Woodland cover target

Detailed Evidence report

Date: 28 April 2022

We are the Department for Environment, Food and Rural Affairs. We're responsible for improving and protecting the environment, growing the green economy, sustaining thriving rural communities and supporting our world-class food, farming and fishing industries.

We work closely with our 33 agencies and arm's length bodies on our ambition to make our air purer, our water cleaner, our land greener and our food more sustainable. Our mission is to restore and enhance the environment for the next generation, and to leave the environment in a better state than we found it.

Contents

Statement of Interests

Statement of transparency for statistical robustness

Woodland is defined by the National Forest Inventory (NFI) as a group of trees of at least 0.5 hectares in area with a minimum of 20% canopy cover and 20 m width and that have the potential to reach a height of at least 5m (1). Woodland cover has been and will continue to be published annually by Forest Research (FR) as an official statistic (2) which is reviewed by the NFI team statistician and Forest Research (FR)/Forestry Commission (FC) Head of Profession for statisticians (3).

Tree cover outside of woodland will be reported in a National Forest Inventory report, consistent with *Tree Cover Outside Woodland in Great Britain* published by Forest Research (FR) in 2017(4). Future reports will be commissioned at least every five years with a new 2022 baseline established for the proposed statutory target. The dataset (Blueskies (5)) used as the basis of the 2017 NFI report on Tree cover outside woodland in Great Britain under-reported canopy cover in urban areas. Extensive analysis of aerial photography and subsequent ground-truthing was undertaken to derive statistical correction factors that were applied to the data set. A methodology is currently being developed to report natural colonisation through remote sensing which will be incorporated into the new (2022) baseline.

Changing status of evidence

An update to the Tree Cover Outside Woodland in Great Britain is expected in 2022; the analysis could result in a change in the baseline figure for tree canopy cover of trees outside woodland, but the impact is considered likely to be small. A provisional update for woodland cover, as of 31 March 2022, will be published in June 2022 with final figures to be published in September 2022. Again, there may be a small but non-substantial impact on the baseline.

Introduction

Woodland creation in England has averaged 2,000 hectares per year over the past decade (6); however, this government has made ambitious commitments on tree planting, including as part of the Net Zero Strategy (7). The Environment Act (8) provides government with the power to set a long-term statutory target for woodland creation to generate the associated carbon savings and helping us to deliver net zero by 2050. A Tree canopy and Woodland cover target would also help to deliver the environmental goals set out in the England Trees Action Plan (9), the 25 Year Environment Plan (10) and some of the other proposed Environment Act statutory targets.

Woodlands provide many benefits as set out in the Office for National Statistics (ONS) Woodland Natural Capital Accounts (11) which estimated that, in 2017, the asset value of woodlands in the UK was £130 billion. England's woodlands account for 51% of this (£66.3 billion). The Natural Capital Accounts recognised the range of ecosystem services provided by woodlands including carbon sequestration (UK woodland removed an equivalent of 4% of total greenhouse gas emissions in 2019), biodiversity, water and air quality improvements.

Woodlands also play an important role in removing carbon dioxide from the atmosphere (12). The Net Zero Strategy highlights afforestation's role in generating negative emissions, with the illustrative pathway assuming UK planting rates rise to 30,000 ha/yr by 2025, 40,000 ha/yr by 2030 and 50,000 ha/yr by 2035 and are maintained through to 2050 (13).

Native and mixed woodland will provide wildlife-rich habitat to enhance biodiversity (14; 15). New woodland habitat will also increase the connectivity and size of the woodland resource, enhancing its resilience to climate change (16; 17; 18; 19).

There is strong evidence supporting the role of woodlands in reducing flood flows and improving water quality (20). The proposed tree and woodland target promotes well-placed woodlands as a way of regulating water flow to reduce flood peaks and improve water quality by cooling water with their shade and reducing the level of pollutants draining into watercourses. New habitat for wildlife and migratory corridors for woodland species will also be created.

Air quality benefits can also be generated by tree planting in urban areas as recognised by the ONS (21). The right tree in the right place can lead to highly localised improvements in urban air quality by removing particulate matter.

Context – current woodland cover and planting rates

Woodland cover in England is currently (as of March 2021) 1.32 million hectares or 10.1% of land area (22); this rises to 14.5% if tree cover of small woods (less than 0.5 ha in area), groups of trees, linear features and individual trees is also included (23). Woodland cover has doubled over the past century but is still much lower than in Wales (15%), Scotland (19%) or the EU-27 average of 40% (24). The rate of woodland expansion since 1924 is estimated at 6,700 ha/yr (25). Robust annual planting statistics are available from 1971, with 6,500 ha the highest rate achieved (in 1971) and an average of more than 5,000 ha/yr maintained between 1993 and 2006. Planting rates have declined since 2005, with an average of 1,720 ha planted in England over the past 5 years (see figure 1), of which 91% was broadleaf woodland (26).

Figure 1: Annual area of woodland planting in England (source: Forestry Statistics) (27)
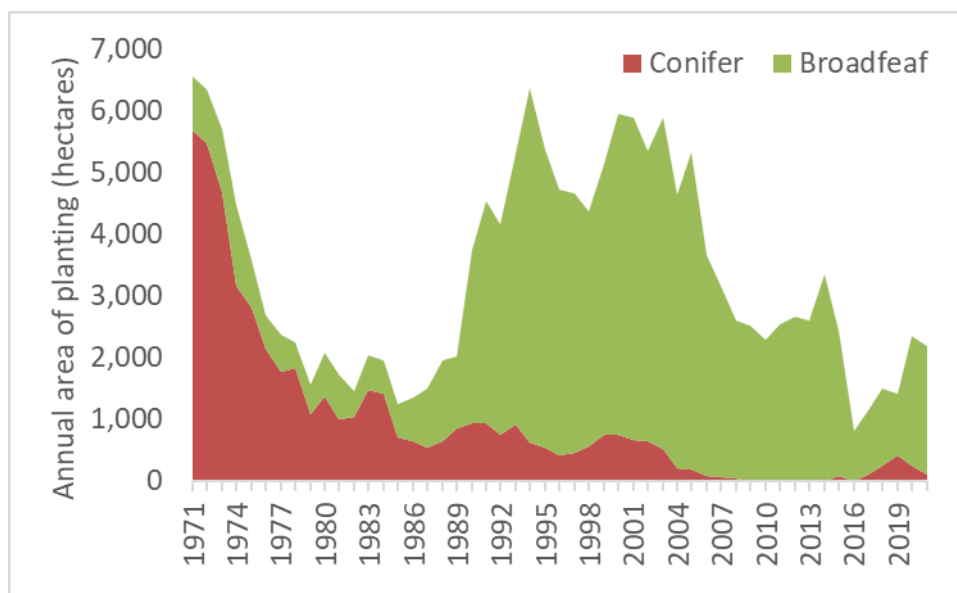
Tree canopy cover outside woodland in England amounted to 565,000 ha in 2017 and comprised 295,000 ha, 193,000 ha and 78,000 ha in small woods, groups of trees and individual trees, respectively (28).

Proposed target

We are proposing a statutory tree and woodland target that would increase England's tree cover from 14.5% to 17.5%. The proposed metric includes woodland cover as defined by the NFI (and published annually in Forestry Statistics), small woods of less than 0.5 hectares (ha), groups of trees and individual trees (including urban); permanent loss of existing woodland and new woodland established through natural

colonisation are also included. The proposed level of ambition would help Government meet its environmental goals by bringing about a marked increase in the level of carbon sequestered and by generating a wealth of co-benefits. The proposed increase in tree cover would help to realise Government's existing woodland targets, including:

- The England Trees Action Plan (ETAP) aims to treble woodland creation by the end of this Parliament as England's contribution to increasing planting UK rates to 30,000 ha/yr by the end of this Parliament (29).
- The 25 Year Environment Plan aspired to increase woodland cover of England to 12% (from 10%) of land area by 2060 (30).
- The Net Zero Strategy's illustrative pathway assumed that annual planting across the UK would rise to 50,000 hectares by 2035 and be maintained at that level to 2050 (31).
- Land use, land use change and forestry (LULUCF) greenhouse gas inventory projections provide a set of illustrative scenarios for afforestation (32).

Independent expert group

The Environment Act requires that independent experts are engaged throughout the development of the target. Details on their duty and membership are set out below.

Duty

The Tree and Woodland Scientific Advisory Group (TAW-SAG) (33) provides expert scientific input, challenge and assurance to Defra on the use of evidence and analysis to support woodland creation and improve woodland management. Its terms of reference are to provide balanced scientific advice to the England Tree Planting Programme, ensuring that Defra receives input from a wide range of scientific experts and disciplines.

Membership

The remit of the chair was agreed after appointment. The chair led on finalising the membership of the TAW-SAG using the existing long-list of potential TAW-SAG members constituting candidates proposed by the Nature for Climate Fund Tree Programme Board and additional candidates were identified as required.

Departmental rules dictated that a diverse range of members within the scope of the programme was considered during the appointments process. The members represent a balance of expertise in the natural and social sciences, economics, and other relevant disciplines. Members were appointed based on their specific skills and experience and act independently of any of their own interests.

TAW-SAG includes a number of 'Observers' who are also affiliated with Defra arm's length bodies. To preserve the independence of advice relating to statutory targets, the observers of the group are required to abstain from any discussion of, or advice provided, on the proposed statutory targets.

Methodology

The proposed target's scope and ambition are consistent with the requirements of the Environment Act (34). Literature, workshops and stakeholder meetings have been used to establish objectively measurable definitions, identify potential options and to gather data on the benefits, risks and uncertainties. As required by the Environment Act, the scientific community has been consulted throughout the process through the Tree and Woodland Scientific Advisory Group (TAW-SAG) (35).

Defra analysis has considered existing targets/aspirations and the level of planting proposed by the CCC to contribute to meeting future carbon budgets. The analysis also assumed a level of woodland loss to open habitat restoration and development together with plant health-related mortality of trees outside woodland. The different scenarios were then assessed against land use and availability, projected carbon sequestration, the capacity of the forestry sector, historical rates of planting, the behavioural change required and their affordability, to establish the preferred option.

Establishing the proposed metric and scope

The following sources of information were considered in establishing the metric:

- The National Forest Inventory (NFI) defines woodland as a group of trees of at least 0.5 hectares in area with a minimum of 20% canopy cover, 20 m width and having the potential to reach a height of at least 5 m (36). Other options were considered, including the definition used for 'forestland' in the UK's greenhouse gas inventory (0.1 ha minimum area). The rationale for basing the metric on the NFI definition is that the NFI is an existing, statistically robust, monitoring programme. Woodland area and new woodland planted are reported annually in Forestry Statistics, with the latter differentiated into broadleaf and conifer woodland. Total woodland area in the comprehensive 2011 Woodland Area report was disaggregated into 12 categories (37).
- Permanent woodland lost to development and open habitat restoration is published annually in the Forestry Commission Key Performance Indicator report (38) and included in annual updates to woodland area reported in Forestry Statistics. However, there is a lag in the analysis and reporting of woodland loss statistics with the most recent published data being for 2017/2018. The baseline (2022) level of woodland loss was assumed to an

average of that reported for the five-year period, 2012/13 to 2016/17, the most recent data available at the time of analysis. Woodland loss is categorised as either for development (baseline of 368 ha assumed in 2022) or for open habitat restoration (baseline of 509 ha assumed in 2022).

- Categories of tree canopy cover outside woodland were defined and reported in 2017 (39).

Stakeholder engagement

Potential options for the metric were discussed at an Applicants' Focus Group (AFG) (40) stakeholder meeting in November 2020. Options considered included total area of woodland/tree cover in England (ha), area of woodland/number of trees planted and tree canopy cover including woodlands and trees outside woodlands. There was a clear preference at the workshop for a tree canopy and woodland cover metric as this better represents the goods and services provided by trees set out in the 25 Year Environment Plan, than a metric restricted to woodland cover.

Discussions with FR's NFI statistician indicated that an aggregate metric of the National Forest Inventory (NFI) Woodland cover and NFI-reported Trees Outside Woodland (NFITOW) was statistically robust and could be assessed in a time efficient and affordable way.

A wide scope for the metric was proposed by TAW-SAG, including agroforestry systems (41; 42) shelterbelts, wood pasture and scrub woodland where the NFI definition of woodland is met. Silvo-pastoral systems can provide benefits from timber, pasture/livestock production, climate regulation and carbon sequestration, landscape, and biodiversity, soil improvement and flood regulation (43; 44). Silvo-arable systems support biodiversity, sequester carbon, reduce nitrate runoff, improve soil structure and are a source of timber (45; 46). Shelterbelts can reduce pests/diseases on crops, improve soil structure, growing conditions and animal welfare, regulate water and support biodiversity (47). Although orchards fall outside the scope of the UK Forestry Standard (48) and the NFI definition of woodland, TAW-SAG advised that they should be included in the basis of their ecosystem services, including fruit production, climate regulation, water regulation, pest and disease control, and pollination (49).

Establishing the level of ambition

Options for setting the level of ambition considered existing targets/aspirations and the level of planting proposed by the CCC to contribute to meeting future carbon budgets. For each planting scenario, the resultant net change in woodland area was calculated by subtracting assumed woodland loss as set out below; the development-related loss was assumed to remain constant throughout the period of analysis. Two different rates

of open habitat restoration were applied to different planting scenarios to calculate overall impact on woodland cover.

- For the lower ambition planting scenarios, the 2022 baseline was assumed to decline linearly to zero in 2042, reflecting successful implementation of the open habitat policy (50).
- For the more ambitious planting scenarios, including that associated with the proposed level of ambition, a higher initial rate of loss was assumed (twice the 2022 baseline), reflecting the higher rate of planting resulting in a lower open habitat policy decision threshold being set, again declining to zero in 2042 (51).

Loss of tree canopy cover outside woodland assumed that all ash trees outside woodland (12% of small woods or 10% of individual trees in 1998 (52)) are likely to be subject to Chalara dieback and felled between now and 2050. This level of loss is unlikely to be realised but is included in the analysis to represent mortality/removal of all trees outside woodland. For all scenarios, the target assumes net gain in canopy cover of trees outside woodland, with those lost to natural mortality, development or tree-health related issues assumed to be replaced by policy interventions such as the Urban Tree Challenge Fund (53) and Local Authority Treescapes Fund (54).

A planting trajectory to 2025 was established based on existing commitments set out in the England Trees Action Plan (ETAP). A range of target options for planting trajectories beyond 2025 were then developed following review of existing and previous policies and policy recommendations:

- The 25 Year Environment Plan aspiration to increase woodland cover from 10% to 12% by 2060.
- The England Trees Action Plan vision to bring the 25 Year Environment Plan forward to 2050.
- The Climate Change Committee's (CCC) net zero proposals including the 'Balanced Net-Zero Pathway', 'High Ambition Net-Zero Pathway' and the 'Wide-Spread Innovation Pathway' (55).
- UK Land Use and Land Use Change and Forestry Green House Gas (LULUCF) greenhouse gas inventory projections (56).
- The Independent Panel on Forestry's 2012 Final Report recommended that Government sustainably increased England's woodland cover from 10% to 15% by 2060 (57).
- Government's illustrative pathway for woodland creation in the Net Zero Strategy.

The area of orchards was assumed to remain constant at that reported in the Farm Business Survey (58), based on the lack of a noteworthy trend over the past decade.

Agroforestry silvo-pasture and silvo-arable planting trajectories (where applicable) were based on the CCC's suggested planting rates in its indicative Net Zero Strategy.

Analysis – setting the target

The ability to achieve each of the planting scenarios was assessed against a range of criteria, including historic woodland expansion statistics, ability to scale up sector capacity, land availability and current policy drivers for woodland expansion, particularly carbon sequestration to help meet carbon budgets and net zero.

Historic woodland planting

Historic planting statistics indicate that expansion rates of more than 5,000 ha/yr have been maintained over the long term (1924-2020) and, in the short term, in the recent past (1995-2005). In both cases, timber supply (1920-1985) and biodiversity/farm woodland planting (1985-2005) were the main drivers of woodland expansion. There is now a greater range of drivers and financial incentives for woodland creation, including carbon credits, flood resilience, water quality improvement and human health and well-being, providing the rationale for Government and landowners to plant a wider range of woodlands on different land types and for more diverse management objectives.

Land availability

The low-risk map for woodland creation (59) identifies 3.2 million hectares of low sensitivity land available for potential woodland creation. Although land included in the Low-Risk map may not receive consent for planting under the Environmental Impact Assessment Regulations as a result of the presence of local sensitivities, it is considered relatively conservative in excluding moderate/good agricultural land (ALC3a) and all designated landscapes (National Parks and Areas of Outstanding Natural Beauty). If behavioral barriers, as set out below are addressed, the analysis concluded that there was sufficient land available to meet the majority of the planting scenarios.

Contribution to Carbon Budgets and Net Zero

Projections of carbon sequestration were compiled using Forestry Research's CSORT model (60). Three indicative woodland types are represented in the model: productive conifer, productive broadleaf, and native woodland managed for biodiversity.

Carbon sequestration modelling is based on conventional forestry growth and yield models which apply an s-shaped growth function with slower growth during the establishment phase (the period after planting), accelerating after canopy closure and then slowing again as the trees begin to reach maturity. Operational emissions associated with establishment are included in model outputs, resulting in net emissions in the years immediately after planting.

As agroforestry has not been commonly practised in the UK, to date, there is uncertainty in how agroforestry systems will be implemented and planted; in particular, spacing, stocking densities and the timing of thinning interventions. Agroforestry carbon emissions/removals have therefore been estimated using the same modelling approach applied to conventional woodland but adjusted to reflect the lower stocking density. Spacing of 7.4 m (470 stems per hectare) that is common silvo-pastural systems, with conventional forestry models constrained using poplar growth and yield models (61).

Carbon sequestration associated with trees outside woodland was estimated using individual tree growth models based on data from I-Tree eco surveys (62).

Annual carbon sequestration rates for an illustrative scenario of 10,000 hectares of either conventional woodland or agroforestry and 1 million trees outside woodland, planted in 2023, are given in Table 1. Annual sequestration is relatively modest over the first 15 years after planting before increasing to a maximum rate over the period 2043-47 during the trees' fastest growth phase and then decline. The table also highlights the lower sequestration potential of agroforestry compared with conventional woodland, although this will be dependent on species, stocking density and silvicultural practice. Sequestration from 1 million trees outside of woodland is also lower than that for conventional woodland or agroforestry.

Table 1: Average annual sequestration rate (MtCO$_2$e) from 10,000 hectares of rural woodland and agroforestry and 1 million trees outside woodland planted in 2023; carbon sequestration rates for trees outside of woodland are based on estimates used for urban trees in Defra's Urban Tree Challenge Fund (UTCF) modelling.

Carbon budget period	Average annual sequestration (MtCO$_2$e)		
	Conventional woodland	Agroforestry	Trees Outside Woodland
CB4 (2023-27)	0.005	0.001	0.000
CB5 (2028-32)	0.034	0.003	0.001
CB6 (2033-37)	0.094	0.009	0.013
CB7 (2038-42)	0.138	0.027	0.018
CB8 (2043-47)	0.180	0.043	0.024
CB9 (2048-52)	0.160	0.033	0.030

Behavioural change

Behavioural evidence on attitudes to tree planting on agricultural land is set out in a recent Natural England research report (63); some of the key conclusions include:

- There is some evidence that farmers with previous experience of woodland creation, environmental schemes or other forms of diversification are more likely to consider tree planting.
- While the uptake of agroforestry systems is increasing, there are remaining barriers including a lack of financial or technical resources, a lack of woodland management knowledge and skills, as well as a perception that agroforestry is not profitable compared with existing farm practices.
- Larger farms are more likely to increase tree cover and marginal land is often preferred for tree planting.
- Economic factors influence decisions, such as planting costs, financial benefits (e.g. those realised through timber production or carbon credits), the loss of agricultural subsidies and lost revenues from reduced agriculture production.
- Tenanted farms are less likely to engage in woodland planting due to the short-term nature (3-7 years) of most farm tenancies. With 30-40% of farms managed by tenants, this is a potentially large barrier to woodland creation.
- A substantial proportion of farmers and landowners are motivated by issues beyond financial incentives, such as concerns over loss of control, regulation, and bureaucracy associated with grant applications.
- Grants only appeal to a proportion of farmers. They are most successful when they align with existing practices and farmer values.
- The long-term nature and permanence of tree planting is a clear barrier to woodland expansion, with a perceived loss of control over land use, and uncertainty about the possibility to revert to alternative land uses.
- Some farmers view forestry as unprofitable, even when it is more profitable than their current farming business.

This suggests that there are several noteworthy cultural and economic barriers to tree planting, which need to be overcome to incentivise land managers to plant trees and reach the proposed ambitious woodland cover target.

An increase in woodland creation could partly be driven through environmental land management schemes supported by expanded green finance models, including carbon finance through the Woodland Carbon Code (65). Given the unprecedented scale of annual planting required, additional policy levers beyond these initiatives will be required to encourage more landowners to establish woodland, including regulatory and spending measures.

Given the UK is currently transitioning away from the Common Agricultural Policy, it is likely that farmer attitudes will undergo change over the coming years, particularly as

they adjust to environmental land management schemes. As such, there is an ongoing need to understand farmer attitudes to tree planting. There is also a lack of evidence on the attitudes to tree planting of other landowners beyond farming, including owners of vacant or derelict land which may be suitable for planting.

Forestry Sector capacity

Short term the risks associated with the ability of the forestry industry to supply sufficient planting stock and a labour-force to meet the demands of the proposed target has been accommodated in the planting profile and through actions set out in the England Trees Action Plan. In the medium and long term, it has been assumed that industry capacity will increase to meet market demand. Forestry sector capacity was assessed during the development of the England Tree Action Plan, which committed to increasing UK sector capacity through the Nature for Climate Fund.

Affordability

An affordability assessment was only conducted for those options included in the Impact Assessment (IA), which provides a breakdown of the costs and all associated assumptions. For options in the IA, 5-10% were assumed to be established through natural colonisation, based on initial applications to the England Woodland Creation Offer.

Discussion

The following section sets out the rationale supporting the proposed metric, scope and level ambition for the statutory tree target presented in the public consultation. The reasons for not taking options forward are also set out.

Scope/reporting options

Design of the metric

Three options were considered for the design and reporting of the target metric, in terms of being outcome or activity-based and whether restricted to woodland or England's wider treescape.

- Total Area of Woodland/Tree Cover in England: Similar format to woodland area currently reported in Forestry Statistics based on a periodic (10-yearly) analysis of aerial photography updated annually through administrative records

of woodland creation and deforestation and remote sensing for woodland loss. This option would be restricted to woodlands of more than 0.5 ha in area.

- Area of trees/woodland planted: Similar format to annual planting published in Forestry Statistics, based on administrative records. This option would be restricted to tree planting and woodland creation funded by government or other delivery partners and exclude natural land use change processes or the impact of deforestation on the tree and woodland resource.
- Tree canopy cover including woodlands and trees outside woodlands: An aggregate indicator of woodland cover as currently reported, annually, in Forestry Statistics and tree canopy cover outside woodlands (small woods, groups of trees, linear features, and individual trees) assessed by remote sensing.

Granularity of reporting

A second consideration was the granularity of reporting/differentiation of woodland type (i.e., conifer, broadleaf or mixed), and whether the proposed target should be restricted to specific woodland types, for example native woodland, or use a broad definition of woodland.

- Undifferentiated target: This option would provide flexibility in achieving the target and avoid constraining future policy development.
- Differentiated target: This option would require a rigid statutory definition of each type of woodland, the ability to discern between the different categories and track changes over time. It would also limit the ability of future forestry policy to respond to changing societal needs.

Scope of the metric

The third consideration in setting the scope of the metric for the target was defining the tree and woodland types that will contribute to the target. Seven categories are set out in Table 2, together with the narrative supporting their inclusion/rejection, as discussed with both the stakeholder group (AFG) and the independent expert group (TAW-SAG).

Table 2: Tree and woodland types considered for inclusion in the scope of the metric

Tree/woodland types considered	Rationale for inclusion
Conventional woodland	Woodland as defined by UK Forestry Standard is central to a tree and woodland target. *[included]*
Agroforestry Systems	Agroforestry systems are included in the pathway to reach net zero in the Net Zero Strategy (66) and in the CCC's pathways. It is assumed that silvo-pasture systems would meet the NFI definition of woodland and silvo-arable systems would be included as trees outside woodlands. *[included]*
Trees Outside Woodland	To recognise the ecosystem services they provide. Defined by the NFI report 'Canopy Cover Outside Woodland in Britain (67)'. *[included]*
Orchards	To recognise the unique ecosystem services they provide, with area reported in the Farming Business Survey (68). *[included]*
Hedges	Hedgerows, trees in hedgerows and linear features of hedgerows are included in the CCC's indicative net zero pathway (69). *[rejected, but see trees Outside Woodland]*
Biomass	Short Rotation Coppice and Short Rotation Forestry are likely to make an important contribution as biomass feedstocks to the net zero pathway (70). *[rejected, subject to consultation responses]*
Natural Colonisation	Woodland established through natural colonisation provides considerable biodiversity benefits (71). *[included]*

Summary of proposed scope

Tree Canopy Cover including woodlands and trees outside woodlands is considered as the most appropriate metric for the proposed target. It is outcome based and would provide an accurate picture of the progress being made towards government's planting

targets. The metric includes small woods and trees outside woodlands which provide a wide range of societal benefits. An undifferentiated metric is concluded as most appropriate for delivering the proposed target, as it is more practical to implement and monitor and is easier to define in legal terms. Woodland and trees included in the scope of the metric are conventional woodlands, agroforestry systems, orchards, small woods, groups of trees and individual trees. The metric also includes woodland established through natural colonisation, in line with the England Woodland Creation offer and supported by an FR analysis of natural colonisation schemes funded by the Woodland Grant Scheme between 1998 and 2003.

Rationale for rejecting metric/scope options

Total Area of Woodland/Tree Cover in England (ha)

This metric was rejected as it would exclude trees outside woodlands and the considerable societal benefits they provide, as set out in the 25 Year Environment Plan.

Area of Woodland/Number of Trees Planted

This metric was rejected as (a) it is action based rather than outcome based and (b) and would not reflect net progress towards government's existing woodland cover targets or government's wider environmental ambitions, including the suite of targets proposed under the Environment Act, though not accounting for deforestation.

Differentiated

A differentiated target was rejected because it would be challenging to both monitor and implement in practice and would also require a strict legal definition of each woodland type and the ability to monitor changes in the composition of existing woodland. The actions we are taking in the England Trees Action Plan, the suite of targets being released, especially biodiversity targets and the UKFS will act as drivers for broadleaf planting and ensure the woodlands created are mixed. Furthermore, if productive (conifer) woodlands were to be excluded, the metric would fail to recognise the support they can provide for biodiversity, particularly when mature (72; 73).

Hedgerows

Hedgerows were excluded as they do not meet the National Forest Inventory definition of trees or woodlands. However, trees in hedgerows are included in the proposed metric and 'outgrown hedgerows' will be included when they meet the definition of linear features, as defined in the NFI trees outside woodland report.

Purpose-grown biomass plantations

Initially excluded as they may not provide the societal benefits expected from conventional, UKFS-compliant woodland, as set out in the 25 Year Environment Plan. However, this decision is subject to the public consultation and may also be revisited after the Biomass Strategy is published later in 2022 with the option to modify the scope and level of ambition for the target. It should also be noted that stands of short rotation coppice or forestry that are components of UKFS-compliant woodland would be included in the scope of the metric.

Options for setting the level of ambition

The tree planting options considered for the tree and woodland target are shown Table 3, based on a range of existing targets, recommendations and aspirations, together with higher ambition options developed through this analysis. Figure 2 shows the profile of land use change between now and 2050 associated with each of the options.

For all options, either no net loss of tree canopy cover outside woodland was implicitly assumed, or net gain explicitly accounted for in the scenarios taken forward to the IA. In all cases, the benefits of gross planting rates were considered, with no account taken of a baseline or assumptions over 'business as usual' planting rates; the rationale for this analytical approach is that in the absence of Government intervention, it is likely that planting rates will fall to minimal levels.

Table 3: Options considered for the tree canopy and woodland cover target

Option	Reference/rationale for inclusion	Suggested land use requirements for each option (ha)
Historical Scenario	The average rate of woodland expansion achieved over the past century and the planting rate sustained following the introduction of a balanced forestry policy (1995-2005); planting rates would rise to 6,000 ha/yr from 2023	Conventional Woodland: 173,264 **Total: 173,264**
25 Year Environment Plan	The planting trajectory (up to 2050) required to meet the 12% woodland cover target in the 25 Year Environment Plan by 2060; planting rates would rise to 7,200 ha/yr from 2025	Conventional Woodland: 208,485 **Total: 208,485**
25 Year Plan bought forward to 2050	The England Trees Action Plan's aspiration of 12% woodland cover by mid-century [assumed to be 2050]; planting rates would rise to 9,900 ha/yr from 2025.	Conventional Woodland: 276,415 **Total: 276,415**
LULUCF GHG Inventory Stretch Scenario	The most recent LULUCF GHG inventory projections (2019i) stretch scenario; planting rates would rise to 17,500 ha/yr from 2035.	Conventional Woodland: 435,701 **Total: 435,701**
Net Zero Strategy	England's contribution to the afforestation profile of the Net Zero Strategy's illustrative pathway; planting rates would rise to 16,700 ha/yr from 2035.	Conventional Woodland: 420,395 **Total: 420,395**

CCC's Widespread Innovation Pathway	The level of afforestation outlined in the CCC's Widespread Innovation Pathway; planting rates would rise to 16,700 ha/yr from 2030.	Conventional Woodland: 433,395 **Total: 433,395**
Canopy Cover of 17.5% Scenario	Woodland expansion profile set out in the illustrative pathway of the Net Zero Strategy with flexible delivery policy including conventional woodland, trees outside woodland, agroforestry systems and orchards; planting rates would rise to 16,700 ha/yr from 2035.	Conventional Woodland: 277,892 Agroforestry: 137,350 **Total: 415,242**
Canopy Cover of 19% Scenario	Conventional woodland planting rising to the level assumed in the Net Zero Strategy with additional agroforestry. A wide scope includes conventional woodland, trees outside woodland, agroforestry systems and orchards; planting rates would rise to 17,500 ha/yr from 2030.	Conventional Woodland: 420,395 Agroforestry: 197,250 **Total: 617,645**
Canopy Cover of 20.5% Scenario	Planting rates assumed in the CCC's Widespread Innovation Pathway combined with additional agroforestry uptake as set by the CCC. A wide scope includes conventional woodland, trees outside woodland, agroforestry systems and orchards; planting rates would rise to 23,000 ha/yr from 2030.	Conventional Woodland: 420,395 Agroforestry: 394,500 **Total: 814,895**

Figure 2: Land use change profile for the nine options considered in setting the tree canopy and woodland cover target.
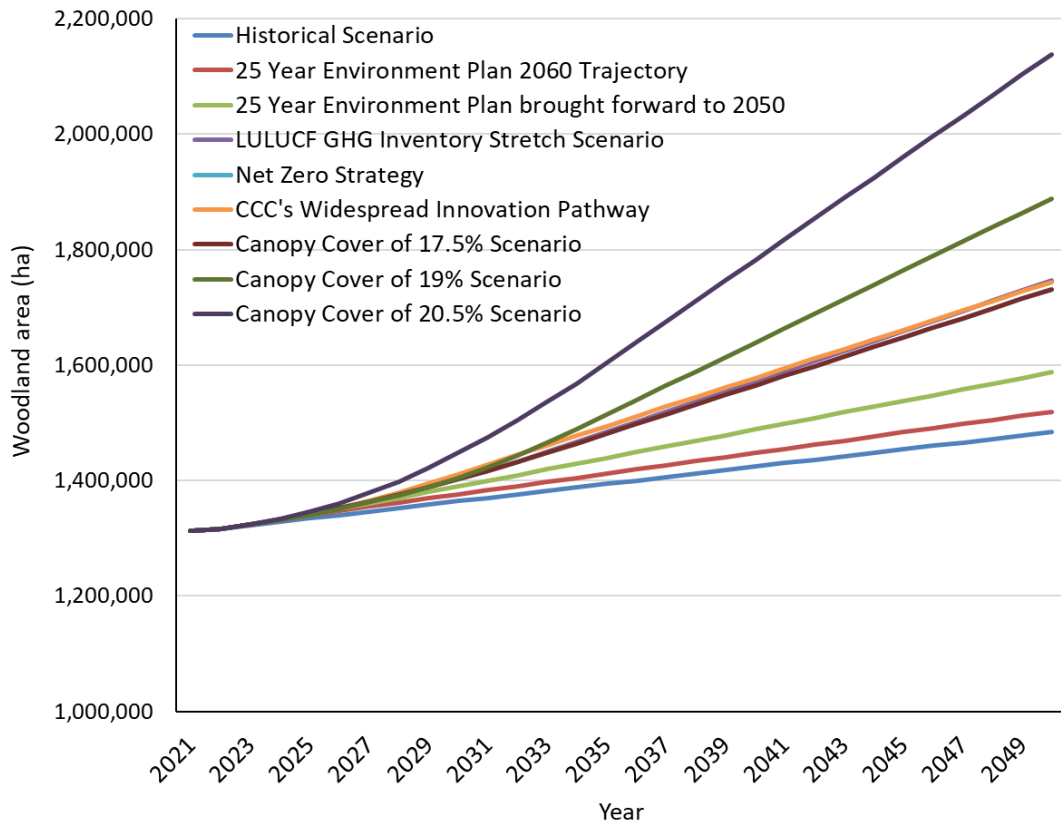

Table 4 presents carbon sequestration potential for each of the planting scenarios (including contributions from agroforestry systems and tree planting outside woodland, as appropriate). Emissions savings are presented by carbon budget period and to 2100, as an indication of the contribution to the illustrative pathway set out in the Net Zero Strategy.

Table 4: Carbon sequestration/emissions savings potential (MtCO$_2$) for each planting scenario considered in target ambition analysis, assuming that planting (and woodland loss) ceases after 2050.

Option	Emission savings (MtCO$_2$)					
	CB4 (2023-27)	CB5 (2028-32)	CB6 (2033-37)	CB7 (2038-42)	To 2050	To 2100
Historical	0.04	0.46	1.61	3.51	16. 1	94.4
25 Year Plan 2060 trajectory	0.03	0.56	1.95	4.28	19.5	113.7
25 Year Plan 2050 trajectory	0.02	0.60	2.21	5.18	24. 1	150.2
LULUCF GHG Inventory Stretch	0.02	0.62	2.50	6.35	31.5	234.4
Net Zero Strategy	0.01	0.61	2.48	6.28	31.0	226.4
Canopy Cover of 17.5%	0.01	0.61	2.54	6.62	32.8	246.6
CCC Widespread Innovation	0.01	0.62	2.63	6.73	33.0	234.0
Canopy Cover of 19%	0.01	0.58	2.59	7.26	38.2	329.0
Canopy Cover of 20.5%	-0.01	0.71	3.49	10.1	53.7	462.8

Proposed level of ambition

An increase in tree canopy and woodland cover from 14.5% to 17.5% by 2050 is proposed as the level of ambition for the statutory target. This level of ambition would require that ~415,000 hectares of new woodland are planted over this period, allowing for some woodland loss, together with a net increase in tree canopy cover outside woodland. Carbon modelling indicates that achieving this target could achieve life-time carbon savings (to 2100) of 247 Mt of CO$_2$ if all ~415,000 ha was planted as a

balanced mix of conventional woodland. If agroforestry systems make a noteworthy contribution to meeting the proposed target (as is assumed in the IA), lifetime carbon savings could fall to 170 $MtCO_2$ (an increase of 141 $MtCO_2$ compared to the baseline).

The proposed level of ambition would change 3% of the country's land use. Analysis of land availability indicates that there is a low risk of driving undesirable outcomes assuming that the current regulatory framework based on the UK Forestry Standard is retained.

Forestry sector capacity would need to increase to meet this level of ambition. Policies are in development as set out in the England Trees Action Plan and support is in place, including to address risks to plant health, through the Nature for Climate Fund.

This level of ambition is consistent with the illustrative planting pathway in Government's Net Zero Strategy and would exceed the planting aspirations and commitments of the England Trees Action Plan and the 25-Year Environment Plan. The level of ambition would also help to deliver other proposed targets, particularly biodiversity and water, proposed through the Environment Act and the wider environmental ambitions in the 25-Year Environment Plan. However, the proposed level of ambition falls short of the CCC's balanced net zero pathway. This recognises that policy flexibility is needed in achieving net zero and that technological solutions may provide alternative pathways.

Consideration of options not being taken forward

Historical Scenario

The planting rate represented in this option is achievable, having previously been reached. However, the option was rejected as it would not generate sufficient carbon savings as the planting rates fall considerably short of those included in the indicative pathway of the Net Zero Strategy, as well as failing to meet the planting commitments of the England Trees Action Plan and the 25-Year Environment Plan.

25 Year Environment Plan

Planting rates are considered achievable, helping to generate a wide range of societal benefits by meeting the planting ambitions of the England Trees Action Plan and the 25 Year Environment Plan. However, the option was rejected as it would not achieve the carbon savings in the indicative pathway of the net zero strategy.

25 Year Environment Plan bought forward to 2050

This option is considered achievable and desirable and would meet the ambitions/commitments of both the England Trees Action Plan and the 25-Year

Environment Plan prior to its target date. However, the planting rates are less than the illustrative pathway of the Net Zero Strategy and the option was rejected as it would not generate sufficient carbon savings.

LULUCF GHG Inventory Stretch Scenario

Planting rates in this option are ambitious, similar to those illustrated in the Net Zero Strategy, and could generate a similar level of carbon savings. This scenario was rejected as only conventional woodland was in scope and, as such, it offered limited flexibility for delivery by excluding agroforestry systems, raising concerns over it being achievable. Trees outside woodlands are also not considered, failing to recognise their societal benefits.

Net zero strategy

Planting rates in this option are ambitious and generate the carbon savings set out in the net zero illustrative pathway. The proposed target has built on this option to recognize the value of trees outside woodlands and to enable greater delivery flexibility for the same carbon benefits.

CCC's Widespread Innovation Pathway

Planting rates are highly ambitious in the short-term, bringing England's afforestation contribution to net zero forward from 2035 to 2030. The scenario focuses on planting a higher proportion of conifers to deliver higher carbon savings, resulting in less delivery flexibility and the potential for undesirable outcomes. The ability to achieve other proposed Environment Act targets, particularly water and biodiversity could also be negatively impacted. The rapid acceleration in planting rates would also put additional pressure on the forestry sector and seed supply in the short term. The option was therefore rejected as considered potentially unachievable, less flexible than other options and with the potential for undesirable outcomes.

Canopy Cover of 19%

Planting rates for this option are highly ambitious reaching 25,000 hectares annually by 2035. Such high planting rates would create notable land pressures and are unlikely to be achievable in the absence of high levels of agroforestry uptake, which is highly uncertain. This level of land use pressure would be likely to increase the risk of undesirable outcomes such as compromises on environmental standards. There would also need to be substantial changes in landowner behaviour which would bear considerable financial costs and require large cultural shifts which are also uncertain. The planting rates would also put extreme pressure on the forestry sector and seed supply chain, which would increase the risk to plant health as a result of the need to import large numbers of planting stock. This option was therefore rejected as likely to be unachievable, highly demanding and potentially damaging to the environment.

Canopy Cover of 20.5%

Planting rates in this scenario are highly ambitious, requiring 35,000 hectares to be planted, annually, by 2035. Given that there are currently uncertainties regarding the uptake of agroforestry, we do not have confidence in the potential impacts this level of land use change would have on other government priorities. There were also Similar concerns over whether the option is achievable and the potential for environment apply as for the 19% canopy cover option, and it was therefore rejected.

Systems Interactions and trade-offs

Tree planting and woodland creation, particularly at the level proposed for the statutory target, could have synergies with achieving a number of the statutory targets that are proposed through the Environment Act. However, poor implementation could have negative environmental impacts and tradeoffs.

Biodiversity

All native woodland creation (as defined in FC's Ancient and Native Woodland Practice Guide) (74) is categorised as priority habitat and will contribute directly to the recovery of biodiversity. The analysis assumes that up to 80% of the woodland planted will be native and, if the proposed target is realised, this would result in approximately 150,000 hectares of priority habitat being created outside protected sites by 2042; this figure could be higher if conventional woodland creation (as opposed to agroforestry systems) makes a larger contribution than currently assumed.

If woodland expansion accelerates there is potential to increase the rate of restoration of open ground habitat (75) (such as heathland) from conifer woodland through lowering the Open Habitats policy bar for compensatory planting; in turn, this would contribute directly to the area of habitat restored, condition of Sites of Special Scientific Interest (SSSIs) and improved status of species populations.

Increasing the area of woodland is likely to improve the status of species populations associated with woodland (red squirrel; woodland bird assemblages) (76).

Inappropriate woodland creation could impact negatively on species associated with open ground habitats or directly on non-woodland wildlife-rich habitat. Site specific impacts are minimised through applying Environmental Impact Assessment (Forestry) (EIA) regulations and maps are being developed highlighting areas where woodland expansion would impact on upland breeding bird populations (Forestry Commission (FC) and British Trust for Ornithology) and flora (Natural England with the Botanical Society of Britain and Ireland).

Water

Increasing the number of well-placed riparian woodlands can reduce fluvial flood peaks (77).

The establishment of riparian woodland (in line with UKFS requirements) will improve geomorphology and the ecology of water courses, including through providing shade and cooling to protect populations of temperature sensitive species from the effects of climate change. Riparian woodland will also help to stabilise the banks of water courses, reducing sedimentation (78).

Woodland expansion could make a small contribution to the condition of Marine Protected Areas (MPAs) through reducing agricultural diffuse water pollution.

Incentivising targeted woodland expansion could lead to a reduction in agricultural diffuse water pollution by reducing the quantity of sediment and associated nitrate/phosphate from entering water courses (79).

Tree roots can enhance infiltration and increase ground water recharge; trees and woodland can also reduce evaporative/transpiration losses (and irrigation requirements) from adjacent land through reducing windspeed (80).

Woodland uses more water than other semi-natural land covers and could increase water demand; impacts on water demand/supplies are therefore important considerations for EIA of large afforestation proposals, particularly those involving conifer species and short rotation coppice or short rotation forest for biomass which have higher water use than most native broadleaf woodland. Catchments subject to 'Low Flows' are of particular concern.

Poor forestry practice at establishment could have a negative impact on freshwater biodiversity and water quality (nitrate and phosphate pollution from agriculture/land management). Forests that are poorly designed or managed and forests planted in unsuitable locations can exacerbate the effects of acid deposition, cause eutrophication, increase sediment delivery, affect water colour and contribute to local flooding damaging aquatic habitats (81).

Woodland creation has a potential role to play in 'phosphate offsetting' associated with new development, to help ensure no net increase in nitrate and phosphate pollution associated with that development. Woodland planting is also being piloted as a mitigation for waste-water treatment and has a role to play in Sustainable Urban Drainage Systems.

Air quality

Trees intercept a range of air pollutants to differing extents, including fine particulate matter and are more efficient than other land covers because of their taller and

rougher canopy and larger leaf area; the efficiency of interception is dependent on the pollutant, leaf morphology and leaf area, with conifers generally representing a larger pollutant sink that broadleaf species.

There is good evidence of the rate of interception of fine particulate matter by tree canopies, helping to reduce ambient air concentrations.

Tree canopies are particularly effective at reducing ammonia concentrations and woodland creation can be deployed to reduce pollution from point sources associated with livestock/poultry farming and to protect receptors (for example, freshwater SSSIs).

As with water, the contribution of the proposed tree target to air quality targets is location (and species) dependent and cannot be quantified at this stage.

In some circumstances, urban and street trees can trap air pollutants (the 'canyon effect'), potentially increasing population exposure to particulate matter.

Depending on the use of timber harvested from the new woodland, there may be negative impacts on air quality; for example, wood burning stoves in urban areas are sources of particulate matter.

Resource productivity

The contribution of productive woodland to help achieve the proposed target to resource productivity would be limited over the period to 2050 and restricted to small dimension (wood) thinnings.

After 2050 there would be an increase in the availability of home-grown timber reducing the need for imports.

Policy scenario analysis

We will set out policy pathways at a future date. Potential policies that would contribute include the Nature for Climate Fund, which has committed £720 million to woodland creation, tree planting and peat restoration.

In the future, environmental land management schemes will include funding for tree planting and woodland maintenance. Initiatives such as the £50m Woodland Carbon Guarantee (82), underpinned by the Woodland Carbon Code (83), will help accelerate woodland planting rates and develop the domestic woodland carbon market and attract green finance. Biodiversity Net Gain, which will be introduced through the Environment Act, also has the potential to bring substantial private investment into woodland creation as will other initiatives, such as the Woodland for Water Code. Policies focused on regulation and the tax treatment of woodlands could also help to further incentivise tree planting.

Future plans for evidence, innovation and technology

Remote sensing could see improvements in its efficiency and accuracy of data capture for both reporting on achieving the proposed target and to support monitoring, reporting and verification of the developing woodland carbon market.

Potential for amending the proposed target or introducing future targets

If policy development and support for agroforestry systems results in a higher level of uptake than that assumed in this analysis, the level of ambition could be increased. Similarly, the level of ambition could be increased if clarity is provided over the design and regulation of dedicated biomass plantations through the Biomass Strategy and subsequent policy development results in a decision to bring them within the scope of the proposed tree canopy and woodland cover target.

Bibliography

1. https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/about-the-nfi/
2. https://code.statisticsauthority.gov.uk/
3. https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/
4. https://www.gov.uk/government/statistics/national-forest-inventory-tree-cover-outside-woodland-in-gb
5. National Tree Map | Bluesky International Limited (bluesky-world.com)
6. https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/
7. https://www.gov.uk/government/publications/net-zero-strategy
8. https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted
9. https://www.gov.uk/government/publications/england-trees-action-plan-2021-to-2024
10. https://www.gov.uk/government/publications/25-year-environment-plan
11. Woodland natural capital accounts, UK - Office for National Statistics (ons.gov.uk)
12. https://www.theccc.org.uk/wp-content/uploads/2018/11/Land-use-Reducing-emissions-and-preparing-for-climate-change-CCC-2018-1.pdf
13. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf
14. https://www.gov.uk/government/publications/keepers-of-time-a-statement-of-policy-for-englands-ancient-and-native-woodland
15. https://www.gov.uk/government/publications/managing-ancient-and-native-woodland-in-england
16. https://www.forestresearch.gov.uk/research/climate-change-impacts-and-adaptation-in-englands-woodlands/
17. https://www.tsoshop.co.uk/gempdf/Combating_Climate_Change_a_role_for_UK_forests_Main_Report.pdf
18. https://www.gov.uk/government/publications/managing-englands-woodlands-in-a-climate-emergency
19. https://www.gov.uk/government/publications/the-uk-forestry-standard
20. https://www.gov.uk/government/publications/woodland-for-water
21. https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/woodlandnaturalcapitalaccountsuk/2020
22. https://www.forestresearch.gov.uk/documents/8143/Ch1_Woodland_FS2021.pdf
23. https://www.gov.uk/government/statistics/national-forest-inventory-tree-cover-outside-woodland-in-gb
24. https://www.forestresearch.gov.uk/documents/8164/Ch9_International_FS2021.pdf

25. https://www.forestresearch.gov.uk/documents/8143/Ch1_Woodland_FS2021.pdf

26. https://www.forestresearch.gov.uk/documents/8095/planting1976-2021.xlsx

27. https://www.forestresearch.gov.uk/documents/8095/planting1976-2021.xlsx

28. https://www.gov.uk/government/statistics/national-forest-inventory-tree-cover-outside-woodland-in-gb

29. https://www.gov.uk/government/publications/england-trees-action-plan-2021-to-2024

30. https://www.gov.uk/government/publications/25-year-environment-plan

31. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf

32. https://naei.beis.gov.uk/reports/reports?report_id=1013

33. https://www.gov.uk/government/groups/trees-and-woodlands-scientific-advisory-group

34. https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted

35. https://www.gov.uk/government/groups/trees-and-woodlands-scientific-advisory-group

36. https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/about-the-nfi/

37. https://www.forestresearch.gov.uk/documents/2729/NFI_ENGLAND_REPORT_010813.pdf

38. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002042/Forestry-Commission-Key-Performance-Indicators-Report-for-2020-21-.pdf

39. https://www.gov.uk/government/statistics/national-forest-inventory-tree-cover-outside-woodland-in-gb

40. https://www.gov.uk/government/groups/applicants-focus-group

41. https://www.theccc.org.uk/wp-content/uploads/2018/11/Land-use-Reducing-emissions-and-preparing-for-climate-change-CCC-2018-1.pdf

42. www.soilassociation.org/farmers-growers/technicalinformation/agroforestry-on-your-farm/download-the-agroforestry-handbook/

43. https://www.woodlandtrust.org.uk/media/1816/benefits-of-trees-on-livestock-farms.pdf

44. https://research.bangor.ac.uk/portal/files/20769613/2017NWORJIM2017pdf.pdf

45. https://www.woodlandtrust.org.uk/media/1815/benefits-of-trees-on-arable-farms.pdf

46. Palma et al., (2007) Modelling environmental benefits of silvo-arable agroforestry in Europe.

47. www.soilassociation.org/farmers-growers/technicalinformation/agroforestry-on-your-farm/download-the-agroforestry-handbook/

48. https://www.gov.uk/government/publications/the-uk-forestry-standard

49. Demestihas C. (2017). Ecosystem services in orchards. A review. In: INRA Science & Impact

50. https://www.gov.uk/government/publications/when-to-convert-woods-and-forests-to-open-habitat-in-england-march-2010

51. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/713805/england-open-habitats-policy-march-2010.pdf

52. https://www.forestresearch.gov.uk/documents/3038/niengland.pdf

53. https://www.gov.uk/guidance/urban-tree-challenge-fund

54. https://www.gov.uk/guidance/local-authority-treescapes-fund

55. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

56. https://uk-air.defra.gov.uk/assets/documents/reports/cat09/2010301108_LULUCF_Projections_to_2050-2100_2017i_.pdf

57. https://www.gov.uk/government/publications/independent-panel-on-forestry-final-report

58. https://www.gov.uk/government/collections/farm-business-survey

59. https://www.gov.uk/guidance/environmental-impact-assessments-for-woodland

60. https://www.forestresearch.gov.uk/research/understanding-the-carbon-and-greenhouse-gas-balance-of-forests-in-britain/

61. Edwards, P.N. and Christie, J.M. (1981). Yield models for forest management. Forestry Commission Booklet 48.

62. https://www.forestresearch.gov.uk/documents/7235/FRRP031.pdf

63. http://publications.naturalengland.org.uk/file/4667803136425984

64. http://randd.defra.gov.uk/Document.aspx?Document=12514_VolumeFour-Woodlandcreationsegmentation.pdf

65. https://woodlandcarboncode.org.uk/

66. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf

67. https://www.gov.uk/government/statistics/national-forest-inventory-tree-cover-outside-woodland-in-gb

68. https://www.gov.uk/government/collections/farm-business-survey

69. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

70. https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf

71. https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0252466&type=printable

72. https://www.forestresearch.gov.uk/documents/6989/fcrp004.pdf

73. https://www.confor.org.uk/news/latest-news/biodiversity-forestry-and-wood/

74. https://www.forestresearch.gov.uk/research/managing-ancient-and-native-woodland-in-england/

75. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/713805/england-open-habitats-policy-march-2010.pdf

76. Achieving government's long-term environmental goals - National Audit Office (NAO) Report

77. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291522/scho0711btyr-e-e.pdf
78. ibid
79. ibid
80. https://www.woodlandtrust.org.uk/media/4808/pontbren-project-sustainable-uplands-management.pdf
81. https://www.gov.uk/government/publications/the-uk-forestry-standard
82. https://www.gov.uk/guidance/woodland-carbon-guarantee
83. https://woodlandcarboncode.org.uk/