Initial Assessment of the Costs and Benefits of The National Forest – Eftec, July 2010

This report has been commissioned by Defra, with support from the National Forest Company. It assesses the public costs and benefits of creating The National Forest. It has been produced in response to the Environment, Food and Rural Affairs Select Committee report into The National Forest (2010), which recommended that Defra undertake an assessment of the public value of the Forest.

Initial Assessment of the Costs and Benefits of the National Forest

For Defra and The National Forest Company

Final report, 29 July 2010

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EXECUTIVE SUMMARY

This report sets out the methodology and findings from research aiming to analyse the social, economic, and environmental benefits of The National Forest (TNF). The analysis focuses on the public benefits gained as a result of the public funds invested in TNF, including the annual grant in aid from Defra to the National Forest Company (NFC), and Forestry Commission grants.

The majority of the analysis was carried out over a short time-frame (approximately 7 weeks from inception meeting to draft report) and aims to provide a 'first-cut' assessment. To do so it uses a framework adapted from a simplifying typology of English woods and forests developed in recent eftec work for the Forestry Commission on the public benefits of the Public Forest Estate in England (eftec, 2010).

The focus is on the value of the impacts of the National Forest Company, based on the changes brought about as a result of NFC's work, relative to a baseline of 'No NFC'. The project considers the value added since the National Forest project started receiving regular funding from central Government in 1991.

An analysis framework was developed applying the typology and value assumptions from eftec (2010) to the development of TNF since 1991 and up to 2100. This long time-scale is necessary to appraise fully the benefits of forest development, which involve decades for trees to mature and their full benefits to be realised. The long time-scale inevitably necessitates simplifying assumptions, and these are reviewed in sensitivity analysis. The review of assumptions also assists with identification of suggestions for further research needed to compile a more detailed analysis. The results presented give a picture of the value of the public expenditure in TNF.

The costs assessed are based on:

- Grants to date and assumed continuation of the £3.51m annual Defra grant.
- FC grant – assumed to continue to manage and re-stock forest.
- An estimate of other sources of funding.
- No further allowance for opportunity cost is made, based on an assumption that these are covered in the costs of developing the forest (e.g. by grants to landowners).

Under the assumptions used in this report, the benefits from TNF are analysed in the following categories:

- Regeneration;
- Biodiversity, wildlife and non-use values;
- Landscape;
- Recreation;
- Carbon sequestration; and
- Timber production.

The non-market valuation evidence required to analyse impacts under these categories is rarely straightforward, and there are uncertainties in several benefit

categories, such as regeneration and biodiversity. The costs and benefits of TNF are shown in Table ES1.

Table ES1: Costs and Benefits from all land brought into forest management, £ million.

	1991 to 2010, Present Values	2011 to 2100, Present Values	1991 to 2100, Present Values	1991 to 2100, Total Values
TIMBER	1	9	10	33
RECREATION	186	375	561	1,393
CARBON	9	177	187	872
LANDSCAPE	4	47	51	187
BIODIVERSITY	4	47	50	236
REGENERATION	24	16	39	46
TOTAL	228	680	909	2,767
TOTAL COSTS	89	99	188	336
RATIO OF BENEFITS TO COSTS	2.6 to 1	6.8 to 1	4.8 to 1	8.2 to 1
BENEFITS MINUS COSTS	140	581	721	2,431

For The National Forest between 1991 and 2100, the of total benefits are estimated at £909m, which exceed estimated costs of £188m by £721m (present values), a benefit to cost ratio of 4.8:1.

Even though forestry projects have front-loaded costs and long term benefits, returns are positive to date (benefits exceed costs between 1991 and 2010). The costs and benefits from 2011-2100 reflect the returns on continued investment in TNF in order to realise the full benefits from existing investments and further benefits from further investment. There is strong justification for continued support for TNF in order to realise the full value of recent investment - going forward the benefit:cost ratio is 6.8:1. Even given the uncertainties involved in this first-cut analysis, the strength of this result gives confidence in the conclusion that public spending on TNF returns a positive cost-benefit ratio overall.

The economic evidence available for this analysis has been thoroughly reviewed in recent work for the Forestry Commission, and has drawn on the extensive data on TNF held by the National Forest Company. Without these sources, this first-cut analysis would not have been possible with the time and resources available. Although the evidence base is poor in some areas, sensitivity analysis suggests the model used to conduct this assessment of TNF is reliable. Where assumptions are required in order to construct the model, conservative assumptions have been made.

There remain gaps in the data and methods available for analysis of the impacts of TNF. In part these relate to intangibles, such as aspects of regeneration which are necessarily delivered through partnerships between whom it is difficult to assign

portions of benefits. Other gaps could be filled through more detailed analysis, particularly using GIS to assess spatial impacts (e.g. on landscape benefits) and more intricate modelling of costs and benefits, for example by developing assumptions about activity going forward to 2100 (including a dynamic baseline) and other refinements. In addition there are also social justice and regeneration reasons for making investments through the NFC, particularly in deprived areas, and these have not been fully captured in value calculations in this research.

Given the conservative assumptions made where data exist and the gaps in data, the net benefits set out in Table ES1 are likely to be conservative and under estimated.

1. Introduction

This project has developed in response to the Efra Select Committee's report (HoC, 2010) in which it encouraged Defra to undertake work to assess the full benefits of The National Forest (TNF), in collaboration with the National Forest Company (NFC), and publish the results as soon as possible.

1.1 Description of TNF

The National Forest concept was developed in the 1980s, but activity to create The National Forest (TNF) began in approximately 1991, through work within the Countryside Commission. The aim of The National Forest is to create a new, multi-purpose Forest for the nation by transforming a 200 square mile (50,200) area across parts of Leicestershire, Derbyshire and Staffordshire. The objectives of the Forest include woodland creation, landscape and biodiversity enhancement, developing a major, new recreation and tourism resource, economic regeneration and rural diversification and community/educational involvement in the Forest's creation. The National Forest is also making a significant contribution to carbon sequestration and climate change mitigation/adaptation through tree planting and building of a resilient landscape.

The National Forest Company (NFC), was established in 1995, it leads the creation of TNF, working in partnership with landowners, the public, private and voluntary sectors, and local communities. The NFC is supported by grant in aid from Defra. Figure 1.1 shows the boundary of The National Forest, the zones within 20, 30 and 60 miles of its boundary, and surrounding major settlements in Central and Southern England. The population within TNF boundary is 221,000, while the population within the 30 mile buffer is 7.8 million.

Figures 1.2 and 1.3 show the expansion of forest cover within TNF boundary between 1991 and 2010.

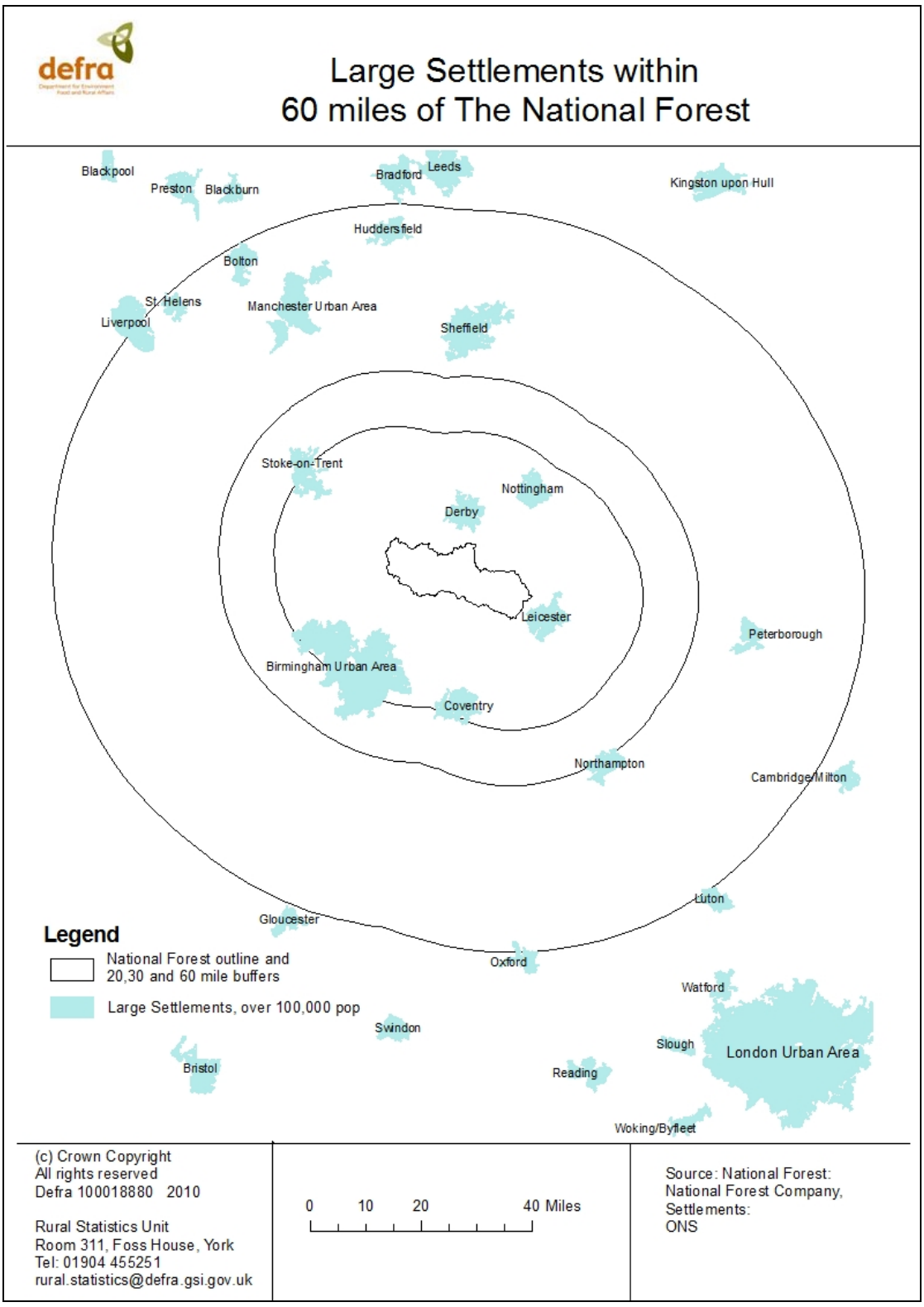

Figure 1.1: boundary of The National Forest and 20, 30 and 60 mile buffer zones.

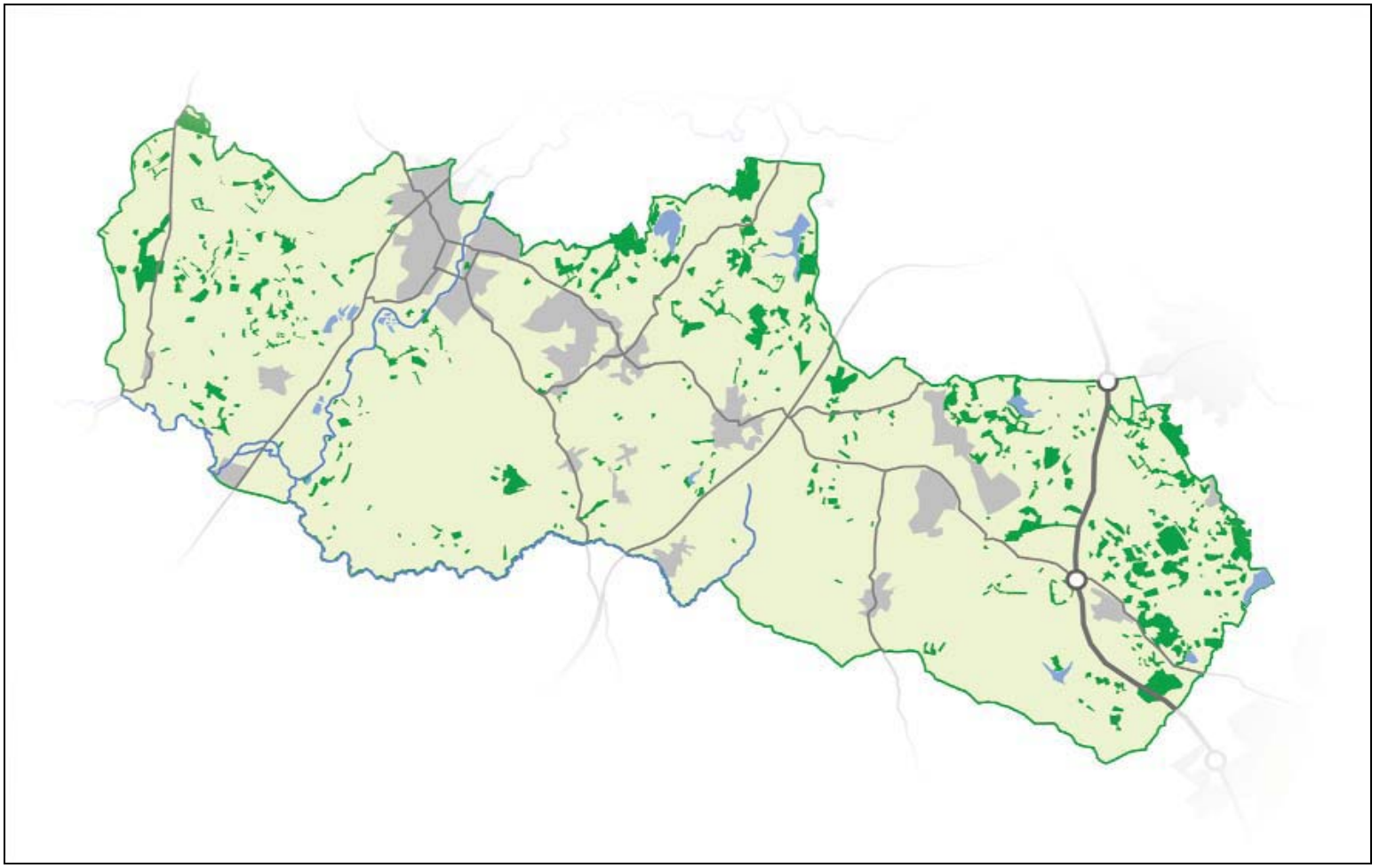

Figure 1.2: Forest cover within TNF boundary, 1991. (Source: National Forest Company)

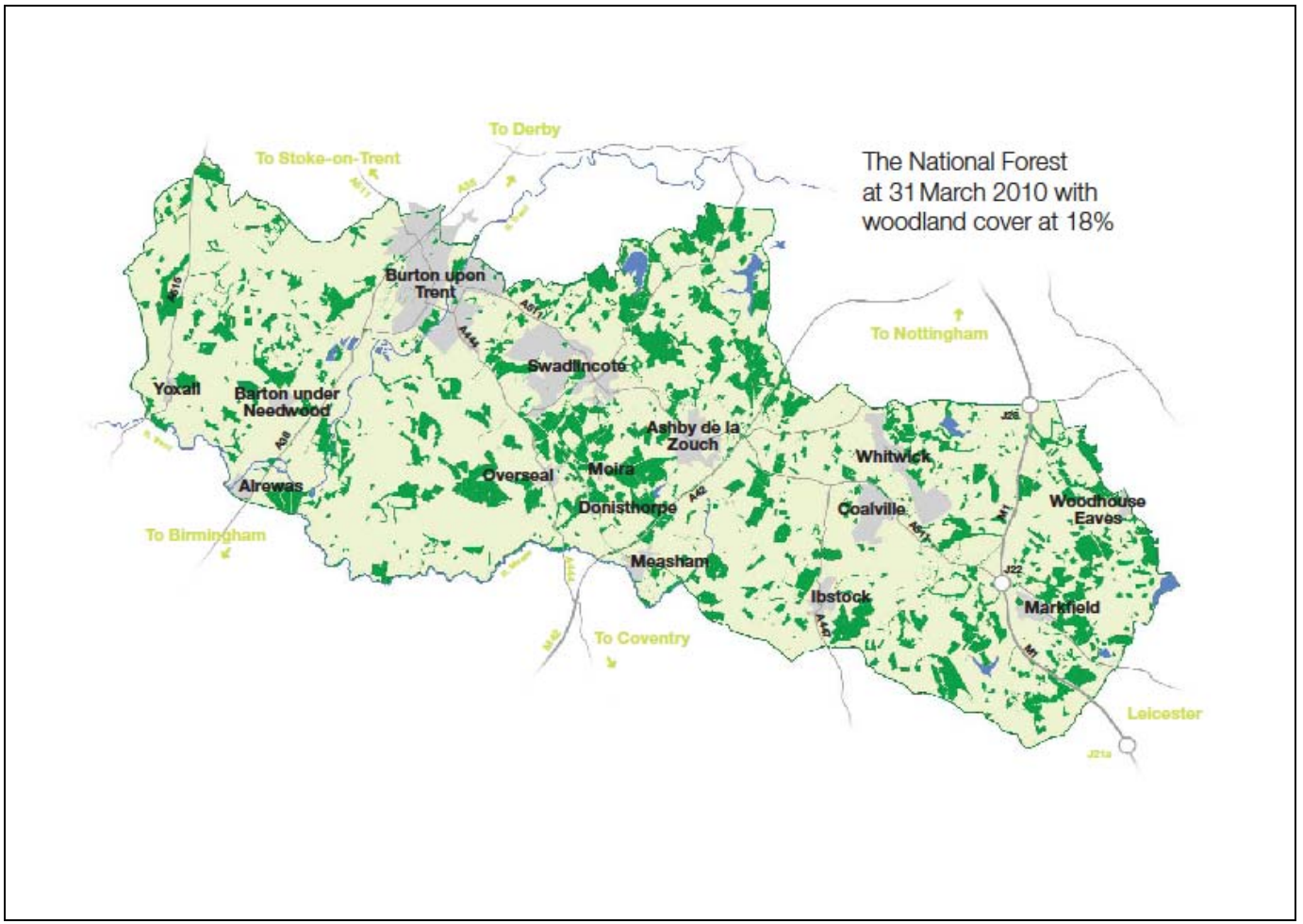

Figure 1.3: Forest cover within TNF boundary, 2010. (Source: National Forest Company)

Figures 1.2 and 1.3 show the expansion of forest cover within TNF boundary between 1991 and 2010.

A 2009 - 2010 Special Committee report of an inquiry into the development of The National Forest declared, "Fifteen years on from its inception, The National Forest is a success story" (HoC, 2010). The area had previously been suffering from economic and environmental decline, but since 1995 TNF has trebled the proportion of land with tree cover to 18%, helped to regenerate the local economy, opened up the Forest to greater public use and improved the natural environment (HoC, 2010).

It should be noted that the term 'forest' can be slightly misleading in the sense that much of the area of TNF includes open habitats and heathland. These areas are very important for biodiversity as well as providing recreation and aesthetic (landscape) values. The typology/ valuation approach used in this analysis accounts for these different habitat types. The term 'forest' is therefore used in the historical sense of 'natural habitats' (originating from areas set aside for hunting) and does not refer exclusively to 'trees'. The term 'woodland' is used to describe areas dominated by trees, and other types of natural habitats (e.g. heathland or grassland) are referred to as such.

1.2 Purpose

The purpose of this project is to undertake a first-cut analysis of The National Forest covering all aspects of public value. This will inform assessment of the value for money to the taxpayer of the public funds invested in The National Forest, by comparing costs to the value of the economic, environmental and social benefits of the Forest. The work also informs assessment of the key gaps in the data and methods used for the analysis, in terms of the impacts of TNF, and the economic evidence on the value of those impacts, and the coverage of the framework used.

In this context, the key policy questions for this project to inform are:

1. What is the total public value in terms of economic, environmental and social impacts of The National Forest?
2. What is the value for money to the tax payer of the grant paid to the National Forest Company relative to the total public value as described above?
3. What are the key gaps in the data and methods available for analysis in terms of the impacts of TNF?
4. How much economic evidence is available on the value of those impacts?

The work focuses on The National Forest, and the benefits of actions carried out within its boundaries. It should be noted that these actions result in benefits both to people living in TNF and in the surrounding area, and visitors.

The analysis is mainly concerned with public benefits arising from TNF, and therefore overlooks private sector benefits arising from public investment that may be equally as important as the public benefits. The focus on public costs and benefits is due to the fact that landscape change through environmental

enhancement, as in TNF, is a public good. Therefore market failures are expected such that these public goods will not be adequately provided through markets, and public funds are therefore needed to stimulate their provision.

The analysis assesses the net benefits between 1991 and 2100, using assumptions about levels of forest cover based on projected tree planting levels as explained in Section 2.9.

This final report:

- sets out the framework used to undertake this first-cut analysis (Section 2);
- calculates the costs of public expenditure and the values of the benefits of the forest (Section 3); and
- draws conclusions and suggests areas for further research needed to compile a more detailed analysis (Section 4).

The values used to calculate the benefits are identified through a review of evidence on ecosystem service and regeneration values, and are presented in Annex 1.

2. Methodology

2.1 Approach

This analysis uses a framework developed to analyse the contribution of the Forestry Commission (FC) Estate in England in a recent report (eftec, 2010 - 'The FC framework'). This uses an ecosystem services approach to value the benefits provided by the Public Forest Estate as a whole. It is based on a typology of forests, designed to match the FC's approach to analysis of forests in the UK.

The FC framework is in line with, and its use is guided by, current Value Transfer guidelines and the ecosystem services approach. Value Transfer guidelines have recently been developed by eftec for Defra[1].

The ecosystem services approach we use is taken from Defra (2007). The main ecosystem services that we will expect to value are described in Table 2.1. It is important to realise that best practice economic valuation of ecosystem services is based on a change in the provision of a service. This means that here each service is described or measured not in absolute terms but rather based on the impacts resulting from the activities of The National Forest, relative to a theoretical baseline in which TNF does not exist (see Section 2.6).

[1] See: http://www.defra.gov.uk/environment/policy/natural-environ/using/value.htm

Table 2.1: Ecosystem services of woods and forests and their economic value

Ecosystem Service	Main types in woods and forests	Economic Value Indicator for NFC
Provisioning Services	Timber (fibre, construction, furniture) Renewable energy (fuel woods) Food (wild foods)	Provisioning services have direct use value and are relatively easy to monetise. For this study potential timber yield (m3/yr) and market prices are used.
Regulating Services	Climate change regulation (carbon sequestration, soil impacts) Air quality regulation Water/flood regulation Water purification Pollination and pest control services	Indirect use values. Some services can be monetised relatively easily, in particular carbon sequestration at official UK shadow prices. Others require production function methods or other techniques, and service definition/ measurement can be difficult. This study makes use of Defra carbon sequestration modelling techniques to evaluate tCo2e/ha sequestered then DECC 2010 values for non-traded carbon.
Cultural services	Walking Picnics Biking Riding Camping Field sports Views/aesthetic enjoyment Historic/cultural values Education Biodiversity (part) Other non-material benefits	Mix of value types: direct use values for many services, but also non-use values. Direct use values measured in some cases via markets, more generally via travel cost and sometimes hedonic methods. Non-use values require stated preference techniques. Valuation issues relating to scale and alternative resources/activities. Care required to avoid double counting. This study applies value transfer to evaluate non-use landscape (aesthetic) and biodiversity values (based on areas of forest) and recreational use values (using visitor numbers).
Supporting services	Photosynthesis/ primary production Soil formation Nutrient cycling Water cycling	Correspond to all components of economic value through their support for the other ecosystem services. Valuation likely to be difficult, but also for most appraisal purposes unnecessary, since generally these are intermediate services and their values are already (largely) contained in the values of the other service categories (meaning that it would often be 'double counting' to value supporting services separately).

The FC framework has some weaknesses in terms of appraisal of investment in TNF. These are dealt with as follows:

1. A key impact of TNF is its contribution to regeneration. This is an issue reflecting the distribution of ecosystem services as well as their provision. It is highly location dependent, and therefore a difficult issue to generalise across the Public Forest Estate in England. As a result it is not covered in the FC framework. Therefore analysis of regeneration impacts has drawn on other sources, particularly eftec's current work on regeneration for CLG (in prep).

2. The FC framework does not account for the development of forest habitats over time, and therefore gives a steady-state analysis (which works for the

FC estate because an average is taken). It does not separate out the costs and benefits of the changing composition of a forest on a year by year basis. For appraisal of a major investment programme like TNF, a time-profile of forest development was used in the model. This is necessary in order to allow for the fact that the costs are front-loaded and the benefits arise further in the future as the forest develops.

3. Simplifying assumptions are used in the FC framework because it is only spatially-explicit in a generic sense (e.g. distinguishing urban from rural). This approach would need to be revised for a full evaluation of TNF, especially for important service categories like recreation and landscape (aesthetic) value where the location of forests in relation to human populations is key. Some important GIS analysis has been incorporated into this analysis, and we discuss further use of GIS, in Section 4.2.

Where limitations in the evidence available, or the need for more time to undertake detailed analysis, are identified, this is also used to scope subsequent work in Section 4.2, so that a fuller study could be developed to overcome them.

The ecosystem services arising from land management depend on a number of variables such as types of vegetation, spacing and mix of trees, access, soil type, slope and context/location in the landscape. The typology of different habitat types analysed within The National Forest only takes account of some of these variables and helps with making general statements about the level of ecosystem services. The typology is described in Section 2.3 below.

2.2 Scope

The analysis is geographically focused on the area within the boundary of TNF. In analysing the public expenditure undertaken within this boundary, such as Defra's grant in aid, the relevant scale on which to assess benefits is the national scale.

This creates difficulties for some types of impacts, as there is an element of displacement in their delivery within TNF. Displacement is very difficult to assess, as the counterfactual (a baseline spanning the decades over which TNF is created) cannot be reliably estimated. Furthermore, the strong regeneration element to the impacts of TNF means that there is a national benefit to delivering these benefits in TNF. This is because regeneration is location-specific, and reflects a lower baseline condition for an area's social and economic circumstances. Delivering enhancements like landscape and recreational access improvements in a regeneration area has higher marginal value (due to the lower existing environmental quality) compared to delivering them in an 'average' location. Regeneration is discussed further in Section 2.7 below.

In focusing on a particular geographical area, the point of this analysis is not that the benefits arising could not have been achieved somewhere else. It is that the benefits have, are and can be delivered through the creation of TNF.

2.3 Typology

The basic approach is to consider the main features of TNF according to the typology shown in Table 2.2. As described in Section 2.1, the typology approach was taken from the FC framework study, but was adapted to suit the needs of TNF. In some instances the typology was generalised to show less detail: such as with the 'ecology' attribute wherein all the tree types in TNF were included in a single 'broadleaved mixed' category, and the 'management' attribute wherein the total NF area was assumed to be "managed for multiple objectives". In other cases the data for the NFC allowed a more nuanced derivation of value by providing differentiated data according to age/class of woodland, total visitor numbers and specified timelines for flows of benefits.

The data on the area of forest expansion between 1991 and 2100 is shown in Annex 2.

Table 2.2: Woodland Typology

Attribute	Indicator
Forest / Woodland Ecology	Broadleaved/Mixed • Established • Young Open habitat
Proximity to users	Peri-urban Rural
Management	Managed for multiple objectives
Access	No public access High Facilities Access encouraged Low Facilities Access encouraged
Biodiversity	BAP priority habitat Not BAP priority habitat

2.4 Economic valuation approach

Economic valuation aims to collate evidence of individuals' preferences for or against environmental impacts. The conceptual framework used for this is Total Economic Value which consists of:

- Use values which arise from consumptive and non-consumptive uses of environmental goods and services (direct use), for example recreation and the services provided by ecosystems (indirect use), for example regulatory services as per Table 2.1;
- Option values which arise due to uncertainty, via individuals' willingness to keep the option of future use of resources open even though they have no current plans to make any such use; and
- Non-use values which arise from individuals' preferences to protect the environment for the use of others (altruistic), for future generations (bequest) and for the sake of the environment (existence).

The preferences are expressed as individuals' willingness to pay (WTP) for an improvement or to avoid a degradation, and their willingness to accept compensation (WTA) to forgo an improvement or to tolerate a degradation.

For this work two types of data are essential to calculate economic values:

1. The impacts of The National Forest (e.g. hectares of forest planted and made accessible, visitor numbers).
2. The economic evidence on the value of impacts

Data on the impacts of The National Forest has been helpfully provided by the staff at the National Forest Company. Data on the economic evidence on the value of impacts is described below.

2.5 Economic data

In the typology, data are used to calculate the net present value (NPV) of costs and benefits. This data are described in detail in Annex 1. In summary the costs of the forest are made up of:

- Defra grant in aid;
- FC grants to plant and manage woodlands; and
- Other sources of funding, such as donations and sponsorship, and public funds for capital and infrastructure projects.

As described in Section 3.1, no allowance is made for opportunity cost because it is assumed it is already accounted for in forest grants.

Benefits are estimated based for the following benefits categories that reflect the ecosystem services and the regeneration benefits associated with TNF:

- Regeneration;
- Biodiversity, wildlife and non-use values;
- Landscape;
- Recreation;
- Carbon sequestration; and
- Timber production.

The economic value evidence in each category is discussed in Annex 3. The results for each category are summarised in Section 3.2. It should be recognised that several benefit categories have been omitted from the analysis due to a lack of evidence. In particular, categories related to, but distinct from, regeneration impacts, such as health benefits, education and social inclusion, have not been analysed.

Benefits values are based on data identified in developing the FC framework, which completed a thorough review of relevant literature in December 2009. Note that many of the values are based on results of non-market valuation studies, which can be subject to significant uncertainty. They can only be transferred to a different decision-context with careful consideration of their use and appropriate caveats. Further uncertainty arises from the use of average area-based values in some categories. These are problematic for values (e.g. aesthetic values of landscape) that are a function of factors such as population density, edge-effects and topography that have high spatial variability.

We do not separately consider employment in forestry or associated industries such as forest tourism. Timber production plays a small but significant role in supporting jobs in rural areas of the UK, with approximately 42,000 jobs in forestry and primary wood processing in the UK overall (Forestry Commission 2009). Visitor facilities and the resulting tourism revenues also support employment, both directly and indirectly (for example local restaurants and shops). These are important impacts from a social policy perspective, but insofar as an economic analysis is concerned, employment is not directly a benefit but rather a cost (the cost of labour), although where unemployment is significant the economic cost of labour may be much lower than the financial cost (because the "alternative use" of the labour is unemployment). Similarly, expenditure within local communities is important for those communities, but from a national perspective largely represents transfer from other expenditures in other areas.

The framework is applied to calculate the value of TNF by estimating the amount of each benefit being produced by the Forest over time, and multiplying these by the value of the benefit. This approach gives a reasonable approximation of the magnitude of costs and benefits provided by TNF. It is however an uncertain estimate because it does not consider details of the spatial configuration of the forest. Spatial modelling would be more complex but essentially feasible within a Geographic Information System (GIS) framework.

2.6 Baseline

The starting point for applying the approach described in this Section is to define the baseline. In this analysis, each service is described based on the impacts resulting from the activities of The National Forest, relative to a theoretical baseline in which TNF does not exist (see 2.5). The total economic value of TNF relates to several factors:

i. Market-based economic activity brought about directly through TNF activity (e.g. value of timber production, increased recreational activity reflected in tourism);

ii. Non-market benefits resulting from changes in the condition of the environment at specific sites (e.g. more areas of accessible natural habitats); and

iii. The indirect (market and non-market) benefits from regeneration as a result of enhancement of the area. This is not linked to one specific site, but results from the overall work/vision of TNF.

The baseline in relation to i) and ii) is defined from the situation in the area at the start of TNF project (1991). The wider social and economic baseline relating to iii) is particularly complex, and is discussed in Section 2.7 below.

The 'true' baseline of what would have happened in the absence of TNF cannot actually be known. It may be possible to estimate from comparison to similar areas of the UK that have not been subject to an initiative such as TNF. Work is ongoing by the NFC to benchmark the economic performance of TNF against comparator areas.

In the absence of TNF, the land-use in the area would have evolved under the influence of a wide range of factors, such as agricultural subsidies, other regeneration schemes, and wider land-use policy influences, including economic development and nature conservation policies.

In practice some tree planting would have been likely in the absence of TNF, in particular in areas of scarred landscape (e.g. some former derelict and landfill sites). However, an ad hoc approach to tree planting would not have achieved the vast majority of the benefits attributed to TNF in this analysis because:

- It would only have delivered a fraction of the scale of planting achieved by TNF, and
- It would not have achieved the considerable benefits resulting from the transformation of image that results from communication of the landscape-scale change that is underway through TNF's activities.

Therefore, the baseline of 'TNF does not exist' is defined in practice through continuation of the conditions (in particular the extent of woodland cover and other land management) that existed when TNF started receiving regular public funding in 1991. The situation in 1987 when TNF concept was conceived was of 6% forest cover. This area changed very little between 1987 and 1991, as the concept of The National Forest developed.

A dynamic baseline, accounting for the expected changes to the landscape in the absence of The National Forest would, in theory, improve the accuracy and reliability of the analysis. However, creating such a baseline would require significant further effort and resources, and the results would remain quite uncertain, in particular looking towards the longer time horizon of 2100.

One major expected change within TNF boundary over the period to 2100 is population growth. The UK population is expected to expand by 15% between 2011 and 2033 (ONS, 2010). Housing expansion is planned in TNF area for potentially a further 40,000–70,000 households by 2100. This is reflected in the predicted population expansion for the Council areas covering TNF, which at 10.7% for 2010 – 2028, is 40% higher than the England average (7.6%) (Defra GIS, pers comm.).

This population growth could increase the benefits from TNF, as more people benefit from the services it provides. It could also increase pressure on land uses, increasing the opportunity cost of land. Given the uncertainties and assumptions required it was considered conservative to omit this change from the calculations for this first-cut analysis.

2.7 The baseline for regeneration

Assumptions about the baseline are particularly important in defining the overall impacts of TNF in terms of regeneration. Many aspects of regeneration (such as confidence in the 'prospects' for an area's future) are very hard to quantify in economic analysis. Data and other limitations make analysis uncertain, and where necessary conservative assumptions are made to retain confidence in the analysis. However, it is important that regeneration benefits are thoroughly described so that the different benefits of TNF are reflected in this analysis.

The situation before the establishment of the NFC was an area, particularly in the central belt of The Forest, suffering from industrial decline and damage to landscape (e.g. as a result of coal mining, clay extraction, quarrying and landfill). The proportion of the National Forest area's population living in communities classified amongst the most deprived in England has declined significantly since 2000. However significant pockets of deprivation remain in parts of the former coalfield and Burton upon Trent. Similarly, there was a significant decline (26% – 16%) in the proportion of TNF's population living in areas ranked amongst the 25% most deprived areas in England between 2000 and 2004 (Staffordshire University, 2004).

TNF has contributed to regeneration by:

- Directly enhancing the landscape, e.g. by redeveloping derelict land as accessible forest;
- Helping restore derelict properties (e.g. Moira Furnace, Ashby Canal);
- Engaging people from areas targeted for regeneration - around 15% of those involved in community and educational activities led by the National Forest Company and partners come from socially excluded groups within the Forest and from surrounding urban areas (The NFC, 2009); and
- Working with partners who have been stimulated to make further investments in the 'Forest'. It is difficult to determine whether these investments would have happened anyway if TNF had not existed - if so, whether they would have happened in TNF boundary - if so, whether they would have been made in natural environment projects (i.e. the Forest

vision), and if not, whether the alternative investments would have yielded greater or lesser benefit for the regeneration of the area[2].

Through these activities, the National Forest Company has been a key part of the regeneration of the area, but it has not been the only driver of this regeneration. Significant other regeneration investment has been undertaken (e.g. by the Coalfields RECHAR[3] programme and through the SRB (Single Regeneration Budget) programme). It is assumed that, in the absence of the NFC, this investment would have happened, but would not have had the same level or type of environmental (Forest) work.

Regeneration is a particularly difficult benefit for which to define an accurate baseline for this study. While certain measures taken in a local area may not be additional at a national level, the fact they have been attracted to a regeneration area is of value. A good example of this is the tourism sector. The local tourism market enhancement due to TNF may be due entirely to activity displaced from elsewhere in the UK, and therefore a transfer which is not additional at a national scale. However, increased tourism is a major benefit for a regeneration area like TNF, firstly for the economic activity it brings to the area, and secondly because being an attractive tourism destination enhances the image of the area.

A further complication is how to assess money levered into the area by TNF. If this money was part of locally ring-fenced regeneration funding (e.g. local Coalfields programme, SRB), it might not be an additional outcome as a result of TNF effort (i.e. it would have happened if TNF did not exist). If the funding is from national/ regional programmes (e.g. RDA, National Lottery), it is reasonable to assume that it is (at least partly) an additional local benefit resulting from the presence of TNF (i.e. it would NOT have happened if TNF did not exist). However, as the scope of analysis is national costs and benefits, it is debatable whether attracting this spending to TNF is an additional benefit or simply a transfer from other areas requiring regeneration.

Given that the regeneration of areas such as TNF is a national policy objective (HMSO 2004) it can be argued that attracting funding to TNF, while a transfer in terms of the national accounts, is an additional benefit to the UK. This is because it succeeds in attracting funding to an area and preventing continued deprivation, which can descend through vicious circles of economic and social decline which are costly to society (e.g. in terms of welfare payments and lost economic opportunities) and are very expensive to reverse in the long term.

A final factor to consider is the effect of the reputation that TNF has built up over time by demonstrating the ability to add value to the local area. This has benefits for local residents, businesses and investors in that it reduces risks that the area

[2] A corollary of this is that by bringing environmental funds not ring-fenced for regeneration into a regeneration area, TNF allows some regeneration funds to be used elsewhere.

[3] A regeneration programme under the European Social Fund.

where they live, work and/or invest in will suffer from the effects of current landscape impacts in the long term.

For example, a business or individuals investing in property that is currently negatively impacted by a landfill site would be expected to value the property less as a result (than if there was no landfill). The presence of plans to remediate the impacts of the landfill would reduce this negative impact. The fact that these plans are owned/driven by a body with a relevant effective track-record (like the NFC) would be expected to increase confidence that they would be delivered. This would further reduce the negative impacts on the property values.

Such confidence in plans to remediate may also impact on the planning system; building trust in such projects leading to more rapid approval. This can have knock-on benefits in terms of strategic planning of land uses (e.g. for areas around current landfill/quarry sites). Evidence of these improvements to property and landscape can be seen in the house prices data from TNF, which show rises in values at a higher rate than the national average (Staffordshire University 2004, NFC pers comm.). The development of TNF is believed to be a strong influence on this rise in house prices (Staffordshire University 2004).

Due to these factors, it is not possible to define precisely the counterfactual in terms of regeneration. Faced with uncertainty on these issues, for this first-cut analysis it is necessary to make assumptions, and in doing so to err on the conservative side so as not to undermine the validity of the overall conclusions of this work. It is conservatively assumed that regeneration impacts in TNF that are the product of other spending programmes should not be included in the analysis as the public sector costs are not reflected in the costs analysed. This is conservative in the sense that TNF undoubtedly plays some part in attracting such expenditure to the area. However, in the absence of an accurate way of quantifying this role, and as allocating all the value from these expenditure to TNF would be an overestimate, this is an appropriate and conservative approach.

Our approach therefore is to value only regeneration benefits that are directly the result of TNF activity (i.e. the value of forest areas as improved public open space). While TNF undoubtedly has wider regeneration benefits than this (e.g. through its impact on the image of the area) we have no practical means of allocating a portion of this to TNF, as distinct from other funding that has contributed to it. The proposed treatment of regeneration attributes is summarised in Table 2.3. There is obviously some overlap in the definition of this category and the recreation category. However, while accessibility is a defining characteristic of the regeneration attribute, this in part relates to the land being managed for wider public benefit. Recreation is valued per additional visit to TNF, whereas regeneration is valued per ha to reflect the uplift in the quality of the land. Therefore, although there is a risk of double-counting between these categories, it is not regarded as a significant flaw in the analysis.

The assumptions made may result in some overestimates of value because some planting or other landscape work would likely have happened in the absence of TNF, as low landscape quality (e.g. spent quarries) are a significant factor in the

conditions necessitating regeneration in the area. However, alternative work would still have required some investment, resulting in costs. In addition, there are also significant underestimates because some of the wider uplift effects of regeneration (e.g. to housing and inward business investment) are undoubtedly attributable to the forest. The absence of a method allowing a part of these values to be apportioned to TNF means they are omitted from the analysis. Overall, the sources of underestimate are considered to significantly outweigh the potential overestimates, and therefore this approach to analysis is regarded as a cautious approach to the uncertainties involved in analysing regeneration.

Table 2.3: Regeneration Assumptions

Regeneration characteristic	How measured	Role of TNF	Allocate value to TNF
Landscape enhancement	Area of new Forest	Significant, measured through change to forest land cover	Yes
Restoration of derelict properties	No of properties restored	Investment in a small number of properties/ infrastructure directly connected to TNF sites	Yes for properties/ infrastructure at TNF sites No for other properties within TNF boundary
Removal of landscape disamenity from mineral working, landfill and derelict land	Area converted to Forest	Significant, measured through change to forest land cover on previously derelict land, mineral workings or landfill sites	Yes in theory, but not possible in first-cut analysis
Economic activity	Through market data	Direct & indirect through forest products	Yes
Business investment	Through market data	Indirect through improved image (landscape) of area	No, role of TNF cannot be separated from wider regeneration initiatives
Employment	Through market data	Through improved image (landscape) of area	
Housing investment/ prices	Through market data	Indirect through improved image (landscape) of area	
Improved image of area	TNF in local branding, anecdotal evidence	Positive through all of the above and the vision provided. NB role of management of well-known sites (e.g. visitor centres)	
Trust in prospects for environmental enhancement	Local opinions of TNF	Track-record of delivery increases confidence that projects to enhance landscape will succeed	Yes in theory, but unlikely to be possible.

2.8 Additionality

A key issue with the model is to ensure that the values calculated are the additional impacts associated with the development of TNF. Additional public spending is relatively easy to identify (although opportunity costs need careful consideration).

The additionality of benefits needs to be assessed carefully, and requires use of data and assumptions representing the additional impact of TNF, rather than its aggregate value. Therefore, the calculations value the changes to TNF area above the baseline conditions in 1991. The assumptions made about the impacts of TNF to try and identify additional benefits are:

- Regeneration: value calculated for the accessible forest area created.
- Biodiversity, wildlife and non-use values: the areas of habitats created are valued.
- Landscape values: the areas of woodland created are valued.
- Recreation: values calculated for the increase in visitors since 1991. It is possible that some visitors' benefits will be displaced from other locations, but it is reasonable to assume an increase in welfare from existing visits to TNF[4], and displaced value can be offset against enhanced value for existing visitors, which is not captured in the calculations.
- Greenhouse gas regulation and timber: impacts modelled using an internal Defra forestry model applied to the new area of managed forest.

2.9 Timings and Discount rate

The analysis in this study divides the activities of TNF into different time periods based on the following three points in time:

START: The NF project began in the 1980's (around 1987) with promotion of the concept of the Forest. From 1991-4, TNF concept was developed through a dedicated team in the Countryside Commission. The National Forest Company (NFC) was set up in 1995, and has received grant in aid from Defra since then. Since the NFC's establishment in 1995, planting/development of forest areas has been funded through a number of mechanisms including the National Forest Tender Scheme, land acquisition, the Changing Landscapes Scheme and other project grants. Other public money has been invested in TNF through Forestry Commission

[4] This assumption is based on equating increased numbers of visitors to an expansion of demand, meaning that more consumer surplus should be realised from within existing visitors.

woodland planting and management grants (which form elements of the Tender Scheme and Changing Landscapes Scheme). As the main purpose of this report is to analyse the public expenditure in TNF, we take 1991 as the baseline year for our analysis. This represents the start of systematic public expenditure in TNF idea.

NOW: The current situation is represented by estimated forest cover in 2009. Note however that 2010 is the base year for the monetary figures.

END OF PLAN (2040). In specifying a model of the development of TNF over time, we assume that the NFC continues to receive its grant and to meet its targets for forest expansion. The Forest expansion rate is currently around 250ha[5] (0.5% of land area) per year, and so a key date is the time at which the planting/habitat management necessary to achieve the 33% forest area (TNF long term goal representing a 'forested landscape') has been achieved. At 0.5%/year, to achieve the 15% further planting required to reach 33% will take 30 more years, i.e. to 2040.

FUTURE: In analysing future benefits, we aim to consider the full value of the forest when it matures. This will happen over a timescale of c. 100 years, over which economic analysis is difficult because uncertainties increase over a long timescale such as this. We set an and-point for the analysis of 2100.

The analysis may be very sensitive to the time-periods for costs and benefits. This is because, while the costs of establishing the forest are front-loaded, the benefits from current and future establishment activities will continue beyond the time when the costs have arisen. This sensitivity is reduced for time horizons beyond 100 years due to the impact of discounting.

One option to reduce this uncertainty would be to insert an arbitrary cut-off point in the analysis (say 2030). However, this approach runs the risk of misrepresenting the full costs and benefits. This is because a shorter time period could lead to under-assessment of benefits relative to costs (because costs are front-loaded). This would not be appropriate for this first-cut analysis, which seeks a holistic (if approximate) assessment in order to guide further efforts to appraise the impacts of TNF with more accuracy. Therefore, in order to maintain a full scope for the work and not restrict the scope of future analysis, it is considered better to use a long time-period (to 2100) for both the costs and benefits, and make simplifying assumptions about long term impacts.

Taking into account these factors, the timelines the analysis covers are:

a. Costs from 1991 to 2010 vs benefits from 1991 to 2010.

[5] Forest sites typically include around 70% tree planting, of varying kinds, plus around 30% of open habitats which are created within the new woodlands (e.g. meadows, rough grassland rides and new wetland habitats).

b. Costs from 1991 to 2100 vs benefits from 1991 to 2100 for all land brought into forest management up to 2010.

c. Costs from 2010 to 2100 vs benefits from 2010 to 2100 for all land brought into forest management up to 2040 (i.e. an analysis that ignores the forest area already established and therefore focuses only on the continuing expansion to deliver target area of forest).

The analysis is sensitive to the timings of when benefits arise. Assumptions in this respect are not straightforward, depending on how the benefits relate to the maturing of trees. In reality some benefits will slowly rise over time to their maximum level (which is assumed to be a steady-state). However, this study does not have capacity to construct these detailed annual time-profiles for each variable analysed. The exceptions to this are Carbon sequestration and timber yields, for which a model for annual impact was already available from Defra[6] (Ritu Patwari pers comm.).

Therefore, simplifying assumptions are made about future timing(s) when benefits start to accrue (i.e. a single step-change from zero to maximum benefit). The choice of this timing can reflect build up of benefits through time towards the maximum, and not just be when the maximum is reached. Different timings are assumed for different benefit categories, taking into account the nature of the benefits and the data used to assign monetary values. The timings used in the analysis are:

- Regeneration: assume benefit arises as soon as area is managed as forest and access arranged.
- Biodiversity, wildlife and non-use values: to allow for the period over which habitat matures we assume that values are realised from 10 years after establishment for open habitats, and 25 yrs after planting for woodland habitats.
- Landscape: Assume the value arises 10 years after planting.
- Recreation: benefit arises as soon as access is arranged to an area of forest.
- Carbon: a full time-profile of carbon sequestration is used, based on an internal Defra model (Ritu Patwari pers comm.).
- Timber: we estimate a growth profile over time from existing evidence, based on intervals over the forest development, and then use interpolation and extrapolation to provide annual data.

[6] This is an internal Defra model based on carbon sequestration data from the National Assessment of UK Forestry and Climate Change Steering Group (2009) and DECC carbon values.

Costs and benefits over time are discounted at the rates specified in the Green Book (HM Treasury, 2007) for long term projects:

Time horizon	Discount rate
0-30 years	3.5 %
31-75 years	3 %
76 – 100 years	2.5%

It can be argued that a lower longer-term discount rate is suitable for socially-beneficial projects that benefit future generations (thereby putting less weight on the time-preference of the current generation). Different discount rates are discussed further in Section 3.5.

3. Results

These results present a first-cut assessment of the costs and benefits of the public investment in TNF. The following sections present the calculation of the values for the public sector costs and each benefit category, and compare these to provide an analysis of the net benefits of the project.

3.1 Costs

The costs of the Forest are estimated through the following data and assumptions:

a) Countryside Commission spending (estimated at £0.5m/yr) on the development phase of TNF (1991-94).

b) Defra (or DOE/DETR[7]) grant-in-aid to the NFC:

- Of £44.3m over 1995-2009 (at current prices), inflated to 2010 prices;
- Of £3.51m in 2010;
- Assuming to continue during 2011 – 2040 at £3.51m/yr, with the actual (nominal) payments increasing in line with inflation, and that therefore for the purposes of analysis the value does not change from this flat rate (at real prices);
- For 2041 - 2100 (after TNF ceases to expand) we assume support to maintain the forest (but not expand it further) continues through a Defra grant and other public spending (e.g. Forestry Commission grants), estimated at £2m/yr. This is based on the assumption that around 1/3rd of existing grant (c. £1.17m) is used for ongoing maintenance, that this will continue through TNF company or other body supported by this level of public sector spend), and allows for the fact that the forest will be larger (33% forest cover versus 18% currently) from 2040;
- Forestry Commission spending on woodland creation and management, based on an internal Defra model of current grant rates (this is based on information from the Forestry Commission on the England Woodland Grant Scheme, see below for more information), applied to the forest expansion to date and the anticipated future rate of expansion; and
- Other additional costs and benefits of investments to develop the facilities of TNF are estimated at £25m. This figure is a conservative estimate, based on, for example, approximately £18.6m of public money that has been invested in the 'Conkers' recreational facilities, and an estimated £3m of

[7] The Department for the Environment (DOE) and Department for the Environment Transport and the Regions (DETR) were predecessor environment departments to Defra.

private sector (developers) investment has already been made in the Forest (Simon Evans, NFC, pers comm.).

The final figure is an estimate that captures other sources of public funding, including donations and sponsorship, visitor infrastructure projects, other grants received, and sundry income. An allowance for additional costs and benefits of further investments to develop the landscape of TNF, or manage it differently are outside the scope of the analysis.

As described in Section 1, the National Forest Company's incentives for forest expansion include channelling of some FC grant money into TNF. However, FC grant rates have also been included in the calculation independently to provide a reality check for future spending and assess additional costs in relation to Defra's grant in aid to the NFC.

The FC grant rates can be calculated based on the England Woodland Grant Scheme (EGWS), which are assumed to continue in order to help to manage and re-stock the forest. The England Woodland Grant Scheme is the Forestry Commission's suite of grants designed to develop the co-ordinated delivery of public benefits from England's woodlands. The aims of the EWGS are to sustain and increase the public benefits of existing woodlands and help create new woodlands to deliver additional public benefit. EWGS consists of 6 grants for the creation and stewardship of woodlands. Of these, those relevant to the NFC are the Woodland Creation Grant (WCG) and the Woodland Management Grant (WMG):

- The WCG encourages the creation of new woodlands where they deliver the greatest public benefits, including annual Farm Woodland Payments to compensate for agricultural income forgone.

- WMG contributes to additional costs of providing and sustaining higher-quality public benefits from existing woodlands.

Table 3.1 lays out the magnitude and timing associated with these grants assuming new native broadleaved woodland being planted over a 15 year period, and then maintained for a further 35 years.

Table 3.1: EWGS Magnitude and Timing of Payments		
	Payment	**Timing**
WCG	The initial lump sum is £1,800 per ha plus a £2,000 per ha bonus if the woodland is considered to contribute to the Local BAP: • Woodland creation grant £3,800/ha (lump sum). Furthermore, the land owner could be eligible for lost income payments for the first 15 years: • £300 per ha for planting on agricultural land;□□ • £200 per ha for planting on improved grassland; and • £60 per ha for planting on unimproved land.	• Lump sum payment in year 1 only • Lost income payments each year for a 15 year period (years 1 through 14)
WMG	Woodland that has been planted for at least 10 years is eligible for annual management grants of £30/ha/year.	Management payments each year for 35 years (years 15 through 49)

Based on this data, the total investment in TNF (from all the public funding sources discussed above) is calculated as having a present value of:

- A total of £188m over the lifetime of the appraisal (1991 – 2100).
- £89m between 1991 and 2010.
- £99m between 2011 to 2100.

It should be noted that no further allowance for opportunity cost is made, based on an assumption that these are covered in the costs of developing the forest. In other words it is accounted for because the cost of public funds (i.e. the value of public expenditure) such as grants to landowners, already reflect opportunity costs. Private sector costs in addition to those above involved in creating TNF are also omitted. There is no reliable available source for estimating these, and so they are excluded from the calculations.

These are not considered significant omissions for three reasons. Firstly, the opportunity cost of some land in TNF may be negative (i.e. derelict land which has a negative value to society in its likely alternative use). Secondly, other than timber values, private returns (i.e. market spending, such as revenues to tourism businesses) are not included in our appraisal of benefits. The focus of the analysis is on returns to public investment, so it is considered acceptable to exclude both private costs and most private market benefits. There is a bit of a grey area here, in that some welfare gains (e.g. landscape, recreational visits, timber) are probably partly reflected in market prices. However, the data cannot be readily divided up further to allow for this, and so this cannot be resolved in this first-cut assessment.

Thirdly, private investment encouraged by grant from TNF can be considered to arise where the opportunity cost and private benefits are already taken into account, and the extra public funding is just what is needed to tip the balance for the landowners between Forest projects and alternative uses of the land.

Therefore, the public investment is the excess (marginal) cost of securing the public benefits analysed below.

3.2 Benefits Calculations

The value of TNF is estimated based on the following benefits data. The details of the value figures used in each calculation are presented in Annex 1:

- Regeneration: £0.05 per household per ha is attributed to all the accessible forest area created. This area is known from TNF records.
- Biodiversity, wildlife and non-use values: a very important category. The areas of habitats created are known from TNF records. Valued very approximately based on literature values, but with serious weakness:
    - High biodiversity value (National Biodiversity Action Plan Habitats): £300/ha
    - Low biodiversity value: £30/ha
- Landscape values: the visual impact of woodland areas, valued per hectare on per previous studies using hedonic or stated preference methods. The area of peri-urban forest is calculated from GIS analysis of the forest created within 1km of urban areas. Note that average area-based values are problematic for landscape based values that are a function of factors such as population density, edge-effects and topography;
    - Peri-urban: £400/ha
    - Rural: £40/ha
- Recreation: a key public use of woodland areas, estimates of beneficiaries based on increased numbers of visitors to TNF since 1991, valued using results of a review of values from travel cost studies and some stated preference studies in two categories:
    - High access recreation (i.e. those with toilets, cafes, detailed interpretation of the forest and related attractions): £12.50/visit
    - Low access recreation: £2.50/visit
- Greenhouse gas regulation: an important regulating service contributing to the combat against climate change, sequestration modelled using a Defra forestry model, and valued at official Government values using DECC's (2009) non-traded price of carbon (lower bound) of £50 per tCO2e sequestered.
- Timber: yield modelled based on current activity in TNF, valued from data on timber prices between 1991-2010, the average of which is applied to 2011 -2100.

All values have been converted to 2010 prices. The benefits of TNF are estimated as present values of:

- A total of £909m over the lifetime of the appraisal (1991 – 2100).

- £228m between 1991 and 2010, and remaining £680m from 2011 to 2100

The breakdown of these benefits between the benefit categories are shown in Table 3.2 below.

Table 3.2: Benefits from all land brought into forest management, £m

	1991 to 2010, Present Values	2011 to 2100, Present Values	1991 to 2100, Present Values	1991 to 2100, Total Values
TIMBER	1	9	10	33
RECREATION	186	375	561	1,393
CARBON	9	177	187	872
LANDSCAPE	4	47	51	187
BIODIVERSITY	4	47	50	236
REGENERATION	24	16	39	46
TOTAL	228	680	909	2,767

3.3 Unquantified benefits

The benefits calculated in Section 3.2 are restricted by relevant data availability, so do not reflect the full value of TNF. In addition to some of the benefits that are quantified but may still be serious underestimates (e.g. regeneration), there are some benefits of TNF that we have not attempted to value at all.

TNF plays a national exemplar role. The National Forest Company has placed high priority on demonstrating its approach to others nationally, especially for landscape enhancement and promoting quality of life. Within the ecosystem services-economic valuation approach this benefit is referred to as the 'cognitive value' or 'learning value' of the approach TNF has demonstrated.

The significance of the cognitive value of TNF is reflected in the conclusion in the Efra select committee report (HoC 2010) that Defra should draw lessons from TNF's delivery and draw up plans to communicate these. Defra is quoted in that report that it considered TNF to be an exemplar of the way in which "real multiple benefits…not simply woodland creation" could be achieved. In addition to this, the following list of organisations that have visited TNF to observe and learn from its actions include:

- International organisations such as: Amsterdam Bos, Canadian Model Forest programme, Indian Foresters, and Russian, Bulgarian and French Government environmental delegations.
- Representatives of UK Community Forests (Great North, Thames Chase, Forest of Mercia, Marston Vale, Mersey Forest, Tees Forest).
- Other forestry managers and projects, such as Forestry Commission Wales, Central Scotland Forest Trust, Lancashire Woodlands project, South West Forest.
- Other organisations such as the Royal Forestry Society, Institute of Chartered Foresters, Small Woods Association, Tree Council, Milton Keynes

Parks Trust, RTPI East Midlands, Farm Woodland Forum, Country Landowners Association, Council for the Protection of Rural England, Defra, Landlife (National Wildflower Centre), Common Ground.

- Educational organisations (students visits) from Bangor University (forestry students), Derby University, Derby College (arboricultural students), and Loughborough University (recreation management students).

However, the omission of cognitive values makes the results of the analysis more transferable to similar future projects, since future initiatives will be less unique or groundbreaking.

Other benefits that are not quantified relate to the contribution of TNF to:

- Alleviating the disamenity of landfill and quarry sites at the end of their working life. Although available valuation literature does look at disamenity from these activities during their operation, it has not been possible to relate this to their distribution in relation to the population of TNF, and the role of TNF in post-operation management of the sites involved;
- Health benefits, in the form of improved physical and mental health as a result of access to improved outdoor environments; and
- Educational and social inclusion benefits, that are related to, but not captured in the analysis of, regeneration impacts.

3.4 Net Present Values

Net present value (NPV) is the discounted benefits minus the discounted costs. Discounting is a technique used to compare costs and benefits that occur in different time periods. It is based on the principle that, generally, people prefer to receive goods and services now rather than later. This is known as 'time preference'. Comparison of the costs and benefits of the forest identifies the net present value and benefit-cost ratios of expenditure in its creation, shown in Table 3.4. The NPV in Table 3.4 calculated using the discount rates specified in Section 2.9.

Table 3.4: Net Present Value from all land brought into forest management, £m

	1991 to 2010	2011 to 2100	1991 to 2100
NPV	140	581	721
B:C Ratio	2.6	6.8	4.8

These results demonstrate value for money on the investments to date in TNF, with benefits exceeding costs by between 2.6 and 6.8 times. Even though forestry projects have front-loaded costs and long term benefits, investments to date in TNF are currently beneficial to society. Going forward, benefits are higher - the up-front investment in the Forest and continuing spending together yield significant net benefits. The higher B:C ratios of 2011 onwards (compared to 1991 to 2010) reflect the benefits flowing into the future as a result of investments made over the last 2 decades in TNF.

In theory, if no further public spending in TNF occurred some of these benefits would continue to arise. However, it is inappropriate to separate the analysis further like this for two reasons. Firstly, ongoing spending is needed to maintain the existing extent and facilities of the forest, without which part of the potential future benefits resulting from past spending would be lost. Secondly, the positive regeneration and other social impacts of TNF are partly driven by its ambitious targets and positive mission for change. Work to continue the expansion of the Forest and then maintain it to 2100 provides positive returns in spending taxpayers money, and therefore the case for continued investment in the forest is sound.

3.5 Sensitivity Analysis

Some of the key sensitivities are discussed here in order to investigate the importance of different assumptions necessary to conduct the analysis. Data gaps and suggestions to extend the analysis with further work are discussed in Section 4.2.

Key sensitivities are:

- Assumptions on the timings of costs and benefits. A case can be made for different assumptions about when costs and benefits will arise. However, it is expected that the alternative assumptions all represent marginal changes on the assumptions used, and therefore would not significantly alter the conclusions of the analysis;

- The key value in the benefits calculation is that of recreation. The visitor numbers that this is based on are conservative – they reflect increased visits since 1991, and do not allow for further increases in visitors from current levels, or any increased value of visits amongst existing visitor numbers. If it was argued that a proportion of the value from increased visitor numbers was displaced from other areas, then the value of recreational visits would be reduced. However, even if the recreational values are halved, the forest still delivers a net present value of £420m.

- The next most important benefit calculation is for carbon. The assumptions here follow Government guidance which should be used to ensure consistent analysis of climate change impacts across the UK. The calculation is reliant of the assumption that future management of the forest continues to yield carbon benefits (because woodland is re-stocked, or thinned and re-grown, over time) up to 2100. If no carbon values are included after 2050, the net present value falls to £615m.

- No other single benefit value makes up more than 10% of the net present value, so other benefits are not analysed further here.

- The discount rates used are standard for public spending analysis. However, an argument can be made for a lower long-term rate (say 1.5% from 2040 onwards) on the basis of the benefits accruing to future generations (and therefore the time-preference of current generations being less important).

Adopting this lower discount rate increases the net present value to £1,027m.

- The model used assumes that forest expansion of 250ha per year is achieved. This rate is subject to unpredictable factors, and therefore it is possible that a slower rate of expansion (say 225ha/year) would be achieved in practice, meaning that the target of 33% forest cover was achieved in 2043. Adjusting the flows of benefits and costs has a very small effect on the figures produced by the analysis. In present value terms, costs increase by £2m (0.5%), and benefits reduce by £7m (approximately 0.8%). The benefit:cost ratio for the period 1991 – 2100 drops from 4.8 to 4.6.

Overall, this brief analysis suggests that the broad results of the analysis are not reliant on individual assumptions in any one part of the analysis. This gives confidence that the results would not change significantly as a result of more detailed modelling or alternative assumptions.

4. Discussion and Policy Conclusions

The results presented in Section 3, based on the typology and valuation framework described in Section 2, lead to results that show benefits significantly exceeding costs:

- Over the lifetime of the appraisal (1991 – 2100), the total present value of benefits are estimated at £909m, which exceed estimated present value costs of £188m by £721m, a ratio of 4.8:1.

- Investments between 1991 and 2010 have produced net benefits. Taking these costs as sunk, continued investment in maintaining and expanding TNF helps to realise the full benefits from existing investments and brings further benefits from further investment, and has a strong cost-benefit ratio of 6.8:1.

Even given the uncertainties involved in this first-cut analysis, the strength of this result gives confidence in the conclusion that investments in the TNF produce returns that significantly outweigh the costs, and are good value for public expenditure.

The breakdown of the benefits identified is in some ways more a reflection of underlying valuation data than the precise attributes of the impacts of TNF. For example, the values estimated for regeneration benefits are probably underestimates, and there are problems associated with using per ha values for recreation and landscape. Despite these weaknesses the analysis has covered the main sources of costs and benefits, and therefore confidence in the conclusions is good for a first-cut analysis.

The results also support some conclusions relevant to future research and policy development. We consider first the strengths and weaknesses of the approach presented, and then the implications for future research and policy.

4.1 Uncertainties

The results presented here are entirely dependent on the assumptions used in deriving them. There are several sources of uncertainty and possible error:

- Errors in determining levels of activity. Many of the services are rather uncertain, and the determination of physical unit values can be difficult. This means that some values have not been included at all, while others are very crude – biodiversity, in particular, is included only as “high” or “low” value habitat. Landscape values are not assessed in physical terms at all, but only through assumptions based on monetary valuation studies. For recreation, the physical unit is visits and this is a key source of uncertainty, as discussed further below.

- Errors in monetary value estimates. The monetary values associated with cost estimates, timber and greenhouse gas regulation are the least

uncertain, though they remain approximate averages within the typology. The landscape and in particular biodiversity values are even more uncertain, based on such valuation evidence as is available, but really no more than ballpark indications of possible values. Recreation values are also uncertain, as discussed below.

- Recreation values are derived from a large evidence base, but while there is good justification for the levels used, there is also significant uncertainty about unit values. The uncertainty in recreation values arises from three sources: uncertainty about the additionality of trips to sites, uncertainty about values per visit, and uncertainty about substitution effects. A key problem here is that we have not accounted fully for substitution effects. The changes in recreation values between scenarios might be interpreted as maximum changes, and if there are significant substitution effects the changes in values would need to be scaled back appropriately. However, it should be noted that even if the recreational values are halved, the forest still delivers a net present value of £420m.

- There remains significant uncertainty regarding biodiversity values in particular. It is possible that the "true" social value of TNF's role in supporting biodiversity could be much greater if higher values could be attributed to biodiversity benefits outside UKBAP priority habitats - further work here is clearly required.

- Landscape values are similarly uncertain, and also suffer from error in the conversion to per hectare values. For all the above issues, a major improvement could be achieved by implementation of a more detailed model, taking account of linear features, human population densities, and substitution effects. There will remain substantial uncertainty about the non-market values of biodiversity and landscapes in particular, and although further studies could refine estimates, full and accurate valuation of these impacts may not be possible. Nevertheless, provided appropriate caveats are made, it remains preferable to attempt to derive best estimates of these important services, in order that their rough ranges of values can be considered alongside other benefits in analysing policy options.

- Population growth in the area is not well accounted for, although it is obviously subject to considerable uncertainty in socio-economic trends up to 2100. Including a growing population would increase the estimates of benefits, thereby increasing the extent to which the benefits of TNF exceed the costs.

- An improved profile of all private sector and non-Defra public spending over time could be created with more detailed research. This could broaden the appraisal to cover all the public and private investments in the forest. However, due to conservative assumptions this first-cut analysis is unlikely to have significantly underestimated costs.

4.2 Possible work to improve the analysis

There are several weaknesses in the methods used. The ease of application and simplification brought by using broad average values related to a small number of different characteristics of TNF reduces the accuracy of the estimates and the ability to represent specific details.

There is a general problem that the model presents some quite cut and dried distinctions between characteristics that in fact are more fuzzy variables. For example the distinction between "peri-urban" and "rural" is clearly difficult in an area that is not densely urban but formerly industrial. This is an inevitable result of using an approach that involves categorising and aggregating impacts rather than assessing each woodland area individually, and is the price to be paid for a method capable of deriving broad assessments rapidly from aggregate data.

There are various problems related to the use of per hectare values and more generally the lack of more spatially and/or temporally explicit data:

- Linear features and edge effects are not taken into account. This is particularly important for landscape values, which depend mostly on the wooded area being visible from residential areas, commercial and work environments and transport routes. This depends on edges more than areas, and is also highly spatially specific. So the use of per hectare values here is a gross approximation.

- There is limited consideration of spatial substitution effects. This is particularly relevant to recreation and tourism, where (for example) the introduction of a second high-facilities woodland near an existing one will not double the number of visitors or the recreation value. The problem is reduced if we can assume that TNF facilities are sited in previously poorly-served areas, and this is a reasonable assumption. Further research could investigate the extent to which increased tourism activity within TNF is displaced from other areas of the UK or represents additional activity.

- More generally we are assuming constant per hectare values where in fact values may be a non-linear function of area. Recreation has already been noted; biodiversity conservation is another clear example in which the marginal value per hectare may be expected to vary with area: to decline as more and more hectares are protected/provided; but increase for areas adjoining existing habitat and therefore forming more valuable habitat blocks.

- Similarly, given the importance of the greenhouse gas service, future work using the kind of framework presented here should consider modelling carbon profiles more precisely.

- It has not been possible to include an increasing population in the analysis for this project. This could be possible using proportional increases in some values (e.g. recreation and landscape), but should then also consider opportunity costs and any other impacts of population changes.

- Regeneration impacts are only valued through one simple measure of value (newly created accessible space). This is because the role of TNF cannot be separated from wider regeneration initiatives, which usually work through synergies to bring about the desired cultural, infrastructural, environmental, economic and other changes that make up a regeneration programme. A more detailed analysis could start to break down the patterns of regeneration that has happened in TNF area (e.g. employment patterns, land uses) and different funding (e.g. coalfields regeneration spending and TNF investments), and thereby attempt to value parts of the regeneration benefits of TNF not covered here.

- Benefits categories related to, but distinct from, regeneration impacts, such as health benefits, education and social inclusion, have not been analysed due to insufficient evidence. Further work could investigate ways of researching, or estimating through Value Transfer, data to apply in these categories.

- For 2041 - 2100 (after TNF ceases to expand) we assume support to maintain the Forest (but not expand it further) continues through a Defra grant and other public spending (e.g. Forestry Commission grants), estimated at £2m/yr. This simple prediction of expenditure could be improved by modelling costs based on predicted forest areas, using more detailed assumptions so that these expenditure levels match up with projections for forest area, facilities and benefits.

- The assumption that cultural values are covered by biodiversity and non-use values could be reversed (i.e. to estimate cultural values and assume that it captured most of biodiversity and non-use values). This might better represent TNF, which arguably has a stronger cultural impact than benefits to *National* biodiversity priorities (these being the basis of the valuation). However, using cultural values might overlap with regeneration and therefore introduce a risk of double-counting.

- More sophisticated assumptions could be used for the development of benefits over time, estimating incremental increases in value rather than a step-change when full value is assumed to arise. However, if other assumptions used in the analysis do not change, this would only be expected to have marginal influence on results.

- There is clearly the potential for extension of the model to include spatial data via detailed GIS analysis. Several refinements to the analysis would be possible on the basis of detailed GIS analysis of some benefit categories (e.g. the proximity of households to landscape impacts and landfill sites). However, the influence of such improved analysis on the overall results of the study may not be large, and therefore it is questionable whether such refinements would be a productive use of resources.

- Calculations of future costs (particularly beyond 2040) could be refined by modelling woodland management costs based on FC cost figures, replacing

the simple assumption about continued costs as a proportion of current Defra grant.

- There is limited consideration of opportunity costs within the model. Where the Forest area is converted from agriculture, or brownfield sites, this may be possible within the model, introducing estimates of values for these land use types corresponding to these uses. However, this would necessitate further adjustments to reflect savings from not having these land-uses (e.g. agricultural subsidies not paid), and so retention of the existing assumptions may be preferable.

- The baseline of 'TNF does not exist' is defined in practice through continuation of the conditions (in particular the extent of woodland cover and other land management) that existed when TNF started receiving regular public funding in 1991. A dynamic baseline, accounting for the expected changes to the landscape in the absence of the TNF would improve the accuracy and reliability of the analysis in theory. However, creating such a baseline is itself an uncertain process (particularly over a long timeline to 2100) and would require significant further effort and resources.

The valuation evidence generally is not very strong, in particular for biodiversity and non-use values, and for landscape values. Although further research continues in these areas, it may be that the prospects for more robust valuation of biodiversity non-use values are limited. Overall these value estimates cannot be considered precise; on the other hand, they can be interpreted as order of magnitude indications that clearly show the high importance of non-timber forest values in TNF, and in conjunction with conservative assumptions allow a good level of confidence in the conclusions of this study.

Several value categories are omitted from the model – most importantly, impacts on water supply quantity and quality, cultural values, some aspects of regeneration, flood risk, and air pollution. Health impacts are not explicitly included, though these will be reflected to some extent in the recreation values. The omitted values are very likely to be substantially smaller overall than the categories that have been valued, but could be important, and further assessment may be warranted.

4.3 Conclusions

The analysis outlined here provides a useful method for a first-cut assessment of costs and benefits associated with public investments in TNF. Given the uncertainties discussed in Section 4.1, it is very clear that the values presented here are only approximate estimates. Even allowing for these uncertainties, the general thrust of the conclusions is unlikely to change. Taking into account non-market impacts, the benefits of TNF are much greater than the costs of planting and management, to the extent that this result is robust to remove any need for a significant scaling back of the benefits estimates.

The general principles are that recreation is a highly important service, greenhouse gas regulation is also important, and biodiversity, landscape and regeneration benefits also make a contribution. Regeneration is likely to be undervalued. Several improvements would be desirable, such as linking with a geographically explicit analysis of forest areas and characteristics, and their location in respect to human populations.

Despite the shortcomings in the data, uncertainties and omissions in the value estimates, and the simplified spatial methodology, the application of the model to TNF yields a useful broad assessment of values arising under different scenarios. Key points are summarised below.

- The model suggests that recreation values are substantial, and the highest values arising.
- Overall, the sensitivity analysis suggests that within quite a broad range of possible values, the non-market benefits for recreation and carbon sequestration are likely to form a large part of total values.
- The value of greenhouse gas regulation is rising over the next 40 years, because the values used derive from Department for Energy and Climate Change (2009) guidance that includes a rising carbon value. The present value of the annual flow of carbon value peaks in 2054 and then declines as forest expansion and growth reduces in influence and discount rates reduce values.

Overall the analysis illustrates the very large non-timber benefits provided by TNF, and in particular by recreational access and facilities within it, by carbon sequestration, and by the natural beauty of wooded areas. These values provide a powerful justification for investments in TNF. There are also social justice and regeneration reasons for making investments through TNF, in deprived areas, and these have not been fully captured in value calculations in this research.

Of course it must also be kept in mind that these conclusions are driven by the assumptions used about impacts and unit values for costs and benefits. These have been derived from the best evidence available, but as noted above there remain substantial uncertainties, meaning that some services have not been valued at all, while for some others the assumptions required to derive values are not ideal.

Annex 1. Derivation of Values of Benefits

This annex describes the derivation of the values used in the benefits calculations in Section 3. It is based on a literature review of forest-related values carried out during the winter of 2009-2010 to inform work for the FC framework.

Woodland Ecology

The National Forest project began in 1987 with 6% (3,010ha out of 50,200ha) of forest cover, of which only 10% was under active management. As of March 2009 an additional 12% (or 6229ha) of forest was created giving a total woodland cover of 9229 ha or18% (NFC 2009a).

This project is considering the environmental changes that relate to the additional cover since 1991 (12%) and the pre-existing forest brought into active management (≈6%). First the framework attempts to value the 6229 ha of Forest creation, which represents an increase of 12% forest cover. The second part of the exercise values the increase to 33% cover, which represents the long term planting target for the Company. The final stream of benefits are those that are expected to continue after planting reaches a steady-state, (such as recreation, amenity, carbon sequestration and biodiversity), which are valued to the year 2100.

The first dimension of the FC report typology distinguishes the forest according to basic ecology:

- Broadleaved, mixed and yew woodland;
- Predominantly coniferous woodland; and
- Open habitat.

This classification has been developed from one widely used in the existing literature (see Hanley et al. 2002; Willis et al, 2003), aiming to match with the UK BAP broad habitats classification, and to account for the increasing importance given to open habitats within woodland areas and more generally. However, a look at the ecological indicators provided by the NFC shows that broadleaved/mixed species are predominant in the forest with a few conifers and some poplars. Data on Forest creation from the NFC show:

- Broadleaved/mixed indicator: 4285.97ha of sites planted with mixed broadleaf/conifers (or 68.81% of total Forest creation).
- Conifer indicator: 0.88ha of sites planted with conifers only (or 0.014% of total Forest creation).

- Open habitat indicator: 1868.7ha of open habitat (or 30% of total Forest creation)
- Poplar indicator: 73.44ha of sites planted with predominantly poplars only (or 1.18% of total Forest creation).

Therefore for simplicity, the ecology classification will be reduced to 'broadleaved/mixed', which will include both conifers and poplars[8] and 'open habitats'.

Proximity to Users

The 'proximity' attribute gives an indication of potential for certain cultural services, particularly recreation, that depend partly on a set of factors including distance from population, size of catchment population, incomes and so on. These factors will all be important in economic valuation; however they need not be explicitly stated in the typology. The typology here does not include any factors associated with access conditions, because that is dealt with separately.

The second dimension of the typology classifies woods and forests according to location with respect to human user populations, both residents and tourists:

- Peri-urban
- Rural

The proportion of additional forest in peri-urban areas was assessed through Defra GIS analysis. This calculated that 62% of the area of new woodland since 1991 is within 1km of existing areas classified as 'Urban'. Therefore, it is estimated that 62% of the new forest since 1991 have been in 'peri-urban' areas. As urban-edge areas are a limited resource, it is assumed that 50% of future forest development is in peri-urban areas.

Management Practice

The need for the framework to allow for management practices was considered. However, in the case of the National Forest it is assumed that *all* of the Forest is managed for multiple use. This does not imply that the land is not managed with timber production as a high priority in some areas. The intention is rather to make a distinction between land managed for timber and other objectives (public access – not necessarily with facilities – and conservation goals) and land managed *solely* with a view to timber benefits (where other non-market benefits may arise, but are not considered in management decisions). It is assumed that *none* of the land in the National Forest is managed in such a way that *only* timber benefits are realised.

[8] The framework will be set up in such a way that poplars can be moved into a separate valuation spreadsheet if necessary.

Public Access

Another dimension reflects the public access status of the forest:

- No public access
- Access encouraged

Currently 82% of TNF area is accessible to the public. Looking ahead to 2030, access is a key aspect of TNF work and is being factored into future plans, and so it is expected that a similarly high proportion of TNF area will be accessible. For the purposes of analysis, a conservative estimate is that 75% of new areas of TNF will be accessible to the public.

Biodiversity

A final dimension to the typology seeks to assess the biodiversity importance of different woodland areas. This is a complex area and we do not have detailed information on which to base assessment. We take a very simple approach that divides woodlands into 'higher' and 'lower' biodiversity importance. 'Higher' importance includes woods and forests that represent at least one of the following categories of NFC Biodiversity Action Plan contributions:

- Ancient or species rich hedgerows;
- ASNW (Ancient Semi-Natural Woodlands);
- Field margins;
- Lowland dry acid grassland;
- Lowland wood pasture and parkland;
- Neutral grassland;
- Orchards;
- Reedbeds;
- Wet grassland and marsh; and
- Wet woodland.

The total area of land classified under the biodiversity action plan (BAP) is 1,363.8 ha and represents the 'high' biodiversity category (NFC 2009). These BAP habitats have been created on land which, at the inception of the National Forest, was of 'low' biodiversity value. Therefore, they are additional to the habitats inside TNF area that existed before the creation of TNF.

Management Costs

The assumptions used to estimate the management and other costs of TNF are described in Section 3.1 of the report.

Values of Ecosystem Services of Woods and Forests

Defra (2007) defines ecosystem services as "the wide range of valuable benefits that a healthy natural environment provides for people, either directly or indirectly". The most widespread categorisation of ecosystem services derives from the Millennium Ecosystem Assessment (2005, which divides services as follows:

- Provisioning services – products obtained from ecosystems, such as timber, fresh water and food;
- Regulating services – benefits from the regulation of natural processes, such as air quality regulation, climate regulation and water/flood regulation;
- Cultural services – benefits people obtain from ecosystems through recreation, aesthetic enjoyment, appreciation of heritage and tradition, learning and similar non-material benefits; and
- Supporting services – services that underpin production of all other ecosystem services, for example primary production, soil formation, nutrient cycling and water cycling.

Table 1: Ecosystem services of woods and forests and their economic value

Ecosystem Service	Main types in woods and forests	Methods of Valuation
Provisioning Services	Timber (fibre, construction, furniture) Renewable energy (fuel woods) Food (wild foods) Ornamental goods (Xmas trees, foliages, moss)	Provisioning services have direct use value and are relatively easy to monetise. Many have market values, and others (such as wild foods) will have market equivalents even if they are not directly sold. Recreational/cultural aspects of wild food collection / hunting will not be covered by market equivalents, but can be treated under 'Cultural services'
Regulating Services	Climate change regulation (carbon sequestration, soil impacts) Air quality regulation Water/flood regulation Water purification Pollination and pest control services	Indirect use values. Some services can be monetised relatively easily, in particular carbon sequestration can be valued at official UK shadow prices. Others require production function methods or other techniques, and service definition/measurement can be difficult.
Cultural services	Walking Picnics Biking Riding Camping Field sports Views/aesthetic enjoyment Historic/cultural values Education Biodiversity (part) Other non-material benefits	Mix of value types: direct use values for many services, but also non-use values. Direct use values measured in some cases via markets, more generally via travel cost and sometimes hedonic methods. Non-use values require stated preference techniques. Valuation issues relating to scale and alternative resources/activities. Care required to avoid double counting.
Supporting services	Photosynthesis/ primary production Soil formation Nutrient cycling Water cycling	Correspond to all components of economic value through their support for the other ecosystem services. Valuation likely to be difficult, but also for most appraisal purposes unnecessary, since generally these are intermediate services and their values are already (largely) contained in the values of the other service categories.

For this study we do not attempt to value supporting / intermediate services. This does not imply that these services are not valuable (on the contrary, they are of great value) but simply that the major part of this value is already reflected via the values applied to final services in the provisioning, regulating or cultural categories. The National Ecosystem Assessment currently being undertaken for the UK and funded by all of the national assemblies, Defra, and others, takes this approach.

The ecosystem service impacts of forestry depend heavily on the species, spacing and mix of trees grown, the types of habitat they replace, and their context/ location in the landscape.

Provisioning Services

Timber/fibre

The most 'obvious' marketed service provided by forestry is timber production, though for The National Forest revenues from other sources such as recreation spend are also significant. In the UK, gross value added in forestry and primary wood processing was slightly over £2bn in 2007 (Forestry Commission 2009). Timber is a marketed product and can be valued using market prices.

Prices can be volatile – for example, the coniferous standing sales price index for Great Britain fell 30% in real terms in the year to March 2009, having risen 52% in the year to March 2008 – and it can be difficult to predict the future values of timber, which depend on demand and, most importantly, on world supply. Since year on year variation is so large, it is important to consider smoothed averages for valuation purposes – available for example in Bateman et al. (2003) who examine price series back to 1870.

See Figure 1 for timber price indices for the period March 1984 to March 2009.

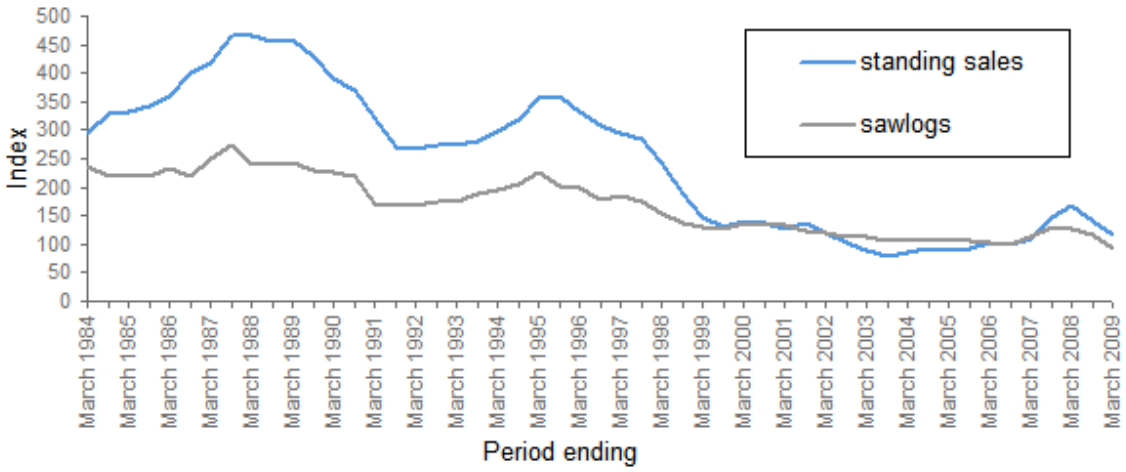

Figure 1: Timber Price Indices in real terms 1984-2009, from FC 2009

The Quantification of the Forest Resource report (NFC, 2009) provides a model of timber yield in The National Forest that distinguishes established and young trees, and conifer, broadleaved or poplar tress types. By applying average historical timber prices per m^3 (£9.15 per for conifers, £10.15 for broadleaved, £11.15 for poplars) to the timber yield per year the value of timber can be estimated. The historical timber prices from 1991 – 2010 were taken from the Coniferous Standing Sales Price Index and the Softwood Sawlog Price Index, for Great Britain (FC 2009) and then the future prices were taken as an average of these.

Estimated timber yields increase over time until a steady-state is reached after planting is completed, with yields from 2032 – 2100 estimated at:

Annual timber yields by woodland type in TNF, 2032 – 2100, m^3				
Established broadleaved	Established conifer	Young broadleaved	Young conifer	Poplar
7,344	12,571	9,198	8,232	1,155

Source: NFC, 2009

We do not separately consider employment in forestry or associated industries such as forest tourism or timber processing. Employment is considered implicitly under regeneration and thus is not valued here.

Renewable energy

Woodfuel is expected to be an important factor in meeting the EU target that 15% of all energy produced in the UK should come from renewable sources by 2020 (DECC 2020). In fact, the Renewable Energy Strategy has anticipated that 30% of these renewable sources will be bioenergy.

In principle the greenhouse gas regulation impacts, and other pollution impacts, arising through displaced conventional power generation, should be considered.

The carbon intensity of the 'average grid mix' is 0.49 $kgCO_2/kWh$ (Carbon Trust, 2006[9]), whereas for woodfuel it can range from 0.354 to 0.349 $kgCO_2/kWh$ for wood chips and pellets respectively (FC 2009). However new official guidelines (DECC 2009) are that new renewable investments should be considered as displacing not conventional but rather renewable sources: "Changes in the level of renewable energy delivered should be valued using the marginal cost of delivering it from other sources: £118/MWh." This is a target-based approach: the UK has a commitment to meet certain levels of renewables, and the impact of producing renewable energy from woodland sources, under this approach, is to reduce the need for renewables investments elsewhere. If valuing in this way, we should not take account of the external costs of conventional energy, because it is not conventional energy that is displaced.

This approach applies only to renewable investments that count towards the UK renewables target; logs for domestic use do not come into this category and it is appropriate to account for the impacts of displaced conventional energy here, although some of the possible impact will be absorbed by increase in service demand (i.e. heating a house/room more than would be the case without the log fire) so a simple energy-content calculation is not strictly accurate.

Costs associated with renewables production should in principle be taken into account. These include the construction and running costs for producing the energy. These can be quite site specific, in particular for woodfuel, for which the efficiency depends on transport costs, though "unless transport distances are very high, the embodied energy of the fuel is generally a small percentage of the energy output from the fuel" (Ayling 2005). Local impacts of transport could be significant and for larger renewable power plants these costs would need to be taken into account.

Conclusion: there are some potentially complex considerations that should in principle be taken into account in a detailed study. However for the purposes of a broad-scale approach, we can use the following line of argument:

- Trees absorb carbon, and this will be accounted for under 'regulation of greenhouse gases' below;
- When harvested and burned for energy, carbon is released, but this displaces energy and carbon emissions from other sources. If it is displacing other renewables, then the result is likely to be a net increase in emissions, so we should in principle value that increase, but also value the energy produced at the marginal cost of renewable investments (DECC 2009);
- The market value of fuel woods is an ecosystem service that should be valued in the assessment BUT the value identified for 'timber/fibre' above

[9] Differs from 0.43 kg CO_2 per delivered kWh often quoted: "figure quoted here uses different data sources and covers a more recent time-period" (Carbon Trust, 2006)

includes all timber sales from TNF and therefore already accounts for fuel woods

Forest foods

Although in principle the value of forest foods such as mushrooms could be calculated via market proxies, in practice this is likely to be low for most cases, and will be reflected in recreational values. An exception to this is any case in which the forest product is actually marketed, in which case that value can be used. Foods arising from field sports are also valuable, but again, this may be better accounted for via the payments made for participation in field sports, with the exception of game traded via game dealers, in which case market values could be considered. Research for Scotland (Edwards et al 2009) showed that value of non-timber forest products like mushrooms was tiny.

Conclusion: we do not attempt to value forest foods directly.

Regulating services

Regulation of greenhouse gas emissions

Carbon sequestration associated with woodlands can be broken down into four main areas (Brainard et al 2006):

- Live wood, including all biomass in plantation trees;
- Wood products (including harvest, storage, displacement factors, fossil fuels used in manufacturing and end-of-life impacts);
- Leaf litter and debris; and
- Soils: generally increase carbon storage when first afforested, eventually reaching new equilibrium, but peat soils are an exception and can release large volumes of carbon when afforested.

In climate change reporting, removals to forestland, also called the forest sink, measures the net annual accumulation of carbon in woods and forests by woody biomass, soils and litter. The annual rate is reported to have peaked in 2004 at 16 million tonnes CO_2 in total, of which 12 million tonnes CO_2 was in living biomass, and is expected to fall steadily to 2020. Under the Kyoto protocol, additional woodland planted since 1990 contributes to the UK's carbon dioxide emissions target; this will increase as woodland continues to be planted (FC 2009).

The valuation of carbon storage requires a value per tonne of carbon: this can be derived in various ways, but in the UK, for public sector appraisals, there are official values that must be used. The most recent guidance, set out in DECC (2010), is based on estimates of abatement costs: this reflects that the UK policy on carbon emissions is target-driven, with cost-effective attainment of a target requiring equal marginal abatement costs across sources. The guidance distinguishes between 'traded' and 'non-traded' carbon ('traded' means 'covered directly or indirectly by the EU Emissions Trading Scheme), because there are different targets. The 'traded' and 'non-traded' prices differ until 2030, from

when it is assumed that a global carbon market is in place with a single price. The relevant prices for the forestry sector are 'non-traded' and rise from £50/tCO_2e (range £25-£70) in 2008 to £70/tCO_2e (range £35-£105) in 2030, then to £200/tCO_2e (range £100-£300) by 2050. Although official values need not be directly related to WTP estimates, they are clearly the most suitable choice for appraisal purposes, for reasons including consistency in appraisal across the public sector and ease of application.

Conclusion: By adapting a Woodland Creation Grant model provided by Defra the adynamic flow of carbon sequestration can be estimated for the NFC up to 2100. Of relevance to carbon in the NFC, the model takes as its inputs the amount of planting and the planting rate (which was taken from the NFC 2009 Quantification of the Forest resource report) and outputs an estimated amount of tCO2e sequestered.

Carbon sequestration/emissions from open habitat within woodland areas are difficult to determine, since they will depend on a wide range of site-specific factors. Total carbon stocks in open habitats will be significantly lower than in woodlands and for simplification they are assumed to be zero in this study.

Air pollution regulation

Woodlands play a role in regulating air pollution, both via direct absorption of pollutants and through their role in producing oxygen. Various methods can be used to estimate the value of avoided illness or death from air pollution. In many cases estimating a dose-response relationship is a preliminary step: this expresses a relationship between pollution levels and statistical health outcomes in a population, including estimation of the impact of woodlands on pollution levels. This is then followed by valuation of the health impacts thereby estimated – for example Willis et al. (2003) used a value of £124,998 for each death delayed by 1 year due to PM10 and SO_2 absorbed by trees, and the average cost for a patient to stay in the surgical ward in a hospital is £400/day (NHS 2009)[10], this means £4400 in costs avoided per patient for an 11 day hospital stay avoided due to reduced respiratory illness.

The total value of air pollution regulation by woods and forests reported in Willis et al (2003) is very low compared to other services, but this may be largely because the research focused on the effects of tree absorption within 1km^2 areas; a lack of information on trees' absorption of pollution on a wider scale meant that assessment of the impacts of pollution absorption beyond this very local scale was not possible.

[10] http://www.institute.nhs.uk/building_capability/general/ready_to_go_no_delays.htm

Conclusion: A key problem here is the availability of data suitable for estimating a dose-response function. In the absence of clear information, we do not attempt to value the role of forests in reducing air pollution. We note, however, that this role could be important, particularly in urban areas, and further research here may be justified.

Water purification and supply

Although water supply is a provisioning service, the role of woods and forests is more indirect – purification, retention – and so woods and forests contribute to regulating services that support water supply downstream in catchments.

There are three major properties of forest watersheds generally responsible for the quantity and quality of water flow; interception, evapotranspiration, and infiltration (Ferguson 1999). Woods and forests play a key role in many watersheds, influencing particle load and timing of runoff, impacting on downstream catchments in terms of water quality and quantity, which can in turn impact on drinking water and on water for irrigation and industry as well as recreational use of water courses. During periods of low precipitation, forestry can reduce runoff to the point where a negative value due to low flow has been suggested for some areas of South West England (Willis 2002) and Ireland (Brander et al. 2009), but Willis (2002) also notes that British water companies perceive little impact of existing forestry on water supply costs.

Willis et al. (2003) use a cost of up to £1.24 per m^3 where water is lost to abstraction for potable uses, depending on the region, but for most areas the marginal cost is zero. The externality cost of woodland on water quality has been 'internalised' within forestry through the application of guidelines on woodland planting and conditions attached to forest certification. However there may be scenarios under which these costs could be significant. Willis (2002) argues that forestry and land-management decisions are long-term and that the value/cost of the water supply service impact can be estimated via the long run marginal costs (LRMC) of water supply in the area. These are estimates for the total cost of abstracting the next cubic metre (m^3) of water, including any capital investment costs. Estimates of LRMC are available from water companies via OFWAT (Willis 2002).

In principle, reduced water availability could also reduce agricultural values due to reduced irrigation. However, Willis (2002) notes that, because of subsidies, the marginal social cost of agricultural production exceeds its marginal value to society, so the cost of reduced water for agriculture is likely to be low at the margin.

Conclusion: forestry impacts on water supply and quality are very uncertain, and site-specific. Willis et al. (2003) do not identify these issues as being among the significant ones. We do not have strong data and valuation estimates for assessing these impacts. Also, the scenario under consideration is wide-scale afforestation, so the impacts on water supply and quality may be expected to be minor. Therefore we do not attempt to value these impacts here, but note that this

ecosystem service could be relevant to the large-scale changes in extent of woodland cover involved in TNF.

Flood mitigation

In addition to possible impacts on water quality and quantity, forestry can influence the frequency, severity and/or control costs for flooding downstream, by influencing water storage capacity and risks of excessive runoff. Valuation can be carried out through estimating the expected damage costs avoided plus any change in flood defence expenditures. Values could also be estimated through willingness to pay to reduce flood risks. Care is needed to avoid double counting if mixing these methods.

To assess values of changes in this service, we would need a clear determination of the link between forestry / land management and flood risks downstream. Data availability is a significant problem here. If a link could be made, the costs of flood risk could be broken into two main components:

- The impact on flood protection expenditures arising from changes in flow and gross risks; and
- The *residual* risk of flooding and the damage costs associated.

Both are highly location specific, though it may be possible to derive ballpark figures for rough assessments.

Conclusion: Full valuation of the benefits of flood risk management is a complex exercise, but achievable, for example following guidelines set out in the Multicoloured Manual (Penning-Rowsell et al 2005).

Cultural Services

Woodland areas have important cultural services, both in terms of use and non-use values. Key uses include recreation and aesthetic appeal, while important non-use values include heritage and biodiversity conservation (there are also use elements to these values). Millward and Royal (2008) summarise questionnaire results supporting the strong cultural and non-use element to how the National Forest Company is viewed. Nearly three quarters of all respondents felt the following were an important part of the NFC contribution:

- Planting and managing trees
- Enhancing and protecting wildlife
- Encouraging public recreation

It is noteworthy that, despite the high value of recreation in forests (see below), other responses made by just under half of the respondents relate to other values:

- Contribute to reducing carbon dioxide
- Stimulate the economy and create jobs

- Encourage alternative uses of farmland

Of these, we assume that the climate change values are adequately reflected in the official values applied to greenhouse gas sequestration. The landscape issue is considered in this section under "aesthetic values" (the use value element) and under "biodiversity and non-use" (the non-use element). The issue of providing habitat for wildlife is considered under "biodiversity and non-use" (for the non-use element) although wildlife also has use values (such as birdwatching) that are considered to be included under the recreation category.

Forest Recreation

The National Forest (NF) attracted 7.97 million visitors in 2008 spending £287 million in the area (NF Company Strategy 2004-14). In line with goals to expand tourism and recreation within the forest the National Forest Company (NFC) has been developing facilities featuring a number of "gateway features": listening posts, seating areas, interpretation signs and boards. The focus has been on five key sites:

- Conkers
- Snibston Discovery Park
- Ferrers Centre for Arts and crafts
- Sence Valley Forest Park
- Rosliston Forestry Centre

A summary of the key gateway features established on these sites was taken from the Phase Two Visitor Survey Report (NFC 2007) and is shown in

Table 2 below. Based on various estimates of visitor numbers to these sites (National Forest Company, pers comm.) it is estimated that they account for 1.2 million visitors per year, (or 15% of total visitors). It is conservatively assumed that all other visitors (i.e. 85%) visit locations with less well developed visitor facilities (described as 'low' facilities below).

Table 2: Summary of Gateway Features for Five Key NFC Sites

Ferrers Centre for Arts and Crafts	Snibston Discovery Park	Conkers	Rosliston Forestry Centre	Sence Valley Forest Park
• Entrance Signage • Stand alone sign • Interpretation and leaflets dispenser • Lockable notice events board • Interpretation and leaflets dispensers • Interpretation floor slabs • Listening Posts • Picnic tables • Litter bins	• Entrance Signage • Stand alone sign • Interpretation and leaflet dispenser • Interpretative tile flooring • Digital projection • Digital wall paper • Web facilities - information kiosk • Catering tables • Education unit	• Stand alone signs • Seating interpretation • Interpretation slabs • Digital wall paper • Catering tables • Picnic tables • Litter bins	• Education unit Landmark feature / sculpture	• Seating shelters • Interpretation listening Posts • Picnic table • Litter bins

Overall, the majority of visitors are either local residents (45%/41%) or day-trippers (43%/47%).[11] Conkers and Snibston attracted the most day visits at (57%/66%) and (57%/64%) respectively. The majority of the visitors to the Sence Valley Forest Park are local residents, which remained constant at 86% across both phases of the survey. Only a tenth of the visitors stayed overnight in either paid accommodation or with friends/relatives in both surveys. Of the 10% of visitors staying overnight, an estimated 42% stayed within The National Forest and 58% stayed outside of The National Forest area. 'Other' visitors, camping or staying in a second home, increased from 1% (Phase One) to 3% (Phase Two), but perhaps this change can be partly attributed to the warmer weather and/or summer vacation period. Most (approximately 70%) of the over night visitors stay were short break visitors, staying 1 – 3 nights.

[11] The first result is form the Phase One Survey (April – May 2007) and the second is from the Phase Two Survey (August – October 2007). Between these two phases a number of gateway features were installed on the key sites and as such one would expect a change in the pattern of visits. Additionally, it must be considered that the Phase Two Survey was undertaken during peak months.

Most adults (59%) visited the forest in pairs with a total of 64% of the parties visiting with children. Mainly due to the fact that certain sites are targeted to families, Snibston Discovery Park (93%), Conkers (95%) and Rosliston Forestry Centre (59%) attracted a higher proportion of parties with children compared to Sence Valley Forest Park (31%), Ferrers Centre for Arts and Crafts (37%), and Calke Abbey (30%). These results of the surveys emphasise The National Forest's popularity as a family destination.

Most visitors to The National Forest sites were repeat visitors (92%) with a mean average of 34.7 trips per year. More than half of these repeat visitors undertook less frequent visits with between 3 to more than 12 months between each trip, while 30% visited on a monthly, weekly or on a daily basis. Regarding the gateway sites, regular trips (within the last month) are highest at Sence Valley forest Park (72%), which may be due to the high number of dog walkers and local residents. The results show that Conkers, Snibston and Calke Abby attract the highest proportions of first time visitors.

It is worth noting that provision of recreation facilities, and tourism expenditure, can be important direct and indirect sources of employment and income in forest areas. This is not reflected directly in the economic value framework used here, beyond the consideration of the value of recreation, and the costs of providing access. In general, at the national level of analysis, the net impacts would be small, because some of the expenditures could be diverted from other areas, and because employing scarce labour is a cost rather than a benefit. Again, the impact of using a shadow value for labour would be small relative to other costs and benefits, and we have not attempted to estimate this explicitly. However, overall employment impacts associated with the NFC development is implicitly accounted for in the regeneration values.

There are a range of approaches for valuing forest recreation. **Table 3** summarises economic valuation methods that can be used to estimate the value of forest recreation.

Table 3: Economic Valuation Techniques for Forest Recreation

Technique	Applicability	Pros	Cons	Overall
Market price	Entrance fees; local expenditures	Easily observable and based on real payments	Relate to prices not values; free access does not mean zero value	Important data that must be processed carefully. Key input for travel cost. Suitable for certain paying activities such as field sports, 'Go Ape'

Table 3: Economic Valuation Techniques for Forest Recreation				
Technique	**Applicability**	**Pros**	**Cons**	**Overall**
Hedonic pricing	In principle, via housing and hotel/holiday let markets	Based on actual behaviour/ expenditures	Data may be hard to get. Problems defining market boundaries and participants.	Potentially useful if data are available but not recommended for primary study.
Travel cost	Any site or activity that involves travel to the uplands.	Based on actual behaviour, relatively straightforward	Hard to value prospective changes	Useful if available. Primary studies possible.
Stated Preference	Yes	Can be used to value all recreational activities. Additionality can be internalized.	Can be complicated to implement and analyse.	Very useful if available. Difficult to separate use and non-use – bear in mind for avoiding double counting (easier to separate user and non-user). Primary study possible.

Forest recreation has long been recognised as important and valuable, and the Forestry Commission established in 1992 an estimated value for recreational visitors of £1 per visit (since indexed) (Willis et al. 2000). Willis et al. (2003) used values of £1.84 to £3.06 (at 2008 prices) for each recreational visit. Bateman and Jones (2003) provide a meta-analysis of forest recreation values for the FC. They include 13 different studies published before 1997, covering 21 different woods and forests that provide a total of 77 different estimates of the per-person per-visit recreational benefits from both travel cost and contingent valuation methods. The majority of these estimates relate to use value, although 16 are classified as relating to use plus option values. Of the 61 value observations related to current use values, estimates range from £0.11 to £4.78 (2008 prices). Christie et al. (2005) estimate the value of recreational improvements to forest sites for different user types (walkers, cyclists, horse riders, nature watchers) ranging between £8.53 - £16.18 per visit (2008 prices) via travel cost studies. Contingent behaviour and choice experiment analyses are used to estimate changes in visitor welfare

associated with improvements[12] to specific recreational facilities (e.g. value of paved cycle track to cyclists). Scarpa (2003) similarly reports values of £1.88 – £3.16 per visit based on contingent valuation data for woodland sites (2008 prices). Murphy 2006 found for an on-site survey in Ireland in a commercial forest per visit that the typical value placed by a user on a visit to a trail or forest site was £4.88 (2008 prices).

Jones et al. (2002) found a weak but statistically significant difference in the value of recreational forest visits based on facilities at a particular site, although the effects of site location, proximity to populations and substitute sites provided a stronger predictor of demand than facilities available. But it is clear that visitors do respond to facilities, publicity and 'welcome', and this is supported by research such as Carter et al (2009).

Conclusion: The value estimates available suggest that values for trips to woodlands could be rather higher than previous estimates used in forestry appraisal. The Christie et al (2006) study in particular would support values around £15 per visit for forests offering specific amenities for walkers, cyclists or horse riders. Zanderson and Tol (2008) find a similar value of £15 in a European meta-analysis. Higher values arise in the Kaval (2006) study: this is for the US, and straight transfer is not advisable, but nevertheless this very wide review gives support to the use of Christie et al's values. The values reported by Bateman and Jones (2003), Scarpa (2003) and Fitzpatrick and Associates / Coillte (2005) are lower, something around £2.50 per visit. The average expenditure (ELVS) for woodland leisure visits from home is ≈£12, and ≈£26 for tourism visits (over 3 hours, to sites not visited regularly); though expenditure figures do not give any direct indication of surplus values.

This dimension picks up on the main features associated with recreation services: can people get in, and what is provided for them on site? 'Low' facilities means restricted to paths and minor interventions to facilitate access; 'high' facilities represents, at least, provision of toilets and car parking (for which there may be a charge), and also covers more intensive provision at visitors centres and so on. The category is also related to what McKernan and Grose (2007) refer to as "the feeling of being welcome in a site", and 'unwelcoming' sites (e.g. 'keep out' signs) might be considered as 'no public access' for valuation purposes, even if there are in fact rights of way over the land. Of course tying a wide range of provision types into a single category means that true values in any specific case may be quite different from the 'average' costs and benefits covered in the typology, and therefore departures from the average values should be considered as appropriate if working

[12] Note however that what one user considers an improvement may be viewed as excessive development by another: in principle, valuation studies should detect averages across all, including those who have negative values for a change. In practice, those who prefer low-facility areas are likely to focus activities on such areas. For detailed specific assessments these factors may be important considerations, but for the current broad assessment, with scenarios involving limited changes in facility provision, such nuances can be ignored.

on specific cases. This is a 'first cut' approach to valuing forest recreation and much better resolution/detail would be expected in a GIS application.

For the purposes of completing this study, we assume that:

- 'High facilities' woods and forests have a value per trip of £12.50, and
- 'Low facilities' woods and forests have a value per trip of £2.50.

By assuming that 85% of visitors will use 'low facilities', we can use the data on visitor numbers to derive a recreation value. Due to the speculative nature of the approach to estimating the relationship between planting and visitor numbers the most conservative assumptions have been adopted wherein visitor numbers remain steady from 2007. This may result in an underestimation of recreation value.

Landscape values

Woods and forests are often considered attractive features of landscapes, though some forms of forest can also be thought to detract from natural beauty. Some part of this aesthetic value is captured within forest recreational values, but the value of viewing forest from the outside is additional. Values accruing to residents with views over forest can be detected via hedonic methods. Values for others could be assessed using stated preference or potentially other methods, but there is generally a problem in identifying beneficiary groups – for example those engaging in recreation on foot or in vehicles in non-forest areas with a view of forest. Some researchers have attempted to value household willingness to pay for particular forms of forest, or for views of woodlands from home or when travelling. Entec and Hanley (1997) use choice experiments to estimate values for selective felling of (£12.89 per household per year), organic shape (£13.90/hh/yr), and diverse mix of evergreen, broadleaf, and larch species (£11.36/hh/yr). The WTP for an 'ideal' forest landscape inferred by summing these variables was £38.15/hh/yr. In a separate CV study, they estimate £29.16/hh/yr for changes to 'ideal' forest form.

Garrod (2002) found values for woodland views from home of £268/hh/yr for urban fringe broadleaves, and a further £226/hh/yr for forest views whilst travelling. Based on this, Willis et al 2003 use an estimate of £269 per household per year, for those households with a woodland landscape view on the urban fringe. Note however that these estimates relate to implicit prices (first-stage hedonic analysis) not full value estimates (second-stage).

At 2008 prices, Garrod's estimates are around £180m per year for the aesthetic appeal of UK forests. This is approximately £60/ha/yr, though of course the actual value per hectare will be highly location specific. Urban woodlands will be particularly valuable, while remote rural woodlands will be less seen. At these levels, aesthetic values would clearly be very important. However they are also highly uncertain.

The visual amenity or aesthetic value of the National Forest, however, represents a different type of change on the sense that much of the land has been regenerated

from post-industrial uses. There are three studies that look at the benefits of such schemes and will provide values for these unique NFC areas:

i. Developmental work to value the impact of regeneration (eftec, in prep.).

ii. A study to estimate the disamenity costs of landfill in Great Britain (Cambridge Econometrics et.al. 2003)

iii. Environmental costs and benefits of the supply of aggregates (ODPM, 1999)

The first study considers the value attached to various regeneration projects: improvements to open space, derelict properties restored, outdoor facilities and improved public space, street cleanliness and green routes. The second study considers landfill disamenity by evaluating the change in house prices moving further away from the site. The third study measures household willingness to pay to secure a quarry closure.

Approximately 2,500ha of land in TNF in 1994 was in use for mineral extraction or landfill, or was derelict in some other way. This is about 5% of the total area inside TNF boundary. The analysis does not capture the value of restoring these landuses (of alleviating the disamenity they cause). There are no monetary values for the post-mineral land restoration by private companies or for regeneration of former coalfields.

There are economic valuation studies for the UK covering the negative effects of aggregates extraction and landfill sites respectively. However, these value the annual disamenity of the sites during operation, whereas TNF's impacts are to alleviate the negative legacy effects of such sites after they have finished operating (it is assumed that they do not cease operations more quickly as a result of TNF). This creates a problem in applying these economic values to TNF. However, some of the negative legacy effects (e.g. scar on the landscape) are the same as the negative effects that arise during the operation of the sites.

The impact of the TNF on landfill/quarries while they operate is related to the effect of the visual impacts of landscaping with trees and the associated mitigation of air/noise pollution, (which is hard to quantify). In future work it might be possible to use existing valuation studies for value transfer based on assumptions that:

- The disamenity arises when the sites are operating and when they are being remediated post-operation.
- The impact of TNF is that the remediation of derelict land sites happens faster than would otherwise be the case. Therefore, the benefits attributable to TNF are fewer years of remediation over which the disamenity persists. This impact is dependent on assumptions about the remediation of sites in the baseline (no National Forest) case, which in turn is dependent on the nature and enforcement of obligations on operators.
- The further benefits of TNF (that may arise from enabling public access to, and/or improving the environmental quality of, the restored sites) will be captured through other variables in the regeneration analysis.

This is effectively saying that the impact of TNF is to remove the negative legacy of these sites more quickly that would otherwise have been the case. This is an uncertain assumption, but could be reasonable due to the effects of tree planting, such as their ability to screen landscape 'scars' and to absorb noise and dust from the sites.

To carry out this approach requires estimates of the populations within a small area (e.g. within 1km) around these sites. Analysis to determine these populations should be feasible with access to the right GIS layers (namely, spatial population distribution and locations of landfill and quarry sites), but has not been possible to inform this report.

Conclusion:

For a working assumption, we use the using the very simple figures from eftec (2010) of the following values:

- Peri-urban woodlands: £400/ha/yr
- Rural woodlands: £40/ha/yr

These are very broad-brush assumptions intended only to give an indicative value for the visual/landscape impact of woodlands. A particular problem is again that we apply values per hectare, while in practice it may be only the woodland edges that are particularly visible from homes and transport routes, and therefore valued. Nevertheless these values are very approximate and could be improved, both by more detailed studies of aesthetic values, and by incorporation in a GIS model taking account of location specific effects, notably population density, and applying values along visible edges rather than woodland areas.

The proportion of additional forest in TNF that is in peri-urban areas was assessed through Defra GIS analysis (Adele Storr, pers comm.). This calculated that 62% of the area of new woodland since 1991 is within 1km of existing areas classified as 'Urban'. Therefore, it is estimated that 62% of the new forest since 1991 have been in 'peri-urban' areas. As urban-edge areas are a limited resource, it is assumed that 50% of future forest development is in peri-urban areas. The Forest is accessible by a multitude of major roadways: M1, M42/A42, A50, A511 and the A38; and by rail at the following stations: Burton upon Trent, Derby, Willington, Tutbury & Hatton, Lichfield, Tamworth, Leicester and Loughborough.[13]

Cultural values

For some people, woods and forests have important cultural, historical/traditional and/or quasi-spiritual importance. Some part of this may be reflected in their use

[13] For a map of the transport links see: http://www.nationalforest.org/forest/whatis/where.php

values for recreation, but there may be additional use and non-use values that cannot be captured using travel cost or other methods focusing on recreational use values. "Group visits to woodlands for educational purposes have few substitutes and are actively pursued by schools, scout groups, bird-watchers and other educational organisations." (Willis et al 2002) – again, some part of this value will be reflected in recreation, but there may be additional values to education, including for values held by third parties for the education of current and future generations.

Cultural values are highly context specific and can be contentious – different people can have different views of the desirable state of a landscape, for example. There can also be cultural values against forestry or tree encroachment – for example preferences for traditional land management or open landscapes, or risks posed by woods and forests to archaeological values. There is some evidence that people place a value on the current intensity of management over either more intensive or less intensive management. For example Willis and Garrod (1993) found strong preferences for the status quo landscape in the Yorkshire Dales, with more conserved landscape also favoured, and strong preferences against intensive and semi-intensive options.

There is a basic choice between valuing whole landscapes/areas, and valuing specific features. Examples of the 'features' approach include Hanley and others (1998), who found strong preferences for increases in broad-leaved woodland, heather moors and wet grasslands, and lower values for dry stone walls and archaeology, for an ESA in Scotland. The Environmental Landscape Features (ELF) model (IERM/SAC 1999, Oglethorpe 2005; see **Table 4**) is a form of meta-analysis / benefits transfer for valuing landscape features in England. Values, based on contingent valuation studies, were included for rough grassland, heather moorland, salt marsh, woodland, wetland and hay meadow (1999) and hedgerows and field margins (2001). The estimates are intended only to account for values of residents, and to allow for diminishing marginal values of additional units of a feature, but aim to value the entirety of a given resource within an area. Eftec (2006; see **Table 5**) reports results of choice experiments examining the value of environmental changes in Severely Disadvantaged Areas across England, and for comparison present these alongside values processed from the ELF to represent 1% changes in the feature within a government region. The results are generally broadly consistent.

Swanwick et al. 2007 conclude that "there are strong arguments for a whole landscape approach as representing more realistically the way that people view and value landscapes", but temper this with the observation that the choice between whole landscape and component based valuation can depend on the proposed use or policy application of the results. They further suggest that contingent valuation is more suited to whole landscape approaches, whilst choice experiments are more suited to landscape component (or feature) valuation.

A general issue with all these valuations is that they are very likely to contain elements of both use and non-use values. People, and survey instruments, may not

be able to distinguish clearly between values for viewing and experiencing a landscape in a particular configuration or quality, and non-use values associated with the same features. This is not a problem for assessing the total (use and non-use) value of a given area, but it does give concern regarding possible double counting if values for cultural heritage and values for recreation are estimated separately and both included in an assessment. Similar problems may arise with separate accounting for cultural values and for biodiversity conservation.

Table 4: Household values for 1% increase in woodland from ELF model, £.

English Region		NE	NW	Y&H	EM	WM	E	SE	SW
Woodland	Lower	5.79	7.74	5.02	4.99	5.07	4.63	2.98	2.28
	Upper	8.72	11.65	7.55	7.52	7.62	6.98	4.50	3.42
	Average	7.26	9.69	6.28	6.26	6.35	5.81	3.75	2.85

Source: Oglethorpe 2005. Values are normalised using relative regional consumer price levels.

Table 5: Household values for 1% increase in broadleaf and mixed woodland in SDAs, £.

English Region	North West	Yorkshire and Humberside	West Midlands	East Midlands	South West	South East
Broadleaf and mixed woodland	0.61 (0.30-0.91)	0.15 (-0.16-0.48)	0.43 (0.07-0.81)	0.97 (0.03-2.46)	0.39 (-0.01-0.78)	1.21 (0.81-1.66)

Figures in brackets are the 95% confidence interval. Note that if the confidence interval spans zero then the WTP is not significantly different from zero. Note that value for South East is for improvement in all other regions (no SDA in south east)
Source: eftec, 2006.

Conclusion: we use separate values for recreation and aesthetic values, and consider any additional non-use values under the heading biodiversity and non-use values, rather than attempting to include a separate value for cultural values. This is in order to avoid double-counting. There would be particular concern about overlap with values expressed for aesthetic aspects of woodlands, and also with recreational values, both of which may be reasons for people to express high cultural values for woodlands. This is not to say that all aspects of cultural values will be captured in one or other of the other categories, but a significant part is likely to be accounted for, and on balance the risks of double-counting outweigh the risks of under-counting.

Biodiversity, wildlife and non-use values

One of the most important services provided by woodland areas and other natural or semi-natural terrestrial habitats in the UK is the conservation of biodiversity. The value of biodiversity conservation can in principle be split into separate components: the non-use value of biodiversity, and the use value in terms of the support function that biodiversity plays in underpinning other ecosystem goods and services. Table 14 summarises how different economic valuation methods can be applied to valuing forest biodiversity and wildlife.

Table 6: Economic Valuation Techniques for Biodiversity and Wildlife

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Very limited – possible premium on labelled products; donations to conservation NGOs	Based on real transactions	Very limited coverage and applicability. Donations usually too general, and/or may include use values	Not a likely option	Premium on FSC timber
Proxy value	possible to calculate cost of creating habitat; some use of stewardship payments as proxy, lowest cost methods of delivering targets	relatively easy to calculate	Creation cost: measures cost, not value; stewardship payments: not necessarily related to value at all	Useful information, but not value estimates. Can be used if costs actually incurred.	Costs of creating compensatory habitats under EC directives; cost-effective ways of delivering safe minimum standards
Stated preference	Yes	Possible to address non-use values fully	May be difficult to separate from use values. Requires very careful study design.	The only real option for valuation (as opposed to cost-based proxies)	

We consider that the use values of biodiversity and wildlife are (in principle) captured under other categories – recreation and aesthetic values for uses involving watching wildlife, and provisioning or regulating services for other direct or indirect uses of biodiversity. As a supporting / intermediate service, it can be argued that accounting for use values of biodiversity separately would entail a significant risk of double-counting, since we are already accounting for the final

services supported by biodiversity. This argument is correct so far as it goes, however it must be recognised that our value estimates for the supported goods and services will only be accurate if in fact the biodiversity necessary to their provision remains present in the future. In other words, if we expect biodiversity to decline, we should reduce our estimates of the value of final services supported by biodiversity, although in practice we may lack the scientific knowledge to do this.

What remains is the non-use component of existence, altruistic and bequest values associated with conservation. This part is difficult to measure in physical or monetary terms. Non-use values need to be estimated via stated preference techniques. Willis et al. (2003) present estimates of 35p per household per year for enhanced biodiversity in each 12,000 ha (1%) of commercial Sitka spruce forest; 84p per household/year for a 12,000 ha increase in Lowland New Broadleaved Native forest, and £1.13 per household/year for a similar increase in Ancient Semi Natural Woodland, for example.

Juutinen (2008) presents meta-analysis of contingent valuation studies for biodiversity value of old-growth boreal forests in Finland, arriving at £200/ha/yr – which puts forest in the range between thresholds for delaying harvesting (£84/ha/yr) and permanent conservation (£398/ha/yr) – but this value may not be suitable for direct transfer to the UK. Lindhjem (2007) presents a meta-analysis of mean WTP for forest protection in multiple use forestry, identifying a value of £120/hh/y (standard deviation £138/hh/y). However the value is scale insensitive, and so it is difficult to derive per ha measures. The issue of scale insensitivity is a crucial one for stated preference valuations, and is discussed further below.

Yousefpour (2008) (see Yousefpour and Hanewinkel 2009) presents a different approach to valuing biodiversity, calculating a Shannon index[14] from simulation runs for forests, and transforming this into a parametric function for the utility of the Shannon index, based on calculating the imposed opportunity costs of the forest owner. However this does not result in a willingness-to-pay based value but rather reflects costs, and so is not suitable for use in a cost-benefit study.

Nunes et al. (2009) present a meta-analysis of studies looking at forest biodiversity values, covering 65 separate studies with 248 value estimates. However by 'biodiversity' values they intend a general conception of biodiversity as the supporting service underpinning all other values, and their data points are for the total values of forest ecosystem services. Not all studies cover all values, so they include dummy variables for cultural services and for provisioning/regulating services, against the omitted category 'all' services. This can allow us to separate out the cultural aspects. However there are problems arising through the log-

[14] A Shannon index is a measure of diversity across a series of categories (like species).

linear form of the value equation. Applying the meta-analysis model to English forests gives approximately the following results per hectare per year:

- €640/ha year for all services;
- €45/ha year for cultural only; and
- €20/ha year for provisioning/regulating.

Considering the balance of €575/ha year to relate to non-use values would be naïve. The problem is that the meta-analysis function is a good statistical fit for explaining the variability in the results of valuation studies, but does not give additive results for the different services. The values per hectare are also highly sensitive to the area under consideration – the values in the list above have been calculated for all English woodlands, but if instead we consider a 100,000 ha forest, the function predicts over €2,000 per ha year for the service value.

This finding of declining marginal values results from a negative estimated coefficient on the log of forest area, and shows significant marginal decreasing utility with the provision of additional hectares. This is in keeping with previous meta-analyses of forest values (Lindhjem 2007) and ecosystem values (Ghermandi et al. (2007), Woodward and Wui (2003)). This is a difficult issue because on the one hand it is a real reflection of values (the more we have of something the less a bit more of it is worth) but on the other hand it can be an artefact of the scale of assessment – as the example presented here shows, since it would arguably be equally valid to consider woods and forests in England as a single entity of over 50,200 ha, but the total values given by the function would be radically different. It is also difficult to account for in the additive cost-benefit framework as it requires values to be functions of provision rather than constant values per hectare.

The values noted in **Table 4** and **Table 5** above are also relevant to the non-use category. If we take even a low value of 10 pence per household for a 1% increase in woodland area, and apply that over the full National Forest area (50,200, so a 1% increase is 502ha), this suggests a value of a little over 18p/ha.[15] More realistically, this value should apply primarily to "high" biodiversity areas that will be culturally preferred. The Willis (2003) estimates above of 35p-£1.13 per household per year for a 12,000ha increase in different types of forest could justify higher values, as could the figures from other studies cited, but on the other hand we need to avoid double-counting with recreational and aesthetic values.

Conclusion: with rather limited hard evidence, we value non-use values of biodiversity and cultural aspects of the Forest using the very simple assumption made in Eftec (2010). 'High' priority sites are assumed to be worth £300/ha/yr,

[15] NFC Data show 92,035 households within the Forest area in 2001, which averages out to 1.8 households per hectare.

and 'low' priority sites £30/ha/yr. Of course this is a major simplification and again is intended only to ensure that a value for biodiversity conservation is included in the study. The value estimates are based on studies of woodland biodiversity, but at this crude level is appropriate to apply to all the natural and semi-natural habitat types found in TNF. There is insufficient evidence to determine whether economic values vary significantly between these different habitat types.

The uncertainty in the value estimates is only half of the problem; we also have very limited knowledge of how exactly the different types in the forest typology relate to biodiversity conservation outcomes. For example, the actual value for conservation of habitats created in TNF is also influenced by their role in increasing connectivity between existing habitats. So while marginal increases in biodiversity would expect to show diminishing marginal economic values, if they increase habitat connectivity they could have increasing marginal impacts on biodiversity conservation. Overall it is important to include a value in this key category, but it is not a value that can be considered precise, and the true benefit in terms of biodiversity and cultural non-use values could be significantly greater.

Supporting Services

Supporting services, though very important, should not in general be accounted for separately in an economic analysis, since they are intermediate services that support other, final services. Where the objective is to highlight the importance of specific ecosystem services, individually, it can be entirely appropriate to value intermediate services, however where – as here – the objective is appraisal of net ecosystem service values in total, this must be avoided. We aim to value the final services, and if we also valued the intermediate services this would result in double-counting of benefits.

Regeneration

We have added another dimension to the typology used in the FC analysis, to reflect the 'regeneration' impacts of TNF. CLG's 3Rs Guidance[16] defines regeneration as being *"a holistic process of reversing economic, social and physical decay in areas where it has reached a stage when market forces alone will not suffice".*

The categories considered for analysing regeneration impacts in TNF are:

- Improvements to open space

[16] Assessing the impact of spatial interventions. Regeneration, renewal and regional development. 'The 3Rs guidance' 2004, Office of the Deputy Prime Minister, HMSO, London.

- Derelict Properties
- Outdoor facilities
- Landfill regenerated
- Quarry Closure

Results from recent work by eftec (in prep[17]) for CLG identified household values for improvements per ha of open space. This work was intended to investigate the feasibility of using stated preference techniques to value regeneration outcomes, and while the values it produced conformed with expectations and were rational, they are based on small samples. Different per household values per ha (from £0.05 to £1.8) were identified depending on how close to the beneficiary population the improvements would arise. Household numbers can be estimated for TNF by dividing its population (221,000) by average household size (2.4) giving an estimated 92,083 households. It is acceptable to apply the regeneration value to all these households because the majority of the new forest area in TNF is within 1km of urban areas.

TNF has brought regeneration benefits across a relatively wide area, and the area of the Forest is similar to the largest scale used in the study location used to generate these values. Therefore, for improvements within the area of TNF, the value of £0.05 per household per ha is most appropriate to apply.

TNF has had direct involvement with restoring only a very small number of derelict properties. The impacts related to outdoor facilities are captured (at least in part) in the analysis of recreational values, and so are not valued here to avoid double counting. Available data does not support valuation of impacts associated with landfill and quarry sites for this study. Nevertheless, regeneration is a key benefit of TNF, and is discussed in more detail in Section 2.7 of the report.

Conclusion: For a working assumption, we use the following values:

- Improvements to open space (£0.05/hh/ha)

As stated in the CLG study, another key dimension of regeneration activity is that "it has typically evolved into a series of discretionary funding programmes, operating in parallel to, though often seeking to influence and complement, the activities of 'mainstream' public service delivery". One example of such funding programmes is the Working Neighbourhoods Fund and its relationship with, for example, mainstream DWP delivery through Jobcentre plus. This example was provided to illustrate the implicit inclusion of employment benefits in regeneration schemes.

[17] For a project managed by Cambridge Economic Associates, examining a range of economic evidence on regeneration.

Annex 2: Forest Area Data

The data on the area of forest expansion between 1991 and 2100 is shown in the table below.

	total area	pre-existing woodland	total new forest	new woodland	**Total NEW**	**new open habitat**	total forest area	% forest cover
1991	50,200	3,109	0	0	-	0	3,109	6.2%
1992	50,200	3,109	348	244	348	104	3,457	6.9%
1993	50,200	3,109	696	487	696	209	3,805	7.6%
1994	50,200	3,109	1,044	731	1,044	313	4,153	8.3%
1995	50,200	3,109	1,392	975	1,392	418	4,501	9.0%
1996	50,200	3,109	1,740	1,218	1,740	522	4,849	9.7%
1997	50,200	3,109	2,089	1,462	2,089	627	5,198	10.4%
1998	50,200	3,109	2,437	1,706	2,437	731	5,546	11.0%
1999	50,200	3,109	2,785	1,949	2,785	835	5,894	11.7%
2000	50,200	3,109	3,133	2,193	3,133	940	6,242	12.4%
2001	50,200	3,109	3,481	2,437	3,481	1,044	6,590	13.1%
2002	50,200	3,109	3,829	2,680	3,829	1,149	6,938	13.8%
2003	50,200	3,109	4,177	2,924	4,177	1,253	7,286	14.5%
2004	50,200	3,109	4,470	3,129	4,470	1,341	7,579	15.1%
2005	50,200	3,109	4,763	3,334	4,763	1,429	7,872	15.7%
2006	50,200	3,109	5,056	3,540	5,056	1,517	8,165	16.3%
2007	50,200	3,109	5,350	3,745	5,350	1,605	8,459	16.8%
2008	50,200	3,109	5,643	3,950	5,643	1,693	8,752	17.4%
2009	50,200	3,109	5,936	4,155	5,936	1,781	9,045	18.0%
2010	50,200	3,109	6,229	4,360	6,229	1,869	9,338	18.6%
2011	50,200	3,109	6,480	4,536	6,480	1,944	9,589	19.1%
2012	50,200	3,109	6,731	4,712	6,731	2,019	9,840	19.6%
2013	50,200	3,109	6,982	4,887	6,982	2,095	10,091	20.1%
2014	50,200	3,109	7,233	5,063	7,233	2,170	10,342	20.6%
2015	50,200	3,109	7,484	5,239	7,484	2,245	10,593	21.1%
2016	50,200	3,109	7,735	5,415	7,735	2,321	10,844	21.6%
2017	50,200	3,109	7,986	5,590	7,986	2,396	11,095	22.1%
2018	50,200	3,109	8,237	5,766	8,237	2,471	11,346	22.6%
2019	50,200	3,109	8,488	5,942	8,488	2,546	11,597	23.1%
2020	50,200	3,109	8,739	6,117	8,739	2,622	11,848	23.6%
2021	50,200	3,109	8,990	6,293	8,990	2,697	12,099	24.1%
2022	50,200	3,109	9,241	6,469	9,241	2,772	12,350	24.6%
2023	50,200	3,109	9,492	6,644	9,492	2,848	12,601	25.1%
2024	50,200	3,109	9,743	6,820	9,743	2,923	12,852	25.6%
2025	50,200	3,109	9,994	6,996	9,994	2,998	13,103	26.1%
2026	50,200	3,109	10,245	7,172	10,245	3,074	13,354	26.6%
2027	50,200	3,109	10,496	7,347	10,496	3,149	13,605	27.1%
2028	50,200	3,109	10,747	7,523	10,747	3,224	13,856	27.6%
2029	50,200	3,109	10,998	7,699	10,998	3,299	14,107	28.1%
2030	50,200	3,109	11,249	7,874	11,249	3,375	14,358	28.6%
2031	50,200	3,109	11,500	8,050	11,500	3,450	14,609	29.1%
2032	50,200	3,109	11,751	8,226	11,751	3,525	14,860	29.6%
2033	50,200	3,109	12,002	8,401	12,002	3,601	15,111	30.1%
2034	50,200	3,109	12,253	8,577	12,253	3,676	15,362	30.6%
2035	50,200	3,109	12,504	8,753	12,504	3,751	15,613	31.1%
2036	50,200	3,109	12,755	8,929	12,755	3,827	15,864	31.6%
2037	50,200	3,109	13,006	9,104	13,006	3,902	16,115	32.1%
2038	50,200	3,109	13,257	9,280	13,257	3,977	16,366	32.6%
2039	50,200	3,109	13,508	9,456	13,508	4,052	16,617	33.1%
2040	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%

2041	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2042	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2043	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2044	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2045	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2046	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2047	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2048	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2049	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2050	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2051	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2052	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2053	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2054	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2055	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2056	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2057	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2058	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2059	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2060	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2061	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2062	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2063	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2064	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2065	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2066	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2067	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2068	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2069	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2070	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2071	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2072	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2073	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2074	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2075	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2076	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2077	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2078	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2079	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2080	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2081	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2082	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2083	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2084	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2085	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2086	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2087	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2088	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2089	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2090	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2091	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2092	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2093	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2094	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2095	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2096	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2097	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2098	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2099	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%
2100	50,200	3,109	13,759	9,631	13,759	4,128	16,868	33.6%

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