out. These should be carried out:

- Three times during the growing season
- Once 6 weeks prior to foliage harvesting
- Once 6 weeks post foliage harvesting

A checklist of the following should be carried out on each site examination;

- Nutritional requirements
- Competition from vegetation
- Pest or disease damage
- Stand tending requirements
- Inspection of drains, fences and roads

6.1.4 Staking

Certain forest foliage species may display prostrate growth and as a result would need to be staked in the first few years. Of the species examined in this report, Monterey cypress Goldcrest appears to be the only one where this practice may be necessary. This activity can be labour intensive and costly. The use of good quality planting material and care during establishment is believed to alleviate the need for staking

6.1.5 Thinning

The availability of light plays a vital role in the development of good quality, healthy foliage stems. This is especially true of Noble fir plantations where overgrown Christmas tree plantations need to be thinned prior to foliage harvesting. The timing of this is very important: if trees are allowed to grow into each other, lower branches will die off thus effecting site productivity.

Thinned trees should be felled, cut into 1-2 meter lengths and neatly stacked under remaining trees unless a market is found for the timber. It is recommended that all commercial standard foliage should be harvested from trees prior to felling so revenue generated can be used to subsidize thinning costs.

6.1.6 Packing Facilities

Another factor growers should consider is that packing and storage facilities are required prior to the dispatch of foliage products. While this can be pretty basic for twig products and foliage stems from hardy species like Noble fir, a lot of other forest foliage products need to be stored in water and protected from the elements. Whelton, (1995) identifies the need for cold storage to remove field heat and to store and preserve foliage in fresh quality. While the costs involved in establishing a suitable cold storage depot may be too much for a single producer. It may make sense for a co-op of growers to establish their own plant. Another option is to utilize the service of a middleman who already has these facilities.

6.1.7 Health and Safety

Health and safety considerations relating to general forest management practices are discussed in the Code of Best Forest Practice. It is highly recommended that landowners request foliage harvesting contractors working on their property to provide public liability and employer's liability insurance cover.

The following have been identified as potential health and safety issues for forest foliage production.

- Cuts from secateurs
- Falls due to poor terrain
- Facial/eye injuries from tree branches

A suitable first aid kit containing assorted plasters, bandages, saline solution, as well as sterile scissors and tweezers should be kept on hand at each forest foliage site. Telephone numbers for the nearest doctor/hospital should be included in the kit. It is recommended that field supervisors receive regular training in first aid.

- R.S.I.

Harvesters may suffer from repetitive strain injury to the hand and wrist from foliage harvesting. This may be due to poor harvesting technique or the use of inappropriate equipment. It is recommended that adequate training be provided by experienced foliage harvesters. Also the choice of secateurs used may reduce the risk of R.S.I. After testing many different brands, staff at Forest Produce Ltd in Kerry have selected a secateurs produced by German manufacturer Loewe-Scheren as the most ergonomic for forest foliage harvesting[6].

- Skin reactions/Allergies

A number of people may develop allergic reactions after handling forest foliage. With the number of people suffering from allergies on the increase globally, future research should explore if any harmful or toxic chemicals are produced from foliage species. It is recommended that gloves be worn by harvesters to avoid possible irritation to the hands.

6.2 Financial Returns

Using data collected in the trials and based on current prices paid to growers, the following tables give a rough estimate of the standing value of foliage in commercial timber crops.

Table 46: Japanese Larch Foliage Values

Japanese Larch			
	2005	2006	2007
Mean # Stems/Plot[7]	199	283	243
Value/Plot	5.97	8.49	7.29
Value/Ha €	**597**	**849**	**729**

[6] The secateurs model selected for forest foliage harvesting is original lowe 1, art. Nr. 1104. See www.loewe-scheren.com.

[7] Data was taken from plots subject to treatment T3. For this treatment the timber and foliage crop were treated separately. The number of stems/plot refers to the total number of commercial standard foliage stems harvested from foliage trees and any removed from timber trees during pruning operations.

Table 47: Monterey Cypress Goldcrest Foliage Values.

Monterey Cypress Goldcrest			
	2005	2006	2007
Mean # Stems/Plot	414	636	550
Value/Plot	12.42	19.08	16.5
Value/Ha €	**1242**	**1908**	**1650**

Table 48: Western Hemlock Foliage Values.

Western Hemlock			
	2005	2006	2007
Mean # Stems/Plot	311	205	91
Value/Plot	9.3	6.15	2.73
Value/Ha €	**930**	**615**	**273**

A level of caution is advised regarding the above figures as harvested foliage yields were measured systematically and for scientific purposes. In reality, harvesters tend to be paid on per stem basis and without adequate supervision they are likely to only harvest stems within easy reach. Also additional costs involved in establishing and maintaining plantations for forest foliage production as discussed in section 6.1 have not been taken into account. This is especially true of Monterey cypress Goldcrest where plants may need to be staked early on in the rotation. Bearing all this is mind, it is the opinion of this researcher that well maintained forest foliage plantations should generate a minimum revenue of €500/ha over at least a 3 year period.

While the trials were subjected to 3 successive years of foliage harvesting, observations indicate that the plantations will continue to provide stems for the next number of years. Industry experts maintain that good quality forestry sites should supply foliage stems annually for a period of 10 years. Feedback received suggests the three key factors affecting profitability are:

- Market demand
- Quality of foliage
- Volume of foliage/hectare.

6.3 Timber and Foliage Dual Crop.

It is suggested from this research that foliage and timber can be co produced from the same plantation. In relation to the final timber crop, it is proposed at this stage that foliage operations should not have an adverse effect on the production of timber if the crop is located on a good quality site. While much more information will be gleaned in the coming years, it is suggested that a more detailed financial analysis be carried out at to assess the economic viability of achieving the dual objectives of foliage and timber production.

6.4 Author's Observations Noted at Trial Sites.

Yields increased for all species the second year after harvest. This may have occurred as lateral branches too short for foliage harvesting in year 1 had achieved sufficient length by the second year. For the Noble fir site, it is thought that a number of stems deemed unsuitable the first year due to poor colour, may have attained commercial standard in year 2 due to greater exposure to light and/or the increase in nutrients attained from the needles of thinned trees.

It was observed in areas of the Monterey cypress Goldcrest site that a number of oak seedlings had naturally germinated among the conifers. It is recommended that these trees be protected and encroaching conifers gradually removed. In addition, a number of birds' nests were found in the branches of Goldcrest trees which would suggest that this species may be beneficial in terms of biodiversity.

Plate 36: Oak Seedling

6.5 Limitations of the Study

While every effort was made to ensure experimental work conformed to scientific protocols, the sample size was limited to the allocated sites and the available number of trees. As this research was essentially a pioneering study, there remain some questions regarding the appropriate time of first harvest which were outside the scope and timescale of the project. It is recommended that the trials be repeated in younger plantations to ascertain when the optimum time of first intervention should be.

While researching the topic, only English language publications were consulted in this project. In future, it would be worthwhile to search for information in other languages. Several European countries are involved in the floriculture industry and it would be useful to make contact with researchers in this area to gain further knowledge of the industry.

6.6 Further Research

At present, there is relatively little information available to individuals or groups wishing to enter into the forest foliage industry. For example if a farmer wishes to plant an area of his farm with a commercial foliage species such as *Pittosporum* spp, he will contact a horticultural advisor who will provide him with clear guidelines. If the same farmer already

has a woodland with good quality birch foliage, currently there is no advisory service available for him. As Collier et al. (2004) identified "The formal education training and advisory services do not have the capacity at present to make a significant input to the development of NWFPs". As a result, the majority of forestry advisors and consultants simply do not have the expertise to offer guidance. Previous research has also shown that there is a need for enhanced co-ordination between the agriculture and forestry services within Teagasc (Collier et al., 2002). For forest foliage production, much knowledge can also be gleaned from the horticulture sector.

The lack of available information from suitably qualified individuals impedes the development of forest foliage and indeed many other potentially viable NWFP enterprises. Further research and development is essential to promote this important forest use.

It is recommended that a centre be established to provide research, development and support facilities to potential NWFP entrepreneurs, farm foresters looking to diversify, students of forestry and forest managers. Several regions in the United States and Canada already offer such services and their establishment has brought huge benefits to the forestry industry and the rural communities supported by it.

With the forest foliage industry in Ireland set to expand, it is important that it receives appropriate support. While research has been identified as a crucial component to the success of forest foliage and other NWFPs, it is equally important that findings are efficiently and effectively transferred to the sector and incorporated into land-use planning and policies.

Possible areas for further research include

- Waste management

Including the potential of composting waste foliage and timber and extracting the energy generated.

- Environmental Issues

The main areas would be; certification of NWFPs including forest foliage, calculating the carbon footprint of foliage products and the ecological effects of foliage harvesting.

- Extraction of Aromatic Compounds

Scent has been identified as a key factor in the market for forest foliage (Pearson, 2007). Many commercially grown forest species possess fragrances and as yet are unknown in the marketplace. Also the oils and extracts of certain woodland plants are known to provide health benefits. Screening for toxic substances should also be carried out on foliage plants.

- Primary Product Production

This involves continuing on the work already carried out over the last few years. Key areas are; investigating new species, developing existing forest and woodland species such as alder and western red cedar, development of harvesting protocols, shelf life testing and crop protection.

In general, value-added craft products are the most profitable, supplying a lucrative giftware market (Williams, 1997). For forest foliage production further investigation is required into value adding processes such as, painting, glittering and the addition of glycerine or preservatives.

- Industry Development

As the foliage sector is an important contributor to rural development, it is suggested that a marketing strategy for the industry be developed and assistance be provided to growers in product development and promotion.

- Training and Development

An educational program should be developed for forestry advisors, managers and students of forestry. Also training in the production of woodland craft items should be provided to farm

foresters to enable them to generate additional income through direct selling from their plantations.

6.7 Conclusions

Feedback from industry experts indicates that the amount of both cultivated and forest foliage currently produced in the country needs to increase rapidly to meet existing market demands. This is an issue that requires immediate attention if the industry is to fulfil its potential.

One possible way of making foliage production more amenable to landowners may be through the agroforestry system known as silvoarable agroforestry. This practice, popular in France and other countries, involves intercropping plant species (in this case various foliage species such as *Prunus* spp., *Pittosporum* spp & *Salix* spp.) within a forestry setting. As well as increasing the level of afforestation, this system would diversify agricultural practices and provide an alternate revenue source for landowners.

According to Eichhorn et al. (2006) "there are economic, environmental and aesthetic reasons to encourage the adoption of silvoarable agroforestry systems in all regions of the European Union". The same paper cites the following European Council Regulation on support for rural development by the European Agricultural Fund for Rural Development (EAFRD):"Agriforestry systems have a high ecological and social value by combining extensive agriculture and forestry systems, aimed at the production of high quality timber and other forest products. Their establishment should be supported" (EAFRD, 2004 cited in Eichhorn, 2006).

As land management systems such as this are not conducive to current Irish forestry or agriculture policy, political promotion would be required on a national basis to lobby for the necessary changes. Technical research into species compatibility and shade effects would also need to be carried out.

As forest foliage to date has only been harvested from well-established plantations, there is a need to investigate the optimum spacing for planting trees for the purpose of foliage production. A large-scale experiment exploring various spacings and incorporating some of the more unusual forest tree species such as *Sequoia* and *Thuja* would be a huge benefit to the industry.

In addition to planting more forest foliage species, foliage could theoretically be harvested from forests due to be felled. Forest managers could liaise with foliage harvesters to remove marketable material prior to thinning or clearfelling operations. As well as harvesting material from suitable tree species, the possibility of harvesting moss from commercial plantations due for clearing may also be worth investigating. Another area for exploration is the use of boundaries or ridelines in commercial forests to produce foliage and other NWFPs.

As with other NWFP production, the development of foliage grower co-ops can provide many benefits to its members. With the establishment of such organizations, producers are less likely to be individualistic and the industry is more likely to succeed. In the foreword to Cocksedge (2001), Turner states "Co-operatives and the networks they sustain would also facilitate research, training and education in matters such as ecoforestry, agroforestry, sustainable harvesting techniques, plant propagation and enhancement, marketing and product development, and quality control of products. They would also assist participants in obtaining certification for their products, as well as in advertising and marketing." For state forestry, research in the USA suggested that agency-harvester collaborations could be used to develop and expand NWFP inventory and monitoring programs. (McLain & Jones, 2005)

In this time of transition, any rural enterprise that provides short-term cash flow while protecting long-term financial viability and at the same time maintains environmental integrity should be seriously considered by policy makers and governments. Ireland has a distinct advantage in that the climate here is highly suitable for foliage production. With further research, development, and training NWFPs such as foliage can look forward to playing a greater role in the sustainable management of Irish forests.

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APPENDICES

APPENDIX 1 – Trees in Modern Irish Literature

APPENDIX 2 – Forest Foliage Species for Investigation

APPENDIX 3 – Location Maps

APPENDIX 4 – Cover Letter & Questionnaire

APPENDIX 1 – Trees in Modern Irish Literature

Priest and author, Fr. Pat Moore discusses the inspiration of trees and forests in the work of two contemporary writers. Personal communication with Amy Costello 17/02/08.

"In John O Donohue's best selling poetry book 'Conamara Blues' (Bantam Books, 2000), one of his poems is called 'The Angel of the Bog'. As he sits in a bog in Conamara, the poet imagines what the vanished life of the bog was like. He makes it visible for us, the reader by imagining the 'Angel of the Bog' mourning in the wind that 'loiters all over these black meadows'. What the wind remembers is how it made music through the leaves of the trees that stood there, how the birds came to nestle in it's branches at twilight, how raindrops filtered through the leaves onto the dust on the ground. Now that the trees are gone, it plays music on the grasslands and remembers so that 'a vanished life might become visible'.
This experience by a contemporary Irish poet gets in touch with the Irish psyche and shows the depth at which the forest is to be found in our archetypal community thinking and feeling.

John Moriarty in his book 'Dreamtime' (Lilliput Press, 1994) describes how a sleánman cutting turf in a bog comes across an old forest down at the depth of the seventh sod. Among the debris, he finds a pair of old shoes which he puts on. He ties the laces on the shoes up to his knee and they bring him on a journey into ancient Ireland. He has to cross over into the way of the otter, which would be his animal instinct in himself. He has to pass by the lake which mirrors no reflection and he finally arrives in a smoke filled cabin where he meets his own collapsed self. This cabin is in the middle of a forest and the reason it is placed there is that in all European literature the forest is the place where confusion and the doldrums of life are to be experienced.
" Midway upon the journey of our life
I found myself within a forest dark,
For the straightforward pathway had been lost." - Dante's Inferno"
The journey that the writer describes brings him back to himself, to a place where he sees himself in a new light for the first time.

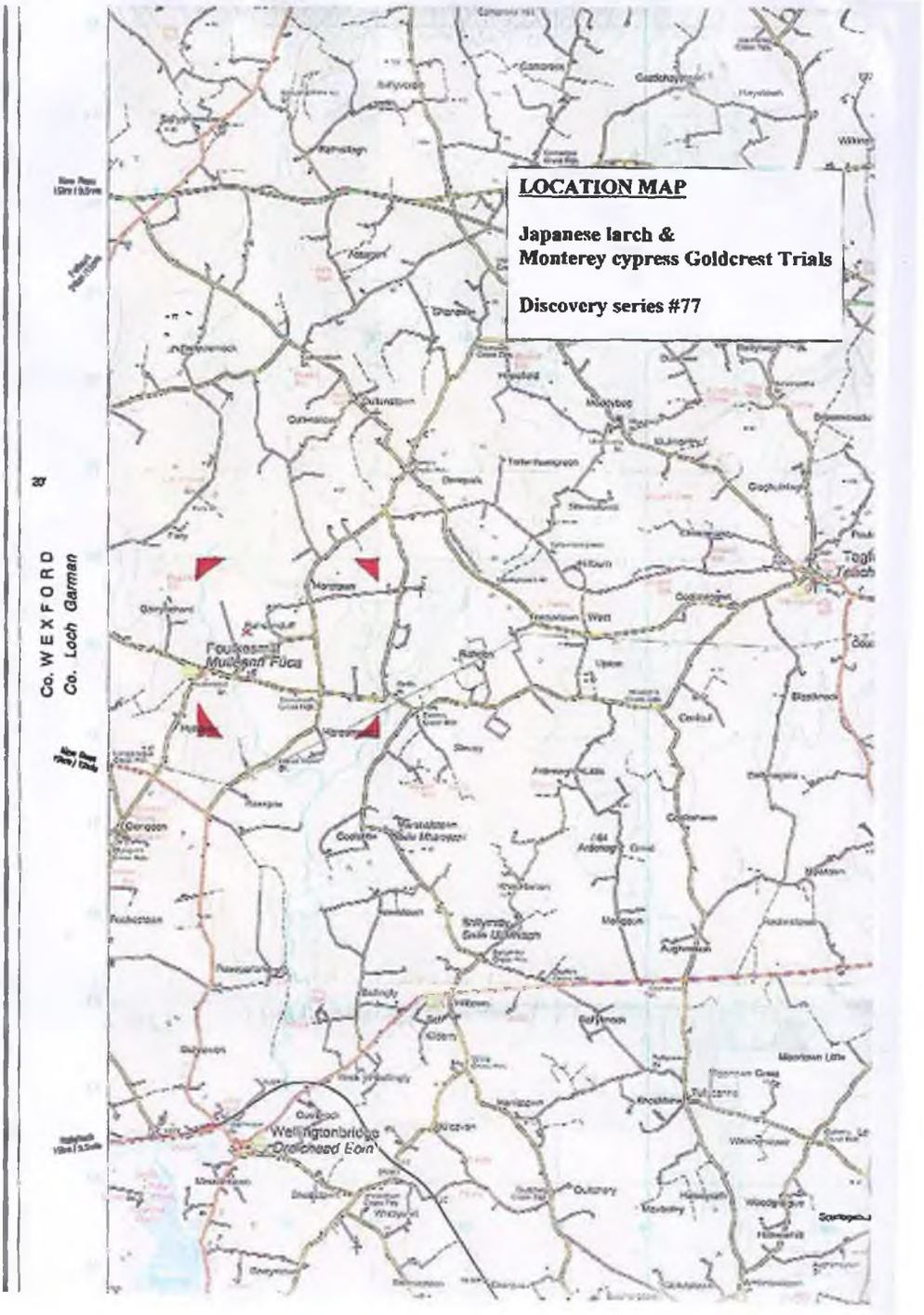
O' Donohue and Moriarty, both philosopher poets, have correctly highlighted the centrality of the forest in the Irish experience."

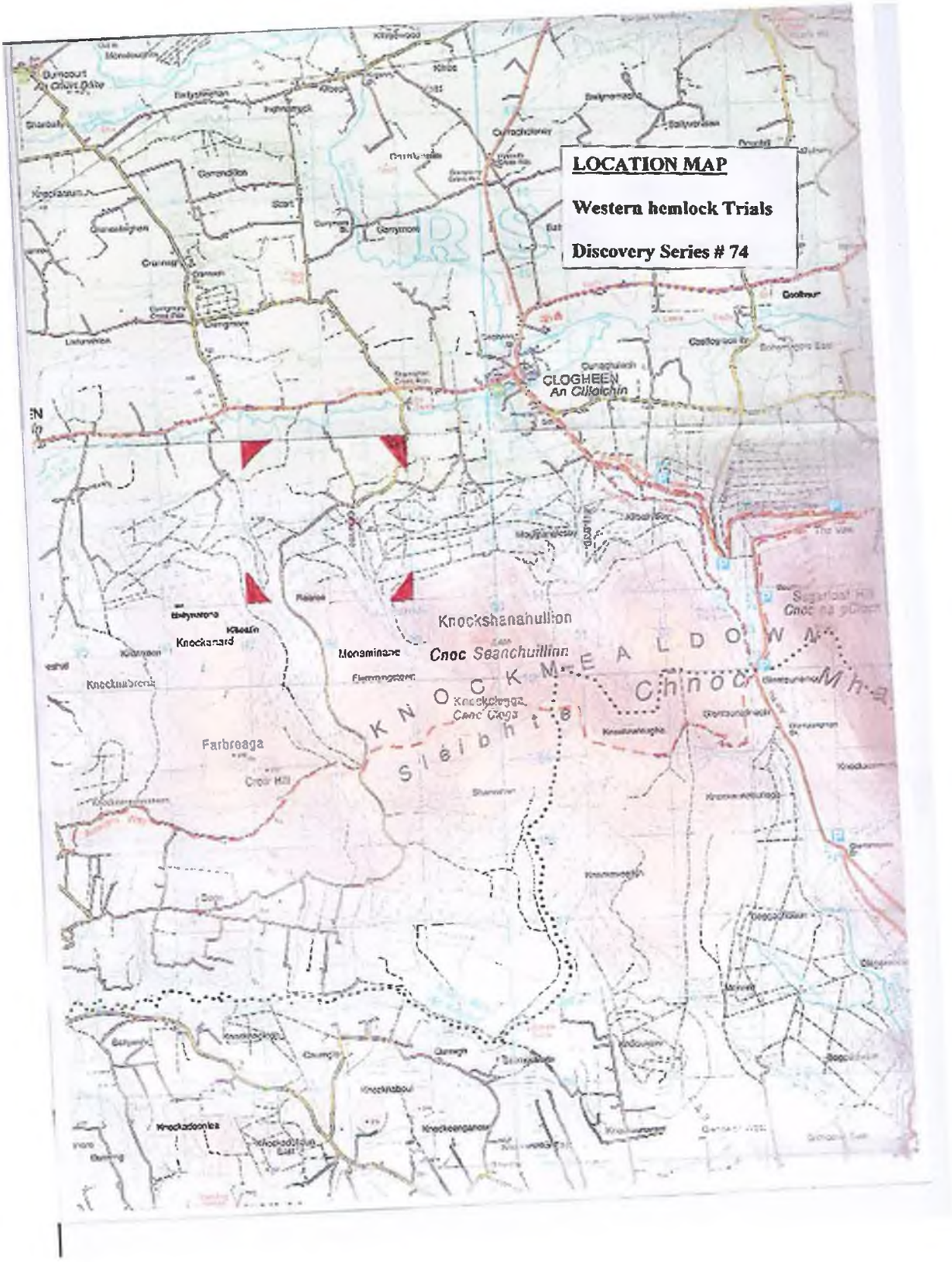
APPENDIX 2 - FOREST FOLIAGE SPECIES FOR INVESTIGATION

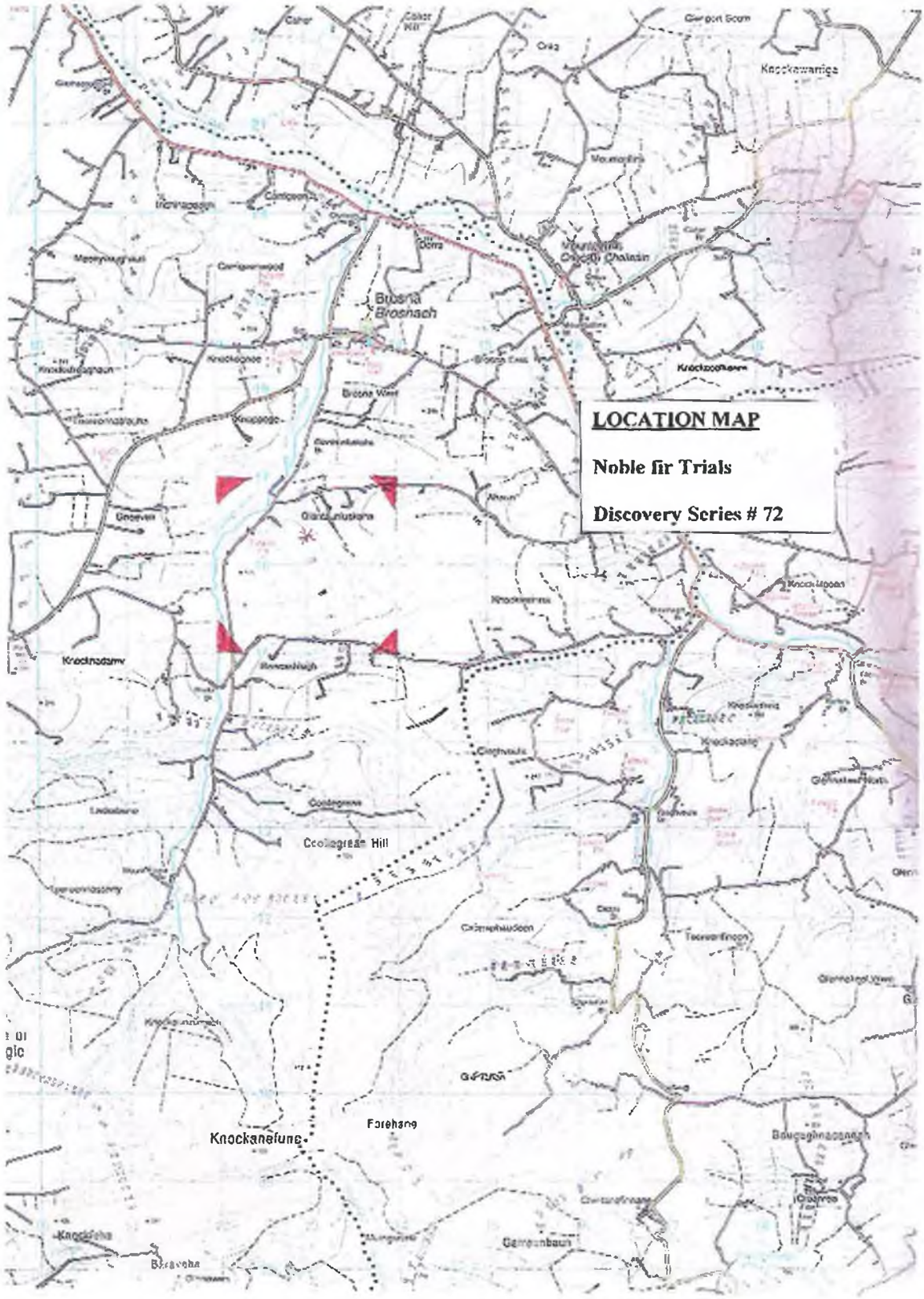
Species	Common Name	Position in Irish forestry	Timber qualities	Foliage qualities		Other benefits
Tsuga heterophylla	Western hemlock	On Forest Service list of approved species – diverse conifer	Pale brown, non-resinous timber. It is not naturally durable and needs to be treated with a preservative, which it takes well for outdoor use. Used for general structural purposes and in manufacture of windows and doors. Also used in paper production and in manufacturing of rayon cellophane and other plastics	Availability	Christmas product also works well with Spring flowers	One of 5 best species for absorbing CO2 Shade tolerant species. Will grow as an understory in broadleaf and coniferous plantations
				Storage & Transit	Stored in water, may be transported dry.	
				Market Category	Commodity and Design[8]	
Larix leptolepis	Japanese larch	On Forest Service list of approved species – diverse conifer	Larch has a distinctive reddish brown heartwood, which is naturally durable and strong. It is used for fencing, gate material, boat building and other outdoor uses. Also used as a flooring material and is often selected for use by architects and designers because of it's attractive reddish colour.	Availability	Attractive, lime green needles during spring, also market for winter twigs with cones.	The only deciduous conifer used in Irish forestry, Japanese larch possesses high amenity values. Very attractive landscape tree.
				Storage & Transit	Water is vital for spring foliage. Winter twigs can be stored and transported dry.	
				Market Category	Commodity and design	
Cupressus macrocarpa	Monterey cypress	On Forest Service list of approved species – diverse conifer	Popular timber species in Australia and New Zealand. Used in furniture, turnery and in boat building. It is a durable timber and can be used untreated as weatherboards or shingles.	Availability	Year round	High amenity value. "Bushy" form provides habitat for birds and wildlife.
				Storage & Transit	Water	
				Market Category	Commodity and Design	
Abies procera	Noble fir	Grown primarily for Christmas tree production not timber. Not subject to grant approval	In Ireland, Noble fir timber is (perhaps unfairly) regarded as being inferior. In North America, Noble fir timber is regarded as highly desirable due to it's strong, lightweight wood. It was used in the construction of World War II fighter planes because of its high weight/strength ratio.	Availability	Christmas product	Popular species for Christmas trees. Highly scented.
				Storage & Transit	Dry, known as a "non shed" species.	
				Market Category	Commodity and design.	

[8] Commodity refers to bulk markets e.g. supermarket bouquets, design suggests more artisan use e.g. florists.

APPENDIX 3 – LOCATION MAPS


LOCATION MAP
Japanese larch &
Monterey cypress Goldcrest Trials
Discovery series #77
Co. WEXFORD
Co. Loch Garman
Wellingtonbridge
Oylegate


LOCATION MAP
Western hemlock Trials
Discovery Series # 74
CLOGHEEN
An Clochán
Knockshanahullion
Cnoc Seanchuillinn
Knockanard
Monaminane
Farbreaga
Knockadoonlea


LOCATION MAP
Noble fir Trials
Discovery Series # 72
Broona
Broonach
Knocknadamv
Coolegrean Hill
Knockanefune
Forehane

APPENDIX 4 – COVER LETTER & QUESTIONNAIRE

Dear Florist,

I am a student at Galway Mayo Institute of Technology currently undertaking an MSc on the subject of forest foliage.

I would be very grateful if you would complete the attached questionnaire and return it in the stamped addressed envelope provided. While my work is focused on a number of coniferous species, I would appreciate any suggestions you have for further research.

Thank you for your cooperation and may I wish you a productive and profitable year.

Yours sincerely,

_____

Amy Costello

FOREST FOLIAGE QUESTIONNAIRE

Thank you for taking the time to answer this questionnaire. Forest foliage refers to any species growing in the forest environment that may be harvested and used to enhance floral arrangements. While this research is focusing on Noble fir, Western hemlock, Japanese larch and Monterey cypress (Goldcrest), I welcome any comments you have on other varieties found growing in our forests.

Name :_____

Location:_____

Q1. Do you perceive a difference between wild forest species and cultivated horticultural foliage species?

Yes ☐ No ☐

Q2. Of the four species being examined, which would you regard as being suitable for use **outside** the Christmas period (Photographs A-D)?

Noble fir ☐ Japanese larch ☐ Goldcrest ☐ Western hemlock ☐

Q3. Have you heard of forest certification?

Yes ☐ No ☐

If yes, would it make a difference to you if foliage was harvested from certified forests?

Yes ☐ No ☐

Q4. Do you see an advantage in grading foliage material?

Yes ☐ No ☐

Q5. Regarding grading, which grades of Noble fir (blue spruce) do you find more useful

Short compact pieces ☐

55-70cm boughs ☐

Mixture of both ☐

Other (Please State) ☐

Q6. At busy times, would you be interested in pre greened baskets, table centres or other part assembled items (see Photo E)?

Yes ☐ No ☐

Q7. Would you be interested in wreaths made from species other than Noble fir (Photo F)?

Yes ☐ No ☐

Q8. Would you be interested in glittered foliage such as in Photograph G?

Yes ☐ No ☐

Q9. Proportion of foliage used in your day to day work

<10% ☐

25% ☐

50% ☐

75% ☐

Other (Please State) ☐

Q10. Would training workshops/demonstrations promoting the use of forest foliage be of benefit to you or your staff?

Yes ☐ No ☐

Q11. General comments

Photo A: Noble fir

Photo B: Japanese larch

Photo E: Greened Arrangement

Photo F: Wreath

Photo C: Goldcrest

Photo D: Western hemlock

Photo G: Glittered foliage