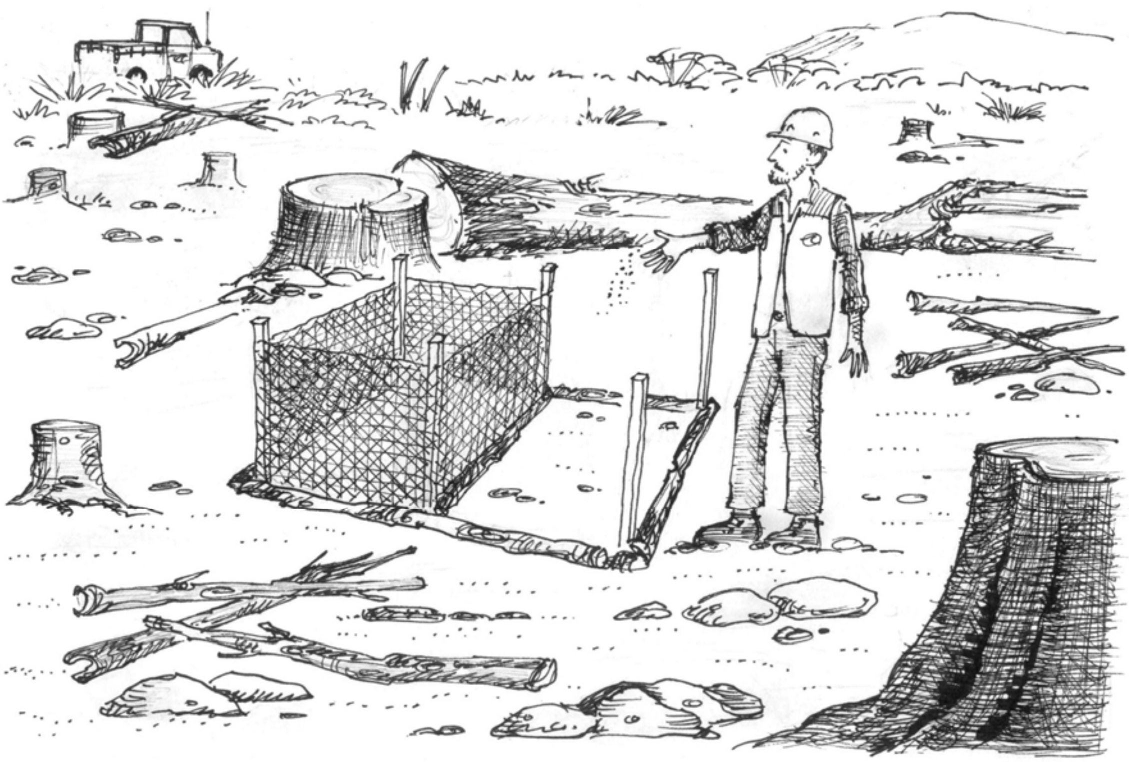
Forestry Tasmania

Native Forest Silviculture

TECHNICAL BULLETIN No. 12

2011



Monitoring and Protecting Eucalypt Regeneration

Forestry Tasmania
79 Melville St.
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ISSN 1034-3261

November, 2011

Acknowledgments
The line drawings are by Fred Duncan.

This bulletin should be cited as:

Forestry Tasmania (2011). Monitoring and Protecting Eucalypt Regeneration, Native Forest Silviculture Technical Bulletin No. 12, Forestry Tasmania, Hobart.

Second Edition (2011): Prepared and revised by
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Forestry Tasmania.

Control procedures for browsing animals are constantly under review. Whilst this Technical Bulletin was current at the time of printing, the most up-to-date information can be accessed through the intranet: Forest Management System; Procedures and Documents; Mammal Browsing: various files including the code of practice, forest operation plan, forms, guidelines, job risk assessment, manuals, standard operating procedures, and technical bulletins. Always check the FMS for the most up-to-date information.

Forestry Tasmania
GROWING OUR FUTURE

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Monitoring and Protecting Eucalypt Regeneration

Contents

Part A: Prescriptions for Monitoring and Protecting Eucalypt Regeneration

1. Introduction

This Technical Bulletin describes the prescriptions and methods for monitoring and protecting eucalypt regeneration during establishment, which is the period from the completion of the regeneration treatment, until the coupe is signed off and the regeneration result reported at the Quality Standards Review.

Controlling mammal browsing currently relies on two related strategies, trapping-and-shooting (hereafter referred to as trapping), and shooting. Both strategies require sustained effort, and need to be managed carefully in order to make their application as efficient as possible.

With respect to mammal browsing monitoring and control, there are two phases in the establishment of native forest regeneration. The first phase is the period from the time of sowing (artificial or natural) until the seedlings are established sufficiently to install a seedling browsing transect (usually about 6 to 9 months). The second phase is from the time of installation of the seedling browsing transect until such time as the coupe is deemed to be successfully established, monitoring of the browsing transect ceases and the coupe regeneration result is reported at the Quality Standards Review. The second phase can be as short as one year, or as long as four years, depending on the forest type.

During the first phase, many young seedlings (cotyledons to the three leaf pair stage) do not recover after browsing, as often the entire seedling is eaten and there are no buds left from which the seedling can reshoot. The loss of seedlings during this phase reduces the seedling density on the coupe. Browsing control prior to and during this time is therefore critical to the establishment of successful regeneration. Mammal browsing control in this phase is termed 'pre-emptive' as it commences before any browsing damage is evident, although evidence of browsing levels on the coupe still informs the control decision.

During the second phase, more established seedlings (more than three leaf pairs), can be quite heavily browsed but usually buds remain in the leaf axils, from which the seedling can reshoot. Heavily browsed seedlings can and do die, but losses at this stage are usually minor compared to the losses in the first phase. Browsing control during this phase protects the established seedlings and late germinants from excessive (lethal) damage. Browsing control in this phase is 'reactive' as the level of control activity required is based on evidence from the seedling browsing damage transects and from observations throughout the coupe.

2. The Forest Management System

The Forestry Tasmania electronic web-based Forest Management System; Procedures and Documents has a section for Mammal Browsing with the following items and links to documents:

- Code of Practice,
- Forest Operation Plan,
- Forms,
- Guidelines,
- Job Risk Assessment,
- Manuals,
- Standard Operating Procedures, and
- Technical Bulletins.

The Forest Management System is the repository for all the up-to-date and authorised Standard Operating Procedures and Forest Operational Plans for browsing animal control. Always refer to the Forest Management System for the most-up-to-date advice, forms and prescriptions.

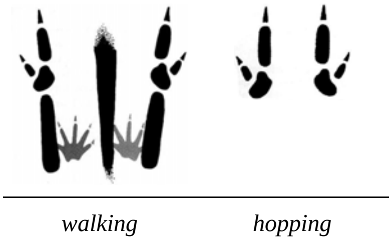
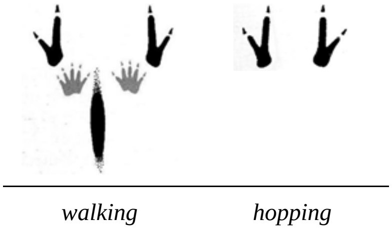
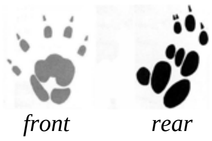
species	appearance	tracks	scats
Eastern grey kangaroo *Macropus giganteus*			
Bennetts wallaby (red-necked wallaby) *Macropus rufogriseus*			
Pademelon *Thylogale billardierii*			
Common brushtail possum *Trichosurus vulpecula*			
Wombat *Wombatus ursinus*			
Fallow deer *Dama dama*			
Goat *Capra hircus*			
Sheep *Ovis aries*			
Rabbit *Oryctolagus cuniculus*			

Figure 1. Guide to the identification of potential eucalypt browsing animals in Tasmania *(Reproduced by permission of Oxford University Press Australia & New Zealand, from Tracks, Scats and Other Traces, by Barbara Triggs, 2004, Oxford University Press).*

3. The Plan, Action and Review approach to management of mammal browsing

PLAN

Before burning – during harvesting and site preparation

- Assess pre-existing browsing levels.
- Plan burning boundaries for optimum burning intensity and timing.
- Plan access for browsing management when tracking the coupe for burning.
- Develop proposed control strategy.
- Prioritise browsing control effort across District.

ACTION

After sowing (artificial or natural)

First phase (cotyledons to seedlings) – commences the day the coupe is sown.

- Establish indicator plots.
- Commence trapping and/or shooting.
- Establish cotyledon browsing transects.
- Assess the animal population through:
  - monitoring of indicator plots,
  - monitoring of cotyledon browsing transects,
  - monitoring of damage to eucalypt crop and recovery after animal control,
  - free feeding and monitoring of uptake,
  - examination of tracks and scats,
  - examination of other evidence of browsing on non eucalypt vegetation, and
  - spotlighting.

Second phase (seedlings to sign off) – commences the day that the seedling transect is established.

- Establish and monitor seedling browsing transects.
- Monitor indicator plots.
- Continue trapping and/or shooting.
- Assess the animal population as above.
- Regeneration surveys at the appropriate time(s) to assess stocking levels.
- Remedial treatments to improve stocking, if required.

REVIEW

Coupe sign-off and reporting

- Complete data entry to Mammal Browsing Database.
- Complete data entry to Forest Operations Database (FOD).
- Report coupe to Quality Standards review.

4. PLAN Before burning – during harvesting and site preparation

4.1. Pre-harvest inspections

During the planning phase, whilst conducting inspections of the coupe, note should be taken of the pre-existing (i.e. prior to harvesting) browsing levels. Clues to the level of browsing activity are the amount of scats and tracks visible on the coupe. Grassy areas and the edges of pools of water are often good places to inspect for scat density and tracks. The intensity of browsing pressure on indicator species such as *Coprosma quadrifida* is another useful guide. Past experience from nearby coupes is often the best guide to local browsing levels.

Figure 2. Heavily browsed Coprosma quadrifida *bushes are a good sign of persistent and heavy browsing.*

4.2. Regular informal inspections

Informal inspections of the coupe should take place as often as is necessary in the establishment phase to be confident that the regeneration is adequate. Where formal inspections such as monitoring and measurement of the browsing transect and indicator plots are taking place, informal inspections of the rest of the coupe are more or just as valuable, as it is important to be sure that the browsing transects and indicator plots are reasonably representative of the whole coupe. A quick traverse through the coupe and a glance at the indicator plot may only take 15 minutes, but may save days of work and many dollars if problems are detected early.

4.3. Planning the burning boundaries and coupe access for browsing control

During the coupe planning process, the coupe should be designed with burning in mind. The more successful the burn in terms of creating receptive seedbed, the better the early establishment of the new crop of regeneration is likely to be. Past experience shows that successfully burnt coupes with high seedling densities are more likely to meet regeneration stocking standards than coupes with poor burns.

During pre-burn tracking, access for browsing control should also be considered. Access to the entire perimeter of the coupe is not always possible, for example in cable coupes, but as much of the perimeter should be accessible as possible. In some instances, additional tracking post-burn, after the slash on the coupe has been reduced by the regeneration burn, may be the most efficient way of establishing access to the furthest corners of a coupe. In other cases the most economical option will be to leave particular snig tracks open and accessible at coupe handover.

4.4. Planning the proposed control strategy

The proposed control strategy for each coupe should be considered well before harvesting is complete, as the control strategy may influence the design of the final harvest boundary. For example, if the coupe is to be fenced, as in a fenced-intensive-blackwood coupe, the final harvest boundary needs to minimise the perimeter to area ratio, and the boundary should not cross streams etc that will be impossible to fence effectively.

5. ACTION After sowing - artificial or natural

5.1 Indicator plots

Indicator plots are established primarily to monitor the amount and timing of seed germination. They also indicate the level of browsing of cotyledonary seedlings. They consist of two, 2 by 1 metre patches of representative seedbed, one of which is fenced. On large varied coupes, consideration should be given to establishing two sets of indicator plots.

Indicator plots must be established routinely in all clearfell coupes to be regenerated and should be established in partially harvested coupes. They should be established on the day the coupe is sown or in naturally sown coupes at the completion of harvesting or seedbed preparation. Indicator plots are sown at approximately 50 times the coupe sowing rate, on the same day as the sowing, to provide essential information on germination and on losses of germinants due to adverse weather or browsing.

In naturally sown coupes, it is recommended that a second fenced plot be established and not sown directly. The three plots then will be able to be interpreted for time of germination of the artificially sown seed, whether natural sowing has taken place in the absence of browsing, and the level of browsing on the sown but unfenced plot.

They are best installed in an accessible but discrete location, away from roads and not on tracks or landings. They should be established on receptive seedbed which is representative of the coupe and where browsing may be expected. Areas that may become waterlogged in winter should be avoided.

The indicator plots should not be relied on to reflect the whole coupe, and informal inspections of the rest of the coupe should also be undertaken.

Construction

The fence should be solidly constructed from 4 cm x 1.4 mm x 90 cm chicken wire supported by cheap wooden posts or similar at the corners.

Figure 3. The 'Bowerman' indicator plot used in Derwent District uses 10 mm steel reinforcing rod, that are later salvaged for re-use.

Such fences have proven better than thinner wire on star pickets because of theft, and the ability of animals to breach lighter fences. The bottom should be stapled to pieces of wood lying on the ground on the outside of the fence. This generally prevents animals pushing under the fence, especially with the heavier chicken wire. The unfenced patch should have similar wood placed around the perimeter as the fenced patch. On coupes expected to be heavily browsed, especially by possums, a wire roof may be necessary on the plot.

Care should be taken during construction of the indicator plot to minimise trampling of the seedbed.

Preparation
The seedbed should not be improved prior to sowing. Pieces of wood and stone should not be removed as the edges of these often provide good micro-sites for germination. If the only germinants adjoin these protective objects, it can be reasonably assumed that severe conditions have prevailed, e.g. drought, frost, browsing.

Sowing
Plots should be hand sown at the same time as the operational sowing of the coupe. The seed centre provides two 10 g seedlots of the same mix as supplied for the coupe, for the express purpose of sowing the indicator plots. Each 10 g seedlot should be sown onto one half (2 m^2) of the indicator plot. This is about 50 times the average sowing rate, and will overwhelm any other seed present, and should produce about 25 well established seedlings on each 2 m^2 patch. Note that the normal coupe sowing rate would be expected to produce about 0.5 seedlings per plot, hence the need for the high sowing rate.

The two patches should be matched for seedbed, amount of seed, sowing time, etc., so that any differences between the patches can be considered to be the result of browsing animals.

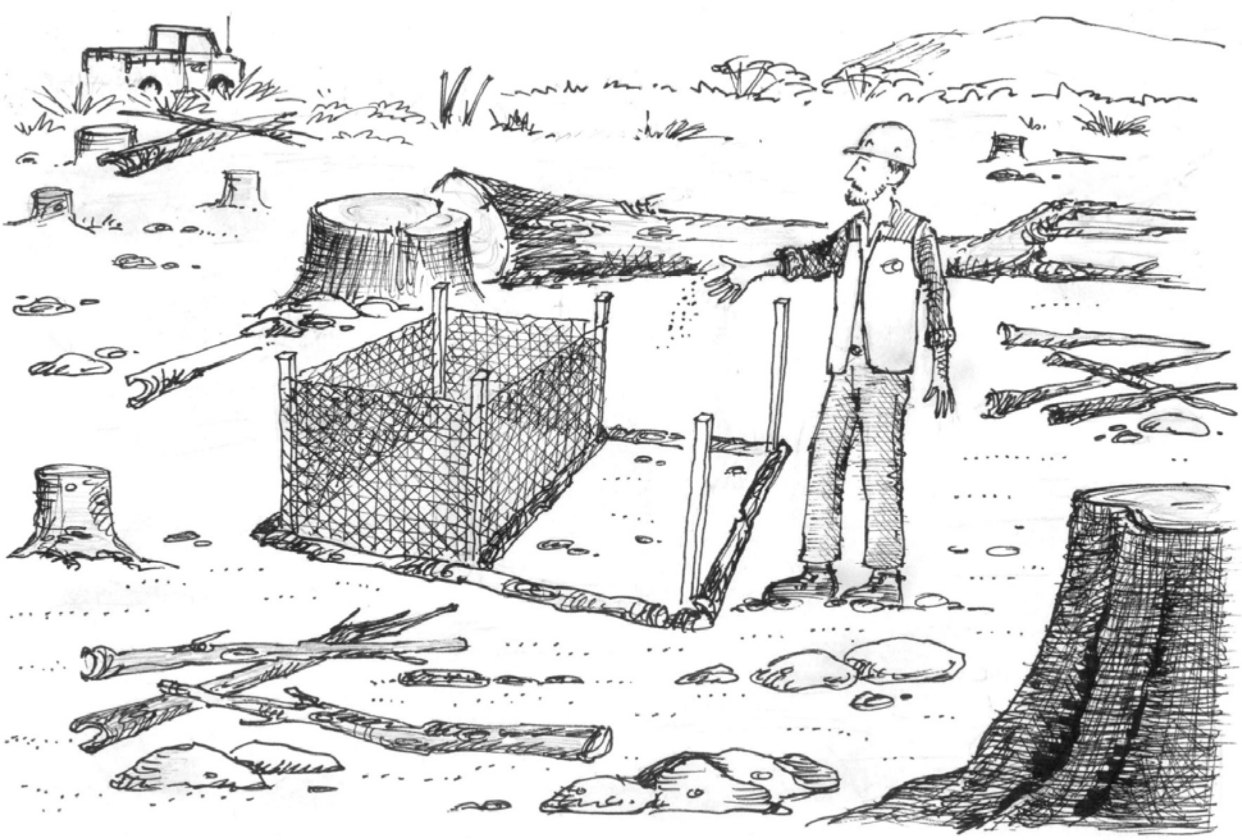


Figure 4. A well constructed indicator plot is established on the day of sowing, on seedbed representative of the coupe, in a place where any browsing may be expected, and is near, but not seen from, the road.

Monitoring
Indicator plots should be inspected about once a month. This should only take 5 minutes per plot, and within reason, the more frequently it is done the better. If the indicator plot shows significant browsing damage at the cotyledonary stage, a control program should be commenced to reduce the level of browsing. The autumn/ winter season is when other food for browsing animals is limited and browsing of eucalypt regeneration is at its heaviest. Frost and disease damage may be more serious in spring.

A standardised assessment recording form is saved at; Forest Management System; Procedures and Documents; Mammal Browsing; Guidelines; Guidelines for Assessing Native Forest Indicator Plots.doc, as shown in Figure 5. It may also be completed with the PDA-based browsing monitoring tool.

The systematic review of a sequence of indicator plot assessments should guide the decision as to whether browsing animal control is required.

The fence around the indicator plots should be retained for at least a couple of years. This allows for the longer term monitoring of growth rates. If a roof has been built, it should be removed prior to the seedlings growing through it. When the seedlings are greater than about one metre tall, their height growth is unlikely to be affected by further browsing.

C; newly germinated cotyledons

C+; cotyledons beginning to grow

2L; genuine 2-leaf seedlings

4L; 4 leaf seedlings, 2 pairs

6L; 6 leaves

8L; a healthy undamaged seedling

Figure 6. Photos and the seedling stage codes for eucalypt seedling development from cotyledon to small seedling.

5.2. Browsing transects

Browsing monitoring aims to determine whether:

- browsing is occurring on the coupe, and
- browsing control operations have been effective.

Browsing transects must be set up in all regeneration coupes to detect and monitor any damage to the regenerating crop. They consist of 50 seedlings that are monitored regularly for growth, health and browsing or insect damage. The earlier any damage is detected and reduced, the smaller the effect on the crop.

There are two types of browsing transect: cotyledon and seedling.

Cotyledon browsing transects are established in the late autumn/ winter following sowing when significant autumn germination has occurred, particularly in lowland wet eucalypt forest coupes. Cotyledon browsing transects monitor the impacts of browsing during the first winter after sowing when the indicator plot may not give enough early warning of browsing damage.

Seedling browsing transects are established in the spring following sowing, to monitor growth and browsing of established seedlings. Browsing pressure often increases in the following autumn and winter, and seedling browsing transects are designed to monitor growth and the levels of browsing damage at this time.

Establishing the transects

This section describes the minimum standards for survey design. Other survey designs are permitted but must equal or exceed the outlined survey design in statistical validity. All mammal browsing surveys are required to be captured on the Browsing Monitoring Tool (BMT). For more details about the BMT and instructions on how to use this tool refer to the Browsing Monitoring Tool field guide on the Forest Management System.

A minimum of 50 seedlings per coupe should be monitored. However the BMT does not have any set limit on how many seedlings it can monitor. The more transects that are measured, the more accurate will be the estimate of browsing level. However, *monitoring should not take more than 1.5 hours per coupe*. Therefore, coupe perimeter access will largely determine the sample design used. Table 1 presents the options of sample designs available. For each coupe, select the best option that is achievable in the allocated time. In other words, where possible use option 1, if this is unrealistic use option 2, and if this is unachievable employ option 3.

Table 1: Options for design of monitoring survey transects.

Option	Transects	Seedlings/ transect	Recommended transect length	Comments
1	10	5	< 15 m	To be used in coupes with excellent perimeter access.
2	5	10	< 20 m	To be used in coupes with moderate perimeter access.
3	3	16, 17, 17	< 60 m	To be used in coupes with very poor access (e.g. partial harvest coupes, cable coupes).

Transects should be evenly distributed as near as feasible around the coupe perimeter. Transects positioned in this way provide an early warning signal for potentially severe damage across the whole coupe. Transects should be numbered sequentially and in a clockwise fashion around the coupe from the starting point. Seedlings should be numbered from 1 through to 50; i.e. independently of transects.

Transects run perpendicular to the coupe perimeter (not parallel to or along the perimeter). Starting from the edge of the coupe, identify a seedling suitable for monitoring. The seedling should initially be healthy and unbrowsed. The seedling should be marked with a high visibility peg placed a few centimetres to the north of the seedling. The number of the seedling should be recorded on the peg so that it can be relocated on subsequent visits. Continue to do this until all of the seedlings for that transect have been established. Attempt to get a spacing of about 3 metres between seedlings.

Seedlings growing on good quality ash-bed should be selected for monitoring in preference to seedlings growing nearby on poorer seed bed. Where a mixture of eucalypt species has been sown, attempt to monitor the same ratio of species that was sown. In other words, if the sowing rate was 40% *Eucalyptus delegatensis* and 60% *E. regnans*, then try and make sure that 40% of the seedlings monitored are *E. delegatensis* and 60% *E. regnans*. Note that where a mixture of eucalypt species exists, browsers might prefer one species over another. For example, in a mixture of *E. regnans* and *E. delegatensis,* more *E. regnans* are likely to be browsed, and more heavily, than *E. delegatensis.* Similarly, *E. dalrympleana* and *E. viminalis* are also browsed more than *E. delegatensis.*

If coupes are re-sown, following failure of the first crop for whatever reason, then new transects must be established on the second crop of seedlings.

Monitoring

Native forest clearfell burn and sow coupes should be monitored *at least* monthly for the first year after transect establishment. Each coupe can then be reviewed to determine the appropriate level of monitoring.

Partial harvest coupes should always have transects established in them when germinants become apparent. Monitoring should be undertaken in the first few months to get an indication of browsing pressure. Where browsing pressure is high, monitoring should be undertaken monthly. If browsing pressure is low, monitoring frequency may be reduced to appropriate intervals. Monitoring is not required in partially harvested coupes where progressive harvesting assessments have been used and the quality standards (particularly for stocking) have been met.

Monitoring should be carried out using the Browsing Monitoring Tool. Where this is not possible, a Browsing Monitoring Form is available from the Forest Management System. However, this information must then be entered into the Browsing Monitoring Tool.

Assess each tree for:

- height in centimetres, and
- mammal browsing score.

Tree height should be assessed as it provides information on crop performance and also forces assessors to examine each plant closely. Height should be measured to the point where the highest fully formed leaf meets the main stem. If a seedling is leaning over, it should be gently pulled to vertical whilst height is being measured.

Browsing score is assessed and recorded as shown in Table 2. Note that if a seedling is not recorded as dead, only browsing damage attributable to mammals should be recorded. Information on levels of insect or pathogen attack should be reported in the comments section.

Table 2: Browsing scores and definitions used when monitoring browsing transects.

Browse score	Code	Definition
No damage	N	no mammal caused foliage loss.
Light	L	< ¼ foliage loss attributable to mammals.
Moderate	M	¼ - ½ foliage loss attributable to mammals.
Heavy	H	½ - ¾ foliage loss attributable to mammals.
Severe	S	> ¾ foliage loss attributable to mammals.
Missing	Mis	Seedling is no longer present, cannot therefore give a death reason.
Unknown	Unk	Seedling is dead, cannot identify the reason for death.
Drought	Dro	Seedling is dead, caused by drought stress.
Frost	Fros	Seedling is dead, caused by frost.
Insect	Ins	Seedling is dead, caused by insects.
Mammal	Mam	Seedling is dead, caused by mammals.
Pathogen	Pat	Seedling is dead, caused by pathogens.
No peg	NP	The marking peg and therefore the seedling could not be found.
Not re-pegged	NR	A new seedling was not pegged (only available in re-pegged section).
Re-pegged	R	A new seedling has been pegged.

Re-pegging

One of the main aims of browsing monitoring is to determine whether:

1. browsing is occurring on the coupe, and
2. browsing control operations have been effective.

If the pegged seedlings become severely browsed the ability of the monitoring transects to detect future new damage lessens. Therefore, if a seedling has died or is severely browsed, the seedling must *if possible* be replaced with a nearby non-browsed or much less-browsed seedling. This needs to be noted in the BMT or on the browsing monitoring form.

Note that a seedling may be re-pegged at any time if in the opinion of the assessor it is no longer suitable for monitoring. An example of where this may occur is if the seedling has grown large enough to withstand browsing whilst the surrounding seedlings remain smaller. The newly pegged seedling must have its height and browse score recorded.

If a seedling cannot be found to be re-pegged, then the 'not re-pegged' code should be used when recording the data.

Summary Information

Summary information of the fifty assessed seedlings is calculated automatically by the Browsing Monitoring Tool. This information is then uploaded into FOD and the Mammal Browsing Database.

The calculations that are carried out are:

1 * $$\% \, browsed = \frac{number\ of\ browsed\ seedlings^{*}}{total\ number\ of\ seedlings} \times 100$$

2 † $$\% \, severely\ browsed = \frac{number\ of\ severely\ browsed\ seedlings^{\dagger}}{total\ number\ of\ seedlings} \times 100$$

3 †† $$Average\ height\ (cm) = \frac{sum\ of\ all\ heights}{no\ of\ seedlings\ with\ heights\ recorded^{\dagger\dagger}}$$

* browsed seedlings: count seedlings recorded as light, moderate, heavy, severe, mammal, missing, unknown
† severely browsed seedlings: count seedlings recorded as heavy, severe, mammal, missing, unknown
†† Heights are not recorded on dead or missing seedlings.

Note: The calculations provided for the current survey do not include any information from re-pegging events. The Browsing Monitoring Tool also provides the previous monitoring surveys summary statistics for comparison. These calculations do include the data collected from re-pegging.

Comments
As the assessor travels around the coupe they should note where browsing pressure is high using a map or aerial photograph. This is useful for planning control operations. Additional coupe level comments can be recorded on the summary page of the BMT or at the bottom of the browsing monitoring form.

5.3. Assessing the animal population – browsing limits

The decision to undertake mammal browsing control is based on growth rates within each coupe, the incidence and severity of browsing (as determined from the indicator plots and browsing transects), the relative performance with the current year's coupes, the forest type being monitored, the time of year, local knowledge and experience.

Eucalypts can tolerate some browsing without significant harm, but severe browsing will cause unacceptable damage or even crop failure. Seedlings which are browsed at the cotyledon stage do not recover and their loss may be undetected unless there is careful and regular inspections of the indicator plot or cotyledon browsing transect.

The limit of acceptable damage varies with the:

- **time of year**. Trees are most susceptible to browsing in autumn and winter. Higher levels can be tolerated in spring and early summer, when the trees have a greater capacity to recover.
- **number and height of seedlings present**. A well stocked coupe can recover from higher levels of browsing than a poorly stocked coupe.
- **effects of weed competition, frosts and drought**. Greater browsing control is needed if site factors are adverse.
- **browsing intensity** and distance to young regeneration or agricultural land. Animal populations are often higher adjacent to pasture, and
- **coupe shape.** Long thin or small coupes with a high perimeter to area ratio are more susceptible to browsing damage.

Indicator plots provide an early warning of browsing of cotyledonary seedlings. As a rule of thumb, if there are significantly fewer seedlings in the unfenced plot than the fenced plot (suggesting browsing is reducing seedling numbers in the unfenced plot), then a browsing control program should be initiated.

Where the browsing transect shows that the average height of the seedlings has decreased between measurements, or where more than 10% of the seedlings on the transect have been significantly browsed (i.e. more than just the odd nip), then a browsing control program should be initiated.

5.4 Examples of different approaches to mammal browsing control.

Good browsing control

This coupe was burnt and sown in March 2009. Initial free feeding and spotlighting (36 animals taken) showed that there was a considerable population of possums and pademelons on the coupe. Saturation trapping with 170 traps per night over a three-week period yielded 295 animals (30 animals/hectare including shooting). Trapping ceased in mid-August, when germinants were beginning to appear in the indicator plot. Despite a small increase in browsing pressure to 6% of monitored seedlings in November 2009, no further game control was deemed necessary. The regeneration survey result in May 2010 was 94% stocked (5,882 stems per hectare). Total number of control visits was 28 (83 man hours).

- Progressive trapping over a single week showed successive daily reductions in the number of animals being taken.
- Having a week-long break and then recommencing the trapping operation produced a spike in numbers taken as animals occupying nearby territories moved in to utilise free territory.
- Further trapping yielded fewer animals until the remaining population was considered low enough for trapping to cease.
- Most animals caught in the second and third weeks of trapping were pademelons, indicating that they take up new territory faster than possums.

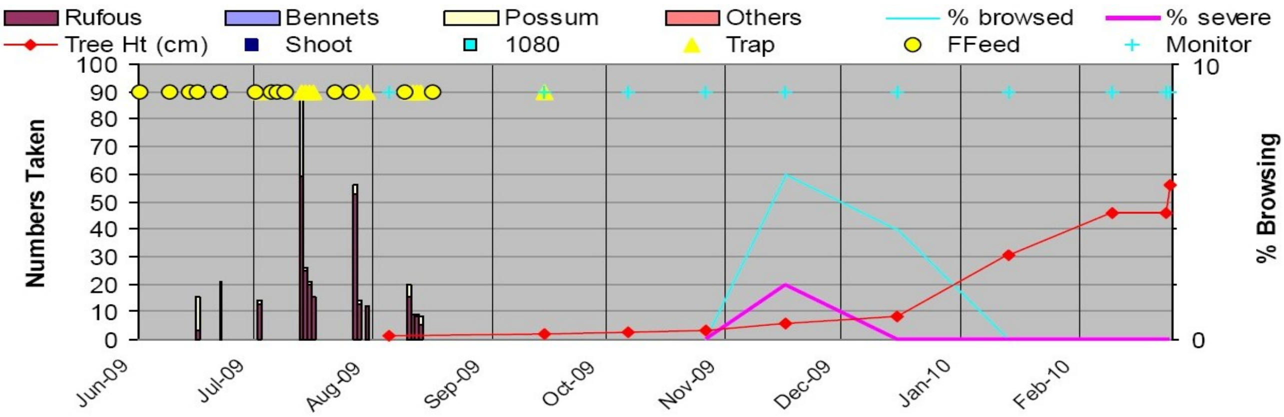


Figure 7. An example of good browsing control.

A coupe that did not require any browsing control

Coupes that do not require any browsing control do occur, but are rare. This coupe was burnt and sown in 2007. Early monitoring of indicator plots showed very little browsing. This trend continued through the transect monitoring phase, although there was a spike in browsing damage in winter 2008, but by this time the seedlings were well established, and able to withstand some browsing. The regeneration survey result in March 2008 was 93% stocked. The coupe was next to a buttongrass plain, which is normally an indication of potential for severe browsing pressure.

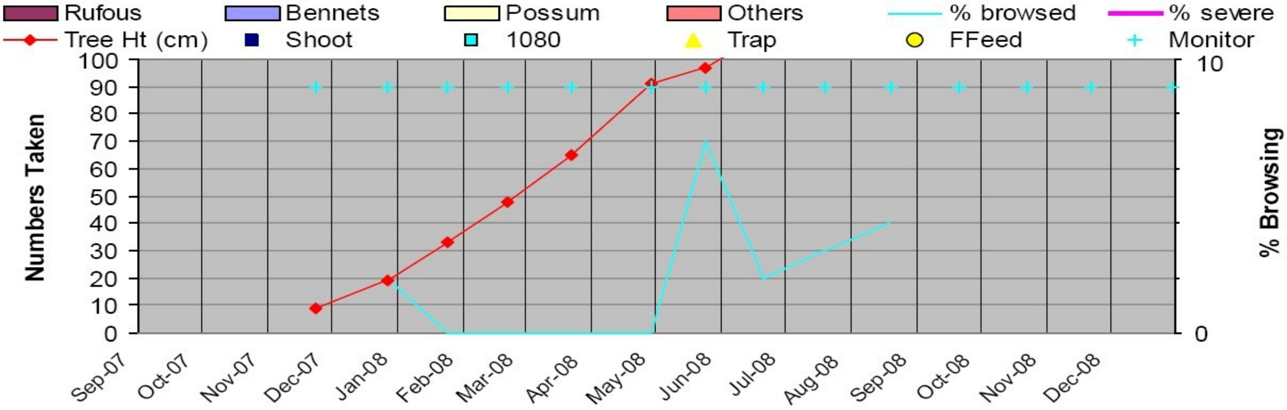


Figure 8. An example of a coupe that did not require any browsing control.

Sub-optimal browsing management

This coupe was burnt and sown in March 2007. Browsing control did not commence until August 2007 (approximate time of germination) and continued weekly for 6 months, yielding a small number of animals on each visit. No free feeding was used to attract animals. Trapping was employed in January 2008 as it became apparent that shooting was not removing sufficient game numbers from the coupe and browsing was occurring on the seedling transects. However, trapping initially only used 16 traps, which was gradually increased to 30 as the browsing problem continued. The regeneration survey result in April 2008 was 25% stocked. Coupe was spot sown and browsing control continued in same manner. The regeneration survey result in April 2010 was 65% stocked. A total of 229 man hours over 149 visits was spent controlling browsing on this coupe, with 664 animals taken over a two year period. One of the problems on this coupe was the presence of Bennetts wallabies, which accounted for 16% of the animal take.

This coupe may have been better served by an initial saturation trapping event to remove pademelons and possums and an intensive free feeding and shooting event to remove Bennetts wallabies. Follow-up shooting events would probably also have been required to reduce the Bennetts wallaby population.

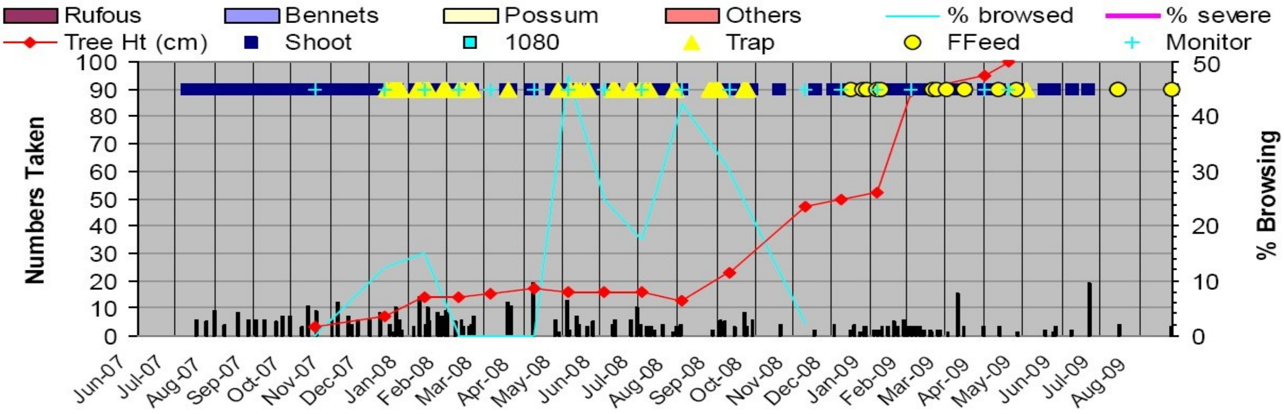


Figure 9. An example of sub-optimal browsing management.

Reactive game control

This coupe was burnt and sown in April 2006. The browsing pressure was initially low but increased during the first summer. Shooting was undertaken in March 2007, which reduced browsing levels briefly, but browsing increased steadily into the winter. The regeneration survey in April 2007 was 82% stocked. More concentrated shooting was employed in May-June 2008 when 35% of transect seedlings were found to be browsed. This reduced measured browsing pressure to 2%. Further shooting controlled another spike in browsing pressure in September 2007. A further regeneration survey was deemed unnecessary despite browsing occurring after the initial survey.

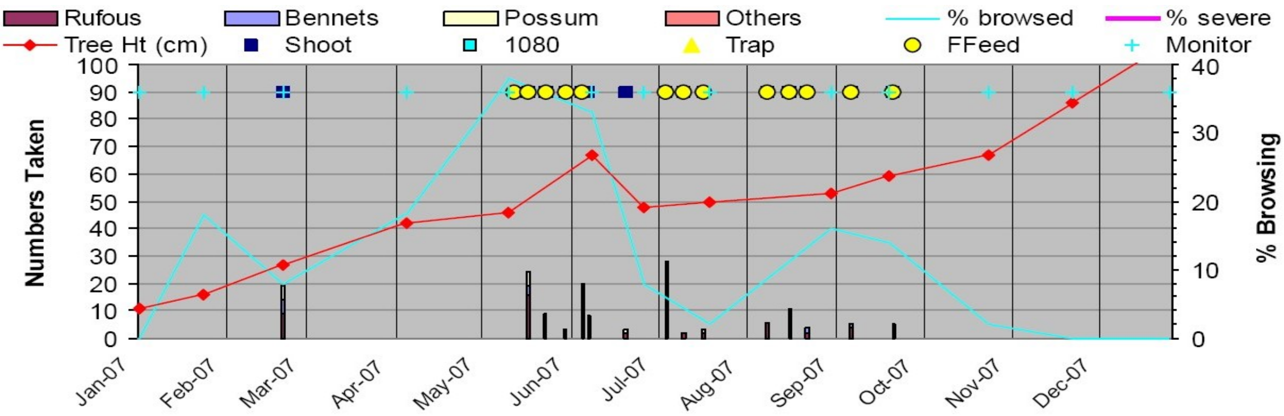
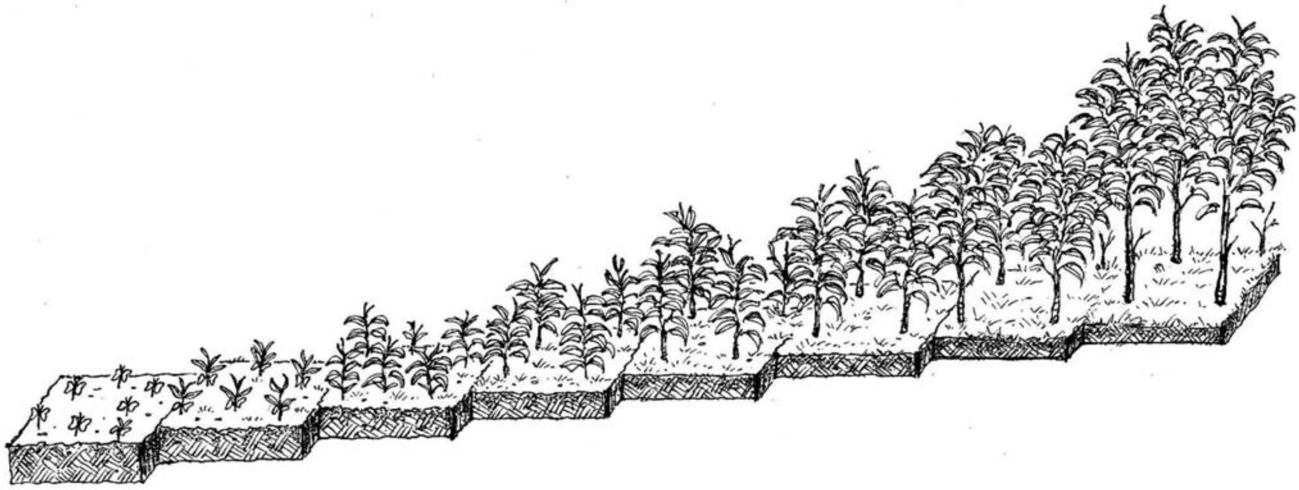
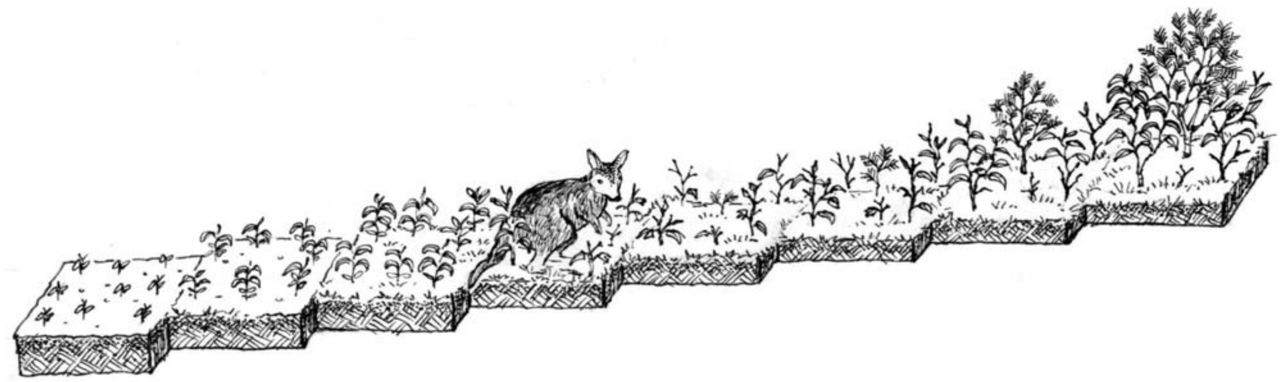


Figure 10. An example of reactive game control.

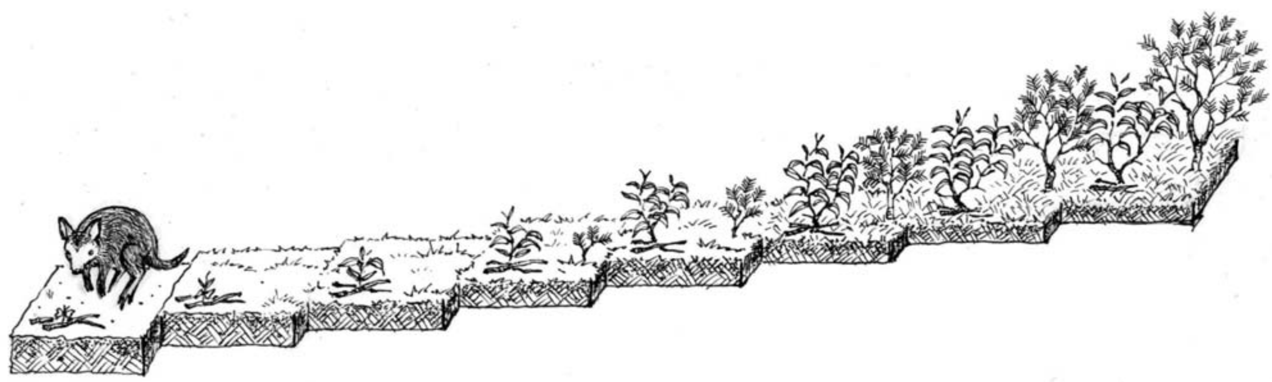
Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer



sowing and germination	insignificant browsing results in good early establishment	more germination occurs from dormant seed	full establishment and growth.	little browsing activity	little browsing activity	rapid growth	eucalypt crop generally greater than 1 m tall



sowing and germination	a well established crop	more germination occurs from dormant seed	full establishment but animal population increasing.	as herbs & grasses reduce, browsing of eucalypts increases	browsing causes severe growth losses		sparse eucalypt crop generally less than 1 m tall



sowing and germination	browsing results in death of cotyledons and reduced stocking levels	more germination occurs from dormant seed	all eucalypts germinated but browsing results in low stocking and poor form	as herbs and grasses reduce, browsing of eucalypts increases	browsing reduces growth of already limited crop		eucalypt crop fails

Figure 11. The effect of three different browsing patterns on eucalypt regeneration.

5.5 Approaches to browsing control

Browsing control timing

Pre-emptive

Many young seedlings (cotyledons to the three leaf pair stage) do not recover after browsing, as often the entire seedling is eaten and there are no buds left from which the seedling can reshoot. The loss of seedlings during this first phase of regeneration establishment reduces the seedling density on the coupe. Browsing control during this time is therefore critical to the establishment of successful regeneration. Mammal browsing control in this phase is termed ‘pre-emptive’ as it commences before any browsing damage is evident, although evidence of browsing levels on the coupe still informs the control decision.

Pre-emptive game control can be carried out effectively with trapping and well planned shooting operations. Pre-emptive game control is often the most effective way of successfully establishing satisfactory regeneration.

Re-active

More established seedlings (more than three leaf pairs), can be quite heavily browsed but usually buds remain in the leaf axils, from which the seedling can reshoot. Heavily browsed seedlings can and do die, but losses at this stage are usually minor compared to the losses described above. Browsing control at this time protects the established seedlings from excessive (lethal) damage, and is termed ‘reactive’ as the level of control activity required is based on evidence from the seedling browsing damage transects and from observations throughout the coupe.

Intensity of browsing control

There are two main approaches to browsing animal control, although over time both may be employed in the one coupe.

Intensive control (saturation control)

Intensive control, also referred to as saturation control, refers to a major operation applied to reduce the animal population to below damaging levels, through an intensive trapping event where a large number of traps are placed on a coupe in conjunction with free feeding events. An example of such an operation is provided in Figure 7. Whilst such control operations are effective, they cannot be applied everywhere at once as there may not be enough resources in the browsing program. Intensive operations involve considerable initial time spent on the coupe but result in fewer visits to the coupe.

Progressive control

Progressive control refers to applying a continual level of game control through the regeneration stages to consistently reduce the browser population. Few animals are taken on each visit, and usually many visits are required to achieve a satisfactory level of control. Control is usually reactive, as it is undertaken in response to evidence of excessive browsing damage from the browsing transects. There is a risk of animals becoming gun shy from familiarisation with shooting operations. It may therefore become difficult to effectively manage coupes using this technique.

5.6 Options for managing browsing damage

Fencing

Fencing is generally recommended only for fenced–intensive–blackwood coupes. However, in areas where experience indicates that browsing control will be difficult, and where the coupe is small, of good shape, and the terrain is suitable (not rocky or deeply dissected with drainage lines), then fencing should be considered. Fence construction is described in Technical Bulletin No. 10, Blackwood; and in Statham and Statham (2010)

Free feeding

Free feeding is an essential component of browsing control and has been shown to increase browsing animal control effectiveness when applied appropriately. Free feeding can also be used to gauge the animal population, familiarise animals with trap bait and encourage animals to areas (tracks/clearings etc) where they can be more easily shot.

Cracked maize scented with aniseed or cinnamon essence is the preferred feed. It is highly attractive and palatable to target species, does not degenerate rapidly, is relatively waterproof, cheap and easy to handle and has no weed creation potential.

Some problems where birds, such as currawongs and cockatoos, have taken bait may be avoided by dying bait blue. This makes bait less attractive to birds, but is a messy job and should only be done when necessary. Protection permits may also be available to control the bird population.

Trapping

Trapping is very effective for controlling possums and pademelons. It may also capture smaller Bennetts wallabies, but should not be relied on to control Bennetts wallaby problems. Another benefit of trapping is that it is conducted in daylight, although the traps must be checked early the following day, and does not require the employment of expert professional shooters. Trapping must only be carried out with approved Mersey box traps and in accordance with the DPIPWE code of practice, which is located on the FMS.

Trapping is an intensive operation that requires the procurement and laying out of traps, free feeding, repeated trapping visits and the ultimate removal of traps. As such, it is a labour intensive exercise. It should therefore be planned and operated to get the most effective outcome. In addition, traps have been shown to be prone to theft and/or vandalism. Consideration should be made towards the likelihood of these occurrences when considering a coupe's suitability for trapping.

The preferred approach to trapping is to conduct a relatively short saturation trapping event where a large number of traps are placed out on the coupe in conjunction with free feeding events. Trapping is then conducted over a consecutive four night period, which usually results in the capture of progressively fewer animals each time (see Figure 7). Traps are then rested for a few days over the weekend, or for a week, before trapping recommences in the same manner. The second week of trapping normally captures the sub-dominant animals or animals that have moved into newly vacated territory. Another round of trapping may be repeated over a third week depending on free-feed uptake. Traps can then be moved onto the next coupe in the program. Such an approach is likely to reduce any browsing problems for a considerable period of time, and generally only small amounts of follow up work are required.

Putting out a small number of traps and continuingly visiting them is also an effective method of control. It may be easier to manage on a large number of coupes with limited trapping resources. However, it may not effectively deal with initial browsing problems

Placing traps:

- place traps in accessible locations,
- try to hide traps near vegetation or rocks to prevent theft and vandalism,
- place traps near any animal runs.

Bait use for trapping:

- free feeding around traps familiarises animals with traps,
- use a small line/spot of grain to attract animals towards the trap.
- place the majority of feed on the trigger plate at the rear of cage so that the animal has to fully enter the trap.

Setting traps:

- do not set traps unless they will be cleared the following morning,
- ensure the trap screw is sensitive enough to ensure rapid closing of lid once triggered.

Clearing traps:

- to avoid attracting non-target species to the trap, ensure that animals are not shot in the trap,
- remove them from the trap using a “knock box” and take them approximately ten metres away from the trap to shoot.

Shooting

Shooting is presently the most common method used to control animals. This is because it is relatively cheap and easy to implement. When planned and carried out correctly, shooting can be very effective at controlling browsing. However, shooting must produce the game control outcomes desired as efficiently as possible. Considerable time and money can be wasted if shooting is employed incorrectly.

Shooting is usually carried out either on foot or from an ATV using coupe access tracks. For this reason, free feeding to attract animals to these tracks is vital. Shooting on foot may be preferred if animals become flighty at the sound of an ATV. A ‘sit and wait’ approach can also be adopted where the shooter remains stationary and waits for animals to come to him.

Population control by shooting will normally involve repeated visits to a coupe. The success of each shooting visit will depend on factors such as coupe access, weather, the ability and equipment of the shooter, the efficacy of the free feeding program, and the size of the animal population and its familiarity with shooter movements.

When conducting the shooting operation, use techniques that minimise animal flightiness:

- use red filters on spotlights,
- minimise noise; ATV mufflers and/ or subsonic bullets,
- consider the use of thermal imaging or night vision gear.

Don’t become predictable in shooting patterns. All animals are different. One technique that was successful to control one animal may not be successful in controlling another animal. In addition, animals can become accustomed to shooters movements and may learn to react in the interests of their well-being. For this reason, it is important to vary factors such as the time of night and length of time of the operation, and the path taken around the coupe. Also vary the shooting set up (e.g. using ATVs versus walking, employing spotlighting versus night vision gear). Trapping may have to be employed to control animals that have not successfully been used using shooting techniques.

Shooting and free feeding
Shooting should be performed in conjunction with free feeding which attracts animals to places where they can be easily shot. It may be easier to control the animals near to the coupe, such as on an adjacent button grass plain, rather than on the coupe itself.

Free feeding can be carried out over several days prior to the shooting event to get animals used to both the location and the taste of grain. Free feeding should also be undertaken on the day of the shooting event so that animals are out in the open when the shooting operation is occurring.

Feed should preferably be laid late in the afternoon to minimise consumption by non-target species. Different animals have different feeding behaviours so there must be sufficient feed to cover all species. As a rule, Bennetts wallabies may feed during the late afternoon, pademelons generally don't come out until after sunset, and possums won't venture out until it is fully dark.

When feeding along a track, handfuls of grain should be laid out every 20 - 30 m. Alternatively, feed can be laid out in a continuous thin line along the track. It is often efficient to have an automated feed dispenser attached to an ATV. When using the 'sit and wait' approach, free feed should be placed in larger piles or lines around the shooter.

6. REVIEW Coupe sign-off and reporting

6.1. Sign off

An *indicative* height that trees are no longer susceptible to browsing, is one metre. However, if other evidence exists that the crop is established, browsing monitoring may cease before trees are this tall. Local knowledge and experience should therefore be used to judge when coupes no longer require monitoring. Other evidence to look for includes:

- the average seedling height is *at least* 60 cm tall,
- there has been little recent browsing pressure,
- the coupe is appropriately stocked as assessed by regeneration survey, and
- the seedlings are obviously established and growing well.

Cessation of monitoring can only be approved by the appropriate forest officer. When this occurs, the corresponding FOD browsing monitoring and control operations must also be updated.

6.2. Forest Operations Database

FOD is the database for capturing planned and actual forest operations that are managed by Forestry Tasmania. It incorporates selected data relevant to forest operations such as harvesting, establishment, stand maintenance, surveys/assessments and road construction and maintenance.

FOD is the single access point for operational data capture, editing, viewing and reporting. It promotes the standardisation of business processes, reduces data capture duplication, and facilitates the automatic population of plan documents with as much existing data as is available within FOD and linked systems.

FOD provides a single, consistent, and authoritative source for corporate reporting.

6.3 Mammal Browsing Database and the Browsing Monitoring Tool

The database was developed to better track the history of activities on coupes. It visually displays dates of monitoring and control visits as well as charting the level of browsing pressure and seedling height growth over time. It also shows the number of animals taken on each control visit. The information is presented graphically and provides a decision support tool as to when browsing control may be needed. It also provides coupe case histories that can help identify problem areas before browsing becomes apparent.

The Database is the repository of all browsing information since 2006. The large amount of information can be summarised into management reports such as monthly, State or District-wide monitoring reports, cost reports and control reports as well as individual coupe reports.

The Browsing Monitoring Tool is PDA-based software that enables in-field data entry of indicator plot and browsing transect assessments. The tool provides automatic coupe summary information, comparison with previous measurements and automated upload of information into FOD and the database. It ensures uniformity in browsing monitoring assessment procedures. This tool provides considerable time saving in the collection of browsing monitoring data.

7. Protection against insects and disease

Under normal circumstances, no specific actions are taken to control insects or diseases in extensive eucalypt-dominated native forest regeneration areas.

The most common insects and diseases of eucalypt regeneration are described briefly in Part B and in more detail in the Pests and Diseases Management Plan (Forestry Commission 1991c).

Part B: Descriptions and Background Information on Monitoring and Protecting Eucalypt Regeneration.

1. Introduction

Monitoring eucalypt regeneration until it is satisfactorily established is an essential part of good silvicultural practice. The earlier that problems such as poor seed germination or heavy browsing can be identified the more effectively and economically any problems can be rectified.

2. Monitoring field germination

Indicator plots

Indicator plots are established primarily to monitor the amount and timing of germination of the seed sown on the coupe. They also indicate the level of browsing.

Regular monitoring of small indicator plots will give a reliable indication of seedling germination, establishment and drought, frost and browsing damage. This is more effective than occasional random inspections of the whole coupe. However, the indicator plots should not be relied on to reflect the whole coupe, and occasional informal inspections of the coupe should be carried out.

Tree percent

Tree percent is the average number of seedlings which become established in a forest from each hundred seeds sown. Indicator plots can be used to monitor the tree percent achieved for the coupe.

The number of established seedlings on each patch of the indicator plot can be used to calculate the tree percent for the coupe. The germination test result for the seed-lot sown multiplied by the sowing rate on the patch gives the number of laboratory germinants expected on the 2 m^2 plot. The number of germinants present can then be calculated as a percentage of the expected. The higher this percentage, the more successful the establishment phase of the selected silvicultural system.

$$\frac{\textit{actual number of germinants on patch x 100}}{\textit{lab germ test result (germs/kg) x patch sowing rate (kg)}} = \textit{tree percent}$$

The base sowing rate for each species sown is currently 62 500 fertile seeds per hectare (Forestry Tasmania 2010). A tree percent of 4 would result in about 2 500 established seedlings per hectare. This is about one seedling per 4 m^2. When indicator plot patches are sown at 50 times the coupe sowing rate on a 2 m^2 patch, this 4% should result in about 25 seedlings.

The tree percent obtained in natural regeneration varies with the size, vigour and genetics of the seed, the presence of seed-eating insects, overstorey or weed competition, seed bed type and amount, time of sowing, rainfall, drought, frost, altitude and timing and intensity of browsing. A high figure would be 10 per cent, a low figure 1 per cent, and a very low figure 0.1 per cent.

More details on seed and sowing rates can be found in Technical Bulletin No. 1.

3. Browsing

Browsing of native forest regeneration by native mammals can cause significant damage to individual seedlings and reductions to stocking and growth in the first two years after sowing (Cremer 1969; Cremer, 1973; Neilsen and Pataczek 1991; Edwards and Wilkinson 1992; Wilkinson and Neilsen 1995). Other causes of understocking include frost, drought and insect damage, disease, and, in wet eucalypt forests, poor burns.

Early research

Early silvicultural research in Tasmania quickly identified the importance of browsing animal control in successful eucalypt establishment (Cremer 1969; Cremer and Mount 1965; Cunningham and Cremer 1965; Gilbert 1961). Mollison (1960) observed that the numbers of browsing animals in regeneration areas built up rapidly. Mount (1976) observed that the size and shape of coupes was important in determining the impact of browsing animals, with browsing damage in small coupes with a high perimeter to area ratio being greater than in large coupes with a lower ratio.

Browsing mammal species

The major browsing animal species in native forest regeneration and in plantations are Bennett's Wallaby (*Macropus rufogriseus*), Pademelon (*Thylogale billardierii*), Brushtail possum (*Trichosurus vulpecula*) and rabbit (*Oryctolagus cuniculus*), not necessarily in that order (Coleman *et al.* 1997; Statham and Statham 2010). In different forest types, different species are the major problem. For example, in the blackwood forests of the north-west, pademelons have traditionally been the major browsing pest (Forestry Tasmania 2005; Statham 1983) whereas in *Eucalyptus delegatensis* regrowth in the Mersey Valley, Bennett's wallaby was the chief offender (Statham 1983). In both examples, other species are also likely to be involved.

Season of browsing

Many losses due to browsing may occur when seedlings have only just germinated. Browsed cotyledonary seedlings do not recover and their loss may not be detected except by careful and regular inspection of the indicator plot. Cotyledonary seedling damage usually occurs in the first autumn and winter following germination, when seedling height ranges from 1 to 30 cm (Statham 1983).

Partial or complete defoliation of more established seedlings results in the loss of growth, development of multiple leaders and death of seedlings. Recovery from browsing depends on the season of defoliation. A single complete defoliation between February and June killed many *E. regnans* seedlings up to 45 cm tall, while defoliation between August and December on similar sized seedlings had little effect on subsequent growth and survival (Cremer 1965).

Wilkinson and Neilsen (1995), in a long term study, found that low to moderate levels of browsing had little impact on survival and growth of planted seedlings, but that heavy levels of browsing had dramatic effects on both survival and growth. Heavily browsed seedlings which survived often suffered suppression by competing vegetation. They concluded that if economic growth rates were to be achieved, seedlings must be protected from heavy browsing. Wilkinson and Neilsen (1995) also noted that the timing of browsing influenced its impact on the growth and survival of seedlings. Autumn browsing resulted in higher mortality and lower growth rates than spring browsing. Similar results regarding the timing and subsequent impact of browsing were recorded by Cremer (1969) in *E. regnans* regeneration and by Candy *et al.* (1992), who were examining the impact of leaf beetle defoliation on *E. regnans*.

Browsing in winter has a greater impact than browsing in summer because the plants have fewer reserves and are not actively growing, so lost foliage is not replaced quickly (Cremer 1969). Heavy browsing in autumn/winter caused greater mortality than similar browsing levels in spring/summer (Cremer 1969; Wilkinson and Neilsen 1995).

Control of browsing
Control of browsing, where necessary, is usually only needed in the first two years after sowing/establishment (or until the seedlings are about one metre in height) after which time they are tall enough to escape most browsing (Coleman *et al.* 1997).

Shooting and trapping are the two currently preferred methods of game control.

Fencing may dramatically reduce browsing damage (Cremer 1969; Forestry Tasmania 2005; Statham and Statham 2010) but it is expensive to erect, difficult to maintain and restricts natural animal ranges and can therefore only be justified for higher value crops. Currently fencing of native forests is used only for blackwood-rich regeneration (Forestry Tasmania 2005; Jennings and Dawson 1998).

The use of 1080 poison on State forests ceased on the 31st December 2005.

4. Browsing limits

The limit of acceptable browsing is not something that can be defined precisely. The impact of browsing will vary depending on many factors; e.g. the time of year, the species of browsing animal responsible for the damage, the numbers of animals involved, the stocking and shape of the coupe and so on. There has been no research on the level of browsing that native forest regeneration can tolerate without long term effects.

Browsing transects have been used to monitor the browsing pressure on eucalypt regeneration. Regular, repeated monitoring is the most useful measure of the impact of browsing on the regeneration, and the best guide to the need to undertake browsing animal control. The layout of the transects in native forest coupes is based on research by Walsh and Stamm (2011) who determined that transects comprising 5 separate sections each of ten seedlings, with the sections well spread around the perimeter of the coupe, were the most informative.

If the browsing transect shows that, in autumn, the mean height of the regeneration has decreased since the previous measurement and the incidence of browsing (number of browsed stems) has increased, then browsing control is required. There will, however, be many instances where the level of browsing damage is marginal. In such situations, local knowledge and experience are required in order to make an informed decision regarding the need to undertake browsing control.

A low cost shooting programme may reduce the browsing pressure enough for the crop to recover and grow. Cull rates may be improved by laying free feed bait piles that should concentrate the browsing animals into areas where control can be effectively carried out.

The free feeding component of a browsing control program also has a built-in method of assessing the need for more control to be undertaken. If the free feed is not being fully taken up, it is an indication that animal numbers and/or browsing pressure are low. If the browsing transects are showing unacceptable browsing damage, then shooting animals at the bait piles should cull the small number of animals causing the damage.

5. General pest and disease management

Detailed information on pest and disease management can be found in the Pests and Diseases Management Plan (Forestry Commission 1991), and in Insect Pests of Trees and Timber (Elliott and de Little 1985).

Insect Pests
Eucalypts can tolerate the chronic, low levels of insect browsing attack to which they are continually subjected. However, some insect species are capable of causing severe growth losses and all the foliage can be removed in outbreak years.

The extent of the damage caused to a given tree by insect attack is dependent on:

- the proportion of leaf area damaged or lost (Elek 1997);
- the time of defoliation. Defoliation occurring late in the growing season causes more serious damage than early defoliation (Candy *et al.* 1992; Elliott *et al.* 1993);
- the age and general health of the tree; and
- whether or not defoliation is repeated over a number of seasons (Candy *et al.* 1992; Elliott *et al.* 1993).

When trees are defoliated over a number of seasons, their growth rate is seriously impaired and they may die (Candy *et al.* 1992; Elliott *et al.* 1993). Loss of tree form occurs and the trees become more susceptible to pathogen attack.

Insect pests fall into three general categories:

Defoliators
These insects reduce growth rates or cause death by restricting photosynthetic ability. They include eucalyptus leaf beetles (chrysomelids), sawflies (*e.g. Perga* spp.) and gum leaf skeletonisers (*Uraba lugens*) (Elliott & deLittle 1985). The chronic nature of severe defoliation caused by the Tasmanian eucalyptus leaf beetle *Chrysophtharta bimaculata* makes it the most notorious insect pest in Tasmanian forests (Elliott & deLittle 1985).

Sap suckers
These insects insert their feeding tubes into the conductive tissue of the plant and feed on the sap, causing leaf wilt and the death of young shoots resulting in rounded crowns and growth loss. The best known of these insects is the gum tree bug, *Amorbus obscuricornis* (Steinbauer *et al.* 1997).

Wood borers
Some borers are extremely destructive and feed only on the sapwood while others tunnel into heartwood. Ambrosia beetles introduce a fungus into the tree when they bore and their larvae feed on this fungus which lines the tunnels. Wood borer damage can block conductive tissue or can be structural, resulting in breakage of the stem. Secondary effects include structural damage by birds seeking the grubs, or the ingress of fungi and bacteria through wounds caused by the borers. Signs of borer damage include holes in the tree varying from 1 to 15 mm in diameter, accumulation of wood fragments and frass pellets, and bird damage. Borers are more likely to attack stressed or unhealthy trees (Elliott & de Little 1985).

Assessment and Control
A system of assessment and integrated control involves monitoring pest population sizes and age, the effectiveness of natural predators and the use of artificial control measures at strategic times in outbreak years.

It is possible to reduce the effects of insect attack if damage is spotted early. Young regeneration generally shows signs of insect damage before older trees.

Fungal Pathogens and Miscellaneous Diseases

Native forests are subject to continual damage from pathogens which are mainly fungal. The following fungi are relatively common in Tasmanian native forests:

Leaf spot fungi

These fungi can occur on regeneration as well as on large mature trees. They are usually worst in high rainfall areas, in sheltered locations where leaves are slow to dry, and on coupes sown with off-site seed. Some leaf spotting fungi like *Aulographina eucalypti* appear as small round areas coloured purple and later brown, grey or black. Lesioned areas on the leaf may be large and irregular in shape. *Mycosphaerella* spp. cause large dead areas especially on young *E. delegatensis* and *E. obliqua* and also result in obvious twisting and deformation of the leaf blade (Forestry Commission 1991).

Vulnerability to severe leaf infection may be increased if off-site seed is included in the sowing mix. Even at the local scale there are measurable differences in susceptibility to leaf disease of seedlings originating from different habitats, e.g. gully bottoms compared with slopes or ridges (Wilkinson 2008). At least 10% of the seed for sowing should be obtained from the stand being felled (Forestry Tasmania 2010).

Root rot fungi

A common root-rot fungus, *Armillaria* spp., attacks a wide range of trees and shrubs, thriving in wetter forests. It does not usually attack vigorous trees, but trees weakened by insects, drought and water-logging (Forestry Commission 1991).

Phytophthora cinnamomi is a pathogen of many trees and shrubs. It rots fine roots and can kill the whole plant by preventing water and nutrient absorption. The fungus spreads slowly, mainly downhill via ground water movement. Rapid spread of the pathogen occurs on transported infested soil, gravel and/or root material.

Dieback

Eucalypts are susceptible to a number of diseases which are grouped under the term dieback. These are discussed in Technical Bulletin No. 8, pp 22 and 23.

6. Further Browsing Information

In 2005 the Australian and Tasmanian Governments agreed to work on a joint program to accelerate research into, and implementation of, alternative strategies for browsing animal control on private forest and agricultural lands, known as ‘The Alternatives to 1080 program’. Their website is at http://www.dpiw.tas.gov.au/inter.nsf/ThemeNodes/LBUN-7YU6ZB?open A range of newsletters and reports are available from that website.

The ‘Field Guide for the Management of Browsing Mammals in Tasmanian Forests and Farmland’ (Dredge 1998) provides details of the browsing animals that are likely to be problems in Tasmania. It also describes their tracks and traces, the types of damage they cause, the process for determining the appropriate control method, fence design and construction, and the planning processes required to undertake a control program. This report draws largely from two technical reports: Coman (1994) and Coleman *et al*. (1997).

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Tasmanian Native Forest Silviculture Technical Bulletin Series

No	*Title*	*Release date*
1	Eucalypt Seed and Sowing	2010
2	*Eucalyptus delegatensis* Forests	2010
3	Lowland Dry Eucalypt Forests	2009
4	High Altitude *E. dalrympleana* and *E. pauciflora* Forests	1990
5	Silvicultural Systems for Native Eucalypt Forests	2010
6	Regeneration Surveys and Stocking Standards	2010
7	Remedial Treatments	2009
8	Lowland Wet Eucalypt Forests	2009
9	Rainforest Silviculture	1998
10	Blackwood	2005
11	Silvicultural Use and Effects of Fire	1993
12	Monitoring and Protecting Native Forest Regeneration	2011
13	Thinning Regrowth Eucalypts	2001

The Technical Bulletins are available from:

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