FRI/INDUSTRY RESEARCH COOPERATIVES

MANAGEMENT OF EUCALYPTS COOPERATIVE

FOREST RESEARCH INSTITUTE
PRIVATE BAG
ROTORUA

TASMANIAN FIELD TRIP

NOVEMBER 1990

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FOREST RESEARCH INSTITUTE

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Executive Summary

During November 1990 the Management of Eucalypts Cooperative travelled to Tasmania for the thirteenth meeting and a field trip. The Forestry Commission of Tasmania, a Cooperative member, were the host organisation.

This report provides details of the field trip summarising the information given at each stop by the different forest companies.

Companies and industries visited included ANM Forests Ltd, APPM Forests Ltd, Forest Resources Ltd, APPM Veneer Mill Ltd, Tiffany Furniture Manufacturers Ltd, and the Forest Commission of Tasmania.

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1 13/11/90: Moogara, Florentine Valley - ANM

1.1 Moogara

Rob Heathcoate - introduction. Dolorite is the main parent rock from which the soil is formed. It is well drained. Generally *E. regnans* is best suited to their sites. Eucalypts are planted on the best sites and pines on the drier margins. The soils are more uniform in the north west compared to southern Tasmania where there is a mix of soils.

1.2 Regnans seedling seed orchard - Moogara

Peter Volker described the trial. Moogara is a bitterly cold site in winter - snow is retained on the ground.

The 1977 provenance trials showed that the Moogara provenance was frost resistant whilst the material from the Strezleckis was not. CSIRO and APM undertook a recollection of 250 seedlots and ANM 300 seedlots. The better families have been selected - 205 families and planted in a single tree plot design replicated 20 times. Now 12 months old. When they are 5 they will be assessed for form and straightness as well as growth.

Carolyn Raymond CSIRO has developed a lab technique based on electrolytic conductivity to test for frost tolerance range -2^{o} to -18^{o}. The range of -8^{o} to -5^{o} is used for *E. nitens* to will allow the families to be ranked. Conditioning has been shown to have a strong effect - gradual cooling confers greater frost tolerance. The out of season frost may affect families differently. For *E. nitens* she has found a different ranking of families for out of season versus normal winter tolerance.

A -15^{o} frost did not kill trees. *E. globulus* just down the road at 500 m altitude was not killed by a -18^{o} frost if there is a gradual decline in the temperature thereby preconditioning the seedlings. Cold tolerance has a heritability of 0.2 - 0.3.

The trial is laid out in an old raspberry paddock which has required repeated spraying. It was cross ripped at 3m intervals then rip mounded (70cm ripping). Slim line containers were used. Pricking out leads to roots growing around the containers plus the seedlings are root bound.
There fore they have gone to open rooted stock now. However they are susceptible to root rot and fine roots are not coming away. That the rot could extend up the tree is a cause for concern

Seedlings are produced by sowing seed into trays and when 50 mm high they are transplanted into the nursery beds, developing a good mass of roots. Open rooted seedlings are larger so that they are less affected by browsing and frost and have less root deformation. They cost 20 c each.

The sequence of priority in evaluating material has been growth and yield, now frost, wood quality next. Rot susceptibility is a potential one to include. For nitens decay entering through persistent dead branches is a problem.

The trial has been sprayed for chrysomelids which were present in large numbers.

The variability of the soils ability to retain moisture in this part of Tasmania is a difficulty.

The site suitability for a species is thought to not necessarily be indicated by its natural distribution. For instance *E. globulus* may be still be finding its niche as it is only 10 000 years since the last ice age and it can occur within stands of *E. delegatensis*.

Chrysophtharta bimaculata can be controlled by a strain of *Bacillus thurengiensis*.

The chysomelid larvae cause the most damage through defoliation. New leaves are their preferred food. The lady bird is one of the most effective predators. Relative proportions of leaf oil affects palatability and there are family differences.

1.3 Maydena

Rob Heathcoate and Arnold Williams explained ANM operations. ANM produces sawlogs and veneer logs from the concession but does not use them. They are supplied to sawmills contracted to the Forestry Commission. Old growth logging is to stop in 1991. Most of the pulpwood will then come from the eucalypt regrowth areas and the pine and eucalypt plantations. They have 20 000 ha of eucalypt plantation. Aerially sown areas are regarded in a similar fashion to rainforest areas. Plantations are up to 5 times the productivity of aerially seeded regrowth areas. They have 2 000 ha of eucalypt/pine mixture.

Land ownership is <50% concession, <50% owned by ANM and 20% joint ventures. Land costs between $500 to $1000/ha.

1.4 Florentine River Valley.

Rob Heathcote described the silvicultural practices undertaken by ANM on the Crown Concession they have in the area.

Native animals (wallabies and possums) have to be controlled by 1080 poison. Wallabies can devastate a stand in three nights. In one area 100-150 wallabies were shot each night.

The annual target for harvesting from the Commissions areas is 1100ha/year. This is made up of 60% *E. delegatensis* and 20- 30% *E. regnans*. The remainder are rainforest species. The royalty is $2-$3 on old regrowth.

Aerial seeding is at 0.5 kg/ha with no filler in with the seed.

The policy is to plant *E. regnans* on ex *E. regnans* sites which accounts for 70 - 80% of the area. Rainfall is 100 cm with frequent drizzle. The altitude planted in *E. regnans* is up to 500 m asl. Above 500 m asl *E. delegatensis* is planted. If *E. obliqua* occurs naturally then it is considered to be a good *P. radiata* site.

The seed, until the seed orchard is producing, is either the best local sources (ie on the site) or from Moogara. Peter Volker intends to more intensively sample the Florentine Valley.

The *E. regnans* old growth yields 40-70% sawlogs. Veneer logs that are produced are sliced around the log to reduce the effect of kino (stay lathe). By using this technique often only a couple of sheets are rejected with an occurrence of kino.

The *E. regnans* sites when planted are expected to achieve 20 m^3/ha/annum by age 20. They are planted for pulp at 4 × 2m and not thinned.

There are some thinning trials (100, 200, and 300 s/ha) in aerially sowed stands which have been reduced to 200-300 s/ha at age 20.

Harvesting small piece size depends on bark removal. A Warratah can thin and clear fell planted eucalypt stands.

1.4.1 Insecticide spraying trial

The area had 1200-1300 t/ha removed in logging a remnant 1804 fire regen stand on the site. It was sprayed with atrazine (8 kg/ha) and planted in August 1988. Fertiliser - 100g NPK - was applied a month later. The soil is a dolorite loam and receives 75 cm of rainfall.

The insecticide tested are a synthetic pyrethroid 'ripcord' and the bacillus. Fortnightly spraying has allowed trees to grow twice the height of the control whilst the one spray treatment has trees 30% higher. There has been a 30-40% long term decrease in Chrysomellids.

Tree form can be affected by the browsing. Apical leaves are eaten during January and February. The trees then flush again. However this new growth is killed by frost leaving trees that look like cabbages.

It is hoped that insecticide spraying will not be required after the trees reach 10m. The spraying costs $25 - $30/ha.

The difference between the bacillus and the pyrethroid is that there is only a limited time when the bacillus can be used ie when the larvae are at the right stage and the weather is O.K.

Spray is best applied at the end of the third instar. Ladybirds can handle first two.

There are possibilities for breeding insect resistance. One theory is that to an insect the new growth flashes white at night and is therefore easily located. If the flush could occur early before the insects attack it may help as long as it is not killed by a late frost.

Leaf oils are another possibility. *E. nitens* is a symphomyrtus which suggests it should not be attacked. However its leaf oils are more like the monocalyptus group.

1.4.2 Establishment site (with wombat)

The site was planted in *E. nitens* and other eucalypts. It was contour ripped and mounded with a twin ripper. Hand planted in late September. Sprayed with Gesoprim.

Costs of operations

Land preparation windrowing and ripping (big stumps and logs) $650. Planting $130. Seedlings $250. Fertiliser $50-60. (10:17:8)

Atrazine and simazine are ineffective on ANM sites - no residual effect on the dolorite loam. Caragard and Ronstar best so far, whilst Gardoprim is promising.

Machine planting is better and more consistent for barerooted stock. If hand planting a root can be left exposed which is fatal.

1.4.3 Conversion of poor eucalypt regrowth.

Some areas of poor quality 20-30 year old are cleared. The trees that will not produce sawlogs or pulp are felled and windrowed before planting. Pulpwood is salvaged from larger trees. The area is ripped and mounded and then burnt in late March. A growth difference is apparent between the windrowed/cleared areas.

Operations like this increase the resource area for planting by utilising and converting the non-productive areas.

Machine planting saves $100/ha

By 2046 concession areas may be replaced by long term leases and the regrowth areas. All old growth logging to halt in 20 years.

ANM Stumpages

Old growth	$1.54

Regen	$1.98
Sawlog	$18.04
Veneer	$46

Five times the royalty is the penalty for over supply. They cut 5 000 tonnes a month. On an annual basis 30 800 is sawlogs??? and 3 600 is veneer. This latter is face grade, clear, rotary sliced, 'stay' lathe.

1.4.4 Dewhurst Rd - 1952 *E. obliqua* thinning trial

Thinning trial in *E. obliqua* regen recently thinned from 500-200s/ha. This removed 50% of the volume (140 t/ha). Damage through bruising could lead to kino and decay. Observable damage affected 6% of trees. The equipment was an excavator with a 1200 Lakohead and forwarder using 5m lengths. The material was debarked.

It was noted that in 25 year old *E. regnans* a thinning from about 500 s/ha to 300, 200 and 100 s/ha resulted in windthrow in the 100 s/ha area

2 14/11/90: Liffey and Stoodley - Forestry Commission

2.1 E. delegatensis plantation

This site was planted in *E. delegatensis* in 1980. It is abandoned farm land. In 1980 good site preparation had not been developed as standard practice so that it was probably cultivated but did not receive herbicide or fertiliser treatment. Altitude 720m. An *E. nitens* provenance trial has been planted at the site also in 1980.

A comparison of growth between *E. nitens* and *E. delegatensis* was made at another site - Maggs Mountain. This latter site was at 900 m altitude and receives lots of snow. Maggs Mountain is regarded as a good *E. delegatensis* site. However the growth of *E. delegatensis* was very poor compared with the *E. nitens*. It is a hard site and at age 4 the best had grown 2.8 m. It had been fertilised and cultivated.

2.2 Provenance Trial Details

Planted 1980. See appendix 1. The trial is replicated at Geeveston in Southern Tasmania at 150 m altitude. Possoms have damaged a couple of seedlots.

MAI hasn't peeked as yet for the best provenance (Mt Erica).

2.3 E. globulus - 1940 planting Stoodley

Details appendix 2.

3 15/11/90 Burnie - APPM

3.1 APPM Veneer Mill Burnie

Mr Geoff Gaby provided a tour of the factory which is the most modern in the Southern Hemisphere. The mill cuts 6 000 m^3 eucalypt, 500 m^3 myrtle *Nothofagus cunninghamii*, 2 00(0?) m^3 *P. radiata*, 200 m^3 blackwood and 100 m^3 other (celery top pine *Phyllocladus aspleniifolius* and sassafras *Atherosperma moschatum*).

For eucalypts 50% is recovered from the log in flitch form. Conversion to veneer is 900 m^2 per m^3 and 30 % is lost during drying.

E. regnans is the best eucalypt being softer and straighter. However it has more kino which is a disadvantage. The fact that it has no stripe is regarded as an advantage also.

Blackwood costs \$1200/m^3 off the saw, \$2500/m^3 kiln dried and sells for \$4.50/m^2 as a veneer.

Regrowth ie 50-60 year old material presents some problems. Logs are smaller. Insect damage leaves a 'worm mark' which doesn't show up if 1/4 cut but they want to cut by semi rotary saw. Because the logs are too small to 1/4 cut they must be 'crown cut'.

E. globulus is excellent for veneer while it is no good as sawn material.

E. nitens is also very good as regrowth as well as old growth material. It is very like *E. regnans* but their is concern about the persistent branching and associated insect and fungal attack.

The logs are soaked in a hot bath and a hot knife is used in the flitch mill built to their design. The veneer can be used in three weeks. It is dried in a dryer - it goes over and under rollers to flatten the sheets. The whole process was very labour intensive.

'Tasmanian Ash' is mainly *E. regnans* and *E. delegatensis*. *E. nitens* would also be marketed as ash. 'Tasmanian Oak' is E. obliqua mainly. 'Ash' and 'oak' are entirely sorted by colour so that it is possible to have one piece of veneer that is half 'oak' and half 'ash'.

3.2 APPM Forests

Kevin Young -Deputy Plantation Manager and David de Little - Research Manager.

APPM were pioneers in the production of paper from eucalypts in 1930. The Burnie mill was set up in 1938.

The move into plantations has been necessary because of the pressure put on natural forests by the export chip trade. In Tasmania's climate burning and aerial seeding are difficult. Although pines had been planted since 1950 it was found that a *P. radiata* approach did not work for eucalypt plantation establishment.

In the 1970s 40 species were tested. Initially *E. delegatensis* was planted but by the early 1980s it was obvious that growth was generally unimpressive. However the *E. nitens* trials looked good. *E. globulus* has high pulp yields in overseas operations. The latter would be an option in coastal areas and at lower elevations. The aim of the organisation is to double pulp productivity in the next 10 years.

A useful measure of tonnes of pulp fibre/ha/annum. This incorporates MAI, basic density and pulp yield (% cellulose) Natural stands have a yield of 2 approximately, seedlings 5 (MAI=15) and clonal material selected for basic density and pulp yield 10. Both basic density and pulp yield are highly heritable. In Brazil a pulp yield of 18 is achieved. See figure 1..

Frost is a major consideration for APPM. The minimum temperature to be expected is -10°C each year with a temperature of -15°C occurring once every 10 years. This puts the site in a marginal category for eucalypts.

Insects are a problem with *E. nitens* but not *E. globulus*. *E. globulus* has a 3% advantage in pulp yield compared to *E. nitens*. *E. nitens* has a higher moisture content. Growth rates are similar so therefore on economic grounds *E. globulus* must be included. However due to frost it can't be planted on 70-80% of their sites

The breeding programme progeny trials include 300-500 families. They are frost screened and set out as progeny trials for conversion to seed orchards. Form of the trees is not a factor considered. Pulp yield is the basis for selection. Pulp productivity can only be gauged at age 6-7. Whole tree sampling is used for measuring pulp yield ie the whole tree is chipped and a sample of chips used. It costs $400 per tree and 600 are done a year. Pulp yield has a heritability of 0.6. Density and pulp yield have been found to be poorly correlated in heritability. Volume production has a heritability of 0.2. Seed orchard material is grafted from material selected on the basis of pulp productivity.

Cuttings and micropropagation are difficult for *E. nitens*. *E. globulus* is easier for cuttings. *E. nitens* clones that don't grow from cuttings can be successfully micropropagated. They have 5 hectares of vegetatively propagated material comprising 25 clones of *E. nitens*, *E. globulus* and hybrids. At 5 years many have vigourous growth and are promising.

Hybridization is being done in association with CSIRO. The only cross possible is with the *E. nitens* as mother. It has a smaller capsule which means fewer seeds unfortunately. Flies and beetles pollinate *E. nitens* and honey bees pollinate *E. globulus*. The flowering times overlap marginally. Hybridization is being pursued for frost resistance. The hybrids have been found to be intermediate in tolerance (-10° to -11° compared with *E. nitens* -13° to -14° and *E. globulus* -7° to -8°. Hybrid *E. nitens/E. gunnii* has a frost tolerance of -20°. The hybrids are performing better than parents. If the hybrid material could be propagated vegetatively it would be an advantage as seed will not be produced in sufficient quantities.

Seed origins currently used are all seed orchard for *E. globulus* (300 000 seedlings) and for *E. nitens* 80% or 3 000 000 seedlings) the sources are equally seed orchard, plantation (known seed origins), and natural forests.

In year 2000 *E. globulus* planting will increase from 5% at present to 10-15%. Up to 30% will be hybrids. The remainder *E. nitens*. This material will represent the top of the *E. nitens* range in terms of pulp productivity which is above the midpoint of the *E. globulus*.

Flowering is induced by the use of paclobutrazol. There are 5 hectares of trials of vegetatively propagated material. Mycorrhizae are being investigated to improve rooting. It may be necessary to establish them on the propagated material before they come in contact with the soil to control what variety they pick up and ensure better rooting. The fungal symbionts used are *Laccaria* and *Paxillus*. Inoculating these fungi under sterile conditions is proving to be most difficult.

Basal coppice can be taken from trees up to 12 years. Some clones have been used continuously since the early 1980s. The usefulness of older material will decrease as second generation material becomes available so that use of older material is not an issue.

Northern NSW *E. nitens* material is performing quite well on some sites. It has good cold tolerance. Errinundra is the worst for pulp yield, Southern NSW next worst and the others mixed.

3.2.1 Nursery

Kevin Young explained the nursery operations. Plantation planted each year includes 2 500 ha from Ridgley nursery and 500 - 600 ha are planted in the northeast of eucalypts and pine. Two types of eucalypt stock are produced in the nursery. These are container stock and half and half stock (stock planted in a container and planted out at 2 months into a nursery bed). The half and half stock extends the planting season.

Eucalypts are planted on 200-500 ha of cleared forest (pine) and 500 ha of ex-pasture including some marginal land. They are not buying top quality land yet. In evaluating suitability for purchase a difference of 5 in MAI equates to 50 km of cartage.

The 'half and half' stock is produced as follows: In mid October to early December seed is sown and pricked out into paper pot containers in late October - Christmas then transferred to the nursery and then planted out, with their paper pot still, May to September.

The paper pot stock are raised by sowing mid February - March in containers and planted in field late spring to January if necessary.

The half and half stock costs $200/1000 and container stock $100/1000.

3.2.2 Establishment

Improvements in MAI from 15 - 20 m^3/ha/yr are possible because of better establishment practices. Land preparation is by windrowing and burning. Good clearing is important for operations such as

mechanical harvesting or row thinning. In March it is possible to broadcast burn and then windrowed. Cultivation is by a 1m winged ripper and 80-90cm discs. They are buying some agricultural land.

Half the planting is done from April to September. They start at 650 m asl and continue down to coastal areas. Herbicide is applied over 2/3 the area by air, remainder ground application.

For the other half of the planting they start at the coast and move back up in altitude with containers. They spray in September for grass control before planting. They tend not to have a weed problem.

Spade planting of bare rooted stock is $125/ha and containers $90/ha pottiputki.

Fertiliser is 100g 18/20/0 applied by knapsack and metered gun in a spade slit.

Pest control with 1080 is required for native animals (wallabies), rabbits and hares once after planting.

Any pasture established is sprayed again 12 months later (August/September). Some maintenance fertiliser is applied at later stages.

Atrazine is the best herbicide on heavier soils. Atrazine 16 *l*/ha (8kg a.i.) over the seedlings.

Moisture is the limiting factor. Have lost 200 000 seedlings in a drought through phytotoxicity. At time of spraying they check if it is dry and postpone the operation if necessary. Simazine/Roundup are O.K on some sites.

On some sites simazine is used for its residual effect and broader range. Could use simazine/roundup before planting.

Escort can be used 6 weeks before planting. It may be O.K. to shorten this time interval.

Cost of establishment in 1989 was $1300/ha. This is made up of the following:

Clearing	$600/ha
Cultivation	$170/ha
Burn	$30/ha
Weedcontrol	$120/ha (incl $80/ha atrazine)
Fertiliser	$90/ha
Planting	$90-125/ha
Seedlings	$200-$300/1000 seedlings

The company is looking at fertiliser rates and follow up applications at 3, 5 and 10 years - not much known.

Radiata pine is grown on a 28 year rotation to produce sawlogs and pulp.

The eucalypts are being grown on a 15-20 year rotation. The mai/cai lines cross at age 12. A reduction in stocking to produce a larger piece size is being looked at. At present planting at 1111 s/ha (3 x 3m).

A pruned resource is being produced for slicing veneer. Each year 50 ha of mainly *E. nitens* but some radiata pine is being pruned at age 3 (10 cm dbh) They have their own plant at Burnie to supply.

Growth rates vary from 15 m^3/ha/annum for no cultivation or weed control or genetic improvement to 38 m^3/ha/annum for one *E. nitens* stand.

Growth rates that can be expected depend on the site - some at 600 m elevation may achieve 20 mai.

3.2.3 Insects

David de Little put the insects in context. Less than 50 % of Australian insects have been named. There are 500 paropsine species in Australia and PNG including 36 in Tasmania. (Cf 600 mainland eucalypt species in Australia including 30 in Tasmania. Any connection?). *Chrysophtharta bimaculata* is not in Victoria. Normally this chrysomelid does not eat the adult foliage of species in the symphomyrtus group because of the cineole oil. However despite *E. nitens* being in the symphomyrtus group the adult foliage is eaten. This is probably because it is more like the ashes which have cineole-phellendrene oil.

Spraying every year with ripcord is an environmentally difficult issue because of waterways and neighbouring landowners concern.

The ladybird beetle, *Cleobora agricola*, eats the eggs of chrysomelid pests and is a major predator. The larvae do most damage. *Chysophtharta agricola* affects the juvenile foliage of *E. nitens* and adult foliage of *E. globulus* and *E. nitens*, *Paropsis charybdis* eats *E. vimimalis* and *Paropsis delittlii* eats *E. nitens*.

Uraba lugens (gumleaf sketetoniser) is a common defoliator that eats the juvenile foliage of *E. nitens* which has been sprayed for *C. bimaculata*. This is a problem in Western Australia as well.

Mnesampela privata (autumn gum moth) can also be a problem at times. Up to two years growth can be lost from a single year of heavy defoliation.

Humphrey Elliot (TFC) is trying to quantify losses due to insects. Age 9-10 year old *E. nitens* has been assessed as having lost two years growth. Kino rings can form with 35% defoliation which is a serious sawlog defect. Secondary predators like boring insects are a concern.

Kevin Young gave some management background. Lower levels of defoliation are a problem for seed production (buds are eaten) and for this reason 600 ha (3% of the forest estate) was been sprayed in 1989.

Refer to Dave de Little's paper N.Z.Journal of Forestry Science Vol 19 No 2/3 223-225.

This year 5-10 % of the forest will be sprayed. One person full time and another half their time, are assessing insects on 5 day cycles. Surveying is done by eye with binoculars if necessary. The silhouettes of the leaves against the sky clearly show the insects. Control by natural predators can be expected to control the 1st and 2nd instars. If there has been previous damage or the area is not good for tree growth then they will spray earlier. The synthetic pyrethroid Dominex at $8/l - 200 ml/ha costs $30-40/ha to apply by helicopter. Spraying contributes 3-4% to the total plantation cost. *C. bimaculata* is 80% of the problem, C. agricola 20%.

Control by use of the *Bacillus thurengiensis* (Santiago strain) which has been used to control the Colorado potato beetle) is specific to coleoptera so that predators are not affected.

Generally a good relationship exists with neighbours because an effort is made to communicate well before hand. There is research into the size of buffer strips required for waterways etc.

3.2.4 Management Section Burnie

Paul Nicholls described the work of the section. The section must cater for an expanding eucalypt programme (1200 ha/yr to 2700 ha/yr). Maintenance of records for the varying sites (geology, climate). Prediction of growth and yield requires an understanding of the impact of the improving establishment techniques and genetics.

The hardware base is PCs and the software base outlined in Appendix 3

The GIS system is made up of information that is polygon, lines and points. Examples of polygon are forest types plantation, reserves; geology, administrative boundaries; coupe boundaries, soils etc. Examples of lines are roads, rivers, telecom lines etc. Examples of points are inventory and trial plots, survey marks, apiary sites, aerial photo points, archeological sites, quarries etc.

Originally a chain and compass were used, then theodolite control points and aerial photos to give maps which are digitised and processed through Geocomp. They have trialled using satellite survey via GPS for input into Arc Info. The advantage of this latter system is that the surveyor walks around the block and the points are precisely located with out the errors of photography and digitisation. At present the accuracy is 1m. Receivers cost $5000.

IDRISI is a raster based system that can process from satellite and video camera input. Overlays can be reduced from 8 hours to 5 minutes. It is possible to fly by plane with a video camera and combine with the vector information. This process could allow crown cover to be assessed to determine if the stand is ready for measurement and in future to reduce the number of PSPs by multistage sampling and image analysis.

At present Husky field computers are used to process data and produce growth and increment information.

3.2.5 Nursery operations

Germination of *E. nitens* is variable - size? genetic? The germination rate is 2300 from 10g and 15% of trees produced from the nursery are unplantable.

With cuttings moisture appears to be the main difficulty. A mix of 50/50 peat and vermiculite is used. The cuttings are in a constant mist where Botrytis can grow and infect cuttings.

The nursery mix for the pots is 60% basalt, 20% gravel, 20% peat. Osmocote and magamp at 2.5 kg/m^3.

3.2.6 *E. nitens* Establishment

E. nitens trial planted this year in an ex-potatoe crop paddock. Ripped and mounded then rotary hoed over the mounds. Purchase price $1700/ha, $1300/ha further up the hill. Factors influencing a decision to purchase include cartage to mill, value of existing crop, neighbours site productivity, water problems, land schemes. Suitability is scored out of 100 for aspect, altitude, rainfall, old growth.

The forest resource is 15% private land holding - half assisted by APPM grants and government funding and the rest joint venture.

The area planted in *E. nitens* each year has been increased over time.

Establishment year	Area planted annually (ha)
1975-81	100
1982-85	1200
1985-	2000

An *E. nitens* nelder was planted 3½ years ago.

3.2.7 Veneer Trial

E. nitens at present 10 years old is Toorongo Plateau seed originally planted at 1111s/ha and thinned to 450 s/ha at time of pruning (4½ years). To avoid stem damage wedges were used. The stocking was higher than would be prescribed operationally as extra trees were left for trials. The MAI is 24 m^3/ha/yr in thinned and 36 m^3/ha/yr in the unthinned. The CAI is still higher in both although it appears to have peaked.

The pruning schedule was a first lift to 2m at 4½ years then to 4 and 6 metres over the next 15 months. A DOS of 17-18 cm. The best were near 10 cm which is what would be the aim of pruning now. When stay lathes installed they will know the log length required for the veneer mill. At the time of pruning about 25% of the branches were live increasing to 75% at the third lift. The oldest trees they have (20 years +) still have branches on the lower stem. At present they are estimating volume as $\frac{BA \times MCH}{3 \times 10^4}$. A 25 year rotation is expected with one thin at 2-3 years age (5-6m height) to 250-350 s/ha. A sawing study was undertaken from trees within this stand by the Young Eucalypt Programme.

3.2.8 *E. nitens* planted 1975

The stand is currently at 21 - 22 m^3/ha/yr. Growing at 600 m altitude. Thinned for seed production to 200s/ha using a John Deere stroke delimber excavator tractor (not forwarder) Warratah head.

Thinning by row removal and thinning bays removing long lengths. Seed collection will be by felling trees - good trees produce 100g seed per tree. A rotation of 15 years to produce 35-45 cm logs at harvest is anticipated.

There is more *C. agricola* this year - egg bunches occur on leaf tips whereas *C. bimaculata* lays eggs further down the leaf. Soil around trees will be drenched with paclobutrazol which is absorbed through the roots to enhance seeding.

3.2.9 APPM/CSIRO Progeny trial.

E. regnans seed orchard planted in 1985 as single tree plots 400 families. Some culling has been undertaken. Origins are Southern Tasmania, Styx, Moogara, Florentine region. Flowering was observed 2 months ago.

3.2.10 APPM *E. nitens* breeding programme

Planted in Spring 1986 there are 200 families from Toorongo, Rubicon, MacAllister ?. Eventually it will be converted to a seed orchard. Early adult foliage has shown up in 30 families (Errinundra type). These will be culled because they are not expected to be as cold tolerant and pulp yield is inferior.

NSW *E. nitens* is included on another site and Victorian and NSW on two other sites. These are a moderately harsh and a very (probably too) harsh site.

Aulographina and *Mycosphaerella* are only considered a problem in summer rainfall areas.

3.2.11 *E. globulus*

Clonal trial 1988. North NSW *E. globulus* crossed with Rubicon *E. nitens* tissue culture. Although genetic deviants are usually picked out in the nursery one lot that looked O.K. were unable to handle a dry period.

Examples of a cross of *E. nitens* and *E. camuldulensis* using pollen off a garden tree showed one good, the other bad. This cross is just an idea to improve the *E. camuldulensis* growth for fuelwood in the tropics.

The pulp yields of improved clones cannot be estimated yet. Pulp samples will be taken next year at age 3. (Pulp yield = % cellulose from dry material when pulped to a kappa number of 18).

In 1995 the mill will start processing plantation eucalypts.

4 16/11/90 Launceston - Camden - Goulds - Country

4.1 TIFFANY FURNITURE MANUFACTURERS

Jim Gray showed what they have been doing with eucalypts. A trial with a European type chair showed that the grain was too open. Solid furniture costs 3 times veneer. Tasmanian oak is used in a layered veneer which is moulded into chair legs to give strength. Blackwood is where the main emphasis is placed by consumers.

4.2 FOREST RESOURCES

Richard Hart and Keith Orme explained the operations. See Appendix 4. They have already planted 627 ha of the 1200 possible (reserves account for a further 200 ha)

Establishment

Cultivation is on the contour to retain water, using a Savannah stump jump 80 cm disc and 60 cm ripper. They have established 1500 ha of new plantation a year. Early on *E. delegatensis* and *E. regnans*, the local species, were used - not successful. Now *E. nitens* is used. Weed control is glysophate/atrazine. Fertiliser 4-7-0 sulphate of ammonia and superphosphate.

E. nitens 1981 plantation

The land being planted is failed farm land at 600 m altitude and 1400mm rainfall It is a cold site but fertility is good. Animal control is important. The stand we saw was established in 1981 at 1000 s/ha. It was mounded, not ripped and the weed control was not very good. Trees were behind those on old forest sites because of grass competition. MAI was 23m3/ha/yr. They now plant 1350s/ha and production thin.

4.2.1 Seedling seed orchard.

Planted at 7 x 7 m, six trees from the same parent per group and reduced to one per spot by age 4. Seed from Toorongo, Rubicon, and MacAllister. They have at age 3 removed the worst 30% of families. Now self sufficient in seed. Grafts have been taken of the proven trees from progeny trials - the 15 plus trees selected on the basis of wood properties rather than progeny testing - density 390-500 kg/m^3, brightness, pulp yield.

They are self sufficient in seed, collecting 200-300 g/tree. They will cut trees down if a good crop. Seeds are produced at age 6-7. One kg of seed -> 300 000 seedlings. They have twice the viability of wild seed. Seeding is doubled with paclobutrazol applied by injection - 2000 ppm.

4.2.2 Thinning trial

A 9 hectare stand was thinned mechanically - every 3rd row out row method of selection. The plots had $\frac{2}{3}$ $\frac{1}{2}$and $\frac{1}{3}$of the stocking retained. They are looking at producing sawlogs and have pruned to 6m with poles at age 8 (7?).

With 60% of the trees retained they had 64 tonnes/ha go over the weigh bridge. A trial of 60 sawlogs were selected as straight 5 m in length with a 20 cm SED were sent to Tumbarrumba NSW. They were left in the forest for 3 weeks and not waxed until they were carted to the yard. The logs took weeks to get to the mill but no further checking occurred. There was a 43% recovery with back sawing. The boards were put outside to air dry and a sample sent to Wodonga to dry to 16%. There was a little checking in the air dried material otherwise it was O.K.

It was considered reasonable to expect a 60 cm log (Butt) at age 25-30 with a thinning at age 6-7 years to 650 s/ha. Veneer would be an option with a 20 cm knotty core. A 100 hectare cut producing 30% veneer logs would keep a mill going (5-10 000 tonnes).

This stand has gone from 14 to 20 m^3/ha/yr MAI over the last two years. At 13-16 years an MAI of 30 is expected. Planted at 1000 s/ha - 4m row spacing- an achieved 90% survival. A higher rate 1350 s/ha is considered better. Seed orchard stock used in the last few years is more uniform in height. The aim is to produce a 0.3 tonne/stem piece size.

A chemical-mechanical pulp mill at Georgetown operational in 2003- 2010 will utilise 42 000 tonnes per year - 8 000 ha.

4.2.3 Fertiliser trial

The 1981 planting was a "luxury" fertiliser trial to measure the response to a second fertilising 12 months after planting. Trees planted on sites which were previously forest respond well to fertiliser (4-7-0) within 12 months of planting. The prescription is now 200g/tree on the down hill side at establishment and then the following spring 400 g/tree. Richard Hart had found that it is only worth while fertilising trees with juvenile foliage. Fertiliser trials showed a 15% gain on MAI. Response to N and P was similar. The best tree in the trial 'Albert' is 30cm at age 8. The MAI is 23.5 m^3/ha/yr.

4.2.4 Plantations

The area viewed showed stream-side reserves. Over zealous site clearing lead to removal of nutrients. Windrowing on contour for 15-30^o slopes. Any steeper areas are spot cultivated with motorised post hole diggers - CSIRO tree planting auger column 45 cm deep, 12.5cm diameter. A two man team plant 1400 trees/day - one with post hole digger the other planting. Establishment cost is $1500.

4.3 SCOTSDALE REGION (FORESTRY COMMISSION)

Tony Atwood gave the back ground to the *E. regnans* and *E. obliqua* stands which did not look particularly successful. It was broadcast burnt and windrowed. Amitrole/atrazine applied. Strong *Acacia verniciflua* competition was present. The trees were planted in 1986. 1983 *P. radiata* sprayed with Tordon and Velpar. There was no fertilising initially and a secondary fertilising did not include P. The area is considered too dry for eucalypts - 1000- 1200mm. The insects population again created interest amongst the New Zealanders.

4.4 LISLE *E.OBLIQUA* PROVENANCE TRIAL

See appendix 5.

4.5 GOULDS COUNTRY ESTABLISHMENT TRIALS

See appendix 6.

Weedicide after planting is considered too risky. Results will be published in Australian Forestry.

Simulated browsing showed that browsing had a greater effect on growth than with *P. radiata*.

Cultivation and weed control interact.

E. nitens is standing at 50 m^3/ha at age 4 - *E. globulus* 40 m^3/ha.

Appendix 1.

RP 252/1,2. *EUCALYPTUS NITENS* PROVENANCE TRIALS.

AIM

The aim of these trials is to determine the extent of *E.nitens* provenance variation when used as a plantation species in Tasmania.

LOCATION OF TRIALS

Trials were established on two sites;

1. RP 252/1. Liffey plantation compartment 1H, corner of Riversdale No.1 and Riversdale No.1/1, Deloraine District. This site is at an altitude of 720 m. It has a high incidence of frost, especially in winter months. Average annual rainfall is in excess of 1100 mm. Soil parent materials consist of Permian mudstone and undifferentiated sandstone.

2. RP 252/2. Esperance plantation compartment 105D, corner of Jacks and Bowling Roads, Geeveston District. This site is at an altitude of 150 m. Frost incidence may not be as frequent as Liffey, however strong, cold westerly winds funnel down the Esperance valley from the Hartz Mountains during winter. Average annual rainfall is about 1300 mm. Soils are derived from Triassic sediments and are characterized by a high clay content, which makes them poorly drained.

The trials were planted in winter, 1980. Trees were planted in plots of 5 rows by 5 trees at Esperance and 5 rows by 6 trees at Liffey. Spacing was 3 m by 3 m (1111 trees per ha). Plots were replicated 5 times on each site, and layed out as an incomplete latin square design (Cochran and Cox, p 528).

MEASUREMENT AND ANALYSES

At the 2 year measurement, all trees were assessed. In subesquent measurements, only 9 trees per plot were assessed. Within each plot, a sub-plot of 3 by 3 trees were measured leaving a buffer surrounding the sub-plot. Dbh was measured on every tree, and height was measured on a single tree in each plot. For trees measured for both height and dbh only, volume was calculated using the equation prepared by Opie for *E. regnans*. This gives entire stem volume under-bark. The equation is;

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V = D ** 2 * H / (10 ** (4.762 - 5613.0 / (D +127.0) ** 2))
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where V is volume, D is dbhob (cm), and H is height (m).

TABLE 1. Details of *Eucalyptus nitens* provenance seedlots.

Locality	Provenance	Lat (S)	Long (E)	Alt (m)	Rain. (mm)	Temp max month	Temp min month	No. famil	Seedlot number
4 Tweed Spur	Rubicon	37°24'	145°47'	1000	1597°	23°	1°	-	Routine
9 Toolangi	Rubicon	37°32'	145°34'	610	1440	25°	2°	6	CSIRO 12404
11 Blue Range	Rubicon	37°23'	145°48'	1000	1598	23°	1°	7	CSIRO 12399
17 Mt Torbrek	Rubicon	37°22'	145°56'	1220	1647	21°	-1°	3	CSIRO 12403
18 Federation R	Rubicon	37°27'	145°57'	1100	1667	22°	0°	3	CSIRO 12401
3 Powelltown	Toorongo	37°47'	145°49'	900	1631	23°	2°	2	CFL 619,620
5 Toorongo	Toorongo	37°49'	146°07'	860	1703	23°	2°	-	Routine
6 Mt Erica	Toorongo	37°54'	146°21'	1080	1362	21°	0°	3	CFL 171-173
15 Noojee	Toorongo	37°48'	146°04'	960	1676	22°	1°	4	CSIRO 12102
16 Mt St Gwinear	Toorongo	37°50'	146°21'	1175	1334	21°	-1°	10	CSIRO 12107
7 Mt Skene	Macalister	37°28'	146°23'	1160	1411	21°	-1°	1	CFL 188
8 Mt Wellington	Macalister	37°27'	146°52'	1200	1167	21°	-1°	5	CFL 181-185
20 Connors Plain	Macalister	37°32'	146°28'	1310	1397	20°	-2°	4	CSIRO 12395
1 Mt Kaye	Errinunda	37°25'	149°07'	1000	1055	23°	-3°	1	CFL 644
10 Bendoc	Errinunda	37°12'	148°52'	1070	908	22°	-2°	8	CSIRO 12155
2 Gunmark R	Errinunda	37°18'	148°51'	1000	922	23°	-3°	5	CFL 61,63-66
12 Tallaganda	Southern NSW	35°37'	149°31'	1200	949	22°	-2°	4	CSIRO 12121
13 Badja Mountain	Southern NSW	36°01'	149°34'	1250	997	21°	-2°	8	CSIRO 12114
14 Anembo Trig	Southern NSW	35°52'	149°30'	1400	1071	20°	-3°	8	CSIRO 12120
19 Ebor	Northern NSW	30°40'	150°00'	1460	958	23°	-1°	3	CSIRO 9471
Liffey		41°40'	146°46'	720	1324	19°	1°		
Esperance		43°18'	146°54'	150	1170	21°	3°		

Climatic variables predicted using BIOCLIM.

TABLE 2. Stem volume (under-bark) of *Eucalyptus nitens* provenances, age 10 years, Liffey, northern Tasmania (assessed 13/8/1990).

Locality	Provenance	Stem volume (m^3ha^{-1})	Adjusted volume (m^3ha^{-1})	Adjusted MAI ($m^3ha^{-1}yr^{-1}$)
6 Mt Erica	Toorongo	210.1	212.6	21.3
21 Dummy	Toorongo?	170.0	196.7	19.7
16 Mt St Gwinear	Toorongo	187.5	192.2	19.2
13 Badja Mountain	Southern NSW	181.9	188.3	18.8
7 Mt Skene	Macalister	184.1	186.8	18.7
18 Federation R	Rubicon	165.6	181.3	18.1
12 Tallaganda	Southern NSW	165.2	170.3	17.0
17 Mt Torbrek	Rubicon	163.9	170.2	17.0
14 Anembo Trig	Southern NSW	159.2	159.2	15.9
8 Mt Wellington	Macalister	172.9	142.4	14.2
9 Toolangi	Rubicon	119.9	125.8	12.6
3 Powelltown	Toorongo	120.8	124.9	12.5
4 Tweed Spur	Rubicon	120.7	116.5	11.7
5 Toorongo	Toorongo	124.2	113.4	11.3
20 Connors Plain	Macalister	114.5	112.7	11.3
11 Blue Range	Rubicon	114.1	97.4	9.7
15 Noojee	Toorongo	80.2	91.6	9.2
10 Bendoc	Errinunda	94.8	90.0	9.0
1 Mt Kaye	Errinunda	71.6	67.4	6.7
19 Ebor	Northern NSW	61.2	57.8	5.8
2 Gunmark R	Errinunda	69.4	54.5	5.5
L.S.D.(0.95)		75.2	64.3	6.4

Analysis of variance

Source of variation	df	Sum of squares	Mean square	F ratio
Columns (reps)	4	5020	1255	0.54
Blocks (adjusted)	20	153904	7695	3.38
Seedlot (unadjusted)	20	194684	9734	4.27
Error	60	136813	2280	
Total	104	490421		

u = 0.008377
Error variance = 1034.0

TABLE 3. Stem volume (under-bark) of *Eucalyptus nitens* provenances, age 10 years, Esperance, southern Tasmania (assessed 9/8/1990).

	Locality	Provenance	Stem volume (m^3ha^{-1})	Adjusted volume (m^3ha^{-1})	Adjusted MAI ($m^3ha^{-1}yr^{-1}$)
9	Toolangi	Rubicon	225.4	220.0	22.0
7	Mt Skene	Macalister	180.6	185.6	18.6
6	Mt Erica	Toorongo	167.9	164.7	16.5
14	Anembo Trig	Southern NSW	150.7	151.7	15.2
21	Dummy	Toorongo?	148.9	146.1	14.6
17	Mt Torbrek	Rubicon	130.2	129.0	12.9
20	Connors Plain	Macalister	124.0	123.1	12.3
11	Blue Range	Rubicon	130.2	120.7	12.1
8	Mt Wellington	Macalister	111.9	119.6	12.0
13	Badja Mountain	Southern NSW	114.4	114.8	11.5
12	Tallaganda	Southern NSW	114.3	114.6	11.5
2	Gunmark R	Errinunda	102.9	112.7	11.3
15	Noojee	Toorongo	114.8	107.2	10.7
5	Toorongo	Toorongo	97.9	102.7	10.3
3	Powelltown	Toorongo	94.8	96.0	9.6
4	Tweed Spur	Rubicon	114.9	92.5	9.3
1	Mt Kaye	Errinunda	67.8	88.5	8.9
10	Bendoc	Errinunda	59.4	66.9	6.7
19	Ebor	Northern NSW	56.4	43.7	4.4
16	Mt St Gwinear	Toorongo	26.9	34.3	3.4
18	Federation R	Rubicon	22.2	21.9	2.2
L.S.D.(0.95)			85.4	80.6	8.1

Analysis of variance

Source of variation	df	Sum of squares	Mean square	F ratio
Columns (reps)	4	10402	2600	0.70
Blocks (adjusted)	20	154657	7733	2.09
Seedlot (unadjusted)	20	240362	12018	3.25
Error	60	221766	3696	
Total	104	627187		

u = 0.006215
Error variance = 1625.0

Appendix 2.

STOODLEY PLANTATION - Devonport District.

Eucalyptus globulus stand, planted 1940.

The Stoodley plantation (25 km south of Devonport) is at an altitude of 200 m, receives an annual rainfall of *c.* 1200 mm, and is located on a shallow red-brown clay loam over tertiary basalt. Site quality is apparently very good, as indicated by the fact that the tallest stems had reached 51 m at 42 years of age. Before planting in 1939, the site was abandoned farmland with a cover of blackberry, bracken and grass. It was cleared and 1·3 ha planted with 1-year-old *Eucalyptus globulus* spp. *globulus* tubed stock at a rate of *c.* 2210 stems ha^{-1} (2·1 × 2·1 m). The provenance of the stock is unknown.

Fertilizer has not been applied to the plantation at any time, although the stand was under-planted with *Robinia pseudacacia* in 1941 in an attempt to increase the nitrogen content of the soil. Compartment records for 1949 describe the *Robinia* as being suppressed and only 1·7 m tall. They also indicate that the *E. globulus* 'failed badly' in several patches and that mortality was 15% for the balance of the plantation. For the purposes of this study, it was assumed that establishment mortality was 20%, leaving a stocking of 1750 stems ha^{-1} at age 10 years.

from other stands

Table 3. Volume table from stand simulation for *E. globulus* at Stoodley

The model was based on an assumed stocking at 10 years of 1750 stems ha^{-1}, the known stocking at age 42 of 570 stems ha^{-1} and an estimated entire stem volume at age 42 of 1045 m^3. The predicted volume (m^3 ha^{-1}), basal area (m^2 ha^{-1}) and stocking (stems ha^{-1}) are shown for each 5-yearly age level and diameter (DBHUB) class, together with the periodic annual increments (PAI) and mean annual increments (MAI) in volume

Age (years)		Diameter class (cm)												Total	PAI (m^3 ha^{-1})	MAI (m^3 ha^{-1})
		0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60			
10	Volume	0·7	12·3	48·9	68·7	3·6	0·0	0·0	0·0	0·0	0·0	0·0	0·0	134	13·4	13·4
	Basal area	0·2	2·5	7·7	9·5	0·5	0·0	0·0	0·0	0·0	0·0	0·0	0·0	20		
	Stocking	170	528	626	412	14	0	0	0	0	0	0	0	1750		
15	Volume	0·2	6·4	34·3	88·3	145·2	135·4	6·1	0·0	0·0	0·0	0·0	0·0	416	56·4	27·7
	Basal area	0·1	1·1	4·2	9·3	13·8	12·1	0·5	0·0	0·0	0·0	0·0	0·0	41		
	Stocking	44	218	335	381	349	210	7	0	0	0	0	0	1544		
20	Volume	0·1	3·6	22·4	65·1	126·9	184·1	177·7	21·6	0·0	0·0	0·0	0·0	601	37·1	30·1
	Basal area	0·0	0·5	2·4	5·8	10·1	13·7	12·6	1·5	0·0	0·0	0·0	0·0	47		
	Stocking	13	108	189	238	254	231	155	15	0	0	0	0	1203		
25	Volume	0·0	2·1	15·3	48·5	102·5	167·5	216·7	182·0	6·4	0·0	0·0	0·0	741	27·9	29·6
	Basal area	0·0	0·3	1·5	3·9	7·3	11·0	13·4	10·9	0·4	0·0	0·0	0·0	49		
	Stocking	3	59	118	159	182	185	163	100	3	0	0	0	972		
30	Volume	0·0	1·2	10·7	36·7	82·3	143·8	207·3	239·9	131·0	0·0	0·0	0·0	853	22·4	28·4
	Basal area	0·0	0·2	1·0	2·7	5·4	8·6	11·6	12·9	6·8	0·0	0·0	0·0	49		
	Stocking	0	32	78	111	133	144	140	117	50	0	0	0	805		
35	Volume	0·0	0·7	7·6	28·0	66·1	121·4	186·6	243·2	244·2	48·4	0·0	0·0	946	18·6	27·0
	Basal area	0·0	0·1	0·7	2·0	4·0	6·7	9·7	12·0	11·6	2·3	0·0	0·0	49		
	Stocking	0	17	53	80	100	113	117	109	83	14	0	0	686		
40	Volume	0·0	0·4	5·4	21·5	53·3	101·8	163·9	228·7	270·5	180·3	0·0	0·0	1026	15·9	25·6
	Basal area	0·0	0·1	0·5	1·5	3·1	5·3	8·0	10·9	12·0	7·8	0·0	0·0	49		
	Stocking	0	8	36	59	77	89	96	96	85	45	0	0	591		
45	Volume	0·0	0·2	3·8	16·6	43·0	85·2	142·3	208·4	268·2	277·7	50·8	0·0	1096	14·1	24·4
	Basal area	0·0	0·0	0·3	1·1	2·4	4·3	6·6	9·1	11·2	11·3	2·0	0·0	48		
	Stocking	0	4	25	44	59	71	79	82	79	64	10	0	517		

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Single-tree and Stand Growth Models for a Plantation of *Eucalyptus globulus* Labill. in Northern Tasmania

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Abstract

Data from a complete stem analysis for selected trees in a 42-year-old plantation of *E. globulus* have been used to derive a single-tree growth model comprising equations for total height, increment of underbark diameter (DBHUB) and entire stem volume. Despite the lack of any mortality data, a stand simulation model was also developed because of the need for such models for *E. globulus* and its importance as a plantation species in Tasmania. Beta functions were fitted to the DBHUB distributions for the 42-year-old stand and an 'average' 10-year-old stand. DBHUB distributions at 5-yearly intervals were then simulated by beta functions, for which the upper bounds were set by the single-tree equation for DBHUB increment, and for which the beta form parameters were calculated by linear interpolation between the parameter estimates for the 10- and 42-year-old stands. Stand density and volume were estimated for each DBHUB distribution by a procedure based on the Self Thinning Rule and the fitted single-tree volume equation. Sensitivity analyses of the effects of varying the major assumptions showed the stand simulation model to be conservative and robust.

[O.D.C. 522.2:524.319:178.83 *Eucalyptus globulus*]

Introduction

The total area of hardwood plantations in Tasmania in March 1983 was 6800 ha (Tasmanian Forestry Commission 1983) with 41% of it comprising *Eucalyptus globulus* Labill. (blue gum). Forest managers have been encouraged to use this species largely because of its ease of establishment on a wide range of sites and its rapid early growth. However, forecasted yield estimates for these young plantations are speculative owing to a paucity of growth and yield data for *E. globulus* older than 10 years. The oldest plantations of *E. globulus* in Tasmania are at Stoodley (planted in 1939), Castra (1941) and King Island (1938). All three plantations have never been fertilized and until recently were unthinned. Unfortunately also, they have seldom been measured and the scant available data are inconsistent, having been obtained from small temporary plots. Nonetheless, they are the only stands from which older-aged growth data for *E. globulus* are available.

This paper describes the derivation of a single-tree distance-independent growth model for the 1939 plantation at Stoodley. A stand growth model is also derived, but without the benefit of data for mortality or an early-aged diameter distribution. This 'speculative' model is intended to serve only as an indication of likely stand dynamics on good sites, but it may prove to be useful because of the absence of any other growth model for 'old' unthinned *E. globulus*.

Appendix 4.

Forest Resources Ltd. N.F.I CAMDEN

Tasman Highway *- Camden Hill Road Junction*

This hillside had been logged by a local sawmiller as a sawlog only operation. It was then purchased by Forest Enterprises of Tasmania a small private forestry company. In conjunction with Forest Resources the block was salvage logged, producing a further 240M³ of low grade sawlog and 2800 tonnes of pulpwood. This material was mainly in the form of headlogs left lying on the block. Planting has been carried out in 1987(14 ha), 1988(27 ha), and 1989 (23 ha).

The planting has been done with grant assistance from Forest Resources. (40% contribution - Landowner must give F.R. first offer of the final crop).

The species planted is Eucalyptus nitens (Shining Gum).

This property continues on the RHS along Priors Hill Rd. Note the pines planted under the transmission lines to produce Christmas trees.

Priors Hill Rd. Entrance gate to NFI Camden.

Pasture country on both sides of the road is owned by Forest Resources and is being established to Eucalyptus nitens plantation with assistance from the Commonwealth Government under the National Afforestation Program.

T.V. Corner

The sharp left hand bend on Priors Hill Road is known as TV corner in honour of the television set on top of the stump - Note jigger board cuts in the stump.

The natural forest in this area is reserved from logging to protect soil, water quality and biological values.

RHS *- First plantations sighted are Shining Gum planted 1986. The site is fairly poor and some deaths can be seen.*

STOP 1.

Site Preparation:

Current clearing operations to be planted during the winter of 1990. This site had been a scrubby wattle and Eucalyptus regnans (Stringy Gum) area resulting from logging in 1978. Growth was very poor compared with adjacent plantation so the area was cleared in the summer of 1989/90.

The site has been cleared on the contour, and then ripped to a depth of 60 cms by a TD20 bulldozer which also pulls a set of giant stump jump discs to form the mounds.

Mounding is done on the contour to prevent water runoff and soil erosion.

During the winter the site will be:

- *sprayed on the mounds to control weed competition.*
  The chemical used will be Atrazine, 6 kg a.u./ha. a low toxicity chemical (less poisonous than table salt) which binds onto the clay in the soil and therefore does not move off the area.
  The aim is to control weed competition for 6-9 months.

- *Planted with Shining Gum - potted stock, 100-150 mm tall, topped to harder stock against game and frost. Planted in August.*

- *Fertilized with 200 gms of 4-7-0 fertilizer (Sulphate of Ammonia and Superphosphate) in a ring around the seedling, about 15 cms away.*

- *Secondary fertilised in the following autumn with a further 400 gms of 4-7-0.*

- *Game control will be carried out during the first winter using 1080. This is applied under Agriculture Dept. supervision. The poisoned carrots are dyed blue to make them less attractive to birds (birds see reds and oranges very well, but blues and greens very poorly). Birds also have much higher tolerance of 1080 than the target species.*

1981 Plantation

This stand was an old pasture site and was planted with Shining Gum in 1981. The area was disced and mounded, but not ripped. Herbicide (destructol) was applied to the grass but the chemical used did not control the grass very well.
170 gms of fertilizer &7:6:0 as Ammonium Sulphate and Superphosphate) was applied/seedling.

Note the dead branches staying on the trees. This is due to the rapid growth of the trees trapping the branches before they can be dropped.

Shining Gum Seed Orchard

This area is a production seed orchard producing seed for the plantation program and the best trees have been included in a tree improvement program for the production of further improved seed.

The orchard was planted in 1981 at 8 c 8m spacing with 6 trees grown from seed from the same parent tree at each spot. At age 2 these were reduced to 2/plot, and at age 4 to one tree/plot.

There were 20 parent tree families present at first, but the poor families have been culled and there are now 14 families remaining.

Toorongo Rubicon - Macallister families are present. 16 trees selected for further breeding. Has been producing seed for production planting for 2 years.

Thinning Trial

An area of 9 ha. was thinned using mechanical harvesting equipment. Every third row was removed completely and the rows on either side were thinned to test various stocking levels.

The aim was to retain 33% (outrow only), 55% (outrows + 1 in 3), abd 67% (outrow + 1 in 2) of the original stand, to test the response of the stand to various thinning regimes.
some pruning trials have been done to see how it affects growth, and to check the costs of pruning.
Approx. 40 tonnes/tree recovered. 40 tonnes of small sawlog sent for automatic mill sawing trial at Tumbarumba N.S.W.

Herbicide Trial

This ex forest site was planted in 1984. At that time the use of chemicals to control competition was not done on forest sites. A herbicide trial was established.

Most successful treatments were glyphostate and Caragard at 1 and 2 kg a.i./ha and glyphosate and Atrazine at 1 and 3 kg a.i./ha. Caragard is not registered for use in Tasmania.

STOP 2.

This 1981 Plantation was a site with bracken and scrub with some scattered timber. The difference in growth is considered to be due to competition from grass which was present at Stop 1, but not here.

Stem with orange band was 30 cms DBAOB at age 8 ("Albert Nitens")

Continue to follow Priors Hill Road.

The smaller trees encountered are Shining Gum planted in 1985. Proceed to the place where on the LHS there is Shining Gum, and on the RHS Stringy Gum (the original site species).

Note the poorer growth rates of the Stringy Gum (Mountain Ash for Victorians). Both sites are the same age and had identical establishment treatments.

Proceed along Cannons Road and stop overlooking the 1988 Plantings.

View across the property and out onto the plantings on Georges Plains.

STOP 3.

1988 Plantation in foreground to 1985 and 1987 plantation background.

Total property area	*1403 ha.*
Currently planted area	*627.2 ha.*
Possible plantable area	*1215 ha.*

Note the native stand between Camden Hill and Georges Plains in owned mainly by the Company - Reserved from logging.

Also streamside reserves along the creek in the 1988 and 1981 plantings.

Depart from property along Cannons Road (1984 Shining Gum) and back down Prios Hill Road.

Appendix 5.

EUCALYPTUS OBLIQUA PROVENANCE AND FAMILY TRIAL

LISLE PLANTATION, NORTH-EASTERN TASMANIA, PLANTED 1970.

Three *E. obliqua* range wide provenance trials were established by CSIRO in 1970. Two sites were in Victoria, and a third in Tasmania.

Seedlots tested

Seed was collected from 22 provenances which covered the complete range of this species distribution. Table 1 shows the provenances sampled, as well as rainfall, temperature and altitude at each collection site. Four collections were made from Strathblane (Tas) covering stands with different site indices. From each provenance, seed was collected from up to 10 mother trees (families), and a total of 216 seedlots were included in this trial. Actual numbers of families per provenance are shown in Table 1.

Site description and establishment techniques

The trial site is on a moderately steep, north facing slope. Soils are gradational yellow podzolics on Devonian/Silurian metamorphised sandstone sediments. The site formerly supported an *E. obliqua* forest with some *E. regnans* in the gullies. Site preparation included clearing, burning and cultivation. No fertilisation or chemical weed control was done, however manual weeding was done in the first year. The area was fenced as protection from browsing animals.

Seedlings were raised in 'drinking cups' 7 cm diameter by 12 cm deep. Seedlings were planted in May 1970, 5 months after pricking out. Spacing at planting was 2.1 m by 2.1 m (2200 trees per ha). At age 8, the trial was thinned to a stocking of 1100 trees per ha.

Trial design and assessment

The trial was originally designed as a cubic lattice, however large numbers of missing plots complicated such an analysis. Therefore, in this study, the trial was analysed as a randomised block design, with 6 replications of 216 seedlots. At planting, plots consisted of a six tree line plot however the thinning at age 8 reduced this to the three largest trees per plot. Consequently, for the age 19 assessment, 6 replications of 3 tree plots were measured.

The trial was assessed in 1989 at age 19 years. All trees were measured for diameter at breast height over bark (dbhob), stem straightness, branch form and branch shedding. Stem straightness and branch form were measured on a 6 point scale where 6 is excellent and 1 is poor. Branch shedding was measured on a 4 point scale where 1 is no shedding and 4 is complete shedding on the lower three-quarters of the bole. A random tree in each plot was measured for height and bark diameter (ie; one third of trees, or 6 per family). Volume was calculated using the equation;

$$V = 0.009287 + 0.3197 \cdot DBHub^2 \cdot Ht$$

where V is entire stem volume under bark, DBHub is diameter at breast height under bark, and Ht is tree height. This equation was developed for *E. obliqua* regrowth in Tasmania (S. Candy, pers. comm.).

PINUS RADIATA PLANTATION

LISLE, NORTH-EASTERN TASMANIA, PLANTED 1970.

This plantation was established in 1970 using open rooted seedlings at a stocking of 1371 stems per ha. Seed stock was probably select trees from a heavily thinned stand. Soil, topography and establishment techniques are the same as those at the *E. obliqua* trial site.

The *P. radiata* stand has received two types of silviculture. Part of this compartment had not been thinned since establishment, and part received a single thinning to about 400 stems per ha at age 13 years. Growth assessments are shown from both stands.

P. radiata growth was assessed using routine inventory plots. In the thinned stand, 5 plots of 0.06 ha had been established, and in the unthinned stand 3 plots of 0.04 ha had been established. Plots had been measured in at age 17 years so age 19 assessments were obtained by extrapolation using a growth model.

TABLE 1. Details of *Eucalyptus obliqua* provenances planted at Lisle, Tasmania.

Provenance	State	Latitude (S)	Longitude (E)	Altitude (m)	Rainfall (mm)	Max. monthly temp	Min. monthly temp	Number of families
Mawbanna	Tas	40° 55'	145° 21'	90	1310	21°	5°	9
Nietta	Tas	41° 22'	146° 04'	300	1343	22°	3°	10
Forester	Tas	41° 04'	147° 40'	90	917	23°	3°	10
Maydena	Tas	42° 43'	146° 32'	610	1546	22°	3°	10
Murdunna	Tas	42° 57'	147° 53'	150	762	18°	1°	8
Strathblane SI 50m	Tas	43° 06'	146° 26'	160	1698	21°	3°	10
Strathblane SI 34m	Tas	43° 06'	146° 26'	85	1631	21°	3°	10
Strathblane SI 29m	Tas	43° 06'	146° 26'	79	1626	21°	3°	10
Strathblane SI 18m	Tas	43° 06'	146° 26'	73	1621	21°	3°	10
Powelltown	Vic	37° 53'	145° 51'	370	1631	23°	2°	4
Lavers Hill	Vic	38° 40'	143° 21'	270	1357	24°	4°	10
Swifts Creek	Vic	37° 08'	147° 54'	730	733	25°	0°	8
Broadford	Vic	37° 19'	145° 12'	450	957	26°	3°	8
Daylesford	Vic	37° 26'	144° 12'	700	1041	24°	3°	10
Drik Drik	Vic	38° 04'	141° 24'	100	890	24°	5°	10
Mount Cole	Vic	37° 16'	143° 12'	700	891	24°	2°	10
Halls Gap	Vic	37° 09'	142° 28'	590	907	25°	3°	4
Redbank	Vic	36° 50'	143° 20'	460	673	27°	3°	9
Brown Mountain	NSW	36° 37'	149° 29'	370	798	27°	2°	8
Mount Werong	NSW	34° 06'	149° 54'	1160	978	22°	-1°	10
Yarrowitch	NSW	31° 21'	152° 01'	1160	1257	23°	0°	10
Styx River	NSW	30° 35'	152° 12'	520	1188	28°	2°	9
Gibralter Range	NSW	29° 38'	152° 08'	1000	1081	25°	0°	9
Furner	SA	37° 27'	140° 19'	30	719	26°	5°	8
Parndana, Kangaroo Is.	SA	35° 47'	137° 16'	150	657	24°	8°	2
Lisle, Tas	Tas	41° 13'	147° 21'	260	1120	23°	2°	-

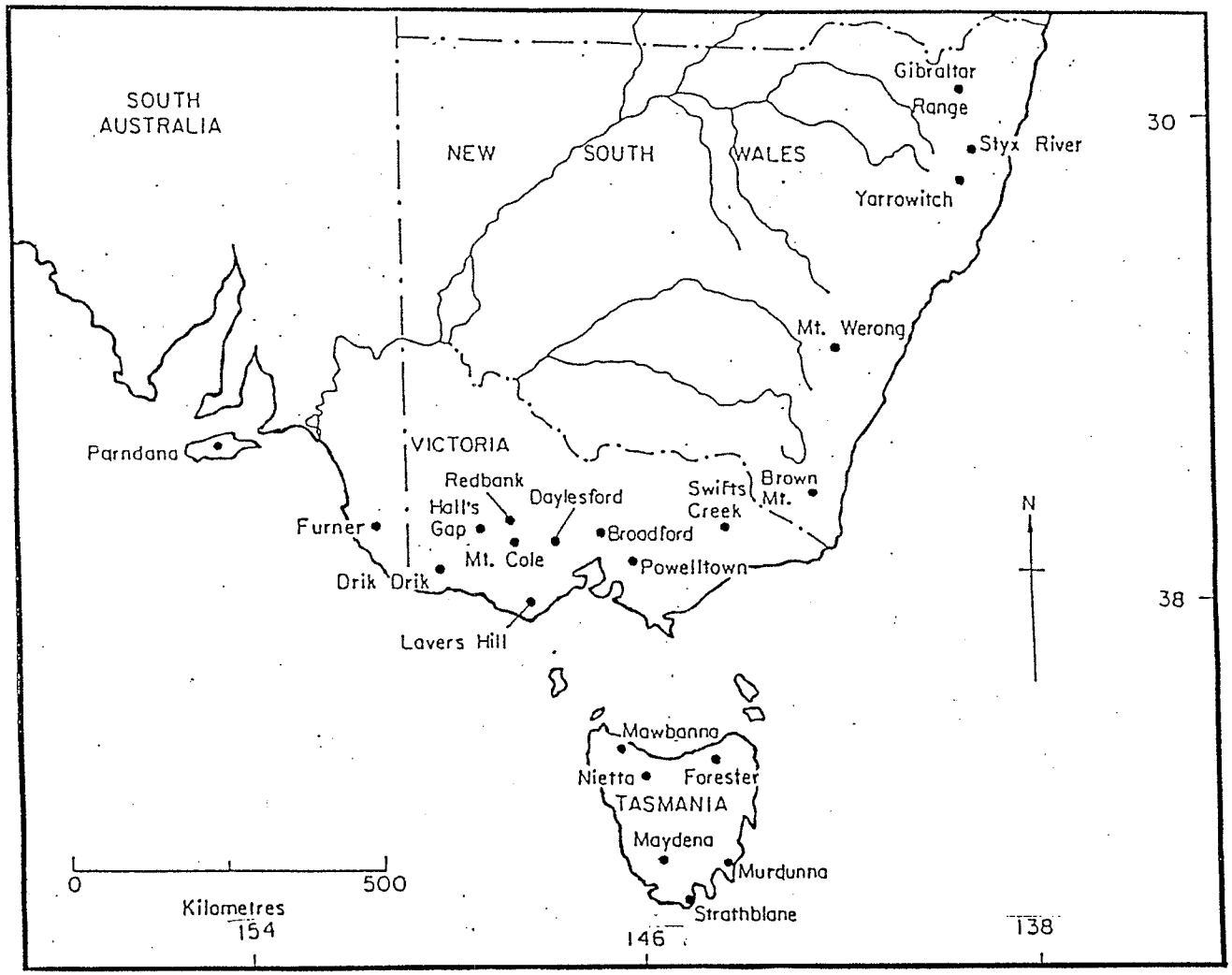
TABLE 2. Provenance means (and rank) of *Eucalyptus obliqua* provenances at age 19 years, Lisle,Tasmania.

Provenance	Number families#	Stem volume ub (m^3/ha)	Stem straight. (1-6)	Branch form (1-6)	Branch shedding (1-4)	Forks + ramicorns (no./tree)	Dbh (cm)	Bark diameter (cm)	Survival (%)
Mawbanna, Tas	9	606.7 (1)	3.47 (9)	3.27 (21)	2.65 (10)	0.49 (21)	29.6 (1)	4.1 (10)	92.0 (4)
Strathblane SI 29m,Tas	10	521.6 (2)	3.30 (13)	3.63 (7)	2.79 (7)	0.42 (16)	26.3 (5)	2.9 (21)	94.4 (2)
Strathblane SI 34m,Tas	10	507.3 (3)	3.19 (16)	3.35 (17)	2.83 (5)	0.41 (13)	26.7 (4)	3.1 (17)	91.7 (5)
Forester, Tas	10	466.6 (4)	3.53 (6)	3.57 (10)	2.90 (3)	0.56 (24)	27.0 (3)	4.1 (8)	91.1 (7)
Lavers Hill, Vic	10	432.0 (5)	3.51 (7)	3.21 (22)	2.80 (6)	0.40 (10)	27.1 (2)	4.9 (3)	96.1 (1)
Strathblane SI 50m,Tas	10	397.6 (6)	3.35 (11)	3.72 (5)	2.89 (4)	0.35 (8)	24.8 (6)	3.1 (20)	86.1 (11)
Nietta, Tas	10	369.8 (7)	3.95 (2)	3.97 (1)	3.17 (1)	0.22 (1)	24.5 (7)	3.8 (13)	91.7 (6)
Strathblane SI 18m,Tas	10	360.4 (8)	3.59 (5)	3.78 (4)	2.90 (2)	0.41 (14)	23.9 (8)	3.1 (18)	84.5 (12)
Powelltown, Vic	4	242.4 (9)	3.41 (10)	3.42 (15)	2.66 (9)	0.43 (17)	22.9 (10)	4.4 (5)	87.5 (10)
Murdunna, Tas	8	227.5 (10)	3.61 (3)	3.51 (11)	2.38 (13)	0.49 (20)	23.6 (9)	4.1 (11)	68.1 (15)
Styx River, NSW	9	218.8 (11)	4.03 (1)	3.12 (24)	2.14 (20)	0.28 (5)	22.9 (11)	5.7 (1)	93.2 (3)
Yarrowitch, NSW	10	162.8 (12)	3.49 (8)	3.20 (23)	1.95 (22)	0.52 (23)	19.9 (12)	4.9 (4)	90.0 (9)
Gibralter Range, NSW	9	107.2 (13)	3.19 (17)	3.33 (18)	2.17 (19)	0.40 (11)	17.5 (14)	5.1 (2)	90.7 (8)
Drik Drik, Vic	10	84.3 (14)	2.58 (22)	3.82 (3)	2.75 (8)	0.40 (12)	16.7 (17)	4.2 (7)	71.7 (14)
Mount Werong, NSW	10	80.3 (15)	3.30 (12)	3.29 (20)	1.89 (23)	0.45 (18)	16.1 (20)	3.7 (14)	75.6 (13)
Daylesford, Vic	10	77.3 (16)	3.06 (18)	3.42 (14)	2.57 (11)	0.31 (7)	17.8 (13)	4.0 (12)	47.8 (16)
Maydena, Tas	10(1)	59.2 (17)	3.22 (15)	3.30 (19)	2.49 (12)	0.36 (9)	17.2 (16)	2.8 (22)	37.2 (19)
Swifts Creek, Vic	8	49.4 (18)	3.59 (4)	3.39 (16)	2.37 (15)	0.24 (3)	17.5 (15)	4.1 (11)	43.8 (17)
Brown Mountain, NSW	8	30.2 (19)	3.23 (14)	3.44 (13)	2.01 (21)	0.41 (15)	16.1 (19)	3.5 (15)	28.5 (21)
Broadford, Vic	8	27.7 (20)	3.03 (19)	3.63 (8)	2.19 (17)	0.51 (22)	12.9 (22)	3.2 (16)	41.0 (18)
Mount Cole, Vic	10	22.1 (21)	2.98 (20)	3.60 (9)	2.38 (14)	0.29 (6)	14.0 (21)	3.1 (19)	30.6 (20)
Halls Gap, Vic	4(1)	12.8 (22)	2.83 (21)	3.45 (12)	1.73 (24)	0.49 (19)	16.3 (18)	4.2 (6)	12.5 (24)
Redbank, Vic	9	4.8 (23)	2.37 (23)	3.71 (6)	2.37 (16)	0.25 (4)	8.2 (24)	1.9 (23)	25.9 (22)
Parndana, Kangaroo I,SA	2	3.5 (24)	1.62 (24)	3.93 (2)	2.18 (18)	0.23 (2)	11.3 (23)	1.7 (24)	13.9 (23)
Furner, SA	8(6)	0.1 (25)	1.60 (25)	2.45 (25)	1.65 (25)	1.60 (25)	7.9 (25)	1.0 (25)	2.1 (25)
Mean		220.2	3.22	3.47	2.48	0.43	21.5	3.7	67.1
Least sig. differance (0.05)		48.3	0.23	0.24	0.21	0.16	1.5	0.4	8.8

Number in brackets is number of families with 0 survival.

TABLE 3. Comparison of stem volumes of *Pinus radiata* and *Eucalyptus obliqua*, at age 19 years, on a highly productive site in NE Tasmania.

Species	Entire stem volume ub (m^3/ha)	Volume thinned (m^3/ha)	Age of thinning (years)	Stocking (stems/ha)	Basal area (m^2/ha)	Mean dbhob (cm)	Mean dom. height (m)
Pinus radiata, unthinned	464	0	-	1108	52.0	18	31
Pinus radiata, knot control	319	200	13	406	33.1	32	31
Eucalyptus obliqua, mean, all provenances	220	<40	8	737	32.5	21	-
Eucalyptus obliqua, top 15 provenances	324	?	8	957	46.4	23	-
Eucalyptus obliqua, Mawbanna, Tas	607	?	8	1012	75.3	30	31
Eucalyptus obliqua, Foretser, Tas	467	?	8	1002	63.9	27	30
Eucalyptus obliqua, Strathblane, Tas	447	?	8	981	54.5	25	29
Eucalyptus obliqua, Lavers Hill, Vic	432	?	8	1057	64.7	27	29
Eucalyptus obliqua, Nietta, Tas	370	?	8	1009	52.1	25	28



Locations of *Eucalyptus obliqua* provenances.

Appendix 6.

Species Trial - Goulds Country

Treatments

1. *E. nitens* (Toorongo provenance)
2. *E. regnans* (Moogara provenance)
3. *E. delegatensis* (FIO)
4. *E. obliqua* (F8)
5. *E. globulus* (Moogara)
6. *E. regnans* (N.E. Provenance - L9)
7. *P. radiata*(Upper Castra S.O.)
8. *Acacia melanoxylon* (Smithton)
9. *P. radiata/A. melanoxylon* (as above)
10. *E. nitens/A. melanoxylon* (as above)

Design

Species treatments (10) are 40 tree plots (4 rows x 10 trees. Each plot is split into 2 stock types* (PP and OR). Each sub-plot is therefore a (2 row) 20 tree plot. treatments are replicated in 3 blocks.

i.e. 10 spp x 2 stock x 3 rep = 60 sub-plots

* Exceptions are *P. radiata* (all OR) and *A. melanoxylon* (PP seedlings were not available and were substituted with late planted (OR stock).

Table 1. Multiple range analysis (LSD) for Volume (m^3ha^{-1}) at age 4 years for species planted at Goulds Country.

Species	Average	
E.nitens over Blackwood	63.476667	a
E.nitens	61.303333	ab
E.globulus	54.140000	b
P.radiata	27.715000	c
P.radiata over Blackwood	27.340000	c
E.regnans (NE Tas)	16.558333	d
E.regnans (Moogara)	15.316667	d
E.obliqua	11.405000	de
E.delegatensis	10.836667	def
Blackwood	6.176667	ef
Blackwood over P.radiata	4.865000	ef
Blackwood over E.nitens	3.453333	f

The effect of cultivation and weed control on the growth of *Eucalyptus nitens* and *Eucalyptus regnans*,

W.A. Neilsen, G.R. Wilkinson and L. Edwards.

Methods

Treatments

Cultivation treatments were:

1. Nil
2. Discing only
3. Mound-plough
4. Discing + mound-plough

Cultivation treatments were carried out under ideal soil conditions in May. Little-giant discs were used in cultivation to 180-200 mm depth.

Mounding was, with the tandem off-set 600 mm discs producing uniform mounds with the dimensions 700 mm wide x 300 mm depth.

Material used for the trial was routine open-root and paper-pot *E. nitens* and *E. regnans* seedlings from Perth Nursery. Open-root seedlings averaged 34.5 cm in height and paper-pot seedlings 8.2 cm.

The weed control plots were sprayed with a mixture of amitrole, 1.3 kg a.i.ha^{-1}, and atrazine, 3 kg a.i.ha^{-1}, in July 1986. A boom spray mounted on a Mercedes 4x4 tractor was used.

Design

Cultivation treatments were laid out as 80 trees plots of 8 rows x 10 trees. Each plot was split into herbicide sprayed and not sprayed treatments. Each of these 40 tree half-plots were further split into 2 species and each species was split into 2 stock types. Each basic sub-plot is therefore a 20 tree plot of 2 rows.

Each treatment is replicated in 3 blocks giving 96 subplots.

Site

The planting site is located in north eastern Tasmania at 120m altitude. It is situated on a well-drained broad ridge with gentle NW aspect and about 5% slope.

Soils are yellow podsolics formed on adamellite granites. The upper horizon generally comprises a coarse, free-draining, dark-grey, gravelly quartz soil to 20-30 cm in depth, overlying a deep, yellow clay with high quartz content. The surface of Undisturbed soils appear to be relatively compacted, however, following disturbance soils remain friable.

The climate is temperate with mild to warm summers and cool to mild winters. Light frosts, $<2^0C$, are common and may be experienced in any month. Heavy frosts, $<0^0C$, are relatively common from May to September. Annual precipitation is approximately 980 mm with a winter peak and periods of summer moisture deficit. The trial site is exposed to prevailing winds, which are predominantly NW in winter, with more easterly winds common in summer.

The site formerly carried *Eucalyptus regnans* F.Mueller forest of 34-41 m predominate mean height. The understorey comprised *Acacia verticillata* (L.Her.) Willd, *Pommaderris spp* and *Olearia lirata* (Sims.)Hutch.

Establishment

The trial area was logged in 1985, broadcast burnt in early March 1986, with a very hot burn, and windrowed in March-April 1986. The soil was cultivated, by discing with little-giant discs, and mound-ploughed, with tandem off-set discs, of 600 mm diameter, in May 1986.

To prevent browsing electric fences were constructed in May-June 1986.

Results

Growth

Cultivation and spraying treatments produced significantly more height growth in the first four years.

Species and stocktype also showed significant differences with *E.nitens* growing more than *E.regnans* and for *E.nitens* open-root more than paper-pot stock. For *E.regnans* there was little difference in growth of different stock-types.

All the cultivation methods, discing, mounding or discing and mounding, produce significantly more growth than uncultivated sites.

Weed control

Spraying significantly reduced weed cover at 14 months and 2 years and at age 2 years cultivated treatments also carried significantly fewer weeds.

Spraying reduced weed cover by 50% while cultivation resulted in a reduction of about 17%.

Table 3. Analysis of variance table for tree volume (m^3) at age 2 years for two species and two stocktypes of eucalypt seedlings planted on areas treated with various site preparation methods and with or without herbicide.

Source Level	df	SS	MS	F	Sig
Blocks	2	5.36	2.68	3.4	NS
Cultivation	3	18.65	6.22	8.0	*
Major Plot Error	6	4.67	0.78		
Spraying	1	47.05	47.05	21.8	**
Spraying x Cultivation	3	14.81	4.94	2.3	NS
Spray Subplot Error	8	17.24	2.16		
Species	1	390.56	390.56	115.3	**
Spec. subplot Error	23	77.92	3.39		
Stocktype	1	66.93	66.93	71.0	**
Stock X Spec.	1	28.29	28.29	30.1	**
Remainder	46	43.23	0.94		
TOTAL	95	714.69			

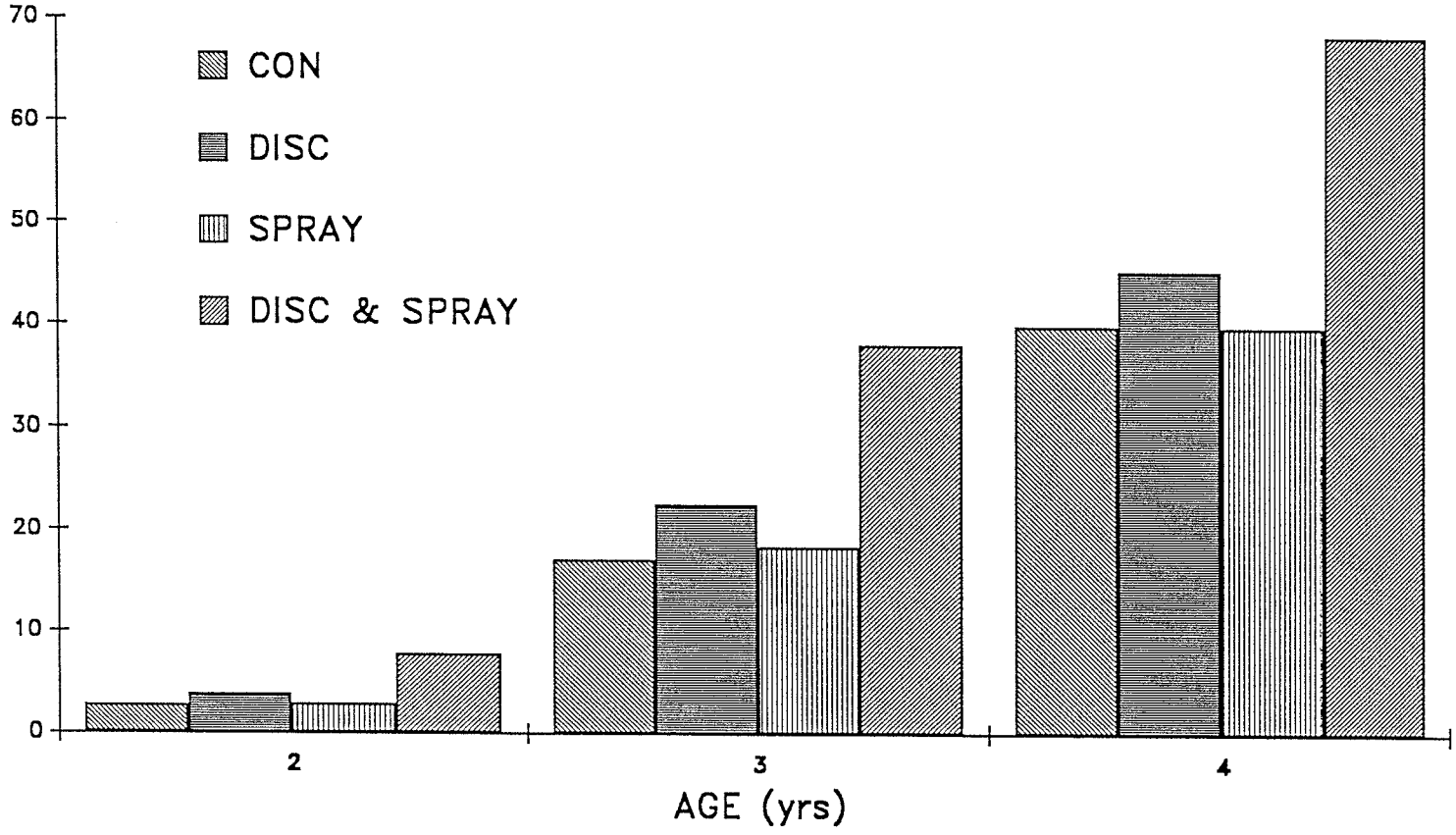
Table 6. Mean height and significant differences between cultivation and spraying treatments at ages 1 and 2 years.

Treatment	Mean height (m)	Non-sign. subsets[a]	Mean height (m)	Non-sign. subsets[a]
Cultivation				
Control	1.10	a	3.05	a
Disced	1.17	b	3.40	b
Mounded	1.21	b	3.44	b
Disced & Mounded	1.22	b	3.41	b
Spraying				
Control	1.10	a	3.07	a
Sprayed	1.26	b	3.58	b

Table 7. Weed cover (%) at 12 and 24 months after establishment of eucalypt plantation following various cultivation treatments and with or without spraying for ween control..

Treatment	Weed cover (%)	Non-sign. subsets[a]	Weed cover (%)	Non-sign. subsets[a]
Cultivation				
Control	64	a	72	a
Disced	48	a	56	c
Mounded	51	a	62	b
Disced & Mounded	44	a	55	c
Spraying				
Control	69	a	80	a
Sprayed	34	b	42	b

Volume against age for E. nitens untreated, disc–cultivated, sprayed with herbicide and both treatments



Effect of herbicides on woody weed control and growth of plantation eucalypt seedlings

G.R. Wilkinson and W.A. Neilsen

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Summary

Various herbicides were applied to control woody weeds on a granitic soil, before and after planting with open-root and paper-pot seedlings of *Eucalyptus regnans* F.Muell. and *Eucalyptus nitens* (Deane et Maiden)Maiden.

All herbicide treatments resulted in significantly reduced weed cover during the first six months after planting. For six treatments, weed control effects persisted for at least two years.

The growth response of eucalypt seedlings was related to both weed control effects and direct herbicide effects. Post-planting applications of atrazine reduced the survival of paper-pot seedlings. High residual levels of atrazine were associated with growth losses. Lower residual levels of atrazine gave significantly better growth and a direct growth stimulation was indicated.

For the study site, atrazine at 4 kg a.i. ha^{-1} was an effective and safe herbicide for pre-planting application to plantation seedlings of *E.regnans* and *E.nitens*.

ıble 3 Herbicide treatments and rates of active ingredients applied in the ːial

ɜrbicide	Rate of a.i. (kg ha^{-1})	Time of application	Treatment code	Approximate chemical cost of treatment ($ ha^{-1}, June 1989)
trazine	4	pre-plant	Atr4pr	27
trazine	8	pre-plant	Atr8pr	54
mitrole atrazine	1.5 + 4	pre-plant	AmAtr	58
trazine simazine	2 + 2	pre-plant	AtrSimpr	28
lyphosate simazine	0.72+ 3	pre-plant	GlSim3	47
lyphosate simazine	0.72+ 6	pre-plant	GlSim6	68
ːlopyralid	1.2	pre-plant	Clopr	178
ıtrazine	4	post-plant	Atr4po	27
ıtrazine	8	post-plant	Atr8po	54
ıtrazine simazine	2 + 2	post-plant	AtrSimpo	28
ːlopyralid	1.2	post-plant	Clopo	178
ıil (control)			Con	0

Figure 1. Height of Eucalypt seedlings 2 years after planting, following weed control with various herbicides.

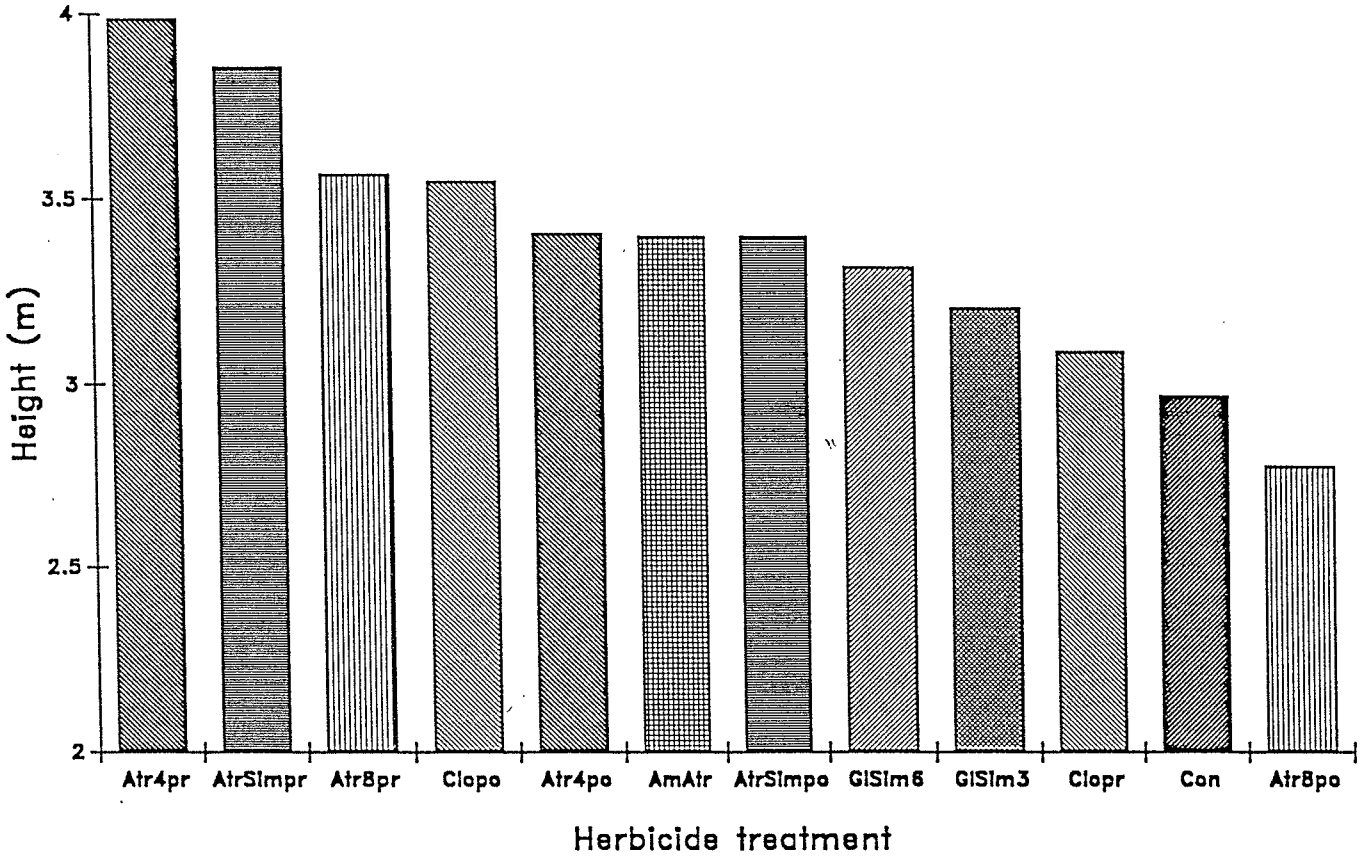


Figure 2. Survival of Eucalypt seedlings, following weed control with various herbicides.

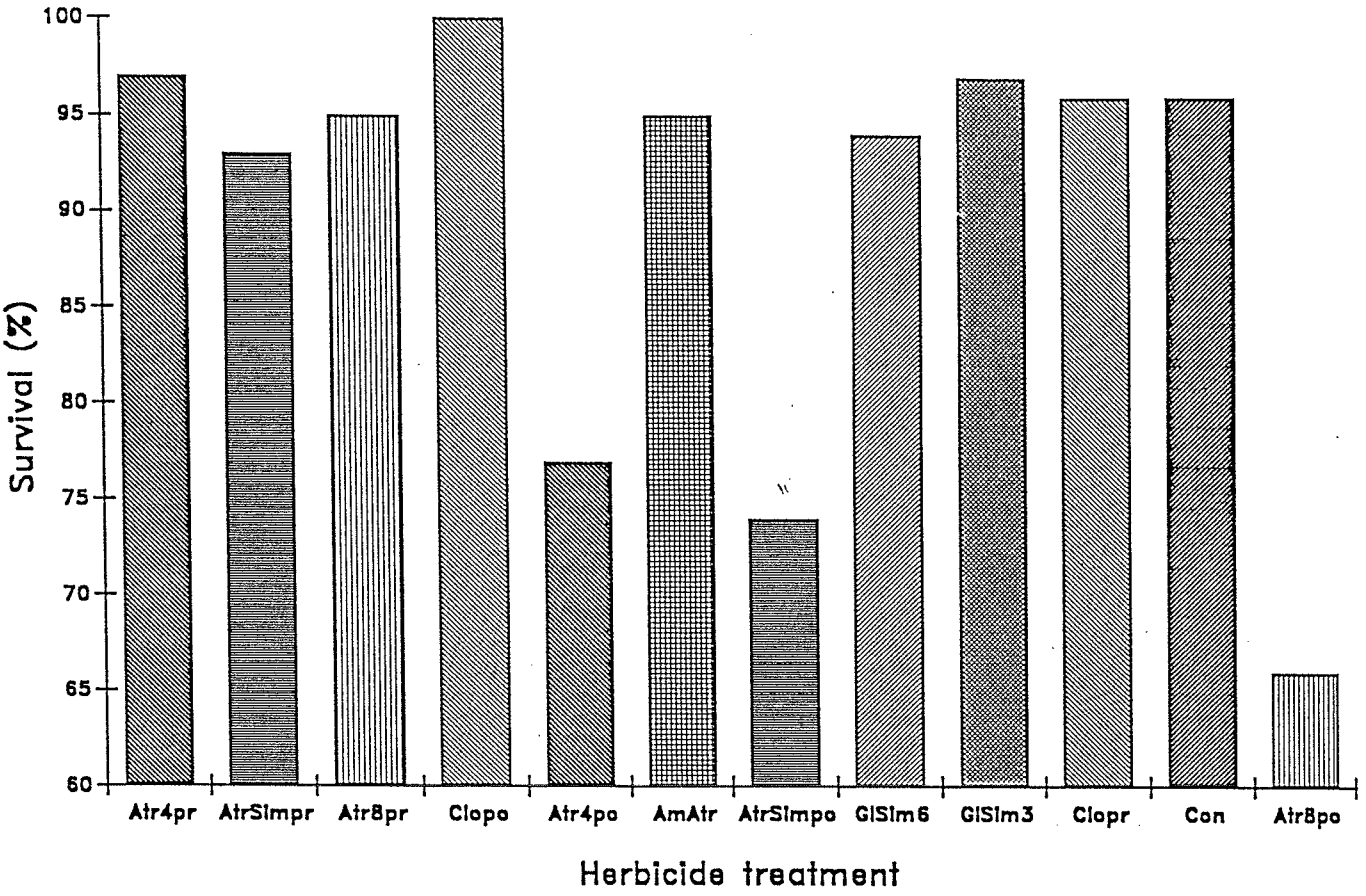
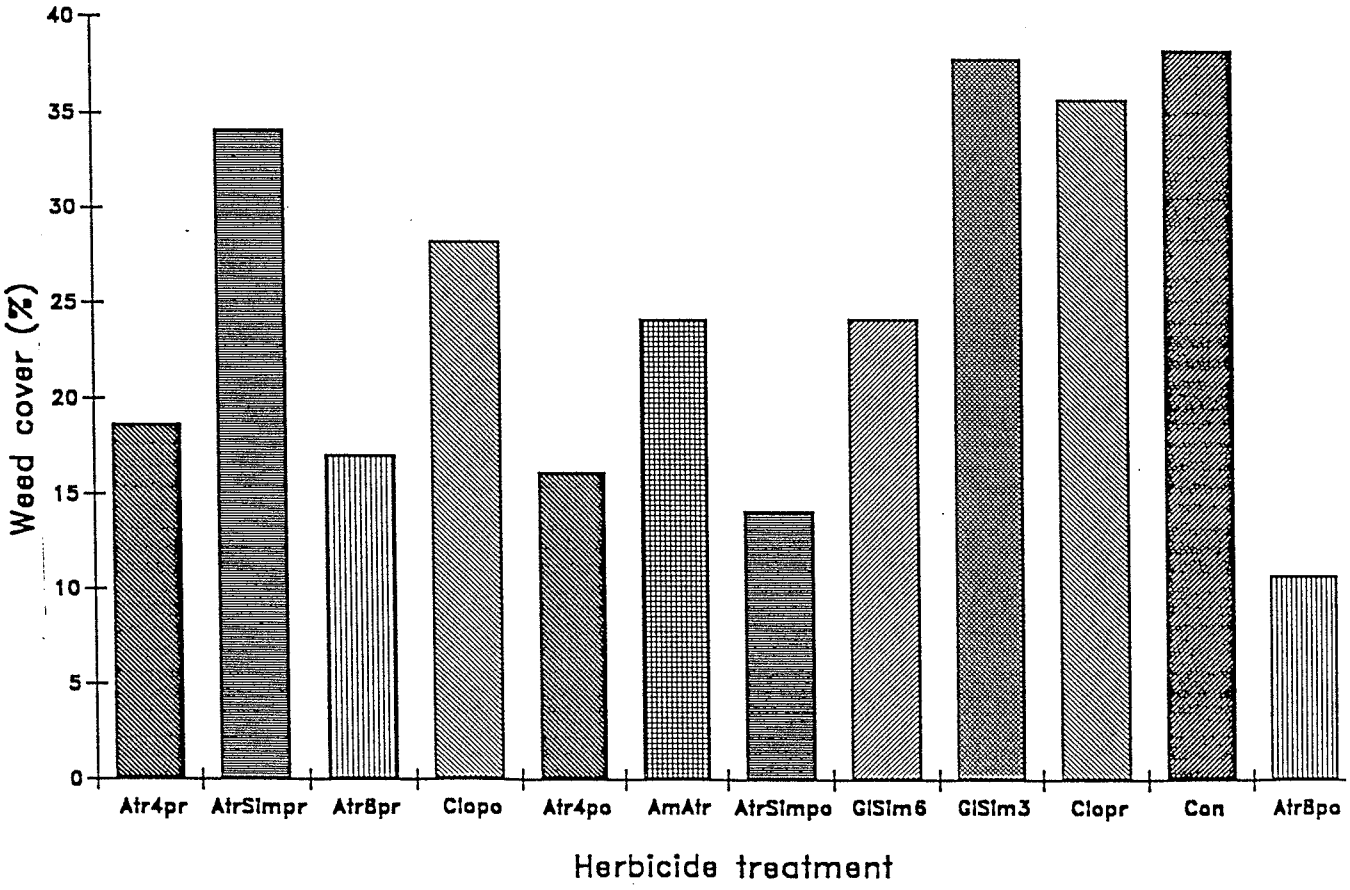


Figure 3. Weed cover at age 1 year, following weed control with various herbicides.



Effect of Simulated Browsing on Survival and Growth of *Eucalyptus nitens* and *Eucalyptus regnans* Seedlings

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Abstract

Severe and lasting growth reductions were caused by simulated browsing damage of planted *E. nitens* and *E. regnans* open-root and paper-pot seedlings in this study in northern Tasmania. Clipping of seedlings was carried out either 2 months or 7 months after planting or on both occasions. Severe "browsing" resulted in growth to age 3 years averaging 0.7 dm^3tree^{-1} compared with 7.7 dm^3tree^{-1} for the control seedlings. Effect on growth was similar for the two times and repeated clipping but the later removal caused death of more seedlings, with only 25% surviving when severely "browsed" at age 7 months. Less severe "browsing" also resulted in significant growth losses.

Methods

Browsing damage of eucalypts in the field consists of the removal of tops, the eating of various proportions of leaves and stems and in severe cases the eating of the seedling to near ground level (Statham 1983). For the trial three severities of treatments previously used in the study of *Pinus radiata* (D.Don) were used (Neilsen 1981). These treatments were tips removed (T), half of the plant removed (H) and severe which was removed to 25 mm of the ground (S).

Three treatment times were used. Early "browsing" (E) was carried out two months after planting of the paper-pot stock. Late "browsing" (L) was carried out seven months after planting and repeated "browsing" (R) was at both two and seven months after planting. Removal of foliage and stems was carried out using secateurs.

Figure 1. Volume of eucalypt seedlings at age 3 years following various simulated browsing treatments.

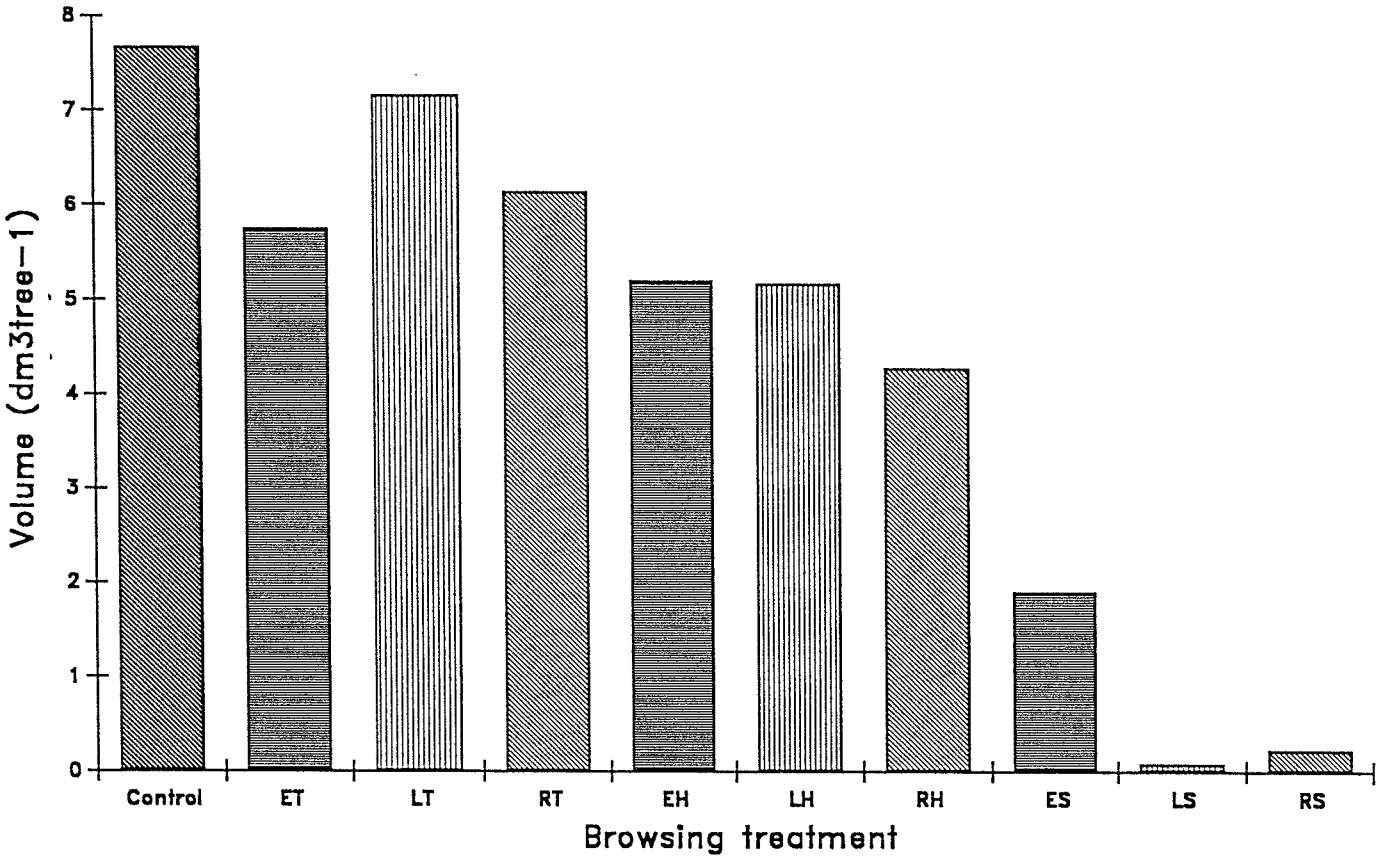
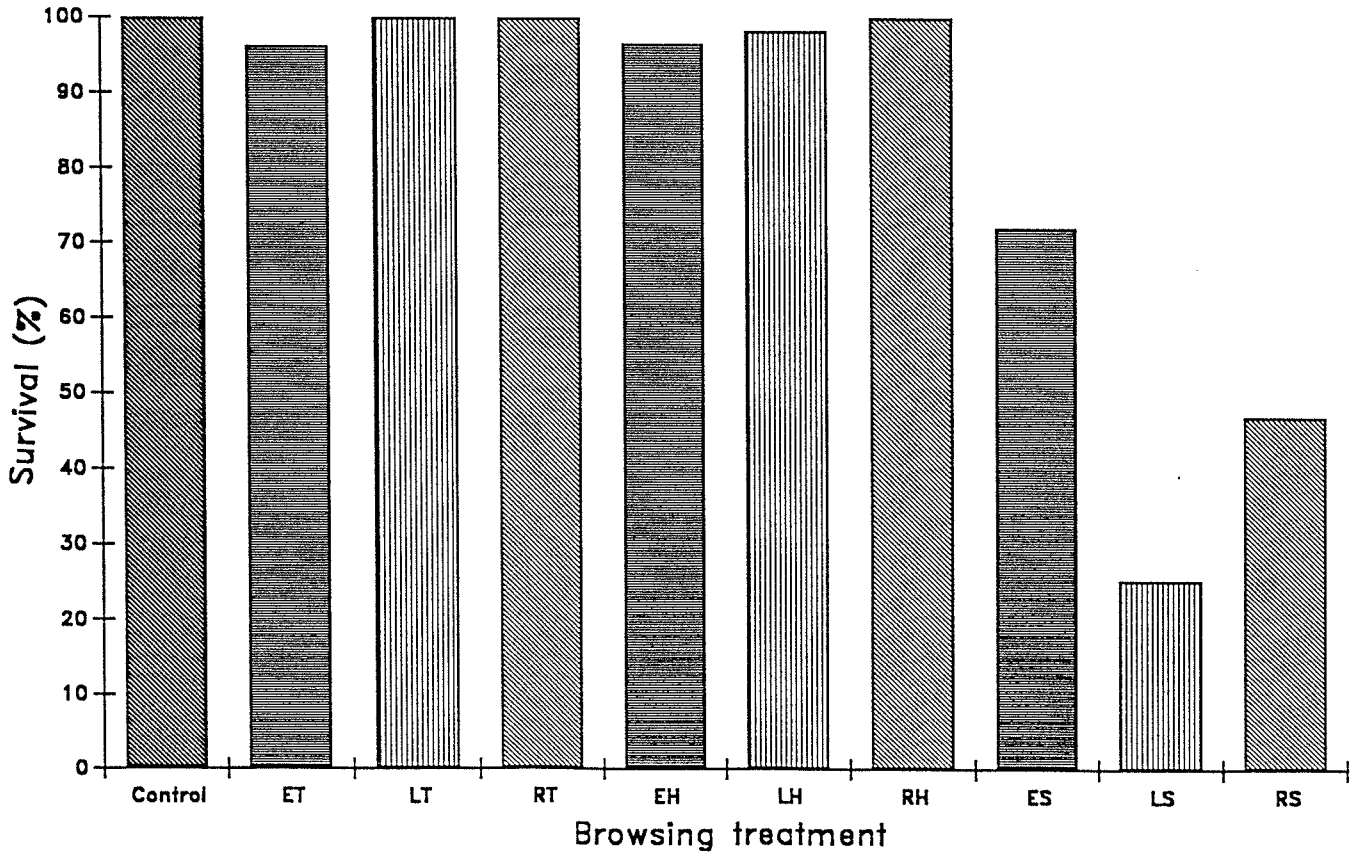
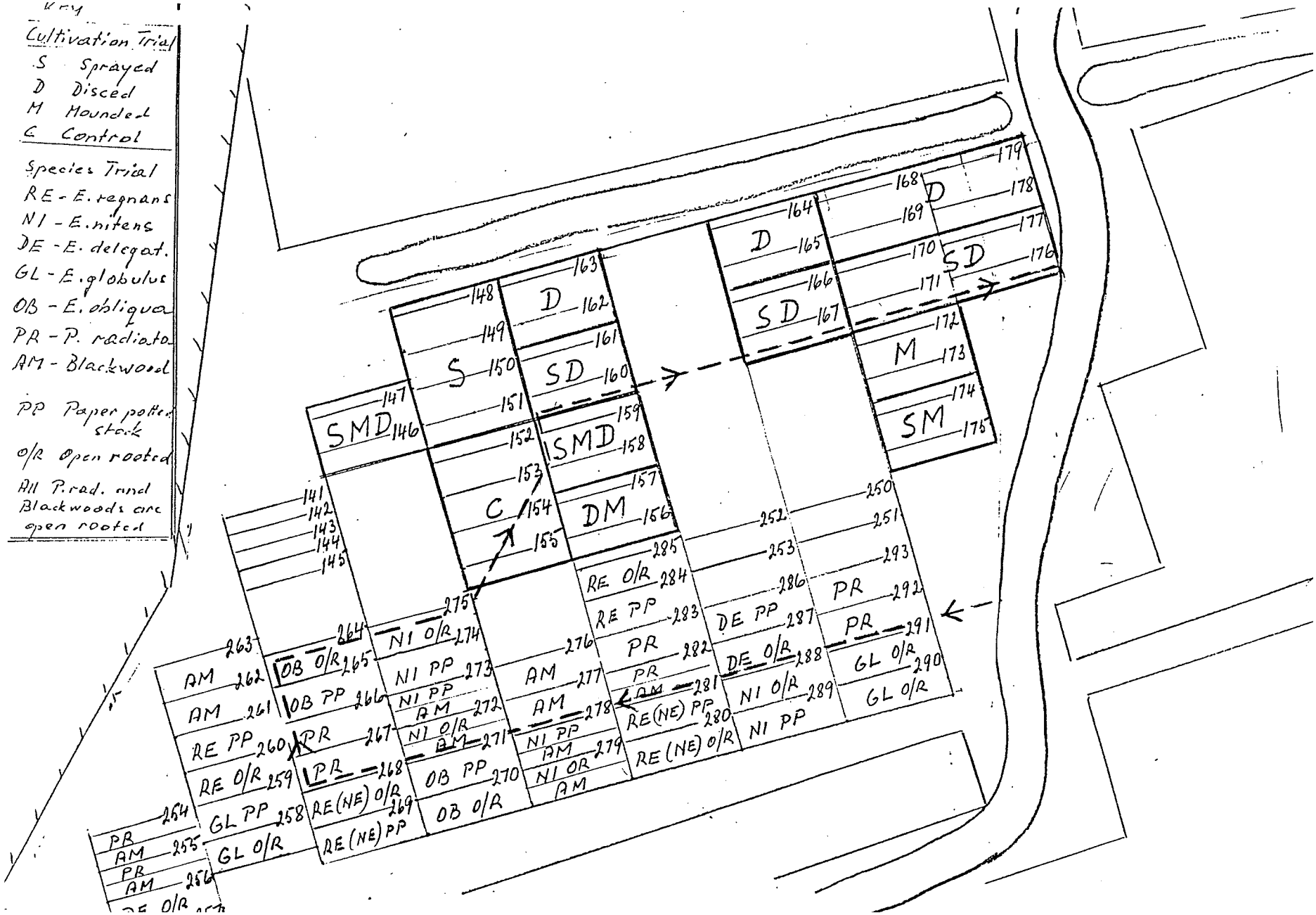


Figure 1. Survival of eucalypt seedlings following various simulated browsing treatments.




Key
Cultivation Trial
S Sprayed
D Disced
M Mounded
C Control
Species Trial
RE - E. regnans
NI - E. nitens
DE - E. delegat.
GL - E. globulus
OB - E. obliqua
PR - P. radiata
AM - Blackwood
PP Paper pottes stock
O/R Open rooted
All P. rad. and Blackwoods are open rooted
S
D
SD
SMD
C
DM
M
SM
AM
RE PP
RE O/R
GL PP
GL O/R
OB PP
OB O/R
PR
RE(NE) O/R
RE(NE) PP
NI PP
NI O/R
DE PP
DE O/R