# Scoping Study on Valuing Ecosystem Services of Forests Across Great Britain

## Executive Summary

**for the Forestry Commission**

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# EXECUTIVE SUMMARY

## ES.1 Introduction

The forestry sector plays a key role in the management of the natural environment and the provision of ecosystem service values, for example through timber production, carbon sequestration, and recreation and tourism benefits. The objective of this study is to review the existing evidence base on the value of ecosystem services to address four specific aims:

i). Review estimated values for the economic, social and environmental benefits produced by Britain's forests from existing literature and categorise these values according to the ecosystem services framework;

ii). Identify gaps in the existing evidence base and recommend future research priorities to demonstrate the ecosystem service value of woodlands across the UK;

iii). Highlight key challenges and uncertainties that could arise in the valuation of ecosystem services and suggest how these could be addressed; and,

iv). Consider practical market opportunities for forest ecosystem services and their potential scale, using case studies, where possible.

The study covers both the public forest estate managed by the Forestry Commission and all private woodland across Great Britain.

## ES.2 Ecosystem services approach

The development of the 'ecosystem services approach' (ESA) (MEA 2003; 2005) has sought to establish and refine an overall framework in which the multiple contributions of ecosystems and the biological diversity contained within them can be consistently assessed for the purposes of environmental policy-making. In the UK, the landmark National Ecosystem Assessment (UK NEA, 2011) provides the first detailed analysis of the benefits that the natural environment provides to society. The increasing interest in the ecosystem services approach reflects the wider-scale recognition of multiple objectives, trade-offs and synergies that exist in realm of 'natural environment' policy.

The four main categories of ecosystem services are provisioning services, regulating services, cultural services and supporting services[1]. **Table ES.1** provides a summary of ecosystem services associated with woodlands and forests in Great Britain along with the principal final goods that are derived. This includes a mix of 'market goods' or 'non-market goods'. The former are formally traded in markets (e.g. timber), whereas non-markets goods are un-priced (e.g. recreation and amenity benefits). Final goods benefit human populations through either direct (e.g. burning of woodfuel) or indirect (e.g. carbon sequestration) use values, and/or non-use values, which arise due to altruistic motives, bequest motives, or for the sake of the resource itself (e.g. conservation of species). The summary highlights that the production of final goods is typically dependent on multiple ecosystem services. For example recreation benefits are attributed to provisioning and regulating services as well as cultural services. Similarly the ecosystem services that are listed are dependent on multiple supporting services, although these are not shown.

[1] See the main report (Section 2.2) for further detail on this classification of ecosystem services.

| **Table ES.1: Classification of final ecosystem services and goods** | |
|---|---|
| ***Final ecosystem service*** | ***Principal final goods*** |
| Production of trees, standing vegetation and peat [P] | Timber and wood fuel<br>Non-wood forest products (ornamental, craft/hobby resources) |
| Food – production of crops, plants, livestock, fish, etc. [P] | Non-wood forest products (wild food products), recreation (field sports) |
| Production of wild species diversity including microbes [P,R] | Genetic resources and bioprospecting<br>Recreation and tourism, landscape and aesthetic amenity, ecological knowledge<br>Non-use values |
| Regulation of climate [R] | Reduction of climate stress |
| Soil, air and water regulation [R]<br><br>(Clean soil, clean air, clean water from purification processes, breakdown and detoxification of waste and production of water quantity) | Potable water and industrial use of water<br>Pollution control, waste removal, waste degradation<br>Physical and mental health<br>Recreation |
| Regulation of hazards [R] | Avoidance of damage from natural hazards (e.g. flood protection, coastal protection, erosion protection) |
| Pest and disease regulation [R] | Avoidance of damage cost (e.g. to crop production) |
| Noise regulation [R] | Amenity value and avoidance of damage/mitigation costs |
| Pollination and seed dispersal, herbivory [P, C, S]<br><br>(Production of wild species diversity including microbes) | Agricultural and horticultural products<br>Recreation and tourism, landscape and aesthetic amenity, ecological knowledge<br>Non-use values |
| Generation and maintenance of meaningful places; socially valued landscapes and waterscapes [C] | Recreation and tourism, landscape and aesthetic amenity, physical and mental health, ecological knowledge<br>Non-use values |

Notes: P = Provisioning services; R = Regulating services; C = Cultural services

## ES.3 Valuing ecosystem services

Policy analysis tools such as Impact Assessments and cost-benefit analysis compare financial costs and benefits with environmental impacts; for example, comparing the costs of a habitat restoration programme to its benefits in terms of enhanced ecosystem service provision, to determine if it represents 'value for money'. Estimating the benefit of ecosystem service provision (or the costs of ecosystem damage) is the final part of a 'three step' qualitative – quantitative – monetary valuation assessment process that combines scientific and understanding and analysis of how the provision of ecosystem services changes, as a result of physical impacts on ecological functions, with economic valuation methods (Defra, 2010).

The scope for using information on the value of ecosystem services in relation to forestry policy is broad. Furthermore, this information can also be relevant to other public policy areas that forestry has close links to such as agriculture, flood risk management and health. Comprehensive and reliable valuation evidence enables:

(i) Better management decisions both at the level of the individual forest and across the nation as a whole. This concerns not only choices for maintaining or enhancing the provision of all

ecosystem services, but also the trade-offs that can be entailed in relation to the provision of individual ecosystem services (e.g. the types of recreation facilities that can be provided for visitors); and

(ii) Enhances the possibility of capturing more of the value of forest ecosystems, by helping to understand the key factors that influence the provision of services which are not traded at present. For example, new goods and services in terms of provisioning services and payments for ecosystem services (PES) for regulating and supporting services.

The main report (Section 3.2) documents the review of evidence. This categorises estimated values for the economic, social and environmental benefits of woodlands according to the ESA classification presented in Table ES.1, and identifies gaps in the existing evidence base to help develop recommendations for future research priorities. The review builds on previous studies including outputs from the UK NEA and research commissioned by the Forestry Commission. The latter includes studies examining health (CJC Consulting, 2005) and recreation (Christie et al., 2005) benefits, and a major assessment completed almost a decade ago entitled the 'Social and Environmental Benefits of Forests' (SEBF) (Willis et al., 2003). The SEBF comprised of a series of research studies that sought to estimate values for changes in the provision of recreation, landscape amenity, biodiversity, carbon sequestration, pollution absorption, water supply and quality, and protection of archaeological artefacts benefits by forests. The assessments were then used to estimate the aggregate value of benefits provided across Great Britain.

Key findings from the review of evidence include:

- **Timber and woodfuel:** the valuation of timber (softwood production) is straightforward using readily available market price and volume data from the Forestry Commission. In contrast hardwood price data are limited, but at present this represents only a small proportion of timber production in Great Britain. In the short term, timber prices can be subject to volatility but values averaged over time will smooth out these fluctuations and reflect longer term trends. Valuation of timber and wood fuel can be more complex in life cycle type assessments related to climate change impacts of materials, and requires that particular attention is paid to the materials/fuel sources that are displaced by its use so that the net climate change impact is established (e.g. whether burning of wood fuel replaces more carbon intensive heating fuels).

- **Non-wood forest products**: there is currently no coherent evidence base for the value of non-wood forest products that are harvested in Great Britain. This is because they are generally not traded (and hence no price data) and there has not been sufficient research about them. In some cases, prices associated with similar products sold in formal markets may provide a proxy value. However, market values for these products will reflect different opportunity costs (i.e. from non-wood forest products that are obtained from foraging). While this is a gap in the evidence base, at a national level the scale of provision of non-wood forest products is likely to be too small to warrant significant attention. At the local level, the benefits can be significant for certain user groups, particularly if commercially exploited by local businesses. Products that are not commercially exploited (i.e. for craft/hobby purposes) may be better associated with cultural services.

- **Genetic resources and bio-prospecting**: in common with the UK NEA, the review here finds that there is no valuation evidence concerning the provision of genetic resources from forests and woodlands in Great Britain. The significance of this gap in evidence is dependent upon future evidence needs. For example, if opportunities for bio-prospecting entail significant

trade-offs with the provision of other ecosystem services, this could create a greater need for value evidence.

- **Reduction of climate stress (climate regulation)**: UK Government guidance for valuing changes in greenhouse gas (GHG) emissions is comprehensively provided by DECC (2009; 2010) and overall there is a substantial evidence base with respect to carbon sequestration rates in woodlands (Read et al., 2009). Average sequestration rates across cycles of planting and rotation are generally taken as appropriate for national scale assessments across all woodlands and forests (as the differences are likely to even out at this scale). The key factor here is to differentiate woodland ecology (coniferous or broadleaved). Site specific assessments, however, would require more detailed analysis of local environmental factors that influence rates of sequestration and emissions. Thus, in some cases more evidence may be needed on different planting and management regimes. The evidence base is weaker for other GHGs, which depend on site-specific factors. For example recent research has shown that afforestation can lower the water table and contribute to reduced methane emissions (Morison et al., 2010).

- **Soil quality**: the review suggests that while the soil quality benefits of forests (e.g. water retention, plant productivity and waste remediation) are widely recognised across various studies in qualitative terms, quantitative assessments of the links between supporting and final ecosystem services, the scale of provision and beneficiaries, and the type of economic goods and benefits provided (e.g. potential human health benefits through stabilisation of contaminated land, avoidance of damage costs, etc.) are currently lacking.

- **Air quality**: also while well-identified and referenced in qualitative terms, value evidence is limited as to the air quality benefits provided by woodlands and forests. In particular, benefits in terms of reduced human health impacts are largely location-specific and dependent on the scale and proximity of the beneficiary population. This suggests that there is scope to understand better the importance of urban woodland and trees in improving air quality. Supporting analysis for the Defra Air Quality Strategy (IGCB, 2007) and the Clean Air for Europe programme (CAFE, 2005) utilise the 'impact pathway approach', linking changes in pollutant emissions and concentrations to human wellbeing impacts, via dose-response functions, however this evidence has not been linked to the air quality regulation benefits of forests.

- **Water regulation:** available evidence suggests that forestry impacts on water supply and quality can be very uncertain and highly site and catchment specific. The scale of effects can be influenced by management practices and changes in woodland cover as well as practices in other sectors, such agriculture. Overall there is not a strong base of evidence, particularly given limited quantification of the link between forests and water provision (e.g. in terms of avoided treatment costs). Nevertheless, a number of practical initiatives are being implemented and will, over time, improve understanding of such effects (e.g. the Sustainable Catchment Management Programme (SCAMP) in North West England).

- **Flood protection**: as with water regulation, flood protection is highly location dependent and assessments need to be site or catchment specific to determine the impacts of particular woodland management options on downstream flood risks. A handful of practical assessments are available, based on projects that have been recently implemented (e.g. the 'Slowing the Flow' project, North Yorkshire), and guidance provided by the Environment Agency (2010) for appraising flood risk management schemes provides the basis for valuing flood protection

benefits, implying that there is scope to develop supporting assessments of the role of woodlands in reducing flood risks.

- **Recreation**: recreation values represent the most researched non-market benefit of forests and woodlands. The evidence base provides values both for informal and specific recreation activities, which is generally consistent and considered to be robust.

- **Landscape and aesthetic amenity:** a number of studies have examined non-market benefits associated with landscape and aesthetic amenity of forests and woodlands. However, in general, this evidence is more dated than that for recreation. Some broad conclusions can be drawn from this evidence; for example a general preference for 'natural' looking landscapes. However caution is required in relation to the transferability of this evidence, which in some cases is based on specific woodland management options that may not be reflective of practice across the sector.

- **Physical and mental health**: human health and wellbeing benefits associated with the natural environment are widely recognised in qualitative terms. There is also a significant body of value evidence for physical health end points (e.g. due to air pollution). The impact-pathways to link these end points to forests are lacking. Evidence for wider health benefits, e.g. mental health, is more qualitative at present.

- **Education and ecological knowledge**: this benefit is increasingly recognised but at present empirical evidence is lacking.

### ES.4 Mechanisms to capture the value of ecosystem services

There are a variety of mechanisms through which ecosystem service values can be captured. These include formal markets which exist for the products of the provisioning services, although these are not the focus of the discussion here. Traditionally, other mechanisms have involved regulating to reduce environmental damage or subsidising land/forest owners through state budget to incentivise the maintenance of land for ecosystem services (e.g. Woodland Grant Scheme). Increasingly more attention is being paid to a wider range of mechanisms to incentivise private markets and voluntary business and public initiatives. **Table ES.2** provides a categorisation of such mechanisms with illustrative examples. The main report (Section 3.3) provides a more detailed summary each type.

**Table ES.2: Mechanisms for capturing ecosystem service values**

| *Mechanism* | *Description* | *Illustrative example* |
|---|---|---|
| Payments for ecosystem services (PES) | The provider (often a landowner) of a service is paid to maintain or enhance that service. | Agri-environment including forestry payments such as the English Woodland Grant Scheme (WGS) |
| Competitive ecosystem service contracts | Private sector providers compete to offer ecosystem service supply contracts. | Australian 'BushTender' contracts |
| Green infrastructure investments | Concept based around planning over large areas, usually urban, and based on building interconnected ecosystem services to maximise social benefit. | Plymouth Green Infrastructure – Saltram Masterplan |
| Carbon finance | Selling the carbon sequestered in the wood and soil into carbon markets. | Voluntary carbon footprint reductions (e.g. Woodland Carbon Code) |
| Biodiversity offsetting/habitat banking | Protecting or developing new forest in exchange for development losses elsewhere | In the UK to date this has been largely restricted to coastal rather than woodland habitats |
| Access payments | Charging visitors to access a forest<br><br>Extracting animal products | There are a broad range of possibilities; e.g. forest concerts, Go Ape, etc.<br><br>Woodland game shooting |

An indication of potential opportunities for capturing ecosystem service values from UK woodlands is provided in the following:

- **Carbon finance:** currently the main forest carbon finance initiatives (REDD and REDD+[2]) are restricted to developing countries. Within the EU Emissions Trading Scheme there is currently no provision for trading in carbon from soil or plant sequestration. The only available mechanism to UK forestry at present is through voluntary (carbon) schemes. There are existing markets through which businesses and households with no obligation to reduce carbon footprints can voluntarily do so. The Forestry Commission has launched a Woodland Carbon Code to provide quality assurance for woodland creation projects in the UK seeking to demonstrate carbon sequestration benefits[3].

- **Payments for access and facilities:** while open access to woodlands and forests in Great Britain is not normally subject to an access fee, charging for more complex or group activities is commonplace. Examples include concerts, visitor attractions (e.g. Go Ape) and parking charges at sites with visitor facilities.

- **Payments for ecosystem services (beyond carbon):** Payments for ecosystem services could potentially provide significant scope for the expansion of funding for forestry, although possibilities for practical application will be dependent on the development of a regulatory framework. The Natural Environment White Paper (HM Government, 2011) signals that in

[2] Reducing Emissions from Deforestation and Forest Degradation (REDD) programme. REDD+ includes provision for the protection of biodiversity as well.
[3] See: http://www.forestry.gov.uk/carboncode

England pilot schemes will be tested to assess both technical challenges and the formation of a regulatory framework and commits to a new research fund targeted at these schemes and to publish a best practice guide for their design.

While to date PES has been mostly provided through public budgets, other options are possible in future. The Natural Environment White Paper commits to producing an Action Plan in 2012 "to expand schemes in which the provider of nature's services is paid by the beneficiaries, after undertaking a full assessment of the challenges and barriers". With better links between specific services and payments, expanding and improving the Woodland Grant Scheme could be a good example of PES (Rowcroft et al., 2011).

- **Competitive ecosystem service contracts:** there is limited practical experience of competitive ecosystem service contracts in the UK. These are an auction based approach where land owners are then asked to bid for contracts to deliver ecosystem services. The aim is to switch from 'input' to 'output' orientated measures of ecosystem service provision by relying upon the local land owners knowledge. Contracts are typically awarded to land owners who offer the most cost-effective outcome (e.g. the largest gain in some agreed measure of ecosystem service provision per unit cost).

- **Biodiversity offsets / habitat banking:** Because of the typically long gestation period, forest offsets are likely to be amongst the more expensive offsets. However they also provide opportunities where high quality forest offsets could be used to compensate for losses of lower quality habitats. There are still uncertainties about the way in which offsetting will be implemented in the UK. It is also likely that simpler and quicker restoration projects such as grassland or wetlands may dominate the market, at least initially. However there is certainly scope for woodland to be involved in biodiversity offsetting markets.

### ES.5 Recommendations for future ecosystem service research priorities

The main report (Section 4.4) concludes by setting out suggestions for future research priorities to expand the value evidence base. These are summarised in the following.

Recommendation 1: *the forestry sector should **use the ecosystem services approach** – at both national policy and local woodland management levels – to assess the range of ecosystem service values forests and woodlands provide.*

The continuing development of a more common language and understanding of concepts related to the natural environment by scientists, economists and other social scientists is encouraging. The recent emphasis on the ESA in policy development across Great Britain suggests that it will be viewed as a useful and influential tool for the foreseeable future. It represents a framework within which multi-disciplinary research can be undertaken and establishes the range of ecosystem impacts that need to be accounted for in decision-making, alongside more traditional economic and employment impacts of forestry. It also helps to reveal the key gaps and uncertainties in understanding and valuing the provision of ecosystem services.

Recommendation 2: *future ecosystem services research conducted by the forestry sector should incorporate a coordinated **multi-disciplinary assessment of ecosystem service values**.*

Following Recommendation 1, development of an evidence base of ecosystem service values requires multi-disciplinary research input from ecologists and other natural science disciplines, forest management experts, and economists as part of the 'three step' qualitative – quantitative

– monetary valuation assessment process. Future research should combine these areas of expertise and avoid studies that are solely focussed on 'scientific' or 'economic' evidence.

Recommendation 3: *the forestry sector should engage and **coordinate future ecosystem services research with other environmental and public policy areas** to enable a comprehensive understanding of the benefits associated with ecosystem service provision.*

A more strategic view of economic valuation evidence needs that matches the requirements of several sectors is required. For example, the potential for value capture mechanisms should be jointly assessed across forestry, agriculture, flood risk management, planning, and other policy areas as relevant. This is a fundamental requirement for improving the evidence base pertaining to regulating services. It is also recognised that forestry can contribute to other public policy areas, such as health and wellbeing, and opportunities for 'feeding in' evidence to wider objectives should also be considered.

Recommendation 4: *the forestry sector should **develop an ecosystem services research strategy** that establishes the key calls on the evidence base in the future. Forestry Commission GB should provide the lead on the strategy.*

Within the forestry sector, any future research strategy needs to take account of priorities across England, Scotland and Wales that may be different. The first step would be to assess the key policy issues (particularly in terms of the types of land use management and/or land use change decisions) to be faced, at both national policy and local management levels. While individual research needs can be commissioned separately, a strategic approach should ensure that consistency is maintained across the sector.

Recommendation 5: ***a phased research programme** of coordinated research including both public and private sector organisations should be considered.*

Taking Recommendations 1-4, a phased approach to future research will ensure that a consistent evidence base is developed. Given that economic analysis can only build on the scientific evidence, priority for new research may initially be focussed on scientific understanding. For updating existing evidence where the science is well understood, economic research should be prioritised.

In terms of individual services, there is already have a significant amount of evidence on provisioning services and hence these are unlikely to a priority for future research. For regulating services however, beyond carbon sequestration benefits, there is a strong need for further evidence, both in terms of science and economics. Final ecosystem services of particular interest include regulation of non-carbon GHGs, air quality, water regulation and flood protection, both in terms of understanding and estimating values, and the potential for implementing value capture mechanisms. The most obvious evidence needs with respect to cultural services relate to non-recreation benefits. Across landscape and aesthetic amenity, physical and mental health, and ecological knowledge there is need to update evidence that is dated (e.g. landscape) or generate value evidence for benefits currently presented in typically qualitative and anecdotal terms (e.g. health and wellbeing benefits).

Recommendation 6: *the forestry sector should **conduct research on the benefits of urban trees** to demonstrate the range of public policy objectives forestry policy can contribute to.*

The case of urban trees provides a microcosm of the wide range of forestry policy objectives in terms of contributing to wellbeing and health, climate change adaptation, biodiversity and conservation. At present, evidence concerning the ecosystem service values of urban trees in Great Britain is limited. Further research is needed and can be coordinated with other regulatory stakeholders such as the Local Authorities.

Recommendation 7: *the forestry sector should **identify policy and research opportunities to contribute to improved valuation of biodiversity**.*

Studies such as the UK NEA have highlighted the challenges faced in estimating economic values associated with conservation of biodiversity and understanding the value of stocks of ecological assets in light of issues as thresholds and ecosystem resilience. The forestry sector should actively engage with research opportunities that arise (e.g. research councils, EU and national policy development) to ensure that woodland and forest biodiversity is appropriately examined.

Recommendation 8: *valuation of ecosystem service provision in the forestry sector should **consider the appropriateness of all valuation methods**.*

In designing research studies to address evidence needs on the value ecosystem services, a thorough assessment of the appropriateness of different valuation methods is required. In general the choice of method depends on the decision-making context, ecosystem service(s) of interest, nature of the affected population(s), availability data, and time and resources available. Valuation methods using market price data, production function approaches (e.g. for regulating services) and revealed and stated preference methods should all be considered, along with the potential for integrating geographical information systems (GIS) to better account for the spatial and context specific nature of economic values.

Recommendation 9: *the forestry sector should **commission research on implementing value capture mechanisms** that provide the greatest opportunity for engaging the private sector within multi-purpose woodland provision.*

This report highlights a number of approaches towards improving the engagement of the private sector within the provision of ecosystem services. Some of these mechanisms are already in use within other sectors (notably agriculture) and the scope for extending these to the private provision of multi-purpose forestry (including open-access woodland) requires further attention. This could provide a more detailed assessment of the practical application of mechanisms; for example assessing the specific factors that determine the provision of ecosystem services from forests and woodlands. The aim would be to identify the options that are best suited to the circumstances of the forestry sector.

# REFERENCES

CAFE (2005), *Cost-Benefit Analysis of Policy Option Scenarios for the Clean Air for Europe (CAFE) programme*, Report by AEA Technology Environment for European Commission DG Environment.

Christie, M., Hanley, N., Garrod, B., Hyde, T., Lyons, N., Bergman, A., and S. Hynes (2005), *Valuing Forest Recreation Activities*: Final Phase 2 report, Report to the Forestry Commission.

CJC Consulting (2005), *Review of Evidence for the Formulation of Forestry Policy in England*. Report to Defra.

DECC (2010), *Updated short term traded carbon values for UK public policy appraisal*.

DECC (2009), *Carbon Valuation in UK Policy Appraisal: A Revised Approach*.

Defra (2010), *Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal*, Prepared by eftec for Department for Environment, Food and Rural Affairs.

HM Government (2011), *The Natural Choice: securing the value of nature, Presented to Parliament by the Secretary of State for Environment*, Food and Rural Affairs by Command of Her Majesty, June.

IGCB (2007), An Economic Analysis to inform the Air Quality Strategy Updated Third Report of the Interdepartmental Group on Costs and Benefits, Defra London.

Millennium Ecosystem Assessment (MEA) (2003), *Ecosystems and human well-being: Synthesis*. Island Press, Washington, D.C., USA.

Millennium Ecosystem Assessment (MEA) (2005), *Ecosystems and human well-being: a framework for assessment*. Island Press, Washington, D.C., USA.

Morison, J., Vanguelova, E., Broadmeadow, S., Perks, M., Yamulki, S. and Randle, T. (2010), Understanding the GHG implications of forestry on peat soils in Scotland. *Forest Research*.

Read, D.J., Freer-Smith, P.H., Morison, J.I.L., Hanley, N., West, C.C. and Snowdon, P. (eds) (2009), *An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change*. The Stationery Office, Edinburgh.

Rowcroft, P., Smith, S., Clarke, E., Thomson, K., Reed, M. (2011) Barriers and Opportunities to the Use of Payments for Ecosystem Services, Draft final report to Defra, June 2011.

UK NEA (2011), *The UK National Ecosystem Assessment: Synthesis of the Key Findings*, UNEP-WCMC, Cambridge.

Willis, K., Garrod, G., Scarpa, R., Powe, N., Lovett, A., Bateman, I.J., Hanley, N., Macmillan, D.C. (2003), *The social and environmental benefits of forests in Great Britain*. Forestry Commission.