# Yield estimates for public eucalypt native production forests in Tasmania - methodology applied by Forestry Tasmania on behalf of the signatories to the 2012 Tasmanian Forest Agreement

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## Summary

A group of non government organisations with a recognised interest in public forests in Tasmania has negotiated a new paradigm for the future management of those forests. The negotiations commenced in mid 2010 and were finalised with the signing of the Tasmanian Forest Agreement on 22 November 2012. Negotiations were assisted by the preparation of yield forecasts, for various scenarios proposed by the signatories during successive stages of their negotiations. The scenarios were defined by key objectives and constraints that reflected the signatories' respective aspirations. The methodology applied by Forestry Tasmania in preparing the yield forecasts for each scenario was based in large part on its established methodology for eucalypt native forest inventory and modelling. The signatories were assisted by independent expertise to facilitate the definition of scenarios and to review the yield forecasts prepared by Forestry Tasmania. The scenario that was ultimately agreed by the signatories represents a significant change to the area of public native forest that is available for wood production in Tasmania and, consequently, to the forecast availability of high quality eucalypt sawlogs and peeler billets from those forests. The agreed scenario provided for the transfer of about 500,000 hectares of former State forest to reserve, a minimum annual supply of 137,000 cubic metres of high quality eucalypt sawlogs from native forest until end June 2027 and then a reduced annual supply of 105,000 cubic metres until end June 2050, and a minimum annual supply of 157,000 cubic metres of eucalypt peeler billets from native forest until end June 2027. These forecast yields were generated from biologically based forest estate modelling of productive capacity, and do not imply supply based on economic criteria. These outcomes will be integrated by Forestry Tasmania with equivalent forecasts for eucalypt plantations to indicate the total wood supply from Permanent Timber Production Zone Land for the next 90 years.

## 1. Introduction

This paper documents the preparation of current yield forecasts for public eucalypt native production forests in Tasmania. The yield forecasts were prepared by Forestry Tasmania (specifically, by staff in its Wood Planning Branch), in accordance with objectives and criteria developed by the signatories:

(a) to the 2010 Tasmanian Forests Statement of Principles to lead to an Agreement ("the Statement of Principles"); and

(b) to the 2012 "Tasmanian Forest Agreement" ("the TFA").

## 2. Background

The signatories represented a spectrum of non government organisations with a recognised interest in the future management of Tasmania's public forests. These included environmental groups, timber industry businesses, community associations and labour unions. The signatories conducted their negotiations over the period from mid 2010 to November 2012, informed by various position papers and by various independently prepared reports commissioned by them or by either or both the Australian Government and the Tasmanian Government ("the Governments") at the time. A summary of key events and publications that are relevant to the signatories' negotiations is appended (Attachment 1).

The signatories' initial negotiations led to the Statement of Principles (signed on 14 October 2010), being an agreed statement of their respective aspirations. Some of these aspirations were recognised at the time to be mutually exclusive, thereby requiring further analysis and negotiation.

An incidental consequence of the Statement of Principles was the conduct of an independent review of Forestry Tasmania's sustainable yield systems by Professor Cris Brack (Waiariki Institute of Technology) and Professor Jerry Vanclay (Southern Cross University). The review was commissioned by the Australian Government on 7 December 2010 *"to ensure that all the parties have an understanding and confidence in the wood resources and the scheduling of those resources by Forestry Tasmania"* (Brack and Vanclay, 2011, p. 1). The review report was released on 1 June 2011. It concluded as follows.

> *"The Reference Group can be confident that the scenarios presented by FT [Forestry Tasmania] offer a reliable indication of resource availability, and that the scenarios are a reasonable basis for comparing options. While the underlying areas, inventory, and simulations conform to best practice, it is not possible to assert a precise long-term non-declining yield for any of the three scenarios without further specification of operational requirements (notably coupe dispersal and swift parrot requirements). Notwithstanding this limitation, the FT summaries offer a good basis for comparing scenarios."*
> (ibid, p. 5)

The work described in this paper was conducted over the period from the signing of the Statement of Principles to final agreement between the signatories (formalised by their signing of the TFA on 22 November 2012) and between the Governments (formalised by their signing of the second Tasmanian Forests Intergovernmental Agreement on 2 May 2013).

The work followed an iterative process. An initial suite of scenarios, defined by the signatories, was analysed by Forestry Tasmania. The relevant report (Forestry Tasmania, 2011a) was submitted to the signatories on 6 June 2011, for them to consider. Included in the report was a proposal to introduce a new factor to discount forecast yields for potential future changes in forest conservation requirements at the operational level, termed "headroom" (ibid., pp. 8-10).

The Governments signed the initial Tasmanian Forests Intergovernmental Agreement ("the TFIA"), based on advice from the signatories, on 7 August 2011. The TFIA established an Independent Verification Group ("IVG"), under the chairmanship of Professor Jonathan West. The IVG prepared advice to the governments, under five primary subject headings:

(a) wood supply;

(b) forest conservation;

(c) mineral prospectivity;

(d) socioeconomics; and

(e) social reserves.

In the case of wood supply, the relevant technical report was prepared by Professor Mark Burgman and Dr Andrew Robinson (each from the University of Melbourne). It comprised a review of Forestry Tasmania's forest inventory and yield methodology, including discussion about the headroom factor that had been proposed by Forestry Tasmania and an analysis of the feasibility of various alternative scenarios (based on those proposed by the signatories at the time, as described in the TFIA).

Forestry Tasmania assisted Burgman and Robinson in their work, by using its forest inventory and yield models to prepare yield forecasts for each relevant scenario.

Burgman and Robinson completed their technical report on 7 March 2012 (Burgman and Robinson, 2012). It was released, along with the other four technical reports and a "capstone report" by Professor West, on 23 March 2012. Burgman and Robinson's wood supply technical report indicated, *inter alia*, that the objective in the TFIA for an additional 572,000 hectares of reserves was not compatible with the objectives in the TFIA for the future supply of high quality eucalypt sawlogs and eucalypt peeler billets from public native production forests.

Professor West subsequently released a "Chairman's report", on 27 March 2012 (West, 2012). Included in the Chairman's report was an assertion by Professor West that *"Tasmania's native forest (not including plantations) have been and continue to be harvested substantially above long-term sustainable yield, in respect of the key product segments to which they provide resources"* (ibid, p. 4).

Professor West's assertion of overcutting came to the attention of the Program for Endorsement of Forest Certification schemes (PEFC), being the international parent body under which the Australian Forestry Standard is certified. At the time, NCS International (an independent certification body) was conducting a biennial recertification audit of Forestry Tasmania, to review the latter's certification under the Australian Forestry Standard. NCS International was requested by PEFC to investigate Professor West's assertion (Berger, 2012, p.1), and subsequently engaged Professor Ian Ferguson (University of Melbourne) to do so on its behalf.

In his report, released on 4 June 2012, Professor Ferguson concluded that he was *"unable to determine a rational basis"* for the assertion by Professor West (Ferguson, 2012, p. v).

The Legislative Council of the Parliament of Tasmania also conducted an inquiry into Professor West's assertion of overcutting. Its report, released on 1 November 2012, determined that Professor West's assertion was unfounded (Parliament of Tasmania, 2012, pp. 18-19). This was because it did not take into account the yield from eucalypt plantations managed by Forestry Tasmania, noting that these plantations were established largely under the Tasmanian Regional Forest Agreement (Commonwealth of Australia and State of Tasmania, 1997) and the Tasmanian Community Forest Agreement (Commonwealth of Australia, 2005) and that their express purpose was to maintain the yields of high quality eucalypt sawlogs that would otherwise have been diminished by the addition of significant areas of public native production forest to new reserves under those Agreements at that time.

The conclusion of the IVG's work in March 2012 was followed by a further iterative process, facilitated by Dr Robinson and in consultation with Forestry Tasmania, through which the signatories defined a set of five indicative scenarios. Yield forecasts for each of these were prepared by Forestry Tasmania and a report to the signatories, based on the yield forecasts, was prepared by Dr Robinson and submitted to the signatories on 24 October 2012 (Robinson, 2012).

This led to the definition of the scenario that was ultimately agreed by the signatories ("the agreed scenario"), for which yield forecasts were then prepared by Forestry Tasmania and submitted to the signatories on 6 December 2012 (Forestry Tasmania, 2012a).

The yield forecasts for the agreed scenario were endorsed by the signatories as the supply commitments in the TFA. The Tasmanian Government then formalised the yield forecasts as the basis for new legislated supply quantities, by legislation to amend the relevant section (s. 22AA) of the *Forestry Act 1920 (Tas)* ("the Forestry Act"). Forestry Tasmania has since negotiated new log supply contracts with each of its relevant customers, consistent with the yield forecasts and new legislated supply quantities.

## 3. Scope

This paper describes yield forecasts for the following products from public eucalypt native forests that are available for wood production in Tasmania:

(a) high quality eucalypt sawlogs, being eucalypt logs with a minimum small end diameter under bark of 30cm, a minimum length of 3.6m and minimal external defect (various categories including internal decay, spiral grain, sweep, scars, limbs and bumps);

(b) eucalypt peeler billets, being eucalypt logs, other than high quality eucalypt sawlogs, with diameter under bark of between 18cm and 70cm, a minimum length of 900mm, no internal decay and minimal other defect (various categories including spiral grain, sweep, scars, limbs and bumps), noting that eucalypt peeler billets are recovered from (and are a subset of) eucalypt peeler logs (see Section 5.5); and

(c) arisings, being the aggregate quantity of various other products that arise from the integrated harvesting of high quality eucalypt sawlogs and eucalypt peeler logs and comprising low quality eucalypt sawlogs, roundwood and pulpwood.

Conversely, this paper does not describe yield forecasts for privately owned forests, nor for public forests beyond 30 June 2032 (for eucalypt peeler billets) and 30 June 2050 (for high quality eucalypt sawlogs), nor for:

(d) non eucalypt sawlogs, including special timbers;

(e) plantation forests, including eucalypt plantation forests;

(f) non timber products (e.g. biofuel); or

(g) specific individual products that comprise “arisings”, i.e. yields for these are forecast in aggregate (see (c) above) and are neither modelled nor reported individually.

## 4. Relationship to other yield forecasts for public forests in Tasmania

Forestry Tasmania and its predecessor, the Tasmanian Forestry Commission, have a long history of native forest and plantation forest inventory and forest yield modelling, including regular reviews thereof (e.g. Forestry Commission, 1959, 1972, 1974, 1982, 1983a, 1983b, 1983c, 1986 and 1987, Forests and Forest Industry Council, 1990).

From 1997, Forestry Tasmania has been required to conduct five yearly reviews of its forecast yields from public wood production forests in Tasmania (Forestry Tasmania, 1998, 2002 and 2007). This requirement arises under the Tasmanian Regional Forest Agreement (Commonwealth of Australia and State of Tasmania, 1997). The results of each review are required to be made public in a suitable format and to include a report by a suitably qualified independent person that has audited the inputs, methods and outputs used in the review.

These previous reviews by Forestry Tasmania have focussed on achieving a sustainable yield of high quality eucalypt sawlogs defined by the following two primary constraints, each applied over a 90 year planning period:

(a) a non declining yield of high quality eucalypt sawlogs, i.e. that the forecast yield in any year of the planning period is no less than in the previous year; and

(b) maintenance of the total standing merchantable volume, i.e. that the forecast total standing merchantable volume at the end of the planning period is no less than at its beginning.

Other products (e.g. eucalypt peeler billets and arisings) have not been subject to equivalent primary constraints in these previous reviews.

The forest estate on which the relevant modelling for these reviews was conducted included both native forests and eucalypt plantations. The method that was applied for the relevant modelling in 1998 was described by Whiteley (1999). The target value for the minimum non declining yield of high quality eucalypt sawlogs was 300,000 cubic metres per year. This target value accorded with Forestry Tasmania's minimum supply obligation under s. 22AA of the Forestry Act, and subsequently confirmed in the Tasmanian Regional Forest Agreement.

The Tasmanian Regional Forest Agreement was supplemented by the Tasmanian Community Forest Agreement (Commonwealth of Australia, 2005). The changes made as a result of this agreement between the governments included *inter alia* a reduced public native forest wood production estate and increased funding for eucalypt plantation establishment. The target value for the minimum non declining yield of high quality eucalypt sawlogs remained at 300,000 cubic metres per year.

The significant reduction in the public native forest wood production estate that results from the TFA (and that is formalised by the *Tasmanian Forests Agreement Act 2013 (Tas)*) is one of several such significant reductions that have resulted from various government policies and agreements over the past 30 years. In the past, such reductions in the area of the public native forest wood production estate have been accompanied by little or no reduction in the legislated amount on which Forestry Tasmania's relevant long term contractual commitments for high quality eucalypt sawlogs were based. Rather, these reductions in forest area were accompanied by increased establishment of eucalypt plantations which were targeted at maintaining overall sawlog yields in future years. The only such reduction in the sawlog supply target over this period was from a minimum 317,000 cubic metres per year to a minimum 300,000 cubic metres per year, effected by the *Public Land (Administration and Forests) Act 1991 (Tas)* (which amended s.22AA of the Forestry Act in accordance with agreement reached in the Forests and Forest Industry Strategy (Forests and Forest Industry Council, 1990)).

## 5. Method

Whiteley (1999) and Burgman and Robinson (2012, pp. 18-28) described the methodology applied by Forestry Tasmania in its calculation of the sustainable yield of Tasmania's State forests. With respect to the methodology that was used to prepare the yield forecasts reported in this paper ("the yield forecasts"), the following description:

(a) summarises those elements of the methodology that remain as described in Whiteley (ibid.) and Burgman and Robinson (ibid.); and

(b) describes the other elements in appropriate detail.

The description is structured as a serial progression of separate stages, in the interests of clarity. However, the methodology includes iterative cycles within an otherwise serial progression. As an example, the assignment of current and forecast yields to planned harvesting units (see below) enabled a reassessment of the status of those coupes, to exclude from subsequent consideration those for which a low forecast yield per hectare (and, potentially, other attributes, e.g. topography and remoteness) led them to be categorised as unviable.

## 5.1 Gross area statement

The gross area of public production forest in Tasmania was defined by reference to standard land tenure maps, available in digital form and managed using a geographic information system ("GIS"). The specific land tenure class that defined the gross area of public production forest, prior to the TFA, was "Multiple Use Forest Land", as defined in the Forestry Act prior to its amendment by the *Tasmanian Forests Agreement Act 2013 (Tas)*. The relevant area at 30 June 2012 (for example) was 1,247,000 hectares (Forestry Tasmania, 2012b, p. 2).

The following additional information was used to define the gross forest area for the purposes of each scenario for which the yield forecasts were prepared:

(a) plantation forests, as defined in Forestry Tasmania's digital maps of its plantation estate; and

(b) areas proposed by the signatories for reservation ("reserve proposals"), provided to Forestry Tasmania in digital form.

In each case, the relevant areas were excluded from the area of Multiple Use Forest Land, using standard GIS methods.

Successive major stages of the negotiations between the signatories were associated with the following definitions of the reserve proposals. There were a number of intermediate iterations of these, to inform negotiations between the signatories as to the gross area scenarios that were to be evaluated.

### 5.1.1 Reported in Forestry Tasmania (2011a)

Forestry Tasmania compared yield forecast scenarios based on two reserve proposals and a base case (comprising no proposed new reserves). Of the two reserve proposals, the first, referred to as the "ENGO proposal" comprised a total area of 572,000 hectares, and the second, referred to as the "industry proposal", comprised a total area of 140,350 hectares. In each case, the reserve proposals comprised a mosaic of wood production forests and informal reserves.

Forestry Tasmania's analysis included its eucalypt plantation estate.

### 5.1.2 Reported in Burgman and Robinson (2012)

Burgman and Robinson analysed the ENGO reserve proposal and a base case comprising no new reserves (each as above).

In addition, the authors' analysis included scenarios to include or exclude Forestry Tasmania's eucalypt plantation estate.

#### 5.1.3 Reported in Robinson (2012)

Subsequent negotiations between signatories resulted in a revised ENGO reserve proposal that comprised a total area of about 521,000 hectares of proposed reserves. The scenarios evaluated by Robinson were based on the "ENGO 521K" reserve proposal, dated 11 September 2012.
Forestry Tasmania's plantation estate was excluded from the evaluation.

This reserve proposal defined the gross area of the public native production forest estate, as agreed by the signatories in the TFA.

The remainder of this paper refers only to analyses based on the definition of gross forest area reported in Robinson (2012).

### 5.2 Nett area statement

The gross area statement was discounted for all areas assessed by Forestry Tasmania to be unavailable for harvest. The relevant assessment was conducted in several stages, as reported by Whiteley (op. cit., pp. 26-27) and Burgman and Robinson (op. cit., pp 18-20). The assessment was conducted by field planners in each relevant location. The stages are summarised as follows.

(a) A map based zoning system (the Management Decision Classification, or "MDC", described in Orr and Gerrand 1998, since updated in Forestry Tasmania 2011b), based on 1:25,000 scale maps, was used by field planners to delineate the primary classification of State forest into "Production", and "Protection" zones. Production zones were considered to be available for harvesting (subject to the outcomes of the remaining three stages, see below). Protection zones were considered to be unavailable for harvesting. The Protection Zones are included within the "Comprehensive, Adequate and Representative" reserve system defined in the Tasmanian Regional Forest Agreement (Commonwealth of Australia and State of Tasmania, 1997). The primary Management Decision Classification was recorded in digital maps.

(b) MDC was then used by field planners to delineate special management zones ("SMZs"), within the primary classifications, in which additional management considerations applied for one or more of 102 special values in fifteen groups (i.e. agriculture, apiary, cultural heritage, fauna, flora, fuel reduction, geoconservation, health, hazard, landscape, recreation, research, special timbers, utilities and water). SMZs that were not compatible with harvesting were reclassified as Protection zones. Of the other SMZs, some required modified harvesting prescriptions that affected the intensity or timing of harvesting. The boundaries and attributes of SMZs were recorded in digital maps.

(c) Provisional boundaries were then delineated by field planners for planned harvesting units ("provisional coupes") within the Production zone. This process took account of local factors that affect the planning and conduct of harvesting, in addition to the MDC (incorporating SMZ delineation). These factors included topography, forest type, access and the requirements of the Forest Practices Code (see Forest Practices Board (2000)). The process resulted in a detailed mosaic of provisional coupes (considered to be available for harvesting) and of areas that were considered to be unavailable for harvesting (i.e. areas within the Production zone, but considered to be unavailable for harvesting). The boundaries and attributes of provisional coupes were recorded in digital maps. At the time that the work described in this paper commenced, Forestry Tasmania's digital maps recorded about 14,500 provisional coupes, accounting for about 682,000 hectares (Burgman and Robinson, 2012, p. 18).

(d) For coupes that had been harvested in the preceding period, and upon the completion of that harvesting, any differences between a coupe's provisional boundaries and its actual boundaries were analysed (Stamm, 2011). These differences may have arisen in the planning stage, when detailed ground reconnaissance revealed additional factors that needed to be accommodated (e.g. unmapped topographic features or special values), or in the operational stage (e.g. areas that were locally inaccessible due to topography or soil conditions, unmapped special values or areas made uneconomic by low yields). The actual boundaries for each harvested coupe were recorded, for future reference.
In addition, the relationship between the actual area of each forest class harvested, relative to the original area of each forest class within the provisional boundary, was used to determine a discount factor (the "forest class discount factor") that was then used to adjust the forecast area and yields available from provisional coupes (i.e. those other coupes that had not yet been harvested).

Each provisional coupe was also classified according to a "coupe confidence" factor, representing the level of confidence that field planners have that Forestry Tasmania will be able to harvest the coupe within forest practices, operational and economic constraints. Provisional coupes with a coupe confidence factor of 0% were excluded from yield forecasts.

The discounts to which (a) to (d) above refer, together with the coupe confidence classification, have been reviewed by Forestry Tasmania on a five year cycle, commensurate with the timetable for the required reviews of sustainable yield under the Tasmanian Regional Forest Agreement. Each review has taken account of the effects of changes to conservation requirements (as expressed in the Forest Practices Code), silvicultural systems, harvesting technology and commercial viability. The nett area statement used for the work described in this paper reflected the outcome of the most recently undertaken five yearly review, conducted during 2010 and 2011.

For forests with an MDC classification of "St", denoting an emphasis on management for special timbers, those provisional coupes with an SMZ classification of "StBwd" or "StRft" were excluded from the modelling, because they did not contain significant quantities of eucalypt. Those provisional coupes with an SMZ classification of "StEuc" (being those that had a eucalypt overstorey, but that were relatively rich in special timbers), were included in the modelling. However, for the "StEuc" provisional coupes, the forecast yields were constrained by an assumption that silvicultural regeneration established after an initial harvest was to be managed for special timbers over a long rotation (e.g. 200 years), in accordance with Forestry Tasmania's Special Timbers Strategy (Forestry Tasmania, 2010).

The work described in this paper applied the newly defined gross forest area (i.e. that which is described in Section 5.1.3) to the then current nett area statement, using standard GIS methods. The new nett area statement, therefore, excluded provisional coupes within the "ENGO 521K" definition of areas proposed for reservation, dated 11 September 2012.

In addition, the signatories agreed to the following classification for some coupes, as specified by those of the signatories that represented ENGOs (see also Section 7 and Attachment 4):

(i) "log of last resort" coupes, being provisional coupes that were only to be assumed as available for harvest during the period 1 July 2022 to 30 June 2032[1], and

(ii) "log, restore and reserve" coupes, being provisional coupes that were only to be assumed as available for harvesting during defined periods, after which it was to be assumed that they would be restored and then reserved from further harvesting.[2]

### 5.3 Classification of forests into forest classes

The following summary of the method used to classify forests into forest classes is drawn in part from Stone (1998, pp. 21-26), Whiteley (1999, p. 26) and Burgman and Robinson (2012, p. 23).

Forestry Tasmania based its native forest inventory on photo interpreted forest types ("PI types") that were derived by interpreting stereoscopic pairs of 1:20,000 scale, colour aerial photographs, and were recorded in digital maps at 1:25,000 scale. PI types were delineated on the basis of key components, being dominant genus (e.g. eucalypt), age class (or age, for areas regenerated at a known date), height class (and potential height class, for immature stands), crown density class and the presence or otherwise of secondary species. There were numerous potential combinations of these key components.

[1] The signatories subsequently agreed that this area of 1,228 hectares would remain as State forest and a decision on future tenure made in 2022 (Clause 39, Tasmanian Forest Agreement 2012).

[2] The signatories subsequently agreed that this area of 20,183 hectares would remain as State forest and a decision on future tenure made in 2022.

The numerous PI types were classified into 91 forest classes, based on the key components. The forest classes have been modified since Stone (1998) and Whiteley (1999), with the current forest classes listed at Attachment 2. Areas identified as plantation (hardwood or softwood) were recorded as forest classes for completeness, but are subject to separate plantation inventory and yield systems and were excluded from native forest yield forecasts.

## 5.4 Assignment of forest class yield tables to forest classes

The following summary of the method used to classify forests into forest classes is drawn in part from Whiteley (1999, pp. 27-28) and Burgman and Robinson (2012, pp. 22-24).

As noted by Burgman and Robinson (2012, p. 20), technical details of the methods used by Forestry Tasmania to estimate yields and forecast yields for native forest have been documented by West (2007, 2008a-c) and Goodwin (2009).

Forestry Tasmania used data from 2,976 inventory sample plots within native forest to determine average current yields and average forecast yields for each relevant forest class. This was done separately for each inventory area (see Whiteley 1999, pp. 25-26). The data were analysed using Forestry Tasmania's "FENRIS" forest inventory and yield system, replacing its previous Forest Inventory Projection System.

Yields derived from plot data and growth models were adjusted to reflect the outcomes of regular analyses of any difference between the actual yields from forest classes within harvested coupes and the planned (predicted) yields for those forest classes (Musk (2009) and Anonymous (2011)).

## 5.5 Assignment of coupe yield tables to provisional coupes

A composite yield table was derived for each provisional coupe, based on the area of each forest class within each provisional coupe, the forecast yields per hectare for each forest class and the forest class discount for each forest class. Yields were modelled for the following forest products:

(a) high quality eucalypt sawlogs, measured in cubic metres;

(b) eucalypt peeler logs, measured in green metric tonnes; and

(c) other products (measured in green metric tonnes and termed "arisings"), being the difference between the quantity of all merchantable logs (other than high quality eucalypt sawlogs) and the quantity of eucalypt peeler logs.

In the case of eucalypt peeler billets (measured in cubic metres), the billets are recovered from eucalypt peeler logs, which in turn are recovered from regrowth pulpwood logs (each measured in green metric tonnes). Accordingly, the relevant yield estimates for eucalypt peeler billets were derived:

(i) firstly, from Forestry Tasmania's yield estimates for regrowth pulpwood logs for each provisional coupe;

(ii) secondly, from Forestry Tasmania's records of historical recovery rates for eucalypt peeler logs from regrowth pulpwood logs in each region (e.g. in the Huon District the relevant historical recovery rate is 40%, i.e. eucalypt peeler logs accounted for 40% of the quantity of regrowth pulpwood logs); and then

(iii) by multiplying the estimate from (ii) by a factor (see below), to account for the conversion from eucalypt peeler logs measured in green metric tonnes to eucalypt peeler billets measured in cubic metres.

This latter factor (0.81) was agreed by the signatories, to account for the conversion from green metric tonnes to cubic metres (i.e. an assumed 1.1 green metric tonnes per cubic metre) and for recovery losses (from log to billet) of ten per cent. Forestry Tasmania applied this factor to the quantity of eucalypt peeler logs arising under each scenario (i.e. to the outputs from the modelling of scenarios), rather than to the yield tables used as inputs for the modelling of scenarios.

An example of the derivation of a yield table used as an input for the modelling of scenarios is presented at Attachment 3.

## 5.6 Definition of scenarios - objectives and constraints

Forestry Tasmania used the "Woodstock" module of the Remsoft Spatial Planning System (version 2012.5), to prepare yield forecasts in accordance with constraints developed by the signatories.

Robinson (2012, pp. 2-4) described the three scenarios proposed by the signatories for analysis ("the penultimate scenarios"). These are summarised below as "A", "B" and "C".

Attachment 4 comprises a list of the specific objectives and constraints that were defined to represent each of the penultimate scenarios. These objectives and constraints were prepared in consultation between the signatories, Dr Robinson and Forestry Tasmania. The constraints numbered 1 to 7 in Attachment 4 applied to each of the penultimate scenarios.

A. For the period 2011/12 to 2026/27, the annual supply of high quality eucalypt sawlogs was to be 150,000 cubic metres per year.

For the period 2027/28 to 2049/50, the annual supply of high quality eucalypt sawlogs was to be maximised.

For the period 2011/12 to 2026/27, the annual supply of eucalypt peeler billets was to be maximised, subject to an upper limit of 180,000 cubic metres per year.

For the period 2027/28 to 2031/32, the annual supply of eucalypt peeler billets was to be maximised.

B. As for A, but with the following additional constraints:

 (a) operational constraints, to reflect infrastructure availability and coupe feasibility (i.e. constraints numbered 8 to 10 in Attachment 4) were included; and

 (b) stand age constraints, to improve product suitability (i.e. constraint numbered 11 in Attachment 4) were included.

C. For the period 2011/12 to 2026/27, the annual supply of eucalypt peeler billets was to be 180,000 cubic metres per year.

For the period 2027/28 to 2031/32, the annual supply of eucalypt peeler billets was to be 95,000 cubic metres per year.

For the period 2032/33 onwards, the annual supply of eucalypt peeler billets was to be unconstrained.

For the period 2011/12 to 2026/27, the annual supply of high quality eucalypt sawlogs was to be maximised, subject to an upper limit of 150,000 cubic metres per year.

For the period 2027/28 to 2031/32, the annual supply of high quality eucalypt sawlogs was to be maximised.

Operational constraints, to reflect infrastructure availability and coupe feasibility (i.e. constraints numbered 8 to 10 in Attachment 4) were included.

Stand age constraints, to improve product suitability (i.e. constraint numbered 11 in Attachment 4) were included.

A key difference between scenario C and scenarios A and B was that scenario C focussed on a fixed annual supply of peeler billets until 2027, and allowed the high quality sawlog level to fluctuate accordingly whereas scenarios A and B focussed on a fixed annual supply of high quality sawlog until 2027 and allowed the peeler billet level to fluctuate.

In each case, the analyses were conducted and reported on a regional basis. The three relevant regions are the northwest, northeast and south of Tasmania, each of which is defined in digital form by Forestry Tasmania (see Attachment 5). Regional targets for supply were based on earlier iterations of the gross area statement and yield forecasts, as reported in Robinson (2012, p. 2) and summarised below:

(i) for high quality sawlogs, over the period 2011/12 to 2026/27, 70% of the total was to be sourced from the south and 30% from the northwest and northeast;

(ii) for high quality sawlogs, over the period 2027/28 to 2049/50, 60% of the total was to be sourced from the south and 40% from the northwest and northeast; and

(iii) for eucalypt peeler billets, 50% was to be sourced from the south and 50% from the northwest and northeast.

Forestry Tasmania (2011a, pp. 8-10), Brack and Vanclay (2011, p. 5), Burgman and Robinson (2012, pp. 27-28) and Ferguson (2012, pp. 12-15) each discussed the rationale for the application of a "headroom" factor. The purpose of a headroom factor was to discount forecast yields by an additional factor that reflected a provision for the impact on nett areas and yields of future changes in the applicable requirements for conservation (e.g. under the Forest Practices Code).

Forestry Tasmania applied a ten per cent headroom factor to all yield forecasts, as was agreed between the signatories. Therefore, the results reported hereafter for all scenarios and all products have been calculated by discounting the forecast yields by ten per cent.

## 6. Results

Initial analysis of the penultimate scenarios, i.e. Scenarios A, B and C, revealed the following three problematic results (Robinson, 2012, p. 7).

(a) Provisional coupes that required cable harvesting accounted for 21.9% of the aggregate quantity of high quality eucalypt sawlogs and 16.1% of the aggregate quantity of eucalypt peeler billets. These levels of cable harvesting exceeded the current operational capacity. The introduction of the constraints numbered 8 and 9 in Attachment 4 limited the forecast yield from cable harvesting operations to the forecast operational capacity in each relevant operational area.

(b) In the south, "low confidence coupes", i.e. provisional coupes for which the coupe confidence factor is greater than 0% but less than or equal to 25%, accounted for 7.9% of the aggregate quantity of high quality eucalypt sawlogs and 5.2% of the aggregate quantity of eucalypt peeler billets. Most of these coupes were rated as low confidence coupes because of the presence within them of karst landforms (55% of the relevant 7.9% of HQSL volume), vegetation communities with a recognised significance for conservation under the Regional Forest Agreement (9% of the relevant 7.9% of HQSL volume) or protected species (6% of the relevant 7.9% of HQSL volume). This was addressed by the introduction of the constraint numbered 10 in Attachment 4, thereby limiting the forecast yield from low confidence coupes to the period beyond 1 July 2027.

(c) Stands aged less than 60 years of age accounted for 4.3% of the aggregate quantity of high quality eucalypt sawlogs in the period 2011/12 to 2020/21, increasing to 19.2% in the period 2021/22 to 2026/27. The resultant likelihood that the viability of eucalypt sawmilling operations would be reduced to unacceptable levels by an overall reduction in average log diameter was identified as a significant problem by industry representatives among the signatories. This was addressed by the introduction of the constraint numbered 11 in Attachment 4, thereby setting to zero the forecast yield of HQSL from stands that were less than 60 years old.

In addition to the four new constraints (as above), the initial analysis of the penultimate scenarios led to the definition of two further variations to Scenario A, as follows:

(i) A / Cable — as for Scenario A, but with cable harvesting capacity limited to a single operation in each of the three relevant operational areas and with the deferral of some cable harvesting yields until after 1 July 2027 (i.e. the addition of the constraints numbered 8 and 9 in Attachment 4); and

(ii) A / Cable / CCC — as for Scenario A, but with cable harvesting capacity limited to a single operation in each of the three relevant operational areas and with the deferral of some cable harvesting, and of all low confidence coupes in the south, until after 1 July 2027 (i.e. the addition of the constraints numbered 8 to 10 in Attachment 4).

Results of the final analysis of the penultimate scenarios, i.e. following the adjustments to which the preceding discussion refers, are summarised in Table 1
(modified from Robinson 2012, p. 5). The summary at Table 1 refers only to the two forest products that were subject to the explicit constraints to which Section 5.6 refers, i.e. high quality eucalypt sawlogs and eucalypt peeler billets.

**Table 1 Forecast statewide yields of high quality eucalypt sawlogs (HQSL) and of eucalypt peeler billets (Peeler) from public eucalypt native forests in Tasmania under three defined scenarios, by period (Km3pa)**

| Period | Scenario | HQSL | Peeler |
|---:|---|---:|---:|
| 2011/12 to 2026/27 | A | 151 | 174 |
| | A / Cable | 144 | 173 |
| | A / Cable / CCC | 140 | 170 |
| | B | 130 | 156 |
| | C | 114 | 179 |
| 2027/28 to 2031/32 | A | 100 | 168 |
| | A / Cable | 99 | 124 |
| | A / Cable / CCC | 104 | 121 |
| | B | 104 | 82 |
| | C | 87 | 87 |
| 2032/33 to 2049/50 | A | 100 | n.a. |
| | A / Cable | 99 | n.a. |
| | A / Cable / CCC | 104 | n.a. |
| | B | 104 | n.a. |
| | C | 87 | n.a. |

The results summarised at Table 1 were considered by the signatories, who placed considerable emphasis on the importance of constraining the clearfelling of aged regrowth by only counting high quality eucalypt sawlogs from coupes that are at least 60 years old (constraint 11, Scenario B). They placed less emphasis on the need to constrain yields on the basis of existing availability of cable harvesting capacity (constraints 8 and 9 as applied in Scenario A / Cable). This consideration resulted in an agreed scenario that was derived from the penultimate scenarios, by adding to the results for Scenario B the difference between the results for Scenarios A and A / Cable. The yields of high quality eucalypt sawlogs, eucalypt peeler billets and arisings from the agreed scenario are summarised in Table 2.

**Table 2 Forecast statewide yields of high quality eucalypt sawlogs (HQSL), of eucalypt peeler billets (Peeler) and of arisings from public eucalypt native forests in Tasmania under the agreed scenario, by period (HQSL and Peeler in Km3pa and arisings in Kgmtpa)**

| Period | HQSL | Peeler | Arisings |
|---|---|---|---|
| 2011/12 to 2026/27 | 137 | 157 | 870 |
| 2027/28 to 2031/32 | 105 | 126 | 618 |
| 2032/33 to 2049/50 | 105 | n.a. | 618 |

The yields summarised in Table 2 were used as the basis for the eucalypt wood supply described in Clause 4 of Tasmanian Forest Agreement 2012. The reserve outcome of about 521,000 hectares used for the yield modelling was essentially the same, in terms of impact on timber yields, as the reserve estate described in the Tasmanian Forest Agreement 2012, which totalled 525,000 ha.

## 7. Discussion

The TFA represented three significant changes to the overall paradigm on which previous yield forecasts by Forestry Tasmania had been based, as follows.

(a) Eucalypt plantations were excluded from the analysis of future yield of high quality eucalypt sawlogs and eucalypt peeler billets considered to be available, i.e. the relevant forest estate was limited to native forest only. This reflected an agreed view by signatories and Forestry Tasmania that plantation material would not produce significant quantities of suitable replacement sawlog material until at least 2027.

(b) The target annual volume for high quality eucalypt sawlogs was reduced from a minimum 300,000 cubic metres (i.e. the legislated amount on which Forestry Tasmania's relevant long term contractual commitments had been based), to 137,000 cubic metres, and the target annual volume for eucalypt peeler billets was reduced from 265,000 cubic metres (i.e. the aggregate amount of Forestry Tasmania's relevant long term contractual commitments at the time), to 157,000 cubic metres.

(c) The planning horizon for modelling purposes was reduced to 50 years (with yields until 2050 being reported), noting in particular that the planning horizon for the new target annual supply quantities at (b) above was fifteen years, i.e. to end June 2027.

These changes were agreed between the signatories and were formalised in the TFA. As such, they represent the collective intentions of the signatories for the future management of public forests, including public wood production forests, in Tasmania. The *Tasmanian Forests Agreement Act 2013 (Tas)* gave legislative effect to the change to the target value for the minimum non declining yield of high quality eucalypt sawlogs at (b) above, by amending s. 22AA of the Forestry Act. Neither of the changes at (a) and (c) above was formalised by amendment to the Forestry Act.

The *Forest Management Act 2013 (Tas)* was given royal assent on 6 November 2013. The new Act replaced the Forestry Act. The prescribed minimum volume of high quality eucalypt sawlogs to be made available annually under the new Act remains at 137,000 cubic metres.

Forestry Tasmania intends to conduct further modelling of yield forecasts for the public wood production forest estate (i.e. that which results from the TFA and the *Tasmanian Forest Agreement Act 2013 (Tas)*). It is intended that the further modelling:

(i) will have a planning horizon of 90 years or more; and

(ii) will consider all components listed at (a) to (f) in Section 3 of this paper,

and will include as "embedded constraints" the relevant outcomes of the TFA, as summarised at (a) to (c) in this Section 7.

As noted at (b) above, the agreement reached by the signatories, together with subsequent agreement between the governments and with legislation that was then passed by the Parliament of Tasmania, represented a significant change in the area available for wood production and the basis for determining forecast yields for public forests in Tasmania. This, in turn, led to a significant reduction to the statutory supply obligations that applied to Forestry Tasmania and significant reductions to the relevant quantities of forest products supplied under its long term contracts with customers. The scenarios for which forecast yields were prepared by Forestry Tasmania, as described in this paper, were defined with reference to the key variables of interest to the signatories, i.e. the area of public production forest that could be transferred to formal reservation and the forecast yields of high quality eucalypt sawlogs and eucalypt peeler billets that could be harvested from the remaining area of public eucalypt native production forest over the period to end 2027 (being the period agreed by the signatories for Forestry Tasmania's sales contracts for the relevant products).

The agreed scenario represented, *inter alia*, agreed assumptions that:

(A) the current cable harvesting capacity in each of three operational areas (i.e. Derwent West Subdistrict, Huon District and Bass District) would be increased; and

(B) those of the provisional coupes that require cable harvesting, within two operational areas (i.e. Derwent Central Subdistrict and the Derwent East Subdistrict), were available for harvesting during the period to 30 June 2027.

These assumptions introduce some risk to the resultant forecast yields, i.e. if there were to be an unreasonable delay in the introduction of a suitably equipped harvesting crew in each of the relevant operational areas.

It is noted that the forecast yields were generated from biologically based forest estate modelling of productive capacity, and do not imply supply based on economic criteria.

It is also noted that, in the case of the "log of last resort" and the "log, restore and reserve" lands, Clause 39 of the Tasmanian Forest Agreement 2012 indicates that these lands will remain as State forest and a decision on their future tenure will be made in 2022. The *Tasmanian Forests Agreement Act 2013 (Tas)* permits native forest harvesting in these areas, until that decision is made.

## 8. Conclusion

The modelling of forecast yields undertaken by Forestry Tasmania, and described in this paper, has been guided by the key aspirations of the signatories. The modelling has enabled the signatories to reach agreement on a strategy that meets their respective stakeholders' previously irreconcilable aspirations for wood production and for preservation.

In particular, for:

(a) about 500,000 hectares of former wood production forest to be transferred to reserve (the actual area has not been determined precisely at the date of this paper, pending the outcome of current detailed consultation about optimal boundaries);

(b) a minimum annual supply of 137,000 cubic metres of eucalypt high quality sawlogs from native forest until end June 2027; and

(c) a minimum supply of 157,000 cubic metres of eucalypt peeler billets from native forest until end June 2027.

Further modelling of forecast yields is required for the whole of the public wood production forest estate, including:

(i) eucalypt plantation forests;

(ii) non eucalypt sawlogs; and

(iii) non timber products (e.g. biofuel),

and over a longer planning horizon (e.g. 90 years or more). Such further modelling can be expected to complement the work described in this paper, whilst maintaining the capacity to meet the signatories' key aspirations for the future management of public forests.

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**Attachment 1 - summary of key events and publications**

This attachment summarises key events and publications that are relevant to the work described in this paper.

| | |
|---|---|
| 8 November 1997 | Commonwealth of Australia and State of Tasmania sign the "Tasmanian Regional Forest Agreement". |
| 13 May 2005 | Commonwealth of Australia and State of Tasmania sign the "Supplementary Agreement" to the Tasmanian Regional Forest Agreement. The Supplementary Agreement is commonly referred to as the "Tasmanian Community Forest Agreement", or "TCFA". Thereafter, the Tasmanian Regional Forest Agreement and the Supplementary Agreement are collectively referred to as "the RFA". |
| 14 October 2010 | Signatories sign the "Tasmanian Forests Statement of Principles to lead to an Agreement".<br><br>This agreement included the following aspirational scenarios:<br><br>(i) for those stakeholders representing environmental groups, an additional 572,000 hectares of public forest was to be formally reserved; and<br><br>(ii) for those stakeholders representing the timber industry, an additional 140,350 hectares of public forest was to be formally reserved and minimum supply of specified forest products was to be maintained. |
| 4 May 2011 | Signatories agree upon their requirements for the evaluation of their respective scenarios. |
| 12 May 2011 | Professor Jerry Vanclay endorses a proposed list of outputs as sufficient to meet the resource modelling requirements of the signatories. |
| 1 June 2011 | Professor Cris Brack and Professor Jerry Vanclay release "Independent review of Forestry Tasmania Sustainable Yield Systems". |
| 6 June 2011 | Forestry Tasmania releases "Evaluation of Wood Resource Scenarios relevant to the *Tasmanian Forests Statement of Principles to lead to an Agreement* - Final Report to Signatories".<br><br>This report compared the two scenarios from the Statement of Principles with a base case that assumed that no additional areas of public production forest were to be reserved. |
| 7 August 2011 | Commonwealth of Australia and State of Tasmania sign the "Tasmanian Forests Intergovernmental Agreement". |
| 7 March 2012 | Professor Mark Burgman and Dr Andrew Robinson complete their report "Review of Tasmanian Forest Estate Wood Supply Scenarios: Final Report to the Independent Verification Group, Intergovernmental Agreement Version 9.9". |

**Attachment 1 - summary of key events and publications (continued)**

| | |
|---|---|
| 23 March 2012 | Professor Jonathan West releases the capstone report, five technical reports and associated appendices, representing the outcome of the work of the Independent Verification Group.<br><br>The technical reports include the report of 7 March 2012 by Professor Mark Burgman and Dr Andrew Robinson, as above. |
| 27 March 2012 | Professor Jonathan West releases his “Report of the Chairman”, effectively a personal summary of the work of the Independent Verification Group. |
| 3 April 2012 | Dr Michael Berger, PEFC, requests NCS International to investigate assertions of unsustainable harvesting by Forestry Tasmania, made in Professor West’s “Report of the Chairman”. |
| 1 May 2012 | The Legislative Council resolves to establish an inquiry into a key finding by Professor Jonathan West’s “Report of the Chairman” (see above). |
| 4 June 2012 | Professor Ian Ferguson releases “Forestry Tasmania’s Sustainable Yield Under the Australian Forestry Standard”. |
| 21 June 2012 | Tasmanian Forests Agreement Bill tabled. |
| 24 October 2012 | Dr Andrew Robinson releases the report “Technical Report of Forestry Tasmania Eucalypt Native Forest Wood Optimisation Modelling of Scenarios” to the signatories. |
| 1 November 2012 | The Legislative Council’s Government Administration Committee ‘A’ releases its “Report of the Tasmanian Forests Intergovernmental Agreement Independent Verification Group ‘Report of the Chairman’”. |
| 22 November 2012 | Signatories sign the “Tasmanian Forests Agreement”. |
| 23 November 2012 | Tasmanian Forests Agreement Bill passed by the Tasmanian Parliament’s House of Assembly. |
| 6 December 2012 | Forestry Tasmania releases the report “Addition to: Technical Report of Forestry Tasmania Eucalypt Native Forest Wood Optimisation Modelling of Scenarios – A P Robinson 24 October 2012” to the signatories. |
| 20 December 2012 | Tasmanian Parliament’s Legislative Council announces an enquiry into the Tasmanian Forests Agreement Bill. |
| 15 March 2013 | Tasmanian Parliament’s Legislative Council releases the final report on its enquiry into the Tasmanian Forests Agreement Bill. |
| 17 April 2013 | Tasmanian Forests Agreement Bill amended by the Tasmanian Parliament’s Legislative Council. |
| 30 April 2013 | Amended Tasmanian Forests Agreement Bill passed by the Tasmanian Parliament’s House of Assembly. |
| 2 May 2013 | Commonwealth of Australia and State of Tasmania sign a new “Tasmanian Forests Intergovernmental Agreement”. |

**Attachment 1 - summary of key events and publications (continued)**

| | |
|---|---|
| 3 June 2013 | *Tasmanian Forests Agreement Act 2013 (Tas)* given royal assent. |
| 5 August 2013 | Commonwealth of Australia, State of Tasmania and Forestry Tasmania sign a new Conservation Agreement to provide protection for State forests within the Future Reserve Land defined under the *Tasmanian Forests Agreement Act 2013 (Tas)*. |

**Attachment 2 - forest classes**

This attachment describes the 91 forest classes that were used in the work described in this paper, preceded by a definition of various codes used to describe the forest classes.

**A. Glossary of codes used in forest classes** (Stone, 1988, p. 31)

Height classes - mature eucalypt forest and rainforest
and
Height class potential - regrowth eucalypt forest and regeneration eucalypt forest

- 1* Average height greater than 76 metres
- 1 Average height 55 to 76 metres
- 2 Average height 41 to 55 metres
- +3 Average height 34 to 41 metres
- -3 Average height 27 to 34 metres
- 4 Average height 15 to 27 metres
- 5 Average height less than 15 metres
- M+ Tall myrtle forest or fertile rainforest site
- M- Short myrtle forest or poor rainforest site
- X Not known (applies only to height class potential)

Height classes - regrowth eucalypt forest

- 6 Average height greater than 50 metres
- 5 Average height 44 to 50 metres
- 4 Average height 37 to 44 metres
- 3 Average height 27 to 37 metres
- 2 Average height 15 to 27 metres
- 1 Average height less than 15 metres

Crown density classes - mature eucalypt forest

- a Crown cover 70% to 100%
- b Crown cover 40% to 70%
- c Crown cover 20% to 40%
- d Crown cover 5% to 20%

Crown density classes - regrowth eucalypt forest

- a Crown cover 90% to 100%
- b Crown cover 70% to 90%
- c Crown cover 50% to 70%
- d Crown cover 10% to 50%

**Attachment 2 - forest classes (continued)**

## B. Forest classes

| Category No. | Class | Description |
|---|---|---|
| Mature eucalypt forest, with neither regrowth nor aged eucalypt regeneration | | |
| 1 | E1a&b | Mature eucalypt forest of height class 1* or 1 and crown density class a or b, with no regrowth or regeneration. |
| 2 | E1c&d | Mature eucalypt forest of height class 1* or 1 and crown density class c or d, with no regrowth or regeneration. |
| 3 | E2a&b | Mature eucalypt forest of height class 2 and crown density class a or b, with no regrowth or regeneration. |
| 4 | E2c&d | Mature eucalypt forest of height class 2 and crown density class c or d, with no regrowth or regeneration. |
| 5 | E+3a&b | Mature eucalypt forest of height class +3 and crown density class a or b, with no regrowth or regeneration. |
| 6 | E+3c&d | Mature eucalypt forest of height class +3 and crown density class c or d, with no regrowth or regeneration. |
| 7 | E-3a&b | Mature eucalypt forest of height class -3 and crown density class a or b, with no regrowth or regeneration. |
| 8 | E-3c&d | Mature eucalypt forest of height class -3 and crown density class c or d, with no regrowth or regeneration. |
| 9 | E4a&b&c | Mature eucalypt forest of height class 4 and crown density class a, b or c, with no regrowth or regeneration. |
| 10 | E4d | Mature eucalypt forest of height class 4 and crown density class d, with no regrowth or regeneration. |
| 11 | E5 | Mature eucalypt forest of height class 5 and crown density class a, b, c or d, with no regrowth or regeneration. |
| Mature eucalypt forest, with unheighted regrowth | | |
| 12 | E1a&b.ER | Mature eucalypt forest of height class 1* or 1 and crown density class a or b, with unheighted regrowth and no regeneration. |
| 13 | E2a&b.ER | Mature eucalypt forest of height class 2 and crown density class a or b, with unheighted regrowth and no regeneration. |
| 14 | E+3a&b.ER | Mature eucalypt forest of height class +3 and crown density class a or b, with unheighted regrowth and no regeneration. |
| 15 | E-3a&b.ER | Mature eucalypt forest of height class -3 and crown density class a or b, with unheighted regrowth and no regeneration. |
| 16 | E4a&b.ER | Mature eucalypt forest of height class 4 and crown density class a or b, with unheighted regrowth and no regeneration. |
| 17 | E5a&b.ER | Mature eucalypt forest of height class 5 and crown density class a or b, with unheighted regrowth and no regeneration. |

**Attachment 2 - forest classes (continued)**

| Category No. | Class | Description |
|---|---|---|
| Mature eucalypt forest, with aged eucalypt regeneration from partial logging | | |
| 18 | E1&2 + aged regeneration | Mature eucalypt forest of height class 1*, 1 or 2, with eucalypt regeneration. |
| 19 | E+3 + aged regeneration | Mature eucalypt forest of height class +3, with eucalypt regeneration. |
| 20 | E-3 + aged regeneration | Mature eucalypt forest of height class -3, with eucalypt regeneration. |
| 21 | E4&5 + aged regeneration | Mature eucalypt forest of height class 4 or 5, with eucalypt regeneration. |
| Unaged eucalypt regrowth forest, with mature eucalypt forest and no regeneration | | |
| 22 | ER4-6 + E1 | Regrowth eucalypt forest of height class 4-6, with mature eucalypt forest of height class 1* or 1. |
| 23 | ER3 + E1 | Regrowth eucalypt forest of height class 3, with mature eucalypt forest of height class 1* or 1. |
| 24 | ER1&2 + E1 | Regrowth eucalypt forest of height class 1 or 2, with mature eucalypt forest of height class 2. |
| 25 | ER4-6 + E2 | Regrowth eucalypt forest of height class 4-6, with mature eucalypt forest of height class 2. |
| 26 | ER3 + E2 | Regrowth eucalypt forest of height class 3, with mature eucalypt forest of height class 2. |
| 27 | ER1&2 + E2 | Regrowth eucalypt forest of height class 1 or 2, with mature eucalypt forest of height class 2. |
| 28 | ER3&4 + E+3 | Regrowth eucalypt forest of height class 3 or 4, with mature eucalypt forest of height class +3. |
| 29 | ER1&2 + E+3 | Regrowth eucalypt forest of height class 1 or 2, with mature eucalypt forest of height class +3. |
| 30 | ER3 + E-3 | Regrowth eucalypt forest of height class 3, with mature eucalypt forest of height class -3. |
| 31 | ER1&2 + E-3 | Regrowth eucalypt forest of height class 1 or 2, with mature eucalypt forest of height class -3. |
| 32 | ER1&2 + E4 | Regrowth eucalypt forest of height class 1 or 2, with mature eucalypt forest of height class 4. |
| 33 | ER1 + E5 | Regrowth eucalypt forest of height class 1, with mature eucalypt forest of height class 5. |

**Attachment 2 - forest classes (continued)**

| Category No. | Class | Description |
|---|---|---|
| Unaged eucalypt regrowth forest, with no mature eucalypt forest and no regeneration | | |
| 34 | ER4-6 / 1 | Regrowth eucalypt forest of height class 4-6, with height class potential of 1* or 1 and no mature eucalypt forest or regeneration. |
| 35 | ER3 / 1 | Regrowth eucalypt forest of height class 3, with height class potential of 1* or 1 and no mature eucalypt forest or regeneration. |
| 36 | ER1&2 / 1 | Regrowth eucalypt forest of height class 1 or 2, with height class potential of 2 and no mature eucalypt forest or regeneration. |
| 37 | ER4-6 / 2 | Regrowth eucalypt forest of height class 4-6, with height class potential of 2 and no mature eucalypt forest or regeneration. |
| 38 | ER3 / 2 | Regrowth eucalypt forest of height class 3, with height class potential of 2 and no mature eucalypt forest or regeneration. |
| 39 | ER1&2 / 2 | Regrowth eucalypt forest of height class 1 or 2, with height class potential of 2 and no mature eucalypt forest or regeneration. |
| 40 | ER3&4 / +3 | Regrowth eucalypt forest of height class 3 or 4, with height class potential of +3 and no mature eucalypt forest or regeneration. |
| 41 | ER1&2 / +3 | Regrowth eucalypt forest of height class 1 or 2, with height class potential of +3 and no mature eucalypt forest or regeneration. |
| 42 | ER3 / -3 | Regrowth eucalypt forest of height class 3, with height class potential of -3 and no mature eucalypt forest or regeneration. |
| 43 | ER1&2 / -3 | Regrowth eucalypt forest of height class 1 or 2, with height class potential of -3 and no mature eucalypt forest or regeneration. |
| 44 | ER1&2 / 4 | Regrowth eucalypt forest of height class 1 or 2, with height class potential of 4 and no mature eucalypt forest or regeneration. |
| 45 | ER1 / 5 | Regrowth eucalypt forest of height class 1, with height class potential of 5 and no mature eucalypt forest or regeneration. |

**Attachment 2 - forest classes (continued)**

| **Category No.** | **Class** | **Description** |
|---|---|---|
| Eucalypt regrowth forest or older aged eucalypt regeneration, with younger aged eucalypt regeneration | | |
| 46 | ER / 1&2 + aged regeneration | Regrowth eucalypt forest or older aged eucalypt regeneration with height class potential of 1*, 1 or 2 and with younger aged eucalypt regeneration. |
| 47 | ER / +3 + aged regeneration | Regrowth eucalypt forest or older aged eucalypt regeneration with height class potential of +3 and with younger aged eucalypt regeneration. |
| 48 | ER / -3 + aged regeneration | Regrowth eucalypt forest or older aged eucalypt regeneration with height class potential of -3 and with younger aged eucalypt regeneration. |
| 49 | ER / 4&5 + aged regeneration | Regrowth eucalypt forest or older aged eucalypt regeneration with height class potential of 4 or 5 and with younger aged eucalypt regeneration. |
| Even aged eucalypt regeneration (in all cases, occurring without mature eucalypt forest, regrowth eucalypt forest or a second age class of eucalypt regeneration) | | |
| 50 | <1959 regeneration / 1&2 | Eucalypt regeneration that originated prior to 1959, with height class potential of 1*, 1 or 2. |
| 51 | <1959 regeneration / +3 or X | Eucalypt regeneration that originated prior to 1959, with height class potential of +3 or with unknown height class potential. |
| 52 | <1959 regeneration / -3 | Eucalypt regeneration that originated prior to 1959, with height class potential of -3. |
| 53 | <1959 regeneration / 4 | Eucalypt regeneration that originated prior to 1959, with height class potential of 4. |
| 54 | 1960s regeneration / 1&2 | Eucalypt regeneration that originated during the 1960s, with height class potential of 1*, 1 or 2. |
| 55 | 1960s regeneration / +3 or X | Eucalypt regeneration that originated during the 1960s, with height class potential of +3 or with unknown height class potential. |
| 56 | 1960s regeneration / -3 | Eucalypt regeneration that originated during the 1960s, with height class potential of -3. |

**Attachment 2 - forest classes (continued)**

| Category No. | Class | Description |
|---|---|---|
| 57 | 1960s regeneration / 4 | Eucalypt regeneration that originated during the 1960s, with height class potential of 4. |
| 58 | 1970s regeneration / 1&2 | Eucalypt regeneration that originated during the 1970s, with height class potential of 1*, 1 or 2. |
| 59 | 1970s regeneration / +3 or X | Eucalypt regeneration that originated during the 1970s, with height class potential of +3 or with unknown height class potential. |
| 60 | 1970s regeneration / -3 | Eucalypt regeneration that originated during the 1970s, with height class potential of -3. |
| 61 | 1970s regeneration / 4 | Eucalypt regeneration that originated during the 1970s, with height class potential of 4. |
| 62 | 1980s regeneration / 1&2 | Eucalypt regeneration that originated during the 1980s, with height class potential of 1*, 1 or 2. |
| 63 | 1980s regeneration / +3 or X | Eucalypt regeneration that originated during the 1980s, with height class potential of +3 or with unknown height class potential. |
| 64 | 1980s regeneration / -3 | Eucalypt regeneration that originated during the 1980s, with height class potential of -3. |
| 65 | 1980s regeneration / 4 | Eucalypt regeneration that originated during the 1980s, with height class potential of 4. |
| 66 | 1990s regeneration / 1&2 | Eucalypt regeneration that originated during the 1990s, with height class potential of 1*, 1 or 2. |
| 67 | 1990s regeneration / +3 or X | Eucalypt regeneration that originated during the 1990s, with height class potential of +3 or with unknown height class potential. |
| 68 | 1990s regeneration / -3 | Eucalypt regeneration that originated during the 1990s, with height class potential of -3. |
| 69 | 1990s regeneration / 4 | Eucalypt regeneration that originated during the 1990s, with height class potential of 4. |

**Attachment 2 - forest classes (continued)**

| Category No. | Class | Description |
|---|---|---|
| 70 | >1999 regeneration / 1&2 | Eucalypt regeneration that originated after 1999, with height class potential of 1*, 1 or 2. |
| 71 | >1999 regeneration / +3 or X | Eucalypt regeneration that originated after 1999, with height class potential of +3 or with unknown height class potential. |
| 72 | >1999 regeneration / -3 | Eucalypt regeneration that originated after 1999, with height class potential of -3. |
| 73 | >1999 regeneration / 4 | Eucalypt regeneration that originated after 1999, with height class potential of 4. |
| 74 | Regeneration / 5 | Eucalypt regeneration of any age, with height class potential of 5. |

Unstocked eucalypt forest

| Category No. | Class | Description |
|---|---|---|
| 75 | Unstocked, but with eucalypts present / 1&2 | Insignificant quantities of eucalypts present, with height class potential 1*, 1 or 2, and with no myrtle or other special timber species present. |
| 76 | Unstocked, but with eucalypts present / +3 or X | Insignificant quantities of eucalypts present, with height class potential +3 or with unknown height class potential, and with no myrtle or other special timber species present. |
| 77 | Unstocked, but with eucalypts present / -3 | Insignificant quantities of eucalypts present, with height class potential -3, and with no myrtle or other special timber species present. |
| 78 | Unstocked, but with eucalypts present / 4 | Insignificant quantities of eucalypts present, with height class potential 4, and with no myrtle or other special timber species present. |
| 79 | Unstocked, but with eucalypts present / 5 | Insignificant quantities of eucalypts present, with height class potential 5, and with no myrtle or other special timber species present. |
| 80 | Unstocked / 1&2 | No eucalypts, myrtle or other special timber species present, with height class potential 1*, 1 or 2. |
| 81 | Unstocked / +3 or X | No eucalypts, myrtle or other special timber species present, with height class potential +3 or with unknown height class potential. |

**Attachment 2 - forest classes (continued)**

| Category No. | Class | Description |
|---|---|---|
| 82 | Unstocked / -3 | No eucalypts, myrtle or other special timber species present, with height class potential -3. |
| 83 | Unstocked / 4 | No eucalypts, myrtle or other special timber species present, with height class potential 4. |
| 84 | Unstocked / 5 | No eucalypts, myrtle or other special timber species present, with height class potential 5. |
| Rainforest | | |
| 85 | M+ | Rainforest, containing myrtle and no significant quantities of eucalypts, with height class M+ or with height class potential M+.<br>or<br>Rainforest, containing myrtle and no significant quantities of eucalypts, with no height class or height class potential recorded and with myrtle dominating other special timber species. |
| 86 | M- | Rainforest, containing myrtle and no significant quantities of eucalypts, with height class M- or with height class potential M-.<br>or<br>Rainforest, containing myrtle and no significant quantities of eucalypts, with no height class or height class potential recorded and with other special timber species dominating myrtle. |
| Other native forest | | |
| 87 | Secondary species other than wattle | Native forest, other than rainforest, containing no significant quantities of eucalypts or silver wattle. |
| 88 | Wattle | Native forest, other than rainforest, containing silver wattle and no significant quantities of eucalypts. |
| Plantation | | |
| 89 | Hardwood plantation | |
| 90 | Softwood plantation | |
| Non forest | | |
| 91 | Non forest | Scrub, moorland, rock, waste, lake, river or sea. |

**Attachment 3 - derivation of a representative coupe yield file**

This attachment provides an example of the method used to derive a yield file for each provisional coupe, as described in Sections 5.4 and 5.5 of the paper. Such yield files were used as inputs to the modelling of scenarios.

The example is an illustrative example, based on an illustrative provisional coupe that was located in the Huon District (see Attachment 5) and that comprised 19 hectares of an illustrative Forest Class "X" and 13 hectares of an illustrative Forest Class "Y".

In each case, the forecast yields apply for the "grown year". If the provisional coupe was assumed to be harvested in a particular grown year, then the forecast yields for that grown year were applied. However, if the provisional coupe was assumed to be harvested in a particular year other than a grown year, then the forecast yields for that particular year were calculated by straight line interpolation.

## A. Glossary of codes used in this attachment

Arisings — Arisings, as defined in Section 3, measured in green metric tonnes per hectare.

HQSL — High quality eucalypt sawlogs, as defined in Section 3, measured in cubic metres per hectare.

PLog — Eucalypt peeler logs, as defined in Section 3, measured in green metric tonnes per hectare.

PW — Pulpwood (including RegPW, see below), measured in green metric tonnes per hectare.

RegPW — Regrowth pulpwood, measured in green metric tonnes per hectare.

## B. Theoretical forecast yields, based on plot inventory data

| | Forest Class "X" | | | Forest Class "Y" | | |
|---|---|---|---|---|---|---|
| Grown year | HQSL | PW | RegPW | HQSL | PW | RegPW |
| 2011 | 259 | 175 | 131 | 91 | 246 | 215 |
| 2021 | 307 | 192 | 148 | 117 | 278 | 247 |
| 2031 | 361 | 197 | 149 | 149 | 302 | 271 |
| 2041 | 423 | 188 | 140 | 191 | 309 | 261 |
| 2051 | 482 | 175 | 40 | 230 | 315 | 216 |
| 2061 | 536 | 165 | 31 | 267 | 319 | 206 |
| 2071 | 585 | 158 | 21 | 305 | 325 | 197 |
| 2081 | 629 | 151 | 11 | 342 | 331 | 43 |
| 2091 | 669 | 148 | 8 | 377 | 338 | 37 |
| 2101 | 705 | 145 | 0 | 410 | 346 | 0 |

**Attachment 3 - derivation of a representative coupe yield file (continued)**

## C. Adjusted forecast yields, based on an analytical comparison of theoretical forecast yields and historical harvest yields

In this example, the relevant factors are 57% for high quality eucalypt sawlogs and 146% for the other products. For each grown year, the forecast yield of high quality eucalypt sawlogs in Step B was multiplied by 57% and the forecast yields of pulpwood and regrowth pulpwood in Step B were multiplied by 146%.

| | Forest Class "X" | | | Forest Class "Y" | | |
|---|---|---|---|---|---|---|
| Grown year | HQSL | PW | RegPW | HQSL | PW | RegPW |
| 2011 | 148 | 256 | 191 | 52 | 359 | 314 |
| 2021 | 175 | 280 | 216 | 67 | 406 | 361 |
| 2031 | 206 | 288 | 218 | 85 | 441 | 396 |
| 2041 | 241 | 274 | 204 | 109 | 451 | 381 |
| 2051 | 275 | 256 | 58 | 131 | 460 | 315 |
| 2061 | 306 | 241 | 45 | 152 | 466 | 301 |
| 2071 | 333 | 231 | 31 | 174 | 475 | 288 |
| 2081 | 359 | 220 | 16 | 195 | 483 | 63 |
| 2091 | 381 | 216 | 12 | 215 | 493 | 54 |
| 2101 | 402 | 212 | 0 | 234 | 505 | 0 |

## D. Nett adjusted forecast yields for a representative provisional coupe, calculated from Step C by applying the applicable forest class discount

In this example, the relevant forest class discounts were 23% for forest class "X" and 28% for forest class "Y", i.e. the forecast yields from Step C were multiplied by 0.77 and 0.72 respectively.

| | Forest Class "X" | | | Forest Class "Y" | | |
|---|---|---|---|---|---|---|
| Grown year | HQSL | PW | RegPW | HQSL | PW | RegPW |
| 2011 | 114 | 197 | 147 | 37 | 259 | 226 |
| 2021 | 135 | 216 | 166 | 48 | 292 | 260 |
| 2031 | 158 | 221 | 168 | 61 | 317 | 285 |
| 2041 | 186 | 211 | 157 | 78 | 325 | 274 |
| 2051 | 212 | 197 | 45 | 94 | 331 | 227 |
| 2061 | 235 | 185 | 35 | 110 | 335 | 217 |
| 2071 | 257 | 178 | 24 | 125 | 342 | 207 |
| 2081 | 276 | 170 | 12 | 140 | 348 | 45 |
| 2091 | 294 | 166 | 9 | 155 | 355 | 39 |
| 2101 | 309 | 163 | 0 | 168 | 364 | 0 |

**Attachment 3 - derivation of a representative coupe yield file (continued)**

**E. Adjusted forecast yields for eucalypt peeler logs and for arisings, based on the applicable factor to derive the forecast yields of eucalypt peeler logs from the forecast yields of regrowth pulpwood**

In this example, the relevant factor for eucalypt peeler logs was 40%, i.e. the forecast yield of eucalypt peeler logs was derived by multiplying by 40% the forecast yield of regrowth pulpwood (RegPW) shown in Step D.

The forecast yield of arisings is calculated by subtracting the forecast yield of eucalypt peeler logs in this step (PLog) from the forecast yield of pulpwood (PW) in Step D.

Note that the forecast yield for high quality eucalypt sawlogs (HQSL) is not affected by this step.

| | Forest Class "X" | | | Forest Class "Y" | | |
|---|---|---|---|---|---|---|
| Grown year | HQSL | PLog | Arisings | HQSL | PLog | Arisings |
| 2011 | 114 | 59 | 138 | 37 | 90 | 168 |
| 2021 | 135 | 67 | 149 | 48 | 104 | 188 |
| 2031 | 158 | 67 | 154 | 61 | 114 | 204 |
| 2041 | 186 | 63 | 148 | 78 | 110 | 215 |
| 2051 | 212 | 18 | 179 | 94 | 91 | 240 |
| 2061 | 235 | 14 | 172 | 110 | 87 | 249 |
| 2071 | 257 | 9 | 168 | 125 | 83 | 259 |
| 2081 | 276 | 5 | 165 | 140 | 18 | 330 |
| 2091 | 294 | 4 | 163 | 155 | 16 | 310 |
| 2101 | 309 | 0 | 163 | 168 | 0 | 364 |

**Attachment 3 - derivation of a representative coupe yield file (continued)**

**F. Adjusted forecast yields for a representative provisional coupe, calculated as the weighted averages by area of forecast yields at Step E for the two forest classes**

In this example, the relevant areas were 19 hectares for Forest Class “X” and 13 hectares for Forest Class “Y”.

| Grown year | HQSL | PLog | Arisings |
|---|---|---|---|
| 2011 | 83 | 72 | 150 |
| 2021 | 100 | 82 | 165 |
| 2031 | 119 | 86 | 174 |
| 2041 | 142 | 82 | 175 |
| 2051 | 164 | 48 | 204 |
| 2061 | 184 | 43 | 203 |
| 2071 | 203 | 39 | 205 |
| 2081 | 221 | 10 | 232 |
| 2091 | 237 | 8 | 235 |
| 2101 | 252 | 0 | 245 |

Note that the methodology reported in this attachment does not include the application of either the factor to convert the forecast yield of eucalypt peeler logs to a forecast yield of eucalypt peeler billets (see Section 5.5(iii) of the paper) or the headroom factor (see Section 5.6 of the paper).

**Attachment 4 - summary of constraints**

This attachment summarises the constraints that were applied in modelling the penultimate scenarios (after Robinson, 2012, pp. 3-4).

1. Total area cut

   This constraint was used to achieve a modelling outcome that reflects a practical and realistic harvesting and management schedule, by constraining the model to cut a reasonably constant area in each year.

2. Total quantity of arisings cut

   This constraint was used to achieve a modelling outcome that reflects a practical and realistic supply schedule, by constraining the model to produce a reasonably constant quantity of forest products other than high quality eucalypt sawlogs and eucalypt peeler billets. These other forest products are collectively referred to as "arisings".

3. Total area cut under second and subsequent stages of partial harvesting

4. Total area of dry forest thinning in Bass and Derwent East

Two sets of constraints reflect the special nature of certain coupes as specified by those of the signatories that represented ENGOs.

5. Apply Log of Last Resort conditions to specified coupes, by restricting harvest to between 2022/23 and 2031/32 only.

6. Apply Once off Log, Restore and Reserve ("OLRR") conditions to specified coupes in areas designated by those of the signatories that represented ENGOs, as follows.

   a. Restrict harvesting to a single harvest, before 30 June 2028, in the Ben Lomond, Frome, St Paul's Dome, Great Western Tiers, Warra and Esperance areas, each as identified by ENGO representatives.

   b. Restrict harvesting to a single harvest, before 30 June 2032 in the Catamaran and Picton Valley areas and in the Dempster, Frankland and Deep Gully area.

   c. Restrict first harvest to before 30 June 2028, and second harvest before 30 June 2040 in the Wentworth Hills area.

An additional constraint was used to provide assurance that peelers and sawlogs would be sourced from sufficiently large trees. This constraint is appropriate and is consistent with the wood supply outcomes sought.

7. Constrain clearfell of aged regrowth, by applying a minimum age rule of 50 years old.

Constraints 8 – 11 only applied to Scenarios B and C. Additional caps were used to provide operationally realistic outcomes from the point of view of resourcing constraints and expected coupe feasibility. As before, these constraints are appropriate.

8. Constrain cable harvest within each of three specific locations (Bass, Derwent West, and Huon) as only one machine is available in each.

**Attachment 4 - summary of constraints (continued)**

9. Constrain operations in cable-harvesting coupes in Derwent Central and Derwent East, by only allowing harvest from 2027/28 onwards. Report this woodflow separately.

10. Constrain harvest of coupes with a coupe-confidence classification (CCC) of 25% in Derwent and Huon Districts, by only allowing harvest from 2027/28 onwards. Report this woodflow separately.

An additional constraint was used to provide further assurance that high quality eucalypt sawlogs would be sourced from sufficiently large trees.

11. Constrain clearfelling of aged regrowth, by only counting high quality eucalypt sawlogs from coupes that are at least 60 years old.

Finally, a collection of constraints that reflect local silvicultural considerations was incorporated in the model. These constraints were kept constant for all scenarios. As examples:

(i) a minimum total mass of product was required for a coupe to be considered for a "shelterwood retention" operation; and

(ii) a higher minimum total mass of product was required for a coupe to be considered for a "potential sawlog retention" operation.

**Attachment 5 - map of Forestry Tasmania's region, District and Subdistrict boundaries**

This attachment shows the relevant regions, Districts and Subdistricts used in the work described in this paper. The Northwest region comprises the Murchison District, the Northeast region comprises the Bass District and the South region comprises the Derwent District and the Huon District.