Rainforest Silvicultural Guidelines

Department of State Growth

Tasmanian Government

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CHAPTER 1. Context

1.1 Purpose

The purpose of these Rainforest Silviculture Guidelines (the Guidelines) is to provide guidance on the selection and application of appropriate silvicultural practices in rainforests in Tasmania subject to special species timber harvesting. These Guidelines are a practical document intended for use in forest practices planning and are not prescriptive.

1.2 Scope

The Guidelines present ecological information about rainforest vegetation communities in Tasmania including species composition, distribution, health and hygiene and regeneration. The Guidelines outline the important considerations in selecting an appropriate silvicultural method and present a variety of rainforest harvesting techniques.

The Guidelines outline silvicultural practices targeting special species timber in rainforests. 'Special species timber' include:

- blackwood (*Acacia melanoxylon*)
- myrtle (*Nothofagus cunninghamii*)
- celery-top pine (*Phyllocladus aspleniifolius*)
- sassafras (*Atherosperma moschatum*)
- Huon pine (*Lagarostrobos franklinii*)
- silver wattle (*Acacia dealbata*)

These Guidelines refer to the harvest of 'special species' in pure rainforest communities only. Appropriate silvicultural prescriptions for timber harvesting in mixed forest (eucalypt forest with a rainforest understorey) are described in Lowland wet eucalypt forests, Native Forest Silviculture Technical Bulletin No. 8 (Forestry Tasmania, 2009). Silvicultural prescriptions for harvesting in blackwood forest communities are described in Blackwood, Native Forest Silviculture Technical Bulletin No. 10 (Forestry Tasmania 2005).

1.3 Policy and legislative framework

Forest practices including special species timber harvesting are regulated through the Forest Practices System under the *Forest Practices Act 1985* and in accordance with the *Forest Practices Regulations 2017*. The objective of the Forest Practices System as outlined in Schedule 7 of the *Forest Practices Act 1985*, is to achieve sustainable forest management*.

The *Forestry (RFI) Act 2014* defines 'special species timber harvesting' as 'the harvesting of special species timber by partial harvesting', and provides for a special species management plan to be created. The Tasmanian Special Species Management Plan (TSSMP) describes the species considered as 'special species', the land to which the plan applies, and briefly outlines three silvicultural techniques consistent with the definition of partial harvesting in the *Forestry (RFI) Act 2014*. This document supports the TSSMP in providing more detailed descriptions of how the relevant silvicultural methods are best selected, implemented and evaluated for the partial harvest of rainforest communities.

*Further information on Tasmania's Forest Management System is provided in Tasmania's *Forest Management System: An Overview 2017* (Department of State Growth, 2017).

1.4 Development and custodianship of this document

This document updates and supersedes the *Native Forest Technical Bulletin No. 9: Rainforest Silviculture* (Forestry Tasmania, 1998) to reflect current knowledge of rainforest ecology and silvicultural methodology.

These Guidelines have been developed from information derived from the best available science, including the results of long-term harvesting and regeneration trials that were undertaken specifically in Tasmanian rainforests. The research trials were established by the then Forestry Commission at various sites across Tasmania. The main silvicultural trial sites were established in 1976-77 in the Sumac region in north-western Tasmania, and re-measured at regular intervals, most recently in 2019. The revised Guidelines incorporate the most recent research results and present the relevant policy framework surrounding special species timber harvesting in rainforest communities.

This document should be cited as;

Tasmanian Government (2019) *Rainforest Silviculture Guidelines.* Department of State Growth (Tasmania).

CHAPTER 2. Rainforest Ecology

2.1 Definition and classification

Cool temperate rainforest in Tasmania has been defined by Jarman and Brown (1983) as forest with trees greater than 8 m in height, dominated by one or more of the following species: myrtle (*Nothofagus cunninghamii*), sassafras (*Atherosperma moschatum*), leatherwood (*Eucryphia lucida*), celery-top pine (*Phyllocladus aspleniifolius*), King Billy pine (*Athrotaxis selaginoides*), pencil pine (*Athrotaxis cupressoides*), Huon pine (*Lagarostrobos franklinii*) or cheshunt pine (*Diselma archeri)*.

For management purposes, a forest stand containing rainforest trees and eucalypts is considered rainforest if the eucalypt crowns comprise less than 5% of the canopy cover (Hickey and Felton 1991). Where the canopy cover of eucalypts exceeds 5%, it is classified as mixed forest rather than rainforest.

2.1.1 Rainforest types

Cool temperate rainforest can be broadly classified by its structure and floristic composition into five different rainforest types (Figure 1), as follows.

Callidendrous rainforest

Callidendrous rainforest typifies the popular idea of cool temperate rainforest. The name is derived from the Greek words kalos (beautiful) and dendron (tree), and refers to the well-formed trees present in many forests (Jarman *et al.* 1984). This rainforest is park-like, with large, widely spaced trees producing a dense canopy above a shaded understorey of manferns, a few inconspicuous shrubs or patches of low ground fern.

Myrtle is the dominant species and may reach 40 m in height in some communities. Sassafras is sub-dominant and is often multi-stemmed. Celery top pine and *Eucalyptus regnans* may also be present in some cases. The understorey species may include cheesewood, blackwood, musk, waratah, native pepper, wooley teatree, native currant, heart berry and bushman's bootlace. Manferns and cat-head fern are common, while ruddy groundfern or batswing fern may be locally dense in disturbed areas.

Callidendrous rainforest communities can occur on fertile soils in lowland or highland areas across Tasmania. Some gullies in eastern Tasmania and sites with very high moisture availability may also contain rainforest communities.

Thamnic rainforest

The term thamnic is derived from the Greek word thamnos (shrub), and refers to the presence of a well-developed shrub layer in these forests (Jarman *et al.* 1984).

Thamnic rainforest is intermediate in structure between the tall callidendrous forests and the low tangled implicate communities. It has trees of a similar height to callidendrous forest but is more shrubby below. Myrtle, leatherwood, celery-top pine and sassafras are the most common tree species. Shrubs are common and may include native laurel, native plum, horizontal and *Trochocarpa* species. Hard water fern is the main ground fern.

Thamnic rainforest occurs in the lowlands of west and south-west Tasmania, often associated with rivers. Higher altitude thamnic rainforest may be found on mountain slopes and highlands, with species such as King Billy pine, deciduous beech, dwarf leatherwood and pandani.

Gallery rainforest

Gallery rainforest is found along the margins of rivers, creeks and lakes in western Tasmania. It occurs in a variety of vegetation types in narrow bands, which may be only a few metres wide. It contains a variety of rainforest, riparian and other species, either derived from the surrounding vegetation or spread opportunistically by water-dispersed seed. Tree species commonly found in gallery rainforest include leatherwood, myrtle and Huon pine. Other common species include river tea tree, ferns, *Epacris mucronulata* and whiteywood.

Implicate rainforest

Implicate forest is named from the Latin *implicatus* meaning tangled or interwoven. It refers to the dense network of stems in the understorey which makes walking through these forests almost impossible (Jarman *et al.* 1984). Implicate forests are often less than 20 m tall, with broken uneven canopies and a dense shrubby understorey. The trees and shrubs form a continuous tangle of twisted stems and low branches. Species such

In lower altitudes, myrtle, leatherwood, celery-top pine and sassafras are the most common tree species. Other trees may include leatherwood and Huon pine. Shrubs may include tea tree, waratah, native laurel, native plum, and horizontal. In higher altitudes (>500 m), species such as deciduous beech, celery-top pine, King Billy pine and leatherwood may be co-dominant with such typical understorey species as white waratah, horizontal, pandani, Cheshunt pine and scoparia.

Montane rainforest

Montane rainforests are usually less than 15 m tall and dominated by pencil pine. The canopy is uneven and open with the crowns widely spaced allowing high light penetration to the lower levels of the forest. The understorey is a dense low shrubbery of coniferous species with deciduous beech, scoparia and yellowbush. Montane rainforests are restricted to highland situations such as the Walls of Jerusalem, Mt Field and the Central Plateau.

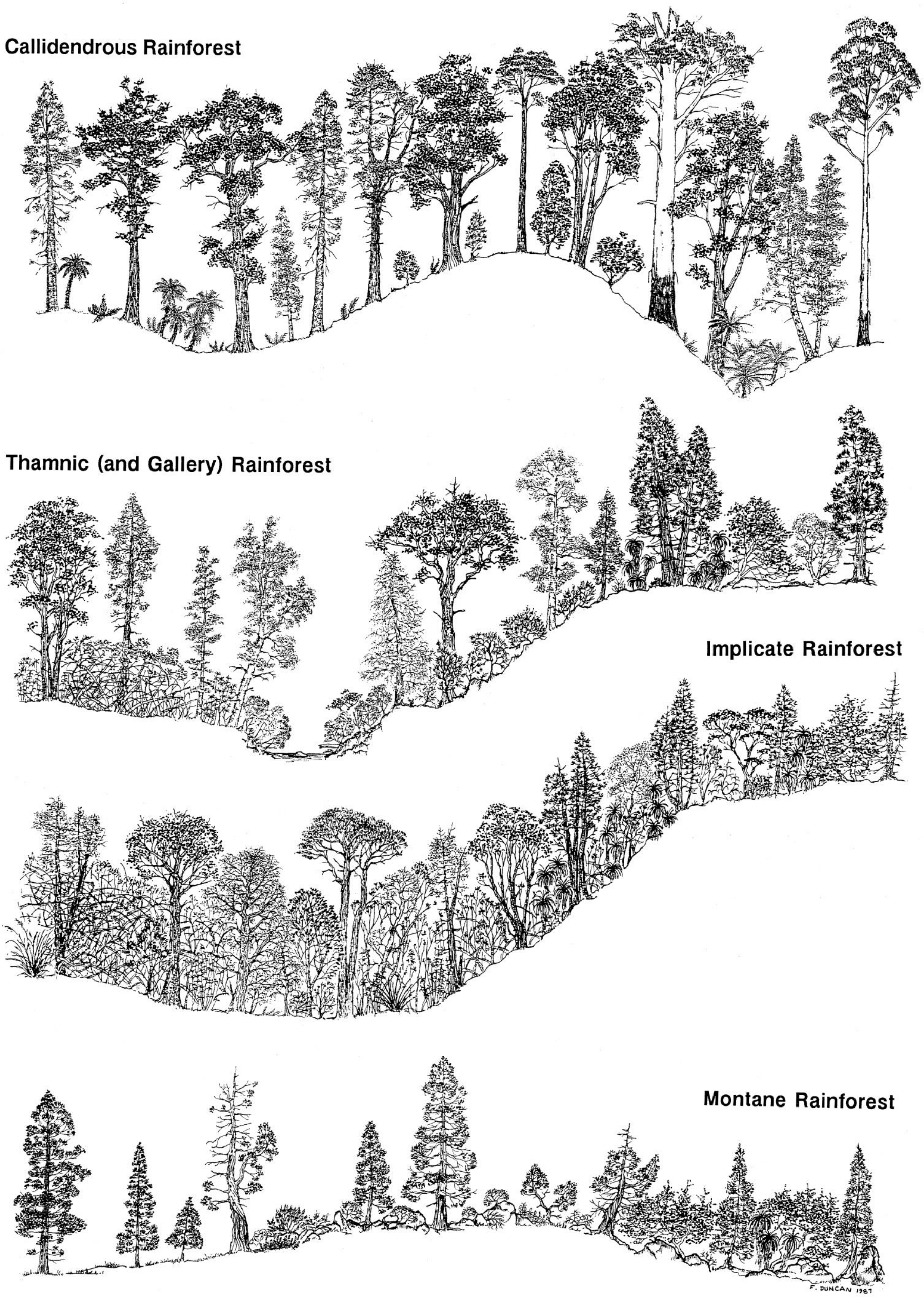


Figure 1: Classifications of Tasmania's cool temperate rainforest. Images courtesy of Fred Duncan.

2.1.2 Further classification

These five broad rainforests types can be further subdivided into different plant communities using a number of different methods. Rainforest communities can be split by their dominant canopy tree species and overall structure into broad Regional Forest Agreement (RFA) communities, or by their species composition according to the descriptions in [TASVEG](#) (Harris and Kitchener 2013), or according to the floristic communities and structure as described in the [Forest Botany Manual](#) (Forest Practices Authority, 2005). The Forest Botany Manual and TASVEG both provide an equivalent RFA community for each vegetation classification in almost all situations but do not link to each other.

There is equivalency between classifications in most situations, but not always. For example, the TASVEG community *Nothofagus-Phyllocladus* short rainforest (TASVEG code RMS) is equivalent to RFA community M-, but not all M- is classified as RMS (there are five TASVEG communities equivalent to RFA community M-). The RMS community may take the form of RAIN-T1.1 or RAIN-I3.1 (or a number of others) according to the Forest Botany Manual depending on the understorey components and whether it is implicate or thamnic in form. Both RAIN-T1.1 and RAIN-I3.1 are classified as M- RFA communities (and they are two of at least 15 Forest Botany Manual floristic communities that are equivalent to the M- category of RFA communities).

The choice of method for rainforest classification will depend on the scale and purpose of the classification. Forest practices officers will complete on-ground floristic assessment of coupes using the Forest Botany Manual, which delivers floristic conservation priority information (required for completing Forest Practices Plans) as well as an RFA community equivalent. Consequently, for the purposes of this Guideline, the silvicultural decision making framework will be presented using the RFA rainforest communities listed in Table 1.

Table 1: Regional Forest Agreement (RFA) rainforest community descriptions.

RFA code	RFA community description
M+	Callidendrous and thamnic rainforest on fertile sites
M-	Thamnic rainforest on less fertile sites
X	King Billy pine forest
PP	Pencil pine forest
PD	Pencil pine with deciduous beech forest
H	Huon pine forest
F	King Billy pine with deciduous beech

2.2 Distribution

In Tasmania, cool temperate rainforest occurs from sea level to alpine areas in patches across the entire state (Figure 2). It is most extensive in the north-west, where it occurs adjacent to and amongst mixed forest patches. Rainforest patches are more fragmented where scrub and buttongrass moorlands increase on the west coast and in the south-west. In drier areas of Tasmania, rainforest is found in sheltered wet gullies.

Rainfall is the main environmental factor that determines the distribution of rainforest. Suitable rainfall conditions are an annual rainfall of more than 1000 mm per year and a summer rainfall of at least 25 mm per month (Jackson 1968).

Disturbance history, such as Aboriginal land management and burning practices, and major historical disturbance events such as intense wildfires, have also affected the present day distribution of rainforests. Soil fertility and altitude largely determine the type of rainforest found in any particular place (Jarman *et al.* 1991).

Most callidendrous rainforests are found on more fertile soils, such as those derived from basalt in the north-west. Thamnic and implicate forests are found mostly in the west and south-west. Thamnic forests tend to occur on soils of medium to low fertility, such as those derived from dolomites and Precambrian sediments. Implicate rainforests are often found on very poor soils derived from quartzites (Jarman *et al.* 1991).

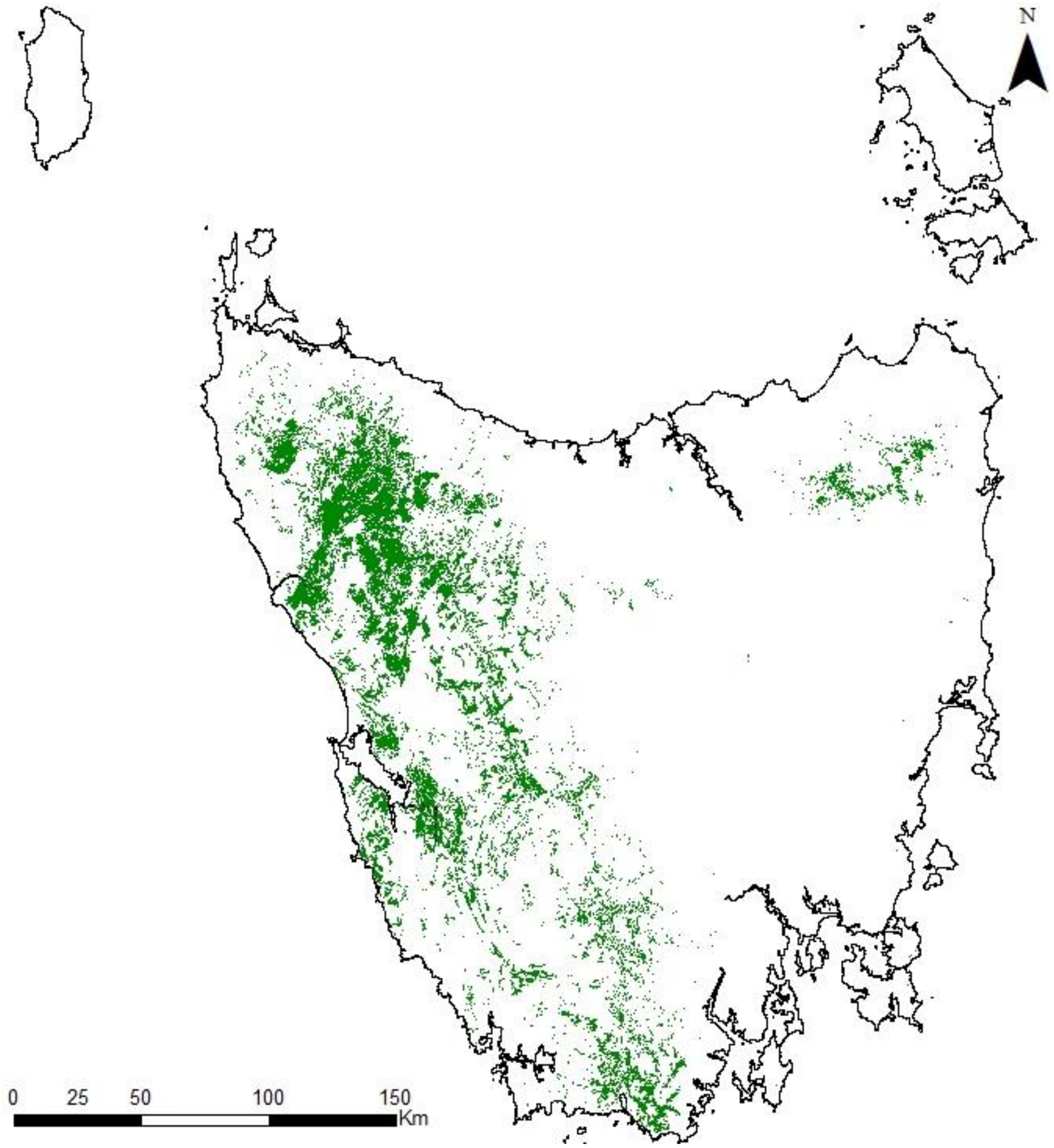


Figure 2: The approximate distribution of rainforest RFA communities in Tasmania according to RFA mapping in 2000. RFA Rainforest community types shown in green in this figure are all those listed in Table 1.

2.3 Huon pine ecology

Huon pine is endemic to Tasmania. The current extent of Huon pine in Tasmania is the remnant of a wider original range which has been substantially reduced by mining, flooding, fire and timber harvesting since European settlement (Peterson 1990). It is now found in the state's west and southwest, from the Huon River catchment to the Pieman River catchment, mainly along the banks of rivers but also in several rainforest communities, most often in thamnic, implicate and gallery forms. It occurs from sea level to 800 metres elevation, but mainly below 150 metres. Huon pine prefers moist and wet conditions, along riverbanks, lakeshores and swampy locations. It is particularly sensitive to fire and drought.

Huon pine is one of Australia's longest lived tree species. Individual trees up to 2 500 years old have been recorded. It has a very slow growth rate (from 0.3 to two millimetres per year in diameter). It is estimated to take an average of about 1 000 years to reach a height of 30 metres and a diameter of one metre. Buried Huon pine logs can be found in some areas – these logs may have been buried for thousands of years and through dendrochronological studies, they can provide valuable scientific information.

The harvest of live Huon pine is not recommended.

Due to the extremely slow growth rate of Huon pine, and previous harvesting history, this species is not recommended for live harvesting. The focus in this Guideline is therefore on the salvage harvest of dead Huon pine timber.

CHAPTER 3. Planning rainforest silviculture

3.1 Suitability of rainforest types for harvest

Rainforests on fertile sites are most suitable for low volume, selective harvest of some Tasmanian rainforest species for three main reasons:

- these forests are floristically simple and their major species have reliable regeneration pathways;
- growth rates are reasonable and sites can be managed to reduce any potential site degradation problems, and;
- wood quality and form are usually relatively good.

Rainforests on fertile sites are usually classified as M+ rainforest RFA communities, and:

- occur at low to moderate altitude;
- comprise callidendrous or better quality thamnic forest;
- contain a moderate to high myrtle density, and;
- contain medium to large diameter trees.

These guidelines provide prescriptions for partial harvest and regeneration of these forests only.

Short callidendrous, implicate and most thamnic forests are usually classified as M- RFA communities (Hickey et al. 1993). They occur predominantly on fibrous peat soils over infertile parent material. Many M- rainforests, rainforests in fragile habitats (i.e. montane/alpine) and rainforest on poor soil quality sites are not suitable for wood production, and therefore must be assessed on a case by case basis. Reasons for this include:

- regeneration is more complex due to greater species diversity than in rainforests on fertile sites;
- some M- rainforests have high value as a leatherwood nectar resource for apiarists;
- soils are generally poor and often peaty and disturbance can lead to site degradation;
- forest growth rates are extremely slow, and;
- harvesting of these forests is often not commercially viable.

However, in M- rainforests where celery-top pine is abundant, wood production can be viable (Hickey and Felton 1991). Although myrtle is usually the most abundant tree, it generally contains too much defective wood on these less fertile sites, to yield significant sawlog. Celery-top pine is the major sawlog species from most M- rainforests, although its occurrence is sporadic (Forestry Tasmania, 1998). If harvesting of these forests proceeds, then it should be confined to selective harvesting for sawlogs only.

Huon pine, which can occur as an occasional species within various rainforest community types (usually within RFA community M- rainforest), or as the dominant species in Huon pine rainforest (RFA community H), is a slow growing, very long lived, high value timber, which has been historically overharvested. It is therefore treated as a special case, and must be assessed for harvest using different criteria, and harvested using different silvicultural prescriptions, than other rainforest types. Huon pine specific harvesting (section 3.3.3) and regeneration techniques (section 4.5) are presented separately to other rainforest types in this document.

3.2 First stage assessment and silviculture selection

The first step in planning for rainforest silviculture is to identify areas likely to be suitable for harvesting that warrant further on-ground inspection. To do this, a desktop assessment can be completed using geospatial information to predict likely rainforest community distribution. The publicly available special species timber spatial layer (Department of State Growth, 2019) is a useful indicative tool for this purpose, or forest managers may use PiType maps. Such geospatial information is predictive only, and can be used to broadly identify potential areas where rainforest may be found, but these must be refined by on-ground assessments of vegetation community and site characteristics before any silvicultural planning can be commenced.

On-ground assessments by an experienced forest practices officer should include mapping of the vegetation communities present, and determination of their suitability for timber harvesting according to various site factors. None of the ‘special species’ timbers are currently listed as threatened species at a state or Commonwealth level, but may be components of threatened native vegetation communities as listed in Schedule 3A of the *Nature Conservation Act 2002*. There are some restrictions on the harvesting of threatened native vegetation communities under the *Forest Practices Act 1985*. It is recommended that on-ground mapping of the vegetation communities is completed using the Forest Botany Manual (Forest Practices Authority, 2005) which will deliver equivalent RFA communities, as well as identify vegetation communities with a priority for conservation (e.g. threatened native vegetation communities). Once a suitable RFA community type has been identified, the selection of an appropriate silvicultural system can occur.

The decision tree in Figure 3 gives general guidance on the suitability of various Tasmanian rainforest RFA communities for silviculture, and a suggestion of the most appropriate silvicultural method for harvesting. This is a first stage assessment of suitability only – any harvesting proposal will be subject to further planning, site specific factors, assessments of natural and cultural values, as well as land manager and permit approvals. Information gathered in this planning stage will assist in the development of a forest practices plan (FPP), required for the harvesting of rainforest timbers in most circumstances.

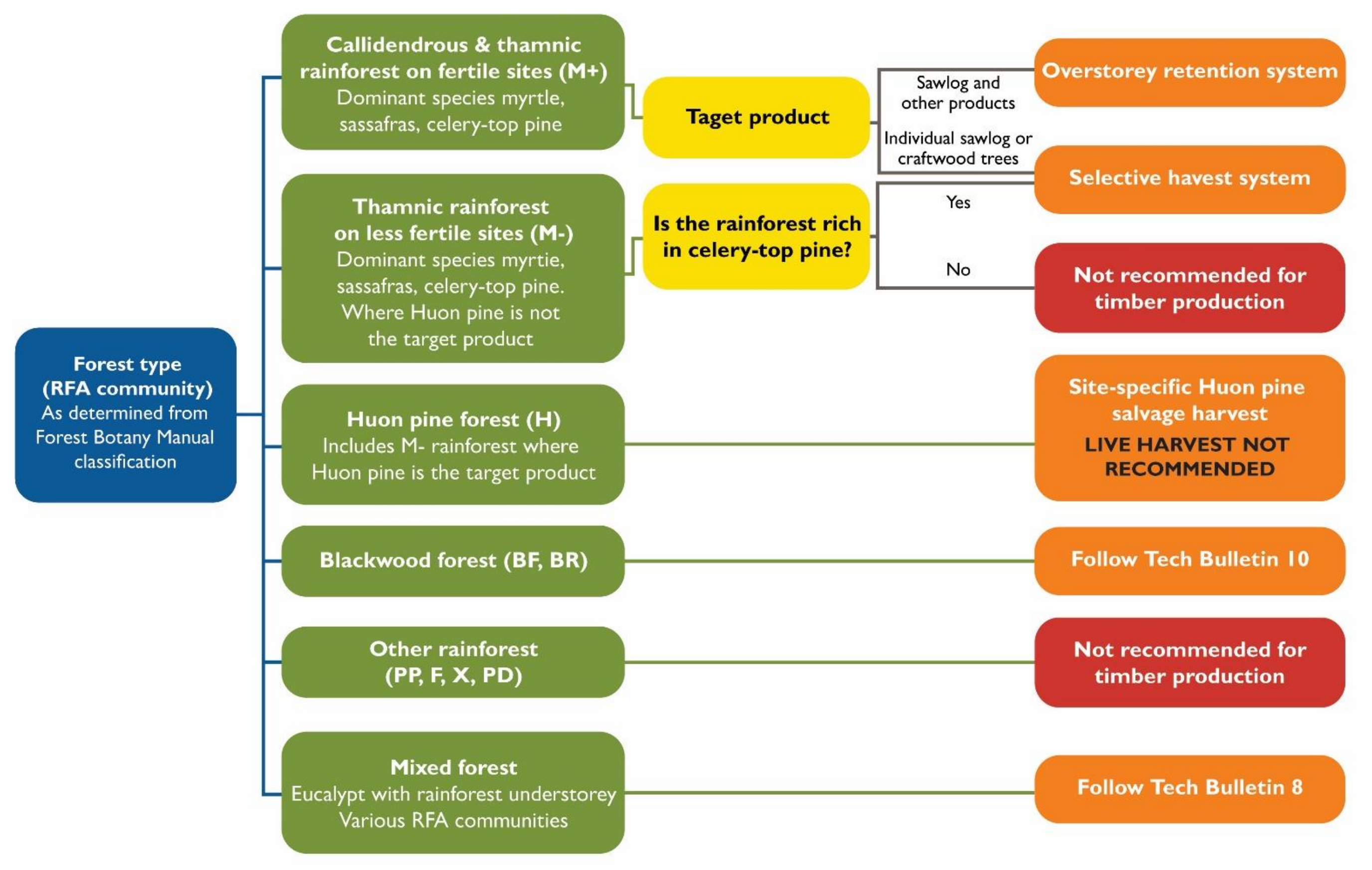


Figure 3: General guideline to the selection of an appropriate silvicultural system

3.3 Silvicultural systems

The choice of silvicultural system is influenced by rainforest type, site conditions, forest condition, market factors, economics, community attitudes and myrtle wilt levels. More vigorous regeneration will be obtained using an overstorey retention system where more of the sawlog and trees targeted for other products are removed. This also gives a higher commercial return from the harvest. However, it is only suitable for fertile sites, and the structure of the forest is significantly altered such that the regenerating forest may be more even-aged than the previous one.

Harvesting with a selective harvesting system results in a regenerating rainforest more closely resembling its original form (North Barker Ecosystem Services, 2019). Whilst selective harvesting retains the original stand structure and most aesthetic values, forest productivity is low as few large trees have been removed, and regeneration grows slowly under the heavy shade.

For both overstorey retention or selective harvesting systems;

- the myrtle seed cycle should be monitored using the method described in Appendix A (this is particularly important if harvesting a sequence of coupes in an area with a fairly high intensity harvest);
- all patches of existing regeneration and advance growth should be retained as they represent many valuable years of seedling establishment and growth;
- good crown health and sound footing is important when selecting seedtrees, as the trees must be able to survive for up to four years to provide seed. Seedtrees do not need to have sawlog form;
- damage to retained trees should be minimised to reduce mortality due to myrtle wilt;
- disturbed seedbed should be created where regeneration is required, and;
- fire should be excluded.

Other silvicultural systems (including strip felling, shelterwood and various forms of clearfelling) have been trialled in rainforests in the past, and are deemed as largely unsuitable for use in most rainforest communities (Hickey and Wilkinson, 1999). Such systems have resulted in higher levels of myrtle wilt, poorer regeneration and a loss of structural diversity (Hickey and Wilkinson, 1999, North Barker Ecosystem Services, 2019).

3.3.1 Overstorey retention

Use of the overstorey retention system in rainforest is generally not recommended.

The overstorey retention system is a higher impact system than selective harvesting. Regeneration establishment takes place over a shorter period, seedling growth is faster because of greater light availability, and a more even-aged forest results. To maximise growth of the regeneration it would be ideal to remove the overstorey about 5 to 10 years after harvesting. This silvicultural system would then be described as a shelterwood system. However the depletion of the retained trees by mechanical damage during harvesting, myrtle wilt, windthrow and exposure combined with their often low commercial value usually results in an overstorey removal harvest being unnecessary or impractical, so it is not recommended. Healthy surviving seedtrees also have value as old growth structures which have biodiversity and aesthetic values.

Overstorey retention harvesting is the silvicultural system most suitable for myrtle dominated rainforest on fertile sites.

Where sawlog and trees for other timber products are harvested, retain an overstorey of 30 healthy, evenly spaced trees per hectare (Figure 4):

- with at least 50% to be evenly spaced myrtles, and;

- with the remainder to include all tree species such as sassafras and leatherwood, and;
- avoid damage to retained stems to minimise myrtle wilt, and;
- conduct multi-age rainforest regeneration surveys as specified in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010). The first survey should occur three years after the completion of harvesting.

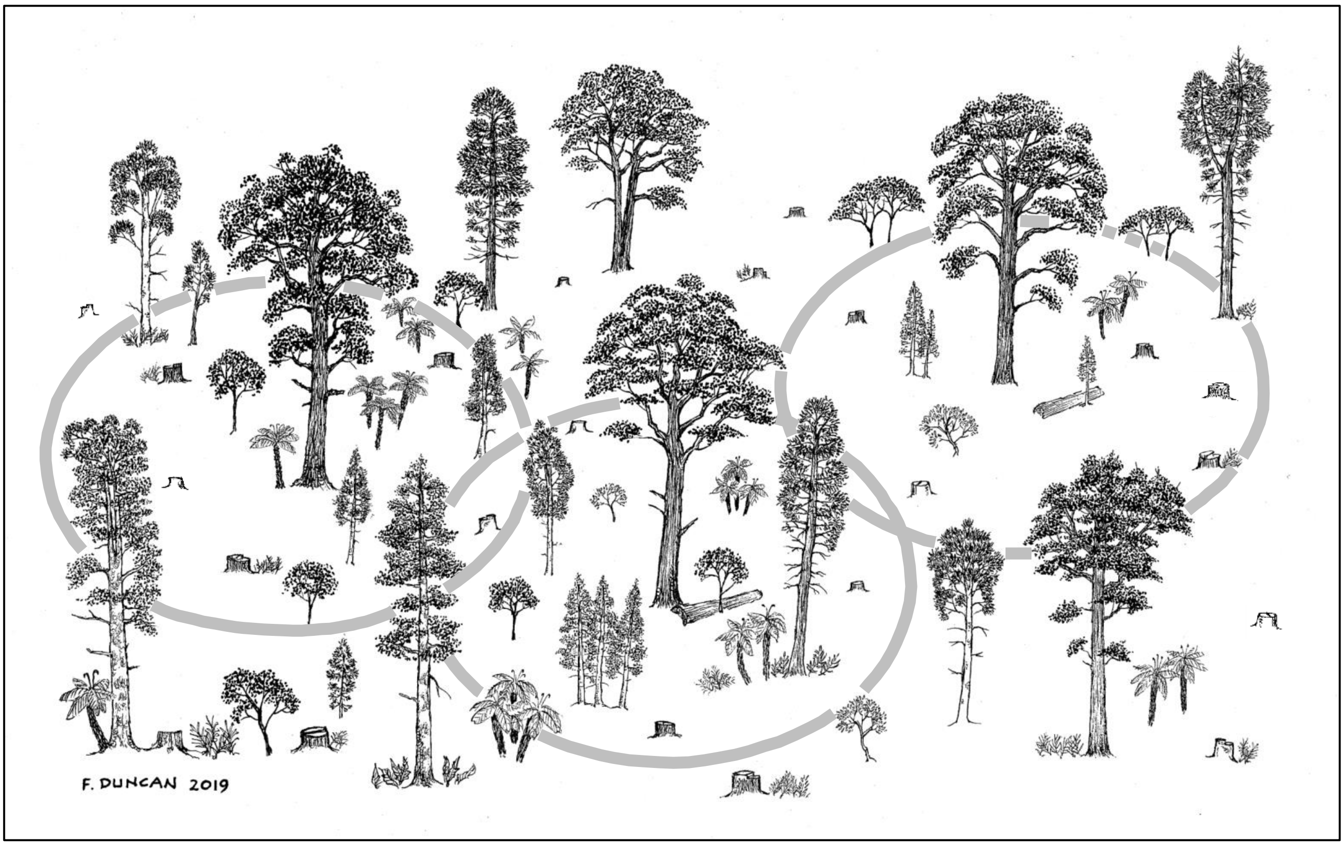


Figure 4: Overstorey retention: Retain myrtle seedtrees plus shelter trees of any species to give a total of 30 trees per hectare at 15 to 20 m spacing (approximate spacing is indicated by grey circles). Images courtesy of Fred Duncan.

3.3.2 Selective harvesting

Selective harvesting is generally considered the most suitable harvesting system for rainforest.

Selective harvesting, where specific trees are targeted, is a harvesting technique most suitable for myrtle dominated rainforest on fertile sites and shorter thamnic rainforest rich in celery-top pine on less fertile sites.

Selective harvesting is a lower impact system which more closely approximates natural gap regeneration of the rainforest but also increases the incidence of myrtle wilt above the natural background level. This may result in large open gaps which are not regenerated in the short term. Regeneration relies on the non-commercial stems providing both seed and shelter but will only occur where a seedbed is exposed. Regeneration establishment generally occurs within one to five years and the result may be patchy, depending on seedfall, seedbed and light availability. Partial canopy retention helps to maintain some of the aesthetic and structural components of the rainforest unless a localised wilt epidemic occurs.

Where individual tree selection occurs primarily for sawlogs, veneer or craftwood (Figure 5):

- retain all non-sawlog trees to provide seed and shelter for regeneration;

- avoid disturbance to areas containing non-sawlog stems;
- to avoid canopy gaps greater than 30 m in diameter, retain myrtle seedtrees on a 15 to 20 m spacing, and;
- conduct multi-age rainforest regeneration surveys as specified in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010). The first survey should occur three years after the completion of harvesting.

Where the objective is to harvest the commercial celery-top pine;

- remove selected sawlog trees while minimising damage to the peat layer and remaining vegetation;
- retain myrtle and leatherwood stems;
- retain all advance growth regeneration;
- protect from fire, and;
- conduct multi-age rainforest regeneration surveys as specified in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010). The first survey should occur three years after the completion of harvesting.

Germination of celery-top pine will occur from ground-stored and bird-dispersed seed but growth rates will be extremely slow.

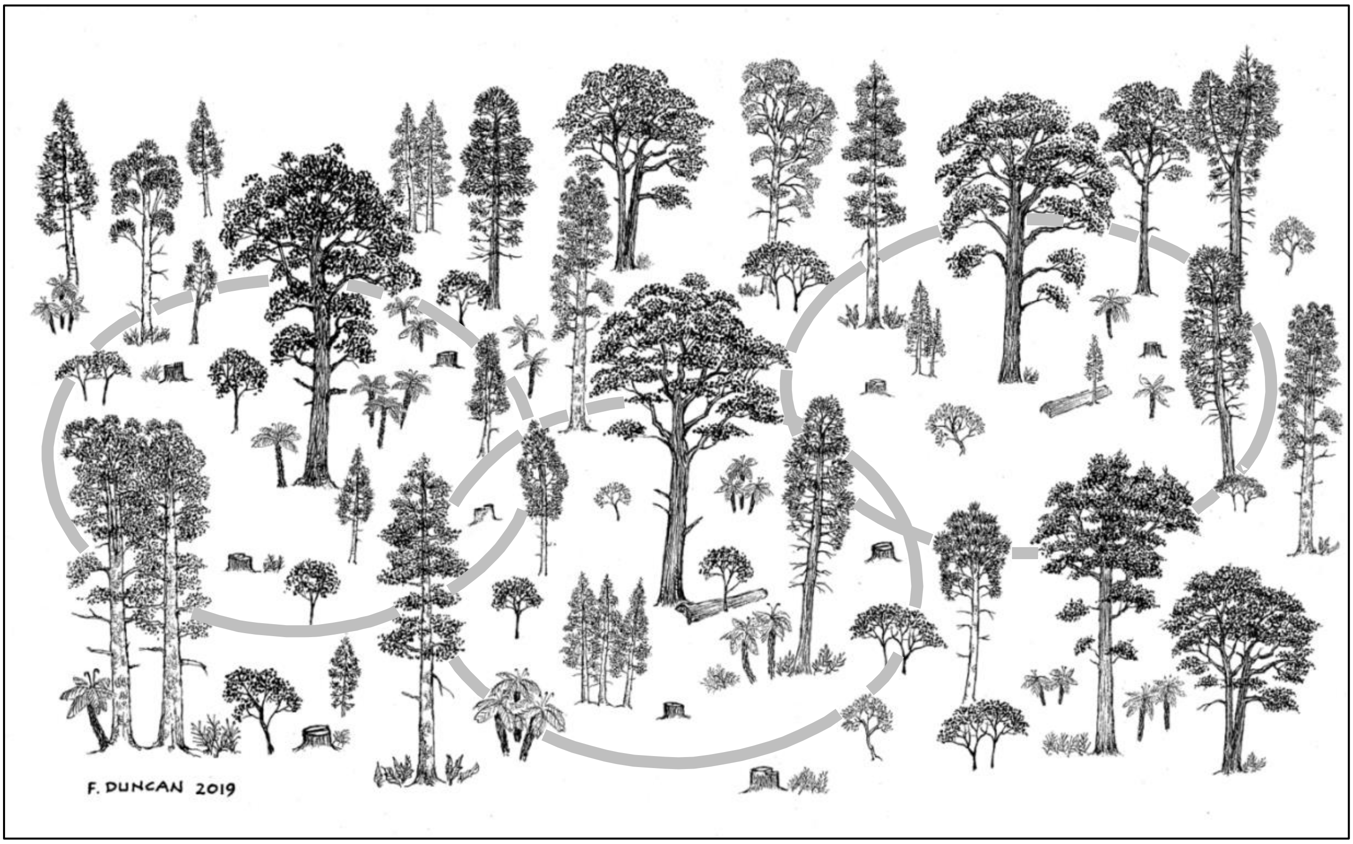


Figure 5: Selective harvesting: Retain non-sawlog trees to provide seed and shelter. To avoid canopy gaps greater than 30 m, retain myrtle seedtrees at 15 to 20 m spacing (approximate spacing is indicated by grey circles). Images courtesy of Fred Duncan.

Note that in both overstorey retention and selective harvesting systems, some lower value logs will arise from the heads of sawlog trees and from felled trees that have the outer appearance of sawlogs but, when felled, have excessive levels of internal decay.

Note that the seasonal availability of leatherwood nectar is important to Tasmania's apiary industry. It is recommended that leatherwood nectar resources are considered in the preparation of a Forest Practices Plan.

3.3.3 Huon pine harvesting

Due to the ecology and harvest history of Huon pine, the harvest of live (green) Huon pine is not recommended, unless incidental.

The harvest of Huon pine should focus on the extraction of salvage timbers only (i.e. hydro storages, rivers, standing fire damaged stags), subject to requirements of the *Forest Practices Act 1985* and *Forest Practices Code*, landowner and land manager permissions and any required permits (e.g. access permits, local government permits, etc). The salvage of Huon pine may provide a valuable resource, but extraction should be carefully planned and managed.

The aim in such harvest operations is to remove merchantable dead Huon pine from a designated area with minimum damage to the associated vegetation, leaving all live Huon pine to maintain the local genotypes on site and allow for continued regeneration into the future. To ensure ongoing regeneration of Huon pine after salvage harvesting, the following principles apply;

- Particular care should be taken to protect from damage any live Huon pine seed trees, advanced growth, or trees within 10 m of a headwater stream.
- Damage to other species on site should be minimised.
- Existing snig tracks should be used for harvesting if required (unless they contain valuable advanced growth).
- Areas not containing merchantable dead timber should be left undisturbed.
- Helicopter harvesting may assist in minimising damage to retained vegetation in sensitive environments but must be assessed for other impacts (e.g. disturbance to nesting eagles).

Huon pine is known to successfully regenerate vegetatively from fallen stems (Hickey and Felton 1991). Seedling regeneration also occurs, but is presumed to be less important. Where damage to live Huon pines has occurred, natural regeneration should be encouraged. If necessary, natural regeneration may be supplemented by the planting of nursery grown seedlings, using the methods outlined in section 4.5. The effort required to restock a site to the standard for Huon pine can be determined by carrying out regeneration surveys, as specified in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010).

CHAPTER 4. Regeneration techniques

4.1 Natural rainforest regeneration

Myrtle, leatherwood and sassafras are able to regenerate, more or less continuously, in small canopy gaps in undisturbed rainforest (Read and Hill 1988). Myrtle may show little regeneration under an unbroken canopy, particularly if the seedbed is poor due to excessive litter or fern layers. Leatherwood and sassafras are less affected by adverse conditions for seedling establishment because of their higher frequency of vegetative regeneration.

Although sassafras is the most shade tolerant species (Read 1985) and might be expected to eventually dominate the rainforest canopy, it often fails to regenerate from seed, probably due to summer desiccation (Read and Hill 1988) and its high palatability to browsing mammals (Hickey 1982).

The rainforest conifers often show population structures that suggest regeneration has been episodic, presumably following large-scale disturbance, which leads to establishment over some decades followed by a reduction in further recruitment as the canopy closes. Such regeneration has been described by Barker and Kirpatrick (1994) for celery-top pine; Gibson and Brown (1991) and Shapcott (1991) for Huon pine; and Cullen (1987) for King Billy pine.

Celery-top pine regeneration is favoured by catastrophic disturbances, including fire, but it is also able to regenerate, to some degree, with minimal disturbance where it shows a preference for elevated sites including logs, buttresses and old stump mounds (Barker and Kirkpatrick 1994).

4.2 Overview of regeneration techniques following harvesting

As a lighter harvesting system, selective harvesting results in a denser stand structure remaining after harvest than a forest harvested under an overstorey retention system. This difference in stand structure post-harvest influences the techniques used for regeneration of the forest.

Each of the major rainforest tree species has its own regeneration strategy. Some rely on sporadic heavy seedfall, some on frequent light seeding, while other species favour vegetative reproduction. Common to all rainforest species is the ability to regenerate without broadscale disturbance such as fire. This should be taken into account when planning for regeneration after harvesting.

Successful regeneration of rainforest after harvesting depends on five major factors:

- good seedfall and germination;
- adequate shelter;
- suitable seedbed;
- sufficient light, and;
- protection of seedlings from disease, weeds, browsing and fire.

Conducting post-harvesting monitoring can help to determine which of these factors require action to achieve good regeneration. If carried out, monitoring should include assessments of the seedbed, browsing severity and seedfall. This process is detailed in Appendix B.

4.2.1 Seedfall and germination

Adequate seedfall for regeneration after rainforest harvesting is achieved by retaining seed trees with healthy crowns, particularly of myrtle, which is the dominant rainforest species. Myrtle seedfall is sporadic, and heavy myrtle seeding (a mast year) can be expected every 2 to 4 years. Myrtle regenerates readily from recently shed seed, though the seed appears to be short-lived and does not store well. Field trials have shown that myrtle seed is unlikely to survive and germinate in the following season (Howard 1973). Flowering occurs in October/November and the main seedfall period is from January to May, peaking in February/March (Hickey *et al.* 1982, Appendix A). Myrtle seed is borne in fruiting bodies as shown in Figure 6.

(a) fruit (b) seeds (c) seeds (magnified)

Figure 6: Myrtle leaves and flowers. Photos courtesy of Rob Wiltshire, UTAS.

The majority of myrtle seed falls within 20 m of the seed source and therefore seedtrees should not be more than 40 m apart (Hickey *et al.* 1982). A seedtree retention rate of 10 -12 live healthy trees per hectare at the time of seedfall (approximately 30 m x 30 m metre spacing) adequately covers the area and makes some allowance for variation in spacing, availability of suitable trees etc. In general 15 trees per hectare should be retained as a seed source to allow for losses due to windthrow, myrtle wilt and poor seed crops. Additional trees should also be retained to provide adequate shelter for young regeneration.

Ideally, seedfall should be monitored at peak flowering and seeding times (Appendix A) so that the occurrence of mast seed years can be roughly predicted, and harvesting can be planned to immediately precede a mast seeding event. Otherwise, retained seed trees may need to survive for up to four years after harvesting before a mast seed year occurs. Studies of myrtle wilt incidence in harvested areas have shown that initial seedtree mortality from wilt and windthrow is highly likely (Packham 1991, Kile *et al.* 1989, Jennings and Hickey 2003), and numbers of retained seedtrees should be sufficient to allow for this mortality. Harvesting supervisors must ensure that contractors are properly trained in seedtree selection and retention, and that they take care not to damage retained trees.

Sassafras produces seed consistently each year but also relies heavily on vegetative reproduction. Flowering occurs in August and September and seed is shed from late December to March, peaking in January/ February. The seed is light and fluffy (Figure 7) and can be windborne over long distances, although most falls immediately under the seed source (Hickey *et al.* 1982). Germinative capacity of sassafras seed is generally low (Hickey *et al.* 1982). Sassafras tends to replace itself by coppicing in undisturbed forest, and coppice regeneration has also been observed following harvesting (Hickey *et al.* 1982).

(a) sassafrass leaves

(b) fruit bodies and fluffy seeds (magnified)

Figure 7: Sassafras leaves, fruiting bodies and fluffy seeds. Photos courtesy of Rob Wiltshire, UTAS.

At low to moderate altitudes, myrtle and sassafras germinate in autumn, within one or two months of seed release (Read 1989). At high altitudes (over 900 m), myrtle germination does not occur until spring (Howard 1973, Read 1989). The germinative capacity of myrtle appears to decrease with increasing altitude. Hickey *et al.* (1982) showed 15% lower peak germinative capacity for myrtle at Pipeline (480 m) than at Sumac (200 m) during two mast seed years. This is consistent with a decrease in seed viability with increasing altitude in Victoria as reported by Howard (1973), and a similar trend in New Zealand for *Nothofagus menziesii* observed by Manson (1974).

Celery-top pine seed production fluctuates from year to year although some seed is produced each year. Seasons of good seedfall often correlate with mast seed years of other rainforest species (Read 1989). Most seedfall occurs from January to June. Barker (1992) found that the timing of seedfall varied between years, and that small amounts of seed continued to fall until September during 1989 (a rainforest mast seed year). It appears that the retention of celery-top pine seedtrees is not necessary for regeneration purposes as celery- top pine seed is both ground-stored and bird-dispersed. The small hard black seeds are partially enclosed within a fleshy receptacle (Figure 8). Birds eat this fleshy fruit and can disperse the seed over long distances.

Celery-top pine germinates sporadically from ground-stored seed. Seedlings establish well if the peat is lightly disturbed but germination is intermittent and may continue for several years. The pattern of seed dormancy of celery-top pine may be similar to that of native pepper, a species which often invades disturbed forest and also has seeds that are commonly bird dispersed (Read and Hill 1983). It is likely that some dormancy mechanism is necessary to survive bird dispersal (Read 1989). The conditions which trigger germination are not understood, but some germination has been obtained from watered soil samples kept in a shade-house for periods of one to two years. All advance growth seedlings and regeneration should be retained to maintain an uneven-aged structure and to provide a future seed source. It is important that retained trees sustain minimal damage during harvesting.

(a) celery top pine leaves

(b) fleshy fruit with emergent seeds (magnified)

Figure 8: Celery-top pine leaves and fleshy fruit with emergent seeds. Photos courtesy of Rob Wiltshire, UTAS.

4.2.2 Shelter

Rainforest species germinants are susceptible to summer drought. They rarely survive their first or second summer in clearfell areas if they germinate on logs or a thick litter layer or in open gaps with no shade. The good-quality rainforest sites tend to have free-draining soils and the poorer quality sites are often on gravels and peats. Most sites dry out very quickly once the vegetation layer is removed. Shelter trees need to be retained after harvesting to prevent loss of the regeneration through drought.

In addition to trees retained as a myrtle seed source, a minimum of 15 additional trees per hectare of any species should be retained. These shelter trees also provide a seed source for species other than myrtle. In areas where leatherwood is present, leatherwood trees be amongst those retained for seed and shelter to provide a continued flowering presence for nectar dependant species.

Adequate shelter will generally be provided by the remaining stems where selective harvesting occurs. Additional disturbance or removal of non-commercial species to create seedbed should not be required. Where rainforest harvesting occurs at higher altitudes, more shelter is required to protect the young germinants from frost.

Celery-top pine seedlings are shade tolerant and require some shelter for early survival. Their growth rates are very slow and the seedlings remain susceptible to drought for several years. Because M- forests contain a high proportion of poorly formed and defective stems there are usually ample trees retained for shelter (Hickey and Felton 1991). However, disturbance or removal of the peat layer overlying these infertile soils during harvesting has the potential to produce serious degradation and erosion of these sites. These impacts are reduced if low intensity harvesting is carried out.

4.2.3 Seedbed

Regeneration of rainforest tree species is best where a disturbed seedbed is provided. Research trials have shown that myrtle and leatherwood seedlings establish more successfully on a mineral soil seedbed than on seedbeds with a layer of litter or vegetation. Successful seedling regeneration is prevented by layers of ferns such as cat head fern or hard water fern which are common under rainforests, and dense patches of ruddy groundfern or batswing fern which colonise rainforest gaps. In undisturbed rainforest, seedling regeneration is common on root balls and mounds of soil resulting from windthrow of mature trees. In harvested areas, most myrtle and leatherwood regeneration is found on snig tracks or other places where mechanical disturbance has occurred.

Adequate seedbed may be provided by disturbance during the harvesting operation. However, if an area which has been harvested is judged to have insufficient disturbance to create a suitable seedbed or stimulate germination, then additional ground scarification may be necessary to increase the seedbed area. Monitoring of the seedbed after harvest will assist in determining the amount of scarification needed (Appendix B). If additional scarification is required, a machine can be used to disturb the humus, litter and ground vegetation. This can be done during or immediately after harvesting and may take one to two hours of mechanical disturbance per hectare. It is important that the soil is not compacted or scalped by the scarification.

In selectively harvested areas where the aim is to minimise damage and disturbance, seedbed will be provided by snig tracks only. Use of more minor snig tracks rather than a few major ones would increase the area covered, but the risk of increasing wilt in the remaining myrtle stems is very high if additional machine disturbance occurs. Selective harvesting will result in patches of regeneration where canopy gaps, ground disturbance and seedfall coincide.

Where all commercial sawlog and trees targeted for other products are removed, approximately two thirds ground disturbance is recommended (Kelly 1989) to enable adequate stocking of regeneration to cover the area. It is extremely important not to damage seed trees and shelter trees or their roots during this operation. All advance growth regeneration should be retained.

Rainforest soils which have been undisturbed for long periods of time contain few viable ground-stored seeds of competing species (Howard 1973). The seedbed remains receptive for several years unless colonised by ruddy groundfern or batswing fern. Colonisation of the mineral soil seedbed by stinkwood, dogwood, eucalypts, dollybush, cutting grass, thistles, foxgloves etc. could prevent successful establishment of rainforest regeneration. Rainforests that have been previously cut-over or disturbed, or are adjacent to other forest types or agricultural land, are more likely to support competing vegetation.

4.2.4 Light

An optimum balance between light and shade must be struck to promote seedling survival and growth for all rainforest tree species. Initial survival of rainforest germinants is best in partial shade, but the growth of established seedlings is fastest in full light. However, though full light conditions may produce faster growth, small seedlings will be more susceptible to summer drought. There is considerable variation between the rainforest tree species in their ability to tolerate shade. Read (1985) measured light compensation points of seedlings (i.e. the light intensity at which photosynthesis just balances respiration) and found that the most shade tolerant tree species was celery-top pine followed by sassafras. Myrtle and leatherwood were less shade tolerant with similar light requirements.

Research trials have shown that the maximum height growth of myrtle seedlings after harvesting is about 40 cm per year over the first two decades (Hickey and Wilkinson, 1997). The growth rate of regeneration in selectively harvested areas is proportional to the level of shading. Growth rates are very slow for seedlings under complete canopies.

Removing commercial stems to allow sufficient light to penetrate whilst retaining additional trees of any species for shelter will assist in creating an ideal growing environment. Regeneration of other species such as leatherwood will often result from seed shed from these retained trees. Where a selective harvesting system is used and the emphasis is on minimal damage and disturbance, slow growth rates must be accepted. Where an overstorey retention system has been used, there should be little problem with light availability for seedling regeneration after harvesting.

4.2.5 Protection of seedlings from diseases, weeds, browsing and fire

Myrtle wilt

Myrtle wilt is a disease caused by the fungus *Chalara australis* and is the main cause of myrtle death in undisturbed stands (Kile and Walker 1987). Surveys of undisturbed forest throughout Tasmania showed a large range in the incidence of wilt from 10-50%, but on average about a quarter of standing myrtle were dead or dying from the disease (Elliott *et al.* 1987, Packham 1991).

Damage or wounding of trees provides a direct infection site for *Chalara*, therefore mechanical disturbance such as harvesting or thinning increases myrtle wilt incidence and mortality due to wilt (Packham 1994, Elliot *et al*., 2005). This fungus can then spread through the forest at a faster rate through natural crown damage or windthrow, or below ground from tree to tree. If this process is prolonged, it will significantly reduce stand productivity and aesthetic values. Myrtle wilt epidemics can kill up to 70% of the mature myrtles and can often be avoided by minimising disturbance (J. Packham pers. comm.). Retained seedtrees, particularly if damaged, have a very high risk of dying from myrtle wilt (Elliot *et al*., 2005). Myrtle wilt levels are considered high if the number of myrtles with brown leaves in the undisturbed stand is greater than three per hectare (Elliot *et al*., 1987.

Some sites are more at risk from myrtle wilt than others. Elliot *et al*. (1987) and Packham (1991) list the predisposing factors which identify higher risk areas of forest:

- low altitude forests are more at risk than high altitude forest;
- callidendrous forests are more at risk than thamnic and implicate forests;
- stands of high myrtle density (130 to 250 stems per hectare) are more likely to suffer severe attack than those with less myrtle;
- mixed forest may be more at risk than pure rainforest of a comparable myrtle density;
- trees with a large diameter are more susceptible than trees with a smaller diameter and trees of less than 12 cm diameter at breast height (DBH) are not usually affected;
- any stand adjoining or near an area of myrtle forest which has high levels of wilt or is disturbed, has itself an increased probability of severe attack.

Mortality is likely to be higher where background levels of active myrtle wilt are high or where there has been recent disturbance within or surrounding the coupe. Myrtle trees with brown leaves are a good indicator of trees currently dying from wilt. Elliott *et al*. (1987) found that the average number of myrtle trees dying from myrtle wilt across 20 undisturbed rainforest sites in Tasmania was 1.6% of live stems per year. More recent work revised that figure down to 0.6% per year after investigating the time taken for myrtles to die (Packham 1994). Myrtle trees take from one to three years to die from wilt (Kile *et al.* 1989) and are infective for most of that time (J. Packham pers. comm.).

Though the risk of increased incidence of myrtle wilt following timber harvesting is initially high, it may not remain so. In a study of 5 Tasmanian rainforest harvesting sites, Elliot et al. (2005) reported that mortality due to myrtle wilt declined significantly and stabilised at background levels some 3-9 years after timber harvesting. Additionally, numbers of wilt affected trees must be interpreted with caution. At the Sumac rainforest trial site, individual trees previously recorded as suffering from myrtle wilt were later recorded as healthy 20 and 25 years later (North Barker Ecosystem Services 2019).

Phytophthora

Root rot is a disease which results from infection by the soil-borne fungus *Phytophthora cinnamomi*. It infects a wide range of plants causing rot of the fine feeder roots, larger roots, root collars and lower stems (Wardlaw 1990). In many species it results in death of the plant.

Generally, soil temperatures are too low under a closed rainforest canopy for the fungus to be active but it can be destructive if the canopy is removed by events such as fire (Podger and Brown 1989). Implicate and thamnic rainforests contain more susceptible species than callidendrous rainforest.

P. cinnamomi is widespread in Tasmania. In rainforest it appears to be confined to areas of disturbance. The fungus was first isolated from dying seedlings of rainforest regeneration on road verges in south-western Tasmania in 1983 (Podger and Brown 1989). Podger and Brown did not recover it from any site in undisturbed rainforest. They found the most common occurrences and severest effects were on burned or disturbed sites in implicate rainforests over infertile peaty soils.

More open communities are likely to have soil temperatures capable of sustaining infection by *P. cinnamomi*. Species in the families Epacridaceae (e.g. pandani, pinkberry, cheeseberry), Proteaceae (e.g. banksia, waratah, white waratah) and Eucryphiaceae (e.g. leatherwood) are highly susceptible (Podger and Brown 1989). Celery-top pine is also susceptible.

Management strategies are identified in the Forest Practices Authority (FPA) Flora Technical Note No. 8 (Management of *Phytophthora cinnamomi* in production forest) (Forest Practices Authority, 2009).

Weeds

Opening of the rainforest canopy (due to natural tree fall or harvesting) can provide the conditions suitable for weeds (e.g. thistles, blackberry) to establish. Weed infestation should be avoided by applying appropriate hygiene protocols for machinery, equipment and vehicles (see Weed and Disease Planning and Hygiene Guidelines, DPIPWE 2015). Introduced weeds should be controlled where necessary, in accordance with the *Weed Management Act 1999* and best practice control guides (e.g. relevant control guides on the DPIPWE website). The implementation of machinery washdown prescriptions as outlined in the FPA's Flora Technical Note No. 8 (Management of *Phytophthora cinnamomi* in production forest) (Forest Practices Authority, 2009) will also help to minimise the spread of weed seeds on harvesting machinery.

Browsing

Young rainforest seedlings are susceptible to browsing, predominantly by pademelons (*Thylogale billardierii*) and to a lesser extent Bennetts wallaby (*Macropus rufogriseus*) and brushtail possum (*Trichosurus vulpecula*). Different plant species have different levels of palatability and can be used as an indicator of browsing (Hickey 1982). Only the most palatable species (sassafras, blackwood, native currant, bushman's bootlace and heartberry) will be eaten when browsing pressure is low. As the number of browsers increases or the food supply diminishes, leatherwood, cheesewood and myrtle are eaten. Browsing pressure is very high when celery-top pine, stinkwood, cheeseberry, pinkberry, native pepper or horizontal are browsed. Where moderate levels of browsing are experienced, regeneration may still be successful but recruitment of seedlings will occur over a longer period of time.

In areas of high browsing pressure, successful regeneration of the most palatable rainforest tree species may be rare. Research trials have shown that all species have better survival and growth rates inside fenced plots. Although conditions are otherwise suitable, sassafras is often absent outside fenced areas, or is found only under logs or growing high on manferns out of reach of browsing animals. Celery-top pine seedlings are not palatable to wildlife and browsing is not usually a problem. However, in areas of high browsing pressure, planted seedlings have been browsed completely within a few days. The retention of live and healthy stems in the forest assists in providing an ongoing seed source to allow continual regeneration opportunities whilst browsing pressure varies.

Fire

Fire is not required for the regeneration of rainforest tree species. Rainforest seedlings and seedtrees are killed by intense fire and have limited mechanisms for recovery (Read, 1999). Rainforest harvesting and regeneration areas have an elevated risk from fire for at least 5 – 10 years and must be kept separate from eucalypt silvicultural systems which involve a hot slash burn.

4.3 Monitoring

Regeneration surveys should be undertaken when new seedlings are properly established. The first survey should be carried out three years after harvesting has been completed (Forestry Tasmania, 2010) so that the site is likely to have received at least one heavy myrtle seedfall. The timing of subsequent regeneration surveys will be determined by the outcome of the first survey, the timing of any subsequent works, and adverse events on the coupe (e.g. significant browsing or windthrow), quality standards reporting requirements, and the management decision of the land manager (Forestry Tasmania, 2010).

Regeneration standards are occasionally updated as more coupes are harvested and surveyed. The most current stocking standards and survey methods can be found in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010). There are no current standards for the stocking of non-myrtle trees in myrtle rainforest as the component of sassafras, leatherwood and celery-top pine in un-harvested rainforest is highly variable.

Informal monitoring on an annual basis for browsing, windthrow, myrtle wilt, seedfall, seedling growth and seedbed receptivity will assist with the understanding of rainforest silviculture. Prescriptions for future harvesting areas may be modified in response to monitoring results. Remedial treatment of any area is not economically justified, and in most cases slow recruitment will continue for many years if a partial canopy has been retained.

4.4 Growth rates and thinning

Early results from measurement plots located in dense even-aged stands of myrtle resulting from spot fires and early harvesting, suggest that at least 200 years are needed to produce myrtle trees of 60 cm dbh. Thinning may reduce rotation lengths to around 100 years (Hickey and Felton 1991) but the cost is likely to be prohibitive. If thinning is prescribed, it should be done while the trees are young and vigorous (up to 40 years of age) otherwise excessive mortality due to windthrow and myrtle wilt may result.

Trial results in vigorous 15-year-old myrtle regeneration in the Sumac rainforest have shown diameter increments of 0.3 to 0.4 cm per year for unthinned plots (50 000 to 100 000 stems per hectare) increasing to 0.8 to 1.3 cm per year for thinned plots (1 900 to 3 000 stems per hectare) for the first five years after thinning. While growth rates may improve with thinning, an economic return is unlikely – thinning of young stands is therefore not recommended.

Thinning of a patch of approximately 70-year-old myrtle forest from 1 200 to 460 stems per hectare resulted in massive mortality from myrtle wilt and windthrow. Only one third of the retained myrtle stems were alive five years after thinning. Therefore, thinning of such stands is also not currently recommended.

4.5 Regeneration of Huon pine after salvage harvesting

Every effort should be taken to protect all live Huon pines before, during and after a salvage operation, and any harvesting or regeneration contractor must be aware of the importance of protecting Huon pine seedlings and trees at all times. This may require the contractor to complete a visual inspection of proposed roadlines and/or snig tracks to identify live advance growth to avoid. These regenerating seedlings are of the local genotype and are established, sometimes having up to 100 years growth advantage over new regeneration.

Where damage to live Huon pines has occurred, particularly to seed trees and advanced growth, natural regeneration should be encouraged and protected from weeds, diseases and fire. In some cases, it may be important to supplement natural regeneration – this will be informed through Huon pine regeneration surveys. Relevant survey methods and stocking standards for Huon Pine forest are specified in Native Forest Silviculture Technical Bulletin No. 6 (Forestry Tasmania, 2010). Understocked areas can be supplemented using one or more of the following methods.

Seedling Regeneration

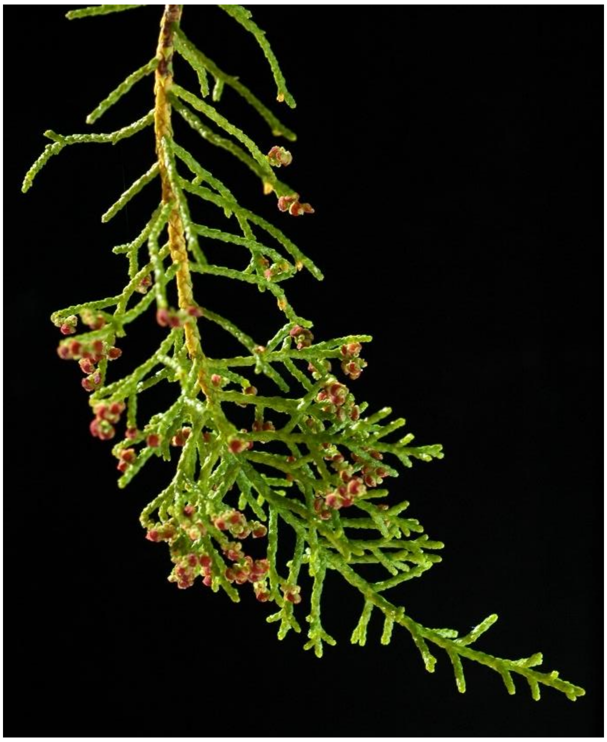
One method of regeneration of Huon pine is through seedling regeneration from natural seedfall. To promote seedling regeneration, particular care should be taken to protect healthy Huon pine seed trees in any timber extraction process.

Huon pine is mostly dioecious (having male and female reproductive organs on separate plants) and is thought to have years of high seed production (mast years) occurring approximately every 5 to 7 years (Shapcott 1991). In one study at Riveaux Creek in southern Tasmania, seedfall was observed to begin in February, peaking 8 weeks later, with the last of the seed still dropping through December in the same year (Shapcott 1991). Huon pine seed does not appear to persist in the soil beyond a few months after falling (Shapcott 1991). The differences between male and female foliage and cones can be seen in Figure 9.

Shapcott (1991) suggests that since the most effective dispersal of Huon pine seed and regeneration appears to be down water channels, stands at the headwaters of catchments represent stocks from which downstream regeneration may be possible. Particular care should therefore be taken to protect any live trees within 10 m either side of the headwaters of creeks to maximise the opportunities for natural seed dispersal.

However, regeneration should not rely solely on seedtrees for the following reasons:

- some previously cut-over areas may not have 10 seedtrees per hectare remaining;
- retained seedtrees may not reach their maximum reproductive potential for many years;
- mast seed years are infrequent (5 to 7 years);
- germination success is low, and;
- Huon pine is extremely slow growing and seedlings remain vulnerable to drought for many years.



(a) female Huon pine

(b) female seed cone (magnified)

(a) male Huon pine

(b) male seed cone (magnified)

Figure 9. Huon pine foliage and reproductive cones. Photos courtesy of Rob Wiltshire, UTAS.

Propagation of cuttings

Huon pine is known to regenerate vegetatively from fallen stems by layering and possibly from broken branchlets striking roots (Hickey and Felton 1991). Propagation of cuttings is therefore an option for supplementing the regeneration of damaged Huon pine stands.

Nursery-grown cutting stock planted at Travellers Creek in 1987 has shown good survival and growth rates. The rooted cuttings averaged 14 cm in height at planting and 40 cm four years later with the tallest plants over 90 cm high. Survival was approximately 70%.

If planning on supplementing regeneration with propagated seedlings, cutting material should be collected in winter from within the salvage harvest area and grown on at the nursery. If cuttings are taken from as many trees as possible, i.e. 10 cuttings from each of 50 trees rather than 50 cuttings from each of 10 trees, then the likelihood of maintaining genetic diversity and a mix of both male and female trees is increased. Planting should take place during the winter following salvage harvesting.

Glossary

Acronyms

DBH	Diameter at breast height
FPA	Forest Practices Authority
FPP	Forest Practices Plan
RFA	Regional Forest Agreement
STT	Sustainable Timber Tasmania (formerly Forestry Tasmania)
SSTMP	Special species timber management plan (2017)

Terms

Advance growth	Seedlings and saplings up to 20 cm dbh established prior to the current planned harvest, usually as the result of a previous disturbance (e.g. Wildfire or past harvesting). It is assumed that these trees have future sawlog potential.
Browsing	Damage to eucalypt seedlings nominally caused by possums and wallabies.
Clearfelling	The felling of all or nearly all trees from a specific area in one operation. The term applies to patches with a diameter greater than four to six times average tree height.
Coppice	Growth of a new stem or stems from the stump or base of a tree to replace a previous stem that is damaged, killed or felled
Coupe	An area of forest of variable size, shape and orientation, on which harvesting takes place. Usually to be harvested and regenerated over one or two years.
Cull trees	Trees greater than 20 cm dbh which contain no timber of commercial value.
Forest practices	As defined in Section 3 of the *Forest Practices Act 1985*: The processes involved in establishing forest, growing or harvesting timber, clearing trees or clearing and converting threatened native vegetation communities, and works (including the construction of roads and the development and operation of quarries) connected with establishing forests, growing or harvesting timber or clearing trees.
Forest practices plan (FPP)	A plan for forest operations as specified in Section 18 of the *Forest Practices Act 1985.*
Group selection	An uneven-aged silvicultural system in which small groups of trees are removed in a dispersed cutting sequence.

Mechanical disturbance	The disruption by machinery of the undergrowth and litter layers to expose the mineral seedbed, often caused during harvesting.
Mixed forest	Forest which comprises a Eucalypt overstorey over a rainforest understorey
Overstorey retention	A type of partial harvest silvicultural system where the majority of canopy trees are harvested but a proportion are retained to provide shelter and seed for the regenerating forest. The proportion of retained stems varies according to the forest type and site factors.
Partial harvesting	Harvesting systems which include the retention of some trees e.g. Advance growth, seed tree, shelterwood, group and single tree selection.
Rainforest	Forest with trees greater than 8m in height, dominated by one or more of the following tree species; myrtle, sassafras, celery-top pine, leatherwood, King Billy pine, pencil pine, Huon pine or cheshunt pine, in which eucalypts comprise less than five per cent of the canopy cover.
Regeneration	Young plants, usually of seedling size. The term may also refer to any tree crop arising following harvesting, irrespective of age, i.e. Silvicultural regeneration.
Regeneration surveys	A systematic assessment of the new crop to provide the formal record of stocking. Regeneration surveys must be timed after seedlings are sufficiently established i.e. Their future growth and development is reasonably assured, but before the opportunities for low cost remedial treatments are lost i.e. Whilst sufficient receptive seedbed remain.
Selective harvest	A harvesting system that targets a small proportion of the stand for specific products. Selective harvesting removes single trees or small groups of trees, while all other growing stock is retained.
Shelterwood	The removal of a forest stand in two cuts. At the first cut, around 30–50% of the stand is retained for 10 years or so to protect the regenerating new forest from extreme weather conditions.
Silvicultural system	A regime of operations applied to a forest to produce or enhance forest values such as wood production, water yield, wildlife habitat, soil conservation and landscape aesthetics. A silvicultural system normally comprises a management objective, a harvesting operation, a regeneration treatment and monitoring of and protection from browsing.
Site factors	The environmental factors that determine the availability of moisture, nutrients and temperatures suitable for growth and the likelihood of factors such as frost and drought.
Snig track	The track along which logs are pulled from the felling point to the landing.
Snigging	The pulling or carrying or carrying of logs from the felling point to a landing by wheeled skidders, forwarders, bulldozers, or tracked loaders.

Special species timbers	As defined in the *Forestry (Rebuilding the Forest Industry) Act 2014*; timber of the following species: Myrtle, sassafras, celery-top pine, blackwood, silver wattle and Huon pine.
Stocking	An indication of the area occupied by trees, usually measured in terms of either basal area per hectare or the percentage of sample plots that are stocked within a surveyed coupe.
Stocking standard	A measure that specifies the minimum levels of growing stock to be retained or regenerated in order to maintain productive native forests after harvesting. Technical bulletin no. 5 2010 page 70 stocking standards vary according to the forest type and silvicultural system being applied, and are described in detail in technical bulletin no 6.
Strip felling	Harvesting of alternate strips, leaving the retained strips to provide a seed source for regeneration.
Strobilus	The male reproductive organ of a species of pine (e.g. Huon pine).
Sustainable forest management	Management to maintain and enhance the long-term health of forest ecosystems while providing ecological, economic, social and cultural opportunities for the benefit of present and future generations.
TASVEG	A statewide map and vegetation classification system for vegetation communities in Tasmania, as described by Harris and Kitchener, 2013.
Tree	A woody plant with a mature height more than about 5 metres tall with usually a single well-defined stem.
Understorey	That part of forest vegetation growing below the forest canopy.
Vegetative reproduction	Relating to non-sexual regeneration of a plant, e.g. From coppice and epicormics.
Windthrow	Uprooting of trees by wind action, often caused by the trees not having a sufficiently deep root system to cope with the extra wind pressure following partial canopy removal.

Common and scientific names of plant species mentioned in this Guideline

* = not native

Common name	Scientific name
Banksia	*Banksia marginata*
Batswing fern	*Histiopteris incisa*
Blackwood	*Acacia melanoxylon*
Blackberry	*Rubus fruticosus*
Bushman's bootlace	*Pimelea nivea*
Cat head fern, (also mother shieldfern)	*Polystichum proliferum*
Celery-top pine	*Phyllocladus aspleniifolius*
Cheeseberry	*Cyathodes straminea*
Cheesewood	*Pittosporum bicolor*
Cheshunt pine	*Diselma archeri*
Climbing heath	*Prionotes cerinthoides*
Cutting grass	*Gahnia grandis*
Deciduous beech	*Nothofagus gunnii*
Dogwood	*Pomaderris apetala*
Dollybush	*Cassinia aculeata*
Drooping pine	*Pherosphaera hookeriana*
Dwarf leatherwood	*Eucryphia milliganii*
*Foxglove	*Digitalis purpurea*
Goldey wood	*Monotoca glauca*
Hard waterfern	*Blechnum wattsii*
Heartberry	*Aristotelia peduncularis*
Horizontal	*Anodopetalum biglandulosum*
Huon pine	*Lagarostrobos franklinii*
King Billy pine	*Athrotaxis selaginoides*
Leatherwood	*Eucryphia lucida*
Manfern	*Dicksonia antarctica*
Mountain teatree	*Leptospermum rupestre*
Musk	*Olearia argophylla*
Myrtle	*Nothofagus cunninghamii*
Native currant	*Coprosma quadrifida*
Native laurel	*Anopterus glandulosus*
Native pepper	*Tasmannia lanceolata*
Native plum	*Cenarrhenes nitida*

Common name	Scientific name
Pandani	*Richea pandanifolia*
Paperbark	*Melaleuca* spp.
Pencil pine	*Athrotaxis cupressoides*
Pinkberry	*Leptecophylla parvifolia*
Purpleberry	*Trochocarpa cunninghamii, Trochocarpa gunnii*
River teatree	*Leptospermum riparium*
Sassafras	*Atherosperma moschatum*
Scoparia	*Richea scoparia*
Silver wattle	*Acacia dealbata*
Stinkwood	*Zieria arborescens*
Tea tree	*Leptospermum* spp.
*Thistles	*Cirsium vulgare, Carduus tenuiflorus*
Trochocarpa spp.	*Trochocarpa cunninghamii, T. disticha, T. gunnii, T. thymifolia*
Waratah	*Telopea truncata*
Ruddy groundfern	*Hypolepis rugulosa*
White waratah (also fragrant candlebush)	*Agastachys odorata*
Whiteywood	*Acradenia frankliniae*
Woolly teatree	*Leptospermum lanigerum*
Yellow bush	*Orites acicularis, Orites revolutus*

Photographs and images

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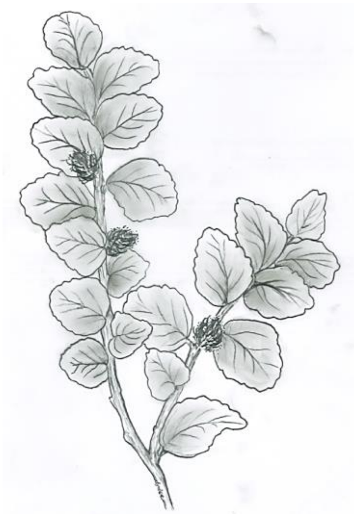
Appendix: Monitoring

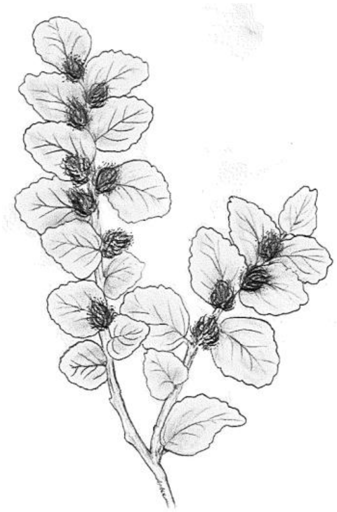
A. Monitoring the myrtle seed crop

Monitoring of the myrtle seed crop to predict a mast seeding event is the best way to plan for adequate seed levels post-harvest. If conducting monitoring, this procedure should be carried out at two sites in the region of the harvesting operation. Undisturbed, representative stands should be selected which can be revisited annually, such as rainforest reserves.

1. Select about 10 trees over 60 cm dbh with large, healthy crowns per site. These trees should be grouped around a central point or on a loose transect for ease of re-location.
2. To monitor flowering, visit the site on about 1 November each year. Carefully search the crowns for myrtle flowers with binoculars. Flowering material is inconspicuous. If flowering is obvious it probably signals a good seed year.
3. To monitor seed quantity, visit the site on about 1 February. Carefully search the crowns for well-developed seed bearing parts to confirm the original prediction. Search the ground for myrtle twigs to check seed maturity and help categorise the abundance of seed.

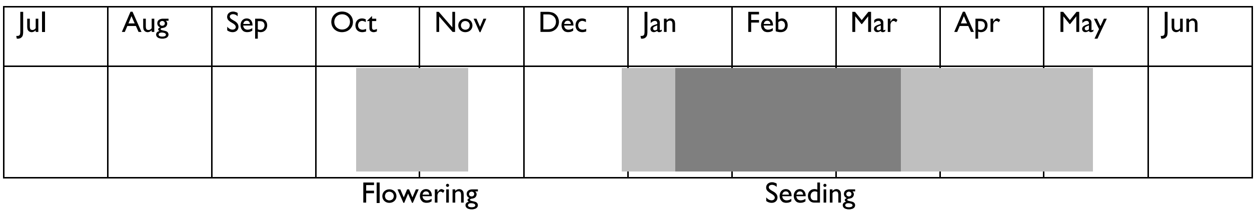


(a) Light seeding year

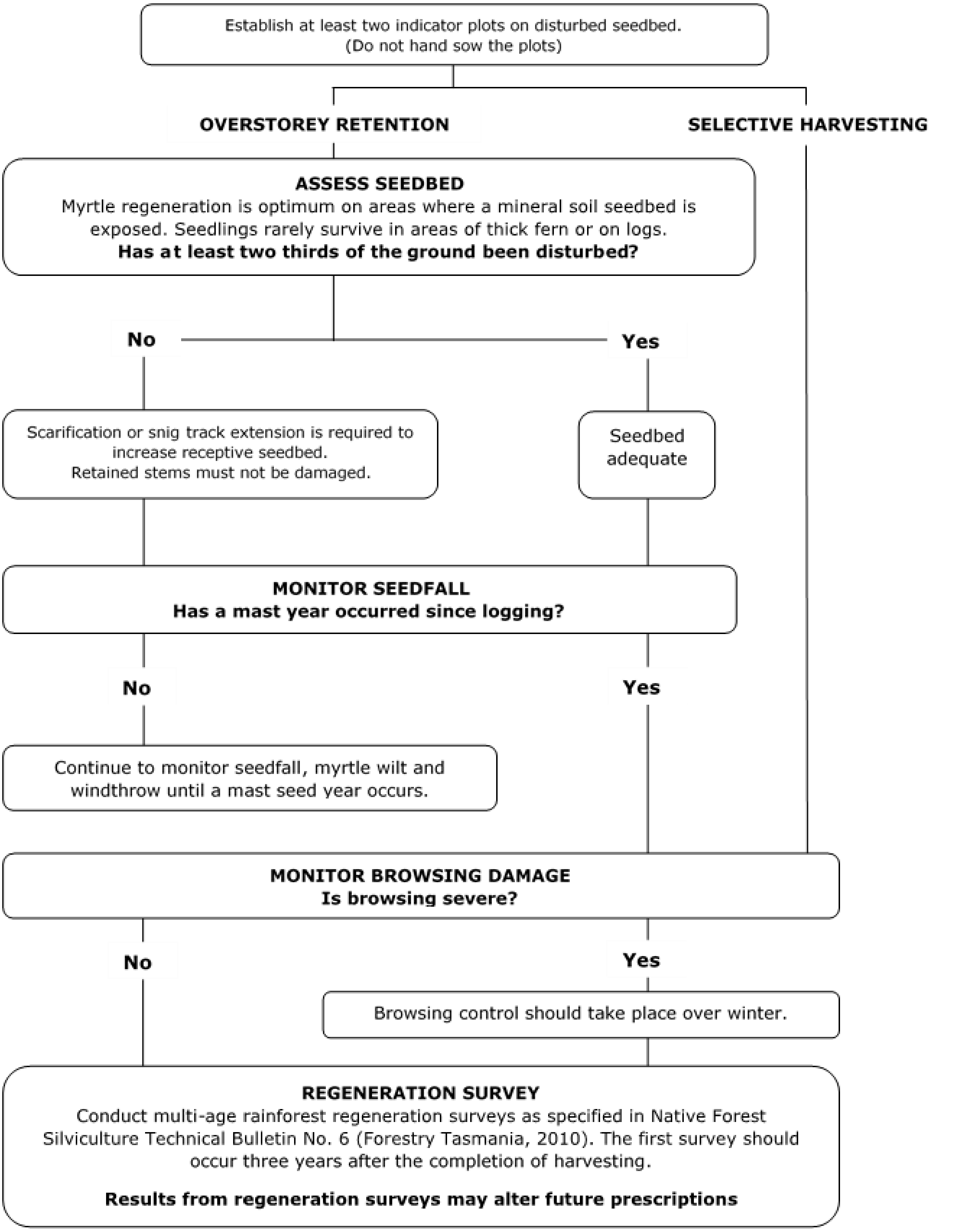


(b) Heavy seeding year

Survey times:



B: Seedbed preparation and monitoring for M+ rainforest



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