Production Forecast Programme Board
Timber Quality – Briefing paper

Background

The Forest Industry has for some time been used to basing much of its investment and policy decision making on the GB Production Forecast (PF) produced by FC on behalf of FC and private sector growers. The core output of the forecast has been to produce an annual volume of conifer timber that is likely to be produced for a sequence of 20 years. The core data within each year is a cubic metres over bark standing figure for conifers. Currently this volume is broken down into the following top diameter ranges: 7-14 cm, 14-16 cm, 16-18cm and 18+ cm. These ranges are published in the five yearly production forecast. Ad hoc queries can be run, utilising other ranges, but volumes in logs above 40+ cm cannot be separated out. Recently the sector have reported finding some investment decisions difficult to take without possessing another dimension of information – that of timber quality.

The FC forecast has been based upon two main sources of data, the Forest Enterprise sub compartment database (SCDB) and the National Inventory of Woodlands and Trees (NIWT). These have now been reorganised into one FC programme; the National Forest Inventory. This inventory is under way and will form the basis of the next PF. The FE data will be produced with an increased focus on accuracy and the private sector data will be derived from a National Forest Map and a series of 1 Ha plots across GB, surveying about 1% of all woodland. These plots will contain mensuration plots where top heights, dbh's, stocking densities, etc will be taken. It is from these measurements that the PF will be derived. FC are also currently working with the sector to explore utilising their data to help this process.

This paper and the issue of quality arises now as FC need to answer the question of whether the NFI and FE inventory adopt any additional field measurements that would be required to maintain quality forecasting and reporting.

Strategic Assessment versus Operational Assessments of Timber Quality

This paper relates to establishing the requirements for a strategic assessment of timber quality and any forecast published would report on these at a regional and national scale, over a 10 or 20 year period. By strategic assessment of timber quality we are referring to the long term and large-scale evaluation of those factors that affect the industry strategically. Much as we would consider that the PF gives us a good overview of the total timber volume to be produced per annum over the next 20 years, but would not consider using it for informing detailed operations, we must view timber quality in the same way. For example, that which would constitute the right level of detail on timber properties at the pre sale stage for a single stand would be different to that required to decide if we located a construction material or fencing mill in a certain region. Therefore it is important to differentiate between:

- What timber quality information do we need at a strategic and national scale for significant investment and policy making? This would probably be on the scale of years and decades.
- What timber quality information do we need at an operational timber procurement and processing level? This would probably be on the scale of weeks and months. An account of research into assessing timber properties for operations is in Appendix A.

Clarification of Definitions of Quality

There would appear to be some lack of clarity on what is meant by timber quality. A useful definition of timber quality is "all the wood characteristics and properties that affect the value recovery chain and the serviceability of end products" (Zhang 1997).

Although it would seem basic, it is of fundamental importance to understand what sits under the term 'quality' and to define a common language and to establish a common understanding of what is meant and required, if we are to achieve progress.

To help ease this confusion the more descriptive term of timber properties has been introduced recently. This helps to differentiate between **log quality** (a sub set of product quality) and **timber properties**. Log quality primarily relates to a log's physical straightness and is a means of differentiating one log product from another for market purposes or price differentiation. It is also affected by length, deviation from cylindrical, knots and visible forms of decay. Timber properties relate to the inherent physiological characteristics of the wood itself, such as wood density, microfibril angle and ring width, which all impact on the performance of the wood or product. This is generally synonymous with wood properties. The three main elements of timber quality which are discussed are:

Product breakdown / assortment.

This relates to the dimensions of the products into which a stem or population of stems can be cut into. The FC currently provides fixed product breakdowns or assortments as listed above. Some of the sector has requested the flexibility to break the volume down by other size classes and lengths.

Straightness.

This would refer to a measure of deviation in the bole / pole from straight or how bent the tree may be. Straightness or lack of it will affect principally the length of products that can be cut from a tree and is also an aspect of log quality. The main methodology for measuring this is the 'stem straightness' process developed by Methley et al and Macdonald et al using a scoring regime from 1 to 7 (poor to straight respectively). This gives a surveyor a more objective framework for assessing straightness in the standing stems in the wood and is assessed at stand level. A methodology for characterising quality in logs is the red / green split, but as well as straightness this also incorporates other criteria on top of straightness such as knots and decay. This assessment is generally done during or after harvest.

Stiffness.

This is a property of a tree or a log, and relates to the grading of the products cut from it. It is determined by wood density, fibre orientation, amount of juvenile and reaction wood, prevalence and form of knots and the age of the tree. These all combine to give the product / baton its inherent structural strength. This strength will determine the use of the timber, especially in the construction sector where timber products need to be load bearing to a specified strength. Structural grade or strength class is measured at the sawmill by mechanical stress grading of kiln-dried battens, using either a bending machine or a x-ray grader. Different grades go to different end uses. Generally higher grades gain higher market value. There is some concern in the sector that the inability to understand this property before the logs arrive at the mill leads to sub-optimisation of the timber resource to the markets for which it is best suited.

What Solutions and Options are Potentially Available?

Product breakdown.

The new PF will give much more flexibility in determining different detailed product classes (ASORT and DSORT projects). For example, using information on the numbers of logs with specific end diameters and lengths, improved log forecasts could be produced. FC could publish a range of product scenarios in the future or could potentially offer this facility on an ad hoc basis or online. This could also be linked to the straightness score to give a measure of probable log quality breakout. Although much of this will not be available for 2011, it will be available in later forecasts.

Straightness.

There is currently no capacity to forecast straightness. However there are outline plans for inclusion of this into the PF.

The first potential solution is to forecast log out turn based upon generic forest data, automatically allocating stands a stem straightness model score. The outputs are derived from generic forest data, such as species, age, elevation, soil, DAMS etc which are able to allocate a stem straightness score for each stand. This is then applied to the forecast data to predict the likely out turn of log types in a conversion model. A red / green split can then be applied to this. (See timber quality report attached).

Secondly, work has been undertaken by NRS staff on producing a red / green log split model for standing timber, based on the measured in the field stem straightness score. (See timber quality report attached). There are outline plans for inclusion of this into the PF, in the form of a QSORT algorithm.

Currently there are no confidence intervals (C.I.) set on the outputs of these models, so we cannot report how accurate the predictions may be yet. These models only work for Sitka spruce as of yet. However, there is also a pine model, which is due for completion in early 2009.

In specifying what the industry needs, we also need to clearly understand the distinction between the impact of basic tree shape (i.e. not accounting for defects) on potential log production and the impact of accounting for defects in tree stems.

Stem straightness assessment or modelling, in combination with better sorting algorithms have the potential to produce greater detail in log length and straightness. At a strategic level, this is critical information for new investment decisions.

Stiffness.

There is no current capacity to forecast stiffness. The requirement for structural grade prediction in the PF is still somewhat of a moot point, with some calling for it as essential, whilst others see it as a luxury or impracticable to achieve. The future of construction grade timber in the UK relies on us producing enough stiff material as a % of the whole production population. There is large variation in stiffness from both stand to stand and within stands. A high % of our main timber supply is very close to not being stiff enough to make C16 strength class for Sitka. Any reduction in stiffness will therefore be a huge cause for concern. We now have models to predict stiffness that could provide us with an indication of what the spread in stiffness in our future resource is likely to be. There appears to be three main potential methods in assessing this

- Generic predictive models based on location, elevation, aspect, crop type etc. These are still under development, and are not able at present to sufficiently explain the reasons for variability at stand and within tree levels, but will be validated further in 2009.

- Sonic measurement of timber in situ – i.e. assessing standing timber or assessing it during harvesting or on logs at roadside. This could be narrowed down to an assessment of commercial conifer only within the NFI.

- At the mill prior to processing.

How we may go about predicting the latter two, is where the greatest contention in approach is found. Whilst the sector says that they need to have stiffness data, some experts report that it is pointless to measure and predict in a strategic forecast. This difference in opinion needs to be resolved.

Some of the concerns that people hold revolve around the 'time dimension' of forecasting grade. Straightness and stiffness change through the life of the crop. Trees tend to straighten as they get older, and are thinned, the thinning usually biasing one stem form or another over time. Within spruce, particularly, the wood on the outside of the tree becomes stiffer with increasing age due to slower rates of growth and a tendency for micro fibril angle to reduce. For example, ring number (or age) is a strong predictor of microfibril angle, density, stiffness and dbh is a strong predictor of straightness (improves with age, yield class and thinning). However it needs to be made clear that this is for stem/log/roundwood stiffness. Forecasting stiffness may not be meaningful if the cutting pattern adopted means the outer, stiffer wood is cut to waste. Models for determining stiffness are also very much in their infancy.

These factors put some question over how far forward it is practical to forecast these elements of timber quality, especially if a grade forecast was to go beyond 10 years. Even so a forecast of these properties over the next 10 years could still be valuable to industry.

However, some companies are already employing the use of acoustic tools for assessing stiffness in standing or felled trees in Scotland, as part of their stand assessment and log sorting processes and this indicates the growing need in this area.

Conclusions

There appears to be a genuine and necessary need to produce and disseminate information on timber quality to help maintain investment in the sector. However the sector's approach to quality is confused in terms of what is required and how this is to be delivered. There is therefore a fundamental importance in defining a common language and establishing a common understanding of what is required, if we are to achieve progress in this area.

Based on observations so far the FC should explore the provision of a:

1. Stem straightness quantification and based upon this a separate red / green breakout forecast for Sitka spruce for at least 0 to 10 years and if viable 0 to 25 years. There appears a strong requirement for this.

2. A strength class forecast for Sitka spruce for 0 to 10 years and if viable 0 to 25 years. There appears to be a requirement for this, but not as strong as that for straightness.

There is a need for a consistent industry view on these issues to ensure that the production forecast is fit for purpose and is neither under or over-specified.

Future decision items

The Confor Processor group is asked to take a view on these matters with the aim of assisting the development of industry policy on forecasting timber properties and log quality and establishing a programme of works to deliver this.

1. What are the sector requirements, do they accord with the observations and conclusions drawn in this paper re assortment, straightness and stiffness?

2. Who decides what the sector requirements are?

3. Who decides how this is to be delivered?

4. What level of involvement do the sector want in the direction of FR work undertaken on timber properties and log quality?

5. Considering the time and resource constraints involved, what level of timber properties and log quality would be desirable as part of the 2011 PF, the 2015 PF and the 2020 PF's (short, medium and long term)?

Ben Ditchburn
PF Programme Manager
November 2008

With significant contributions from R. Coppock, R. Matthews, B. Gardiner and E. Mackie

Appendix A – Research into Operational Quality Assessment

Work by Irish company Treemetrics in conjunction with Forest Research is investigating the use of laser scanning technology to perform pre-harvest inventory survey. The work comprises two pieces of software, which are of interest to the sector. First the Treemetrics software analyses the laser scan and converts the data into a stem file, similar to that produced by a modern harvester. Taper algorithms added by Forest Research can then predict height from the scanned data to tip or to any desired diameter. Tree straightness, height, and diameter every 10 cms up the stem are determined. The second piece of software analyses the data against a variety of cutting files to assess what the optimal log out turn, based on current prices, would be. This information is valuable to both grower and purchaser in that it reduces uncertainty, and can assist the process of matching product to mill much more efficiently. The process is currently being used for operational purposes, but has the potential to provide basic data to the forecast for more strategic predictions.