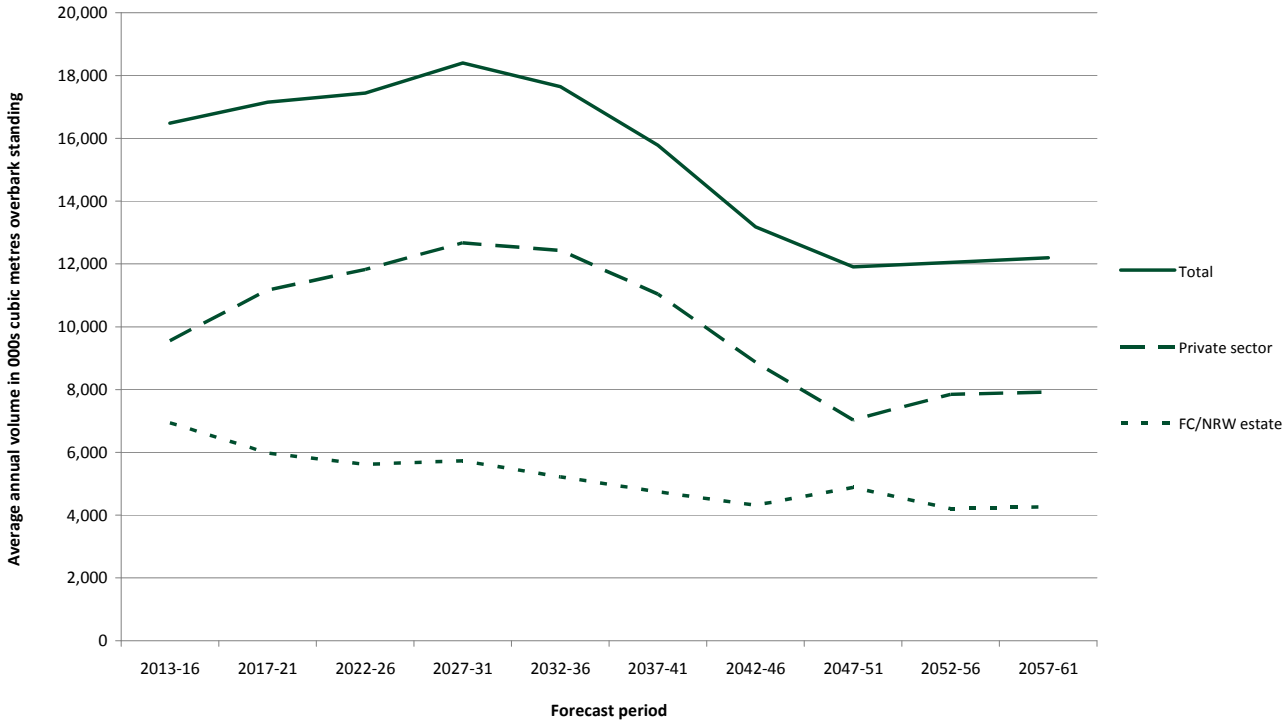
50-year forecast of softwood timber availability

Overview of the 50-year forecast of softwood timber availability



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Summary

The National Forest Inventory provides a record of the size and distribution of forests and woodlands in Great Britain and information on key forest attributes. This information, together with Forestry Commission growth and yield models, is used to forecast softwood and hardwood timber availability. This Report provides a 50-year forecast of softwood timber volume that could potentially be produced from conifers growing in forests and woodlands in GB, if public forests are managed to plan and private forests to maximise potential yield. It includes estimates for England, Scotland, and Wales, broken down by Forestry Commission/Natural Resources Wales (FC/NRW) and Private sector ownership.

Some of the key findings of this report are:

- The forecast of softwood availability for the GB forest estate is an average of 15.2 million m^3 of softwood timber per annum over the 50-year period. For England this equates to an average of 3.5 million m^3 per annum; for Scotland 10.2 million m^3; and for Wales 1.5 million m^3.
- The forecast of average annual GB softwood availability for the next 50 years is 29% higher than the annual softwood production across GB for 2012, reported in Forestry Statistics 2013, as 11.8 million m^3 (9.652 million green tonnes). However, annual softwood production has not been constant in the past and has risen over the last four decades.
- Potential softwood availability changes over the period of the forecast; it increases from an average of 16.5 million m^3 per annum in the period 2013–16, rising to a maximum of 18.4 million m^3 per annum in 2027–31, after which it falls away then levels out, reaching an average of 12.2 million m^3 per annum in 2057-61.
- The pattern over time of future softwood availability from the FC/NRW estate and Private sector estate are different. In the FC/NRW estate there is a gradual decline over time from the beginning to the end of the 50 year period, while in the Private sector there are increases through to the 2027-31 period, followed by a steep decline, but finally stabilising at a level lower than the initial reporting period at the end of the 50 year period.
- The FC/NRW estate is projected to generate an average of 5.2 million m^3 per annum for the next 50 years, if existing forest management plans are followed and production is not constrained, 6.9 million m^3 per annum would be produced in the first period (2013–16) and this will decline to an average of 4.3 million m^3 per annum in the final five-year period (2057-61). However, it is the published intention in Scotland and Wales to constrain production in the short term with a view to smoothing production over the medium to long term.

- The potential availability of softwood timber from the Private sector estate is forecast to average 10.0 million m^3 per annum for the next 50 years, under a management scenario of maximising timber productivity. For England the average is 2.4 million m^3 per annum; for Scotland 6.9 million m^3 per annum; and for Wales 0.8 million m^3 per annum.

The actual levels of timber that will be produced will vary from the results reported here as production depends on the harvesting choices made by forest and woodland owners. In this report, a range of alternative scenarios have been explored for the Private sector to assess the impact of such choices on the amount and timing of production in the private sector.

This report provides a summary of the 50-year forecast of softwood availability. A separate NFI report is simultaneously published providing 50-year forecasts of hardwood timber availability in Great Britain. NFI reports are published at:

www.forestry.gov.uk/inventory.

Table 1a Summary of FC/NRW softwood forecast

	2013-2016	2017-2021	2022-2026	2027-2031	2032-2036
	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)
England	1,632	1,330	1,211	1,159	1,066
Scotland	4,220	3,658	3,516	3,789	3,215
Wales	1,082	991	895	778	934
Great Britain	**6,933**	**5,980**	**5,622**	**5,726**	**5,216**

	2037-2041	2042-2046	2047-2051	2052-2056	2057-2061
	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)	volume (000 m^3 obs)
England	1,013	1,055	1,014	828	1,250
Scotland	2,936	2,730	3,280	2,886	2,339
Wales	794	531	585	495	679
Great Britain	**4,744**	**4,316**	**4,879**	**4,209**	**4,269**

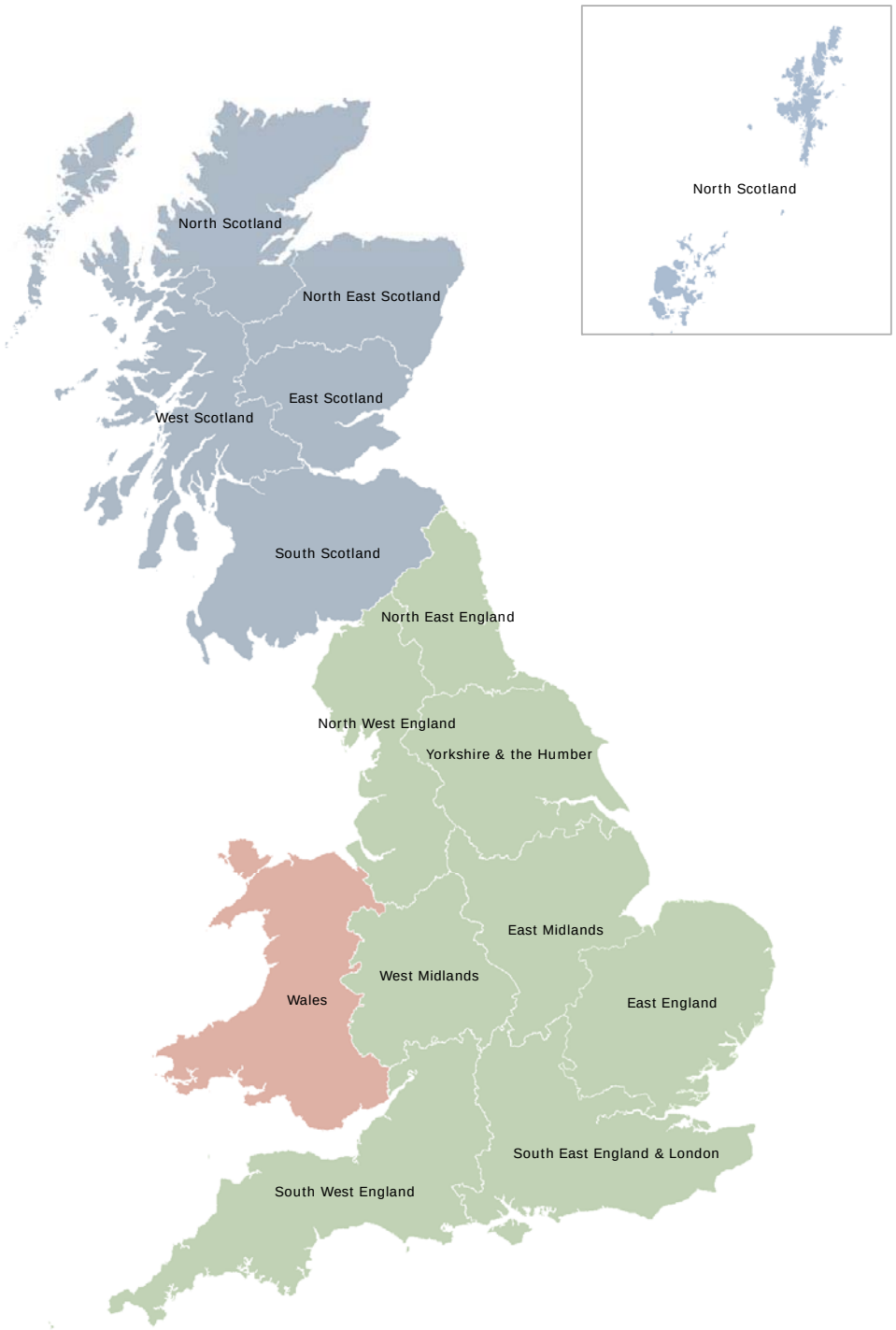
Table 1b Summary of Private sector softwood forecast

	2013-16		2017-21		2022-26		2027-31	
	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*
England	2,945	*5*	3,225	*5*	2,903	*5*	2,986	*5*
Scotland	5,708	*5*	6,997	*5*	7,830	*5*	8,910	*5*
Wales	901	*16*	949	*13*	1,087	*14*	775	*15*
Great Britain	**9,554**	***4***	**11,171**	***4***	**11,820**	***4***	**12,671**	***4***

	2032-36		2037-41		2042-46		2047-51	
	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*
England	2,850	*6*	2,224	*6*	1,848	*6*	1,523	*5*
Scotland	8,847	*5*	8,133	*5*	6,527	*5*	4,986	*5*
Wales	736	*15*	679	*15*	490	*15*	521	*14*
Great Britain	**12,433**	***4***	**11,035**	***4***	**8,865**	***4***	**7,030**	***4***

	2052-56		2057-61	
	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)	*SE %*
England	1,431	*6*	1,603	*6*
Scotland	5,679	*4*	5,627	*4*
Wales	734	*13*	694	*12*
Great Britain	**7,845**	***3***	**7,924**	***3***

Figure 1 National Forest Inventory Reporting Regions



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Introduction

National forest inventories are carried out by the Forestry Commission to provide accurate, up-to-date information about the size, distribution, composition and condition of the forests and woodlands in Great Britain (GB). This information is essential for developing and monitoring policies and guidance to support sustainable forest management.

The current National Forest Inventory (NFI), which began in 2009 (the first cycle is due for completion in 2015), is a multi-purpose operation that has involved the production of a forest and woodland map for GB and a continuing programme of field surveys of the mapped forest and woodland areas.

Information and data collected by the National Forest Inventory will be used for a number of purposes, including estimates of current values and forecasts of future values of forest metrics such as:

- Standing volume
- Timber availability
- Tree growth and increment
- Carbon stocks
- Biomass

Estimates of aspects of the biodiversity and social value of forests and woodlands will also be provided by the Inventory.

This NFI Report sets out the results of the 50-year forecast of softwood timber* availability for all forests and woodlands in GB. The public sector comprises forests and woodlands managed by Forestry Commission England, Forestry Commission Scotland and Natural Resources Wales. Private sector woodland is all other forests and woodlands owned and managed by other bodies or individuals.

A ‘sister’ forecast of hardwood availability will also be published in 2014. Further information on this and other National Forest Inventory outputs is available from www.forestry.gov.uk/inventory.

*Timber is defined in this report as the volume of stemwood to 7 cm top diameter in m^3 overbark standing (obs), including stump (above ground) and usable branchwood (of minimum 3 m in length and 7 cm top diameter).

Forecast of softwood availability

The last forecast of softwood availability in the UK was published in the 2012 NFI report entitled *25-year forecast of softwood timber availability*. This new report, in addition to providing the latest overall forecasts for 25 and 50 years, gives a breakdown of forecast volume by country, by principal species, size class and National Forest Inventory region.

The baseline for the forecast of softwood availability for Great Britain is the National Forest Inventory assessment of Standing timber volume, the original version of which was published in 2012 (*Standing timber volume for coniferous trees in Britain*). This assessment of standing volume has subsequently been revised as more samples from the National Forest Inventory have been collected. The revised assessment of standing timber volume forms the basis of this forecast.

How forecasts are derived

Forecasts of softwood availability are derived by assessing:

- Woodland area.
- Woodland characteristics (e.g. age, species) within this area.
- How quickly the trees are growing (yield class).
- When the trees will be harvested.

The forecast of softwood availability for GB is composed of three separate forecasts: a forecast for the Forestry Commission (FC) estate in England and Scotland; a forecast for the Natural Resources Wales (NRW) estate* and a forecast for the Private sector estate in GB. The forecasts have been derived separately for the FC/NRW estate and for the Private sector estate. They are based upon the same principles but use different data sources.

For the FC/NRW estate, information on woodland area and woodland characteristics has been extracted from the Forestry Commission's long-established Sub-compartment database. For the Private sector estate, the estimates were derived from results obtained to date from the National Forest Inventory.

* The Natural Resources Wales estate in this report refers to the estate formerly managed by Forestry Commission Wales. It does not include former holdings in Wales of the Environment Agency or Countryside Council for Wales, which are treated as Private sector woodland in this report.

The *National forest inventory forecasts methodology overview* and the technical documentation on *Felling and removals forecasts* give more information on the approaches used to derive the forecasts (see www.forestry.gov.uk/inventory).

Sub-compartment database

The Sub-compartment database is a record of all land managed by the Forestry Commission and Natural Resources Wales. Each stand of trees is represented spatially, together with information on individual stand characteristics (for example species, planting year, spacing and yield class) which is periodically updated. As new surveys of stands are conducted (e.g. for operational purposes), survey results are also recorded against the stands. In addition, the database contains details of how the stands are to be managed – in particular, the planned frequency and type of thinning operations and a 'due date' for felling.

National Forest Inventory

The National Forest Inventory is composed of two elements: a woodland map and a field survey. The woodland map covers all forests and woodlands over 0.5 hectares with a minimum of 20% canopy cover (or the potential to achieve it), including new planting, clearfelled sites and restocked sites. The map was established in 2010 and was based upon 25 cm resolution colour aerial photography for England and Scotland and 40 cm resolution aerial photography for Wales. The map was originally validated and updated using satellite imagery (available up to 2009), which gave an independent crosscheck of woodland present. Since then the map has been updated annually using 25cm resolution colour aerial photography and satellite imagery (available up to 2012). These sources were used in conjunction to identify areas of recently felled forests and newly established trees. Particular attention was paid to identifying areas of woodland loss verified as being due to the establishment of windfarms or the restoration of habitats.

Field survey work is then used to refine the map-based estimates of woodland and clearfelled areas and to measure detailed aspects of the forest. Field surveys carried out between 2009 and 2013 were used to estimate standing volume and other forest metrics that have been utilised in the production of this report. This involved the ground surveying of one-hectare sample squares that were partially or entirely covered by forest, including clearfelled areas, according to the woodland map. Further details of the mapping work and the derivation of forested areas can be found in the 2010 & 2011 Woodland Area reports at www.forestry.gov.uk/inventory.

Estimates for the Forestry Commission and Natural Resources Wales estates

Information from the Sub-compartment database was used to estimate standing volume at the reference date of 31 March 2012 on a stand-by-stand basis. For each stand, if an operational survey had been carried out close to the reference date, information from that survey was used to estimate standing volume. Otherwise, an estimate was made of the state of the stand, normally involving the application of standard Forestry Commission growth and yield models that take into account the past management of the stand. This data formed the basis of the volume forecasts.

Forestry Commission growth and yield models were then used to 'grow' the stands, based upon the Inventory data and yield class estimates. The stands were grown taking account of harvesting events that either thinned or felled a stand over the forecast period, producing the standing volume, increment and production volumes projected by the forecasts. The timing and scale of thinning and felling events was taken from FC/NRW forest management plans, which set prescriptions for harvesting across productive forest areas on the FC/NRW estate. This was then aggregated to produce the estimated total production across a defined geographic area for particular types of stand (classified, for example, by species, age or size class). The production forecast is an output of this stand modelling process.

Because the resulting estimates are based on a full record of data from the Sub-compartment database, there is no sampling error involved in the estimation process, therefore no sampling standard error is calculated. However, the nature of the estimation process within each individual stand does introduce estimation error, with variable contributions from stand to stand, due to the type, age and accuracy of the information held in the Sub-compartment database. These estimation errors have not been quantified in this report.

Estimates for the Private sector estate

Forests on the National Forest Inventory woodland map were first separated into FC/NRW estate and Private sector estate holdings using Forestry Commission spatial records of management boundaries. Estimates of softwood availability on the Private sector estate used a woodland area obtained from the map updated to 31 March 2012 (published in May 2013). A full account of the National Forest Inventory mapping exercise can be found in the *National Forest Inventory forecasts methodology overview*. The mapped woodland area results can be found in the *National Forest Inventory woodland map reports for Great Britain, England, Scotland and Wales*, available online at www.forestry.gov.uk/inventory.

The results in this report are based on survey returns from 9,594 sample squares surveyed across all woodland types between October 2009 and August 2013. These surveyed sample squares represent a sub-sample of a planned 15,000 statistically representative squares covering all GB woodland that will be surveyed during this first cycle of the National Forest Inventory survey (due for completion in 2015).

At each sample square, the forest was stratified into different woodland types or stands, where information on species, age, management and a range of other parameters was collected. Typically, sample squares covered parts of two or more different forest stands, resulting in around 27,490 stands being assessed. Within each stand, field-based computer systems were used to locate two or three randomly located 100 m^2 (0.01 hectare) circular plots, within which all trees of greater than or equal to 4 cm diameter at breast height (DBH) were mapped, species and age identified, stocking rates assessed and diameters measured. As a result a total of around 366,000 trees were measured. For around 105,000 of these trees, additional measurements of tree height and crown dimensions were taken to establish estimated yield class and for other purposes; for 77,921 trees, stem straightness was also assessed. The resulting data were used to estimate the standing volume of the trees and this formed the basis of the volume forecast. All squares were marked on the ground with metal pegs and GPS data of their location were recorded for checking and future measurement. All measurements were subject to office-based checks and 7% were re-measured in the field by an independent quality assurance team to ensure consistency and high standards.

The 2012 Inventory data for the Private sector estate was then run against several future harvesting scenarios (including the felling assumptions used for the 2005 Private sector forecast) to understand the impact of different felling ages and thinning rates on future standing volume, increment and production volumes. Such alternative scenarios were investigated since there is neither a comprehensive record of felling and thinning plans for the Private sector estate nor a commitment to harvest a given volume.

From these scenarios, a single prescriptive and uniform management scenario was chosen to produce the ‘headline’ forecast. Under this scenario, Private sector forests are managed under a regime designed to maximise productivity (biological potential), within which it is assumed that timber will be harvested in the year of maximum Mean Annual Increment (MAI). It also takes account of wind constraints. This scenario, selected after consultation with Private sector woodland owners and timber processors, aims to maximise timber production in a way that involves relatively straightforward and transparent management prescriptions.

A similar approach was taken for thinning by applying a series of prescriptions set out in Forestry Commission management tables – known as management table thinning – to areas not at significant risk from windthrow if thinned. In areas considered to be at high risk, determined by a Detailed Aspect Methodology Score (DAMS) of 16 or more, a strategy of no thinning – and felling conditional upon attainment of a top height of 25 metres – was assumed. Forestry Commission growth and yield models were then used to predict future growth and consequent future standing and harvested volumes.

The harvesting scenarios considered in the forecast are described below. They generate a range of outcomes from a relatively high level of possible sustainable potential production to more restricted levels of production. Several are based upon the biological potential approach (felling at maximum MAI), with each of these biological potential based scenarios adopting a different approach to restocking. In addition to the scenarios based on biological potential, two other alternative scenarios have been investigated; one based upon the 2005 industry-prescribed harvesting approaches and another based upon felling of all stands at 25 metres in height. Details of the scenarios can be found in Appendix D, a summary of which is presented in Table D1 and is described below.

- Clearfelling to biological potential. This assumes choosing a felling age which maximises long-term productivity by clearfelling at year of maximum MAI. Within this overall approach to management, several variants were defined:

    - **Modified biological potential**, thinning and felling assuming moderate wind risk measures – the 'headline' forecast. This scenario takes account of wind risk, but assumes a relatively risk-tolerant approach in applying wind-risk constraints to harvesting practice. This assumes felling to year of maximum MAI and thinning of all stands to management table in all crops planted in areas with a DAMS score of less 16, or otherwise felling at an assumed terminal height of 25 metres (if this is attained before year of maximum MAI) and no thinning for stands in areas with a DAMS score of 16 or greater. Three additional variants of this approach are provided where:

        - Scenario 1. A proportion of overdue timber is felled over the forecast period, **no open space is introduced** at restock, a 'like for like' species choice is made on restock and currently clearfelled land is restocked;
        - Scenario 2. A proportion of overdue timber is felled over the forecast period, there is a **10% reduction in conifer stocked area** at restock, currently clearfelled land is restocked and predicted species choices are used for the restock (Appendix D, tables D3 to D5); and

  - Scenario 3. A proportion of overdue timber is felled over the forecast period, there is a **20% reduction in conifer stocked area** at restock, currently clearfelled land is restocked and predicted species choices are used for the restock (Appendix D, tables D3 to D5).
  - Scenario 4. **Applying the same[*] assumptions as used in the 25-year forecast** for comparative purposes. This involved no overdue allocation, like for like restock and no restocking of currently clearfelled land.

- Scenario 5. **Felling and thinning to the 2005 industry 'view'.** This scenario uses region-specific sets of harvesting and restocking prescriptions based on an industry view of future harvesting practice with regard to age of felling and amount, type of thinning and species choice on restocking. These were derived in consultation with private sector growers and processors and were the basis of the 2000 and 2005 forecasts.

- Scenario 6. **Felling stands when they achieve a top height of 25 metres.** This scenario assumes felling at a top height of 25 metres, the thinning of all stands to management table in all crops less than DAMS 16 and no thinning for stands at or above DAMS 16. This scenario arose through the private sector consultation process and was suggested by Colin Kennedy of Scottish Woodlands. Its benefits are that is gives the simplest and most transparent prescription for timing of felling and gives an entirely independent approach to that of felling at maximum MAI. The 25 metres threshold was originally suggested for South Scotland, a high wind risk area, so extending this to other regions will tend to shorten rotations across GB compared to using maximum MAI.

- Scenario 7. **Management felling and thinning plans.** A forecast based upon detailed stand by stand plans prescribing age of felling and type and intensity of thinning. This applies to the FC/NRW estate only. There is one exception to this due to the fact that existing forest plans generally only contain information on one rotation of felling within a 50 year period. Therefore if the first clearfell is imminent and the next rotation is unusually short it may occasionally be the case that a second felling occurs within the forecast period. As the forest plans do not generally contain felling information for such a second felling, provision within the scenario must be made for such circumstances. In these instances it is assumed that sites are restocked according to the prescription set out in Appendix D (tables D3,4 and 5) after the design plan felling date, and subsequently managed with management table thinning and felling at maximum MAI.

[*] Except for changing land ownership to reflect, sales of land. which was performed in the 25-year forecast but not in this 50-year scenario.

The following scenarios were analysed in the 25-year forecast and are not included in this report of the 50-year forecast:

- Biological potential felling and thinning for all stands;
- Modified biological potential; thinning and felling assuming strong wind risk measures;
- Modified biological potential assuming thinning based upon observed activity;
- Biological potential felling with no thinning; felling to maximise productivity by clearfelling at year of maximum MAI and undertaking no thinning, and.
- No harvesting. Known as zero intervention, this scenario assumes no felling or thinning of any stand.

These scenarios were used to inform the choice of the headline forecast scenario through exploring issues such as the impact of levels of thinning and approaches to wind risk. They were considered to be less relevant to the 50-year forecast and were excluded. Details of these scenarios and the results of their application over 25 years can be found in the NFI Reports entitled *25-year forecast of softwood timber availability* and *Interpreting National Forest Inventory timber volume forecasts*.

The impacts of applying different harvesting approaches are set out in the NFI report *Interpreting National Forest Inventory timber volume forecasts*.

Modifying the 25-year ‘headline’ scenario for a 50-year forecast

The scenario of modified biological potential, thinning and felling assuming moderate wind risk measures was used as the ‘headline forecast’ for the 2012 25-year forecast.

For the purposes of a 50-year forecast further refinements to the assumptions used in this and other scenarios needed to be made to provide realistic outlooks over 50 years. These new assumptions take factors into account that would impact more significantly on a longer term forecast. These factors were:

- how sites felled within the forecast period were restocked.
- how existing clearfell sites were restocked.
- how stands overdue for felling were treated.
- how FC and NRW land sales were accounted for within the forecast.

The next section describes the assumptions made in the scenarios about future management and harvesting of stands.

Assumptions used in the forecasts

Ownership

As different harvesting strategies are used across different ownership types, and a forecast is largely based upon the approach taken to harvesting, assumptions have been made about future forest ownership and thus how stands will be harvested over the forecast period. In the 25-year forecast changing ownership was accounted for by:

- Removing any forest areas already sold by the Forestry Commission from the Sub-compartment database and transferring this area to the Private sector forecast. This approach was replicated in the 50-year forecast.

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- Accounting for any planned land sales by the Forestry Commission (planned disposals are flagged in the Subcompartment database). In the 25-year forecast these areas continued to contribute to the Forestry Commission forecast until the date of disposal. After that point areas and volumes were reported separately from the main forecast. In the 50-year forecast planned disposals have been ignored and the assumption of this forecast is that ownership will remain constant between the sectors over the forecast period. This is due to the fact that it would be difficult to predict the extent of disposals and acquisitions out of and into the public sector estate over a 50-year period.

Restocking

The 25-year forecast used the assumption that, when stands are felled within the forecast period, they are replanted with trees of the same species and yield class (i.e. like-for-like) for both FC/NRW and Private sector woodlands. The like-for-like assumption is only one possible scenario out of many for restocking.

Conifer restocking is currently lower than has been the case in the past and several factors, such as tree diseases new to GB, are currently driving different species choices. Restocking scenarios that takes such factors into account need to be considered in a longer term forecast. Consequently, scenarios have been constructed for the 50-year forecast that explore alternative restocking strategies.

The chosen restocking scenarios were developed in consultation with the private sector (see *Consultation paper to inform requirements for a 50-year conifer forecast*) and explore the impact of increasing open space within woodlands through establishing lower levels of stocked area on restocking sites at point of restock. They also allow for different species choices on restock to reflect contemporary and predicted species choices. The main restocking scenarios are:

1. No open space introduced at restock and 'like for like' species choice
2. A 10% increase in open space at restock and predicted species choices
3. A 20% increase in open space at restock and predicted species choices

These different assumptions were applied to the **Modified biological potential, thinning and felling assuming moderate wind risk measures – the 'headline' forecast**, to produce 3 variants of biological potential.

The predicted species choices are based upon current species proportions, but modified to reduce the proportion of tree species such as the larch genus, Corsican pine and lodgepole pine that are susceptible to current disease outbreaks. These reductions are replaced with increases in the amount of open space, broadleaves and less susceptible species. The predicted species choices can be found in Appendix D, Tables D3-D5 and are set at a national level (England, Scotland and Wales).

The yield classes applied to stands restocked within the forecast period are the mean yield classes observed in the NFI field survey to date for that region and species.

Currently clearfelled areas

Forest area that was currently clearfelled as of 31 March 2011 was not included in the 25-year forecast. It was acknowledged within the reports that not including some level of replanting would create a small underestimate of future production in most 25-year forecast results, which would be more evident in the later years of the forecast.

Not restocking currently clearfelled areas would, on the other hand, have a significant impact on the results of a 50-year forecast (and more so on a 100-year forecast), as such areas would become productive within the forecast period. To account for this the 50-year forecast restocks all clearfelled areas, both within FC/NRW and the Private sector, applying the restocking assumptions as described above in the section on restocking.

For the FC estate, the Sub-compartment database records of clearfelling were used to estimate area of clearfell. For the Private sector estate, the area of clearfell was first identified by aerial photography and then updated with satellite imagery. This was used in conjunction with the field survey to estimate stocked area and area of clearfell.

Overdue timber

'Overdue timber' is timber contained within stands that are already over the age prescribed for felling according to the management scenario used for a forecast at the start of the forecast period. Strict application of the rules of the scenario dictates that such stands be immediately felled on day one of the forecast. This approach was taken for all scenarios in the 25-year forecast, excepting the 2005 industry 'view' scenario. In the 25-year forecast the volumes immediately felled by reason of being 'overdue' were reported separately from other harvested volumes.

If the volume of overdue timber represents a significant amount of total standing volume, as it does in the Private sector, this indicates that a portion of the estate is not currently being managed according to the assumed scenario. As this occurs for the 'biological potential' scenarios, this in turn implies that the current practice, on at least a portion of the Private sector estate, is to leave some stands beyond the age of maximum MAI.

Since such stands are currently being managed in a way contrary to the assumed prescription, these, and some other stands that are currently below the age of maximum MAI, are also not likely to be managed in the assumed way in the future. As these 'overdue' stands represent a significant area of land and volume of timber, which will impact on a longer term timber forecast, special provision has been made for them.

In the 50-year forecast a separate series of prescriptions for overdue timber have been derived and implemented and these were run in parallel to the main scenario. For example, if the biological potential scenario is used, those stands less than age of maximum MAI will be managed according to that scenario, but for those stands currently beyond maximum MAI a separate prescription was used. The proposed prescriptions were developed in consultation with the private sector, allocating around 70% of overdue timber and are set out in appendix D, Table D2. The prescriptions take into account tree species, presence and impact of current tree diseases, age of stand in relation to age of maximum MAI and historical market trends in harvesting.

All areas felled as overdue were restocked in the forecast according to the restock scenario chosen, in common with any other felled stand in the forecast period.

Accuracy of estimates and forecasts from NFI sample data

The forecast results for individual surveyed squares were aggregated and scaled up to the areas identified by the woodland map, using standard statistical survey methodology, to produce the estimates and forecasts in this report. Along with these estimates and forecasts, associated sampling standard errors have also been calculated and reported, giving a measure of accuracy, conditional upon the underlying assumptions. The sampling standard error will account for random variation arising from the selection of the sample, and random measurement errors, but not from any systematic biases in the field measurements. However, because of the quality assurance process it is thought unlikely that any substantial biases of this nature are present in the survey data.

For estimates of current standing volumes and stocked areas, the sources of error that are not accounted for in the reported standard errors will be those arising from use of empirical models to estimate standing volumes from the recorded survey data and forecasting errors arising from the use of Forestry Commission growth and yield models. Sampling error makes the largest contribution to overall variability in these estimates and, as a result, the quoted standard errors are expected to be a good representation of the scale of the total error of the estimates.

For forecasts of future harvested and standing volumes and increment, the effects of unpredicted future events that impact upon the tree stock, and variations of future management strategies from those assumed by a particular scenario, are expected to cause the largest differences of forecasts from the eventual realised outcomes. The quoted sampling standard errors attached to a forecast are therefore indications of the variability of the estimates of future outcomes deriving from sampling of the population. Actual future outcomes are subject to the effects of unpredicted future perturbing events and deviations of future management of the woodland resource from that assumed by the scenario underlying the forecast. Sampling standard errors do not take such future uncertainties into account and therefore only indicate the expected scale of actual differences of forecasts from outcomes in the absence of future uncertainties. Taking account of such uncertainties would increase the standard errors attached to forecasts in such a way that forecasts further into the future are more uncertain than those made for near-term outcomes.

Impact of future events

The 2012 25-year forecast made certain assumptions about pests and diseases. The volumes set out in the main reports assumed no impact on production occurring from current or potential outbreaks of pests and diseases. Instead the volumes most likely at risk were reported upon separately, as well as being included in the main forecast. Through this it was planned that users of the forecast could make their own estimates about how much volume may be impacted upon and when. This 'neutral' approach was taken since reliably predicting the rate of spread and impact of the pests and diseases currently of concern was considered to be impractical.

This 50-year forecast takes the same approach to felling and thinning for the same reasons, but reports production for susceptible species alongside other species, making accommodations where restocking is concerned. For example, it is assumed that the advent of *Phytophthora ramorum* and *Dothistroma septosporum* (Dothistroma Needle Blight) make it unlikely that the planting of larch, Lodgepole pine and Corsican pine will continue at historical levels.

Hard to harvest sites

Whether timber on hard to harvest sites will come to market will depend on the economic viability of the harvesting at that point in time, which in turn will depend upon the technology of the time, the cost of harvesting and the value of timber at that time. These are all difficult factors to predict over a long forecast period; historically, ease of harvesting has alternated between making notable to little impact on production. The 2012 25-year forecast assumed that almost all coniferous timber within woodlands would come to market at some point, irrespective of ease of harvesting or site access. Figures on the proportion of 'difficult' sites to harvest were however provided, so users of the forecast could make their own estimate of what proportion of that timber would never come to market due to these factors. The 50-year forecast has taken the same approach and detailed statistics on hard to harvest areas can be found in the NFI Statistical Analysis Report *UK 25-Year Forecast of Softwood Availability*. In addition and in response to requests arising from the consultation process, a selection of these statistics for the 9594 sample squares have been broken down by NFI region within this report and can be found in Appendix C, figures C1 and C2.

For more information about the Inventory methodology, see the *National Forest Inventory forecasts methodology overview*.

Results

Tables 2 and 3 give the stocked area and standing volume of conifers by country and by sector (FC/NRW and Private sectors) as of 31 March 2012, the baseline for the forecast. Tables A1 and A2 in Appendix A provide breakdowns of these values by principal species.

Table 4 gives the 50-year forecast of softwood timber availability from the headline scenario for GB and each country, broken down by FC/NRW estate and Private sector estate. The results are presented as average annual availability of softwood timber in 5-year periods (apart from an initial 4-year period). Appendix B, Table B1 provides a breakdown of these values by principal species. Table B2 gives a breakdown of the forecast by the percentage of spruce within overall softwood volumes (spruce comprises Sitka spruce and Norway spruce), by country and NFI region.

Figures 2 and 3 illustrate the 25-year forecast, broken down by GB, country, sector and five-year period in Figure 2, and plotted at GB level only in Figure 3.

Table 5 and Figure 4 show the evolution of standing volume under the headline scenario used to derive the forecast results, in similar manner to Table 2 and Figure 3 for availability, while Table 6 and Figure 5 show the evolution of annual increment in like manner.

Figure 6 shows a schematic evolution of the forecast from the headline scenario in terms of future development of standing volume, production and net increment on a GB scale. From this, the essential functional relationships between these three key variables of the forecast can be observed. Similar presentations of these variables at the scale of individual countries are shown in Figures 7, 8 and 9 for England, Scotland and Wales respectively.

Table 7 gives the 50-year forecasts of softwood timber availability for GB for the private sector under the 6 scenarios investigated in the forecast, in terms of average annual production per period.

Figure 10 shows the impact of alternative restocking and species choice scenarios upon forecast volumes (contrasting scenarios 1, 2 and 3 in Table 7).

Figure 11 shows the impact of using alternative approaches to choosing when to harvest upon forecast volumes (contrasting scenarios 2, 5 and 6 in Table 7).

Figure 12 shows the impact of allocating overdue timber upon forecast volumes (contrasting scenarios 2 and 4 in Table 7).

Table 8 gives the area of currently clearfelled land as at 31 March 2012, broken down by sector, country and region.

The baseline date for these forecasts is 31 March 2012. The forecast starts in 2013, with 2013 defined as starting 1 April 2012 and ending 31 March 2013. This convention applies to all forecast years or periods quoted. All values are given in m^3 overbark standing (obs) and, as in previous forecasts, all annual harvested volumes include 'thinning plus felling'. Volumes are presented as average annual harvested volume for each five year period, except for 2013-16, which is a four year period. The values in the tables have been independently rounded, so may not add to the totals shown. In some breakdowns of Private sector estimates and forecasts (e.g. by principal species) the estimates or forecasts in the body of the table may not sum to the quoted total because each individual value, including the total, has been independently generated by the estimation procedure used for results from the NFI sample survey. Sampling standard errors (SE) attached to Private sector estimates are expressed in relative terms (%) to the right of the relevant estimate.

Appendix E, figure E1, illustrates the evolution of potential production over a 100 year forecast period, assuming the headline forecast scenario for the private sector and application of forest felling and thinning plans for the FC/NRW estate (augmented by modified biological potential in the later periods) and restocking as per Appendix D.

Appendix E, figure E2 illustrates the forecast volumes that arise over a 100 year period when the alternative harvesting scenarios (described on page 12) are applied to the Private sector estate.

Table 2 Stocked area of softwood at 31 March 2012

Country	FC/NRW	Private sector		Total
	area (000 ha)	area (000 ha)	*SE %*	area (000 ha)
England	127.6	178.9	*2*	**306.6**
Scotland	366.5	505.5	*1*	**872.0**
Wales	81.8	47.1	*3*	**129.0**
Great Britain	**576.0**	**731.6**	***1***	**1,307.5**

Table 3 Standing volume (overbark standing) of softwood at 31 March 2012

Country	FC/NRW	Private sector		Total
	volume (000 m^3 obs)	volume (000 m^3 obs)	*SE %*	volume (000 m^3 obs)
England	26,770	63,723	*2*	**90,493**
Scotland	80,189	146,700	*2*	**226,889**
Wales	19,427	17,939	*6*	**37,365**
Great Britain	**126,386**	**228,362**	***1***	**354,748**

Table 4 50-year forecast of softwood availability; annual average volumes within periods

Forecast period	FC/NRW	Private sector		Total
	volume ($000m^3$ obs)	volume ($000m^3$ obs)	*SE%*	volume ($000m^3$ obs)
England				
2013-16	1,632	2,945	*5*	**4,577**
2017-21	1,330	3,225	*5*	**4,555**
2022-26	1,211	2,903	*5*	**4,113**
2027-31	1,159	2,986	*5*	**4,145**
2032-36	1,066	2,850	*6*	**3,916**
2037-41	1,013	2,224	*6*	**3,237**
2042-46	1,055	1,848	*6*	**2,903**
2047-51	1,014	1,523	*5*	**2,537**
2052-56	828	1,431	*6*	**2,259**
2057-61	1,250	1,603	*6*	**2,853**
Scotland				
2013-16	4,220	5,708	*5*	**9,928**
2017-21	3,658	6,997	*5*	**10,656**
2022-26	3,516	7,830	*5*	**11,346**
2027-31	3,789	8,910	*5*	**12,700**
2032-36	3,215	8,847	*5*	**12,062**
2037-41	2,936	8,133	*5*	**11,069**
2042-46	2,730	6,527	*5*	**9,257**
2047-51	3,280	4,986	*5*	**8,266**
2052-56	2,886	5,679	*4*	**8,566**
2057-61	2,339	5,627	*4*	**7,966**
Wales				
2013-16	1,082	901	*16*	**1,983**
2017-21	991	949	*13*	**1,940**
2022-26	895	1,087	*14*	**1,982**
2027-31	778	775	*15*	**1,553**
2032-36	934	736	*15*	**1,670**
2037-41	794	679	*15*	**1,473**
2042-46	531	490	*15*	**1,021**
2047-51	585	521	*14*	**1,106**
2052-56	495	734	*13*	**1,229**
2057-61	679	694	*12*	**1,373**
Great Britain				
2013-16	6,933	9,554	*4*	**16,487**
2017-21	5,980	11,171	*4*	**17,151**
2022-26	5,622	11,820	*4*	**17,442**
2027-31	5,726	12,671	*4*	**18,398**
2032-36	5,216	12,433	*4*	**17,649**
2037-41	4,744	11,035	*4*	**15,779**
2042-46	4,316	8,865	*4*	**13,181**
2047-51	4,879	7,030	*4*	**11,909**
2052-56	4,209	7,845	*3*	**12,054**
2057-61	4,269	7,924	*3*	**12,193**

Figure 2 50-year softwood forecast summary

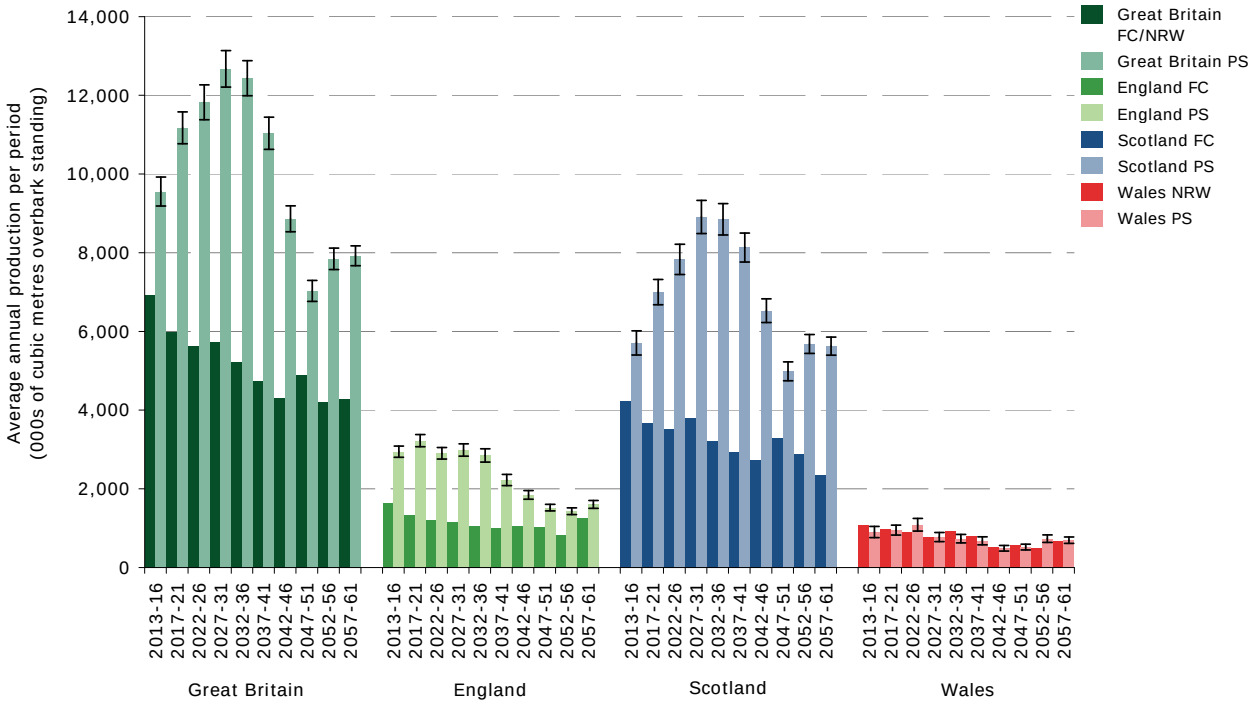


Figure 3 50-year forecast of softwood standing volume by sector

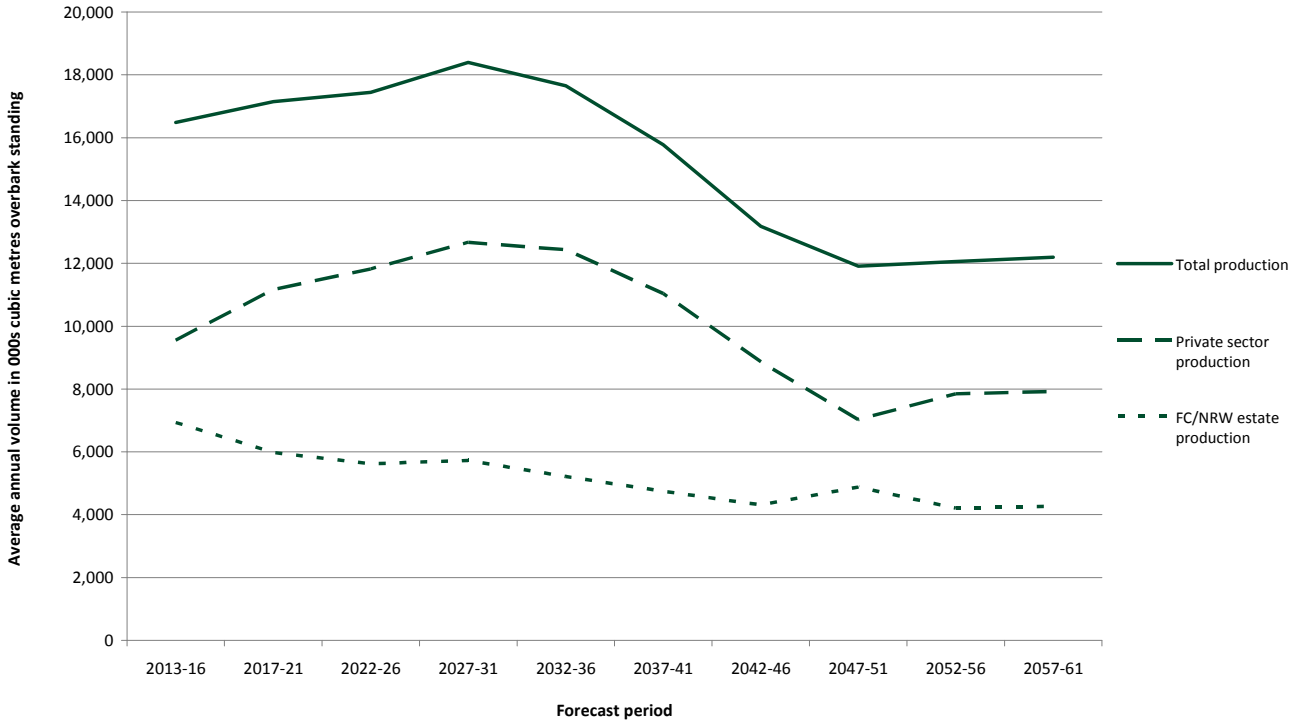


Table 5 50-year forecast of softwood standing volume; annual average volumes within periods

Forecast period	FC/NRW	Private sector		Total
	volume ($000m^3$ obs)	volume ($000m^3$ obs)	*SE%*	volume ($000m^3$ obs)
England				
2013-16	25,754	59,904	*2*	**85,658**
2017-21	25,665	55,669	*2*	**81,334**
2022-26	25,351	49,020	*3*	**74,371**
2027-31	25,162	41,874	*3*	**67,036**
2032-36	25,164	34,712	*3*	**59,877**
2037-41	25,435	29,726	*3*	**55,162**
2042-46	25,573	26,736	*3*	**52,309**
2047-51	25,914	26,428	*3*	**52,343**
2052-56	26,460	28,198	*3*	**54,658**
2057-61	26,926	30,389	*3*	**57,315**
Scotland				
2013-16	77,899	145,899	*2*	**223,798**
2017-21	76,254	146,074	*2*	**222,328**
2022-26	73,496	139,525	*2*	**213,021**
2027-31	70,394	130,362	*2*	**200,756**
2032-36	68,521	112,057	*2*	**180,578**
2037-41	68,465	97,279	*2*	**165,744**
2042-46	69,734	86,798	*2*	**156,532**
2047-51	71,768	85,351	*2*	**157,120**
2052-56	73,382	86,071	*2*	**159,454**
2057-61	78,028	88,217	*2*	**166,245**
Wales				
2013-16	18,753	17,147	*5*	**35,899**
2017-21	18,236	15,535	*6*	**33,772**
2022-26	17,708	13,289	*6*	**30,996**
2027-31	17,884	11,207	*7*	**29,091**
2032-36	17,378	9,835	*7*	**27,214**
2037-41	16,879	8,987	*7*	**25,865**
2042-46	18,347	9,187	*7*	**27,534**
2047-51	20,023	9,582	*6*	**29,605**
2052-56	22,034	9,743	*6*	**31,777**
2057-61	24,077	10,123	*5*	**34,200**
Great Britain				
2013-16	122,405	222,950	*1*	**345,355**
2017-21	120,156	217,278	*1*	**337,434**
2022-26	116,555	201,833	*1*	**318,388**
2027-31	113,441	183,442	*2*	**296,883**
2032-36	111,064	156,605	*2*	**267,669**
2037-41	110,779	135,993	*2*	**246,772**
2042-46	113,654	122,721	*2*	**236,375**
2047-51	117,706	121,361	*2*	**239,067**
2052-56	121,876	124,013	*2*	**245,889**
2057-61	129,031	128,730	*1*	**257,760**

Figure 4 50-year forecast of softwood standing volume

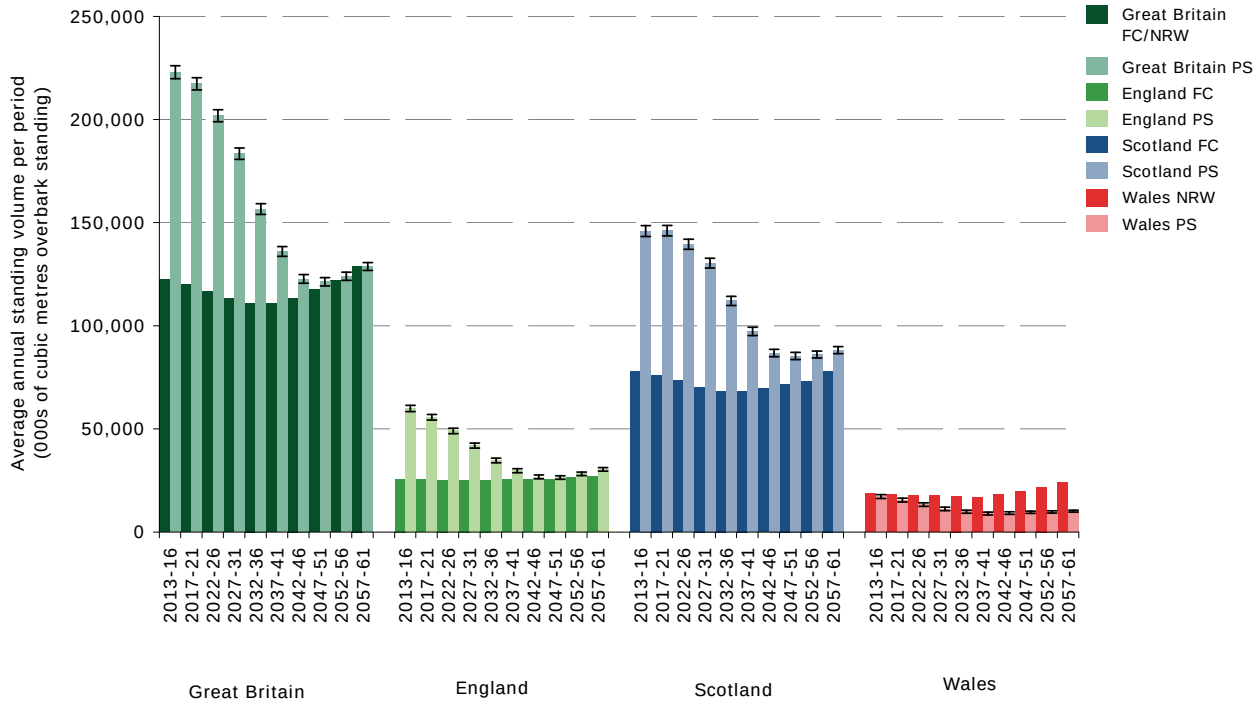


Table 6 50-year forecast of softwood increment; annual average volumes within periods

Forecast period	FC/NRW	Private sector		Total
	volume ($000m^3$ obs)	volume ($000m^3$ obs)	*SE%*	volume ($000m^3$ obs)
England				
2013-16	1,235	2,085	*2*	**3,320**
2017-21	1,252	1,964	*2*	**3,216**
2022-26	1,160	1,701	*3*	**2,861**
2027-31	1,120	1,523	*3*	**2,643**
2032-36	1,082	1,395	*3*	**2,477**
3037-41	1,074	1,397	*3*	**2,471**
2042-46	1,067	1,493	*3*	**2,560**
2047-51	1,065	1,669	*3*	**2,734**
2052-56	1,064	1,868	*2*	**2,932**
2057-61	1,081	2,045	*2*	**3,126**
Scotland				
2013-16	3,464	6,510	*2*	**9,974**
2017-21	3,292	6,685	*2*	**9,977**
2022-26	3,035	6,427	*2*	**9,461**
2027-31	3,026	6,087	*2*	**9,113**
2032-36	3,008	5,500	*2*	**8,508**
3037-41	3,114	5,186	*2*	**8,301**
2042-46	3,253	5,035	*2*	**8,288**
2047-51	3,379	5,285	*2*	**8,664**
2052-56	3,426	5,668	*1*	**9,094**
2057-61	3,505	6,035	*1*	**9,540**
Wales				
2013-16	764	646	*5*	**1,410**
2017-21	846	616	*5*	**1,463**
2022-26	829	544	*6*	**1,373**
2027-31	862	495	*6*	**1,358**
2032-36	835	498	*5*	**1,333**
3037-41	789	537	*5*	**1,327**
2042-46	834	588	*5*	**1,421**
2047-51	919	656	*5*	**1,576**
2052-56	981	705	*4*	**1,685**
2057-61	1,007	726	*4*	**1,733**
Great Britain				
2013-16	5,463	9,241	*1*	**14,704**
2017-21	5,390	9,266	*1*	**14,655**
2022-26	5,024	8,672	*1*	**13,696**
2027-31	5,008	8,106	*1*	**13,114**
2032-36	4,925	7,393	*1*	**12,318**
3037-41	4,977	7,121	*1*	**12,098**
2042-46	5,153	7,116	*1*	**12,269**
2047-51	5,364	7,611	*1*	**12,974**
2052-56	5,470	8,241	*1*	**13,711**
2057-61	5,593	8,806	*1*	**14,400**

Figure 5 50-year forecast of softwood increment

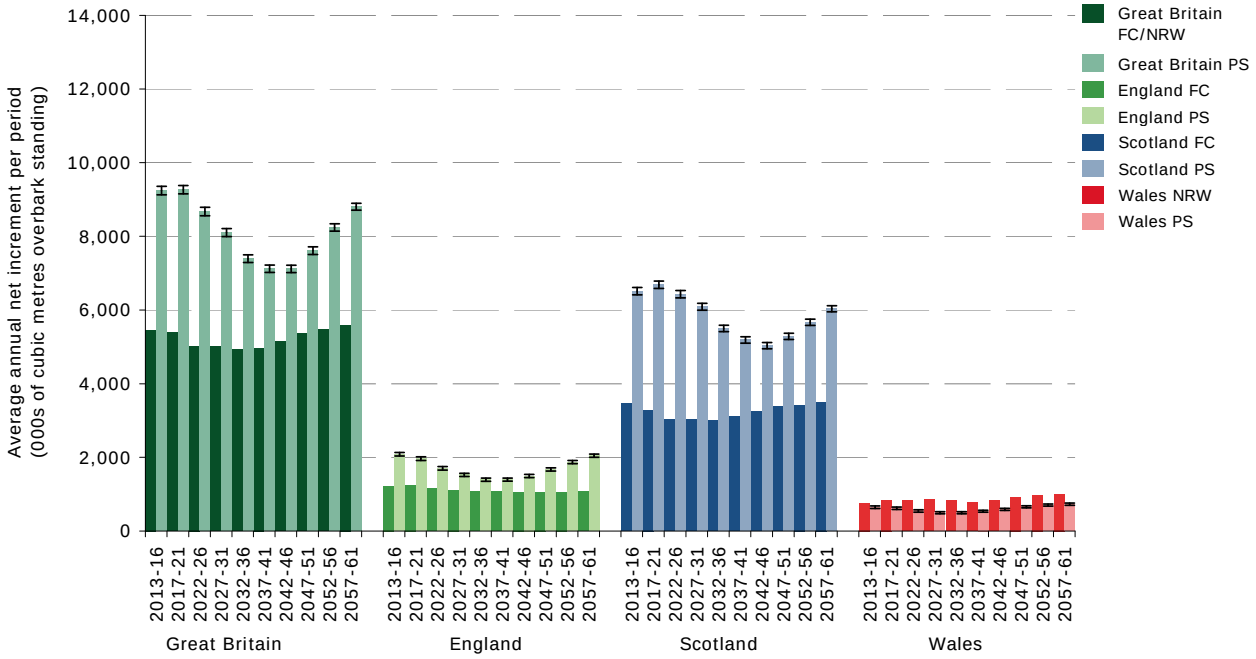


Figure 6a 50-year summary of softwood standing volume, increment and production for GB

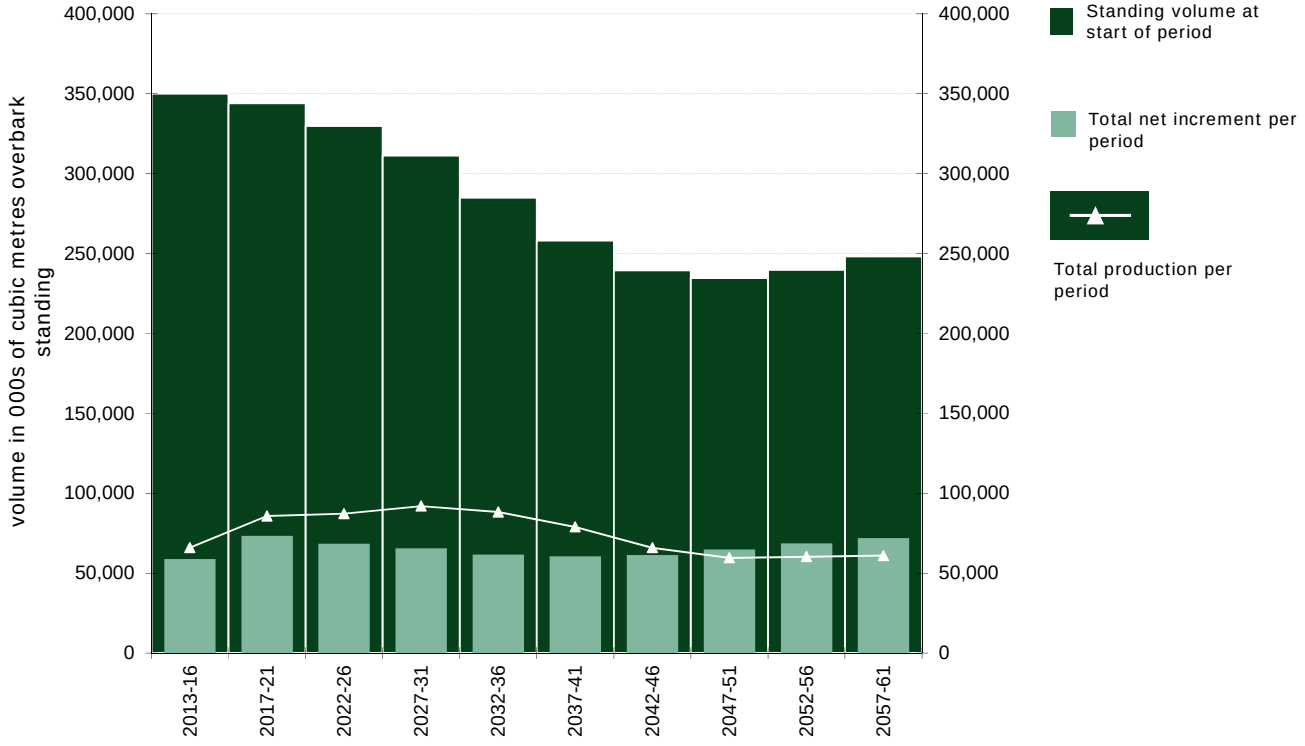


Figure 6b 50-year summary of softwood standing volume, increment and production for GB (FC/NRW and PS)

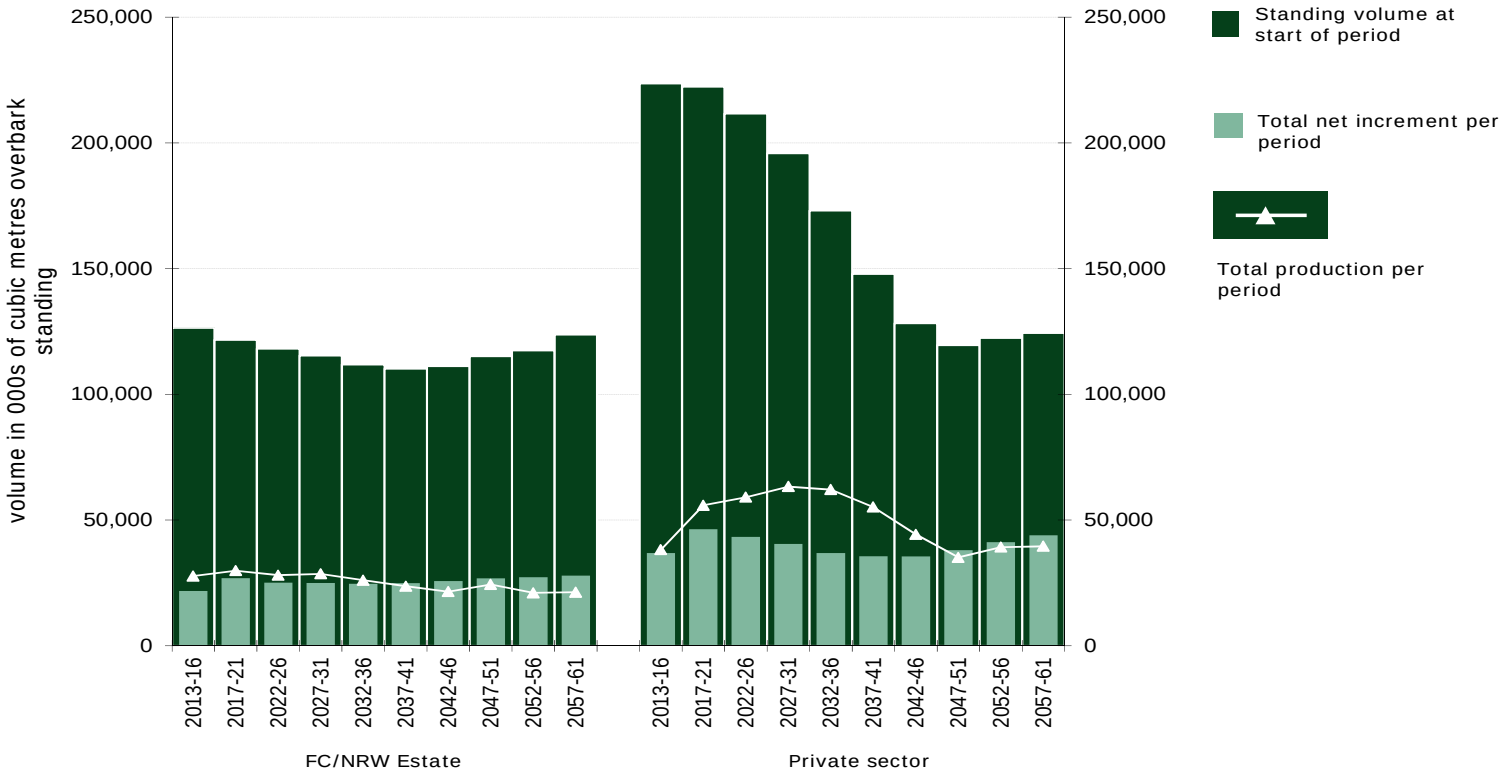


Figure 7 50-year summary of softwood standing volume, increment and production for England (FC and PS)

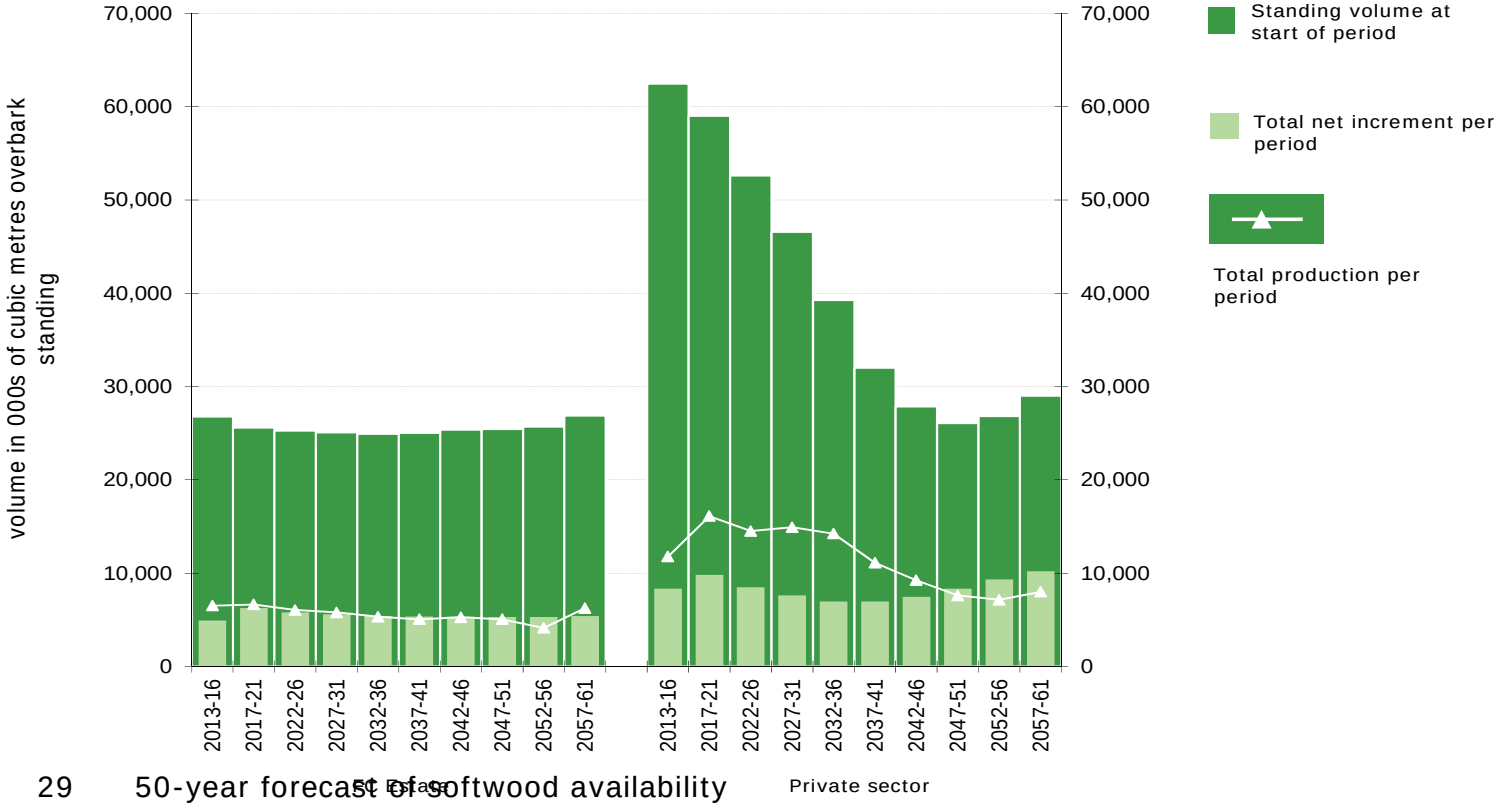


Figure 8 50-year summary of softwood standing volume, increment and production for Scotland (FC and PS)

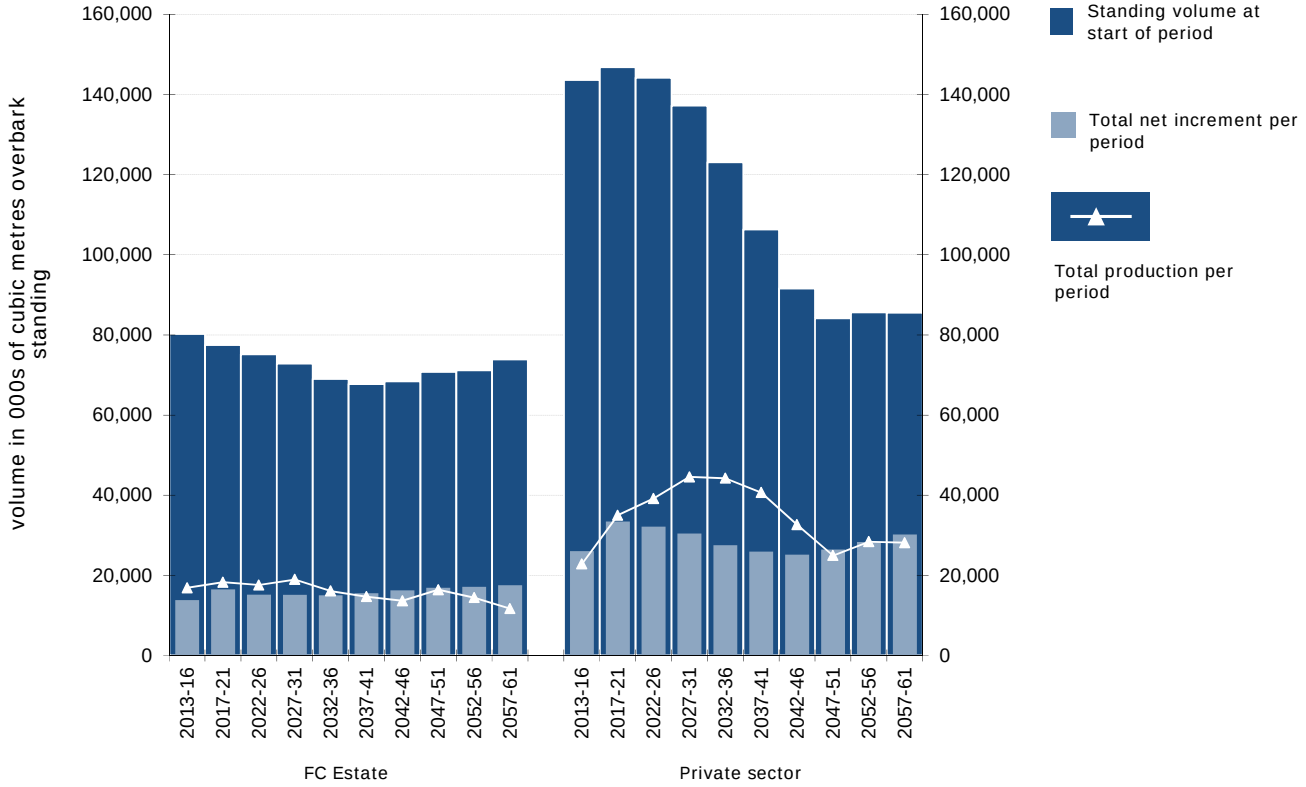


Figure 9 50-year summary of softwood standing volume, increment and production for Wales (NRW and PS)

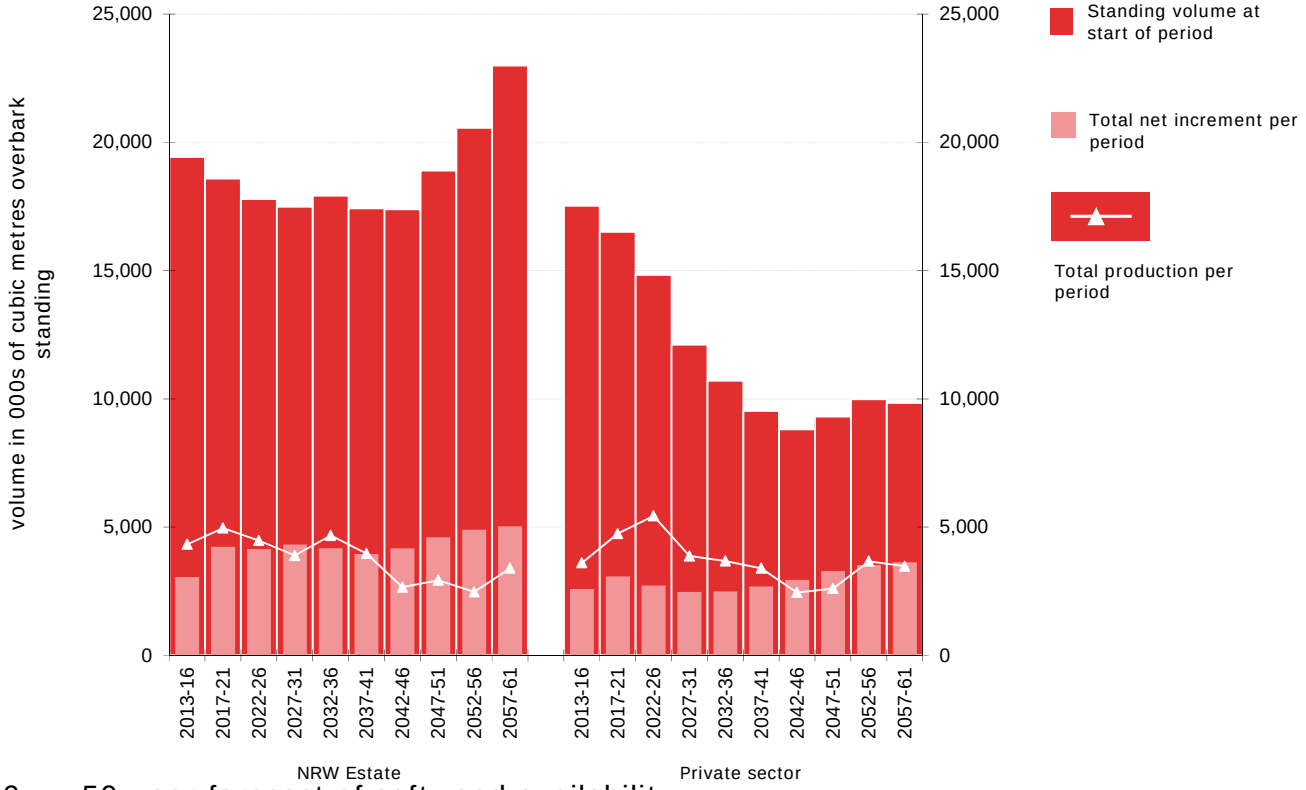


Table 7 Impacts of harvesting scenarios

Scenario	Units	Standing volume 2012	Standing volume 2061	Overdue	2013-2016	2017-2021	2022-2026	2027-2031
1. Modified biological potential. no open space is introduced	000m^3 obs	223,593	131,514	0	9,554	11,171	11,820	12,687
2. Modified biological potential, 10% reduction in conifer stocked area	000m^3 obs	223,593	128,827	0	9,554	11,171	11,820	12,671
3. Modified biological potential, 20% reduction in conifer stocked area	000m^3 obs	223,593	118,348	0	9,554	11,171	11,820	12,671
4. Applies the assumptions used in the 25-year softwood forecast	000m^3 obs	225,080	111,312	48,962	7,827	9,535	10,647	11,672
5. Felling and thinning to the 2005 industry 'view'	000m^3 obs	225,018	150,428	0	10,801	11,825	11,737	11,096
6. Felling stands when they achieve a top height of 25m	000m^3 obs	223,599	165,957	0	10,721	10,005	11,175	10,455

Scenario	Units	2032-2036	2037-2041	2042-2046	2047-2051	2052-2056	2057-2061	Cumulative Production to 2061
1. Modified biological potential. no open space is introduced	000m^3 obs	12,520	11,172	9,032	7,227	8,405	9,190	951,480
2. Modified biological potential, 10% reduction in conifer stocked area	000m^3 obs	12,433	11,035	8,865	7,030	7,845	7,924	928,342
3. Modified biological potential, 20% reduction in conifer stocked area	000m^3 obs	12,403	10,974	8,761	6,877	7,628	7,543	878,897
4. Applies the assumptions used in the 25-year softwood forecast	000m^3 obs	11,440	10,520	8,388	6,571	8,324	8,197	928,790
5. Felling and thinning to the 2005 industry 'view'	000m^3 obs	8,742	7,156	6,204	6,000	5,909	5,990	724,968
6. Felling stands when they achieve a top height of 25m	000m^3 obs	8,817	8,283	6,846	8,064	8,668	7,051	831,481

Figure 10 Impact of introducing open space and species conversion

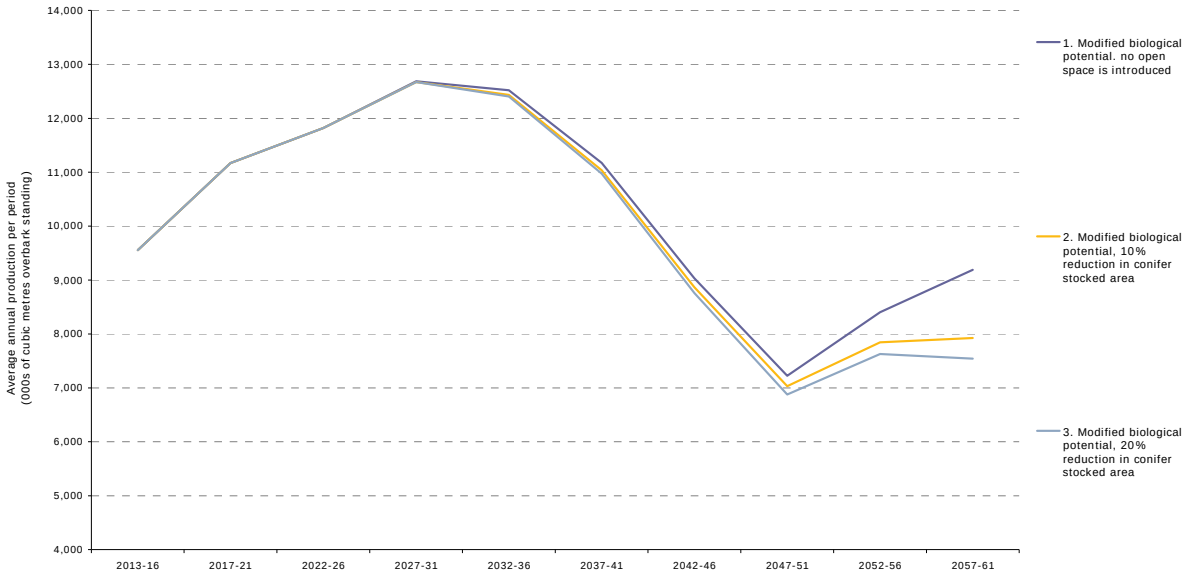


Figure 11 Impact of different approaches to determining age of felling

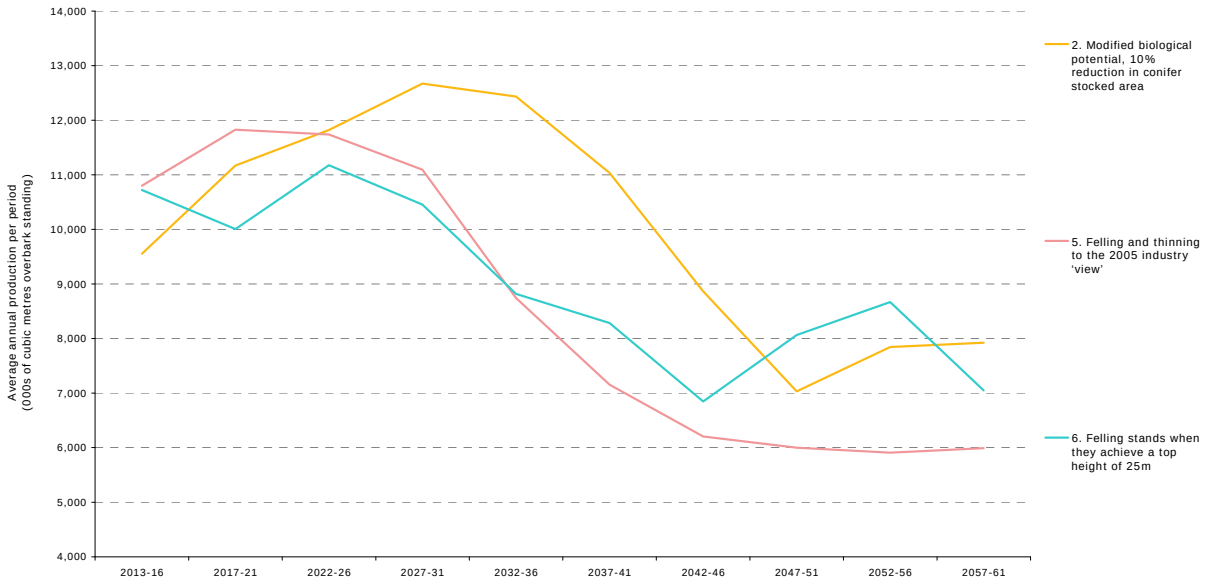


Figure 12 Impact of allocating a proportion of overdue timber for harvesting

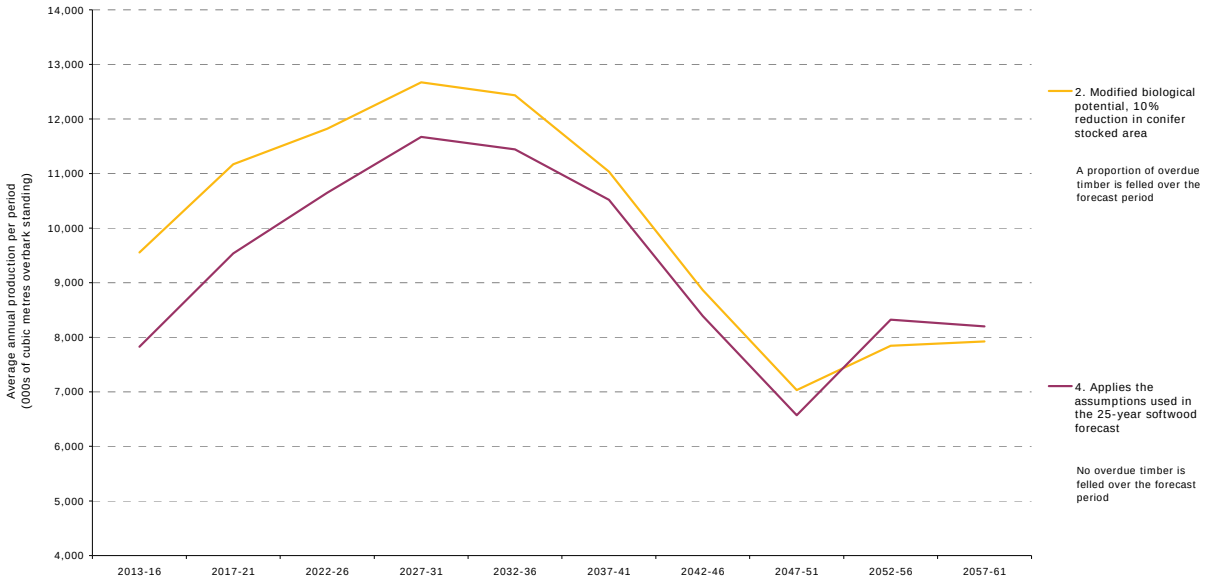


Table 8 Clearfelled area at 31 March 2012

All conifers	FC/NRW	Private sector		Total
	area (000 ha)		*SE%*	area (000 ha)
England	**8.5**	**8.8**	***13***	**17.3**
North West England	1.2	1.3	*33*	**2.6**
North East England	2.3	1.4	*38*	**3.7**
Yorkshire and Humber	1.2	1.1	*30*	**2.4**
East Midlands	0.5	0.4	*65*	**0.9**
East England	0.7	0.5	*51*	**1.2**
South East England	0.8	2.5	*26*	**3.3**
South West England	1.0	1.1	*28*	**2.1**
West Midlands	0.7	0.4	*48*	**1.1**
Scotland	**33.2**	**37.0**	***8***	**70.1**
North Scotland	7.3	5.9	*22*	**13.2**
North East Scotland	5.9	4.8	*21*	**10.7**
East Scotland	1.6	3.7	*21*	**5.2**
South Scotland	9.1	12.6	*13*	**21.7**
West Scotland	9.4	10.0	*13*	**19.4**
Wales	**6.2**	**2.9**	***24***	**9.1**
Great Britain	**47.8**	**48.7**	***6***	**96.5**

What the results tell us

Over the 50 year period average annual potential production is higher than the current (2012) level of production of 11.8 m^3 obs (9,652,000 green tonnes in 2012 – FC Forestry Statistics 2013). The general trend in potential production is comparable to that of previous forecasts for the first 25 years of the forecast period, in that volume levels increase to a peak and then begin to decline to a level higher than current levels of production. However, the trend for the last 25 years of the forecast period is different with a progressive reduction in potential production until levels are similar to current levels of actual production. This is followed by a short period where levels of potential production gradually rise. (The 100-year forecast illustrated in Appendix E shows this to be a trend which would continue through the 50 to 100 year period.)

Within this overall trend there are different trends forecast for the FC/NRW and Private sector estates.

Forecast for the FC/NRW estate

The forecast set out in this report for the FC/NRW estate is broadly comparable to the forecast reported in 2012 – both in terms of total production and the shape and timing of the profile of production. This is because they have been derived in a similar way; the inventory estimates used in 2012 are consistent with those used in this forecast and felling and thinning rates have not changed noticeably.

The FC/NRW estate is projected to generate an average of 5.2 million m^3 per annum for the next 50 years, if existing forest management plans are followed and production is not constrained. (However, the published intention in Scotland and Wales is to cap production below management plan levels in the short term.) 6.9 million m^3 per annum would be produced in the first period (2013–16) and this will decline to an average of 4.3 million m^3 per annum in the final five-year period (2057-61). The proportion of spruce varies through the 50 year period of the forecast, starting at 58% in the first period (2013-16) and ending at 67% in the last period of the forecast (2057-61).

However, there has been an increase in total volume over the first 5 year period when comparing the respective forecasts (2012 and 2014). A significant element of this shift is the inclusion of overdue timber into the forecast compared to the 2012 forecast. Another factor is volume arising from planned land sales, which were excluded from the 2012 forecast. (In practise, whether and when this volume will be realised is not known.) The inclusion of restocking 48,000 hectares of currently clearfelled land into the forecast will also have increased levels of production compared to the 2012 forecast. All three factors

have increased the overall forecast volumes for the Forestry Commission and NRW estates.

In the later period of the current forecast, beyond 25 years, the level of potential production declines from the earlier period to an average annual availability of around 4.5 million m^3, which is 35% lower than forecast availability in the first period of 6.9 million m^3. The decline reflects, in the main, the underlying age class structure of the FC/NRW estate, the assumption to fell overdue timber in the first few years of the forecast and the assumption of reducing stocked area of conifers by 10% at restock. Also the use of broad-brush species choices at restock based upon a predicted National distribution of species as opposed to a predicted regional distribution will have an impact. This will occur where it is the case that regional species choices in the past were rational and tailored to suit individual regions. Thus when applying a predicted National distribution to a region it is likely to make some sub-optimal species choices within that region. This will depress future yield class and production, as species may be introduced into regions were they may produce less yield, lowering yield class overall.

The future pattern of softwood availability from the FC/NRW estate reflects the policy of restructuring the estate through the design planning process. The forecast shows that, over the 50 year forecast period as a whole, average annual net increment and removals are almost in balance (average of 5.19 million m^3 annual availability versus 5.24 million m^3 net increment), indicating a stable and sustainable resource.

In the 50 – 100 year timeframe, however, FC/NRW production increases, exceeding that of the first 50 years, again reflecting the underlying age class structure and the assumption that areas felled during the forecast will be restocked with new stands.

This is a long term and strategic forecast and as such will not entirely reflect current policy and is unlikely to reflect future policy as the forecast is based on felling and thinning plans as of 31 March 2012. For example Forestry Commission Scotland is in the process of aligning their current felling and design plans to their strategic target of smoothing long term production. It should also be noted that whilst Forestry Commission has made a series of commitments associated with the standard 25-year forecast, these commitments do not apply to the 50-year forecast.

Forecast for the Private sector estate

Over the 50 year period average annual potential production is higher than current levels of production of 6.3 million m^3 obs (5.2 million green tonnes as of 2012 – Forestry Statistics 2013). The general trend in potential production is comparable to that of the previous 2012 forecast for the first 25 years of the forecast, in that volume levels increase to a peak and then begin to decline to a level higher than the starting point. This is not surprising as the forecasts followed the same basic approach, with similar approaches in the harvesting scenarios used and similar (but extended) baseline data gathered from the NFI field survey.

Analysis of the data has shown that the small differences for the first 25 years between the two forecasts are due to four main factors:

- The base year for the forecast moving from 2011 to 2012, reflecting real change on the ground.
- Alternative harvesting scenarios being applied.
- Extended baseline data, increasing from 4036 samples to 9594 samples.
- Marginal changes in methodology.

However, the trend for the last 25 years of the forecast period shows a progressive reduction in potential production to a point where levels are lower than the first period of the forecast and are similar to current levels of actual production. This low point is followed by a short period where levels of potential production rise. This rising trend continues into the 50 to 100 year period.

Analysis of the underlying factors influencing the future trend in potential production has shown that the profile of the Private sector estate reveals three main contributory factors, which are discussed in more detail below:

- Age class structure
- Harvesting activity
- Overdue timber

Age class structure

The main factor behind the profile of potential production for the private sector estate is the age class structure of existing stands. The NFI report *Standing timber volume for coniferous trees in Britain* provides an in - depth study of the composition of conifers within GB. The report shows that 42% of stocked area in conifers in the private sector is within stands aged between 21 and 40 years, and a further 26% is within stands aged between 41 and 60 years. Further clustering of stocked area within smaller age bands occurs within these classes. Such a distribution of ages leads to a clustering of harvesting activity within similar bands of time. The clustering of coniferous tree ages is a product of the development of the planted forest resource in GB and has led to this uneven planting and age profile, which is the principal determinant of the production profiles in the 50-year forecast. The principles and rationale behind equating age class structure and potential production profiles are expanded upon in the NFI report *Interpreting NFI Timber Volume Forecasts.*

Harvesting activity

The 'biological potential' scenarios used in this forecast represent the volume of timber that would be produced if felling took place in the year of maximum MAI and thinning conforms to management table thinning (except in high wind risk areas, as noted previously). These therefore represent an upper limit of what could be produced sustainably. In contrast, the 2005 forecast scenario uses an 'Industry view' of likely future harvesting activity, which assumes shorter rotations, as does the scenario assuming harvesting at 25 metres top height, both of which depress cumulative volume production. For the 2005 industry 'view' this depression of production is further compounded by assuming low levels of conifer restocking and is, as a result, the most pessimistic scenario.

Choosing biological potential-based scenarios over the 2005 approach illustrates the 'upper ceiling' of potential production attainable through harvesting choices. This in combination with thinning and restocking assumptions leads to a projected increase in cumulative volume production of around 22% over the 50-year period (and by a similar percentage over a 100-year period according to the analysis summarised in Appendix E). This principally arises because the biological potential forecast uses longer rotations and a higher proportion of thinning than those used in the 2005 scenario, but later in the forecasts lower restocking rates of conifer in the 2005 assumptions will increasingly account for the difference. The alternative harvesting scenario of felling all stands at 25 metres in height also depresses cumulative volume production, in this case by more than 10% over the 50-year forecast period when compared to the headline scenario that involves felling and thinning to biological potential.

As well as impacting cumulative production, the timing of felling alters the profile of production significantly between the three main approaches to scenarios, with the 2005 and 25 m scenarios shortening rotations and bringing forward and depressing the likely peak of production. For example, when compared with biological potential, the pattern of production for the scenario based on the 2005 Industry view is very different between five-year periods, with, for example, around 30% less production in the 2032–36 period. This effect can be seen in figure 11 and Appendix E, Figure E1.

Shorter rotations produce significantly less volume per hectare at time of clearfell and reduce overall standing volume compared with biological potential. The shorter rotation of the 2005 Industry view scenario can maintain cumulative production in the short term, compared to the longer rotations of the biological potential scenario, by bringing volume forward from the next rotation, but in the medium term depresses volume significantly.

Such variation in potential production shows how changes in overall harvesting activity can have a significant impact on the timing and level of volume forecasts within periods and demonstrates the difficulty in accurately predicting actual levels of future harvesting. They also show the cost in volume terms of using shorter rotations. The *Interpreting National Forest Inventory timber volume forecasts* report discusses how approaches to harvesting influence and constrain the amount of timber that is likely to be harvested in any given period.

Overdue timber

In the 2012 25-year forecast this volume was modelled as being felled in the first year of the forecast and was reported separately. The harvesting scenario used for the 25-year forecast highlighted that there was around 46 million m^3 of overdue timber within GB, with the majority (42 million m^3) on the Private sector estate. Whether this timber is available for harvesting or not will depend upon a number of factors, including management objectives and environmental constraints. In practice a wide array of felling and retention practices will apply to these stands, with some being retained and some felled at different points in time in the future.

The 2005 forecast categorised 25.4 million m^3 of timber as ‘overdue’. Based on expert opinion, a proportion of this volume (around 53%) was allocated for felling over the 20-year forecast period and this was combined with the five-year average annual volumes. The 50-year forecast allocates around 70% of this timber for the private sector over the forecast period, with a higher allocation to the earlier periods. This approach increases forecast production for the 50-year forecast in comparison to the 2012 25-year forecast and the impact can be seen in figure 12.

Impact of restocking

The 2012 25-year forecast did not restock currently clearfelled land, but did include 'like for like' restocking after future clearfelling for the FC/NRW estate and the Private sector estate.

The 50-year forecast restocks currently clearfelled land and reduces stocked area at restock, as well as altering the species mix.

These differences do not impact greatly within the first 25 years of either forecast, but in the second half of the 50-year forecast the impacts are evident. As there are around 49,000 hectares of currently clearfelled sites on the private sector estate, adding this area to the area under production increases production. This can be seen in the comparison of the results in figures 10 and E1 (Appendix E). Similarly there are around 48,000 hectares of currently clearfelled land on the FC/NRW estate that have been restocked in the 50-year forecast.

Also, as for the FC/NRW forecast, the use of broad-brush species choices at restock based upon a predicted National distribution of species as opposed to a predicted regional distribution will have an impact. This will occur if regional species choices in the past were rational and tailored to suit individual regions. Thus when applying a predicted National distribution to a region it is likely to make some sub optimal species choices within that region. This will depress future yield class overall, as species may be introduced into regions where they may produce less yield, lowering yield class overall.

The impact of restocking at 100%, 90% and 80% can depress future potential timber production by considerable amounts in later periods of the forecast, reaching differences of 1.2 million m^3 and 1.6 million m^3 per year 50 years in the future for 10% and 20% restock area reductions respectively. (These differences expand further beyond the 50-year period, reaching 1.8 and 2.7 million m^3 respectively after 100 years, according to the forecast summarised in Appendix E.)

Yield class

The yield classes applied in this forecast for the Private sector estate are derived from the NFI fieldwork. Physical measurements were taken on a stand-by-stand basis to derive the yield classes applied in the growth and yield models used to project future development of each stand. For young stands on which an estimated yield class could not be reliably established, the mean yield class observed on older stands of the same species in the same NFI region were used. These are based upon 9594 NFI samples in the current forecast, as opposed to the 4036 used in the 2012 forecast. The mean yield classes derived from the larger sample were marginally increased over those from the smaller sample, but not to an extent that significantly impacts on overall volumes. The mean yield classes calculated for the 2012 forecast are published in the Statistical analysis report *UK 25-year forecast of softwood availability*.

Species composition of volumes

The proportion of spruce contributing to total volume in the private sector ranges between a minimum of 51% in 2013-16 to a maximum of 67% in 2027-31, with an average of 61% for the forecast period.

Impact of future events

The impact of future harvesting events on production levels in the Private sector is explored through the use of the scenarios. However, as owners have a wide range of objectives, it is unlikely that the majority of forests and woodlands will be managed to the biological potential scenario used for this forecast. For example, the biological potential forecast relies on the assumption of higher levels of thinning and longer rotations than are typical under current practice. Therefore cumulative volume production is likely to be less if current approaches to harvesting continue. Actual harvesting activity may follow a number of possible patterns and thus actual production will almost certainly vary from the forecast results. In addition to the impact of harvesting decisions, there are other unpredictable external factors that are likely to have an impact on all production over the period of the forecast. For example, pest and disease outbreaks (current risks include Dothistroma needle blight and *Phytophthora ramorum*), economic factors, severe weather events (windthrow), changes in land use (wind farms and habitat restoration) and changes in government policy (affecting for example restock grants and regulation, land sales and forest management) will all have impacts.

Impact of harvesting on standing volume and increment

The level and frequency of thinning and felling will have an impact on standing volume and increment over time. If removals exceed increment then standing volumes will be reduced and vice versa. Standing volume for both public and private sector for GB at 31 March 2012 is around 355 million m^3. As the harvesting scenarios of this forecast are applied, total standing volume declines to an average annual figure of around 236 million m^3 by the 7th period of the forecast (2042-46). By the last period of the forecast (2057–61) the average annual standing volume rises to 258 million m^3. This profile arises as forecast removals exceed forecast increment. Annual net increment is 14.7 million m^3 for the first period (2013–16) and for the remaining periods ranges between 12.1 and 14.7 million m^3 per annum with an average of 13.4 million m^3 per annum over the whole 50-year forecast period. The forecast average annual removals for the forecast period is 15.2 million m^3, and as such it can be concluded that increment is currently forecast to be less than potential harvest within GB, which is the cause of the reduction in standing volume. However, this relies on the harvesting assumptions used, which will vary over time.

The increment fluctuations reflect the changing age class structure of the growing stock and the proportion of clearfelled land to stocked area at any one point in time. Further expansion on this phenomena can be found in the NFI report *GB 25-year forecast of standing coniferous volume and increment*. Similarly, age class impacts on the proportion of increment that can be sustainably cut, with older age classes supporting a higher proportion of harvesting as opposed to lower age classes. This factor, alongside harvesting choices, drives the relationship between increment and level of harvest.

Thus it can be seen that a large determinant in the forecast for total standing volume in GB is the unusual age class structure. The development of a planted forest resource has led to an uneven planting and age profile which, in combination with the assumption to fell, is the principal determinant of standing volume. This is in contrast to forests of a more evenly distributed age, which result in a more even development of total standing volume, increment and production through time. Any comparisons of level of removals to increment should account for this. It should also be noted that this forecast provides a limited 50-year time window of the evolution of standing volume, which represents a fraction of the life cycle of GB forests. When looking at a 100-year or greater window, a different perspective would be apparent, and the nature of biological potential-based scenarios is such that increment and removals will be in balance over long timescales.

The reports *standing timber volume for coniferous trees in Britain*, *25-Year forecast of standing coniferous volume and increment* and *Interpreting National Forest Inventory timber volume forecasts* discuss this subject in more detail.

Conclusions

During the course of the development of the 25-year forecast it became apparent that if a full picture of the evolution of potential timber production and standing volume within GB was to be gained a longer term forecast was necessary. This was principally because the average rotation length of a conifer stand exceeds 25 years. To achieve such longer term forecasts modelling tools had to be developed to take better account of factors that would influence longer term forecasts, such as future restocking choices and how overdue timber would be managed. That approach and development, commenced in 2008, is now completed and this 50-year forecast provides a window onto how potential production, standing volume and increment will evolve over time, under alternative harvesting and restocking scenarios.

These scenarios all paint a similar picture, with average levels of potential production in the 50 year forecast period being higher than actual production in the previous 50 or 25 years, and with potential production levels fluctuating over time. A proportion of this timber is therefore additional to current domestic utilisation, but past domestic utilisation has been variable and it is therefore possible that it will also change from current levels in the future. The timing of additional timber coming to market in the forecasts varies significantly within the forecast periods and to some extent between harvesting scenarios. It should also be noted that the further into time that the forecast projects, the more contingent it is upon the assumptions used around restocking and harvesting and the less upon the baseline condition of the resource assessed by the current inventory. That being said the scenarios used have been developed through wide consultation and are sensitivity tested through the provision of several scenarios, which all point to a probable trend of potential production.

The general trend predicted by the first 25 years of the 50-year forecast is comparable to that of previous forecasts in that volume levels rise to a peak and then begin to decline to a level which is still higher than the starting point. For the period 25 to 50 years however, an overall decline in potential production is observed with a levelling off of potential production at around 12.2 million m^3 per annum. The initial peak in potential production in the first 25 years of the forecast is driven by the underlying age class structure of the forests in Britain, which reflects the boost in planting from the post-war period through to the late 1980s. The subsequent reduction in potential production in the following 25 years is a result of lower levels of planting from 1990 onwards. This overall pattern of an initial rise to a peak, followed by a decline and subsequent recovery is followed in each country, but there are variations in the level of fluctuation and the timing of the phases. These patterns also vary between NFI regions.

The Forestry Commission/NRW forecast predicts production of softwood timber at a level reasonably consistent with previous forecasts. The volume of timber potentially available over the forecast period falls from a potential 6.9 million m^3 in the first period (2013–16) to 4.3 million m^3 in the final period (2057–61), averaging 5.2 million m^3 per annum over the forecast period, of which around 70% is produced from spruce. However, it is the published intention in Scotland and Wales to constrain production in the short term with a view to smoothing production over the medium to long term.

There is a significant increase in potential production for the Private sector, followed by a decrease. The volume of timber potentially available over the forecast period rises from 9.6 million m^3 in the first period (2013–16) to a peak of 12.7 million m^3 in the fourth period (2027–31), before declining to 7.0 million m^3 in 2047-51, then recovering marginally to 7.9 million m^3 in the final period (2057–61). Over the 50 year forecast period, around 61% of timber production from the Private sector is from spruce.

The principal determinant in the forecast of standing volume in GB and its relationship to potential harvest and increment is the unusual age class structure of GB woodlands. The development of a planted forest resource has led to an uneven planting and age profile which, in combination with the assumption to harvest at maximum MAI, determines the changes in the relationships between standing volume, potential harvest and increment through the forecast period.

When and if timber is harvested will depend on a number of factors, not least of which are the choices made by the Forestry Commission/NRW and Private sector forest and woodland owners. There are some constraints on Forestry Commission/NRW production in the short term and, for the Private sector, the biological potential scenario is one of many possible scenarios. Owners for example are unlikely to manage their forests and woodlands to biological potential throughout the 50-year period and actual production will therefore vary from these estimates. There is also the factor of overdue timber. In this forecast the majority of currently overdue timber has been allocated for harvesting within the forecast period. However, this may not occur and no provision has been made within the forecast for any of the forthcoming rise in forecast volumes becoming overdue themselves. Since 14% of current standing volume is overdue, it is not unreasonable to assume that a proportion of stands will be managed in this way in the future. If so, that would have the effect of moving a proportion of harvested volume forward in time. Also, in future it may not be economically viable to produce timber from some areas that are hard to harvest as the forecast assumes and this could depress availability. The forecast also assumes that 90% of the 100,000 hectares of currently clearfelled land is restocked, which may not occur in all instances. Additionally, the assumed future species choices used in the restocking over the forecast period will not necessarily reflect intelligent planting choices made on a site by site basis to maximise yield, and thus are likely to depress future forecasts of yield compared to those that may arise from actual

future practice. What proportion of sites currently under conifers, will be replaced with conifers will also impact upon availability. Such assumptions about restocking markedly impact upon availability in the later periods.

When drawing conclusions from this report it should also be noted that this is a snapshot of potential production, taken within a 50-year time period, which will omit some aspects of the evolution of the growing stock over the longer term. To help build a wider view, taking some of these aspects into account, a summary 100-year forecast has also been supplied in addition to the 50-year forecast (Appendix E). This provides a wider perspective on potential production and standing volume, illustrating how, if the assumptions used in the forecast hold true, both recover to some extent in the longer term.

Future work

Future reports will explore the impacts of improved genetic material on potential production, will develop regional planting prescriptions and will explore alternative harvesting scenarios. Once information from the second cycle of the NFI fieldwork becomes available, statistics on the rate and type of timber removals in GB can be estimated from direct observation. These will be used to inform future harvesting scenarios. Statistics on net restocking rates will also arise from the second cycle and these will be used to inform future restocking scenarios.

Appendix A Stocked area and standing volume at 31 March 2012

Table A1 Stocked area by principal conifer tree species at 31 March 2012

Principal species	FC/NRW	Private sector		Total
	area (000 ha)	area (000 ha)	SE%	area (000 ha)
England				
All conifers	**127.6**	**178.9**	***2***	**306.6**
Sitka spruce	48.6	31.9	*7*	**80.5**
Scots pine	16.7	44.7	*5*	**61.4**
Corsican pine	26.7	13.7	*9*	**40.4**
Norway spruce	6.8	20.5	*7*	**27.4**
Larches	9.9	30.3	*5*	**40.2**
Douglas fir	9.8	14.8	*8*	**24.6**
Lodgepole pine	4.4	3.3	*17*	**7.7**
Other conifers	4.7	19.1	*7*	**23.7**
Scotland				
All conifers	**366.5**	**505.5**	***1***	**872.0**
Sitka spruce	225.0	281.8	*2*	**506.8**
Scots pine	45.0	108.5	*3*	**153.6**
Corsican pine	1.6	1.3	*35*	**2.8**
Norway spruce	10.8	14.5	*11*	**25.3**
Larches	26.4	39.4	*6*	**65.8**
Douglas fir	5.3	7.2	*14*	**12.5**
Lodgepole pine	49.0	38.9	*6*	**88.0**
Other conifers	3.3	7.6	*14*	**10.9**
Wales				
All conifers	**81.8**	**47.1**	***3***	**129.0**
Sitka spruce	49.9	27.4	*7*	**77.3**
Scots pine	2.1	1.1	*41*	**3.2**
Corsican pine	1.9	0.5	*37*	**2.4**
Norway spruce	5.3	2.6	*24*	**7.9**
Larches	11.9	8.0	*13*	**19.9**
Douglas fir	5.1	3.5	*21*	**8.6**
Lodgepole pine	2.7	1.5	*28*	**4.1**
Other conifers	2.9	2.1	*24*	**5.0**
Great Britain				
All conifers	**576.0**	**731.6**	***1***	**1,307.5**
Sitka spruce	323.5	341.1	*2*	**664.6**
Scots pine	63.8	154.3	*3*	**218.2**
Corsican pine	30.2	15.4	*9*	**45.6**
Norway spruce	23.0	37.6	*6*	**60.6**
Larches	48.2	77.7	*4*	**126.0**
Douglas fir	20.2	25.4	*7*	**45.6**
Lodgepole pine	56.1	43.7	*6*	**99.8**
Other conifers	10.9	28.8	*6*	**39.6**

Table A2 Standing volume by principal conifer tree species at 31 March 2012

Principal species	FC/NRW volume ($000m^3$ obs)	Private sector volume ($000m^3$ obs)	Private sector SE%	Total volume ($000m^3$ obs)
England				
All conifers	**26,770**	**63,723**	***2***	**90,493**
Sitka spruce	8,866	11,395	*8*	**20,260**
Scots pine	3,951	14,689	*5*	**18,640**
Corsican pine	5,471	4,725	*10*	**10,196**
Norway spruce	1,746	7,082	*8*	**8,828**
Larches	1,726	10,690	*6*	**12,416**
Douglas fir	2,654	6,407	*10*	**9,061**
Lodgepole pine	814	1,026	*21*	**1,839**
Other conifers	1,543	7,571	*10*	**9,114**
Scotland				
All conifers	**80,189**	**146,700**	***2***	**226,889**
Sitka spruce	52,059	87,988	*3*	**140,046**
Scots pine	8,844	24,461	*5*	**33,305**
Corsican pine	371	348	*38*	**719**
Norway spruce	3,487	5,950	*12*	**9,437**
Larches	4,811	12,325	*7*	**17,136**
Douglas fir	1,440	3,498	*17*	**4,938**
Lodgepole pine	8,151	7,359	*8*	**15,510**
Other conifers	1,026	3,032	*25*	**4,058**
Wales				
All conifers	**19,427**	**17,939**	***6***	**37,365**
Sitka spruce	11,088	9,477	*10*	**20,565**
Scots pine	512	269	*45*	**781**
Corsican pine	606	218	*41*	**824**
Norway spruce	1,481	1,344	*28*	**2,826**
Larches	2,712	3,322	*16*	**6,035**
Douglas fir	1,345	1,563	*23*	**2,908**
Lodgepole pine	606	342	*33*	**948**
Other conifers	1,077	1,141	*36*	**2,218**
Great Britain				
All conifers	**126,386**	**228,362**	***1***	**354,748**
Sitka spruce	72,012	108,859	*3*	**180,872**
Scots pine	13,306	39,419	*4*	**52,725**
Corsican pine	6,448	5,291	*9*	**11,738**
Norway spruce	6,715	14,376	*7*	**21,091**
Larches	9,250	26,337	*5*	**35,586**
Douglas fir	5,439	11,468	*8*	**16,907**
Lodgepole pine	9,571	8,727	*7*	**18,298**
Other conifers	3,646	11,744	*10*	**15,390**

Appendix B Breakdown of the forecast

Table B1 50-year forecast volume by principal conifer tree species at 31 March 2012

Principal species	2013-16			2017-21			2022-26			2027-31		
	FC/NRW	Private sector		FC/NRW	Private sector		FC/NRW	Private sector		FC/NRW	Private sector	
	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*
England												
All conifers	**1,632**	**2,945**	***5***	**1,330**	**3,225**	***5***	**1,211**	**2,903**	***5***	**1,159**	**2,986**	***5***
Sitka spruce	682	466	*17*	524	693	*16*	491	684	*15*	490	658	*16*
Scots pine	168	502	*10*	146	526	*9*	134	613	*9*	120	867	*10*
Corsican pine	332	309	*15*	306	303	*15*	294	234	*19*	264	182	*22*
Norway spruce	138	270	*12*	84	333	*15*	50	376	*17*	49	440	*12*
Larches	79	544	*8*	77	561	*7*	73	386	*7*	58	300	*8*
Douglas fir	113	443	*15*	95	361	*12*	89	240	*13*	101	195	*14*
Lodgepole pine	53	48	*41*	40	37	*49*	34	52	*40*	22	40	*43*
Other conifers	66	360	*12*	58	408	*12*	45	309	*12*	54	300	*12*
Scotland												
All conifers	**4,220**	**5,708**	***5***	**3,658**	**6,997**	***5***	**3,516**	**7,830**	***5***	**3,789**	**8,910**	***5***
Sitka spruce	2,953	3,493	*8*	2,762	4,447	*6*	2,703	5,742	*7*	2,873	6,639	*6*
Scots pine	232	669	*9*	207	874	*9*	216	960	*9*	238	1,077	*9*
Corsican pine	11	7	*40*	4	6	*38*	8	5	*42*	2	35	*75*
Norway spruce	145	202	*15*	110	261	*28*	87	251	*19*	99	228	*18*
Larches	207	782	*12*	196	658	*10*	158	485	*12*	183	383	*12*
Douglas fir	53	147	*27*	50	269	*24*	38	100	*25*	46	103	*21*
Lodgepole pine	588	224	*16*	305	185	*24*	282	172	*16*	322	331	*20*
Other conifers	31	136	*36*	23	229	*27*	25	70	*19*	25	59	*18*
Wales												
All conifers	**1,082**	**901**	***16***	**991**	**949**	***13***	**895**	**1,087**	***14***	**778**	**775**	***15***
Sitka spruce	732	449	*29*	673	527	*21*	606	640	*20*	549	435	*22*
Scots pine	15	8	*56*	23	30	*72*	16	9	*56*	10	11	*60*
Corsican pine	19	5	*43*	25	12	*63*	28	39	*47*	20	1	*75*
Norway spruce	75	39	*29*	69	61	*55*	59	46	*43*	41	66	*40*
Larches	89	264	*22*	90	173	*20*	83	92	*24*	66	108	*33*
Douglas fir	54	87	*46*	48	70	*33*	53	131	*40*	45	66	*50*
Lodgepole pine	31	7	*39*	26	7	*33*	20	8	*33*	18	5	*35*
Other conifers	68	30	*31*	38	57	*52*	30	109	*73*	28	72	*50*
Great Britain												
All conifers	**6,933**	**9,554**	***4***	**5,980**	**11,171**	***4***	**5,622**	**11,820**	***4***	**5,726**	**12,671**	***4***
Sitka spruce	4,367	4,408	*7*	3,959	5,667	*6*	3,800	7,065	*6*	3,913	7,732	*6*
Scots pine	415	1,179	*7*	377	1,430	*7*	366	1,582	*7*	368	1,955	*7*
Corsican pine	362	321	*15*	335	321	*15*	331	278	*18*	287	218	*22*
Norway spruce	358	510	*9*	263	655	*15*	196	673	*12*	190	734	*10*
Larches	375	1,590	*7*	363	1,391	*6*	314	962	*7*	307	792	*8*
Douglas fir	220	678	*13*	194	700	*12*	180	471	*14*	193	364	*13*
Lodgepole pine	671	279	*15*	372	229	*16*	336	231	*15*	362	376	*18*
Other conifers	164	525	*13*	118	694	*13*	100	488	*18*	107	431	*12*

Table B1 cont. 50-year forecast volume by principal conifer tree species at 31 March 2012

Principal species	2032-36			2037-41			2042-46			2047-51		
	FC/NRW	Private sector		FC/NRW	Private sector		FC/NRW	Private sector		FC/NRW	Private sector	
	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*
England												
All conifers	**1,066**	**2,850**	***6***	**1,013**	**2,224**	***6***	**1,055**	**1,848**	***6***	**1,014**	**1,523**	***5***
Sitka spruce	450	691	*18*	413	476	*19*	436	339	*17*	430	256	*10*
Scots pine	97	808	*9*	86	748	*12*	86	470	*13*	91	472	*12*
Corsican pine	264	144	*29*	245	104	*28*	222	86	*26*	186	40	*37*
Norway spruce	36	449	*15*	50	244	*13*	55	378	*15*	55	250	*16*
Larches	56	280	*8*	56	189	*9*	73	144	*8*	64	154	*10*
Douglas fir	110	170	*13*	114	154	*19*	126	158	*14*	129	137	*7*
Lodgepole pine	16	21	*51*	5	79	*43*	4	39	*43*	6	8	*47*
Other conifers	37	278	*17*	45	222	*18*	52	229	*19*	54	203	*10*
Scotland												
All conifers	**3,215**	**8,847**	***5***	**2,936**	**8,133**	***5***	**2,730**	**6,527**	***5***	**3,280**	**4,986**	***5***
Sitka spruce	2,511	5,845	*6*	2,291	4,972	*6*	2,059	3,878	*6*	2,376	2,884	*7*
Scots pine	199	1,415	*10*	164	1,540	*10*	203	1,293	*10*	276	973	*11*
Corsican pine	5	40	*61*	4	23	*74*	7	8	*95*	4	1	*79*
Norway spruce	57	340	*23*	77	391	*22*	83	324	*25*	163	282	*25*
Larches	149	392	*10*	142	214	*9*	172	208	*13*	174	199	*10*
Douglas fir	55	115	*18*	60	89	*18*	65	101	*15*	84	84	*10*
Lodgepole pine	220	491	*17*	177	682	*14*	106	596	*14*	155	415	*16*
Other conifers	20	113	*20*	22	135	*28*	36	84	*19*	47	106	*19*
Wales												
All conifers	**934**	**736**	***15***	**794**	**679**	***15***	**531**	**490**	***15***	**585**	**521**	***14***
Sitka spruce	686	504	*21*	526	322	*23*	216	273	*21*	311	273	*18*
Scots pine	13	4	*64*	11	6	*45*	11	11	*31*	13	13	*25*
Corsican pine	11	3	*100*	12	0	*90*	12	0	*75*	14	0	*74*
Norway spruce	44	32	*26*	45	157	*43*	35	97	*46*	41	92	*58*
Larches	72	85	*25*	94	54	*32*	152	25	*26*	93	30	*35*
Douglas fir	74	35	*25*	66	76	*30*	67	45	*14*	78	56	*13*
Lodgepole pine	9	32	*53*	7	32	*58*	2	10	*94*	4	11	*72*
Other conifers	26	38	*35*	34	23	*26*	37	23	*18*	30	38	*28*
Great Britain												
All conifers	**5,216**	**12,433**	***4***	**4,744**	**11,035**	***4***	**4,316**	**8,865**	***4***	**4,879**	**7,030**	***4***
Sitka spruce	3,647	7,040	*6*	3,230	5,770	*6*	2,712	4,490	*6*	3,118	3,414	*6*
Scots pine	308	2,227	*7*	260	2,294	*8*	299	1,775	*8*	380	1,458	*8*
Corsican pine	280	187	*26*	260	127	*27*	241	93	*25*	204	40	*36*
Norway spruce	137	821	*13*	172	791	*14*	174	799	*14*	259	624	*16*
Larches	276	757	*7*	292	456	*7*	397	377	*8*	331	383	*7*
Douglas fir	239	319	*10*	240	319	*13*	258	305	*9*	291	277	*5*
Lodgepole pine	244	545	*16*	189	794	*13*	112	645	*13*	166	434	*16*
Other conifers	83	429	*13*	102	381	*14*	124	335	*14*	130	348	*9*

Table B1 cont. 50-year forecast volume by principal conifer tree species at 31 March 2012

Principal species	2052-56			2057-61		
	FC/NRW	Private sector		FC/NRW	Private sector	
	volume ($000m^3$ obs)		*SE%*	volume ($000m^3$ obs)		*SE%*
England						
All conifers	**828**	**1,431**	***6***	**1,250**	**1,603**	***6***
Sitka spruce	343	292	*11*	622	440	*17*
Scots pine	81	310	*12*	124	360	*12*
Corsican pine	124	51	*40*	114	48	*54*
Norway spruce	49	275	*22*	85	188	*15*
Larches	47	135	*8*	93	145	*7*
Douglas fir	124	169	*12*	133	191	*10*
Lodgepole pine	7	6	*30*	10	3	*41*
Other conifers	53	191	*8*	71	226	*8*
Scotland						
All conifers	**2,886**	**5,679**	***4***	**2,339**	**5,627**	***4***
Sitka spruce	2,017	3,739	*6*	1,639	4,021	*5*
Scots pine	258	1,007	*9*	255	861	*8*
Corsican pine	8	1	*62*	4	1	*80*
Norway spruce	108	222	*28*	123	162	*19*
Larches	171	170	*9*	139	177	*8*
Douglas fir	69	127	*17*	73	121	*9*
Lodgepole pine	196	231	*21*	44	143	*29*
Other conifers	60	151	*15*	63	130	*7*
Wales						
All conifers	**495**	**734**	***13***	**679**	**694**	***12***
Sitka spruce	220	480	*18*	342	472	*16*
Scots pine	14	37	*72*	17	12	*17*
Corsican pine	17	0	*77*	14	0	*79*
Norway spruce	40	38	*51*	73	44	*23*
Larches	76	18	*32*	80	19	*30*
Douglas fir	80	102	*22*	88	77	*19*
Lodgepole pine	6	8	*98*	13	18	*81*
Other conifers	41	40	*15*	51	43	*18*
Great Britain						
All conifers	**4,209**	**7,845**	***3***	**4,269**	**7,924**	***3***
Sitka spruce	2,579	4,512	*5*	2,603	4,934	*5*
Scots pine	352	1,355	*8*	395	1,232	*6*
Corsican pine	149	52	*39*	132	49	*53*
Norway spruce	197	534	*16*	281	395	*11*
Larches	294	323	*6*	312	340	*5*
Douglas fir	274	397	*9*	294	388	*6*
Lodgepole pine	209	245	*20*	66	164	*25*
Other conifers	154	383	*7*	184	400	*5*

Table B2 Summary of volume by country and region with % spruce

Country / region	2013-16							2017-21						
	FC/NRW		Private sector			Total		FC/NRW		Private sector			Total	
	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce
England	**1,632**	**50**	**2,945**	***5***	**25**	**4,577**	**34**	**1,330**	**46**	**3,225**	***5***	**32**	**4,555**	**36**
North West England	174	82	265	*17*	56	**439**	66	130	78	302	*15*	51	**432**	59
North East England	589	86	286	*19*	53	**875**	75	412	85	368	*17*	52	**780**	69
Yorkshire and the Humber	125	36	292	*11*	32	**417**	33	118	37	332	*15*	37	**450**	37
East Midlands	91	5	123	*13*	12	**214**	9	83	3	142	*16*	15	**225**	11
East England	186	0	179	*11*	7	**365**	4	166	0	216	*12*	5	**383**	3
South East England and London	127	9	629	*9*	10	**756**	9	124	10	598	*7*	12	**722**	11
South West England	230	42	741	*10*	24	**971**	28	207	40	893	*10*	40	**1,101**	40
West Midlands	109	14	432	*16*	17	**540**	17	90	15	374	*16*	26	**463**	24
Scotland	**4,220**	**73**	**5,708**	***5***	**65**	**9,928**	**68**	**3,658**	**79**	**6,997**	***5***	**67**	**10,656**	**71**
North Scotland	587	25	558	*13*	40	**1,144**	32	367	34	777	*14*	50	**1,143**	45
North East Scotland	488	49	958	*8*	27	**1,446**	34	395	57	1,284	*9*	42	**1,679**	46
East Scotland	208	66	945	*14*	59	**1,153**	60	164	65	968	*14*	59	**1,132**	60
South Scotland	1,594	88	2,081	*11*	84	**3,674**	86	1,457	89	2,429	*9*	80	**3,887**	83
West Scotland	1,342	87	1,167	*10*	78	**2,509**	83	1,275	88	1,540	*12*	82	**2,815**	85
Wales	**1,082**	**75**	**901**	***16***	**54**	**1,983**	**65**	**991**	**75**	**949**	***13***	**62**	**1,940**	**69**
Great Britain	**6,933**	**68**	**9,554**	***4***	**51**	**16,487**	**58**	**5,980**	**71**	**11,171**	***4***	**57**	**17,151**	**61**

Country / region	2022-26							2027-31						
	FC/NRW		Private sector			Total		FC/NRW		Private sector			Total	
	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce
England	**1,211**	**45**	**2,903**	***5***	**37**	**4,113**	**39**	**1,159**	**47**	**2,986**	***5***	**37**	**4,145**	**39**
North West England	150	81	447	*17*	74	**596**	75	150	88	378	*15*	62	**528**	69
North East England	314	88	367	*17*	60	**682**	73	277	90	483	*19*	52	**760**	66
Yorkshire and the Humber	124	37	300	*11*	38	**424**	38	102	43	338	*17*	53	**440**	51
East Midlands	74	4	143	*22*	12	**216**	9	67	4	159	*17*	17	**226**	13
East England	157	0	199	*16*	6	**357**	3	171	0	262	*17*	13	**433**	8
South East England and London	101	8	591	*9*	16	**692**	15	87	9	598	*9*	20	**684**	18
South West England	185	42	517	*9*	27	**702**	31	209	43	515	*9*	37	**723**	39
West Midlands	106	10	339	*18*	39	**445**	32	96	15	254	*16*	25	**350**	22
Scotland	**3,516**	**79**	**7,830**	***5***	**77**	**11,346**	**77**	**3,789**	**78**	**8,910**	***5***	**77**	**12,700**	**77**
North Scotland	365	32	619	*13*	56	**984**	47	457	30	901	*12*	53	**1,358**	46
North East Scotland	369	60	1,258	*9*	41	**1,627**	45	409	65	1,414	*10*	43	**1,823**	48
East Scotland	178	66	735	*12*	65	**913**	65	192	68	682	*11*	60	**874**	62
South Scotland	1,373	91	3,223	*9*	88	**4,597**	89	1,307	91	3,872	*8*	92	**5,179**	92
West Scotland	1,230	88	1,994	*10*	90	**3,224**	89	1,424	87	2,042	*10*	89	**3,466**	88
Wales	**895**	**74**	**1,087**	***14***	**63**	**1,982**	**68**	**778**	**76**	**775**	***15***	**65**	**1,553**	**70**
Great Britain	**5,622**	**71**	**11,820**	***4***	**65**	**17,442**	**67**	**5,726**	**72**	**12,671**	***4***	**67**	**18,398**	**68**

Table B2 cont. Summary of volume by country and region with % spruce

Country / region	2032-36							2037-41						
	FC/NRW		Private sector			Total		FC/NRW		Private sector			Total	
	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce
England	**1,066**	**46**	**2,850**	***6***	**40**	**3,916**	**42**	**1,013**	**46**	**2,224**	***6***	**32**	**3,237**	**37**
North West England	114	83	288	*19*	69	**402**	73	133	83	181	*13*	48	**314**	63
North East England	280	92	535	*19*	68	**815**	76	234	90	481	*19*	56	**714**	67
Yorkshire and the Humber	109	41	223	*13*	29	**332**	33	88	53	204	*16*	44	**292**	47
East Midlands	70	4	128	*18*	23	**198**	16	52	10	110	*25*	20	**162**	17
East England	162	1	304	*18*	11	**465**	7	171	2	226	*18*	7	**397**	4
South East England and London	78	10	516	*11*	20	**594**	18	86	10	453	*13*	17	**538**	16
South West England	166	40	453	*9*	36	**619**	37	164	41	365	*12*	37	**529**	38
West Midlands	88	13	403	*19*	47	**491**	41	86	15	205	*23*	12	**291**	13
Scotland	**3,215**	**80**	**8,847**	***5***	**70**	**12,062**	**73**	**2,936**	**81**	**8,133**	***5***	**66**	**11,069**	**70**
North Scotland	440	39	1,356	*10*	52	**1,796**	49	405	50	1,623	*10*	39	**2,028**	41
North East Scotland	337	66	1,606	*9*	34	**1,943**	40	333	69	1,547	*10*	39	**1,881**	45
East Scotland	170	63	893	*13*	74	**1,063**	73	123	71	856	*13*	60	**978**	62
South Scotland	1,094	92	3,032	*9*	85	**4,125**	87	919	89	2,444	*9*	89	**3,363**	89
West Scotland	1,175	91	1,960	*9*	85	**3,135**	87	1,157	89	1,663	*10*	87	**2,819**	88
Wales	**934**	**78**	**736**	***15***	**73**	**1,670**	**76**	**794**	**72**	**679**	***15***	**71**	**1,473**	**71**
Great Britain	**5,216**	**73**	**12,433**	***4***	**63**	**17,649**	**66**	**4,744**	**72**	**11,035**	***4***	**59**	**15,779**	**63**

Country / region	2042-46							2047-51						
	FC/NRW		Private sector			Total		FC/NRW		Private sector			Total	
	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce
England	**1,055**	**47**	**1,848**	***6***	**39**	**2,903**	**42**	**1,014**	**48**	**1,523**	***5***	**33**	**2,537**	**39**
North West England	113	58	215	*17*	55	**328**	56	101	70	170	*14*	58	**271**	63
North East England	324	91	255	*22*	63	**579**	79	297	91	190	*17*	46	**486**	74
Yorkshire and the Humber	77	55	172	*14*	32	**248**	39	84	53	168	*14*	39	**253**	44
East Midlands	56	12	138	*22*	28	**194**	23	48	10	92	*20*	21	**141**	17
East England	130	2	137	*20*	19	**267**	11	114	2	89	*21*	12	**202**	6
South East England and London	105	8	439	*13*	30	**544**	26	110	9	319	*12*	20	**429**	17
South West England	169	36	347	*12*	36	**516**	36	168	42	318	*10*	36	**485**	38
West Midlands	81	14	146	*19*	41	**227**	32	92	11	178	*21*	28	**270**	22
Scotland	**2,730**	**78**	**6,527**	***5***	**64**	**9,257**	**69**	**3,280**	**77**	**4,986**	***5***	**63**	**8,266**	**69**
North Scotland	355	55	961	*11*	43	**1,317**	46	450	50	585	*13*	32	**1,035**	40
North East Scotland	373	63	1,484	*10*	39	**1,857**	44	508	68	974	*11*	31	**1,482**	44
East Scotland	147	70	746	*12*	62	**893**	63	155	69	504	*13*	57	**660**	60
South Scotland	925	85	2,158	*9*	83	**3,082**	84	1,126	85	1,726	*9*	86	**2,853**	86
West Scotland	930	89	1,178	*11*	81	**2,108**	84	1,040	87	1,197	*10*	75	**2,236**	81
Wales	**531**	**47**	**490**	***15***	**76**	**1,021**	**61**	**585**	**60**	**521**	***14***	**70**	**1,106**	**65**
Great Britain	**4,316**	**67**	**8,865**	***4***	**60**	**13,181**	**62**	**4,879**	**69**	**7,030**	***4***	**57**	**11,909**	**62**

Table B2 cont. Summary of volume by country and region with % spruce

Country / region	2052-56							2057-61						
	FC/NRW		Private sector			Total		FC/NRW		Private sector			Total	
	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce	volume ($000m^3$ obs)	% spruce	volume ($000m^3$ obs)	*SE%*	% spruce	Total vol	% spruce
England	**828**	**47**	**1,431**	***6***	**40**	**2,259**	**42**	**1,250**	**57**	**1,603**	***6***	**39**	**2,853**	**47**
North West England	105	81	194	*16*	65	**299**	71	184	82	226	*22*	62	**410**	71
North East England	234	88	172	*18*	51	**407**	72	417	87	242	*21*	53	**660**	75
Yorkshire and the Humber	59	44	139	*9*	43	**199**	43	199	54	156	*11*	40	**355**	48
East Midlands	62	8	111	*24*	37	**173**	27	55	10	121	*27*	27	**176**	22
East England	82	3	122	*21*	6	**204**	5	82	4	96	*15*	14	**178**	9
South East England and London	74	10	306	*15*	36	**380**	31	101	10	267	*9*	24	**368**	20
South West England	140	38	264	*10*	34	**404**	35	142	40	357	*13*	41	**500**	41
West Midlands	72	11	123	*20*	36	**195**	27	69	11	137	*14*	30	**206**	23
Scotland	**2,886**	**74**	**5,679**	***4***	**70**	**8,566**	**71**	**2,339**	**75**	**5,627**	***4***	**74**	**7,966**	**75**
North Scotland	418	59	736	*13*	42	**1,155**	48	426	60	648	*12*	64	**1,074**	63
North East Scotland	366	65	1,255	*8*	43	**1,621**	48	336	64	1,206	*9*	46	**1,542**	50
East Scotland	585	65	603	*15*	68	**1,188**	66	191	58	411	*11*	61	**602**	60
South Scotland	787	81	2,337	*7*	89	**3,123**	87	664	83	2,321	*7*	88	**2,986**	87
West Scotland	730	85	749	*8*	82	**1,479**	84	722	87	1,040	*9*	89	**1,762**	88
Wales	**495**	**53**	**734**	***13***	**71**	**1,229**	**63**	**679**	**61**	**694**	***12***	**74**	**1,373**	**68**
Great Britain	**4,209**	**66**	**7,845**	***3***	**64**	**12,054**	**65**	**4,269**	**68**	**7,924**	***3***	**67**	**12,193**	**67**

A table showing the full regional breakout of the forecast by principal conifer tree species can be found in Table B3 of the accompanying spreadsheet.

Appendix C Constraints on harvesting

Figure C1 Suitability for harvesting

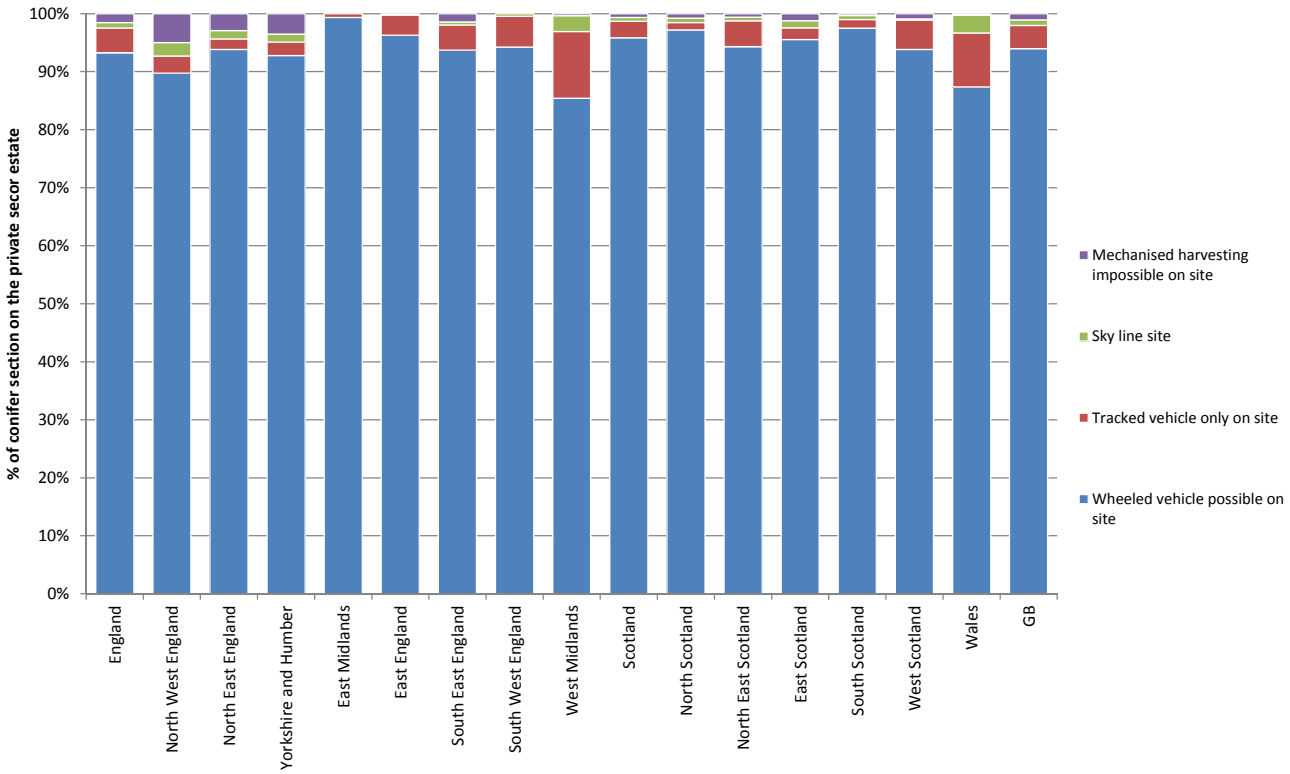
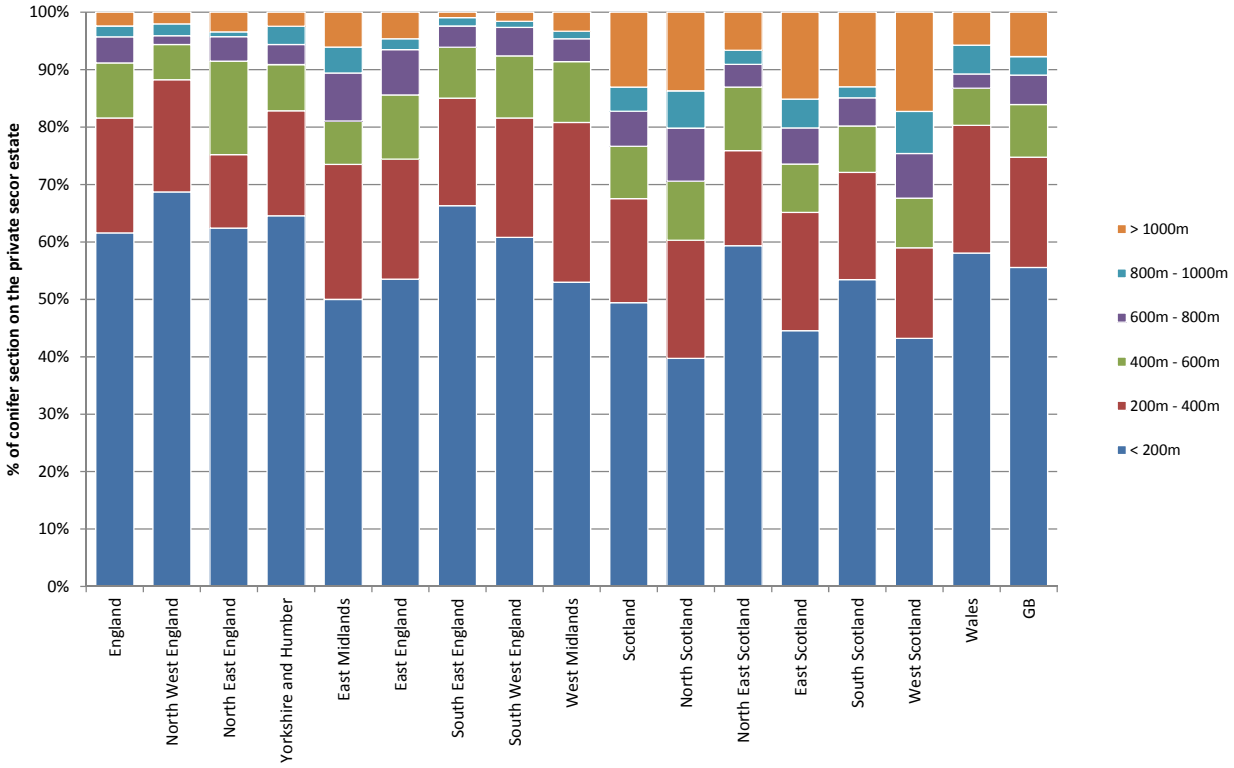


Figure C2 Distance to road of a sample square



Appendix D Forecast scenarios

Table D1 Scenarios summary

Principle harvesting scenarios to be included in the 50-year forecast	Overdue timber treatment	Replanting scenario	Hard to harvest timber / lower likelihood of availability	Scenario Number	Publish later
Private Sector					
Modified biological potential, thinning and felling assuming moderate wind risk measures – the 'headline' 25 yr forecast run for 50 years	Overdue option 1	Restock option 2 – like for like (0% reduction in conifer area, same species proportions)	Included	1	
Modified biological potential, thinning and felling assuming moderate wind risk measures – the 'headline' 25 yr forecast run for 50 years	Overdue option 1	Restock option 1 (10% reduction in stocked conifer area & change in species proportions)	Included	2	
Modified biological potential, thinning and felling assuming moderate wind risk measures – the 'headline' 25 yr forecast run for 50 years	Overdue option 1	Option 3 – restocking variant (20 % reduction in conifer stocked area)	Included	3	
Applying the same assumptions as used in the 25-year forecast for comparative purposes: Modified biological potential,	Felled at day one of the forecast and volume reported separately.	Like for like restock for felling arising during the forecast period. Currently	Included	4	

Principle harvesting scenarios to be included in the 50-year forecast	**Overdue timber treatment**	**Replanting scenario**	**Hard to harvest timber / lower likelihood of availability**	**Scenario Number**	**Publish later**
thinning and felling assuming moderate wind risk measures – the 'headline' 25 yr forecast run for 50 years		clearfelled land restocked to the main restock option (1), at 100% stocking.			
Felling at 25m top height	Overdue option 1	Restock option 1	Included	5	
Felling and thinning to the 2005 industry 'view'	Overdue option 2 treatment as per the 2005 industry view	Option 4 treatment as per the 2005 industry view	Included	6	
Public Sector					
Management felling and thinning plans	Overdue option 4 Fell all within ten years	Restock option 1	Excluded		
Option for a revised industry 'view'	Overdue option 3	Restock option 5	To be decided		Yes
Improved SS Yield *	Overdue option 1	Restock option 6	Included		Yes
Modified biological potential, thinning and felling assuming moderate wind risk measures – the 'headline' 25 yr forecast run for 50 years	Overdue option 1	Restock option 1	Excluded		Yes

Table D2 Overdue timber allocation option 1

	Prescription by years beyond maximum MAI (as of base year)		
Species	0-10 yrs beyond	10-30 yrs beyond	30 + yrs beyond
Sitka spruce	Fell 50% 1- 25 yrs	Fell 50% 1- 25 yrs	Fell 75% 1-25 yrs
	Fell 50% 26-50	Fell 40% 26-50 yrs	
		10% zero intervention	25% zero intervention
Norway spruce	Fell 50% 1- 25 yrs	Fell 50% 1- 25 yrs	Fell 75% 1-25 yrs
	Fell 50% 26-50	Fell 40% 26-50 yrs	
		10% zero intervention	25% zero intervention
Douglas fir	Fell 50 % 1- 25 yrs,	Fell 75 % 1- 25 yrs,	Fell 75% over 10 yrs
	Fell 25% 26- 50 yrs	25% zero intervention	25% zero intervention
	25% zero intervention		
Scots pine	Fell 0% 1-25 yrs	Fell 50 % 1- 25 yrs,	Fell 50% 1- 25 yrs
	Fell 75% 26-50 yrs	Fell 25 % 26-50 yrs	50% zero intervention
	25% zero intervention	25% zero intervention	
Larches	Fell 50% 1- 10 yrs,	Fell 50 % 1- 25 yrs	Fell 75% 1- 10 yrs
	Fell 40% 11-25 yrs,	Fell 40 % 26-50 yrs	25% zero intervention
	10% zero intervention	10% zero intervention	
Corsican pine	Fell 50% 1- 10 yrs,	Fell 50 % 1- 25 yrs	Fell 75% 1- 10 yrs
	Fell 40% 11-25	Fell 25 % 26- 50	25% zero

	Prescription by years beyond maximum MAI (as of base year)		
Species	0-10 yrs beyond	10-30 yrs beyond	30 + yrs beyond
	yrs,	yrs	intervention
	10% zero intervention	25% zero intervention	
Lodgepole pine	Fell 50% 1- 10 yrs,	Fell 50 % 1-25 yrs	Fell 75% 1- 10 yrs
	Fell 40% 11- 25 yrs,	Fell 25 % 26- 50 yrs	25% zero intervention
	10% zero intervention	25% zero intervention	
Other species	Fell 50 % 1-25 yrs,	Fell 75 % 1- 25 yrs,	Fell 75% 1- 10 yrs
	Fell 25% 26- 50 yrs	25% zero intervention	25% zero intervention
	25% zero intervention		

Assumptions and principles used to set overdue timber prescriptions

It was assumed that stands a few years beyond the age of maximum MAI are more likely to be harvested close to age of maximum MAI as compared to those stands significantly beyond age of maximum MAI. Underlying this assumption is that several factors make it difficult or undesirable to harvest exactly at the age of maximum MAI, whilst harvesting close to or around the age of maximum MAI may still be the objective. Some of the factors that influence owners to harvest close to, rather than precisely at year of maximum MAI are:

- Establishing the exact year of maximum MAI is difficult.
- The organisation of harvesting to an exact year may be problematic.
- The ability to market timber at an exact year may be problematic.
- Market demand and price may prevent felling at an exact year from being the optimum economic strategy.
- Planning issues may not facilitate felling at an exact year.
- The felling of stands may be deferred so that they can be grouped into parcels of several stands to achieve economies of scale in harvesting and marketing.

- The nature of stand growth is such that typically an increment plateau exists for a number of years before significant losses are experienced in terms of productivity through the retention of stands.
- The widely held belief that incremental yield does not tail off as quickly as FC Yield Tables suggest

Such stands are therefore assumed to be harvested within a short period after maximum MAI is achieved.

- Older stands, those well beyond maximum MAI, are considered to be more likely to be retained for longer periods, as their retention, based on their age, discounts the above factors being a reason for them not being harvested to date and that their retention appears more likely to be deliberate. The reasons for retention may include:

    - The stands being part of natural reserves.
    - The stands being managed for amenity or landscape purposes.
    - The stands being a part of a silvicultural system that involves longer rotation lengths.
    - Owner choice.

Some specific factors influencing whether stands are managed for felling at maximum MAI or not are:

- A proportion of all species will be within unmanaged woodland, natural reserves and sites that that would be expensive or difficult to harvest and therefore a proportion of all species are not harvested;
- That some woodland will be in parks, cemeteries, gardens etc. and will not be managed primarily for commercial purposes and thus will contribute to overdue timber being permanently retained;
- As Scots pine is a native tree species, it is assumed that a higher proportion of overdue timber is retained, reflecting natural reserves;
- As Spruces are a non-native genus and are generally considered to be commercial species, a lower proportion of overdue timber is retained;
- Spruces and Lodgepole pine are more likely to be planted on less wind firm sites than other species and therefore on average will have shorter rotation lengths. As a result, a higher proportion of their overdue timber is felled to avoid wind damage;
- The retention of the larches, Corsican pine and Lodgepole pine will almost certainly be reduced due to the spread of pest and diseases such as *Dothistroma* needle blight and *Phytophthora ramorum*; and

- That certain species, such as Douglas fir and larches, are more likely to be retained for amenity purposes.

For the purposes of a strategic 50-year forecast this report assumes that the same prescriptions for overdue are applied across GB. This was also the approach taken in the 2005 forecast.

Restock Options per Country

The following tables set out the prescriptions for which tree species will be replanted during restocking of woodland felled within the forecast period. The same prescription applies to restocking currently clearfelled land. They also set out the assumption for the reduction in net conifer stocked area as a percentage of current net stocked conifer area.

Restocking Option 1

Species proportions as per those proposed in Tables D3, D4 and D5 below, and loss of conifer stocked area at a rate of 10%. The lost area will be allocated as 50% open space and 50% broadleaved species (i.e. 5% each from the previous conifer stocked area).

Restocking Option 2

Reduction of conifer stocked area by 20% in the restocked crop, with 10% allocated to open space and 10% allocated to broadleaved species. Proportions of conifer species within the area restocked with conifers is as in option 1.

Table D3 Restock options 1 for England

Species	Current stocked area	Conifer species as a % of conifer area	Proposed conifer species as a % of conifer area	Assumed % change to conifer woodland
Sitka spruce	81	25.2	30.0	
Scots pine	67	20.9	25.0	
Corsican pine	43	13.4	0.5	
Norway spruce	29	9.0	10.0	
Larches	44	13.7	2.0	
Douglas fir	25	7.8	14.0	
Lodgepole pine	8	2.5	0.5	
Other conifer species	24	7.5	18.0	
Total	321	100.0	100.0	-10
Areas	Area	% of total woodland area		
Total conifer stocked area	321	24.8		
Total broadleaved stocked area	886	68.5		
Total conifer and broadleaved stocked area	1,207	93.3		
Total unstocked area	88	6.8		
Woodland area at 2011	1,294			
Projected change after one rotation				
Resultant total conifer stocked area	289	22.3		
Resultant total broadleaved stocked area	902	69.7		
Resultant total conifer and broadleaved stocked area	1,190	92.0	Figures assume 50% of the conifer reduction goes to blvd trees and 50% to open	
Resultant total unstocked area	104	8.0		

Table D4 Restock options 1 for Scotland

Species	Current stocked area	Conifer species as a % of conifer area	Proposed conifer species as a % of conifer area	Assumed % change to conifer woodland
Sitka spruce	523	57.7	59.0	
Scots pine	171	18.9	24.5	
Corsican pine	3	0.3	0.0	
Norway spruce	26	2.9	6.0	
Larches	68	7.5	2.0	
Douglas fir	11	1.2	3.0	
Lodgepole pine	94	10.4	0.5	
Other conifer species	10	1.1	5.0	
Total	906	100.0	100.0	-10
Areas	Area	% of total woodland area		
Total conifer stocked area	906	65.4		
Total broadleaved stocked area	265	19.1		
Total conifer and broadleaved stocked area	1,171	84.5		
Total unstocked area	214	15.5		
Woodland area at 2011	1,385			
Projected change after one rotation				
Resultant total conifer stocked area	815	58.9		
Resultant total broadleaved stocked area	310	22.4		
Resultant total conifer and broadleaved stocked area	1,126	81.3	Figures assume 50% of the conifer reduction goes to blvd trees and 50% to open	
Resultant total unstocked area	259	18.7		

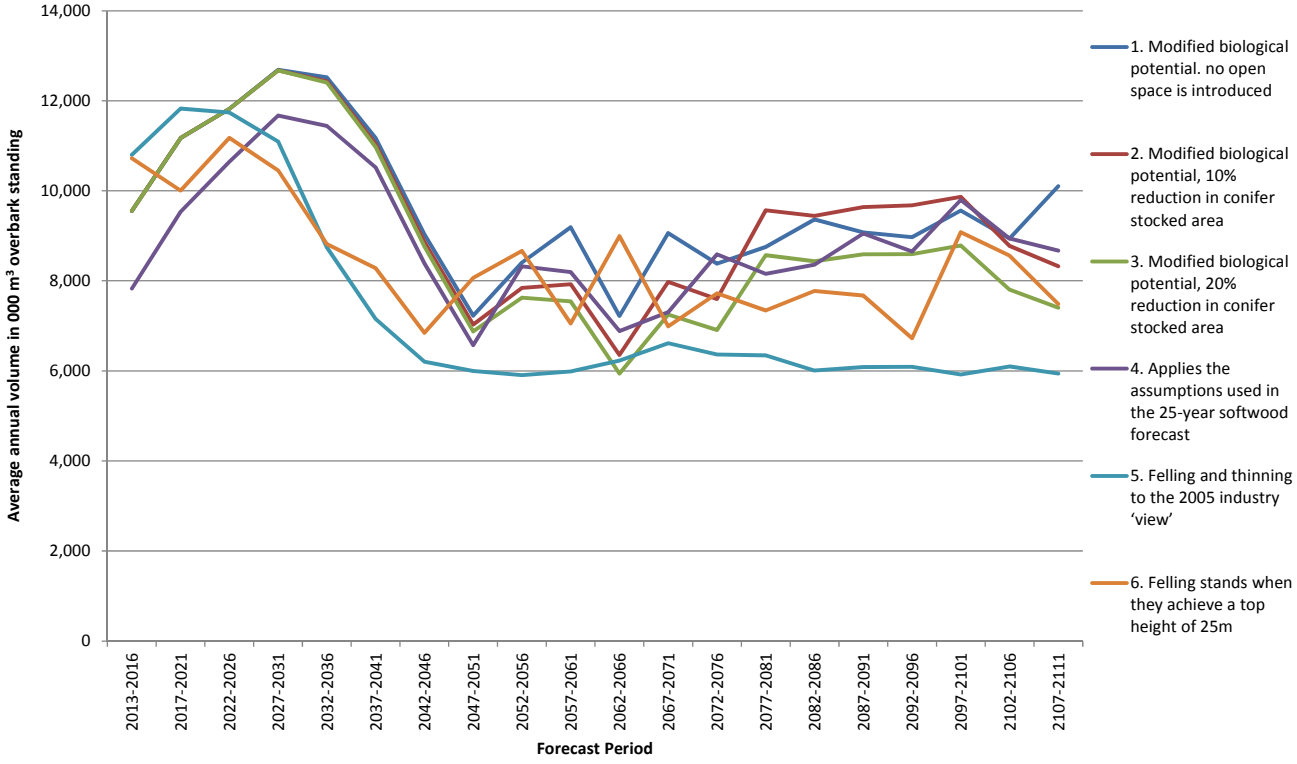
Table D5 Restock options 1 for Wales

Species	Current stocked area	Conifer species as a % of conifer area	Proposed conifer species as a % of conifer area	Assumed % change to conifer woodland
Sitka spruce	78	59.1	60.0	
Scots pine	4	2.8	6.0	
Corsican pine	3	2.1	0.0	
Norway spruce	7	5.2	8.0	
Larches	21	16.0	0.5	
Douglas fir	10	7.2	17.0	
Lodgepole pine	4	3.2	0.5	
Other conifer species	6	4.3	8.0	
Total	131	100.0	100.0	-10
Areas	Area	% of total woodland area		
Total conifer stocked area	131	43.1		
Total broadleaved stocked area	126	41.4		
Total conifer and broadleaved stocked area	257	84.6		
Total unstocked area	47	15.5		
Woodland area at 2011	304			
Projected change after one rotation				
Resultant total conifer stocked area	118	38.8		
Resultant total broadleaved stocked area	133	43.6		
Resultant total conifer and broadleaved stocked area	250	82.4	Figures assume 50% of the conifer reduction goes to blvd trees and 50% to open	
Resultant total unstocked area	54	17.6		

Appendix E 100-year softwood forecast

Figure E1 100-year forecast of softwood timber availability by sector

Figure E2 100-year forecast of softwood timber availability for the Private sector under different harvesting scenarios



Glossary

Actual production	Timber actually felled and removed from the forest. The Forestry Commission keeps records of actual production for its estate, while estimates for the Private sector are compiled from reports made by harvesting companies. These figures are available from Forestry Commission Statistics
Age class	A grouping of trees into specific age ranges, for classification purposes.
Area (forest/woodland)	Forest and woodland area can be defined in net or gross terms. Net area is the land actually covered by trees (in the National Forest Inventory that is to the drip line of the canopy). Gross area includes both the area covered by trees and the open spaces (<0.5 hectares) within (e.g. rides, glades, ponds).
Availability	A term to describe what timber could potentially be available for harvesting within a forest area.
Biological potential	A term applied to forecast scenarios with the objective of maximising timber production. It typically involves felling stands in the year of maximum MAI and Management table thinning. It may not take account of factors that constrain thinning and felling (e.g. wind risk or pest attack). The forecast results set out in this report involve constraints on thinning and times of felling to take account of wind risk.
Broadleaves	Trees and shrubs that belong to the angiosperm division of the plant kingdom (as distinct from the gymnosperm division that includes conifers). Most in the UK have laminar leaves and are deciduous. Sometimes referred to as 'hardwoods'.
Clearfelling	Cutting down of an area of woodland (if it is within a larger area of woodland it is typically a felling greater than 0.25 hectare). Sometimes a scatter or small clumps of trees may be left standing within the felled area.
Conifers	Trees and shrubs that belong to the gymnosperm division of the plant kingdom (as distinct from the angiosperm division that includes broadleaves). Conifers mostly have needles or scale-like leaves and are usually evergreen. Sometimes referred to as 'softwoods'.
Cumulative volume production	The total volume of timber that is forecast to be produced over the entire forecast period, including any overdue timber
DAMS (detailed aspect methodology score)	A measure of exposure at a particular location. Can be used as a proxy indicator of the risk of catastrophic wind damage to a stand of trees. May be used to influence decisions on thinning and timing of clearfelling where wind is a risk factor.
DBH (diameter at breast height)	The diameter of a tree (overbark) at breast height, which is usually defined as 1.3 metres along the axis of the stem from the ground.
Design plan	A holistic spatial and temporal plan covering the main aspects of long-term woodland management such as felling and restocking.
Dothistroma Needle Blight	An important disease of conifers (especially pines) which causes premature needle defoliation, resulting in loss of yield and, in severe cases, tree death. Also known as Red Band needle blight.
FC estate (Forestry Commission estate)	Forests, woodlands, open land and other property managed by the Forestry Commission.
Felling plan	A spatial and temporal plan of harvesting activity within a woodland.
Forest	Land predominately covered in trees (defined as land under stands of trees with a canopy cover of at least 20%, or the ability to achieve this,

	and with a minimum area of 0.5 hectare and minimum width of 20 metres), whether in large tracts (generally called forests) or smaller areas known by a variety of terms (including woods, copses, spinneys or shelterbelts).
Forestry Commission	The government department responsible for the regulation of forestry, implementing forestry policy and management of state forests in England, Scotland and (until 31 March 2013) Wales. Forestry policy is devolved, with the exception of common issues, addressed on a GB or UK basis, such as international forestry, plant health and forestry standards.
Great Britain (GB)	England, Scotland and Wales.
High forest	Woodland which is not managed as coppice or pollards and which may or may not be managed for timber.
Increment	The increase in volume of a tree or a stand over a year or annualised over a specified period measured either in m^3 obs per year or in m^3 obs per hectare per year. See also Mean annual increment (MAI).
Like-for-like restock	Replacement of felled trees by species with similar productivity. Usually taken to mean, after a period of two years, replacement of felled trees with trees of the same species and yield class.
Maximising productivity	The management of woodland to maximise volume production by thinning at the MTI.
Mensuration	The science of measuring time and distance, used in forestry to mean the measurement of standing and felled timber.
Maximum MAI (maximum mean annual increment) (MMAI)	The age at which a stand reaches the maximum average rate of volume increment which it can achieve. Felling the stand at this age will ensure that the stand reaches its highest average production per annum for its lifespan, thus optimising the stand in terms of volume production over the long term.
Mean annual increment (MAI)	The average annual rate of volume production from year of planting to a given year, expressed in m^3 obs per hectare per year. In even-aged stands it is calculated by dividing cumulative volume production by age.
MTT (management table thinning)	A sequence of thinnings prescribed by Forestry Commission yield tables over the life of a forest stand. Management table thinning refers to the pattern of thinning recommended in these yield tables. In standard yield tables the thinnings are set to an intensity which aims to maximise diameter increment whilst also maintaining maximum cumulative volume production
MTI (marginal thinning intensity)	The maximum sustainable intensity of thinning defined as 70% of yield class per hectare per year (m^3/ha/year).
National Forest Inventory	An inventory run by the Forestry Commission, set up in 2009, to provide a record of key information about GB forests and woodlands.
Natural Resources Wales (NRW)	The body responsible for advising the Welsh Government on the environment, created on 1 April 2013. NRW is responsible for the functions previously undertaken by the Environment Agency in Wales, the Countryside Council for Wales and Forestry Commission Wales. The woodland referred to in this report as “NRW” relates to the woodland previously managed by FC Wales
Overbark	Used as a definition when the volume of wood includes the bark.
Overbark standing (OBS)	Timber is defined in this report as the volume of stemwood to 7 cm top diameter in m3 overbark standing (obs), including stump (above ground) and usable branchwood (of minimum 3 m in length and 7 cm top diameter).
Overdue	Timber contained in stands that are beyond the felling age prescribed by

	the harvesting scenario at the start of the forecast
Phytophthora ramorum	Fungus-like pathogens that can cause extensive damage and mortality to trees and other plants.
Planned production	The volumes and assortments published in the removals forecast, reflecting the cumulative impact of managing the FC estate (as of 31 March 2011) in accordance with approved forest design and thinning plans.
Potential production	A forecast which will not necessarily transpire. As the private sector estate forecast makes assumptions about future levels of harvest, and the assumptions may not transpire, this forecast is one of potential production.
Private sector estate	Forests and woodlands in the UK not owned or managed by the Forestry Commission or Natural Resources Wales. In the context of the National Forest Inventory, 'Private sector' is used for convenience although it includes land owned or managed by bodies such as local authorities and charities.
Production forecast	A forecast of softwood volume production based on a firm plan of harvesting
Restocking plan	A spatial and temporal plan covering replacement planting in harvested areas.
Softwood	The wood of coniferous trees or the conifers themselves.
Stand	A relatively uniform collection of trees (from either artificial or natural regeneration), composed, for example, of a single species or a single age class.
Standard error (SE)	The measure of the margin of error associated with an estimate as a result of sampling from a population with statistical variability. Larger standard errors indicate less precision in the estimate. Standard errors in this report are quoted in relative terms (i.e. as percentages of the value of the estimate).
Standing volume	The live stemwood and useable branchwood of trees (up to 7 cm top diameter). It excludes roots, below ground stump material, small branches, foliage and deadwood. For Private sector woodland only, it also excludes standing volume in trees in woodlands of less than 0.5 hectares. Usually expressed as m^3 overbark standing (m^3 obs).
Stem wood	The woody material forming the above ground main growing shoot(s) of a tree or stand of trees. The stem includes all woody volume above ground with a diameter greater than 7 cm overbark. Stemwood includes wood in major branches where there is at least 3 m of 'straight' length to 7 cm top diameter.
Stocked area	The area stocked with living trees. The stocked areas in this report are quoted in gross terms for the FC/NRW estate and in net terms for the Private sector estate (see definitions of Area above)
Sustainable (forest management)	The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity and vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems.
Terminal height	The top height of a stand at which risk of wind damage is expected to reach a level necessitating clearfelling.
Thinning	The removal of a proportion of trees in a forest after canopy closure, usually to promote growth and greater value in the remaining trees.
Timber	The woody product from felled trees, which is destined for construction

	material, pulp or paper industries.
Top diameter	The diameter of the smaller (top) end of a log, often used to define different categories of wood products (e.g. sawlogs, roundwood, pulp) and merchantable timber.
Top height	The mean total height of the 100 largest dbh trees per hectare.
UK (United Kingdom)	Great Britain plus Northern Ireland.
Volume per hectare	The woody volume of trees (measured in m^3 obs/ha).
Windthrow/windblow	Uprooting of trees by the wind. Windthrow can be endemic – i.e. that caused by frequently recurring peak winds – or catastrophic – an infrequent occurrence associated with exceptionally strong winds where large areas/numbers of trees are blown down
Yield class (YC)	An index used in the UK of the potential productivity of even-aged stands of trees based on maximum MAI. It reflects the potential productivity of the site for the tree species growing on it.

NFI national reports and papers

The principal themes reported on for the 2011 woodland profile and future forecasts are:

- GB 2011 preliminary estimates of broadleaved species
- GB 2011 standing coniferous timber volume
- UK 25-year forecast of softwood availability
- GB 25-year forecast of coniferous standing volume and increment
- Biomass in live woodland trees in Britain
- Carbon in live woodland trees in Britain

Each theme has a series of associated reports, papers and data, tailored for different audiences and uses.

The principal themes reported on for the 2012 woodland profile and future forecasts are:

- 50-year forecast of softwood timber availability
- 50-year forecast of hardwood timber availability

All the documents and data can be found on the NFI website www.forestry.gov.uk/inventory.

Official Statistics

This is an Official Statistics publication. More information about Official Statistics and the UK Statistics Authority is available at www.statisticsauthority.gov.uk

National Forest Inventory Statistician: Alan Brewer