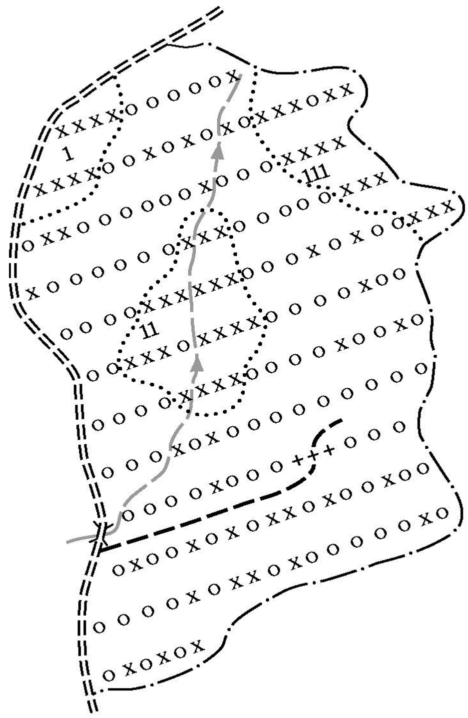
Forestry Tasmania

Native Forest Silviculture

TECHNICAL BULLETIN No. 6

2010



Regeneration Surveys and Stocking Standards

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79 Melville St.
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ISBN 1034-3261

February 2012

Acknowledgments
The line drawings are by Fred Duncan.
The cover graphic was prepared by Gerald Coombe.

This bulletin should be cited as:

Forestry Tasmania (2010). Regeneration surveys and stocking standards, Native Forest Silviculture Technical Bulletin No. 6, Forestry Tasmania, Hobart.

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Regeneration Surveys
and
Stocking Standards

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Part A: Regeneration Surveys for Native Forests

1. Introduction

This Technical Bulletin describes the types of regeneration surveys used in Tasmania, which forests they should be applied to, how to carry out those regeneration surveys, and how to analyse and report the results.

Regeneration surveys are undertaken to assess the success of the harvesting and regeneration treatment and to identify areas that may require remedial treatments. This is done by conducting a systematic survey of the coupe and calculating the percentage of surveyed plots that are stocked.

Stocking is a measure of site occupancy and involves assessing either the presence of seedlings that are likely to grow into productive trees and/or the basal area of retained trees. The exact definition of a stocked plot varies with forest type and silvicultural treatment.

A set of quality standards have been developed that specify the minimum levels of stocking to be retained or regenerated in order to maintain productive native forest after harvesting operations. These standards are based on the number and distribution of acceptable seedlings, saplings or trees which occur within the forest area being assessed.

The aim for all regenerated coupes is to achieve *at least* the minimum stocking standards within a specified period of time. All coupes must also be visually inspected at reporting age in order to ensure that the coupe manager is satisfied that the regeneration is successfully established. Final results are reported each year in the annual Stewardship report.

2. Regeneration survey types

The type of regeneration survey employed is determined by the forest type and silvicultural treatment applied to the area to be surveyed. Table 1 provides a quick reference to determine the appropriate regeneration survey type.

Regeneration surveys can be split into two general categories; seedling only or multi-aged surveys.

Seedling only regeneration surveys are applied when few or no productive stems have been retained by the silvicultural treatment and the growing stock will originate exclusively from new seedlings from artificial or natural sowing, or retained advanced growth (seedlings, lignotuberous shoots or saplings).

Multi-aged regeneration surveys are applied when mature or maturing trees have been retained and can be considered part of the growing stock of the forest. Where this occurs, both seedling density and retained basal area need to be assessed in order to determine the stocking level of the forest.

The forest type will determine the species to be assessed as part of the survey. Surveys carried out in eucalypt-dominated forest usually only assess eucalypts. In intensively managed wet forests rich in blackwood, both eucalypts and blackwoods are assessed. In rainforest, surveys usually involve the assessment of myrtle, leatherwood, celery-top pine and sassafras.

Species composition surveys, where the stocking of a specific species is recorded, can be carried out in conjunction with the appropriate survey type. They are currently only required for forests containing *Eucalyptus radiata*.

3. Timing of the first regeneration survey

The primary purpose of a regeneration survey is to determine the success of regeneration operations and to provide information on any further works that may be required. For this reason, regeneration surveys should be undertaken:

- after seedlings are established, i.e. their future growth and development is reasonably assured; and
- before the opportunities for low cost remedial treatments are lost, i.e. while sufficient receptive seedbed remains.

As seedling recruitment takes longer in some forest types than others, the appropriate time for the first regeneration survey also varies, as shown in Table 1.

Some partially harvested coupes have progressive harvesting assessments (PHA) carried out on them whilst harvesting is occurring. Where this occurs, and the PHA shows that the harvesting has met quality standards, there is no requirement for a regeneration survey.

Table 1. Regeneration survey types and timing for the range of forest types and silvicultural systems in Tasmania.

Forest type	**Harvesting/silvicultural treatment**	**Regeneration survey type**	**Timing of first survey**
Native eucalypt forest	• Clearfell burn and sow • Aggregated retention • Seed tree retention	Eucalypt seedling survey	In late summer/early autumn the first year after the regeneration burn
Native eucalypt forest	• Potential sawlog retention • Commercial thinning • Advanced growth retention • Shelterwood retention • Shelterwood removal	Multi-age eucalypt survey *(not required where a coupe has passed a progressive harvesting assessment)*	Within two years of the completion of harvesting
Dry *E. delegatensis* forest	Harvested up to 15 years previously to a shelterwood retention prescription	Eucalypt sapling survey	Before the removal of the shelterwood
Wet eucalypt/ blackwood forest (FIB)	• Clearfell, burn and sow and fence	Eucalypt + blackwood seedling survey	In late summer/early autumn the first year after the regeneration burn
Swamp blackwood tea tree forest	• Clearfell and disturb/burn	Swamp blackwood seedling survey	In late summer/early autumn the first year after the regeneration burn/ disturbance
Rainforest	• Overstorey retention or • Selective sawlogging	Multi–age rainforest survey	Three years after the completion of harvesting
Swamp/riverine blackwood rich in rainforest	• Selective harvesting	Multi-age blackwood or rainforest survey	Three years after the completion of harvesting
Huon Pine	• Selective harvesting	Huon Pine survey	Five years after the completion of harvesting

4. Survey design

This section describes how to design and carry out a regeneration survey.

Recent technological advances mean that it is now possible to design and carry out regeneration surveys using Geographic Information Systems (GIS) and Global Positioning Systems (GPS). This is now the preferred methodology as it captures spatially referenced information, reduces data entry errors and produces summary statistics and a map easily. The rules set out in this bulletin are the same as those used to conduct GPS surveys. For guidelines on how to conduct regeneration surveys using GPS refer to the Regeneration survey GPS/GIS Manual on the Forest Management System.

Equipment required:

- map of coupe,
- scale rule,
- protractor,
- compass,
- hip chain,
- wire peg to mark the plot point,
- a tape or standard capable of consistently measuring 2.26 m,
- a factor 2 basal area wedge for multi-age surveys,
- booking board and pencil,
- PDA with GPS capability (recommended, but optional),
- Regeneration Survey Field Sheet (Appendix 1) or field recording book,
- Regeneration Survey Stocking Report Form (Appendix 3).

Number of plots and grid spacing

Regeneration surveys plots are set out on a pre-determined systematic grid. In order to obtain a statistically reliable result, a **minimum of 50 plots** must be completed. Table 2 provides the recommended grid spacing for a specific coupe size. The standard spacing is 100 m between transect lines, with plots 20 m apart. This equates to 5 plots per hectare. Coupes less than 10 ha will require transect spacing to be reduced to reach the 50 plot minimum. This can normally be achieved by using a 50 m transect spacing. On coupes smaller than 5 ha, it is recommended that transects are placed 50 m apart and plots are assessed every 10 m.

Table 2. Recommended transect grid and sample intensity of regeneration surveys.

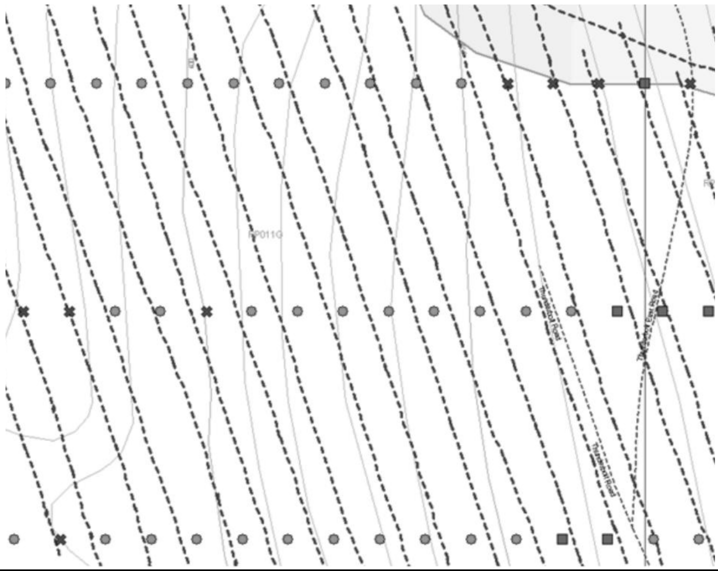
Coupe size	Transect width	Plot spacing along transect	Plots/ha	Sample intensity
<5 ha	50	10	20	3.2 %
5-10 ha	50	20	10	1.6 %
>10 ha	100	20	5	0.8 %

Transect layout

The starting point of the transect grid layout should be located randomly. The 'Plot Location Tool' available at (Intranet: FT Online Web applications) can be used to randomly generate a set of waypoints over the coupe that can be navigated to using a GPS. Alternatively, a random number such as the last two digits on the vehicle odometer could be used to determine how far from an identified corner to place the first transect.

The transect direction should take into account the topography of the coupe as shown in Figure 1. If the coupe is steep, transects should be placed so that they run perpendicular to the majority of the contours on the coupe. This should make the survey easier to conduct in the field. Where the topography is relatively flat the transect lines should be perpendicular to any artificial sowing flight lines. (Note that the flight lines can normally be viewed on the INTRAGIS view 'NF Sowing flight paths'). A protractor should be used to determine the bearing of the transects. Allocate each transect a number for ease of reference.

Figure 1. An example of the contours, artificial sowing lines and the regeneration survey transect layout.



Conducting the survey

Travel to the start point of the first transect. Tape should be placed where each transect starts, crosses roads and ends to assist with relocation if necessary. From the transect start point measure out the specified plot spacing distance to the first plot. Mark the plot point with the wire peg or lay the hip-chain on the ground. Plot points should be located exactly at the specified spacing distance and should not be moved. Do not relocate the plot from this point under any circumstances, even where the plot point occurs on top of a log or rock etc. Moving the plot point may bias the survey result.

Navigating between plots

Once the plot has been assessed, use the compass bearing and hip chain to navigate to the next plot point. *The use of a GPS to measure plot spacing is not recommended as it increases the chance of locating a plot with bias.* Continue this process until the end of the transect is reached. The transect bearing should be recorded so that you can plot up a map if required.

Navigating between transects

At the end of the transect, the assessor should normally move around the boundary to the start of the next transect. This can be done using a GPS, hip chain and/or a coupe map or aerial photo marked with the transect lines.

5. Assessments at the plot

It is recommended that assessors record data on the Regeneration Survey Field Sheet as shown in Appendix 1. Figure 4 also provides a filled-out example. Some of the columns on this sheet are not needed for all regeneration survey types. Provided all relevant information is captured, a field book can also be used.

Once a plot is located, a decision must be made about the disturbance regime at the plot.

Not surveyed plot

When the ground is generally undisturbed, trees remain intact, and there are no stumps or recent fallen crowns within 10 m of the plot point, the plot is recorded as ‘unlogged’ (UL) and no further assessment is required.

A plot that falls or partly falls on a maintained gravel or bitumen road should not be surveyed, but recorded as 'road clearing' (R). Snig tracks and non-gravel landings should have been rehabilitated and are therefore assessed as part of the regeneration survey.

What to assess on a surveyed plot

Plot number
Reset the hip chain at the beginning of each transect and record the distance as the plot number. (e.g. 20, 40, 60, 80, 100, 120).

Stocked plot
The primary objective of a plot assessment is to determine whether or not the plot is stocked. The definition of a stocked plot depends on the type of regeneration survey being carried out. Table 4 (over page) provides the definitions of stocked for each regeneration survey type.

There are often *several* or *alternative* criteria that have to be met for a plot to be stocked. It is therefore beneficial to record each required piece of information separately. Table 4 also describes the features of the plot to assess for each regeneration survey type. Note that not all features need to be recorded for each type of regeneration survey. Although some information is not used to determine stocking *per se*, it is recorded because it may be of use in interpreting stocking levels.

Acceptable seedling
An acceptable seedling must be healthy, have no stem damage, exhibit minimal mammal, insect or pathogen damage and be likely to exhibit vigorous growth. Only seedlings that are deemed acceptable should be recorded. Table 3 defines an acceptable seedling or sapling.

The presence of cotyledons and unacceptable seedlings may be noted in the comments.

Table 3. Definitions of acceptable seedlings and saplings.

Survey type	acceptable seedling or sapling
All surveys	healthy no stem damage minimal mammal, insect or pathogen damage likely to exhibit vigorous growth
Eucalypt seedling	at least 3 leaf pairs at least co-dominant with surrounding vegetation healthy coppice that is attached to stump <20 cm above ground level
Eucalypt sapling	at least 1.5 m tall and likely to be able to withstand frost after the removal of the shelterwood
FIB blackwood seedling	at least 10 cm tall
Blackwood seedling	at least 100 cm tall
Rainforest seedling	at least 3 cm tall
Huon pine seedling	at least 30 cm tall

Table 4. Stocked plot definitions and plot assessment requirements for each regeneration survey type.

Regeneration survey type	Stocked plot definition	Species to assess*	16 m^2 seedling count	Seedbed	Height	Nurse crop	Wedge count total	Wedge count productive
Eucalypt seedling	at least one acceptable eucalypt seedling	eucalypts	yes	yes	optional	not required	not required	not required
Eucalypt sapling	at least one eucalypt sapling > 150 cm tall	eucalypts	yes	yes	yes	not required	not required	not required
Eucalypt multi-age	at least one acceptable eucalypt seedling *or* a wedge count of 12 m²/ha or more of productive trees	eucalypts	yes	yes	optional	not required	yes	yes
Eucalypt + blackwood seedling (fenced intensive blackwood)	either an acceptable blackwood *or* eucalypt seedling	eucalypts and blackwood	both eucalypts *and* blackwoods	yes	optional	not required	not required	not required
Swamp blackwood seedling	at least one blackwood seedling > 100 cm tall, *and* a nurse crop present	blackwood	yes	yes	yes	yes	not required	not required
Multi-age rainforest	at least one acceptable seedling, *or* a total basal area >12 m²/ha	myrtle, blackwood, sassafras, celery-top pine, leatherwood	yes	yes	optional	not required	yes	not required
Multi-age blackwood	at least one acceptable eucalypt seedling, *or* at least one blackwood seedling >100 cm tall *and* a nurse crop, *or* a total basal area >12 m²/ha	blackwood, eucalypts	yes	yes	yes	yes	yes	not required
Huon pine	at least one Huon pine seedling > 30 cm tall	Huon pine	yes	yes	optional	not required	not required	not required

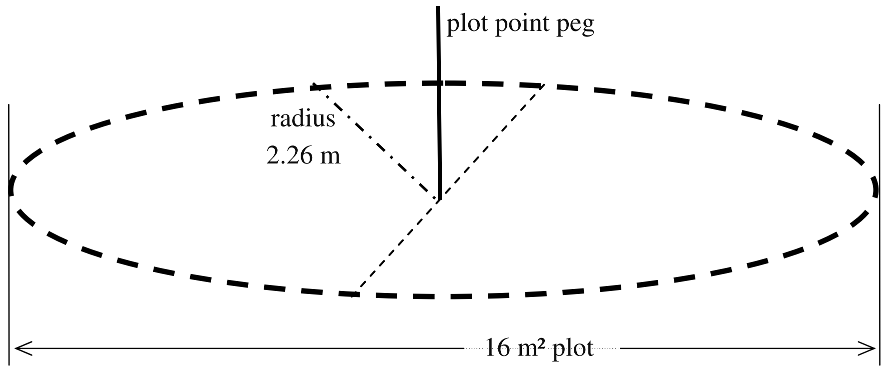
*species assessments can be made on any regeneration survey, but are only compulsory in forest containing *Eucalyptus radiata*

Comments are optional for all survey types.

Seedling 16 m^2 count

The presence of seedlings is assessed on a 16 m² plot with a circular radius of 2.26 m around the plot point as illustrated in Figure 2. This can be measured with a tape measure or other system such as a pre-measured piece of string tied to a marker peg. The 16 m² plot should be closely inspected for an *acceptable* seedling. The base of the main stem of a counting seedling must be within the 2.26 m radius. Where there is any doubt the distance *must* be checked.

Figure 2. Layout of 16 m² circular plots.



If an acceptable seedling is not located within the 16 m^2 area, a zero is entered in the number of seedlings column of the survey sheet. If this is a seedling only survey, the plot is unstocked.
If the plot is stocked, a quick visual *estimate* of the total number of acceptable seedlings within the plot should be made and classified into the classes shown in table 5:

Table 5: Visual estimate classes for acceptable seedling count on regeneration surveys

No of seedlings:	1	2	3	4	5	6–10	11–20	>20
Record as:	1	2	3	4	5	8	15	25

Seedling height

Seedling height (in cm) is the height of the tallest acceptable seedling on the plot. It may be recorded for any survey type, but is only compulsory for swamp blackwood seedling surveys and eucalypt sapling surveys.

Nurse crop

The assessment of a nurse crop is only required when carrying out swamp blackwood seedling or multi-aged blackwood surveys. Nurse crops provide competition for acceptable seedlings and promote height growth and good stem form. The absence of a nurse crop is likely to result in non-productive stems.

An adequate nurse crop is defined as at least one stem of woody species growing on the plot. Appropriate species include:

- any eucalypt,
- tea-tree (*Leptospermum* or *Melaleuca* spp.),
- tallow-wood (*Nematolepis squamea*),
- native pear/dogwood (*Pomaderris apetala*),
- native willow (*Acacia mucronata*),
- prickly wattle (*Acacia verticillata*), or
- any other woody species that has similar growth rates to blackwood seedlings.

Myrtle, leatherwood or celery-top pine seedlings would only be considered as suitable nurse crop species if they are more than 6 m tall.

The presence or absence of suitable nurse crop species is recorded as a simple yes or no.

Seedbed

The seedbed class under the tallest dominant seedling is recorded. Where there is no seedling present, the seedbed on the majority of the 16 m² plot is recorded. The nature of the seedbed should be categorised into one of three categories:

- Burnt (B): the last major occurrence on this site was fire. (This overrides any mechanical disturbance).
- Disturbed (D): the seedbed has been mechanically disturbed but not burnt.
- Unburnt/undisturbed (U): the seedbed has been neither burnt or mechanically disturbed.

Total Wedge Count

Wedge counts of retained trees are required in all multi-aged surveys.

Conduct a wedge count (or prism sweep) of live trees using a factor 2 optical wedge. Record the number of 'In' trees (see below for description of how to use optical wedges). Include trees of any size, regardless of whether they have been counted in a previous sweep.

The basal area (m^2/ha) can then be calculated by multiplying the number of trees that were 'In' by the basal area factor of the prism.

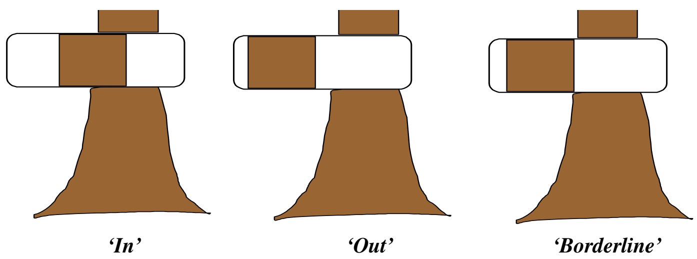
In eucalypt forests, any live eucalypt can be assessed. In rainforests or blackwood forests, only healthy eucalypt, blackwood, myrtle, celery-top pine, sassafras or leatherwood stems can be counted.

When carrying out a prism sweep, ensure that you know the basal area factor of the wedge (2 is recommended) and that you hold the prism over the plot point and move around the prism. Trees must be assessed at breast height (1.3 m above the ground).

Figure 3 illustrates the concept of 'In', 'Out' and 'Borderline' trees. Trees are considered 'In' if their wedge displacement overlaps with the rest of the stem. Trees are considered 'Out' if their wedge displacement is clearly separated from the rest of the stem. Trees with a displacement lining up very closely to the outside of the stem should be considered 'Borderline'. For the purposes of regeneration surveys, you can count each second borderline tree you assess as 'In'.

A string or block gauge may also be used to assess basal area. The gauge must have its calibration checked regularly and the assessor must be confident that they are using it correctly. When using a string gauge, the eye of the assessor must be positioned over the plot point.

Figure 3. The displacement seen in a prism wedge when a tree is 'In', 'Out' or 'Borderline'.



Productive Wedge Count
Productive basal area only needs to be recorded in multi-age eucalypt forests.

Record the number of productive eucalypts you assessed in the prism sweep. Productive trees are defined where the potential PI type is:

- E+3 or better (>34 m), as any tree with the potential to produce a section of sawlog,
- E-3 or lower (<34 m), as any tree with the potential to produce a section of sawlog or pulpwood.

Species
It is only compulsory to record the species of regeneration on coupes with *E. radiata* present. Where species assessment is required, record the three-character species code for each species present as listed in Appendix 2.

Comments
'Comments' is an optional field and may help in interpreting the results or drawing the map.

Some examples of useful comments are: on snig track, class 4 stream, cotyledons present, rocky, landing, dry ridge, scrub boundary, browsed heavily, seed tree nearby, boundary of unburnt area, take off point coordinates, etc.

Table 6. Regeneration survey procedure summary. *Not all items are required for all survey types.*

1. Locate and mark the sample point.
2. Is the plot surveyable?
3. Assess the seedbed.
4. Count the acceptable seedlings.
5. Complete the wedge count; productive and total.
6. Is a nurse crop present?
7. What is the height of the tallest seedling?
8. What species are present?
9. Record any relevant comments.
10. Taking into account all the assessments above, is the plot stocked?

Figure 4. A part - completed example of the Regeneration Survey Field Sheet.

Coupe BB101D Survey date: 4/04/2011 Brg°: 15°T Assessor: LRC page: 1 of: 1

Note: not all columns are always required to be filled out. Refer to Table 6 in Technical Bulletin 6.

transect	plot no	surveyed	seed bed	seedling count	prod wedge count	total wedge count	nurse crop	height	species	comments	stocked
1	20	Y	B	1					OBL	on snig track	Y
1	40	Y	B	4							Y
1	60	R								on spur road	
1	80	Y	B	2							Y
1	100	Y	D	0						landing	N
1	120	Y	D	8							Y
1	140	Y	B	15							Y
2	20	Y	B	25						start strip 2 @ 195°T	Y
2	40	Y	D	3							Y
2	60	Y	B	4							Y
2	80	UL								just in aggregate	
2	100	UL								aggregate	
2	120	UL								aggregate	
2	140	Y	B	0							N
2	160	Y	B	5							Y

Codes to use

Surveyed: Y if valid plot, UL if unlogged, R if gravel road clearing
Seedbed: B: Burnt, D: disturbed, U: unburnt/undisturbed
Seedling count: 0, 1, 2, 3, 4, 5 ,6-10 = 8, 10-20 = 15, > 20 = 25
Wedge count: 0, 1, 2, 3, 4, 5, 6 ,7, 8, 9, 10, >10
Height: record in centimetres
Nurse crop: present: Y, absent: N
Spp: use three letter species code (refer Appendix 2 of TB 6)
Stocked: Yes: Y , No: N , Not surveyed: leave blank

A blank form is included in Appendix 1.

Coupe summary information

At the end of the survey, notes should be made whilst still at the coupe, of general information likely to help in determining any possible remedial treatments required to adequately regenerate the area. The Regeneration Survey Stocking Report Form (Appendix 3) can be used for this purpose. Updated versions of this form are available from the forest management system.

Coupe summary information may include the effect of browsing; the species present on the coupe both as regeneration and as retained growing stock; possible reasons for under-stocked patches, e.g. unburnt areas of the coupe or a lack of seed in the retained trees; and sketch maps of important features.

6. Calculating the result

The percentage of plots stocked is the main indicator of regeneration success. Many other summary statistics can be obtained from the regeneration survey data and can greatly assist in the interpretation of the regeneration survey result. Most are calculated automatically using the regeneration survey database or the regeneration survey Excel template that is available from the Forest Management System. The key result calculations are described below.

Calculating the percentage of plots stocked

Tally the stocked and unstocked plots over the whole coupe. 'Not surveyed' plots are not included.

$$\%\,stocking = \left(\frac{number\ of\ stocked\ plots}{total\ number\ of\ plots}\right) \times 100$$

For example:

plots assessed	122
not surveyed plots	3
plots surveyed	119
stocked plots	98
unstocked plots	21

$$\%\,stocking = \left(\frac{98}{119}\right) \times 100 = 82\%$$

Multi - age survey stocking analysis:

The % stocking of both basal area and seedlings can be calculated.

Tally the number of plots stocked by seedling only; the number of plots stocked by basal area only; and with both basal area and seedlings.

For example:

plots assessed	122
not surveyed plots	3
plots surveyed	119
stocked plots (seedling only)	62
stocked plots (BA only)	31
stocked plots (seedling and BA)	5

$$\%\,stocking\ of\ seedlings = \left(\frac{62+5)}{119}\right) \times 100 = 56\%$$

$$\%\,stocking\ of\ basal\ area = \left(\frac{31+5)}{119}\right) \times 100 = 30\%$$

Calculating seedlings/ha

The seedling density (stems/ha) for each plot can be obtained by multiplying the visual estimate of the number of seedlings by 625. Plots where no seedlings are present have 0 stems/ha (spha). Some rounding to the mid-range point is applied when using the visual estimate classes. Table 7 describes the stems per hectare figure to use for the seedling classes.

Table 7: Seedling densities used for each seedling class

Visual estimate of seedlings:	0	1	2	3	4	5	6–10	11–20	21-50	>50
Seedling density (stems per ha):	0	625	1250	1875	2500	3125	5000	9500	18,750	31,250

Calculate the average number of seedlings per plot for the whole coupe.

For example:

plot	no of stems	stems/ha
20	0	0
40	1	625
60	not surveyed plot	
80	4	2500
100	6-10	5000
120	0	0

$$Average\ stems\ per\ hectare\ = \left(\frac{(0 + 625 + 2500 + 5000 + 0)}{5}\right) = 1625 \text{ spha.}$$

Total basal area/ha

Determine the basal area of each plot by multiplying the wedge count by the basal area factor used in the regeneration survey.

For example: (basal area factor used = 2)

plot no.	wedge count	basal area/ha
20	0	0
40	10	20
60	not surveyed plot	
80	4	8
100	6	12
120	2	4

$$Average\ basal\ area\ = \left(\frac{(0 + 20 + 8 + 12 + 4)}{5}\right) = 8.8 \text{ m}^2\text{/ha.}$$

Productive basal area/ha

The productive basal area is calculated by multiplying the productive wedge count from the regeneration survey by the wedge factor.

Ratio of productive to total basal area

Divide the productive basal area by the total basal area and multiply by 100. If this figure is more than 70%, it suggests that too many cull trees have been retained and cull falling should be considered to improve the productive capacity of the forest.

For example:

Average total basal area:	8.8 m^2/ha
Average productive basal area:	6.1 m^2/ha

$$Basal\ area\ ratio = 100 \times= \left(\frac{6.1}{8.8}\right) = 69\%$$

Seedbed composition

Tally the number of plots that fall into each seedbed category. Divide each figure by the number of surveyed plots. Do not include 'not surveyed' plots.

$$\%\ seedbed\ type = 100\ \times \left(\frac{no\ of\ plots\ of\ seedbed}{no\ of\ surveyed\ plots}\right)$$

For example:

plots assessed:	122
not surveyed plots:	3
plots surveyed	119
burnt seedbed	100
disturbed seedbed	10
unburnt/undisturbed	9

$$\%\ burnt\ seedbed\ = 100\ \times \left(\frac{100}{119}\right) = 84\%$$

$$\%\ disturbed\ seedbed\ = 100\ \times \left(\frac{10}{119}\right) = 8\%$$

$$\%\ unburnt/undisturbed\ seedbed\ = 100\ \times \left(\frac{9}{119}\right) = 8\%$$

Average height

Sum the seedling heights and divide the total by the number of plots stocked with seedlings.

For example:

plot	no of stems	height
20	0	-
40	1	52
60	not surveyed plot	
80	4	12
100	10	65
120	0	-
	Average	43

$$average\ height\ = \frac{52+12+65}{3} = 43\text{ cm}$$

7. Mapping

Any coupe that has failed to achieve the minimum stocking requirements must have a map drawn up. It is recommended that a regeneration survey map be drawn up for each survey. Regeneration surveys carried out using GPS technology have a map automatically generated in INTRAGIS.

A map of the regeneration survey may aid interpretation of the results. In particular, it may identify specific areas where many plots have been surveyed as unstocked. Such "patches" may require specific remedial treatments.

The map needs to show the stocking status of each plot. This is best done by drawing a line representing each transect and then determining the location of the surveyed plots along this line.

Symbols for plots

O	=	plot stocked
X	=	plot not stocked
+	=	not surveyed plot

Determination of understocked areas

The aim of mapping understocked patches is to determine those areas of a coupe that potentially require remedial treatment. A set of mapping rules have been developed to facilitate this. The rules are not perfect, but aid the mapper in identifying patches of the coupe that should be further examined in the field.

An **understocked section** contains a group or groups of three or more consecutive unstocked plots along a transect with less than three consecutive stocked plots between them:

e.g.	x x x	
	x x x o x x x	
	x x x o o x x x	
	x x x o x o o x o o x x x	are all understocked sections.

The boundary between stocked and understocked sections of the transect should be drawn next to the stocked plot by using a back slash or a coloured pencil.

right	x x x /o o o/x x x x
wrong	x x /x o o o x /x x x

Where necessary the boundaries should be linked from transect to transect to delineate understocked patches. Any field notes taken may assist in a more accurate location of this boundary.

Understocked patches usually relate to some feature such as aspect or poor burn. It is important to know the seedbed in these patches as this will influence the remedial treatment technique.

Understocked patches of more than 1 ha should be considered for remedial treatments.

An example of mapped out understocked patches is shown in Figure 5. These patches may require further field inspection, monitoring and/or remedial treatment.

Figure 5. Regeneration survey map.

stocked	total
5	10
7	18
10	17
11	18
10	21
9	17
11	17
13	15
10	11
10	17
12	17
3	6
111	**184**

Total plots surveyed *184*
Total plots stocked *111*
16 m² coupe stocking *60%*

Field notes for possible remedial treatment.

Area I	OK for spot sowing.
Area II	OK for spot sowing.
Area III	Re-burn when adjacent coupe is burnt, and sow.

An even distribution of understocked plots may not yield any understocked patches *per se*. Theoretically, a coupe could be 33% stocked and the mapping rules yield no understocked patches.
e.g. xxoxxoxxoxxoxxoxxoxxoxxo.

Where stocking is consistently low, remedial treatment over the whole coupe should be considered. Technical Bulletin No. 7 provides more details on remedial treatments for understocked areas.

8. Stocking standards

A set of stocking standards have been developed that specify the minimum % stocking to be retained or regenerated in order to maintain productive native forest after harvesting operations (Table 8).

The standards are based on forest type rather than seedling survey type. Each regenerating coupe is to be assessed against these standards.

Table 8. Stocking by silvicultural forest type and management objective. (Outlined and shaded boxes indicate the range of acceptable stockings for each forest type).

	% stocking range and management objective				
Forest type (and regeneration age for reporting)	**0 to 9%** (not stocked)	**10 to 39%** (minimum ecological stocking)	**40 to 64%** (low wood production)	**65 to 84%** (optimum wood production)	**85 to 100%** (maximum clear wood with thinning)
Lowland dry eucalypt forests (3 years)	not acceptable	not acceptable	**acceptable**	**acceptable**	**acceptable**
High altitude *E. delegatensis* forests (>50% DEL) (3 years)	not acceptable	not acceptable	not acceptable	**acceptable**	**acceptable**
Lowland wet eucalypt forests (3 years)	not acceptable	not acceptable	not acceptable	**acceptable**	**acceptable**
Fenced-intensive-blackwood (3 years)	not acceptable	not acceptable	not acceptable	**acceptable**	**acceptable**
Rainforest and swamp blackwood (5 years)	not acceptable	not acceptable	not acceptable	**acceptable**	**acceptable**
Huon pine forests (5 years)	not acceptable	**acceptable**	**acceptable**	**acceptable**	**acceptable**

9. Recording regeneration survey results

The results of each regeneration survey *must* be recorded in the Forest Operations Database. This can be done by creating a regeneration survey against the monitoring operation of the coupe.

A retrievable copy of the regeneration survey and map (if required) should be stored in a recognised corporate system. This could include the document management system (coupe file), the regeneration survey database or FOD.

10. Requirement and timing of subsequent regeneration surveys

The requirement and timing of another regeneration survey on a coupe will be determined by:

- the outcome of the first regeneration survey,
- the timing of any subsequent works,
- any adverse events on the coupe (e.g. significant browsing or windthrow),
- quality standards reporting requirements, and
- the management decision of the coupe manager.

The coupe management objective is to ensure that the coupe exceeds minimum stocking standards by the age of regeneration success reporting. See Section 12 and see Table 8.

A survey that initially exceeds the minimum standards may not indicate that the regeneration operation is complete. Nevertheless, the sooner a coupe achieves an acceptable level of stocking the easier it is to manage until considered regenerated. The following protocol is designed to ensure that regeneration operations are complete:

- If a coupe has not met stocking standards and remedial treatment has been carried out, then another regeneration survey is required in the autumn after treatment to determine the success of the treatment and assess the stocking improvement.

- If a coupe has not met stocking standards and remedial treatment is deemed unnecessary, then another regeneration survey is required in the following autumn to determine if the stocking has improved.

- If a coupe meets minimum stocking standards, but suffers significant browsing damage or other adverse events such as windthrow or wildfire, then another regeneration survey is required after any remedial treatments to determine the latest stocking level.

- If a coupe meets minimum stocking standards, and suffers insignificant browsing or other adverse events, no further regeneration survey is required.

A visual check at reporting age is required before any coupe can be reported in the quality standards tables.

11. Visual inspection of a coupe

Regardless of any regeneration survey outcome, a visual check must be conducted in all coupes at quality standards reporting age. This assessment should rate the level of stocking compared with the last regeneration survey and be attached to the coupe file.

Coupes will normally fall into one of three categories;

- there have **never been any serious issues** with this coupe, the regeneration survey was satisfactory, any browsing was controlled and the coupe appears well stocked and is growing vigorously.
- there is **some doubt** as to whether the coupe is stocked. Remedial treatment should be considered if viable, and another regeneration survey conducted at an appropriate time.
- this coupe has **always had regeneration issues** and many attempts to improve the stocking have failed. It is ecologically stocked with merchantable species. It does not meet stocking standards.

12. Reporting regeneration survey results

Reporting of regeneration success will be by silvicultural forest type and strata based on management objective as shown in Table 8. Each District must compile the table for the annual quality standards review.

All eucalypt coupes (including fenced-intensive-blackwood coupes) are due for reporting three years after the major site preparation works have been carried out. Other forest types are required to be reported five years after the major site preparation works. For more details on definitions of what constitutes major site preparation works and the guidelines for reporting of regeneration survey results refer to the Native Forests Quality Standards Manual.

Part B. The History and Development of Regeneration Surveys and Stocking Standards

1. A National standard for regeneration surveys

As part of a National project Lutze (2001) reviewed the various approaches to regeneration surveys and stocking standards as used by the different Australian States that harvest native forests. The key recommendations arising from the Lutze review were:

- adopt 16 m^2 stocking as a National reference,
- convert existing measures to the proposed national reference,
- use the coupe as the management unit for reporting,
- use systematic grids as the basis for sampling,
- surveys to be conducted 1 to 5 years after harvesting treatment,
- data to be aggregated by forest type or silvicultural system for reporting.

Tasmania already used systematic grids placed over the coupe as the basis for reporting and conducted surveys at the appropriate time intervals and the Tasmanian 'mapped-as-stocked' system readily converted to the proposed National reference. At the same time as the Lutze project was being conducted, a review of the Tasmanian methodology identified the following shortcomings in the Tasmanian system:

Regeneration Surveys:

- acceptable seedling not defined,
- tree species composition not considered,
- mapping rules were ambiguous (results could differ with strip direction),
- the 'mapped-as-stocked' system was complex.

Stocking Standard:

- the standard was low – theoretically, if every third plot in 80% of the coupe was stocked, then the coupe would meet the standard with only 27% of the 16 m^2 plots stocked,
- the 4 m^2 plot stocking was calculated but rarely considered.

Reporting:

- simple pass/fail approach which was not related to management objectives.

In 2003, Forestry Tasmania elected to conform with the recommended national reference of 16 m^2 plot stocking as the basis for reporting all regeneration survey results, and also made changes to address the issues identified above by the Lutze report and the Tasmanian review.

2. The stocked quadrat method

The stocked quadrat method for surveying the success of a regeneration treatment following harvesting was first proposed by Lowdermilk (1927). Cunningham (1960) developed the concept for *E. regnans* forests in Victoria and Mount (1961) developed and tested the stocked quadrat and associated mapping method for ash forests following clearfelling in Tasmania. The early systems all used the milacre (1/1000th of an acre or 4.047 m^2) quadrat as the basis for the survey.

The stocked quadrat method is efficient because there is no need to count the number of seedlings in each quadrat – each quadrat is either stocked or unstocked. A disadvantage of the system is that the number of stocked plots is only weakly related to the density (stems per hectare) of the regeneration. As regeneration is often aggregated (i.e. the seedlings are often clumped together in groups), the number of stocked plots provides only limited information about the density.

The relationship between the true stand density (stems per hectare) and the assessed 16 m^2 plot stocking is determined by the heterogeneity of the stand being measured (Mount 1961). He calculated a heterogeneity factor (h) to indicate the degree of aggregation.

$$heterogeneity\ (h) = \frac{\mathrm{d_o} - \mathrm{d_m}}{\mathrm{d_r} - \mathrm{d_m}}$$

where d_o is the observed density of a distribution of frequency f,
f is the percentage of stocked plots,
d_m is the minimum density possible with a frequency f (uniform distribution of seedlings),
d_r is the density corresponding to a random distribution whose frequency is also f and can be read directly from tables provided in many statistical texts, e.g. Greig-Smith (1983).

The heterogeneity factor cannot be calculated from data where only the presence or absence of stocking has been recorded – a sample in which the numbers of seedlings present on each plot are counted is required in order to determine d_o.

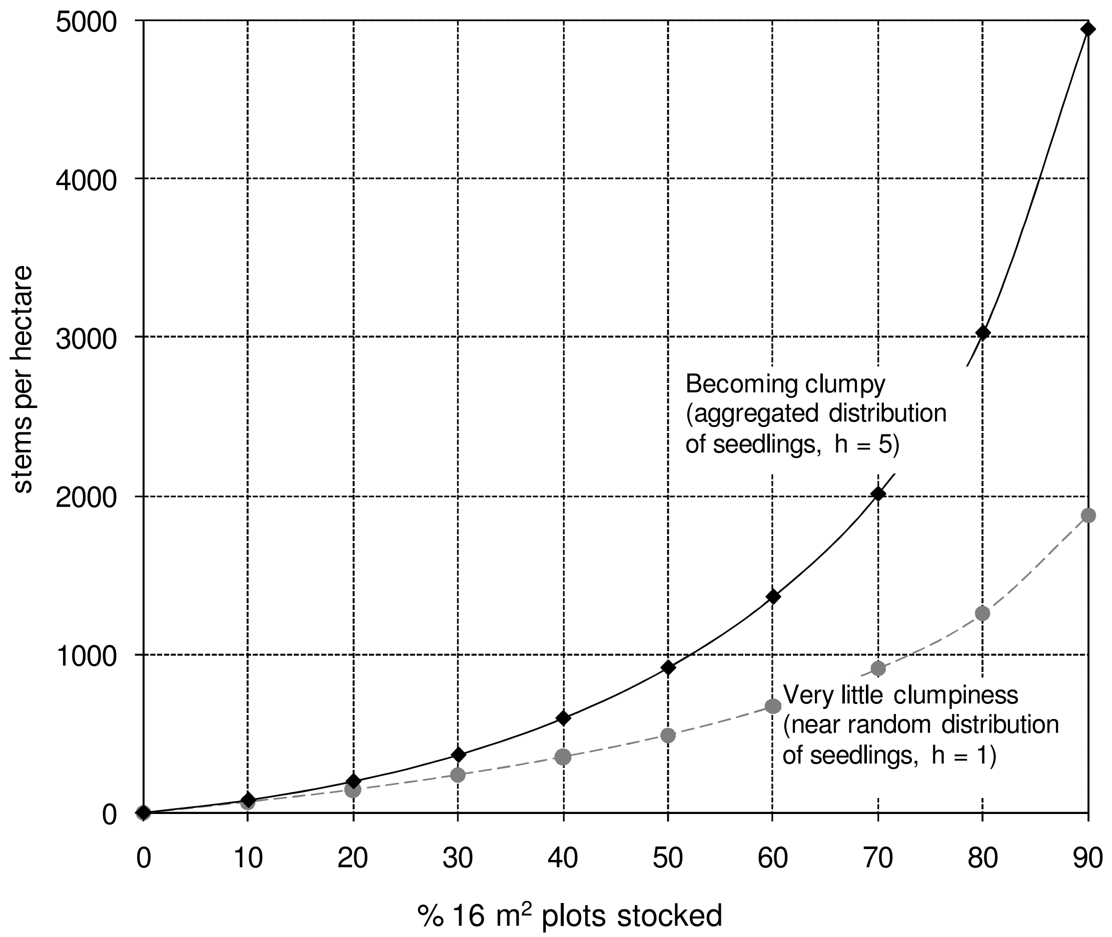
If the seedlings in a stand were distributed such that there was one seedling in each stocked plot (h = 0), density could be determined directly from the quadrat stocking (% of 16 m^2 plots stocked x 625/100 = number of stems per ha), but in most stands the seedlings are not randomly distributed but are aggregated or clumped. For example, the distribution of receptive seedbed is often determined by the distribution of slash and/or snig tracks, and seedlings may be restricted to disturbed areas. In seed tree coupes the seedlings are typically clumped around the seed trees with lower densities of seedlings further away from the seed trees. As the seedlings become more highly aggregated, the more the estimate of density determined directly from the quadrat stocking will underestimate the true seedling density.

Figure 6 shows the percentage of 16 m^2 plots stocked versus calculated seedling density for nearly random (h = 1) and moderately aggregated coupes (h = 5). The average number of seedlings on the 16 m^2 plots across a coupe may be multiplied by 625 to get a rough estimate of the seedling density in stems per ha.

The adoption of GPS technology to collect regeneration survey data has shown that recording of an estimate of the number of seedlings on a plot is not overly time consuming. The advantage of obtaining good estimates of both seedlings/ha and the heterogeneity index outweigh the few extra seconds required per plot to record this data. As of 2009, it is now required practice to provide the seedling count estimate when carrying out surveys.

For each coupe the currently prescribed regeneration survey method provides the stocking (% of plots stocked) and density (stems per hectare) of the regeneration, an indication of the spatial distribution of that regeneration, and the basal area of retained trees.

Figure 6. Percentage of 16 m^2 plots stocked vs seedling density (spha).



3. 16 m^2 vs. 4 m^2 plots

A component of the Lutze (2001) review involved examining the optimal quadrat size. He found that the percentage stocked figure calculated using older style 4 m^2 plots is sensitive to the degree of aggregation of seedlings. In contrast, the 16 m^2 plot gives a relatively consistent indication of stocking over a range of aggregations. Larger plot sizes would provide even greater consistency, but there is an obvious trade off between the time it would take to assess larger plots and reliability of the survey result. The other factor that led to the abandonment of the 4 m^2 plot was the fact that it was formerly assessed and calculated but rarely considered when analysing the regeneration survey result.

4. Statistical power of a regeneration survey and a minimum number of required plots.

The % stocked figure that is calculated from a regeneration survey may be different from the % stocked figure obtained when the entire coupe area is sampled. There is however some likelihood (called the confidence interval) that the true % stocked figure falls within a particular range around the value obtained from the regeneration survey.

A 95% confidence interval provides the range of stocking that we are 95% confident that the true coupe stocking figure lies within. It can be calculated for any survey by using the following formula:

$$95\%\ CI = \ p\ \pm 1.96\ \times \sqrt{\frac{p(1-p)}{N}}$$

Where p = the proportion of plots stocked and N = the number of plots assessed.

The magnitude of a confidence interval is determined by both the number of plots assessed and the proportion of those plots that are stocked. Figure **7** displays the confidence interval sizes of regeneration surveys over a range of plots sampled with 65% stocking. It shows that an increasing number of plots reduces the confidence interval size. So that confidence can be had in the survey estimate, there is therefore a requirement that at least 50 plots (and preferable more) be assessed for each coupe.

Figure 7. 95% confidence intervals for 65% stocked regeneration surveys

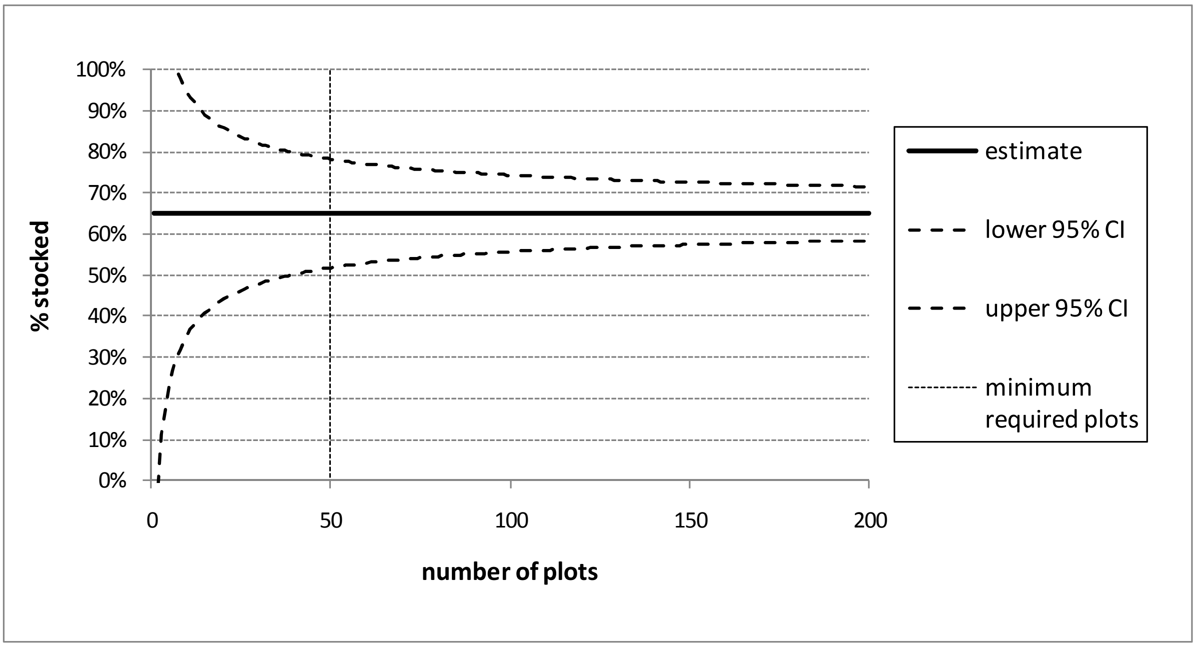


Figure **7** emphasises the fact that a regeneration survey is a sample. A coupe where a survey consisting of 100 plots reports 65% stocking could have an actual stocking anywhere between 56% and 74%. It is therefore likely that regeneration surveys carried out on the one coupe within a month or so of each other will yield slightly different results. Unless there is doubt about the survey timing or the quality of the assessments, it is not recommended that a repeat survey be carried out to obtain a 'better' result. If doubt exists about the stocking figure, it is advised to increase the sample size by conducting the survey at a decreased transect interval.

5. Alternative regeneration survey methods

In response to the perceived weaknesses of the stocked quadrat method a range of other survey methods had been developed. Alternative methods used in Australia include triangulated tessellation (Ward 1991), used in WA (CALM 1990, 1997), and closest individual and point-centred quadrat methods used in NSW (SFNSW 1999).

Dignan and Fagg (1997) and Lutze (2001) have reviewed the application of these methods in Australia. Dignan and Fagg (1997) found for even-aged seedling regeneration that the stocked quadrat method produced acceptable results. Lutze (2001) found that the closest individual method was biased, unless the seedlings were randomly distributed, which usually is not the case, and that while the triangular tessellation method produces acceptable results, it does so at a much higher cost than the stocked quadrat method. Lutze (2001) also recommended the stocked quadrat method as an acceptable national standard. In light of these reviews, Tasmania has adopted the stocked 16 m^2 quadrat method as the standard for all regeneration surveys.

6. Multi-aged surveys

The move away from clearfelling, particularly in drier forest types, led to a need for a stocking standard that incorporated the retained growing stock. Multi-aged surveys were first introduced to Tasmania in the 1991 edition of this Bulletin and required that either the 16 m^2 plot was stocked with a seedling or that there was a local basal area equivalent to at least 12 m^2/ha of retained productive growing stock around the plot point. The retention level of 12 m^2/ha is based on the work of Battaglia and Wilson (1990) who established that, in *E. delegatensis* forest, retention levels above 12 m^2/ha had a pronounced suppressive effect on the growth of regeneration. If a plot has at least 12 m^2/ha BA the retained trees occupy the site and any seedling regeneration in the area will not contribute significantly to the growth of the stand.

McCormick (1988) showed that in the conditional dry peppermint forests of the east coast of Tasmania, seedling recruitment could continue for many years. Partially harvested coupes with marginal stockings at the time of their first regeneration survey are typically found to have improved stockings at later surveys.

7. Rainforests, Huon pine forests and blackwood forests

Stocking standards for these forest types have been developed following extensive research over many years into the silviculture of these forests. Studies into rainforest silviculture have extended over thirty years in the north-west rainforests at the Sumac trial (Hickey and Wilkinson 1999). They found that high levels of myrtle regeneration were achieved across the range of silvicultural treatments, wherever disturbed seedbeds were within 40 m of retained trees. Regeneration of other rainforest species was slower than that for myrtle but some saplings of all species were present after 20 years.

Huon pine regeneration, like the growth of the mature trees, is slow. Gibson and Brown (1991) found that in unlogged stands, Huon pine regenerates intermittently in response to canopy disturbance. Huon pine, like myrtle, has mast seed years but their frequency is uncertain. Shapcott (1991) recorded 2200 seeds/m^2 immediately under a Huon pine canopy at Teepookana, but found no seeds at a distance of one tree height. Where a regeneration survey shows that the stand is understocked, planting of nursery grown seedlings is recommended. Kelly (1988) showed that planted seedling survival is acceptable and a reasonable means of establishing seedlings in the absence of natural regeneration.
Blackwood silviculture trials also have a long history which is summarised by Jennings *et al.* (2000). The palatability of young blackwood seedlings has resulted in the extensive use of fencing to protect seedlings

from mammal browsing. Trials have shown that whereas fenced coupes can achieve regeneration of up to 7,000 stems per ha, in unfenced coupes following similar silvicultural treatments, stockings of less than 100 stems per ha were achieved (Jennings *et al.* 2000). Only fenced coupes achieved the stocking standard of 65% of plots stocked with blackwood.

Jennings *et al.* (2000) also noted that blackwood form, which is obviously important to the growth of sawlogs, was positively influenced by the presence of suitable nurse species, so this requirement has been incorporated into the stocking standard for blackwood coupes.

8. Steep country

Lockett (1995) reviewed regeneration success on steep country coupes which had been clearfelled and cable yarded. Some difficulties had been experienced achieving satisfactory regeneration on some steep country coupes, but Lockett found no particular cause for the problem, nor did he find that the problem was peculiar to steep country coupes. Recent experience suggests that the difficulty of achieving adequate control of browsing animals in steep country is a leading cause of understocked steep country coupes.

Lockett (1995) noted that many steep country coupes continued to 'stock-up' in the first two years after the regeneration burn, and that the stocking of marginal coupes could be expected to improve. This is the result both of delayed germination and of small seedlings being overlooked at the first survey (Lockett 1995). He also noted that the requirement in the 1991 version of this Bulletin, that there be no understocked patch in excess of 1 ha, was unrealistic, as patches as small as one hectare could not reliably be discerned in the field.

9. Mapped-as-stocked problems

One of the identified problems with the mapping rules was that the results could vary depending on minor variations in the results of the survey. In the worst cases, working from one end of a line, the whole line could map as stocked, whereas working from the other end of the line, the whole line could map as understocked. Lutze (2001) has shown that the 65% of 16 m^2 plots stocked standard is usually a slightly higher standard (ie requires more seedling per hectare) than the 80% mapped-as-stocked standard.

Adopting the recommended national reference of percentage of 16 m^2 plots stocked reduces the need for interpretation of the mapped surveys. With the change in the stocking standard to > 65% of plots stocked, compared to the old > 80% mapped-as-stocked criterion, the requirement 'that there be no understocked patch in excess of 1 ha' has been discontinued, although users are still required to map the results of the regeneration survey whenever the stocking standard is not met, in order to identify understocked areas which may require remedial treatments.

10. Acceptable seedling definition

Until 2003, Forestry Tasmania had no definition of an 'acceptable' seedling. Technically, a chlorotic, insect-damaged, frost-bitten, water-logged cotyledonary seedling could qualify a plot as stocked. Typically this isn't the case, as most surveys are done at a time designed to allow the seedlings to be well established, and it is easier to find a healthy well established seedling than a sick cotyledonary one.

Acceptable seedlings are defined elsewhere (e.g. Dignan and Fagg 1997) and after examining other definitions and much discussion the following criteria were established for acceptable eucalypt seedlings in Tasmania:

- at least three leaf pairs,
- healthy (green),
- no stem damage,
- minimal insect damage,
- minimal mammal browsing damage,
- at least co-dominant with surrounding vegetation,
- coppice that is attached less than 20 cm above ground level is also acceptable.

11. Species composition surveys

The new Australian Forestry Standard (AS 4708) states (amongst other things) that:

'4.3.5 The forest manager shall regenerate native forest with species and provenances native to the area, or from an equivalent locality, as far as reasonably practicable to maintain local gene pools and species mixes.'

In most instances it is possible to demonstrate that this requirement has been met from existing information. For example, for clearfelled coupes, the sowing mix report should demonstrate that all species present pre-harvest have been sown back on the coupe and that no off-site species have been introduced. For partially harvested coupes, the forest harvesting monitoring report should indicate whether the coupe is being felled according to the FPP prescriptions, and-by inference- that appropriate species mixes have been retained.

For rare tree species, which are managed by prescription, for example *E. radiata*, an additional column must be added to the regeneration survey field book and the presence of the species of interest is recorded for every plot. In this way the stocking for both the coupe and for the species of interest can be reported.

12. Species composition

Current Forestry Tasmania policy (Forestry Commission 1991) is that the sowing mix must accurately reflect the species composition of the stand prior to harvesting. However in the early 1970s some sowing mixes used reflected a belief that sites could be made more productive by having a higher proportion of ash-species in the mix. Elliott *et al.* (1991) have shown for dry eucalypt forests that the species composition of the regeneration at about age 10 was generally closer to that of the unlogged forests than that of the sowing mix used. Only on one coupe, which originally contained no *E. delegatensis,* and on which the sowing mix contained 70% *E. delegatensis,* was the regeneration, at 45% *E. delegatensis,* strongly influenced by the sowing mix.

13. Site occupancy

A major concern to the forest grower when regenerating a coupe is the simple question, 'Is the site now fully occupied?'. Much of the work reported earlier by Lutze (2001) focuses on our ability to answer this question with confidence. Lockett and Goodwin (1999) examined stocking, growth and development of regeneration from seed germination to age 16. They showed that a coupe with 30% of 4m^2 plot stocking (which is generally considered marginal in terms of regeneration success and which is roughly equivalent to 65% of 16m^2 plots stocked) will produce over 90% of maximum possible volume over a 90-year rotation. Clearly then, stands which achieve better than the minimum standard for regeneration success are fully stocked, in terms of their ability to produce the maximum amount of wood possible over the planned rotation.

Analysis of the crown density of the existing mature eucalypt forest estate in Tasmania shows that about one-third each falls into the three groups; 5 to 20%, 20 to 40% and 40 to 70%. Less than one percent of the forest has a crown cover of greater than 70% and about 5% has a crown cover of less than 5%. In the natural forest therefore, there is quite a range of crown density. Coupes which achieve the stocking standard of 65% of 16 m^2 plots stocked are likely to grow into forests with canopy cover greater than 40%. Coupes which fall into the 40 to 65% of 16 m^2 plots stocked class are likely to grow into forests with lower canopy cover. Such forests will not produce as high a proportion of sawlogs as forests in the higher classes, but they will continue to produce good quality wood.

14. Reporting by management objective

An ongoing problem with reporting of regeneration surveys in Tasmania is that the approach was simply pass or fail. Whether coupes failed to reach the standard by 1% or 50% was not reported, nor could the results be analysed to determine whether any particular forest type was proving more difficult to successfully regenerate than others.

Lutze (2001) recommended that reporting of regeneration success be by both forest type and by management objective, as illustrated in Table 8. (Lutze (2001) did not provide the forest types; the types listed are those described by the Native Forests Silviculture Technical Bulletin series used in Tasmania).

15. Regeneration surveys and intensive forest management

Dignan and Fagg (1997) noted that regeneration surveys could provide ‘basic mensurational information to assist the prediction of future growth and yield’. LaSala and Dingle (2001) examined the regeneration survey results from 52 coupes. They found that the regeneration surveys did not provide a sufficiently intense sample to allow for the identification of later-age stem density, to a level sufficient to allow selection of coupes for intensive forest management treatments such as thinning. They did find that the early regeneration survey data provided sufficient information to allow for rejection of insufficiently stocked coupes. LaSala (pers. comm.) recommends that coupes with a stocking of > 85% of 16 m^2 plots are those most likely to be suitable for later intensive forest management.

16. Remedial treatments for understocked coupes

The definition of understocked coupes depends on the management objective (see Table 8). In most cases the objective is to achieve a high level of future wood production, but this may vary according to other objectives, e.g. for wildlife or aesthetics. However, in all cases, a minimum ecological stocking must be achieved so that particular forest types, as defined by the Regional Forest Agreement and monitored under the Permanent Native Forest Estate Policy, are maintained. Remedial treatments are mandatory for coupes which have not met minimum ecological stocking. They should also be considered for coupes that do not reach the 65% stocking level but the decision to undertake remedial treatments should be informed by cost, likelihood of success, effects on non-wood objectives and on long-term wood supply.

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Appendix 1. Regeneration Survey Field Sheet

Coupe:___________ Survey date____________ Bearing_______ Assessor______________________ Page_____of ______

Note: not all columns are always required to be filled out. Refer to Table 4 in Technical Bulletin 6.

transect	plot no	surveyed	seed bed	seedling count	productive wedge count	total wedge count	nurse crop	height	species	comments	stocked

Codes to use

Surveyed: Y if valid plot, UL if unlogged, R if gravel road clearing

Seedbed: B: Burnt, D: disturbed, U: unburnt/undisturbed

Seedling count: 0, 1, 2, 3, 4, 5 ,6-10, 10-20, > 20

Wedge count: 0, 1, 2, 3, 4, 5, 6 ,7, 8, 9, 10, >10

Height: record in centimetres

Nurse crop: present: Y, absent: N

Spp: use three letter species code (refer appendix of TB 6)

Stocked: Yes: Y , No: N , Not surveyed: N/A

Appendix 2. Three character species codes for species assessed in regeneration surveys.

Group	SPP code	Species	Common name
Eucalypts	AMY	*Eucalyptus amygdalina*	Black peppermint
Eucalypts	ARC	*Eucalyptus archeri*	Alpine cider gum
Eucalypts	BAR	*Eucalyptus barberi*	Barbers gum
Eucalypts	BRO	*Eucalyptus brookeriana*	Brookers gum
Eucalypts	COC	*Eucalyptus coccifera*	Snow peppermint
Eucalypts	COR	*Eucalyptus cordata*	Tasmania silver gum
Eucalypts	DAL	*Eucalyptus dalrympleana*	Mountain white gum
Eucalypts	DEL	*Eucalyptus delegatensis*	White top stringy bark
Eucalypts	GLO	*Eucalyptus globulus*	Tasmanian Blue Gum
Eucalypts	GUN	*Eucalyptus gunnii*	Cider gum
Eucalypts	JON	*Eucalyptus johnstonii*	yellow gum
Eucalypts	MOR	*Eucalyptus morrisbyi*	Morrisby's gum
Eucalypts	NID	*Eucalyptus nitida*	Western peppermint
Eucalypts	OBL	*Eucalyptus obliqua*	Brown top stringybark
Eucalypts	OVA	*Eucalyptus ovata*	Black gum/swamp gum
Eucalypts	PAU	*Eucalyptus pauciflora*	cabbage gum
Eucalypts	PER	*Eucalyptus perriniana*	spinning gum
Eucalypts	PUL	*Eucalyptus pulchella*	white peppermint
Eucalypts	RAD	*Eucalyptus radiata*	Forth River peppermint
Eucalypts	REG	*Eucalyptus regnans*	Mountain Ash/Swamp Gum
Eucalypts	RIS	*Eucalyptus risdonii*	Risdon peppermint
Eucalypts	ROD	*Eucalyptus rodwayi*	Black swamp gum
Eucalypts	RUB	*Eucalyptus rubida*	Candlebark
Eucalypts	SIE	*Eucalyptus sieberi*	Iron bark
Eucalypts	SUB	*Eucalyptus subcrenulata*	Alpine yellow gum
Eucalypts	TEN	*Eucalyptus tenuiramis*	silver peppermint
Eucalypts	URN	*Eucalyptus urnigera*	Urn Gum
Eucalypts	VER	*Eucalyptus vernicosa*	Varnished gum
Eucalypts	VIM	*Eucalyptus viminalis*	White gum
Blackwood	BLA	*Acacia melanoxylon*	Blackwood
Rainforest	SAS	*Atherosperma moschatum*	Sassafras
Rainforest	LEA	*Eucryphia lucida*	Leatherwood
Rainforest	HUO	*Lagarostrobos franklinii*	Huon pine
Rainforest	MYR	*Nothofagus cunninghamii*	Myrtle
Rainforest	CTP	*Phyllocladus aspleniifolius*	Celery top pine

Appendix 3. Regeneration Survey Stocking Report

Regeneration Survey Stocking Report

Coupe: ____________ **Area:** ________ **FOD Survey ID:** ____________

Survey type: ____________ **Minimum stocking standard:** ____________

Survey date: ____________ **Regeneration age:** ____________

Transect Brg: ____________ ° True **Assessors:** ____________

Stocking Summary:

Total plots ________ - Not-surveyed plots ________ = surveyed plots ________

Stocked plots ________ / surveyed plots ________ X 100 = % stocked ________

Coupe exceeds minimum standard (circle) **Yes** **No**

GPS file names

General observations on browsing, seedbed quality, seedling height and performance

Comments on any understocked areas e.g. southern area of coupe below road is very poorly stocked.

Recommended further action e.g. supplementary sowing, no further action, scarify and re-sow.

Tasmanian Native Forest Silviculture Technical Bulletin Series

No	*Title*	*Date*
1	Eucalypt Seed and Sowing	2010
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3	Lowland Dry Eucalypt Forests	2009
4	High Altitude *E. dalrympleana* and *E. pauciflora* Forests	1990
5	Silvicultural Systems	2010
6	Regeneration Surveys and Stocking Standards	2010
7	Remedial Treatments	2009
8	Lowland Wet Eucalypt Forests	2009
9	Rainforest Silviculture	1998
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