An Economic Evaluation of the Market and Non-Market Functions of Forestry

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1 Executive Summary

This study had the following objectives:

1. To provide strategic information by indicating the relative benefits of forest management practice respectively directed at the outputs of recreation, biodiversity, landscape, water quality and carbon sequestration;
2. To estimate the relative public benefits of public forestry and private forestry, including farm forestry;
3. To demonstrate the net public benefit of forestry in comparison with other land uses;
4. To determine the direct and indirect contribution of the tradable goods and services of forestry to the national and regional economies;
5. To examine those factors which determine public benefits and determine if benefit transfer estimates from abroad would be applicable to Ireland;
6. To place values in a public cost-benefit framework by comparing policy cost with the social benefits and combining this information with the private costs and benefits motivating forestry uptake over time.

The technique used to assess the economic impacts of forestry and the wood products sectors was input-output analysis. To assess the non-market benefits of forestry, a sample of the adult population of Ireland was surveyed. A choice experiment was administered to the sample of 996 people to estimate the relative benefits of an afforestation programme defined by the following attributes: species type (conifer; broadleaf; mixed); biodiversity reserve areas (0%, 15% and 30% of the forest area), harvesting (clearfell; single tree harvesting), access for recreation (none; access on a single trail, access on trails and basic facilities) and forest location (close to cities and towns, in the wider countryside, in remote upland areas). The inclusion of a cost attribute in the choice experiment allowed "willingness to pay" (WTP) values to be generated where a WTP value is the mean amount of money that an individual is willing to pay annually in additional tax to support an afforestation programme that provides that attribute.

Key findings

- In 2010, direct output in the forestry sector was €379.8 million. Of this €31.7 million represented gross value-added (GVA) which was 0.02% of Gross Domestic Product (GDP) or 0.024% of Gross National Product (GNP).

- The type 2 output multiplier for forestry was 1.78, thus for every one million euro in expenditure in the forestry sector a further €850,000 in expenditure was generated in the rest of the economy. When the indirect and induced effects were taken into account using the multipliers, the overall value of forestry to the Irish economy was €673.0 million in 2010.

- Direct employment in forestry was 3,125. The type 2 employment multiplier was 1.77, thus for every 100 jobs in the forestry sector an extra 77 full-time equivalent jobs were provided in other sectors of the economy. Accounting for the induced and

indirect effects, the total employment supported by the forestry sector was estimated to be 5,531.

- Direct output in the wood products sectors (i.e. panel board mills, sawmills and other wood products sector) was €1330.9 million. Of this €375.2 million was gross value-added (GVA) representing 0.24% of GDP or 0.29% of GNP.

- Output and employment multipliers for the wood products sectors were somewhat lower than for the forestry sector. The output multipliers for the panel board mills, sawmills and other wood products sector were 1.61, 1.70 and 1.65 respectively while the employment multipliers were 1.62, 1.72 and 1.61 respectively.

- The multipliers were used to determine the indirect and induced impact of the three wood products sectors. The total value to the economy of the three sectors was €2.20 billion.

- Direct employment in the wood products sectors was 3,907. When the indirect and induced employment impacts are derived using the employment multipliers, the wood products sector supported a total of 6,408 jobs.

- Regional multipliers for forestry were lower than the national figures. The output multiplier for the South-East Region was 1.43, for the West Region 1.36, while for the BMW Region it was 1.30. These lower multipliers reflect the leakage of economic activity that arises due to the expenditure on inputs from outside the regions as well as the spending of wages and salaries from forestry outside the region.

- A full cost-benefit analysis of game hunting in Irish forests is long overdue; a rough estimate of the value to the economy of deer hunting in 2010 was €1.8 million.

- The value of production in the forest foliage industry was estimated to be €2.5 million in 2010.

- The public ranked nature conservation and biodiversity as the most important outputs from forests. Recreation and timber production were considered the least important outputs.

- The general public were shown to support the afforestation programme and were willing to contribute significant amounts of money to achieve their preferred management options in the context of afforestation.

- The public expressed a strong preference that there should be public access for recreation in the forests established under the afforestation programme and that this access should be complemented with facilities. This attribute generated the highest willingness to pay (WTP) value, i.e. €89.94. In the attitudinal section of the household survey almost half of the respondents indicated that there should be public access to private forests again reflecting the importance of this attribute. Significantly those who will most likely own these new forests, i.e. those from farming households, were less likely to agree with public access.

- How the forests established under this afforestation programme would be harvested was an important issue amongst respondents. The public expressed a preference for single tree harvesting over clearfelling. This attribute generated a WTP value of €37.50.

- In this study a specific area given over for "plants and animals" was included as an attribute rather than a direct measure of biodiversity. This attribute produced WTP values of €21.07 for the 15% area and €32.95 for the 30% area, in comparison to no area being given over.

- Amongst the tree type attribute levels, mixed forests were most preferred followed by broadleaf in comparison to conifer forests, WTP values of €27.94 for mixed species forests and €20.64 for broadleaf forests were generated.

- The public expressed their preference for forests to be established close to urban areas and in the general countryside rather than in more remote areas. Given the increasing urbanisation of the Irish population (65% and 32% of the sample chose the close to cities and countryside label respectively as representing where they live) such a result is unsurprising.

- The volume and value of the carbon sequestered under a number of afforestation scenarios were estimated. This ranged from 195 million tonnes of carbon being sequestered by 2060 in if 21,397 ha were planted annually between 2011 and 2030 assuming pure conifers were planted and 0% of the area set-aside for biodiversity to 31 million tonnes if pure broadleaves were planted and 30% of the area set-aside for biodiversity.

- An indicative cost-benefit analysis found that the net present value (NPV) of the public's willingness to pay for an afforestation programme comprised of mixed species rather than broadleaves compensates for the loss in value associated with timber production and carbon sequestered. Similarly, willingness to pay values for including either a 15% reserve area or 30% reserve area for biodiversity compensates for the loss in carbon and timber. In the case of planting pure broadleaves rather than conifers the public's willingness to pay does not compensate for loss in these outputs.

- Empirical data on the impacts of afforestation on water quality suggests that quality can be maintained where planting conforms to best practice. The information on the impact on water supply is scant for Ireland. It seems likely that additional forestry will store more water. In the context of climate change, this is likely to have a negative effect on those areas that are at risk of reduced rainfall and possible drought. On the other hand, forestry is likely to provide a buffer to flash flooding induced by more extreme weather conditions, although information on the adequacy of this buffer in an Irish context is deserving of more research.

2 Background

Forestry in Ireland, as indeed elsewhere in Europe has changed over the last 30 years. Society's demands have evolved and the "industrial" timber-production model of forests no longer dominates. Instead today, the market, which is driven by an increasingly urbanised society, demands that forests deliver multiple benefits, including economic, environmental and social benefits such as:

- timber
- outdoor recreation;
- supporting and enhancing biodiversity;
- contributing to the visual quality of the landscape;
- taking up carbon from the atmosphere;
- regulating water supply and water quality.

Early attempts at placing a value on the benefits of forestry in Ireland were largely limited to assessments of the value of timber production (e.g. Gray, 1963) with some cognisance taken of the "social" benefits such as job creation and the secondary effects from the purchase of machinery (e.g. Forest and Wildlife Service, 1983). Murphy and Gardiner (1983) carried out the first study on the non-market value of forests in Ireland when they determined the annual recreational value of Portumna Forest Park. Following on from this, the EU CAMAR project assessed the recreational value of the existing forest estate using both the travel cost and contingent valuation methods (Ní Dhubháin et al., 1994). Subsequently a comprehensive assessment of the net non-market benefits of Irish forests was carried out by Clinch (1999). Clinch's estimate of the total economic value of forestry accounted for the timber component as well as the assignment of values to a number of external benefits including carbon sequestration, water, recreation, tourism, biodiversity and landscape.

A number of assessments of the economic impact of forestry have been carried out in the subsequent period. Bacon and Associates (2004) calculated the impacts of the forestry investment programme using a cost-benefit analysis that incorporated both timber and non-timber values against the context of changes in the CAP. The estimate of non-market benefits included recreation, biodiversity and carbon sequestration. The last of these estimates was based on the value of carbon trading, while those for recreational value and biodiversity involved value transfer methods based on modified estimates for the UK developed by Garrod and Willis (1997). In 2005, forest recreation was addressed by Fitzpatrick Associates (2005) who assessed the economic value of trails and forest recreation in Ireland.

Most recently, the ECONTRIB project (Ní Dhubháin et al., 2006) quantified the contribution of forestry and timber processing to the national and regional economies, but restricted its estimates to the core social and economic impacts rather than other forest externalities. Specifically, this study evaluated the direct and indirect economic contribution of the forestry sector to the national and regional economics using input-output analysis. It also estimated the contribution of the wood products sector to the national economy.

In summary, it is apparent that a number of estimates of market and non-market benefits of forestry have been prepared over the years and a number of these have used the afforestation programme as their basis. However, none have addressed what approach to forest

management maximizes public benefits.

The objectives of this research are to:

1. Provide strategic information by indicating the relative benefits of forest management practice respectively directed at the outputs of recreation, biodiversity, landscape, water quality and carbon sequestration;
2. Estimate the relative public benefits of public forestry and private forestry, including farm forestry;
3. Demonstrate the net public benefit of forestry in comparison with other land uses;
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6. Place values in a public cost-benefit framework by comparing policy cost with the social benefits and combining this information with the private costs and benefits motivating forestry uptake over time.

3 Introduction

In environmental valuation, total economic value (TEV) is a term that offers a taxonomic deconstruction of the range of values associated with a given environmental asset. These values can be broadly divided into use and non-use values i.e. values that an individual derives directly from the good through its consumption or use directly or indirectly and values that individuals derive from a good not related to its use. Forest values include:

- *Direct use values*: values arising from consumptive and non-consumptive uses of the forest, e.g. timber and fuel, tourism;
- *Indirect use values*: values arising from various forest services, such as protection of watersheds and the storage of carbon;
- *Option values*: values reflecting a willingness to pay to conserve the future option of making use of the forest, even though no such use is currently made;
- *Quasi option values:* values of learning about future benefits that would be precluded by loss of forest resources (e.g., values related to the existence of chemical active principles not discovered yet).
- *Non-use values (also known as existence or passive use values):* these values reflect a willingness to pay for the forest in a conserved state. However, the willingness to pay is unrelated to current or planned use of the forest;
- *Intrinsic values* such as moral or ethical value, spiritual, religious and cultural value (SCBD, 2002).

In a forestry context, many direct use values are often associated with an established market such as that for timber, entrance fees for recreation or other products like foliage production. Indirect uses are associated with the broad range of ecological services supplied by forests such as water catchment protection or damage, air pollution reduction, and the sequestering of carbon for the regulation of the global climate. Although these services are rarely marketed they are often interlinked with marketed activities. For example, forests may control water pollution and sedimentation that increases water quality for human consumption or fish production. Removal of the forest may also remove this service and cause damage to water quality.

The production and consumption of most goods by an individual or firm has an impact on the welfare of others. An externality describes the situation where this impact occurs in an unintended and uncompensated way (Perman et al., 2003). Afforestation and harvesting for timber production are associated with a range of positive and negative externalities. Planting a forest on agricultural land can create or potentially destroy important habitats for wildlife and improve or reduce biodiversity. This impact is not included in the calculations of the profitability of the forest but may have an impact on societal welfare. Externalities can vary greatly in their impact but in all situations are considered as market failures as the associated economic activity failed to take into account all costs and benefits.

One of the main reasons for the existence of externalities associated with forests is the public good nature of many of the benefits and costs associated with them and their management. Pure public goods are defined by two main characteristics, the fact that they are non-rivalrous and non-excludable. Rivalry, in economic terms, refers to the situation where the consumption of a good by one individual affects the ability of another to consume it. Many

forest benefits are non-rivalrous, for example individuals can derive benefit from the provision of habitat conservation or the sequestration of carbon by trees without affecting another's ability to experience the same benefit. This can be contrasted against harvesting timber whose direct benefits can only be enjoyed by a limited number of people at the expense of other individuals' ability to utilise this good. Non-excludability refers to the situation where it is not possible to exclude an individual from consuming a good, it is impossible to stop an individual from benefiting from carbon sequestration or from enjoying the external view created by a forest landscape.

Given the complex nature of forests and the way in which people interact with them, it is necessary to note that in some situations benefits which are generally considered public goods have a rivalrous or excludable nature to them, such as some forms of recreation. The concept of private and public goods should be viewed as extreme situations with varying intermediate goods (Table 1).

Table 1 Characteristics of private and public goods related to forests

	Excludable	***Non-excludable***
Rivalrous	Pure private good e.g. Timber	Open-access resource e.g. Mushroom picking
Non-rivalrous	Congestible resource e.g. Forest park recreation	Pure public good e.g. Carbon sequestration

Table adapted from Perman et al. (2003)

3.1 Valuing the non-market benefits of forestry

A number of methodologies for valuing the non-market benefits of forest have been identified (Bishop, 1999):

- Revealed preference approaches;
- Production function approaches;
- Stated preference approaches;
- Cost-based approaches.

A brief overview of these methodologies now follows:

3.1.1 ***Revealed preference approaches***

The two common revealed preference approaches used to value some of the non-market benefits of forestry are the travel cost method and hedonic pricing. The travel cost method (TCM) uses the cost of experiencing a particular non-market good as a proxy value of the good itself and, therefore, relies on the assumption that an individual values the experience at least as much as it costs to attain it. TCM requires users of a resource to be surveyed. This method focuses on constructing a demand function for a given location which can then be used to identify the associated consumer surplus which reflects its value to current users. The history of TCM is closely linked with forest recreation and it has been used extensively to value the recreational benefit of forest parks (Zandersen and Tol, 2008).

The hedonic pricing method attempts to identify the influence of an environmental amenity or risk on the market price of a good or service (Bishop, 1999). The most commonly used good in environmental studies is the price of a house. A large amount of data about the

characteristics of houses, their location and the price they attain is gathered. Prices can then be modelled against these characteristics and the contribution of a public good, such as open space, forests or air quality, to the price of a house might be identified.

3.1.2 ***Production function approaches***

Often, a change in an environmental resource will have an impact on the output of a marketed good or service. A frequently used example relative to forestry is the external cost of pollution to a stream, for example by poorly managed forest harvesting, and the resultant fish kills in a down-stream fish farm. Using the same elements, a well-established riparian woodland might reduce pollution from adjacent agriculture and increase water quality and reduce the number of fish deaths. Such effects can be difficult to quantify and value. This process involves first identifying the extent of the relationship between the environmental service and the marketed good and the effect of changes in the former on the latter. Secondly a given change in the environmental service can be valued by examining the value of loss or gain in the marketed good.

3.1.3 ***Stated preference approaches***

Stated preference valuation techniques use surveys and offer individuals the opportunity to describe their future behaviour in a hypothetical market. This could be their willingness to pay (WTP), for example as an increase in their annual tax bill, for a given quantity of an environmental good or for the protection of a good. Within forestry alone numerous forms of stated preference studies can be identified as demonstrated by meta-analysis (e.g. Lindhjem, 2007; Barrio and Loureiro, 2009; Meyerhoff et al., 2009).

The two main stated preference valuation methods are contingent valuation and choice experiments both of which are survey based. The contingent valuation method is one of the most established methods for valuing environmental non-market costs and benefits. It involves surveying individuals to ascertain their willingness to pay for an environmental benefit (or to avoid a loss), or their willingness to accept compensation for a loss. To reduce the information burden on respondents, contingent valuation studies tend to focus on a single change to a policy. The change is described and then respondents are asked a valuation question which is often presented in the referendum format (yes or no for a given change at a given price), or as an open-ended question (maximum WTP). Choice experiments differ in that they describe a good in terms of its constituent attributes using two or more alternatives scenarios or states which the respondent is called upon to trade-off by allocating a preference to one or the other. These attributes are then varied for each question depending of various changes in the scenarios or provision. Thus the focus in choice experiments is on the attributes as well as the overall change in the environmental good (Meyerhoff et al., 2009). They have become a popular valuation tool amongst environmental economists as they offer the potential to identify the relative value of attributes which make up an environmental resource i.e. they value the part-worth of each attribute which describes the environmental good in question. Focus groups and pilot studies are typically used in choice experiments to ensure that the levels of attributes cover the widest possible demands of respondents while being realistic and understandable to all (Hanley et al., 2001).

3.1.4 ***Cost-based approaches***

A number of cost-based approaches have been used to assign values to non-market benefits, including:

- Replacement cost methods which measure environmental values by examining the costs of reproducing the original level of benefits;
- Preventative expenditure methods which estimate the costs of preventing or defending against the degradation of the environment;
- Opportunity cost approaches which use production costs as a proxy for the value of non-market benefits (Bishop, 1999).

The replacement cost method has been used to estimate the value of soil nutrients lost due to increased erosion associated with logging, with the cost of the fertilizer needed to replace the nutrients lost used as an indicator of the value (Niskanen, 1998). The preventative expenditure approach places a value on environmental goods by estimating the cost of preventing a reduction in the level of benefits. The opportunity cost method is most often used to assign a value to the subsistence benefits associated with non-timber forest products collection where labour is the main input (Bishop, 1999).

3.2 Non-market benefits of forestry

A brief overview of the non-market benefits of forestry and previous assessment of their value in the Irish context now follows.

3.2.1 ***Forests and biodiversity***

The Irish government made commitments at the United National Conference on the Environment and Development and at the second Ministerial Conference on the Protection of Forests (MCPFE) to maintain and enhance biodiversity in Irish forests. These international commitments are now enshrined in Irish forestry policy and practice, through the adoption of the Irish National Forestry Standard (Forest Service, 2000a) and its associated Guidelines on Biodiversity (Forest Service, 2000b). The latter outlines how best to design, plan and manage forests in order to converse and enhance biodiversity. From a planning perspective, the Guidelines recommend that biodiversity considerations (habitats and species of interest) be incorporated in the initial site development plan. The Guidelines also acknowledge the influence that tree species selection has on the habitat value and biodiversity of a forest and recommend that broadleaf species be favoured as much as possible, subject to site conditions. The Guidelines indicate that on sites greater than 10 ha[1] in size 15% of the forest area must be treated with particular regard for biodiversity. These so-called "Areas for Biodiversity Enhancement" are comprised of open spaces and retained habitats and can include *inter alia* hedgerows, scrub and archaeological sites.

Other initiatives that aim to recognize and enhance biodiversity in Irish woodlands are the Native Woodland Scheme and Forest Environment Protection Scheme (FEPs). The former was launched in 2001 in recognition that native woodlands are among Ireland's most valuable habitats with a high biodiversity value and provides funding to conserve and establish native woodlands. FEPS was launched on a pilot basis in 2007 'to encourage farmers to establish and maintain high nature value forestry through measures such as increasing biodiversity and protecting water quality'(http://www.teagasc.ie/forestry/financial_info/feps.asp). Only farmers in receipt of REPS payments can apply for FEPS payments. In addition to the normal afforestation premium, a FEPS payment of between €159 and €200 per ha for five years is available to farmers in REPS who plant under the FEPS scheme. With the closure of the REPS scheme in July 2009, participation in FEPS has declined and is expected to continue to do so.

Forest management

Biodiversity within a forest stand is influenced by stand age, species, forest management practices as well the environment in which the forest stand in located. Species diversity increases over time as forest composition becomes more complex (Oliver and Larson, 1996) with the highest species-richness and diversity occurred either in the early successional stages of the forests cycle (for 10-20 years after planting) or in stands retained beyond economic maturity (Quine and Humphrey, 2003). Mixed forests have been found to support the greatest diversity of species followed by broadleaves (Iremonger et al., 2007). The initial stand spacing and thinning practices can also influence biodiversity levels (Quine and Humphrey, 2003). However, the EPA BIOFOREST Project (Iremonger et al., 2007) also discovered that Irish plantation forests can also contain surprisingly high levels of biodiversity.

[1] In sites less than 10 ha the open space element of areas for biodiversity enhancement should be designed in conjunction with neighbouring land use and may be reduced (Forest Service, 2003; p. 21)

Valuing biodiversity

Increasing biodiversity levels in forests not only has benefits for a range of direct and indirect users but also offer benefits for the wider ecosystem (Willis et al., 2000). Improving biodiversity can for example, make the forest more attractive for certain types of informal recreation. At the same time it is possible for individuals to receive benefits from increased biodiversity without actually visiting the forest, an existence or passive use (Willis et al., 2000). Clinch (1999) used a contingent valuation approach to assign a value to the impacts of the Government's afforestation programme on biodiversity. In the household survey he undertook respondents were given options with regard to the potential impact of the afforestation programme on wildlife, i.e. that it would create better wildlife habitats or that it would destroy wildlife habitat. He presented combined results for landscape, wildlife and recreation and indicated that the net present value of these elements of the Forest Strategy was IR£129 mn (5% discount rate). More recently, Bacon and Associates (2004) estimated the additional annual welfare associated with biodiversity from the afforestation programme using figures derived from a study conducted by Garrod and Willis in the UK (1997) to be €23.3 mn.

3.2.2 ***Water quality and quantity***

Forestry can potentially affect the quality and amount of water available to other users (Willis, 2002). Catchment experiments have shown that there is decreased runoff from areas under forestry compared with areas under shorter crops (Calder, 2006). This is due to two processes:

1. Interception of rainfall, i.e. rainfall which is held on leaves and evaporated by the wind before it reaches the ground;

2. Transpiration where water is drawn up through roots and evaporated from leaves through the stomata (Nisbet, 2005).

Inception losses are greater for tree species than for other vegetation, with interception values for conifers ranging from 25-40% while for broadleaves they range from 10-25% (Nisbet, 2005). Annual transpiration losses due to forests are estimated to be 300-350 mm and these are not influenced by tree species.

The extent of the impact of forestry depends upon the proportion of the river catchment area covered by woodland, and the type of woodland. For every 10% of a catchment covered by a closed conifer canopy, there would be a 1.5-2.0% reduction in water yield (Nisbet et al., 2011). On drier lowland sites this could increase to 7-10% per 10% forest cover. Forest management can also have a large effect on water use. For example, clearfelling of a stand will have a dramatic effect on water use, but if an understorey remains this effect is reduced.

Woodland also has positive benefits on water supply. By regulating runoff, it may reduce down-stream flooding, prevent soil erosion, etc. In other countries, e.g. Britain, afforestation schemes have recently targeted water benefits and additional funding has been made available to encourage new planting in areas contributing to flood risk management (Nisbet et al., 2011, p.5). However, there continues to be a lack of comprehensive information on these impacts (Bacon and Associates, 2004; Willis, 2002). Indeed Nisbet et al. (2011) indicate that the impact of woodland on both drought and floods remains a contentious issue, with studies presenting conflicting results. Although there is evidence of a positive forest impact on flood flows at a local level (< 100 km^2) and for small flood events, forest hydrology studies in the UK and world-wide provide little support for a significant effect on extremes floods flows at the wider landscape level. However, at an international level, forests have been found to act

as a buffer against sudden run-off and to reduce the frequency of floods at least in circumstances unless the foliage and ground is already saturated (Bradshaw et al., 2007).

Forests can influence water quality through two processes, i.e. acidification and contamination. Conifers capture airborne pollutants and can increase the risk of acidification in soft-water streams draining areas which receive heavy loads of atmospheric pollutants (Harriman and Morrison, 1982). In Ireland increases in stream acidity have been found in afforested catchments in the east and west of the country, although plantation forests have not been found to lead to acidification and related problems in the south of Ireland (Giller and O'Halloran, 2004). Forests can also lead to contamination of water ways through the application of fertilizer or herbicides.

In recognition of the potential impacts of forests on water quality the Forest Service published Forestry and Fisheries Guidelines in 1991 (Forest Service, 1991a); these were subsequently augmented by the Code of Best Forest Practice (Forest Service, 2000c); Forestry and Water Quality Guidelines (Forest Service, 2000d), Forest Harvesting and Environmental Guidelines (Forest Service, 2000e) and the introduction of statutory regulations on aerial fertilisation (Forest Service, 2006). The implementation of these guidelines led Bacon and Associates (2004) to conclude that "potential negative externalities from forestry with respect to water quality are already being internalised through adherence to standard operating procedures based on best practice and Forest Service guidelines, water quality monitoring, collaborative studies and the FSC certification process".

Valuing the impact of forests on water quality and quantity

Typically when valuing the impacts of afforestation/forestry on water quality/quantity, production function methods are used. Clinch (1999) used such an approach when estimating the impact that the afforestation programme would have on water quantity and quality. He estimated what the reduction in water supply (in the east of the country) would be if forest cover was to increase to the level envisaged in "Growing for the Future" (DAFF, 1996). The value he assigned to this, IR£2 mn (@5% discount, was the cost of addressing this shortfall by repairing leaks. Clinch using a benefit transfer approach (using figures from Whiteman, 1999) estimated the "cost" of eutrophication to be IR£8 mn (@ 5% discount rate).

Bacon and Associates (2004, p. 63) referred to the potential impacts of forestry on water quantity and quality. However he did not assign a value to these but instead argued that the "potential negative externalities from forestry with respect to water quality are already being internalised through adherence to standard operating procedures based on best practice and Forest Service guidelines, water quality monitoring, collaborative studies and the FSC certification process". On this basis he concluded that there will be a minor negative impact on water quality but that this can be minimised by adherence to regulations. He did not evaluate the impact on water quantity.

In the UK Willis (2002) valued the impact of forestry on water supply and quality. He used replacement and mitigatory costs: e.g. the cost of having to develop alternative water sources where forests reduce supply; the reduced cost to society where forests regulate run-off and hence lower flood risks and the need for flood prevention to assess the value of water. To apply a value to this he used the estimates of long run marginal costs of water supply provided by water companies in Britain. In the case of the impacts of forestry on water quality, Willis (2002, p. 17) too took the view that adherence to the Forestry Commission's

Forests and Water Guidelines that forestry had largely internalised the negative externality impact of forest operations on water quality".

3.2.3 ***Carbon***

There is scientific evidence that climate change is occurring and that the main contributor is the accumulation of greenhouse gases in the atmosphere (Hendrick and Black, 2009). Forests act as increasing sinks though their ability to sequester and store atmospheric carbon. Referring back to the introduction of this section, this positive externality of forests has over time transferred from being a quasi-option value, to an option value to potentially an indirect use value now that forest area is being included in countries' carbon national accounting. The rate of sequestration is affected by many factors including species, yield class, soil type as well as management activities such as harvesting, fertilisation and previous land use (Byrne and Black, 2003). Conifer forests rapidly accumulate carbon, while broadleaves do so at a slower rate but over time they potentially will accumulate the same amount of carbon as conifers (Hendrick and Black, 2009). The lower the rate of growth of the trees (i.e. the lower the yield class), the slower the uptake of carbon.

The ultimate use to which the timber is put in forests has an impact on the extent to which forests provide a carbon sink. Harvested timber is converted into a variety of products. The carbon in these produced is fixed until they decay or are burned. It is increasingly recognized that harvested wood products play an important role in the forest sector C cycle by acting as a physical pool of carbon; a substitute for more energy-intensive materials and a raw material for energy generation (http://ec.europa.eu/enterprise/sectors/wood-paper-printing/climate/harvested-wood-products/index_en.htm).

Clinch (1999) estimated the value of the carbon sequestered under the afforestation programme outlined in the strategic plan for forestry (DAFF, 1996). Similarly, Bacon and Assoicates (2004) provided estimates of the volume of carbon that would be sequestered under various afforestation scenarios and assigned values to these using figures ranging from 15 to 29 euros per tonne.

3.2.4 ***Landscape***

Forests have the potential to contribute and detract from the landscape in which they are found. Irish forests have had a particularly significant impact on the landscape because those planted during much of the 20th century were monocultures of Sitka spruce or lodgepole pine located on hills and in large open spaces (Ní Dhubháin, 1994). The visual impact of forests has often been perceived for be adverse and this impression has been compounded by the speed of landuse change to forestry in certain parts of the country.

The Forest Service published Landscape Guidelines in 1991 (Forest Service, 1991b) and these were updated in 2000 (Forest Service, 2000f). The Guidelines stress that forests should be planned and managed in a way that enhances the landscape and outline in some detail how this might be achieved.

All applications for afforestation are subject to an Environmental Impact Assessment (EIA) screening process undertaken by the Minister. The screening determines whether an application requires an EIA. An Environmental Impact Statement (EIS) must accompany

applications for the afforestation of areas of 50 hectares or more. An EIS must accompany applications for the afforestation of areas less than 50 hectares where a proposed development is deemed by the Minister as likely to have a significant environmental impact.

Forest landscape valuation

Valuing the landscape impacts of forests is complicated and more subjective than for other forestry outputs. Willis et al. (2000) attributed this to a number of issues including:

- The lack of a biological relationship between a forest's appearance and individual preference;
- Landscape is a very complex good that can be valued in different ways by different people;
- Preferences for forestry in rural landscape are conditioned by the landscape setting;
- There are difficulties in identifying relevant user groups and hence aggregating policy benefits.

Reflecting this there have been few attempts to value the impact of forests on the landscape in Ireland. Clinch (1999) did not value the impact of forestry on the landscape on its own but instead used a contingent valuation approach to assign a value to the combined effects of forestry on the landscape, wildlife and recreational value, which he indicated to be £129 m. Bacon and Associates (2004) concluded that it was impossible to place any value the landscape impact of forestry in the absence of precise data and assigned a zero value to the impact in the absence of data to the contrary.

3.2.5 ***Recreation***

Over the past few decades, there has been increasing use of forests for recreation in developed nations (Price, 1989). This increase is related to the increasing need for people living in growing urban environments to escape to accessible and natural environments (Saraj et al., 2009). Forests, in particular are robust, natural environments which can offer varied recreational opportunities and which have a good capacity for absorb users and noise. There has been an increase in the demand for recreational opportunities in forests in Ireland too. Hynes et al. (2007) noted that as a result of the growth in the urban population in Ireland, significant increases took place in outdoor recreation participation throughout the 1990s and into the early 2000s. In 1999, for example, it was estimated that Coillte's forests attracted over 8 million visitors annually (Clinch, 1999). A more recent study by Fitzpatrick Associates (2005) estimated the approximate usage of Irish forests to be 18 million visitors per year. The overwhelming proportion of this recreation occurs in the public forest estate, where an open forest policy applies. In effect, this means that individual forest visitors are welcome unless there are major harvesting operations taking place within the forest, while activity clubs require a permit (www.coillte.ie). In contrast to other European countries where the "right to roam" policy prevails, the public do not have the right to access private lands, including private forests.

A study by Murphy and Gardiner (1983) was the first attempt at putting a value on forestry recreation in Ireland. A type of contingent valuation question was employed to quantify the annual recreational value of Portumna Forest Park, described as being "under multiple-use management for timber production, recreation and wildlife habitat conservation". A show-card type question was presented to respondents who were asked to identify the maximum

they would be willing to pay to access the park. Responses were used to build a demand curve from which the consumer surplus was calculated. The CAMAR study (Ní Dhubháin et al., 1994) surveyed recreationists at 13 forest sites across the Republic of Ireland and found that the "willingness to pay" for a single day-visit to a forest was between €1.02 and €2.73 (1992 prices). In 2004, Bacon and Associates estimated a willingness to pay for a single day-trip to be €3.34. This work was further updated again by Fitzpatrick and Associates who estimated the total non-market value of forest recreation in Ireland as €97 m with the value of single visits estimated at €5.42. Most recently Cahill and Hynes (2007) estimated the non-market values of recreational activities in two forests in Galway, i.e. Barna Woods and Renville Forest Park at €7.69 per trip.

4 The non-market benefits of the afforestation programme

A key objective of the study was to provide strategic information to policy makers by indicating the relative benefits of forest management practices respectively directed at the values associated with recreation, biodiversity, landscape, water quality and carbon sequestration. In addition the study aimed to identify what factors influence the public benefits that are derived from forests.

4.1 The household survey

A choice experiment was designed to ascertain the public's willingness to pay (WTP) for different forest management approaches to the afforestation scheme and was administered in the form of a household survey to a random sample of the population in Spring 2010. We chose the choice experiment approach as it has the capacity to account for the value of future resources and non-use values, which are important for many forest benefits. In addition, this approach produces a range of WTP values for marginal changes in the different characteristics of the afforestation scheme. The afforestation scheme was selected as the subject of the study as it represents one of the most important goals of Irish forest policy and is comprehensible and tangible to the general public, an important issue in environmental valuation studies. Employing an extensive literature review, interviews with forest professionals and focus groups, five characteristics were chosen to describe the scheme. These were the possible location of new forests, the types of tree planted, the inclusion of biodiversity enhancement areas within new forests, the method of harvesting employed and the provision of recreational access to new forests.

4.1.1 Focus groups

Prior to developing the choice experiment two focus groups of eight participants were conducted with randomly selected members of the general public. The overall goals of the focus groups were to gauge the level of knowledge of forestry and forest management among the general public and to determine the public's acceptance of an afforestation scheme that was to be funded by the tax payer. A further objective was to establish whether the attributes of the afforestation programme that had already identified in the project objectives and in the literature were relevant and comprehensible to the general public. This included free discussion amongst participants as well as structured moderator-led discussions. In addition, the payment vehicle (and amounts) for this proposed publicly funded afforestation programme was discussed as was the method of presentation of the experiment (i.e. what visual aids to use) during the groups.

The focus groups were conducted in June and July 2009. A professional market research company,[2] was employed to recruit the participants. In addition to the aforementioned goals, focus groups were located in different locations to investigate whether a general difference existed between rural and urban communities. For this reason, one group was conducted in Dublin with the second conducted in Co. Leitrim, a county with a primarily rural population and a strong and varied relationship with forest policy in Ireland (O'Leary et al., 2000). Although both groups were as heterogeneous as possible individuals associated with environmental groups and those employed in land management were excluded as such

[2] Rockviewfield Resources

individuals were felt to have greater knowledge levels in relation to the issues of interest than the majority of the population. Two members of the project team were present at each group, with one member taking on the role of moderator.

The focus groups were initiated with a general discussion on forestry. The level of knowledge of forestry varied considerably within and across the groups. It was clear that for some individuals a lack of knowledge on the issues acted as a barrier to their engagement. It was also suggested by some of those in the focus group that the general public wouldn't know enough on such issues or wouldn't care.

The Leitrim group had more complex opinions on forestry, which is not surprising given the history of forestry in the area. Some members of the group felt that their county had been unfairly "targeted with forestry" in the past despite identifying a range of possible benefits derived from new forests, including employment which was a driving force for forest policy in this area. In addition, they were not opposed to increasing national forest cover in general. Additionally, some participants expressed satisfaction with the amount of forest recreation facilities in their locality (the group was conducted close to one of the more important forest parks in Ireland – Lough Key Forest Park) and noted that other communities might benefit from such facilities. The Dublin group were generally positive towards the forests and could name and identify a number of forests in their area. This group also recognised the importance of forests for recreation. However, overall, the Dublin group did show a lack of detailed knowledge of forests and forest management and struggled to make suggestions about how new forests might be managed. This group raised concerns about suggesting how landowners might manage their forests due to concerns of private property rights. This emerged during a discussion of existing forests.

4.1.2 Attributes of the discrete choice experiment

Following the general discussion on forestry the concept of the afforestation scheme was introduced. Participants were asked to indicate any specific characteristics of new forests that they would like but a range of issues were also suggested by the moderator[3]. This proved particularly useful as it highlighted issues, and language, that members of the public might struggle with. Five attributes were chosen as the most policy relevant, while being comprehensible and meaningful to the public, i.e. tree type, biodiversity reserve areas, harvesting, access for recreation and location. A sixth attribute "cost" was also included.

Tree type

The type of trees planted in Irish forests has been a controversial and, to some, a defining aspect of Irish forest policy. Current forest cover statistics show the clear dominance of a limited number of species in Irish forests, although significant changes have occurred in recent years.

Both focus groups showed an interest in this issue but were also limited in their knowledge. Participants struggled with terms such as conifer and broadleaf although many had some familiarity with them. Words such as "pine", "hardwood" and "softwood" were favoured and most respondents could give examples of each, with some significant errors (spruce was

[3] Issues that were discussed yet were not emplyed in the DCE included: the use of chemical pesticides and fertilizers; the use of only native tree species; landscape design protocols; thinning regimes and the amount of timber production. These were excluded as participants did not feel they were significant enough relative to the other attributes or because they appeared too technical for general comprehension.

suggested as a hardwood by one participant).

A difference between commercial and "natural" forests was offered by some participants and it was suggested that they contain conifer and broadleaf trees, respectively. This is perhaps not surprising given the dominance of conifer species in Irish forests in general and commercial forests in particular. In addition, many notable forest parks and demesnes that the public may be familiar with possess older stands of broadleaf or mixed forests.

Three levels were adopted to describe this attribute in the choice experiment. It was suggested that forests could be established with broadleaf, conifer or mixed species (Table 2). It was clear however, that participants would require an explanation of these terms in the survey.

Table 2 Attributes and levels that formed the choice experiment

Label/Attribute	**Levels**
Tree type	Broadleaf, Conifer, Mixed
Plant and animal reserve area	None, 15% 30%
Harvesting	Block clearfell, Individual tree harvesting
Access for Recreation	No access, Access on a single trail, Access on trails and basic facilities
Location	Close to cities and towns, In the wider countryside, In remote upland areas
Cost (€)	10, 25, 40, 55, 70, 85

Biodiversity Reserve Areas

A requirement of attaining funding for forest planting in Ireland is the inclusion of "Areas for Biodiversity Enhancement" (see section 4.2.1) in afforestation proposals and it was one of the outputs/benefits that was to be considered in this valuation exercise.

The term biodiversity was unfamiliar to almost all of the focus group participants although many suggested similar ideas during the discussion. When investigating potential forest benefits the provision of habitats for a diverse range of flora and fauna was frequently mentioned. Once explained participants felt that a simpler term for biodiversity was needed. The expression "plants and animals" was chosen which, although far from capturing the true complexity of the word biodiversity, offers a comprehensible expression of the concept to the public.

During the session with the Leitrim group, a participant suggested including a specific area for plants and animals in each forest, which was greeted positively by other participants. This was also raised by the moderator during the Dublin group and was again greeted very positively, particularly given the potential financial sacrifice required by the landowner. Hence in the choice experiment the biodiversity aspects of the afforestation programme were taken into account by the attribute "Plant and Animal Reserve Areas. Three levels were chosen for this attribute, i.e. 0%, 15% or 30% of the forest set aside as a plant and animal reserve (Table 2). The 15% level represents the current requirement under the afforestation programme, while the 0% and 30% levels were considered to represent the extremes.

Harvesting
After tree type, harvesting is perhaps one of the most contentious issues in forest management in Ireland. Poorly planned forest harvesting can have significant negative effects on biodiversity, landscapes, and water quality.

Some members of the focus groups were particularly concerned with harvesting practices in commercial forests. One participant suggested that funding an expansion of forests was pointless as they would "all be cut down anyway" and that it was a "false promise". Some participants identified areas in their locality where harvesting had occurred and were unhappy with the extent of clearfelling employed ("a touch of the moon").

Some participants suggested that "natural" forests can develop their own ecosystems whereas commercial forests are felled regularly so wildlife levels would be lower. However, participants seemed to recognise the need to produce timber from Irish forests, and although lacking detailed preferences, were supportive of the idea of harvesting occurring without the use of large-scale clearfelling. It is important to note that the Leitrim group had much stronger views on the issue of harvesting.

It was clear from the discussion that the approach to harvesting was one that was important to the public. At the same time, the afforestation scheme has a distinct commercial element to it so suggesting that no tree harvesting would take place was not deemed to be realistic or useful for the study. Given this and the complexity of the issue only two levels were employed to describe alternative approaches to harvesting (Table 2). One was block clearfelling and the other was individual tree harvesting where no large areas of trees would be removed at the same time. Although simple such descriptions do capture alternative approaches that exist on the same scale, although at different extremes.

Access for Recreation
The use of forests for recreation is perhaps the most frequently investigated non-market forest benefit. Recreation was identified early on in both focus groups as important to some participants and to society in general. Individuals were more familiar with the recreational benefits of forests than others. Both groups were aware of forest recreation areas in their vicinity and identified parts of the country that were associated with forest recreation (e.g. Co. Wicklow).

The majority of individuals supported a landowner's right to exclude people from their land. However, the idea of recreational schemes that paid landowners to give recreational facilities to the public was greeted positively.

Previous afforestation programmes have not required land-owners to provide recreational access to their lands, although the option was included in FEPS. In this study three levels of the attribute were included in the alternatives (Table 2). No access to the forests, access limited to a single trail and access across a network or trails with recreational facilities.

Location
One of the objectives of the project was to investigate how location, in addition to management, influences forest values. Location was not investigated directly in the focus groups but was accounted for indirectly by the choice of the focus group venues. Although

important, location is a difficult issue to incorporate into a choice experiment as it can interact strongly with other forest characteristics by giving them a more meaningful context. For this reason, location was employed as a label for each alternative in the choice sets. Labelled alternatives should incorporate all possible options open to the respondent. For this study three locations were chosen; close to cities and towns, in the wider countryside and in remote upland areas. Although extremely simple in description these locations incorporate all possible locations for new forest establishment in Ireland. In addition, they are relevant to current and previous forest policy as they include the historic location of new planting (remote, primarily upland areas), the current focus of policy (wider countryside) and a location of recognised importance from a social perspective (urban based forests). A fourth alternative was included in each choice set which suggested no new forests would be established in Ireland at no cost to the respondent. This alternative acts as an opt-out for respondents with zero WTP and for those that did not encounter an acceptable afforestation alternative in the choice set.

Costs

An attribute representing some form of financial sacrifice is essential where the purpose of a choice experiment is the production of WTP figures. Many participants were apprehensive about funding an afforestation scheme in the economic climate of the time. Alternative uses of public funds were suggested. However, some participants were satisfied with the idea that public funding was necessary for afforestation to occur. A number of payment vehicles were discussed with some participants favouring some form of property based tax as they identified many of the benefits as being local in nature. However, after discussion there was a general agreement that general taxation could be used for such a scheme. During the second focus group participants were asked to write down the maximum that they would be willing to pay to fund the afforestation scheme.

It should be noted that some members of the Dublin group were particularly uneasy about the idea of funding an afforestation scheme given the potential costs involved and the economic uncertainty of the time. Some participants mentioned other emotive issues that they felt warranted more attention, such as funding the health system.

In the choice experiment an individual tax increase for each of the afforestation alternatives was included with a zero cost assigned to the opt-out alternative of “no new forests planted”. The range of figures employed in this study was guided by the literature and as suggested by members of the focus groups. Six figures were chosen finally; €10, €25, €40, €55, €70 and €85. Six possible cost levels were chosen to ensure participants had a wide selection of values to choose from while maintaining a realistic size of experimental design, which combines attribute levels to produce the choice sets. The figures took account of previous choice experiments in Ireland and the UK and of the figures suggested by the participants to try and ensure a value close to the maximum WTP could be included.

4.1.3 Visual representations of attributes

Adamowicz et al. (1998) suggest that visual representations of attributes and attribute levels in choice experiments are generally preferred as they introduce greater consistency into respondent interpretation and, thus, the analysis of their preferences. It was felt that images would play an important part in describing the afforestation scheme in the survey. Therefore,

photographs and simpler illustrations were compared and tested during the focus groups. It was found that respondents had a tendency to misinterpret the contents of photographs particularly when they were asked to compare photos of similar forests. Respondents appeared to look for visual clues in the images on which to make their decisions. For example, when presented with two photos, both of conifer plantations, with different groundcover, respondents suggested that the forest containing more groundcover was a "natural" forest compared to the second photo. Simpler diagrammatic representations were interpreted more consistently. For that reason along with the strong visual connection between the attributes under investigation a series of high quality illustrations were favoured over the more traditional verbal and icon-based descriptions. To this end a professional graphic designer was employed to produce individual illustrations for the three location labels, eleven forest related attributes and the cost attribute and to advise on overall layout and display.

4.1.4 The experimental design of the discrete choice experiment

The above process identified three attributes with three levels each, one with two levels and one with six levels for inclusion in the choice experiment. For presentation to the public, these attributes must be combined to form alternative descriptions of the afforestation scheme. The process of combining attribute levels to form alternatives and choice sets and identifying how choice sets will be divided among a sample of individuals comprises the experimental design aspect of conducting a choice experiment. The theory underlying choice modelling is summarised in Appendix A.

Design of discrete choice experiments has become increasingly sophisticated in recent years with greater emphasis being placed on designs that capture information efficiently (Scarpa and Rose, 2008). For this study, a Bayesian efficient design was employed that minimised the d-error of the design with a given multinomial logit model form. Relatively small prior estimates of parameters were used in the design process. These were based on the literature review and focus groups and the uncertainty associated with the estimates was accounted for in the design. The final design consisted of 72 choice sets blocked into 12 groups. Each respondent therefore answered 6 choice sets. Each choice set contained an opt-out alternative describing no new afforestation at zero cost. Such alternatives are recommended to facilitate individuals who do not want to support the given policies or are not willing to pay the specified amounts (Hensher et al., 2005). A sample choice set is contained in Figure 1.

Figure 1 Example of a choice set

4.1.5 The questionnaire

The final questionnaire administered to a sample of the population included the choice experiment as well as a number of attitudinal and socio-demographic questions[4]. Respondents were also asked to indicate how often they visited forests and to outline the purpose of their visits. With respondent consent the coordinates of their house were recorded and if denied respondents were assigned an average coordinate for the sampling point, over 90% of the sample consented to this information being recorded. The questionnaire is presented in Appendix B.

4.1.6 Additional data

To investigate the effect of existing forest cover on respondents' preferences, spatial data on national forest cover was obtained from the Forest Service. As these data are derived from a number of sources that employ different definitions of forest composition, a detailed division of forest types was not possible. Instead forests were divided into conifer forests and all other forests, both mixed and broadleaf. An additional important characteristic of Irish forests is ownership. Publicly owned forests include the six national parks managed by the National Parks and Wildlife Service and forests managed by the state forestry company, Coillte. The Coillte estate is dominated by conifer plantations, which are managed with a primarily commercial focus. All publicly owned forests are open to the general public and many are actively promoted for recreation. In contrast, private forest owners are not obligated to provide public access to their forests and, although tolerated by some owners, entry is often discouraged. Total forest cover was, therefore, divided into private conifer forests, private mixed/broadleaf forests, public conifer forests and public mixed/broadleaf forests. Using the coordinate data collected during the survey forest cover, measured in hectares, in a 5 km radius around each respondent's household was calculated, in terms of the previously described divisions. The figure of 5 km was chosen to incorporate forests that respondents would be familiar with on a regular basis.

[4] Ipsos MRBI were recruited to carry out the survey

4.1.7 The administration of the survey

A form of quota based stratified sampling was employed to achieve a representative sample of 996 individuals from the general population. Seventy-five sampling points were selected across the country within which households were chosen randomly and a quota was filled based on gender, age and working status. A market research company was employed to conduct the survey in the spring of 2010. Characteristics of the sample are shown in Table 3 along with the corresponding statistics for the 2006 population census.

Table 3 Key socio-demographic characteristics of survey sample compared to those of the population

Characteristic	Survey 2010 %	ROI Census 2006 %
Gender		
Male	50.1	49.6
Female	49.9	50.4
Age		
18 – 30	25.5	28.2
31 – 54	46.1	44.5
55+	28.4	27.3
Working status*		
Working	58.0	57.1
Not working	42.0	42.9

* Note: Survey 2010 is based on 18+, Census is based on 15+

Surveys that employ choice experiments to investigate the preferences and values held by the public require that the information supplied to interviewees is consistent across the sample as well as being comprehensible. Respondents were required to read a 10-page colour booklet (Appendix C) before completing the choice experiment. This booklet contained a description of the Government plan to increase forest cover to 17% by 2030, outlining that the scheme would be managed by the Department of Agriculture and that forests would be established on less productive farmland. Each of the attributes and its associated imagery were explained in the booklet, which was available to the respondents throughout their completion of the choice experiment. Descriptions were maintained deliberately simple but did include possible outcomes of the management changes. For example, it was suggested that mixed forests would contain the highest level of biodiversity.

4.2 Results of the household survey

In this section the attitudes of those surveyed to forests are presented first. The results of the choice experiment are then outlined.

4.2.1 Attitudes to forests

As a precursor to the choice experiment that formed that main body of the household survey, respondents were asked to give their opinion on the environment and forests. A number of statements were presented to them and they were then asked whether they agreed/disagreed (and to what extent) with the statements. The attitudes were generally positive (Table 4) with the majority of respondents:

- recognising the importance of protecting the environment even when there are economic challenges facing the country;
- agreeing that all types of forests are good for the environment;
- indicating that forests are an important part of the traditional Irish landscape.

In exploring whether responses to these statements varied according to respondent gender, age, location and occupation (farmer/non-farmer) it was clear that differences emerged between farmers and non-farmers. For example, farmers were more likely than non-farmers to disagree:

- with people being allowed walk in all forests in Ireland (private/public);
- that all types of forests are good for the environment than other respondents;
- that forests are an important part of the traditional landscape of Ireland.

In addition farmers were more likely than non-farmers to agree that people worry too much about the future of the environment and not enough about prices and jobs. Interestingly city dwellers were less likely that those living in the countryside or remote areas to agree that people should be allowed walk in all forests in Ireland.

Table 4 Attitudes of respondents towards forests and the environment (n=996)

	Strongly disagree (%)	Disagree (%)	Neither agree or disagree (%)	Agree (%)	Strongly agree (%)
In order to protect the environment Ireland needs economic growth.	2	11	9	60	18
Protecting the environment is important to me.	2	2	6	51	39
We worry too much about the future of the environment and not enough about prices and jobs today.	8	39	19	29	5
People should be able to walk in all forests in Ireland even if they are on private land.	5	29	17	41	8
All types of forests are good for the environment.	2	11	7	58	22
Forests are an important part of the traditional landscape of the Irish countryside.	2	3	3	57	35

Respondents were asked to rank various outputs from forests according to the importance they placed on them. The output that respondents most commonly classed as most important was nature conservation and biodiversity (i.e. plant, animals and wildlife) (Table 5). In contrast recreation and timber production were the outputs that were mentioned least by respondents. The protection role of forests with regard to water, air and the climate was classed by almost one third of respondents as the second most important output of forests.

Table 5 Importance of outputs from forests

Output	Most important (%)	Second most important (%)	Third most important (%)	Fourth most important (%)
Recreation & leisure	12	15	25	21
Timber and wood production	12	13	16	24
Protecting water, climate and air	21	31	21	14
Plant and animal/ Wildlife/nature conservation	37	25	18	12
Employment & jobs	18	16	20	29

A significantly greater proportion of males than females ranked timber production as the most important output of forests. In contrast females placed greater importance on the nature conservation role.

Respondents were asked their views on forest management and the involvement of the general public in decisions regarding forest management (Table 6). It is clear that the general public want to have input into how forests are managed. Just over two-thirds indicate that it is important that they know how forests are managed while a similar proportion feel that the public should have more opportunities to comment on how forests are managed. The majority (60%) trusted foresters to always make the right decision about managing forests although a sizeable minority did not.

Table 6 Respondents' views on involvement of general public in forest management (n=996)

	Strongly disagree (%)	Disagree (%)	Neither agree or disagree (%)	Agree (%)	Strongly agree (%)
The general public should only be asked their opinions on forests in their local area; not about forests throughout Ireland.	9	44	9	34	4
I would trust foresters to always make the right decisions about managing forests.	4	21	14	55	6
Knowing how Irish forests are managed is important to me.	1	11	20	55	13
The general public do not know enough about forests so their opinions should not matter.	12	54	10	20	4
The general public should have more opportunities to comment on how forests are managed in Ireland.	1	8	12	62	17

Forest visits

Just under one third of those surveyed had not visited a forest in the last 12 months whereas 28% had visited forests more than 6 times (Figure 2). Typically respondents travelled to the forest by car (90% of respondents).

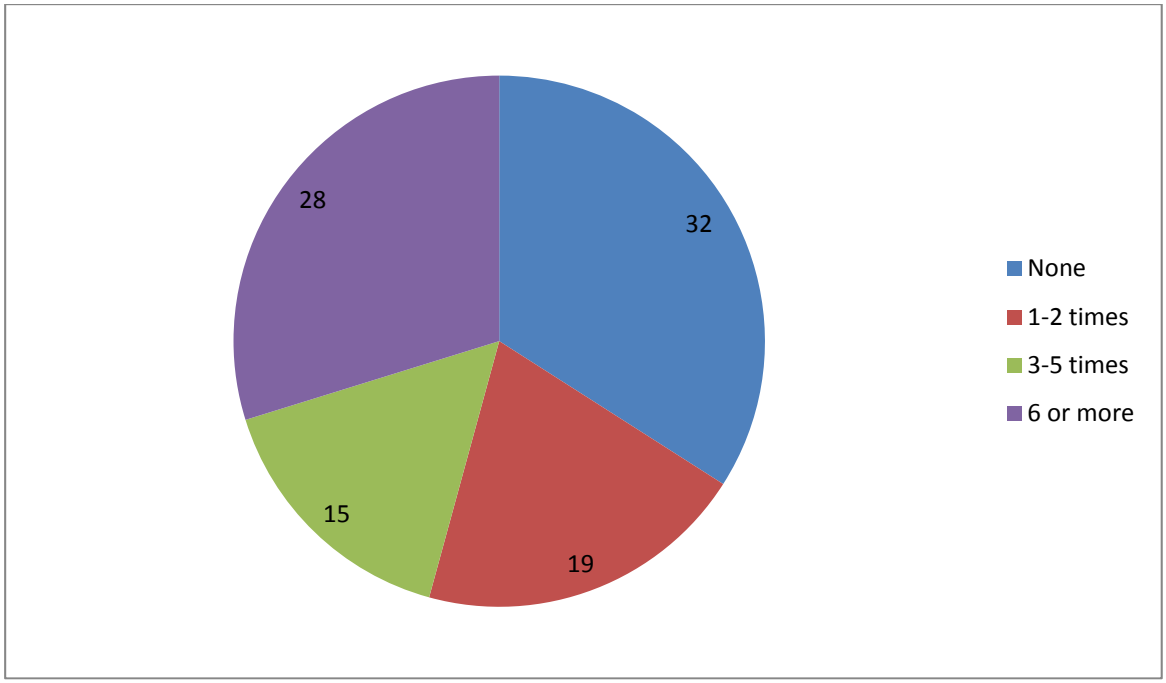

Figure 2 Frequency of visits to forests

4.2.2 The relative value of afforestation programmes

The choice experiment formed the key component of the household survey and was the means by which the relative values that the public placed on various "forms" of the afforestation programme were assessed. The output of one of the choice models (see Appendix B for description of the model) is given in Table 7. By the nature of the model the parameter estimates shown in Table 7 cannot be interpreted directly but rather give an indication of general support for the management changes described in the alternatives, in other words they show the effect of moving from the base attribute level to another on the respondent's preference for an afforestation alternative, e.g. 0.547 for the move from conifer to mixed forests. A positive parameter means that respondents are more likely to choose a form of afforestation with that characteristic and the larger the parameter the stronger the preference for that characteristic. Hence from the parameters shown in Table 7, gaining access to new forests on forest trails and including basic facilities is particularly important to respondents, resulting in the largest relative parameter estimate of the attributes (1.760). Mixed forests are most preferred of the included forest types although broadleaf forests are also strongly preferred over conifers.

The inclusion of reserve areas also had a strong positive effect on preferences, particularly for 30% reserve areas. However, the current requirement of 15% of the grant aided area to be given over to biodiversity enhancement also produces significant values.

Limited research has been conducted on public preferences for forest harvesting in Ireland but this issue was raised by participants in the focus groups. Individual tree harvesting was preferred over block clearfelling and this change produced one of the largest model parameters (0.734).

As expected the attribute “cost” produced a negative parameter indicating that as costs increase for an alternative, respondents are less likely to choose it.

The location of new forests under the afforestation programme is also a concern. The estimates of the constants for each of the three locations (Table 7) indicate that respondents preferred forests to be established closer to populated areas rather than remote areas (i.e. the constants for “close to cities and towns” (1.840) and “in the wider countryside” (1.886) are larger than that for the “remote areas (1.370)).

The heterogeneity in preferences within the respondents was explored to investigate what proportion of the population is expected not support the specified changes in forest management. It is evident from these results that changes are generally supported by respondents. Of particular interest is the small proportion of the sample that is expected to hold negative views of both recreational access attributes, i.e. 4%. Further research into this issue showed that members of farming households are less supportive of allowing access to new forests than other survey respondents.

Table 7 Results of the analysis of the choice experiment (Model 1)

Attribute Change		Estimate	Standard Error	P-value	% Neg.
Random Parameters					
City/Town constant	μ	1.840	0.136	0	
	σ	1.237	0.079	0	
Country constant	μ	1.886	0.131	0	
	σ	0.742	0.087	0	
Remote constant	μ	1.370	0.133	0	
	σ	0.903	0.086	0	
Conifer to Mixed	μ	0.547	0.065	0	23%
	σ	0.743	0.105	0	
Conifer to Broadleaf	μ	0.404	0.067	0	26%
	σ	0.621	0.109	0	
None to 15% reserve	μ	0.412	0.062	0	18%
	σ	0.455	0.13	0	
None to 30% reserve	μ	0.645	0.075	0	27%
	σ	1.050	0.101	0	
Clearfell to Individual	μ	0.734	0.065	0	27%
	σ	1.193	0.082	0	
None to Trail	μ	1.332	0.074	0	6%
	σ	0.860	0.101	0	
None to Trails/Facilities	μ	1.760	0.078	0	4%
	σ	0.992	0.103	0	
Non-random Parameter					
Cost		-0.02	0.001	0	
		Log-likelihood		-5917.272	
		No. Parameters		21	
		No. Observations		5976	
		McFadden-Pseudo R^2		0.286	

Using the parameter estimates shown in Table 7, willingness to pay values for management changes can be calculated by dividing the related parameter by the cost parameter estimate (see Appendix B for more detail). This can be interpreted as the amount of money that a respondent would forgo to achieve their preferred management change. Table 8 contains the willingness to pay estimates. It is evident from these results that the Irish public are willing to contribute significant amounts of money to achieve their preferred management options in the context of afforestation. Gaining access and facilities in new forests has a particularly large WTP of €89.94. This value can be interpreted as the mean amount of money that an individual is willing to pay annually in additional tax to support an afforestation programme that provides access and facilities. It should be noted that this issue relates to gaining access to future forests rather than examining current usage of forests.

Table 8 Willingness to pay for management changes (€)

Attribute Change	WTP
City Alternative	94.03
Country Alternative	96.39
Remote Alternative	69.99
Conifer to Mixed	27.94
Conifer to Broadleaf	20.64
None to 15% reserve	21.07
None to 30% reserve	32.95
Clearfell to Individual	37.50
None to Trail	68.07
None to Trails/Facilities	89.94

A second model (Model 2, Appendix B) was run to investigate the impact of management changes within the context of where the new forests would be located (i.e City/town, Country, and Remote). This found that gaining access to new forests was particularly important when forests are to be established close to cities and towns. This finding corresponds well to previous studies on urban and peri-urban woodland. In addition, it would suggest that schemes such as the neighbourwood scheme produce particularly large public values. This specification also found that respondents were less concerned with the inclusion of reserves and harvesting methods in forests established in remote areas.

The extent of forest cover surrounding respondents was included in a third model (Model 3, Appendix B) to investigate its effects both on overall support for afforestation and on respondent's preferences for the suggested management approaches. Forest cover was divided in terms of ownership, between public and private, and composition, between conifer and broadleaf/mixed species. This model showed that the extent of forest cover surrounding a respondent influences their attitudes towards afforestation differently depending on both its ownership and composition. In particular, the greater the extent of publicly owned broadleaf/mixed forests surrounding an individual the greater the likelihood that they would support the afforestation programme and the stronger their preferences for the management attributes.

4.2.3 The influence of the public's preferences for the afforestation programme for other non-market benefits and for timber production

In the choice experiment respondents were asked to indicate their preferences (and assign a value to these) for different approaches to the afforestation scheme. These preferences will have consequences for other externalities associated with the afforestation programme, i.e. carbon sequestration and impacts on water supply and quality. In addition, these preferences will have consequences for the timber output from the afforestation programme. Hence in this section of the report the consequences of the public's preferences for carbon sequestration, water supply and quantity, and timber production are explored.

4.2.3.1 Carbon

To assess the volume of carbon sequestered as a result of the afforestation programme, software developed as part of the CARBWARE project (www.coford.ie) was used[5]. In particular the impact of a number of the attributes used to describe the afforestation programme in the household survey, i.e. tree type (conifers; broadleaves; and mixed) and biodiversity areas (0%, 15% and 30%)[6], on the volume of carbon sequestered is investigated[7].

The CARBWARE software requires details of the species planted, the productivity of the land afforested as well the details of the silvicultural management to be employed to be inputted. The assumptions made regarding these characteristics are outlined in Appendix D.

Two different afforestation rates were considered. First an annual afforestation rate from 2011 to 2030 of 21,397 ha (Scenario 1) is assumed. Thereafter a zero afforestation rate is assumed. This represents the area that would need to be planted annually from 2011 if the target of 17% forest cover as outlined in "Growing for the Future" is to be reached in 2030 and coincides with the extent of the afforestation programme outlined in the household survey.

However, afforestation rates currently lag considerably behind the targets outlined in the strategy. Thus a second rate of afforestation is considered, i.e. 8000 ha which coincides with the current (2010) rate of planting (Ryan, 2011). Under this scenario (i.e. Scenario 2), 8,000 ha are assumed to be planted annually from 2011 to 2060.

Once the volume of carbon was estimated, a value was assigned to each tonne. These values were derived from a Department of Finance circular on monetising the impact of capital investment projects in CO_2 emissions. In this circular prices are given for use in cost benefit analyses (Table 9).

[5] Kevin Black, FERS Ltd., assisted with this section of the work.

[6] The software assumes a 10% reduction in area across all afforestation scenarios to account for unproductive areas; therefore the 0% set-aside for biodiversity in reality reflects a 10% reduction in the total area planted ; the area unplanted associated with the 15% and 30% area set-aside for biodiversity were constrained to 20% and 35% of the total area respectively.

[7] The harvesting method, i.e clearfell versus single tree harvesting, will also influence carbon sequestration rates, however models have yet to be developed to quantify how these rates differ.

Table 9 Values to be used in monetising carbon emissions

Year	Price €/t
2011	14.61
2012	15.59
2013	16.76
2014	17.93
Post -2014	39.00

Source: Dept of Finance

Carbon sequestration under different forms of afforestation programme

In the household survey respondents were asked to consider the afforestation programme as outlined in "Growing for the Future", i.e. their willingness to pay for an afforestation programme that would result in 17% forest cover by 2030. Mixed forests were most preferred of the included forest types although broadleaf forests were also strongly preferred over conifers. The CARBWARE software estimated that the total volume of carbon sequestered if a mix of conifers and broadleaves was afforested (50:50 conifer broadleaf mix and assuming 0% of the area set aside for biodiversity) is 119 MT by 2060 (Figure 3). This is substantially lower than the volume that would be sequestered if the afforestation programme was comprised entirely of conifers (i.e. 195 MT). Broadleaves were also preferred by the public over conifers and for the period in question (i.e. 2011 to 2060) an afforestation programme comprised solely of broadleaves would sequester only 42 MT.

Using this approach the consequences of the publics' preferences for areas to be aside for biodiversity were also assessed. The public showed a strong preference for 30% of the forest area to be set aside for biodiversity. This would result in the volume of carbon sequestered being approximately 27% less (irrespective of species planted) than it would be if no area was set-side (Figure 3).

It was useful also to assess the volumes of carbon sequestered if the afforestation rate continued at a rate of 8,000 ha per annum (2010 rate). The carbon sequestered if only conifers were planted over the next 50 years would be 106 MT (assuming 0% set aside for biodiversity) (Figure 4), while for pure broadleaves it would be 27 MT.

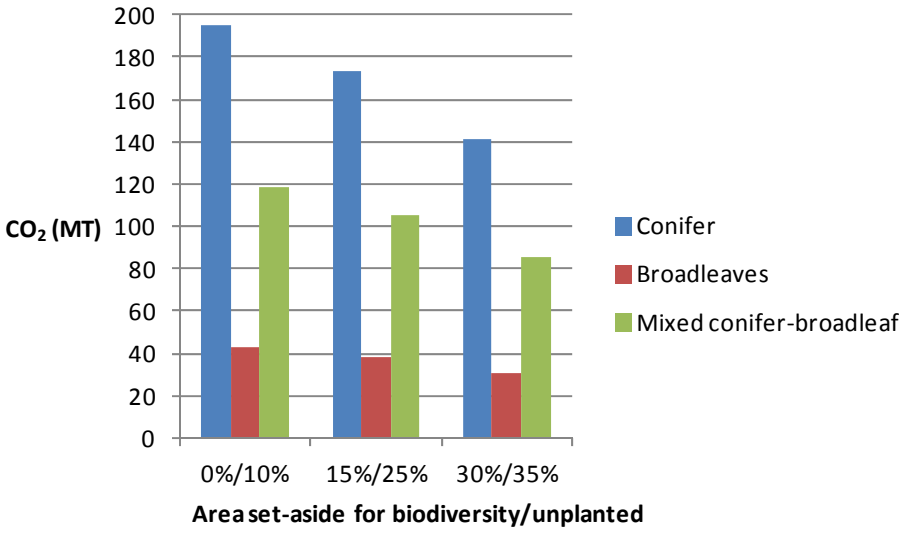

Figure 3 Total carbon sequestered over period 2011 to 2060 for scenario 1

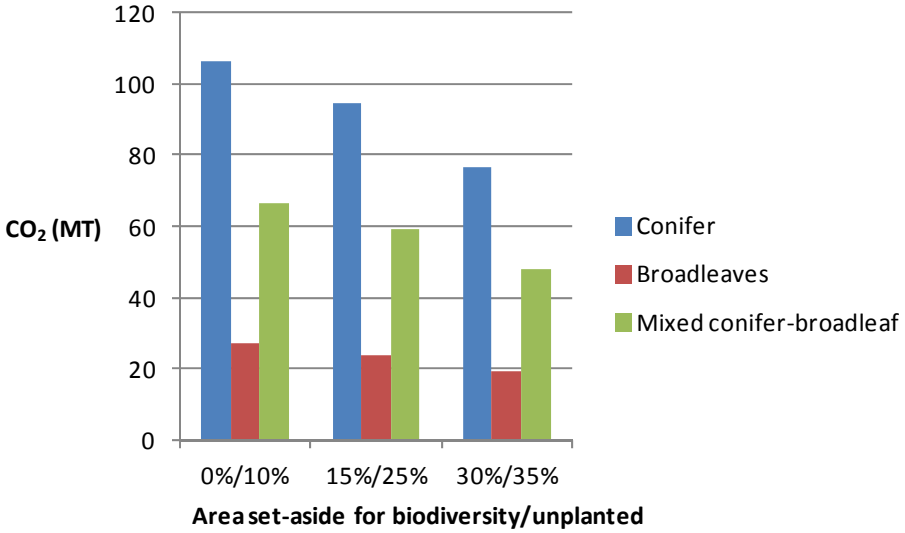

Figure 4 Total carbon sequestered over period 2011 to 2060 for scenario 2

4.2.3.2 Water supply and quality

The impacts of afforestation on water supply and quality are externalities associated with the afforestation programme. In this section of the report the implications of the preferences expressed by the public for different forms of afforestation programme on these two externalities are explored.

Water supply

In assessing the impact of the afforestation programme on water supply, it is necessary to know the current supply situation and the current cost of addressing any shortfall in that supply that can be attributed to forestry. Water supply in the Dublin region (Dublin, Kildare and North Wicklow and parts of county Meath) comes from rainfall in the Liffey and Vartry Catchments. The raw water is then treated at treatment plants in Ballymore Eustace, Leixlip, Ballyboden, Roundwood and Bog of the Ring. The maximum output from these plants (2010) is between 540-550 million litres per day. With average daily demand between 530-540 million litres there is no spare capacity in the system (Anon, 2010, p 10). This implies that an increase in forest cover could lead to a reduction in supply that would have to be addressed. Current approaches to increasing supply "involve leakage management, water conservation initiatives and the incremental expansion of the Ballymore Eustace water treatment plant and operation of all treatments plants beyond their sustainable production capacities" (Anon., 2010).

Forest cover in Dublin, Kildare, Wicklow and Meath counties is currently 3.9%, 5.4%, 21.5% and 3.0% (ITGA, 2012), i.e. an average of 8.45%. This is similar to the forest cover over a decade ago, i.e. 8.33% (Clinch, 1999) revealing that there has been a very limited increase in forest cover in the counties that supply water to Dublin. This trend is not perhaps surprising in that some of the best land in Ireland can be found in these counties and typically this type of land is not used for forestry. There is no reason to believe that this trend will differ in the future as there remains a strong resistance among farmers to planting "good land" (Duesberg et al., 2011).

The trends outlined above would suggest that the afforestation programme, irrespective of the species planted, would not have a negative effect on water supply. There is however insufficient information available to adequately assess the potential positive effects of the afforestation on water supply.

Water quality

The implementation of the Forest Service Guidelines on Forestry and Water Quality, Forest Harvesting and Environmental Guidelines and the statutory regulations on aerial fertilisation would suggest that Bacon and Associate's (2004) conclusion that "potential negative externalities from forestry with respect to water quality are already being internalised through adherence to standard operating procedures based on best practice and Forest Service guidelines, water quality monitoring, collaborative studies and the FSC certification process" still applies. Hence it is assumed in this study that the afforestation programme will have no negative impact on water quality. Currently research is being undertaken to investigate the impact of forest operations on Ireland' aquatic ecology and the results from this will help clarify the effectiveness of the Guidelines (www.coford.ie).

The positive impacts of forests on water quality are increasingly being recognised. In Britain Willis (2002) outlined how eutrophication of water arises mainly from agriculture and that

benefits in terms of water quality might occur by the afforestation of agricultural land in certain water catchment areas.

4.2.3.3 Timber production

One of the primary outputs of forests is timber. The make-up of an afforestation programme in terms of what species are used and what proportion of the area is set aside for biodiversity are among the factors that influence the volume of timber produced. Other factors such as site productivity and silvicultural management are also important. In this section the influence of the public's preferences for the make-up of the afforestation programme for timber production is investigated.

To do this use was made of the Forestry Commission Yield Models which produce estimates of the volume of timber produced according to species, site productivity and silvicultural management. Similar scenarios and assumptions were employed as were used in modelling carbon sequestration values (see section 5.2.3.1 and Appendix D).

The results show that the total volume of timber produced by 2060 under scenario 1 is almost 84 million m^3 if only conifers were planted while the volume produced were broadleaves planted would only be just over 50 million m^3 (assuming 0% of the area set aside for biodiversity) (Figure 5).

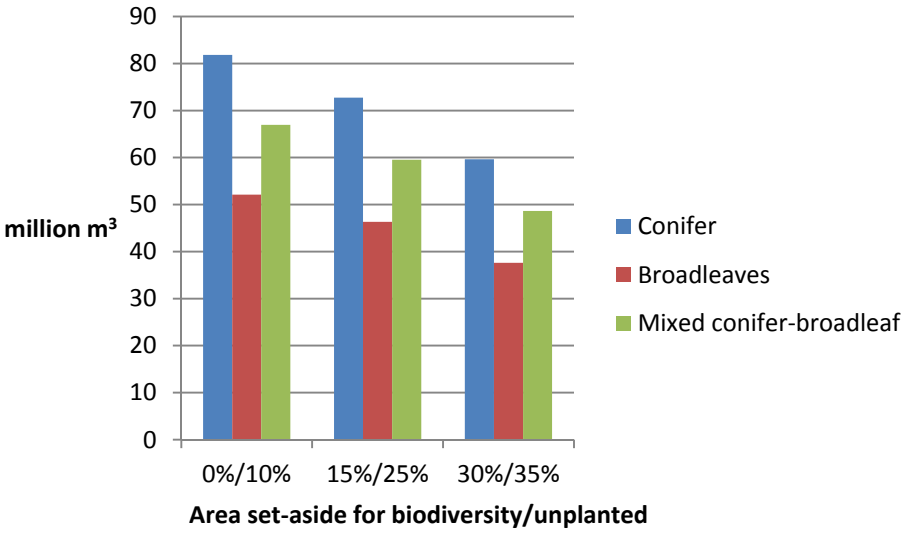

Figure 5 Total timber output over period 2011 to 2060 for scenario 1

If current afforestation rates continue at the current rate (i.e. 8000 ha per annum), the total timber output if conifers were to comprise the afforestation programme would amount to 29 M m^3 while if mixed species were planted this would fall to 24 M m^3 (Figure 6).

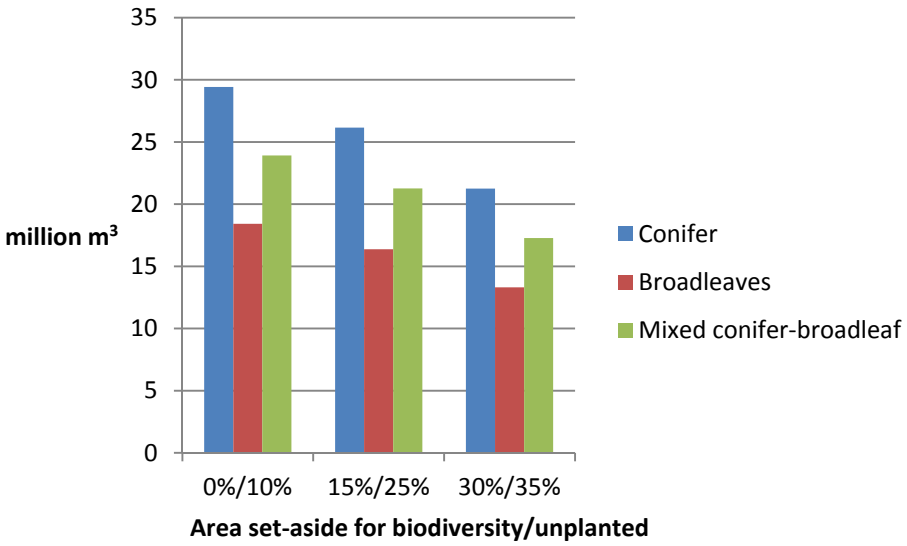

Figure 6 Total timber output over period 2011 to 2060 for scenario 2

4.3 The value of the tradable goods and services associated with the existing forest estate

The objective of this section was to determine the value of the tradable good and services associated with existing estate. To assess the value of timber production in the current estate input-output analysis was used. This allowed the direct and indirect contribution of timber production (hereafter referred to as forestry) to the national and regional economies to be assessed. This technique was used in a previous study (ECONTRIB) undertaken in Ireland, funded by COFORD, and full details of the background to the theory and application of input-output analysis is presented in the report on that study (Ní Dhubháin et al., 2006).

In this study the most recently published input-output table for Ireland, which related to the Year 2005 (CSO, 2009), was used. In this table forestry is grouped with agriculture and fisheries. However, using data obtained from the CSO, this sector was divided into its component parts (i.e. forestry, agriculture and fisheries). The following ways in which forestry contributes to the economy were then assessed:

(i) The Direct Contribution of Forestry
The direct contribution is the impact of the spending by the forestry sector on goods and services.

(ii) The Indirect Contribution of Forestry
The indirect contribution of forestry is that which occurs when suppliers to forestry firms purchase goods and services to meet demand.

(iii) The Induced Contribution of Forestry
The induced contribution of forestry refers to the additional consumer expenditure that takes place when the wages and salaries generated from the direct and indirect contributions of forestry are in turn spent.

Both the indirect and induced contributions will be higher when leakages from the economy are lower - in other words, when the expenditure on imports from outside the country or region under analysis is lower.

The sum of the *direct, indirect and induced contributions*, described above, represents the overall contribution of forestry. These contributions may be expressed both in absolute terms and in terms of multipliers for output (i.e. purchases of inputs), income and employment. The total contribution of the forestry sector can thus be expressed in terms of money and jobs.

Once the absolute contributions are estimated the direct, indirect and induced multipliers are obtained. From these multipliers two other multipliers are calculated: Type 1 multipliers reflecting the direct and indirect impact and Type 2 multipliers which represent the induced impact in addition to the direct and indirect impacts. The Type 2 multiplier indicates that the overall impact expenditure on the region or country.

The 2005 input-output table was also used to assess the value of timber processing as the Wood and Wood Products is a sector represented in it. In this study this sector is divided into three sub-

sectors: Panelboards, Sawmills and other Wood products (excluding furniture) (hereafter this will be referred to as Other Wood Products).

The expenditure patterns of the forestry sector of the Irish Economy for the year 2010 are shown in Table 10. The sector has strong linkages to the domestic economy. Intermediate purchases account for 66% of all expenditure and imports account for only 26% of total expenditure. Wages and salaries make up 12% of expenditure. This latter value may be understated as the sector subcontracts much of its work to small operators. Other Domestic Inputs are primarily Product Taxes less Subsidies. The large negative number reflects the large level of subsidisation in the Forestry Sector. Total direct employment is 3125.

Table 10 Forestry - direct expenditure (€ millions –2010) and employment (units) by sector

	Expenditure	% of Total Spend
Total Intermediate Inputs	249.2	66
Wages & Salaries	47.5	12
Profits	10.1	3
Other Domestic Inputs	-25.9	4
Total Domestic Inputs	280.9	-----
Imports	97.2	26
Total Inputs	378.1	
Employment	3125	-----

Estimates of the direct, indirect and induced impacts of forestry on the Irish economy in the year 2010 are reported in Table 11. Forestry gross value added is 31.7 (i.e. 47.5 + 10.1 – 25.9), which represents 0.02% of the national GDP.

The expenditure and employment multipliers are also reported. The type 2 output multiplier is 1.78. Thus for each one million euro in expenditure in the forestry sector a further €780,000 in expenditure is generated in the rest of the economy. The type 2 employment multiplier is 1.77. For every 100 jobs in the forestry sector an extra 77 full-time equivalent jobs are provided in other sectors of the economy. The results indicate that €378.1 million is the direct output in the forestry sector (year 2010). When the other impacts are taken into account, the overall value of forestry to the Irish economy is €673.0 million. Total direct employment in forestry, i.e. 3125, while the total overall employment related to forestry sector activities is estimated to be 5531.

Table 11 Output and employment impacts of forestry for the year 2010

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	378.1	102.1	192.8	480.2	673.0
Multipliers	1.00	0.27	0.51	1.27	1.78
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs	3125	750	1656	3875	5531
Multipliers	1.00	0.24	0.53	1.24	1.77

4.3.1 Contribution of the wood and wood products sector to the national economy

An overview of the economic expenditures for industries involved in the wood and wood products sector is given in Tables 12 to 14. Total direct employment in this sector is 3907. The "other wood products" has the largest share of employment (54%).

Table 12 Panel boards - direct expenditure (€ million –2010) and employment (units)

	Expenditure	% of Total Spend
Total Intermediate Inputs	98.4	35
Wages & Salaries	49.3	17
Profits	47.3	17
Net Other Domestic Inputs	6.8	2
Total Domestic Inputs	201.8	
Imports	83.2	29
Total Inputs	285.0	100
Employment	805	

The panel board sector has the smallest share of employment (20%). The overall value of wages in this sector is €49.3, which represents 24.5% of the total wages in the Wood and Wood Products Sector. Gross value-added in the Wood and Wood Product is 375.2 (i.e. 198 + 158 + 19.2), which represents 0.24% of National GDP.

Table 13 Sawmills - direct expenditure (€ million –2010) and employment (units)

	Expenditure	% of Total Spend
Total Intermediate Inputs	201.7	56
Wages & Salaries	40.7	11
Profits	10.5	3
Net Other Domestic Inputs	5.2	1
Total Domestic Inputs	263.5	
Imports	106.7	29
Total	370.2	100
Employment	996	

Table 14 Other wood products - direct expenditure (€ million –2010) and employment (units)

	Expenditure	% of Total Spend
Total Intermediate Inputs	291.1	43
Wages & Salaries	108.0	16
Profits	100.2	15
Net Other Domestic Inputs	7.2	1
Total Domestic Inputs	506.5	
Imports	169.2	25
Total Inputs	675.7	100
Employment	2106	

Information presented in Tables 15, 16 and 17 represents the total impacts (direct, indirect and induced) in the economy as a result of expenditure in the panel board, sawmill and "other wood products (excluding furniture)" sectors in 2010. Impact estimates are not directly aggregateable with the data presented in Table 6 due to an overlap in indirect and induced impacts. General comparisons do, however, further support the conclusion regarding the importance of these sectors to the Irish economy. For example, there were 6,408 full-time equivalent jobs associated with the three processing sectors in 2010. Total related expenditure of the three sectors is €2.20 billion.

Table 15 Panel boards - expenditure and employment impacts – Year 2010.

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	285.0	74.1	99.7	359.1	458.8
Multipliers	1.00	0.26	0.35	1.26	1.61
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs units	805	201	298	1006	1304
Multipliers	1.00	0.25	0.37	1.25	1.62

Table 16 Sawmills - expenditure and employment impacts – Year 2010

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	370.2	107.4	151.8	477.6	629.4
Multipliers	1.00	0.29	0.41	1.29	1.70
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs units	996	309	408	1305	1713
Multipliers	1.00	0.31	0.41	1.31	1.72

Table 17 Other wood - expenditure and employment impacts – Year 2010

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	675.7	202.7	236.5	878.4	1114.9
Multipliers	1.00	0.30	0.35	1.30	1.65
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs units	2106	611	674	2717	3391
Multipliers	1.00	0.29	0.32	1.29	1.61

4.3.2 Contribution of forestry to the regional economies

The contribution of the forestry and wood products sectors to a number of regional economies was also investigated. Regional input-output tables were generated by McFeely (2011) for the NUTS 2 regions in Ireland, i.e. The Border, Midland and Western (BMW) region and the

Southern & Eastern (SE) region. The tables are general purpose in nature and are fully consistent with the official national Supply & Use and Input-Output tables and the regional accounts. The tables were constructed using a survey based or bottom-up approach rather than employing modeling techniques, yielding more robust and credible tables.

Output from forestry in the SE region was €456.6 million while in the BMW region it was €233.9 million (Table 18). The sum of these outputs is greater than the national output (i.e €378.1 million). This is due to the inclusion of domestic imports and exports. Since the domestic imports of one regions are the domestic exports of another region, this results in the larger output figure. At a national level these flows are netted out.

Using the data shown in Table 18 and multipliers calculated from the regional input-output tables, the overall impact of the forestry sector in the specific regions is determined (Tables 19 and 20).

Table 18 Forestry-direct expenditure and employment for the two regions –year 2010

Region	Direct output (€ millions)	Employment (units)
South-East	456.6	1956
BMW	233.9	1169
State	378.1	3125

Table 19 Output and employment impacts of forestry for the year 2010 for the South-East Region

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	454.4	63.9	132.4	520.3	652.7
Multipliers	1.00	0.14	0.29	1.14	1.43
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs	1956	508	1076	2464	3540
Multipliers	1.00	0.26	0.55	1.26	1.81

Table 20 Output and employment impacts of forestry for the year 2010 for the BMW Region

Output					
	Direct	Indirect	Induced	Type 1	Type 2
€ millions	223.9	21.1	49.1	255.0	304.1
Multipliers	1.00	0.09	0.21	1.09	1.30
Employment					
	Direct	Indirect	Induced	Type 1	Type 2
FTEs	1169	245	573	1914	1987
Multipliers	1.00	0.21	0.49	1.21	1.71

4.3.3 The value of game hunting in Irish forests

The aim of this section of report is to assess the contribution of game hunting in Irish forests to the national economy. A full cost-benefit analysis is long overdue but is beyond the scope of this study. Instead this assessment will solely focus on estimating what "money" circulates in the Irish economy arising from game hunting in Irish forests. This assessment was based on a combination of a desk-top study along with consultation with a number of experts in the field[8]. There is limited economic data published on the topic.

It is assumed that the only game that are hunted (in any significant numbers) in Irish forests are deer (woodcock are also hunted but it is very difficult to get any data on the value to the economy). Thus this section will only focus on wild deer; the economic importance of farmed deer is not considered.

Four deer species are currently present in Ireland. These include red deer (*Cervus elaphus*); Sika deer (*Cervus Nippon*), fallow deer (*Dama dama*) and Muntjac deer (*Muntiacus* sp.). Forests are a favoured habitat for deer.

Reliable estimates of the total number of deer present in Ireland are difficult to obtain. It was estimated that the 25,000 deer (2009 figures) shot in 2009 accounted for approximately 8 – 10% of the total deer population (Purser et al., 2009).

Deer shooting is controlled under a licence system. The National Parks and Wildlife Service (NPWS) issues annual permits to hunters who apply with permission from a land owner to hunt on lands holding deer. In 2010, the NPWS issued licenses to over 4,000 hunters. There is no charge for a deer hunting licence from NPWS.

Once hunters have been issued with a licence from the NPWS they are then free to shoot deer within season on the land for which they have permission. In some cases hunters pay the landowner a fee for the right to shoot deer on his/her property. Coillte operate a deer lettings system whereby hunting on their forest properties is tendered amongst the hunting community. The sporting value of different lettings ranges widely depending on location, access, scale, deer abundance and other factors. Fees of up to €10 /hectare are offered for some properties in Wicklow (Purser et al., 2010). In 2009 it was estimated that hunters paid €0.5 million to Coillte for leasing land for hunting. Although there is no formal letting system across the private sector, similar arrangements can occur between private land owners and hunters. No figures are available on this.

Some hunters who have obtained permission to hunt on particular properties use these properties for client stalking. This is where the lease holder guides paying hunter clients to optimise their hunting/sporting experience. The client is charged a fee for this service by the lease holder. The client also purchases other tourism related services such as meals, accommodation, car hire etc. The majority of deer stalking tourists coming to Ireland come from Denmark and Sweden and other European countries. It is not possible to assess the value of client fees although one Wicklow deer hunting guide reported bringing income in the region of €150,000 to the County per annum.

[8] Paddy Purser of PTR Ltd assisted with the section of the work.

Of the estimated 32,000 deer that were reported shot in NPWS returns in 2010 it is not clear how many of the carcasses were sold for venison to licensed game dealers of which there are 4. Payments of between €1.00 and €1.50 per kg are made for weighed carcases which, for a 47 kg animal, equates to €47 to €70 per deer (Purser et al., 2010).

Neither the Department of Agriculture nor the Central Statistics Office publishes statistics for venison alone. A Dept of Ag official did provide an estimate for 2009 of 55 tonnes of venison produced in Ireland. The majority of this meat is exported to European markets (Purser et al., 2009).

In order to obtain a deer hunting licence, hunters must first have a licence for a suitable firearm for deer hunting (rifle of 0.22 / 250 calibre with a minimum muzzle energy of 1,700 foot pounds, which uses bullets not weighing less than 50 grains). In 2009, 3473 such licences were issued in Ireland. These licences cost €80 / rifle for 3 years and the annual revenue to the State from these licences is estimated at approximately €100,000. In addition to licences, hunters spend money on hunting vehicles, equipment and ammunition. Such expenditure varies widely but is estimated to average approximately €300 / hunter per annum, contributing a further €1 million to the economy.

Deer impact on the economic value of forests through browsing, bark stripping and fraying and thrashing. No nationwide estimate of the value of this loss is available. However, Purser et al. (2009) estimate that between €18 million and €34 million worth of damage has been caused by deer to the broadleaved forest estate.

Table 21 summarises the value to the economy from game hunting in forests.

Table 21 Summary of value of game hunting to economy

Activity	Value (€)
Leasing land for deer hunting	500,000
Client fees	150,000
Venison	70,000*
Purchase of rifles	100,000
Other purchases	1,000,000

- A rough estimate based on the unofficial Dept of Ag figures of 55,000 kilos of venison @ €1.25 per kilo

4.3.4 The value of the forest foliage industry

The assessment of the value of the foliage production in forests also involved consultation with experts in the field.

The Irish foliage industry commenced in 1993 and has grown steadily to over 200 hectares in 2011. The value of production in 2010 was €2.5 million. The main cultivated foliage species include *Eucalyptus*, *Pittosporum* and *Viburnum*. A significant proportion of the foliage exported is wild or woodland foliage. The main woodland species are *Abies procera*, *Pinus* spp., *Cupressus macrocarpa* and *Betula* spp. with *Rhododendron* being the main wild species.

There are three companies involved in forest foliage, all based in the south of the country. The enterprises are owner/family owned and all would be considered SMEs. The largest accounts for over 70% of the total value and employs 40 persons full-time, with up to 100

part-time at peak times, all of which are rural-based.

This is an industry which is expected to expand. In particular, added value at Christmas is beginning to become very important – mainly wreaths and table arrangements into supermarket packers and chain stores in UK. The production of glittered twigs has also been an area that has expanded.

5 Discussion

The study showed that the overall value of forestry (i.e. the current forest estate) to the Irish economy is €673.0 million giving rise to a total overall employment of 5531. Further economic activity is generated through the processing of the wood from these forests, i.e. €2.20 billion, with an associated overall employment of 6,408. These results confirm the significant contribution that forestry makes to the national economy. However, there is increasing recognition that forests generate a wider range of benefits than just timber production and that if the State is to continue to invest in new forests that these should be planned and managed in such a way as to maximise the public benefit that can be derived from them. Hence the primary aim of this study was to provide strategic information by indicating the relative benefits of forest management practice respectively directed at the outputs of recreation, biodiversity, landscape, water quality and carbon sequestration. To do this, a sample of the general public was asked, through the application of a choice experiment approach, to indicate their preferences for different attributes of an afforestation programme and to indicate what they would be willing to pay for a programme that had these attributes.

The results of the attitudinal section of the household survey indicate that the vast majority of the public agree that that all types of forests are good for the environment (80%) and recognise that forests are part of the traditional landscape of Ireland (92%). There was general support for the afforestation programme and for forests planted as part of this programme to:

- include access for recreation (including provision of recreational facilities);
- have 30% (and to a lesser extent 15%) of the forest area set-aside for biodiversity;
- have individual tree harvesting rather than clearfell;
- be comprised of broadleaves or conifer/broadleaf mixes rather than pure conifer.

The highest willingness to pay values were for the provision of recreational access and for this access to be complemented with facilities. This finding is not surprising as such changes are relatively easy to comprehend and appreciate and are associated with important potential use values. Although large, the WTP values, €68.07 for access and €89.94 for access and basic facilities, are reasonable in comparison to annual expenditure on recreation. Fitzpatrick and Associates (2005) found that forest trail users spent, on average, €161 annually on trail equipment and had a WTP of €5.42 per forest visit. In the attitudinal section of the household survey almost half of the respondents indicated that there should be public access to private forests again reflecting the importance of this attribute. Significantly those who will most likely own these new forests, i.e. farmers, were less likely to agree with public access.

Biodiversity values have been examined in other discrete choice experiments using a variety of attributes (e.g. Meyerhoff et al., 2009). In this study a specific area given over for “plants and animals” was included as an attribute rather than a direct measure of biodiversity. This attribute produced WTP values of €21.07 for the 15% area and €32.95 for the 30% area, in comparison to no area being given over.

There is increased interest in alternative silvicultural systems to clearfell in Ireland, with a small, but increasing number of forest owners adopting these alternatives in their stands. Public preferences for harvesting has not been examined in detail in Ireland, although the Forest Service have produced specific guidelines in relation to harvesting methods that take account of external effects (Forest Service, 2000e). This study found that harvesting was an important issue amongst respondents and produced one of the largest WTP values of €37.50.

Other choice experiments have similarly found that respondents prefer more diverse stand structures and less intensive harvesting to single storey forests and clearfelling (e.g. Nielsen et al., 2007; Meyerhoff, 2009; Berninger et al., 2010).

Amongst the tree type attribute levels, mixed forests were most preferred followed by broadleaf in comparison to conifer forests. Other stated preference studies have identified strong preferences for mixed stands (Mill et al., 2007) and for broadleaf (Clinch, 1999; Mill et al., 2007) both in Ireland and abroad (Nielsen et al., 2007). Although the current survey produced significant WTP values for this attribute, €27.94 for mixed and €20.64 for broadleaf, these were amongst the smallest values produced by the attribute selection. This is somewhat surprising given the importance attached to this issue in previous research.

Although much of the early state afforestation was carried out in remote rural areas, the public expressed their preference for forests to be established close to urban areas and in the general countryside rather than in these more remote areas. Given the increasing urbanisation of the Irish population (65% and 32% of the sample chose the close to cities and countryside label respectively as representing where they live) such a result is unsurprising. The planting of forestry in remote areas still received a positive value and so it is likely are not disinclined to sensitive planting in remote areas. Rather, the results indicate that the planting of more forestry would be valued closer to where people live. In this respect, there is evidence of a relationship with the expectation of access and therefore with the ownership of the new forestry with attributes of new forests located in cities producing some of the highest WTP estimates, particularly for recreation. The public considered the method of harvesting less important for forests located in the wider countryside than for forests close to cities.

Specific agricultural communities have been found to have a general dislike of afforestation in Ireland (O'Leary et al., 2000; Ní Dhubháin et al., 2009). In describing the afforestation policy to survey respondents, marginal farmland was identified as being the target of forest expansion in line with current and previous forest policy in Ireland. This study found that members of farming households were less likely to choose any of the forest alternatives in comparison to the opt-out. Previous literature would suggest that a perception exists in some communities that establishing forests on farmland is a waste of land or potentially a threat to farming and rural communities (O'Leary et al., 2000; Elands et al., 2004). In particular, farmers may view afforestation not in economic terms but rather as a loss of land and identity (McDonagh et al., 2010). In comparison to other occupations, Clinch (1999) found that farmers were more likely to believe that afforestation would spoil the landscape, destroy wildlife and is generally bad for the countryside. Some of this hostility may stem from the potential competition posed by forestry. In the past, land has been bought and afforested by financial institutions for investment purposes, increasing competition for land and potentially denying local farmers the opportunity to expand their landholding (Flechard et al., 2007). Fundamentally this may be linked to the engrained productivist ethos of Irish farmers and the view of agriculture as the preferred land use (McDonagh et al., 2010). Such views are a challenge to the goals of current Irish policy as private landowners, primarily farmers, are expected to provide land for afforestation. Such resistance amongst farmers might mean that instilling a positive attitude amongst farmers in Ireland towards forestry is potentially more important than including public attitudes if afforestation goals are to be met. Irish farmers who chose to plant may see afforestation primarily as a viable use of poor quality land (Wall and Ní Dhubháin, 1998), which might offer the opportunity to diversify afforestation through appropriate funding. Another COFORD-funded project, POLFOR, is exploring farmer's

attitudes to afforestation and will provide recommendations as to how greater uptake of the afforestation scheme can be achieved.

Empirical data on the impacts of afforestation on water quality suggests that quality can be maintained where planting conforms to best practice. The information on the impact on water supply is scant for Ireland. It seems likely that additional forestry will store more water. In the context of climate change, this is likely to have a negative effect on those areas that are at risk of reduced rainfall and possible drought. On the other hand, forestry is likely to provide a buffer to flash flooding induced by more extreme weather conditions, although information on the adequacy of this buffer in an Irish context is deserving of more research.

5.1 Implications of the public's choices

The choice experiment revealed the "type" of afforestation programme that maximises gross public benefit. However, delivering such a programme will have implications for the other outputs of forests. The following is an "indicative" cost-benefit analysis of delivering on some of these preferences. Yield models are not available for alternative silvicultural systems in Ireland thus it is not currently possible to estimate how changing from the clearfell system to individual tree harvesting would influence timber production and carbon sequestration. Similarly it is assumed that the introduction of trails for recreation will not have consequences for timber production and carbon sequestration. Hence the analysis that now follows is restricted to estimating how changing species make-up and the extent of the area set aside for biodiversity, will impact on the volume (and value) of timber produced and carbon sequestered.

Recall the WTP value of €20.64 represents, on average, what an individual would be willing to pay, per annum, for an annual afforestation programme amounting to 21,397[9] ha, that comprised broadleaf forests rather than conifers. The change in the value of timber produced and volume sequestered was estimated for a rotation (i.e. 50 years) and the net present value (NPV) of the change is shown in Table 22. Full details of the assumptions used in generating these values are shown in Appendix E.

This analysis shows that for the period covered by the cost-benefit analysis (2011-2060) the NPV of the public's willingness to pay for an afforestation programme comprised of broadleaves rather than conifers does not compensate for combined loss of value associated with carbon and timber. However, the greater willingness to pay for a programme comprised of mixed species does compensate for the loss in value of these other outputs. In addition the willingness to pay values for including either a 15% reserve area or 30% reserve area for biodiversity compensates for the loss in the carbon and timber.

[9] At the time of the survey forests covered 10% of land in Ireland; respondents were asked their willingness to pay to increase this to 17%, i.e. equivalent to planting 21,397 ha per annum

Table 22 Indicative cost-benefit analysis

Attribute Change	NPV (million €) of WTP	NPV (million €) of timber production	NPV (million €) of carbon	Net public benefit/cost (million €)
Conifer to broadleaf	1,267	-1,381	-234	-347
Conifer to mixed	1,716	-690	-117	908
0% reserve area to 15% reserve area	1,294	-136	-47	1,111
0% reserve area to 30% reserve area	2,023	-340	-115	1,567

,

5.2 Discussion of the methodology

A choice experiment was used to assess the relative value that the public placed on different approaches to the afforestation programme. The strength of the technique is that it allowed the public to indicate the relative value that they placed on various aspects of the programme. To ensure that the choice experiment was as "understandable" as possible, respondents were required to read a detailed information booklet about the afforestation programme which provided descriptions of the attributes. By necessity, this description needed to be as straightforward as possible as the preceding focus groups had highlighted a lack of knowledge and understanding among the public of forestry from the context of species, biodiversity etc.

The choices that people made during the course of the experiment have implications for other forest outputs. A benefit of choice experiments is that they require people to make trade-offs, but these only apply to the attributes included in the experiment and not to other contextual factors that were not introduced such as carbon sequestration or timber production and the associated employment. Neither were they advised of the potential economic benefits of greater recreation. Several of these aspects are assessed in the indicative cost-benefit analysis.

Input-output analysis was used to investigate the economic contribution of forestry and the wood products industry to the Irish economy. This technique was also used in the ECONTRIB project. In that project economic figures for forestry were not available from the Central Statistics Office, instead forestry was grouped with agriculture and survey data and research data from other studies were used to derive the forestry data from the agriculture data. In this study reported it was possible to obtain forestry data from the Central Statistics Office. This accounts for the change in the gross-value added value for forestry in 2010 which was €31 million compared to €134.5 million in 2003 as the former figure now includes net subsidies, whereas the latter did not. It is also important to note that the indirect and induced impacts of the forestry sector cannot be added to the indirect and induced impacts of the wood products sector due to an overlap in the values.

6 Conclusions

Forestry and the associated processing of the timber output continue to contribute significantly to the Irish economy. The overall value of the current forest estate to the Irish economy is €673.0 million giving rise to a total overall employment of 5,531. Further economic activity is generated through the processing of the wood from these forests, i.e. €2.20 billion, with an associated overall employment of 6,408.

The study showed that the general public support the afforestation programme. Indeed, if the sum of annual WTP for the most desired attribute levels for the expansion programme is aggregated to the total adult population then the public benefits would themselves amount to over €600 million. Although substitution effects between attributes caution against this even the individual attribute aggregated values are very sizeable, it is evident that the public hold distinct preferences in relation to the character of the proposed forestry programme and are willing to pay, through their taxes, for the fundamental attributes of this expansion. It is apparent that the public value the biodiversity benefits that would follow from allowing a proportion of the forest area to be kept free of planting for this purpose. It is also apparent

that people wish to see a greater diversity of tree species, including non-conifers, a factor that itself would have both biodiversity benefits and implications for the landscape. Most significantly, the values associated with access are relatively high, which combined with the evident preferences for where most new planting should take place, demonstrates that a forestry programme that provides for public access has the capacity to deliver a significant public good benefit. While private ownership is not incompatible with public access, it is evident that the forestry programme will need to specify requirements in this respect if it is to receive public endorsement.

There are, of course, implications, including potential external costs and benefits, depending of the extent to which public preferences are allowed to inform the planting programme. Requiring areas to be set aside for biodiversity could reduce the area available for planting commercially valuable tree species unless compensated by a larger overall forest area. The choice of species will have implications for timber output and carbon sequestration. The location of new forests could also impact positively and negatively on water supply and the incidence of flooding. However, the exact nature of these impacts and their relative costs and benefits depends to a large extent on precisely how the programme is managed, for example whether trees are planted in parts of the country that are vulnerable to moisture deficits, whether these trees are planted beside valuable agricultural areas or in catchments valuable to activities such as angling, the extent to which the Irish forestry industry can adapt to or capitalise on the growth of the alternative tree species, and the extent to which the leisure and recreation sector can secure economic and employment and retain these within particular locations. The choice experiment required the public respondents to make overt trade-offs with regard to their preferences for attributes such as recreation and biodiversity, but additional trade-offs will still be made by policy makers to ensure that these preferences are adequately represented but also balanced with other public good objectives.

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8 Full list of outputs from the project

Peer-reviewed publication

Upton, V. 2011. Ni Dhubhain, A. and Bullock, C. 2011. Preferences and values for afforestation: the effects of location and respondent understanding on forest attributes in a labelled choice experiment. Submitted for publication to Forest Policy and Economics.

Upton, V. 2011. Ni Dhubhain, A. and Bullock, C. 2011. The Effects of Existing Forest Cover on Public Preferences for Afforestation: Results from a Choice Experiment in Ireland. Submitted for publication to Land Use Policy.

Presentations

Upton, V. 2011. Ni Dhubhain, A. and Bullock, C. 2011. Public Preferences and Values for Afforestation in Ireland. Paper presented at Ulvon Conference in Environmental Economics. Ulvon, Sweden.

Upton, V. 2011. Ni Dhubhain, A. and Bullock, C. 2011. Public Values for Afforestation in Ireland. Seminar Series of Centre for Environmental and Resource Economics, University of Umea. Umea, Sweden.

Upton, V., Ni Dhubhain, A. and Bullock, C. 2010. Valuing the Afforestation Scheme Under Different Management Approaches. Paper presented at the Agricultural Economics Society of Ireland Young Researcher Seminar, Dublin, Ireland.

Ni Dhubhain, A. Upton, V., and Bullock, C. 2010. Valuing Forestry Public Goods. Presentation made to Heads of European National Forest Research Institutes, July 2010, Dublin, Ireland.

Ni Dhubhain, A. Upton, V., and Bullock, C. 2010. Valuing Forestry Public Goods. Presentation made to Forest Policy Review Group , July 2010, Dublin, Ireland.

9 Appendix A: Information sheet used in household survey

Introduction

Ireland currently has 10% of its land covered by forests. This is low compared to other European Union (EU) countries, which have on average 36% forest cover. In the past, Ireland had far more forests than it does now. However, over time much of these were cut down for timber and fuel or to be replaced with farmland.



Irish forests provide homes to many types of animals such as deer, squirrels, bats, birds and insects. Some plants and fungi only grow in the types of soils that are found in forests. Typical forest plants in Ireland include ferns, wood sorrel, and bramble and shrubs such as elder and hazel.



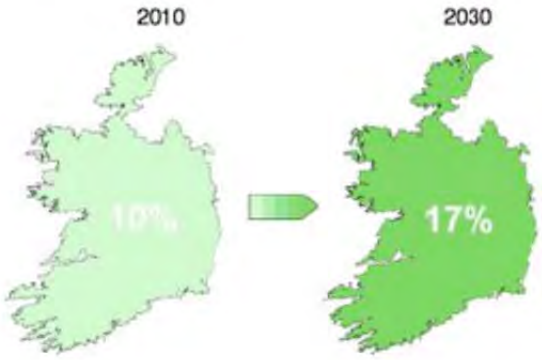
Forests are also a popular place for people to visit for recreation. People visit forests to walk and relax and also to do particular sports such as mountain biking and orienteering.



Plan for the Future

In recent years, the area of forest in Ireland has been increasing using financial support from the EU. Although forests were planted using this support some people feel that too much emphasis was placed on producing timber and not on the environment.

Financial support for forests is no longer available from the EU. However, the Irish Department of Agriculture is planning to promote the planting of forests in Ireland over the coming years. The plan is to expand forest cover from the current 10% to 17% of the country by the year 2030.



These forests will be mainly planted on less productive farmland and will be situated all over the country. The way that these new forests are planted and managed will affect the number of plants and animals that live in them, the way that they look and how people use them.

Have your say

We would like your opinion on how these new forests should be planted and managed. After reading more about this scheme you will be asked to compare different options for these new forests. There are **six** issues we would like you to think about

the **location** of the forests,
the **types** of trees planted,
having a **reserve area** for wildlife,
how trees are **harvested**,
having walking **trails** in the forests and
the **cost** of the new forests.

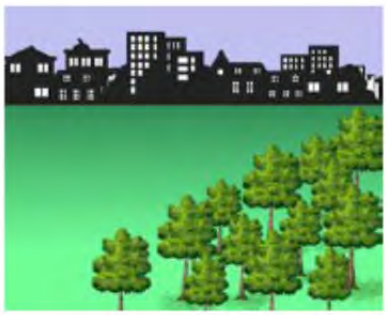
Each question will look like this:

One option will be to not plant any new forests (Row 4). The three other options (Row 1, Row 2, and Row 3) will describe different approaches to planting new forests in three different locations.

Please read the following explanations of the above issues paying particular attention to the **meaning** of the **images**.

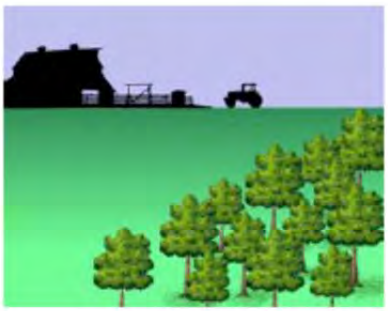
Location

There are three possible locations for these new forests.



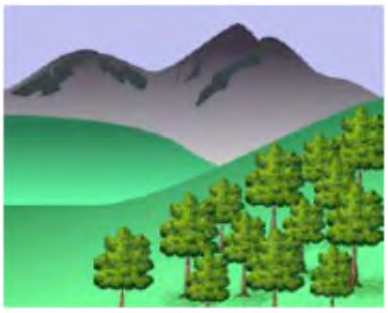
Close to cities/towns

Forests could mainly be planted close to cities, towns and other urban areas.



In the countryside

Forests could mainly be planted in the general countryside.



In remote areas

Forest could mainly be planted in remote upland or mountainous areas.

Types of trees

These new forests could be planted with broadleaf or conifer type trees or a mixture of the two.

Conifer Forest

Conifer ("pine" or "softwood") trees have thin needle type leaves that usually remain in the winter. Conifers tend to produce timber faster and so have been favoured in the past.

Broadleaf Forest

Broadleaf (or "hardwood") trees have wide leaves that are usually lost in winter. Broadleaves generally produce timber at a slower rate but may support a greater variety of plants and animals than conifers.

Mixed Forest

Mixed forests have both conifer and broadleaf trees. Having a mixture of both types tends to increase the total number of plants and animals in the forest.

Plant and Animal Reserve Area

Plants and animals will live throughout the forests but one part of these new forests could be managed just for this purpose.

Reserve in 15% of Forest

Within the reserve area, old trees, wet areas or other places that support plants and animals would be kept. Parts would be left open to let more light into the forest.

Reserve in 30% of Forest

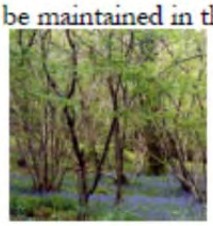
This area would be the same as above but twice the size.

No Reserve Area

No area will be managed primarily for wildlife in each forest.

Different types of areas will be maintained in the reserves.






Harvesting

Timber will be harvested from these new forests in one of two ways. New trees will be planted to replace the ones that are removed in both cases.

Cut Individually

Trees could be removed individually throughout the forest so that no large areas are ever left without trees.

Cut in Blocks

Trees could be removed in blocks where all the trees are removed from an area at once and then replaced.

Walking Trails

These new forests could be used for recreation by placing walking trails in them.

No Trails

Without trails these forests would not be accessible to the public.

Basic Trail

Each forest could have one basic walking trail.

Trails and Facilities

Each forest could have a network of walking trails and facilities such as picnic tables and information signs.

Cost

For the Irish state to pay for these new forests money would be raised from the general public through taxation.

In the questions you will see different values that describe how much **you** would have to pay per year for these forests until 2030.

Think of this as if **you** were asked to pay a small increase in the taxes **you** pay per year and that this money would **only** be used to plant and manage these new forests.

Although this could improve the environment it would mean that you would have a little less money to spend on other things, including other ways to help the environment.

What do you think?

You will now be presented with the **six** questions. The types of trees, reserve area, harvesting methods, trails and cost will vary between rows and questions.

In each question we would like you to first choose what you think would be the **best** option of the four rows.

Next, we would like you to choose what you think would be the **worst** option.

Finally, choose the **better** of the remaining two options.

Each row is a realistic example of how these forests could be **managed** and how much this would **cost** per year to **you**. Your answers will help the Department of Agriculture and foresters to make decisions about planting and managing forests in the future.

These questions are about **your** personal preferences and there are no right or wrong choices.

10 Appendix B: Theory underlying choice experiments

Choice experiments are viewed through the framework of Lancaster's characteristic theory (Lancaster, 1966) and random utility theory (RUT) based choice behaviour (McFadden, 1974). Under RUT an individual faced with a decision over a set of alternatives will choose the one that provides the highest utility. Furthermore, the utility associated with an alternative (U) can be divided into an observable portion (V) and a stochastic element (ε). Thus probabilistic statements can be made about preferences between alternatives. The probability of individual n choosing alternative i over j becomes;

$$Prob_{ni} = (V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj}, \forall\, i \neq j) \quad (1)$$

This can be extended to a case of multiple alternatives. The observed utility (V) is normally assumed to be linear in parameters where *x* can be a combination of alternative attributes and respondent characteristics and β' is a vector of parameters. Specifying ε as being Gumbel distributed leads to the multinomial logit model (MNL);

$$Prob_{ni} = \frac{\exp(\mu\beta\prime x_{ni})}{\sum_{j=1}^{J} \exp(\mu\beta\prime x_{nj})} \quad (2)$$

Hausman and Rudd (1987) extended the MNL to ranking studies to create what is known as the exploded logit model. This model treats ranks as a series of discrete choices over a decreasing number of alternatives and facilitates the interpretation of ranked data through random utility theory. In the above specifications μ is the scale factor of the distribution which is normally set at one, however this is unlikely to be true where data comes from different sources. Swait and Louviere (1993) developed a test of the relative difference in the scale parameter from different data sets, including different ranks in a ranking experiment. They proposed a two-stage test where firstly the hypothesis of equal parameter estimates, allowing the scaling factor to differ, is tested and if not rejected the second hypothesis of equal scale factors is tested.

Specification of the parameters can be generic across alternatives or specific to each alternative. As the MNL models the differences in utilities no variable that is constant across all alternatives can be modelled (Train, 2003). Instead the variable is excluded from one (or more) of the alternatives and the result is interpreted in relation to it. This is relevant to both constants and respondent characteristics.

Specification of the MNL model requires the limiting assumption of independent and identically distributed error terms, which if not satisfied may result in questionable results. In addition, the MNL model does not account for, or identify, heterogeneity across the sample, which may be of particular interest to policy makers in testing the general acceptance of attribute changes. The random parameter logit (RPL) model has been developed to circumvent the limitations of MNL and to investigate heterogeneity in the parameter estimates. Under RPL, parameter estimates are specified as being randomly distributed across a continuous distribution, facilitating the identification of individual level parameter estimates;

$$\Pr ob_{ni} = \frac{\exp(\beta_n' x_{ni})}{\sum_{j=1}^{J} \exp(\beta_n' x_{ni})} \quad (3)$$

In simple terms the parameter vector β_n from population k is extended as;

$$\beta_{kn} = \beta_k + \sigma_k v_{kn} \quad (4)$$

Where v_{kn} is the individual specific heterogeneity and σ_k is the standard deviation of the distribution around β_k, the sample population mean, the form of which is specified by the analyst. Heterogeneity around the mean can be investigated by introducing choice invariant characteristics into the distribution. Thus, the β_{kn} can be redefined as;

$$\beta_{kn} = \beta_k + \delta_k' z_n + \sigma_k v_{kn} \quad (5)$$

Where z_n represents the characteristic of individual n that is expected to influence the heterogeneity. A detailed description of the development of random parameter logit (RPL) models and how they are modelled can be found in Train (2003) and Hensher et al. (2005).

Marginal willingness to pay (WTP) values can be calculated as the parameter of the attribute change of interest divided by the parameter of the cost attribute;

$$WTP = -\frac{\beta_{Attribute}}{\beta_{Cost}} \quad (6)$$

A number of different models were developed. Model 1 (see section 4.2.2) was derived from an RPL model containing the generically coded forest attributes specified as following a normal distribution. Cost was defined as fixed to simplify the identification of WTP estimates in all models following equation 6. The context provided by the location label on each alternative was expected to influence respondents' preferences for management changes. Therefore, in Model 2 (Table 23), each management change was defined as specific to each alternative, except cost which was again specified as fixed and generic across alternatives to facilitate the production of WTP values (Table 24). Previous Irish research on forest preferences has indicated that the forests located surrounding individuals can have an important impact on their views of forestry in general. In Model 3 (Table 25), forest cover, divided into four groups, was included as interaction terms in the afforestation alternatives. Additionally, income and a dummy variable representing whether a respondent was from farming household were included. This model took a similar form to Model 3 aside from the addition of the interaction variables. Summary statistics of the additional respondent characteristics included in some models is also contained in Table 25.

Table 23 Output from Model 2

Attribute Change		City Alternative Est.	City Alternative St. Error	City Alternative P-value	Country Alternative Est.	Country Alternative St. Error	Country Alternative P-value	Remote Alternative Est.	Remote Alternative St. Error	Remote Alternative P-value
Alternative specific constant	μ	1.316	0.160	0.000	1.444	0.146	0.000	1.520	0.152	0.000
	σ	1.060	0.076	0.000	0.610	0.102	0.000	0.681	0.089	0.000
Conifer to Mixed	μ	0.269	0.102	0.008	0.615	0.097	0.000	0.412	0.111	0.000
	σ	0.622	0.233	0.008	-	-	-	0.885	0.201	0.000
Conifer to Broadleaf	μ	0.300	0.096	0.002	0.555	0.099	0.000	0.282	0.099	0.004
	σ	-	-	-	-	-	-	-	-	-
None to 15% reserve	μ	0.350	0.099	0.000	0.336	0.093	0.000	0.316	0.101	0.002
	σ	-	-	-	-	-	-	-	-	-
None to 30% reserve	μ	0.564	0.106	0.000	0.723	0.100	0.000	0.334	0.100	0.000
	σ	0.817	0.202	0.000	0.966	0.157	0.000	-	-	-
Clearfell to Individual	μ	0.733	0.088	0.000	0.532	0.081	0.000	0.464	0.086	0.000
	σ	0.591	0.225	0.009	0.502	0.179	0.005	0.737	0.136	0.000
None to Trail	μ	1.509	0.111	0.000	1.083	0.103	0.000	1.000	0.114	0.000
	σ	-	-	-	0.627	0.226	0.005	0.693	0.224	0.002
None to Trails/ Facilities	μ	1.974	0.118	0.000	1.593	0.106	0.000	1.283	0.108	0.000
	σ	0.874	0.193	0.000	0.909	0.152	0.000	0.685	0.191	0.000
Cost		-0.017	0.001	0.000						

Log-likelihood	-6017.08
No. Parameters	40
No. Observations	5976
McFadden-Pseudo R^2	0.274

Table 24 WTP values derived from Model 2

Attribute Change	City WTP (€)	Countryside WTP (€)	Remote WTP (€)
ASC	75.37	82.70	87.03
Conifer to Mixed	15.43	35.22	23.57
Conifer to Broadleaf	17.19	31.77	16.15
None to 15% reserve	20.04	19.26	18.08
None to 30% reserve	32.33	41.40	19.15
Clearfell to Individual	41.98	30.48	26.6
None to Trail	86.45	62.03	57.26
None to Trails/Facilities	113.04	91.23	73.47

Table 25 Output from Model 3

Attribute Change		Estimate	Standard	P-value
Random Parameters				
City/Town constant	μ	1.753	0.249	0.000
	σ	1.221	0.079	0.000
Country constant	μ	1.801	0.246	0.000
	σ	0.711	0.089	0.000
Remote constant	μ	1.282	0.246	0.000
	σ	0.912	0.085	0.000
Conifer to Mixed	μ	0.544	0.065	0.000
	σ	0.727	0.106	0.000
Conifer to Broadleaf	μ	0.402	0.066	0.000
	σ	0.607	0.109	0.000
None to 15% reserve	μ	0.411	0.062	0.000
	σ	0.442	0.131	0.000
None to 30% reserve	μ	0.638	0.074	0.000
	σ	1.035	0.101	0.000
Clearfell to Individual	μ	0.728	0.064	0.000
	σ	1.171	0.082	0.000
None to Trail	μ	1.321	0.073	0.000
	σ	0.852	0.101	0.000
None to Trails/Facilities	μ	1.751	0.078	0.000
	σ	0.973	0.102	0.000
Non-random Parameter				
Cost (€)		-0.019	0.001	0.000
Farm		-0.645	0.354	0.068
Public Con (1,00s ha)		-0.246	0.053	0.000
Public M/B (1,00s ha)		4.248	0.974	0.000
Private M/B (1,00s ha)		-0.300	0.106	0.005
Income (1,000s €)		0.016	0.007	0.038
		Log-likelihood		-5896.563
		No. Parameters		26
		No. Observations		5976
		McFadden-Pseudo r^2		0.288

11 Appendix C: Questionnaire used in household survey

The following is the text of the questionnaire used in the household survey.

Ireland's landscape and environment has changed a lot in recent years. It has been suggested that the general public has not had an opportunity to get involved in some of these changes. University College Dublin is carrying out this national survey to find out the public's attitudes towards forests in Ireland. Even if you don't know much about these issues your opinions are very important.

When we talk about forests in this survey we would like you to think about all of the areas which are mainly composed of trees. This might include forest parks, new plantation forests, nature reserves and forests on old estates. Forests in this survey do not include public parks and gardens. ***[SHOW CARD WITH FORESTS IMAGES]***
This survey will take about 30 minutes. Would you mind answering a few questions?

Q1. Firstly, we would like your opinion on the environment and forests.
Please state how much you agree or disagree with the following statements?
[SHOW CARD 1]

READ OUT AND ROTATE STATEMENTS	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Don't know**
	1	2	3	4	5	6
In order to protect the environment Ireland needs economic growth						
Protecting the environment is important to me						
We worry too much about the future of the environment and not enough about prices and jobs today						
Private owners should have the right to deny the public access to forests on their land						
All types of forests are good for the environment						
Forests are an important part of the traditional landscape of the Irish countryside.						

Q2. *(Including all of the types of forests mentioned in the introduction and areas recently harvested)* Compared to other parts of Ireland do you feel you live in an area that has:

Almost no forest	Few forests	A lot of forests	Don't know

Q3. Forests in Ireland can be managed for a number of different reasons. Could you please rank the five reasons written on this showcard in terms of which you feel are the most important outputs from forests for Ireland? 1 for the most important, 2 for the second most important…

[SHOW CARD 3]

	Rank
Recreation and leisure	
Timber and wood production	
Protecting water, air, climate	
Plant and animal / Wildlife / Nature Conservation	
Employment / Jobs	

Q4a. I will now ask you to read some information about forests in Ireland and a plan to increase the amount of forests in the country. This will take a few minutes, after which I am going to ask you some questions about what you read and understood.
Please have a look at these cards.

[SHOW SET OF CARDS AS INSTRUCTED ON SCREEN: SHOWCARD 4A - INTRODUCTION, FOLLOWED BY SHOWCARD 4B - PLAN FOR THE FUTURE, FOLLOWED BY THE SHOWCARD LOCATION, SHOWCARD TREE TYPE, SHOWCARD PLANT & ANIMAL RESERVE AREA, SHOWCARD WALKING TRAILS, SHOWCARD HARVESTING, SHOWCARD COST]

[ASK AFTER THE RESPONDENT HAS READ CARD 4A]

Q4b. Have you heard about this plan before?
Yes/No

Q5. Question 5 contained on [***SHOWCARD HAVE YOUR SAY]***
[SHOW LEAFLET OF CARDS AS INSTRUCTED ON SCREEN]

Knowledge of scheme

[REMOVE LEAFLET FROM RESPONDENT]
Now I'm just going to ask you some questions about what you just read, but do not worry if you do not know an answer, it is not a test so just answer as close as possible to what you can remember
[SHOW TEST CHOICE SET AND WALK RESPONDENT THROUGH FIRST CHOICE]

Q6a. You were asked a number of questions about increasing forest cover in Ireland. Could you tell me what is the current percentage of forest cover in Ireland?
[***RECORD NUMBER]***

Don't Know/Ref/Null

Q6b. We discussed a policy to increase forest cover; could you tell me what the percentage of forest cover will be after the policy is completed? [***RECORD NUMBER]***

Don't Know/Ref/Null

Q6c.Which department will promote this scheme? [***DO NOT PROMPT]***

[CODE TO PRECODES]

1	Department of Agriculture
2	Don't know
3	Other (Do not specify)

Q6d. Could you identify the following pictures of leaves as coming from broadleaf or conifer trees?
[SHOW CARD 6D]

	Conifer "Pine"	Broadleaf Hardwood	Don't know
Leaf A 			
Leaf B 			
Leaf C 			
Leaf D 			

In making a choice between forests you were asked to think about six issues:
Location, Tree Type, Reserve Area, Trails, Harvesting, Cost;
Have a look again.
[***SHOW SET OF CARDS AGAIN]***
[SHOWCARD LOCATION, SHOWCARD TREE TYPE, SHOWCARD PLANT & ANIMAL RESERVE AREA, SHOWCARD WALKING TRAILS, SHOWCARD HARVESTING, SHOWCARD COST]

Q7a. In making these choices do you feel you concentrated on any of the 6 issues more than others?
Yes / No/ DK
[IF NO/DK GO TO Q8]

Q7b. Which one (s) did you concentrate on more?
[MULTICODE- PROBE TO PRECODES]

Issue	**Code**
Location	1
Types	2
Reserve	3
Trails	4
Harvesting	5
Cost	6

Q8. Overall, how well do you feel you understood the 6 issues we discussed?
[***SHOW CARD 8]***
Please rate on a scale from 0 to 10 where 0=No understanding and 10=full understanding

No understanding...Some understanding….Good understanding….Full understanding											Don't know/ Ref
0	1	2	3	4	5	6	7	8	9	10	

[***IF ANSWERED 10, GO TO Q10a]***
Q9. Which issues were difficult to understand?
[MULTICODE- PROBE TO PRECODES]

Issue	**Code**
Location	1
Types	2
Reserve	3
Trails	4
Harvesting	5
Cost ***[REVERT TO COST SHOWCARD IF FURTHER EXPLANATIONS NEEDED]***	6
All	7
None	8

[GO TO Q11 IF RESPONDENT ALWAYS CHOSE OPTION "No new Forest planted" AS <u>BEST OPTION</u> IN THE CHOICE SET]
Q10a. Why do you think more forests like the ones you chose should be planted in Ireland? (What would be the benefits?)
Q10b.Any other reason? **10c.** Any other?
[RECORD AS MANY AS MENTIONED IN ORDER MENTIONED]
[***MULTICODE- PROBE TO PRECODES]***

Reason	**10a**.1st mention	**10b.**2nd mention	**10c**.3rd mention
Wildlife, biodiversity, plants and animals	1	1	1
Climate change, carbon	2	2	2
Recreation, leisure, visit	3	3	3
Clean, water, soil, air	4	4	4
Economic, employment, timber, wood	5	5	5
Landscape changes, appearance	6	6	6
Education, community, future generations/ children	7	7	7
"The Environment" (No more specific reason)	8	8	8
Other (Specify): _____	9	9	9
Don't Know	10	10	10
No (other) reason	11	11	11

[ASK ONLY IF RESPONDENT ALWAYS CHOOSES "No new Forest planted" as the <u>BEST OPTION</u> IN THE CHOICE SET]

Q11. You always chose the "no new forests" option as the <u>best</u>. Why is that?

[MULTICODE- PROBE TO PRECODES]

Reasons	Code
I can't afford to contribute to this scheme	1
I didn't see any type of forest that I thought was worth it	2
Tax should be spent on other things	3
I would contribute to this scheme but not through a tax increase	4
I don't understand this issue enough	5
Planting forests is a waste of agricultural land.	6
Planting more forests would be bad for the environment.	7
I don't like forests	8
I don't want to see any trees cut down in these forests	9
Other (Specify): _____	10
Don't Know	11
No reason	12

Q12. We discussed three locations in the previous questions: close to cities and towns; in the countryside; and in remote upland areas. Which of these three locations best describes where you currently live?

[SHOW CARD 12]

Locations	**Code**
 In or close to a city/town	1
 In the countryside	2
 In a remote area	3

Q13. And which of the locations best described where you were grew up before the age of 16?

[SHOW CARD 12 AGAIN]

Locations	**Code**
 In or close to a city/town	1
 In the countryside	2
 In a remote area	3
Don't Know/ Don't remember	4

[READ OUT]

As I said the answers collected in this survey will help foresters and the Department of Agriculture to make decisions about managing forests in the future.

Q14. Using this card, please tell me how much you agree or disagree with the following statements; ***[SHOW CARD 14]***

[READ OUT AND ROTATE STATEMENTS]	**Strongly disagree**	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**	**Don't know**
The general public should only be asked their opinions on forests in their local area not about forests throughout Ireland.						
I would trust foresters to always make the right decisions about managing forests.						
Knowing how Irish forests are managed is important to me.						
The general public do not know enough about forests so they shouldn't be asked their opinions on them.						
The general public should have more opportunities to comment on how forests are managed in Ireland.						

[READ OUT]

We would like you to tell us about visiting forests for recreation or leisure. When answering these questions we would like you to think of times when you left your home to visit a forest in particular, not including times when you were away from home, such as on holiday. Remember when we talk about forests we mean areas covered in trees and not public parks or gardens.

Q15a. In total about how many times over the last 12 months have you visited a forest in Ireland for any form of recreation or leisure, such as walking, picnicking, biking or other activities? [***RECORD NUMBER]***

Don't know/Ref/Null
[IF RESPONDENT ANSWER "NEVER/ZERO", GO TO Q15b, OR SKIP TO Q16]

Q15b. If none/zero is that because: [***MULTICODE- PROBE TO PRECODES]***

Reasons	**Code**
I don't have enough recreation time	1
I prefer visiting other places	2
There are no forests close to my home	3
There are no forests that I would like to visit in this area	4
I can't travel to a forest	5
I don't like forests	6
I have a disability that prevents me from visiting	7
Other (Specify): _____	8
Don't Know	9
No reason	10

[NOW GO TO Q21]

Q16. How many different forests in Ireland, do you think you have visited over the last 12 months? ***[RECORD NUMBER]***

Q17a. What is the main activity you usually do when you visit a forest?
Q17b. Anything else?
[MULTICODE- PROBE TO PRECODES]

Activity	**Q17a.**1st mention	**Q17b.**Other mentions
Strolling / Relaxing	1	1
Running/Jogging	2	2
Bringing family/children walking / picnicking	3	3
Dog walking	4	4
Animal / Bird watching	5	5
Photography	6	6
Hill walking / hiking / climbing	7	7
Mountain biking / Cycling	8	8
Orienteering / Mountain running	9	9
Mushroom picking	10	10
Horse-riding	11	11
Hunting / Fishing	12	12
Camping	13	13
Other (please specify) _____	14	14

Q18. On average how long (hours and minutes) do you usually spend when visiting a forest? [***RECORD TIME]***

☐☐☐hrs☐☐☐min
Don't know/Ref/Null

Q19. How do you usually travel to a forest?

SINGLE CODE	**Code**
Walk	1
Bicycle	2
Motorcycle	3
Public transport (bus/ train)	4
Car	5
Taxi	6
Horse riding	7

Q20. Approximately, how far (in km) is the **furthest** forest that you **visited** to your home? (Remember this only includes trips where you have left your home to visit a forest specifically) ***[PLEASE ROUND UP TO NEAREST KM]***

☐☐☐km
(Note that 1 mile = 1.6 kilometres, please convert)

1-Half a Km or less
2-Between half and 1 km
3-Don't know/Ref/Null

Q21. Approximately, how far (in km) is the **nearest** forest that you **can** visit to your home?

☐☐☐km
(Note that 1 mile = 1.6 kilometres, please convert)

1-Half a Km or less
2-Between half and 1 km
3-Don't know/Ref/Null

Question on Coordinates
An important part of this research is identifying where people would like more forests or not and how the area in which they live influences their opinions about forests. Could we note the location of your house for UCD to use in this research? It will not be possible to identify or contact you as a result.

[READ OUT IF FURTHER EXPLANATION NEEDED]
How? All buildings in Ireland have been given a unique code which relates to their location.

This code can be used to identify the coordinates of your house on a digital map.

What research? Using your location UCD will be able to identify how much forest and what kind of forest exist in your area. It will then be possible to see if people living in similar areas have similar attitudes towards forests**.**

Yes	1
No	2

[RECORD]

Socio-economic questions

C1- Age

What was your age last birthday? [***RECORD NUMBER AND/OR CODE TO PRECODE]***

Ages	Code
18 – 24	1
25 – 34	2
35 – 44	3
45 – 54	4
55+	5

C2- Personal income

Using this card, please tell me which letter describes your total personal income, after tax and compulsory deductions, from all sources?
If you don't know the exact figure, please give an estimate.
Please use this card
[SHOW CARD C2]

Incomes	Code
<€190/w, €800/m or €10,000/y	J
€190<€310/w , €800 < 1,350, €10,000 < €16,000/y	R
€310<€430/w , €1,350 < €1,850/m, €16,000 < €22,000/y	C
€430<€550/w , €1,850 < €2,400/m, €22,000 < €29,000/y	M
€550<€680/w , €2,400 < €2,950/m, €29,000 < €35,000/y	F
€680<€830/w , €2,950 < €3,600/m, €35,000 < 43,000/y	S
€830<€1020/w , €3,600 < €4,400/m, €43,000 < €53,000/y	K
€1020<€1210/w , €4,400 < €5,250/m, €53,000 < €63,000/y	P
€1210<€1490/w , €5,250 < €6,450/m, €63,000 < €77,000/y	D
>€1490/w , > €6,450/m, > €77,000/y	H
No Income	X
Refused	0
Don’t Know	Y

[READ OUT IF NECESSARY/IF DK]

Personal income - check

To check, does the letter you chose represent your personal income only or the income of your household, for example including your spouse/partner's or parent's income?

C3- Employment

Which of these **best** describe you?

[SHOW CARD C3]

In a paid job and..	**Code**
Working full-time 30 hrs+/week	1
Working 8-29 hrs/week	2
Working less than 8 hrs/week	3
Not working and..	
Retired from full-time job	4
Unemployed	5
Housewife	6
Other (***Specify***) _____	7
Student	8

C4a.- Education

What is the highest level of education you have achieved?

Please use this card.

[SHOW CARD C4]

Education	**Code**
None / Primary not completed	1
Primary or equivalent	2
Intermediate/Group/Junior Cert or equivalent	3
Leaving Cert or equivalent	4
Diploma or Certificate	5
Primary Degree	6
Postgraduate Higher Diploma / Masters	7
PhD	8
Don't know	9
Refused	10

[ASK IF ANSWERED CODE 5, 6 ,7, 8]

C4b. Do you hold any third level qualification(s) which you attained after completing 2 or more years of study?

Yes/No

[IF NO, GO TO Q5x]

[ASK IF ANSWERED CODE 5, 6 ,7, 8]

C4c. What is the main subject area in which the third level qualification is held?

Subject Area	**Code**
Education	1
Humanities and Arts (including Foreign Languages, History, Philosophy, Fine Arts, Music and Performing Arts, Design)	2
Social Science/Business/Law (including Psychology, Economics, Journalism, Finance, Accounting)	3
Life Science, Physical Science, Mathematics and Statistics	4
Computing	5
Engineering, Manufacturing and Construction (including Architecture)	6
Agriculture and Veterinary (including Forestry, Fishery, Horticulture)	7
Health (including Medicine, Nursing, Dental Studies, Therapy and Rehabilitation, Pharmacy)	8
Social Services (including Child Care and Youth Services, Social Work and Counselling)	9
Services (including Hotel, Catering, Sports, Transport, Environmental Protection, Security, Occupational Health and Safety, Military and Defence)	10

C5x- ***INTERVIEWER: Is C.I.E. a Farmer***

Yes	1
No	2

IF FARMER ASK:

C5y- How many acres does C.I.E. farm?

			Acres

CODE

F1 (50+ acres)	1
F2 (Less than 50 acres)	2

C7- Nationality

C7a- Are you a citizen of Ireland?

Yes	1
No	2

[If No]

C7b- Are you a citizen of…..?

Europe	1
North America	2
South America	3
Asia	4
Africa	5
Australia	6

C8- Marital status

Could I ask about your current legal marital status? Which of the descriptions on this card applies to you?

[SHOW CARD C8]

Married / in a civil partnership	1
Separated (still legally married)	2
Divorced	3
Widowed	4
Never married	5
Refused	6
Don't know	7

C9- Children (number and age)

C9a- How many children do you have? [***RECORD NUMBER]***

[If 0/NULL, GO TO C1]

C9b- And how many are under the age of 18? ***[RECORD NUMBER]***

C10- Car ownership

Do you own or have access to a car that you can use?

Yes	1
No	2

C11- Environmental concern

C11a- Are you a member of any group whose main aim is to preserve or protect the environment?

Yes	1
No	2

C11b- Have you done any of the following over the last five years <u>for environmental reasons</u>?
[SHOW CARD 11B]

	Yes I have	No I haven't
Signed a petition about an environmental issue?		
Given money to an environmental group?		
Taken part in a protest or demonstration about an environmental issue?		
Taken part in voluntary work that helps the environment?		

12 Appendix D: Assumptions made in estimating volume of carbon sequestered and timber produced

In using the CARBWARE software to estimate the volume of carbon sequestered under the various afforestation scenarios, a number of assumptions relating to the species composition, yield class, site type afforested and silvicultural management used (Tables 26 and 27). Aside from the assumptions made relating the proportion of the area left unplanted for biodiversity (i.e. 0%, 15% and 30%) all scenarios assume that a 10% in timber yield to account for unproductive part of sites.

Table 26 Assumptions for all the conifer scenarios

Species	Area %	Yield Class	Silviculture	Rotation Age
Spruce	10	12	No Thin	20% less[3]
Spruce	11	16	MTI[1]	MMAI[3]
Spruce	14	20	Comm[2]	20% less
Spruce	17	24	Comm	20% less
Lodgepole Pine	5	10	No Thin	MMAI
Larch	2	10	MTI	MMAI
Lodgepole Pine	9	12	No Thin	20% less
Scots Pine	5	8	No Thin	MMAI
Spruce	27	16	No Thin	MMAI

1. Thin to marginal thinning intensity on a 5 year cycle
2. Thin to marginal thinning intensity on a 4 year cycle
3. Clearfell at age of maximum mean annual increment (less 20%)
4. Clearfell at age of maximum mean annual increment

Table 27 Assumptions for all broadleaf scenarios

Species	Area %	Yield Class	Silviculture	Rotation Age
Beech	7	8	MTI	MMAI
Sycamore Ash Birch	14	6	MTI	MMAI
Sycamore Ash Birch	14	10	MTI	MMAI
Sycamore Ash Birch	14	6	MTI	20% less
Sycamore Ash Birch	14	10	MTI	20% less
Oak	10	6	MTI	MMAI
Oak	15	8	MTI	20% less
Oak	5	8	MTI	MMAI
Beech	7	6	MTI	MMAI

1. Thin to marginal thinning intensity on a 5 year cycle
2. Thin to marginal thinning intensity on a 4 year cycle
3. Clearfell at age of maximum mean annual increment (less 20%)
4. Clearfell at age of maximum mean annual increment

13 Appendix E: Assumptions made in indicative cost-benefit analysis

An indicative cost-benefit analysis was undertaken for a number of attribute changes. The following is a summary of the steps taken when conducting this analysis:

1. Duration of the analysis 2011-2060.
2. Assumes an annual afforestation rate from 2011 to 2030 of 21,397 ha (Scenario 1). Thereafter a zero afforestation rate is assumed (see section 5.2.3.1).
3. WTP values grossed up to represent WTP for the population (population 18 years + is 3,203,814 (CSO, 2006)).
4. Volume of carbon and timber harvested for broadleaves, conifers and mixed (50:50 broadleaf conifer) and for various biodiversity scenarios (i.e. 10%, 20% and 35% unplanted and classed as biodiversity areas) for 50 year period estimated using CARBWARE software and British Yield Models respectively.
5. Value of carbon calculated using prices shown in Table 9.
6. Value of timber calculated using the following roadside assortment prices per m^3:
    a. Conifers:
        1. Pulp €26
        2. Pallet €40
        3. Sawlog €55
    b. Broadleaves:
        1. Assumes all sold for firewood @ €35 per m^3
7. NPV calculated using using a 5% discount rate.