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EIGHT EUCALYPT SPECIES AT FOUR SITES IN NORTHLAND, NEW ZEALAND AT AGES 7-11 YEARS

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GROWTH, FORM AND HEALTH OF EIGHT EUCALYPT SPECIES AT FOUR SITES IN NORTHLAND, NEW ZEALAND, AT AGES 7 TO 11 YEARS

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Key Words
Eucalyptus, E. nitens, E. fastigata, E. regnans, E. globulus, E. maidenii, E. saligna, E. grandis, provenance, Northland, growth, form, density.

EXECUTIVE SUMMARY

Species and provenance trials of eucalypts, planted in Northland between 1988 and 1993 included several provenances each of *E. fastigata, E. regnans, E. saligna, E. botryoides, E. grandis, E. nitens, E. globulus and E. maidenii.* Trials were planted at Carnation road, Karaka road, Walker road and Knudsen road, all located between Kaikohe and Dargaville. Results of assessments of two trials at Carnation road and two at Walker road (aged 11 and 9 years) and of *E. nitens* only at Karaka road are reported here.

Trial designs were mainly 64-tree square plots with two to four replications. Trees were assessed for diameter at breast height, bole straightness, malformation and crown health. Results were expressed as provenance and species means at each site, and also as basal area per ha., volume per ha. and frequencies of crop trees, mortality and runts (suppressed sub-dominants).

Eucalyptus fastigata showed best growth and health of all species (MAI at Carnation road averaged 52 m^3/ha./year) but suffered some basal and upper stem forking. *Eucalyptus regnans* also grew well, with good crown health but *E. nitens* of central Victorian provenances showed poor crown health and high mortality in spite of good earlier growth. *Eucalyptus saligna* (and *E. grandis*) grew slower than other species and showed a high frequency of runts. *Eucalyptus maidenii*, only planted in one subsidiary trial at Carnation road, had better crown health, higher survival and better growth than *E. saligna, E. grandis* and *E. globulus*, though its volume growth appeared to be less than *E. fastigata* in the main trial.

It was concluded that *E. nitens* of central Victorian provenances was poorly adapted and unlikely to continue its earlier good growth and that even the healthier NSW provenances appeared insecure. *Eucalyptus fastigata* was a clear winner on growth and health, followed by *E. regnans. Eucalyptus globulus* had generally poor health and slower growth than *E. nitens*. *Eucalyptus maidenii*, although a slower starter, had good crown health, good survival and showed higher wood density than *E. nitens* and *E. globulus*, and by inference, *E. fastigata* and *E. regnans. Eucalyptus saligna*, originally the most widely-planted species in Northland, had much lower volume production than the other species.

INTRODUCTION

In 1981, an afforestation project was begun in Northland, New Zealand by New Zealand Forest Products Ltd. (NZFP), (later Carter Holt Harvey Forests Ltd., CHH). Initially, only *Pinus radiata* was planted but in 1985 it was proposed that the "Mangakahia Project" should include up to half its area in eucalypts to provide short-fibred pulp for a kraft pulp mill to be built in the Northland region (P. Smale, unpublished). A series of eucalypt establishment trials as well as species and provenance trials was initiated by Paul Smale (for NZFP) in 1986. That year and in 1987 some establishment trials were undertaken with *E. saligna* and *E. regnans*. *Eucalyptus saligna* was traditionally the main species grown for shelter, amenity planting and timber production in Northland on better sites, while *E. botryoides* had been used on wetter sites. Earlier trials by NZFP in the 1970's had also shown *E. saligna* to be the more suitable species (H. McKenzie, unpubl). *Eucalyptus regnans* was included and later, *E. fastigata*, as the species with which the company had successfully established a large pulpwood resource of some 7000 ha in the Central North Island, near Tokoroa. For various reasons, commercial scale eucalypt planting by CHH never went ahead and neither has any pulp mill been constructed in Northland.

There were, initially, some problems with survival, especially with *E. regnans* and *E. fastigata* on wet clay soils. By 1988 establishment techniques, including ripping and bedding or v-blading, and fertilising and weed control by herbicides had been worked out and *E. saligna* was still appearing as the most suitable species of eucalypt for Northland. The species and provenance trials, initiated in 1987 and planted in 1988, fortunately as it turned out, included *E. regnans* and *E. fastigata* as well as *E. saligna* and *E. botryoides*. "New" species to the region that were included in the trials were *E. nitens*, *E. globulus*, *E. maidenii* and *E. grandis*. Species and provenance trials were planted at Carnation Road (two trials) and at Karaka Road in 1988, at Walker Road (two trials) in 1990 and at Knudsen Road in 1991 (previously reported by Low and Shelbourne, 1999). An assessment of the Carnation Road and Walker Road trials at ages 11 and 9 years respectively is reported here (*E. nitens* only was also assessed at Karaka Road).

MATERIALS AND METHODS

Seedlots

In all, 20 seedlots from eight species were tested in two nearly adjacent trials (1 and 2), planted in 1988 at Carnation Road, and 10 seedlots from three species were tested in two adjacent trials at Walker Road, planted in 1990. An identical trial to Carnation Road Trial 1 was planted at Karaka Road. Code numbers, seedlot numbers, where available, and their provenance or origin are listed in Table 1 and their natural distributions in Australia are shown in Figures 1-5 (Orme, 1977; Boland et al., 1984; Tibbits and Reid,1987). The seedlots were chosen as those that were available at the time and do not represent a proper sampling of the range of each species in most cases. An exception to this would be the good provenance sample for *E. nitens* at Knudsen Road.

For *E. saligna*, two seedlots from natural populations in NSW (Bateman's Bay and Kangaroo Valley) had performed well in a 1976 *E. saligna* provenance trial (C.B. Low, unpublished data). For *E. fastigata*, only one native provenance (from the southernmost part of the range in eastern Victoria) was represented which had performed mediocrely in a 1980 provenance trial in the central North Island (F. Burger, unpublished). *Eucalyptus regnans* was represented by two seedlots, from Tasmania and Victoria, as well as seedlots from selected parents in the Wiltsdown (Tokoroa) provenance trial of 1976, and from a New Zealand clonal seed orchard. *Eucalyptus nitens* seedlots included one from NSW (a mixture of seed from southern NSW populations at

Tallaganda, Nimmatabel and Bondi), and two different lots from Toorongo in central Victoria. *Eucalyptus botryoides* was represented by one seedlot, from the Woodhill seed orchard.

The seedlots of *E. grandis*, *E. globulus* and *E. maidenii* in Trial 2 at Carnation Road were all from exotic stands for which there is no provenance information, and the *E. saligna* seedlot was a bulk of all *E. saligna* lots in Trial 1. At Walker Road, the *E. nitens* provenances include one each from Barrington Tops, NSW, (the second most northerly population from latitude 34°S), Mt Anembo(Tallaganda S.F.), Nimmatabel (ex Cpt. 905, Kaingaroa, NZ) in the southern NSW group, and from Toorongo, central Victoria, and from a mix of 8 central Victoria provenances. The NZ seedlot originated from a small stand of Victorian provenance, whose offspring provided the seedlot used in the trial, which was possibly inbred. Two *E. globulus* provenances, included one from southern Tasmania and one from Jeeralang, Victoria, in the north-eastern margin of the *E. globulus* distribution where it adjoins and can hybridise with *E. pseudoglobulus*. The *E. saligna* seedlot in the Walker Road trials was from the NZ Tairua seed orchard.

Sites

Carnation, Karaka, Walker and Knudsen Road trials are located south of Kaikohe, longitude 173° 48'E, latitude 35° 24'S, as shown in Figure 6. The Carnation Road site is at altitude 150 metres, and the soil is a Waimatenui clay; at Walker Road, altitude 50 metres, and Karaka Road, altitude 100 metres, the soil, is a Waiotira clay loan. Knudsen Road, at altitude 150 metres has a clay soil with a capping of volcanic ash in part of the area. Climatic data from Bioclim for these sites are shown in the Appendix.

DESIGN AND LAYOUT

Carnation Road (and Karaka Road) Trial 1

Both trials involve 16 seedlots of five species, planted on ripped and bedded sites in June 1988 at 2 x 2m spacing (2500 stem/ha). The design was randomised complete blocks with 64-tree plots, 8 x 8 rows, 16m square, with four replications. There was a two-row surround on western and southern margins at Carnation Road but not on northern and eastern margins. The trial was thinned to 1250 stem per ha, two years after planting.

Carnation Road Trial 2

Four seedlots (four species) were planted in November 1988 at 4 x 2m spacing. The design was randomised complete blocks with four replications of 20-tree plots (two rows of 10 trees, with 4m between and 2m within rows). A single row surround was planted around the trial. No thinning had been carried out up to the time of assessment.

Walker Road Trial 1

Five seedlots (three species) were planted in July 1990 at between 3 and 4m x 2m spacing in a randomised block design with two replications of 64 tree plots (8x8 rows). Only half of one plot of *E. globulus* was planted. Spacing was variable in the 3-4m direction as it followed the ripped and bedded lines.

Walker Road Trial 2

Five seedlots (3 species) were planted in September 1990, as in Trial 1, in five replications of a randomised complete block design. No thinning was apparently carried out in the Walker Road trials.

ASSESSMENTS

The same assessment procedure was used in all four trials. Each tree position was scored as a missing tree, a dead tree or a runt (a tree that was well below the canopy in height and with a diameter less than 120 to 150 mm, depending on species). All remaining trees were measured for diameter at breast height (DBH), and subjectively scored for bole straightness (1 = very crooked to 9 = straight), malformation (1 = multiple forks to 5 = single stem) and crown health and density (1 = almost leafless to 9 = long, dense crown of undamaged leaves).

Between 20 and 30 trees of *E. globulus* and *E. maidenii* (in Trial 2) and *E. nitens* (southern NSW) in Trial 1 at Carnation Road were increment core sampled for outer-wood basic density, as part of tree selection for a kraft pulp and wood properties study. A 10-tree sample of top heights of each species was measured at Carnation Road.

ANALYSIS

The presence/absence data on missing and dead trees, and "runts" were expressed as seedlot mean percentages of crop trees, early mortality and thinnings, later mortality and runts (which were not assessed for anything else).

Individual tree values for DBH, straightness, malformation and health scores were subjected to analysis of variance and Tukey's test was used to indicate significant differences among seedlot means. Diameter was converted to basal area on a plot mean basis and expressed as basal area per ha. Volume equations, devised for *E. regnans*, *E. fastigata* and *E. saligna*, were used to calculate volume per ha. for appropriate seedlots and the equation for *E. regnans* was used for the other species. Basal area and volume per hectare were also calculated from the inner plot of 6 x 6 rows, originally of 36 trees, to eliminate competition effects as far as possible. However, with the original spacing of 2 x 2 m and subsequent mortality this means that each plot basal area is based on an average of from 8 trees for *E. saligna* up to 16 trees for *E. fastigata*, which is too small for reliable estimates. Both inner and total plot values will be shown, therefore.

RESULTS AND DISCUSSION

Carnation Road Trial 1

Seedlot mean percentages for crop trees, early mortality and thinnings, later mortality, runts and basal forks are shown in Table 2, giving a picture of the stand in terms of survival and development of competitional effects. About 50% of the trees were reportedly removed in a very early thinning (age 2 years). Most seedlots show early mortality plus thinnings to be close to this figure, apart from severe early mortality in *E. regnans* seedlot, R4. Later mortality, recorded by scoring dead trees, was quite variable but was particularly severe in *E. nitens*, N2, from Toorongo, Vic. and *E. regnans*, R4, from the NZ seed orchard. *Eucalyptus fastigata* from Bendoc, Vic. also showed 14% later mortality. Survival of *E. botryoides* was so low that these plots were not assessed: early possum damage was severe and may have been the cause of the failure of this species (P. Smale, unpubl. data).

The frequency of runts was species-dependent and highest in all the *E. saligna* seedlots, averaging 26%. It was evident in the plots of *E. saligna* that there were a few healthy, well-grown individuals and a large proportion of co-dominant and suppressed stems that contribute to the "runt" category.

Basal forking was almost absent in *E. saligna*, relatively low in *E. nitens* and *E. regnans* (6%) but high in *E. fastigata* (22%).

Crop tree percentages differed substantially between species, as a result of the differences in the other frequency traits. *Eucalyptus fastigata* had an average of 43% and *E. saligna*, 23% of crop trees of the original number planted, with *E. nitens* and *E. regnans* intermediate. These frequencies of crop trees have an important influence on both mean DBH and on volume per ha. of different seedlots. There was considerable variation amongst the seedlots of *E. nitens*, with one Toorongo seedlot well stocked (N3) and the other (N2) poorly stocked owing to recent mortality.

Growth rate is expressed in Table 3 as mean diameter at breast height, basal area per hectare and volume per hectare. Runts were included for the basal area and volume per ha., but contributed very little. Mean DBH of all *E. saligna* seedlots was clearly well below the other three species, averaging 240mm. DBH of *E. nitens* was lower than *E. fastigata* and *E. regnans*, with *E. fastigata* averaging 315 mm across all provenances.

Highest basal area and volume per ha. was produced by *E. fastigata*, followed by *E. regnans* and then *E. nitens*. The volume production of *E. saligna* was only half that of *E. fastigata*. Considering the more conservative volume per ha. figures, based on the inner plots, the best *E. fastigata* seedlot from Oakura, NZ is showing a mean annual increment (MAI) of 61m³/ha/year. *Eucalyptus fastigata*, *E. regnans*, *E. nitens* and *E. saligna* are averaging MAIs of 52, 50, 40 and 29m³/ha/year respectively. Excluding the aberrant *E. regnans* seedlot R4 which had heavy early mortality, the average MAI for *E. regnans* was 56m³/ha/year. On a global basis, these figures for *E. fastigata* and *E. regnans* are encouragingly high for a heavy clay soil in Northland.

There is important variation between seedlots within *E. fastigata* (and within the other species) but this is only suggestive of the possibilities of gain in growth rate from provenance testing and breeding.

Bole straightness scores (Table 4) were lowest for *E. saligna* as were malformation scores. These reflect the high incidence of top breakage and subsequent forking and stem deformation, probably caused by wind and opossums. Bole straightness scores were lower for *E. fastigata* than *E. nitens* and *E. regnans* and so were malformation scores, because of forking (there was also a high frequency of basal forks in *E. fastigata*).

Crown health was good for *E. fastigata* but the Bendoc, Victoria provenance averaged only 5.1 versus 6.1 for the other two seedlots. Crown health was poor in the two Toorongo provenances of *E. nitens* (3.4 and 3.8) and better in the NSW provenances (5.0), as was found in the Knudsen Road trial (Table 13). The low crown health scores combined with high mortality in the Victorian seedlots resulted in a sick-looking stand. Crown health scores for *E. regnans* were quite good but mediocre for *E. saligna*, possibly reflecting damage by *Ophelinus*, the gallwasp.

Carnation Road Trial 2

There was no thinning carried out in this trial so that crop tree % represents relative survival or stocking of dominant and co-dominant trees (Table 5). *Eucalyptus maidenii* had best survival of all four species (80 %) with 14% deaths and few runts. *Eucalyptus saligna* and to a lesser extent *E. grandis*, had high proportions of runts as was typical in this species in Trial 1. *Eucalyptus globulus* suffered the worst mortality of all species which appeared to be still occurring, and health score was very low (3.0).

Height growth was similar for all species (Table 6), but *E. saligna* was 3 metres shorter than in Trial 1 (at 21.7m) indicating a difference in site quality between the two trials; direct comparison of volume per ha. and basal area per ha. will thus be unreliable. Because 20 tree plots were used in Trial 2, calculation of inner plot basal area and volume was impossible.

Eucalyptus maidenii exhibited the largest basal area per ha. and MAI of 43 m^3 /ha./year at an actual stocking of 1000 stem/ha. *Eucalyptus globulus*, *E. saligna* and *E. grandis* showed a similar crop tree stocking (about 60% or 750 stems/ha.), similar DBH (212mm) and MAI varying from 34 m^3/ha. (*E. globulus)* to 36 m^3/ha./year (*E. grandis)*. From experience at Clive in Hawkes Bay, *E. maidenii* seems likely to be able maintain this high stocking without mortality for some time (Low & Shelbourne, 1999).

Bole straightness was best for *E. maidenii* (7.0) and *E. globulus* showed least malformation. *Eucalyptus saligna* and to some extent, *E. globulus* had signs of past broken tops which were depressing straightness and malformation scores. The crown health of *E. maidenii* was good (6.3) but particularly bad for *E. globulus*. This species' future survival looked uncertain based on its past mortality and present crown health.

Basic density of outerwood (Table 7) of *E. maidenii* was high at 578 kg/m^3, somewhat lower for *E. globulus* (505 kg/m^3) and very low for *E. nitens* from southern NSW, estimated in Trial 1 at 412 kg/m^3. By comparison (Shelbourne, unpubl. data), at age 8 years at Knudsen Road the outerwood density of these species was respectively 530, 430 and 412 kg/m^3; two provenances of *E. maidenii* (from Bolaro Mountain in the north, and Eden at the southern end of the range in NSW), two provenances of *E. globulus* (from Tasmania and Jeeralangs, Vic) and three provenances of *E. nitens* from southern NSW were sampled.

Karaka Road

Four plots of seedlot, N1, *E. nitens* from southern NSW and four plots of N2, *E. nitens* from Toorongo Vic., were assessed at the Karaka Road trial, as a cross-check on their performance at Carnation Road (Table 8). This trial had been thinned to 50% stocking at age 2 years, like Carnation Road. There was somewhat higher recent mortality in the Toorongo seedlot than in that from NSW (14 versus 6%). The most noticeable difference was in crown health; the Toorongo provenance crown score was only 1.8 indicating most of the trees were now near death. The health score of the southern NSW seedlot was 4.0 which was appreciably lower than at Carnation Road. DBH was slightly lower for the NSW seedlot and inner plot basal area per ha. was 51 for the NSW and 39m^2 for the Victoria provenance. Compared to Carnation Road, DBH of both provenances was much lower, stocking of the NSW seedlot was higher and basal area /ha. a little higher. However, the general health and current growth of the NSW provenance appeared worse at Karaka Road.

Walker Road Trials 1 and 2

The results of these trials are best considered together, though statistically they have to be analysed separately. Results from Trial 1 are shown in Tables 9 and 10 and for Trial 2, in Tables 11 and 12. With only two replications of Trial 1, its precision is low. The two trials together accommodate six seedlots of *E. nitens*, including native populations in all cases except one. These range from Barrington Tops, northern NSW to central Victoria. *Eucalyptus globulus* is represented by southern Tasmanian and Victorian provenances and *E. saligna* is presented in both trials as a Tairua, N. Z. seed orchard seedlot.

Only half a single plot was planted of *E. globulus* from Tasmania in Trial 1, which thus shows a high "early mortality". Total mortality was high (51%) for seedlot NMIX, a mix of 8 Victorian provenances and very high in Trial 2 for *E. nitens* from Glentunnel, NZ, an inbred, second-generation seedlot originally from central Victoria. This is underestimated at 70%, as one whole plot of trees was dead or missing, and not analysed. NSW provenances generally showed lower mortality. *Eucalyptus saligna* had a high percentage of runts and did not show serious early or later mortality. Basal forking was not a problem with any seedlots in these trials.

In Trial 1, *E. nitens* from Barrington Tops had the highest basal area though DBH was lower than that of NMIX, the mix of Victorian provenances. In the second trial, *E. nitens* from Nimmatabel in southern NSW, had the highest DBH and basal area/ha.

Bole straightness was generally acceptable for all species except *E. globulus* from southern Tasmania in Trial 1, which also suffered severe malformation. The Jeeralangs, Vic. provenance did not have the same problem in Trial 2.

Health score for *E. globulus* from Tasmania was 4.1 and the species looked very sick. Health of *E. globulus* from Victoria was much better (5.6). Health score of *E. nitens* central Victoria seedlots in Trial 1 and Trial 2 ranged from 4.0 to 4.8 whereas NSW seedlots ranged from 6.3 for Nimmatabel to 5.4 for Mt. Anembo (Tallaganda).

Basal area of the more vigorous seedlots was generally overestimated in the whole plots versus the inner plots. The higher mortality in Victorian provenances of *E. nitens* tends to result in higher DBH but the basal area of NSW provenances is generally higher than Victorian provenances, reflecting their lower mortality and better health.

Seedlot means at the Knudsen Road trial for *E. nitens* provenances from NSW and Victoria, *E. globulus, E. maidenii, E. grandis, E. saligna* and *E. botryoides are shown* in Table 13 (from Low and Shelbourne, 1999) for purposes of comparison. In particular, the *E. nitens* provenances from NSW at Knudsen road, aged 7 years, had much healthier crowns than the N1 (southern NSW) seedlot at Carnation and Karaka road trials, aged 11 years.

IMPLICATIONS AND CONCLUSIONS

Although *E. fastigata* was only assessed at Carnation Road, it is clear that this species exceeds all others in these trials for adaptation, health and volume growth. The Oakura, NZ seedlot grew particularly well with an MAI of 60m^3/ha/year. Form, however, of these seedlots was marred by frequent basal forking and some tendency to fork higher up the stem, a common defect of this species in many seedlots. There are known to be certain seedlots and progenies that are free of it, for instance, a particular South African seedlot planted as a filler in an *E. nitens* trial at Walnut Road, Kinleith, and at Tolaga Bay, where there is a 40 ha. stand of the same seedlot. *E. regnans* suffered from early mortality (P. Smale, unpublished) caused by Phytopthera, but volume growth has been only a little less than E. *fastigata*, (average MAI 50 m^3/ha/year), and crown health appears good.

Eucalyptus nitens is showing generally poor crown health and high mortality at Carnation Road and even worse crown health, especially in Victorian provenances, at Karaka Road. Although the southern NSW seedlot appears more healthy than the central Victorian, the current growth rate appears depressed, the volume growth is lower than *E. fastigata* and *E. regnans* (MAI 40 m^3/ha/year) and the prospects for continued good growth look poor.

At Walker Road, which is two years younger, the Victoria seedlots of *E. nitens* are showing poor health, more mortality and slower growth than the provenances from northern and southern NSW. At Knudsen Road at age seven years (and presently at age eight), *E. nitens* of Victorian provenances are showing acute mortality and health problems but the NSW provenances from northern and southern populations were still healthy in the crown and much less subject to mortality. Basal area per ha. averaged $40m^2$/ha. for southern NSW seedlots and 19 m^2/ha. for Victorian seedlots. It could reasonably be hypothesised that this species is generally ill-adapted to the warm climate of Northland, which has high rainfall throughout the year and clay soils, coming as it does from much higher altitudes between latitude 37° and 31°S, and that decline with age is just a matter of time. Outerwood density of *E. nitens* from southern NSW, which is important in kraft pulping and also for solid wood products, is particularly low in Northland; at age 11 at Carnation Road it was 412 kg/m3 and age 8 at Knudsen Road it was the same (Shelbourne, unpubl. data).

Eucalyptus saligna was the original species of choice for Northland. It has become afflicted by two insect pests, *Ophelinus*, the gall wasp, and *Cardiospina*, the brown lace lerp, which is a sap sucker. The latter has probably not reached these trials yet in its northernward migration but it is causing complete defoliation of *E. saligna* as far north as Whangarei (T. Withers, pers. comm.). Possums and/or wind appear to have caused top breakage in the past which is evidenced by stem bends and forking. On top of these problems, this species at these ages is showing a high proportion of "runts", poorly-grown subdominants, and low basal area and volume per ha. (average MAI 28 m^3/ha/year at Carnation Road) which disadvantages it as a short rotation pulpwood species; it can no longer be considered a species option for Northland. Much the same can be said about *E. grandis*, a related species with a natural distribution centred on summer rainfall, subtropical latitudes.

Eucalyptus globulus is showing similar health problems to the Victorian provenances of *E. nitens*, both at Carnation Road and at Walker Road. However the Jeeralang, Victoria provenance at Walker Road has better crown health than the Tasmanian provenance. Volume growth of *E. globulus* is substantially less than the best provenances of *E. nitens*, especially in Trial 2 where the Victorian provenance is well replicated. It can be concluded that *E. globulus* of either Tasmanian or Victorian provenance is less well adapted to these sites than NSW provenances of *E. nitens* whose long term health and survival prospects are still not good. At Knudsen Road both Tasmanian and Victorian provenances of *E. globulus* have grown less than NSW *E. nitens* and have much poorer crown health.

Eucalyptus globulus would be the species of choice from a kraft pulping standpoint on account of its excellent fibre properties and relatively high wood density, compared with *E. nitens* and *E. fastigata*, but it is evidently poorly adapted to Northland. A closely related taxon from eastern parts of Victoria, (see Fig 1) *E. pseudoglobulus,* has not been tried in Northland. In a trial at Omataroa in the coastal Bay of Plenty (Concheyro et al., unpubl.) it has performed in growth at age 4 better than *E. globulus* provenances (from Victoria) as well as in health at age five (Withers and Kimberley, unpubl.).

Eucalyptus maidenii is another member of the *E. globulus* species complex (also known as *E. globulus ssp. maidenii*) and this species has shown much better crown health than *E. globulus* and *E. nitens* at Carnation Road, and similar health to the best NSW provenance of *E. nitens* at Knudsen Road. However, at age 7 at Knudsen Road, its basal area was only 70% of that of the best NSW *E. nitens*. Its volume growth in Trial 2 at Carnation Road of 43 m^3/ha/year is also less, apparently, than *E. fastigata* and *E. regnans* in Trial 1 which show over 50 m^3/ha/year. How much of this difference is due to different site conditions between the two trials is uncertain (E. saligna is 3m shorter in Trial 2 than in Trial 1). Its outerwood density of 578 kg/m³ versus 412 kg/m³ for *E. nitens*, its capability of carrying high stockings without mortality, its good form and good health are all points in its favour.

The good health of the southern and northern NSW provenances of *E. nitens*, of *E. fastigata* and *E. maidenii* (as well the good adaptation of *E. saligna* and *E. grandis*, apart from insect attack), all from NSW, is noteworthy. This could be a basis for thinking that eucalypt species from SE Australia that come from areas where there is some rainfall during summer or even a summer rainfall peak, (as opposed to strongly winter rainfall), may be better adapted to Northland, coastal Bay of Plenty and possibly other North Island climates. The prevalence of infection and defoliation of young *E. nitens* in the Bay of Plenty by *Mycosphaerella spp.* and by *Kirramyces eucalypti* which is currently causing concern is one example. NSW provenances of *E. nitens* have been shown to be less affected by *Mycosphaerella* in South Africa (Purnell & Lundquist, 1986) and in Victoria, *E. maidenii,* and to a lesser extent Victorian provenances of *E. globulus* have been shown to be less affected by *Mycosphaerella* than Tasmanian provenances (Carnegie et al., 1994). The climatic domains characterised for *E. fastigata* in NSW contrast with those for *E. nitens* and *E. regnans* in central Victoria in showing more rainfall in the summer months (Lindenmayer, Mackey and Nix, 1996).

These trials have provided valuable experience with replicated large plots for comparing species and provenances i.e. 16 x 16m., 0.025 ha. and 64 trees at 2500 stems per ha. (Trial 1) and 20 x 8m., 0.016 ha. and 20 trees at 1250 stems/ha.(Trial 2), both at Carnation Road,16 x 21 m., 0.038 ha. and 64 trees at 1666 stems/ha at Walker Road and 14 x 13 m., 0.019 ha. and 49 trees at 2631 stems/ha at Knudsen Road. Testing different species and different provenances requires trial designs that are robust to long-term interplot competition effects and which provide enough trees per plot at the end of the rotation (or conclusion of the trial) to estimate basal area and volume per ha. At least one border row around each measurement plot are needed for eucalypts. This means that a plot of 0.044 ha. and 49 trees (inner plot 25 trees) planted at 1111 stems/ha. with 800 stems/ha. surviving would leave 18 trees in the inner plot. If trials are required to be thinned for eventual production of sawlogs on longer rotations eg. to 300 stems / ha., a 0.090 ha., 100-plot with a 64-tree inner plot would be required, to leave 17 trees in the inner plot. Trials with large plots can only accommodate relatively few seedlots with a few replications without being excessively large and costly to establish and assess. Unfortunately, tests of different species and provenances require continuation nearly to rotation age.

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The foresight of NZFP Forests Ltd (now CHH) in initiating these well-designed trials must be commended; the lack of long-term species and provenances trials in many other parts of NZ hampers successful planting of alternative species. The help of R. Cameron in the field assessment and Eva Moke with wood density determinations, as well as the cooperation of CHH Forests Ltd are gratefully acknowledged.

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Table 1. List of Seedlots

Trial 1: Carnation Road			
Species	**Code**	**Seedlot No.**	**Provenance/origin**
E. saligna	S1	ex GTI[4]	Batemans Bay, NSW
	S2[1]	ex GTI	Waitangi, NZ
	S3[2]	ex GTI	Seed orchard NZ
	S4	ex GTI	Kangaroo Valley, NSW
	S5	1/0/86/27	Waipoua, NZ, Cpt. 8/1
E. fastigata	F1		Natal, S. Africa ex Walkers Road, Kinleith
	F2	8/0/87/38	Bendoc, Vic
	F3	ex GTI	Oakura, NZ
E. regnans	R1		Wilmot, Tas
	R2	2/2/86/32	Kinleith, NZ Atiamuri Seed Stand
	R3	ex GTI	Strzlecki, Vic
	R4	ex GTI	Seed orchard NZ
E. nitens	N1[3]	ex GTI	NSW (Southern)
	N2	8/0/37/31	Mt Toorongo plateau, Vic
	N3	8/0/87/33	Mt Toorongo plateau, Vic
E. botryoides	B1	1/3/87/8	Woodhill seed orchard
Trial 2: Carnation Road			
Species	**Code**		
E. grandis	Grandis	FRI77/2055	Francinus Rus, SA Forest Investments Ltd, Sabie, S. Africa S/N S467
E. saligna	Saligna	Mixed	
E. globules	Glob G	HO/0/77/19	Australian Seed Co. (L.J. Langley) ex California
E. maidenii	Glob M	88/853	Waiohiki, Napier, NZ

[1] S2 – Mix of SA 128 (stand) 8.8g and SA 124 (single tree 1.3g
[2] S3 – Half ex FRI and half ex Kaueranga seed orchards
[3] Mix of Tallaganda 10g, Nimmatabel 6g, Bondi 5g
[4] Provided by Genetics and Tree Improvement, NZ Forest Research Institute, Rotorua, NZ

Table 1. Continued

Trial 3: Walker Road			
First Species Trial			
	Code	**Seedlot No.**	**Provenance/origin**
E. nitens	N22	GTI Code 2	Barrington Tops, N. NSW 31° 59'S, 151° 50', Alt. 1520m
E. nitens	N63	GTI Code 63	Anembo, Tallaganda, S.F. 35° 48S' NSW Alt. – 1220m
	N Mix	GTI Code 81	Connors Plain, Licola, Vic, 37° 32'S, 146° 28'E, Alt. 1310m
		GTI Code 105	Barnewell Plain, Vic. Alt. 930m
		GTI Code 116	Mississippi, Poweltown, Vic. Alt. 920m
		GTI Code 124	Blue Range, Taggerty, Vic. Alt. 1100m
		GTI Code 21	Toorongo plateau, Vic 37° 36'S, 146° 10'E, Alt. 1066m
		GTI Code 23	Toorongo plateau, Vic 37°50'S, 146° 13'E, Alt.854m
		GTI Code 95	Loch Valley, Noojee Forest District, Vic 37° 48'S, 146° 04E, Alt. 960m
		GTI Code 98	Toolangi, Vic 37° 32'. 145° 34'E, Alt. 600m
E. saligna	S89	GTI Code 9/3	Tairua seed orchard (9 clones)
E. globulus	G89	GTI Code 89/264	Cygnet, Tasmania
Second Species Trial			
E. nitens	N32	89/725	Glentunnel NZ
E. nitens	N33	90/110	Toorongo, Vic
E. nitens	N34	90/8	Cpt 905, Kaingaroa, NZ (ex Nimmatabel, S. NSW)
E. globulus	C31	88/231	Jeeralang, Vic
E. saligna	S31	89/3	Tairua seed orchard

Table 2. Carnation Road Trial 1 Species and Provenance means: Frequency Traits (Percentage of number planted)

Species, Code No. and Origin	crop trees	Early mortality and Thinning	Later Mortality	Runts	Basal Forks
E. fastigata					
F1, Kinleith, NZ	43 a	51 ab	0 a	5 abc	21 abc
F2, Bendoc, VIC	41 a	38 a	14 abc	7 abc	25 c
F3, Oakura, NZ	44 a	51 ab	2 abc	3 ab	21 bc
Mean	*43 a*	*47 a*	*6 ab*	*5 a*	*22 b*
E. nitens					
N1, Southern NSW	34 abcd	50 ab	8 abc	8 abc	13 abc
N2, Toorongo, VIC	26 bcde	54 ab	20 bc	1 a	0 a
N3, Toorongo, VIC	40 a	51 ab	6 abc	4 abc	5 abc
Mean	*33 b*	*51 a*	*11 b*	*4 a*	*6 a*
E. regnans					
R1, Wilmot, TAS	34 abcd	48 ab	8 abc	10 bc	8 abc
R2, Atiamuri, NZ	38 ab	49 ab	4 abc	9 abc	7 abc
R3, Strzlecki, VIC	36 abc	51 ab	1 ab	12 c	4 abc
R4, NZ Orchard	15 e	61 b	21 c	4 abc	3 ab
Mean	*31 b*	*52 a*	*8 ab*	*8 b*	*6 a*
E. saligna					
S1, Batemans Bay, NSW	18 e	51 ab	3 abc	28 d	0 a
S2, Waitangi, NZ	24 cde	48 ab	3 abc	25 d	2 ab
S3, Seed Orchard NZ	25 bcde	48 ab	1 ab	25 d	0 a
S4, Kangaroo valley, NSW	23 de	48 ab	2 abc	27 d	2 ab
S5, Waipoua NZ	26 bcde	48 ab	2 abc	23 d	0 a
Mean	*23 c*	*49 a*	*2 a*	*26 c*	*1 a*

Table 3. Carnation Road Trial 1 Species and Provenance means: Metric Traits

Species, Code No. and Origin	Height	Dbh	Basal Area m3/ha		Volume m^3/ha	
	m.	mm.	Whole	Inner	Whole	Inner
E. fastigata						
F1, Kinleith, NZ		299 abc	82 b	69 abc	627 bcd	518 abcd
F2, Bendoc, VIC		301 abc	80 b	73 ab	609 bcde	542 abcd
F3, Oakura, NZ		345 a	111 a	87 a	879 a	668 a
Mean	*27.5*	*315 a*	*91 a*	*76 a*	*705 a*	*576 a*
E. nitens						
N1, Southern NSW		286 bcde	60 bcde	48 cde	586 bcde	465 abcdef
N2, Toorongo, VIC		292 bcd	45 def	41 de	441 defg	401 bcdef
N3, Toorongo, VIC		248 def	52 cdef	49 cde	496 cdef	468 abcdef
Mean	*25.5*	*273 b*	*52 b*	*46 c*	*508 e*	*445 b*
E. regnans						
R1, Wilmot, TAS		307 ab	69 bc	66 abc	679 abc	645 a
R2, Atiamuri, NZ		284 bcde	65 bcd	61 cde	639 bcd	587 abc
R3, Strzlecki, VIC		306 ab	74 bc	63 bc	730 ab	617 ab
R4, NZ Orchard		328 ab	35 f	35 e	357 fg	362 def
Mean	*27.4*	*306 a*	*61 b*	*56 b*	*601 b*	*553 a*
E. saligna						
S1, Batemans Bay, NSW		237 ef	29 f	29 e	267 g	268 f
S2, Waitangi, NZ		243 def	36 f	34 e	337 fg	317 ef
S3, Seed Orchard NZ		232 f	35 f	35 e	320 fg	326 def
S4, Kangaroo valley, NSW		237 ef	34 f	32 e	315 fg	294 ef
S5, Waipoua NZ		251 cdef	41 ef	39 de	383 efg	365 cdef
Mean	*24.7*	*240 c*	*35 c*	*34 d*	*324 d*	*314 c*

Table 4. Carnation Road Trial 1 Species and Provenance means: Metric Traits

Species and Origin	Bole straightness 1-9	Malformation 1-5	Crown Health 1-9
E. fastigata			
F1, Kinleith, NZ	5.3 bcd	4.0 bcd	6.1 ab
F2, Bendoc, VIC	6.4 ab	3.7 de	5.1 abcd
F3, Oakura, NZ	5.8 abcd	3.9 cd	6.2 a
Mean	*5.8 b*	*3.9 b*	*5.3 a*
E. nitens			
N1, Southern NSW	6.3 abc	4.6 a	5.0 abcde
N2, Toorongo, VIC	7.1 a	4.8 a	3.8 fg
N3, Toorongo, VIC	6.9 a	4.4 abc	3.4 g
Mean	*6.8 a*	*4.6 a*	*4.1 b*
E. regnans			
R1, Wilmot, TAS	6.3 abc	4.3 abc	5.6 abc
R2, Atiamuri, NZ	6.9 a	4.4 abc	4.9 cdefg
R3, Strzlecki, VIC	7.0 a	4.5 ab	5.9 ab
R4, NZ Orchard	6.9 a	4.1 bcd	5.5 abcd
Mean	*6.8 a*	*4.3 a*	*5.5 a*
E. saligna			
S1, Batemans Bay, NSW	4.8 d	3.0 g	3.6 fg
S2, Waitangi, NZ	5.1 bcd	3.4 efg	3.6 g
S3, Seed Orchard NZ	5.0 cd	3.1 fg	4.3 cdefg
S4, Kangaroo valley, NSW	4.9 d	3.5 def	4.3 cdefg
S5, Waipoua NZ	5.0 cd	3.2 efg	4.6 cdefg
Mean	*5.0 c*	*3.2 c*	*4.1 b*

Table 5. Carnation Road Trial 2, Species Means:
Frequency Traits (percent of number planted)

Species and Origin	Crop trees	Mortality	Runts	Basal Forks
E. globulus, California USA	60 a	33 b	8 a	0
E. maidenii Waiohiki, Napier, NZ	80 a	14 ab	6 a	0
E. grandis, Sabie, S. Africa	61 a	21 ab	18 a	0
E. saligna Mixed	56 a	9 a	35 b	0

Table 6. Carnation Road Trial 2, Species Means:
Metric Traits

Species and Origin	Bole straight-ness	Malform-ation	Crown Health	Height m.	Dbh mm.	Basal Area M^2/ha	Volume M^3/ha
E. globulus, California USA	6.5 a	7.4 a	3.0 c	21.7	212 b	27 ab	228 b
E. maidenii Waiohiki, Napier, NZ	7.0 a	6.4 ab	6.3 a	22.7	236 a	42 a	353 a
E. grandis, Sabie, S. Africa	5.1 b	5.1 b	6.1 a	22.2	211 b	24 b	211 b
E. saligna Mixed	6.3 a	5.5 b	5.0 b	21.7	214 b	26 ab	244 ab

Table 7. Carnation Road trials 1 and 2, Species means:
Outerwood Basic Density

Species and Origin	Outerwood basic density Kg./m^3
E. nitens, N1, Southern NSW	412
E. globulus, California USA	505
E. maidenii Waiohiki, Napier, NZ	578

Table 8. Karaka Road, Provenance means:
Frequency Traits and Metric Traits

Species, Code No. and Origin	Crop Trees	Early Mortality and Thinnings	Later Mortality	Runts	Basal Forks
E. nitens N1, Southern NSW	42 a	52 a	6 a	0	8 b
E. nitens N2, Toorongo, VIC	32 b	53 a	14 a	0	1 a

Karaka Road, Species and Provenance Means:
Metric Traits

Species, Code No. and Origin	Bole Straightness	Malform-ation	Crown Health	Dbh	Basal Area M^2/ha	
	1-9	1-5	1-9	mm	Whole	Inner
E. nitens N1, Southern NSW	5.8	4.5	4.0	253	57	51
E. nitens N2, Toorongo, VIC	6.1	4.5	1.8	242	39	39

Table 9. Walker Road, Trial 1, 1999 Species and Provenance Means:
Frequency Traits (percentage of number planted)

Species, Code No and Origin	Crop Trees	Early Mortality	Later Mortality	Runts	Basal Forks
E. globulus G89, Cygnet, TAS	44	28	25	3	0
E. nitens, N22 Barrington Tops, NSW	66	17	13	4	2
E. nitens, N63 Mt Anembo, NSW	63	20	13	5	1
E. nitens, NMIX Central VIC	38	24	27	11	0
E. saligna, S89 Tairua, NZ	54	12	7	27	0

Table 10. Walker Road, Trial 1, 1999 Species and Provenance Means:
Metric Traits

Species, Code No and Origin	Bole Straightness	Malform-ation	Crown Health	Dbh	Basal Area M^2/ha	
	(1-9)	(1-5)	(1-9)	mm	Whole	Inner
E. globulus G89, Cygnet, TAS	4.4 b	3.6 c	4.1 c	226 ab	24 a	24 a
E. nitens, N22 Barrington Tops, NSW	6.1 a	4.5 a	6.2 a	223 ab	34 a	32 a
E. nitens, N63 Mt Anembo, NSW	6.3 a	4.8 a	5.4 ab	213 b	30 a	28 a
E. nitens, NMIX Central VIC	6.5 a	4.6 a	4.6 bc	250 a	26 a	20 a
E. saligna, S89 Tairua, NZ	6.6 a	4.0 b	5.3 b	175 c	21 a	21 a

Table 11. Walker Road, Trial 2, Species and Provenance Means: Frequency Traits (percentage of number planted)

Species, Code No and Origin	Crop Trees	Early Mortality	Later Mortality	Runts	Basal Forks
E. globulus G31, Jeeralang, VIC	36 ab	41 ab	16 a	7 a	8 b
E. nitens, 32, NZ, ex VIC	21 b	45 b	25 a	8 a	6 ab
E. nitens, N33, Toorongo, VIC	48 a	38 ab	8 a	7 a	3 ab
E. nitens, N34, NZ, ex Nimmitabel, NSW	50 a	33 ab	9 a	8 a	6 ab
E. saligna, S31, Tairua Orchard, NZ	40 a	16 a	5 a	39 b	0 a

Table 12. Walker Road, Trial 2, Species and Provenance Means: Metric Traits

Species, Code No. and Origin	Bole Straightness	Malform-ation	Crown Health	Dbh	Basal area M^2/ha	
	(1-9)	(1-5)	(1-9)	mm	Whole	Inner
E. globulus G31, Jeeralang, VIC	6.07 b	4.63 a	5.59 b	224 b	20 bc	20 ab
E. nitens, N32 NZ, ex VIC	6.49 ab	4.80 a	4.04 d	232 ab	13 c	12 b
E. nitens, N33 Toorongo, VIC	6.41 ab	4.68 a	4.82 c	225 b	25 ab	24 a
E. nitens, N34, NZ ex Nimmitabel, NSW	6.07 b	4.77 a	6.27 a	245 a	32 a	26 a
E. saligna, S31 Tairua, NZ	6.63 a	4.31 b	6.01 ab	186 c	19 bc	19 ab

Table 13. Knudsen Road Species and Provenance Trial

Species and Origin	Code number	Crop Trees (%)	Dbh mm	Basal Area M²/ha	Bole Straight-ness 1-9	Malform-ation 1-9	Crown Health 1-9
E. nitens Barrington Tops, NNSW	NN48	48	177	34	8.0	8.3	6.0
E. nitens, Tallaganda S.F., NSW	NN46	46	185	34	6.4	7.7	4.9
E. nitens, Badja S.F., NSW	NN47	48	204	43	7.2	8.4	6.4
E. nitens, Nimmitabel, NSW	NN45	44	211	43	5.7	8.3	5.6
Southern NSW Mean		*46*	*200*	*40*	*6.4*	*8.1*	*5.6*
E. denticulata, Errinundra Plateau, VIC	NN44	43	163	25	6.6	7.6	4.8
E. nitens, Toorongo Plateau, VIC	NN41	14	201	13	7.1	7.6	3.9
E. nitens, Rubicon, VIC	NN42	20	195	16	7.7	8.4	3.2
E. nitens, MacAlister, VIC	NN43	17	201	15	6.7	7.7	3.6
E. nitens, *Mt Erica, VIC*	NN4A	21	214	21	8.2	8.8	3.5
E. nitens, Connors Plain, VIC	NN4B	26	204	23	7.3	8.1	2.8
E. nitens, Rotoaira, NZ ex VIC	NN49	30	192	23	7.7	8.8	3.3
Central VIC mean		*21*	*201*	*19*	*7.5*	*8.2*	*3.4*
E. globulus, Huonville, TAS	GG41	38	178	26	6.1	7.0	3.1
E. globulus, Jeeralang, VIC	GG42	28	162	16	6.0	6.6	3.3
Mean of all *E. globulus*		*33*	*170*	*21*	*6.1*	*6.8*	*3.2*
E. maidenii, Eden, NSW	GM41	45	176	30	6.4	7.3	6.5
E. maidenii, Bolaro Mtn, NSW	GM42	46	172	29	6.7	7.2	6.5
Mean of all *E.maidenii*		*46*	*174*	*30*	*6.6*	*7.3*	*6.5*
E. grandis, Kenilworth, NSW	GR41	45	211	30	6.6	5.8	7.0
E. grandis, Coffs Harbour, NSW	GR42	41	185	30	5.9	5.2	6.3
E. grandis, Coffs Harbour, NSW	GR43	45	177	31	6.6	6.1	6.2
Mean of all *E. grandis*		*44*	*191*	*30*	*6.4*	*5.7*	*6.5*
E. saligna, Kiola, NSW	SS42	39	165	23	6.1	5.7	5.7
E. saligna, Armidale, NSW	SS43	48	167	29	6.1	5.6	6.4
E. saligna, Guyra, NSW	SS44	43	174	29	7.1	6.3	6.5
E. saligna, Kangaroo Valley, NSW	SS45	46	149	22	6.7	6.0	5.9
E. saligna, Helido, QLD	SS46	45	175	30	6.6	6.4	6.3
E. saligna, NZ Orchard	SS41	43	152	23	7.3	6.9	6.2
Mean of all *E. saligna*		*44*	*163*	*26*	*6.7*	*6.2*	*6.2*
E. botryoides, Bodalla S.F., NSW	BB41	34	143	16	5.6	5.0	4.5
E. botryoides, Cann River, VIC	BB42	34	139	15	5.7	5.1	4.1
Means of *E. botryoides*		34	141	16	5.7	5.1	4.3
E. robusta, Nowra, NSW	RR41	44	141	19	5.2	4.7	6.3

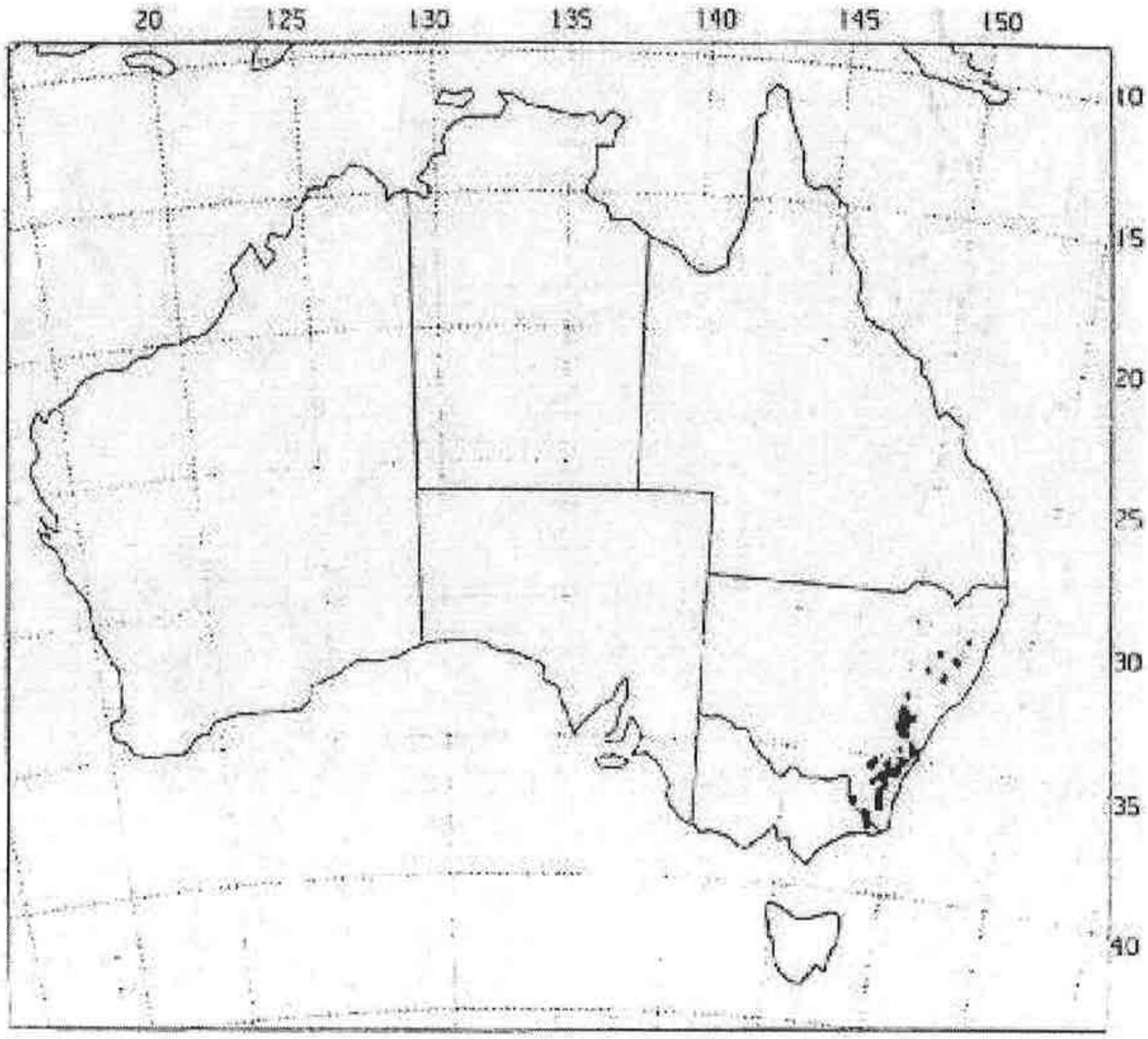


Figure 1. Distribution of *Eucalyptus fastigata* Deane & Maiden (after Boland *et al.*, 1984)

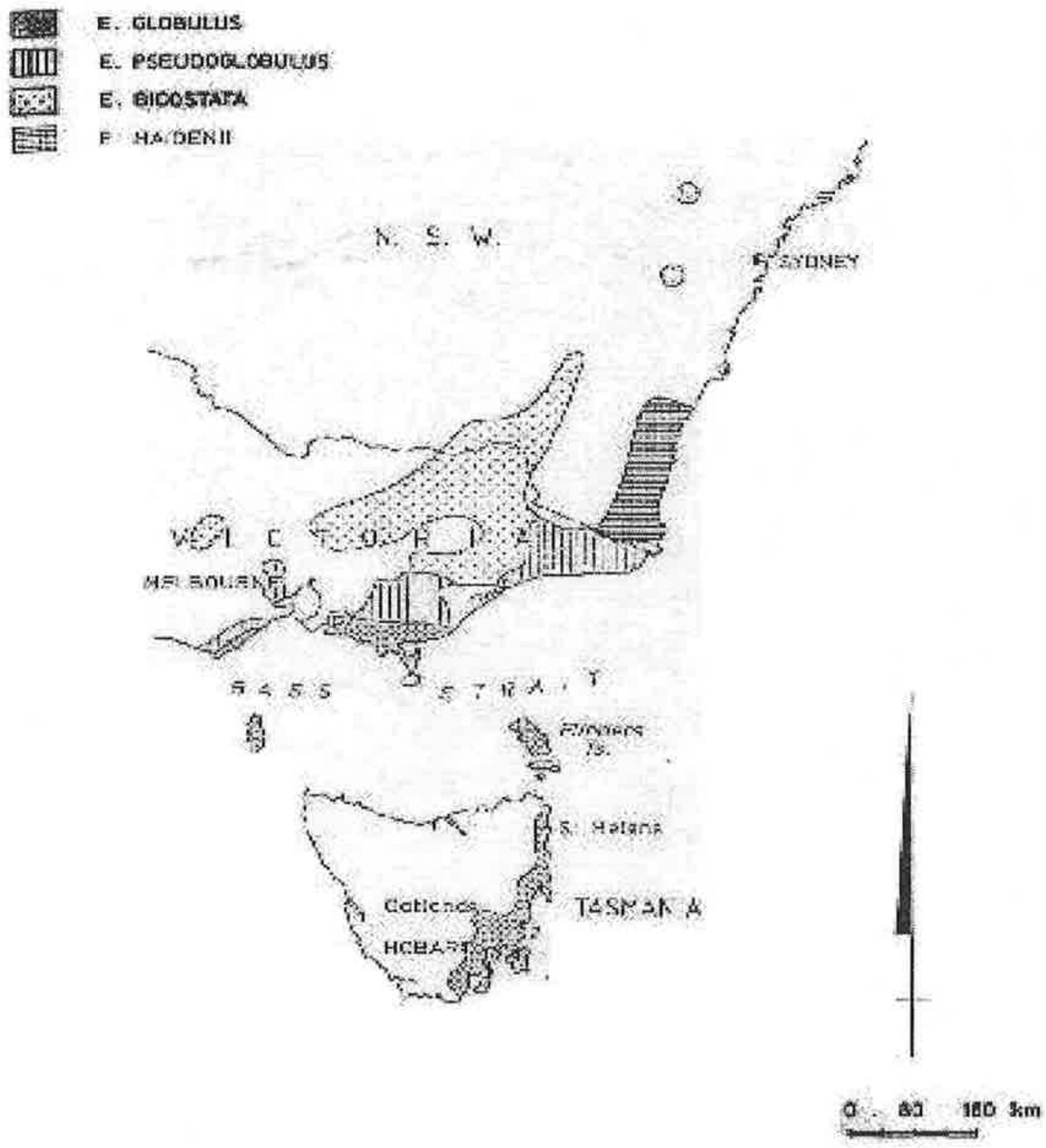


Figure 2. Distribution of *Eucalyptus globulus* subspecies (from Orme, 1977)

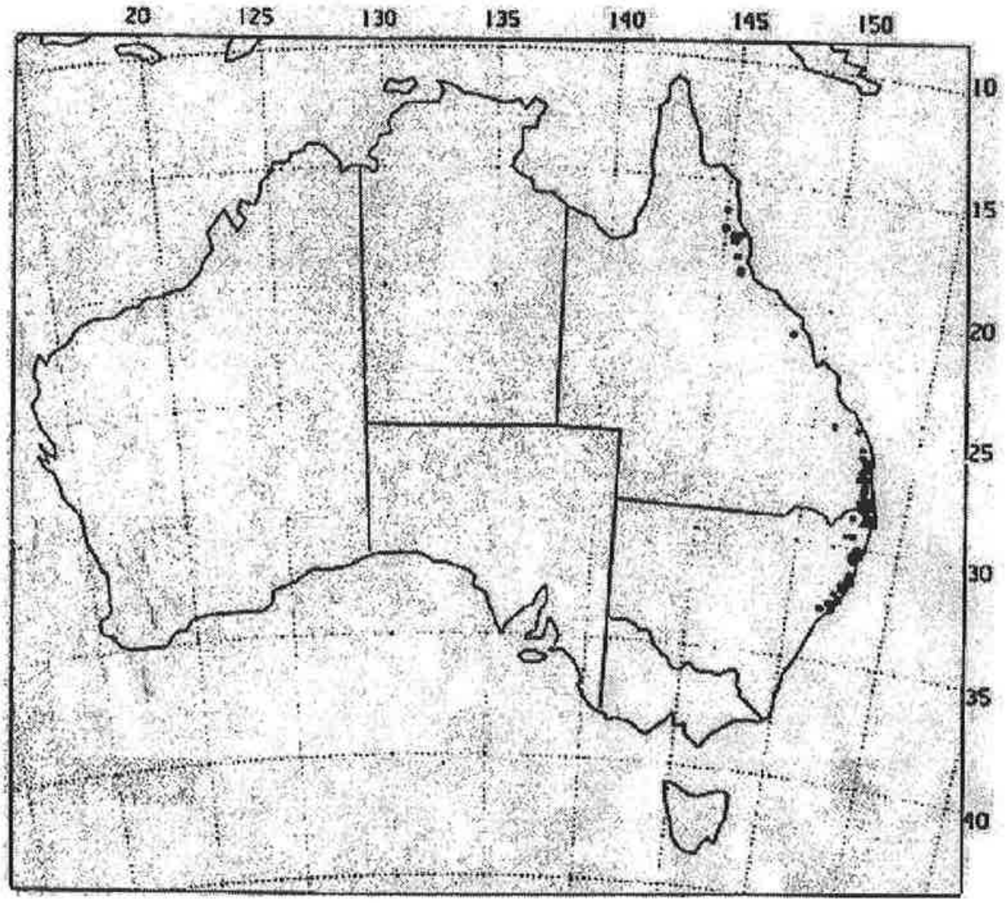


Figure 3. Distribution of *Eucalyptus grandis* W. Hill ex Maiden (after Boland *et al*, 1984)

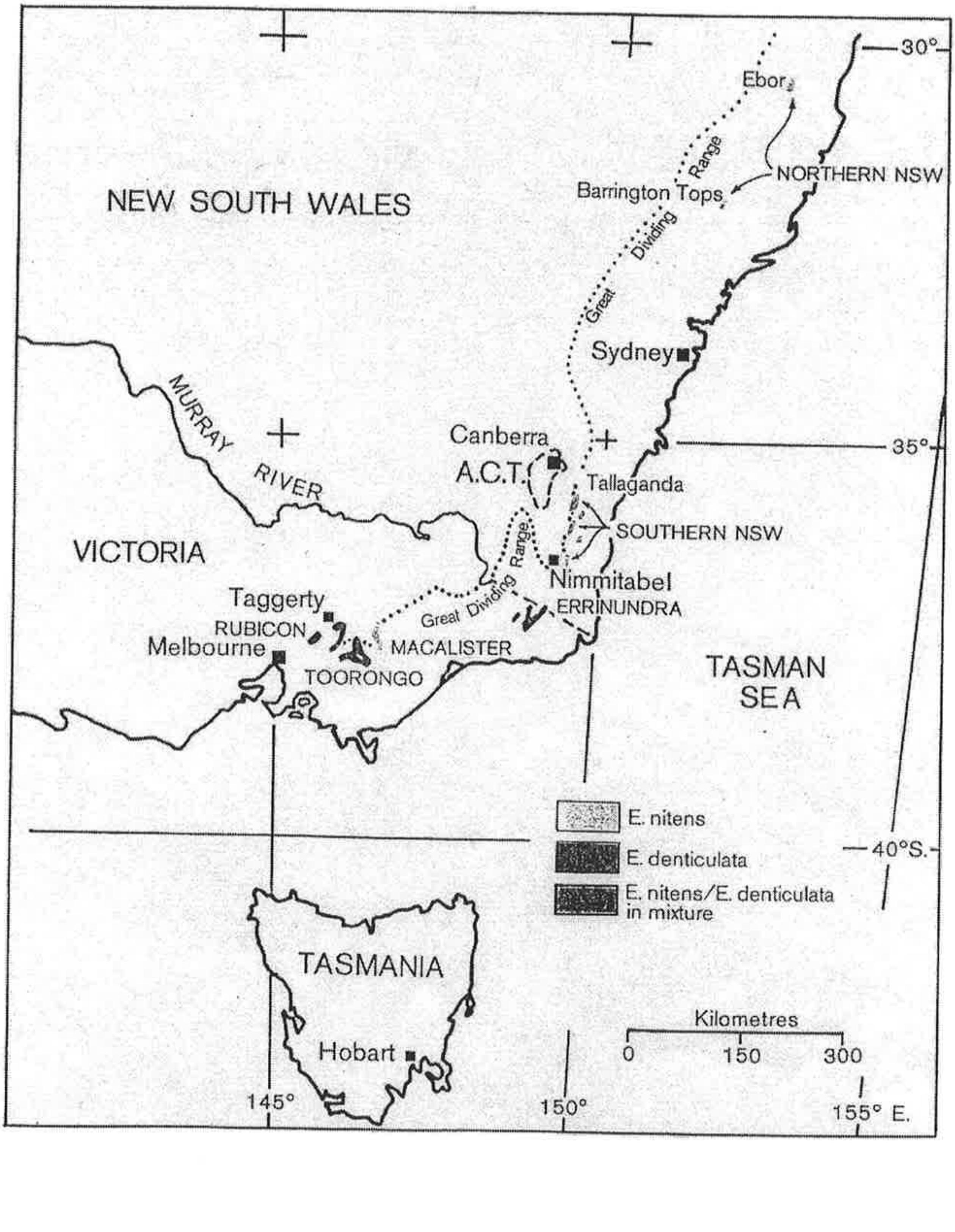


Figure. 4. Natural distribution of *E. nitens* and *E. denticulata* in Australia (After Tibbits and Reid, 1987; Cook and Ladiges, 1991)

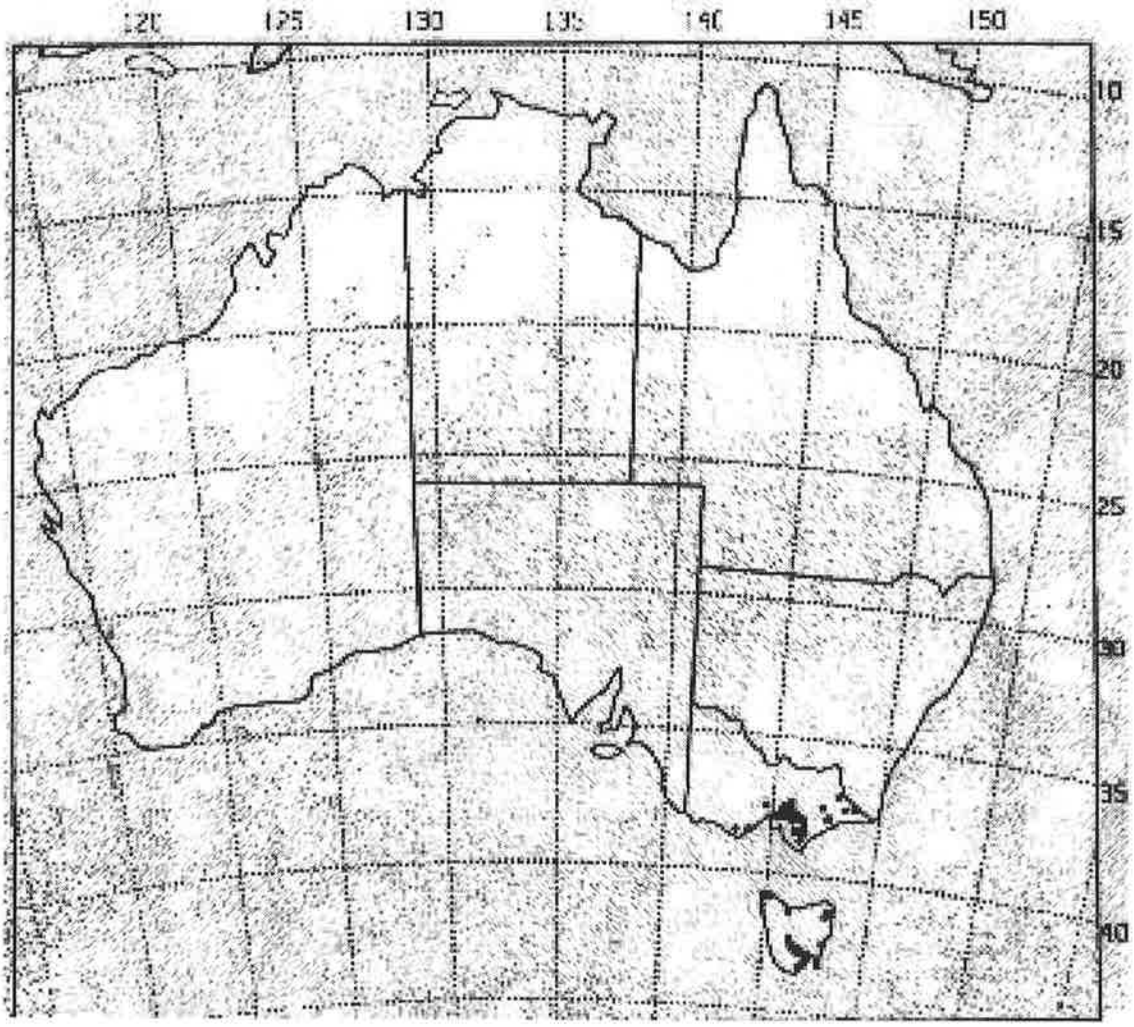


Figure 5. Distribution of *Eucalyptus regnans* F. Muell (after Boland et al, 1984)

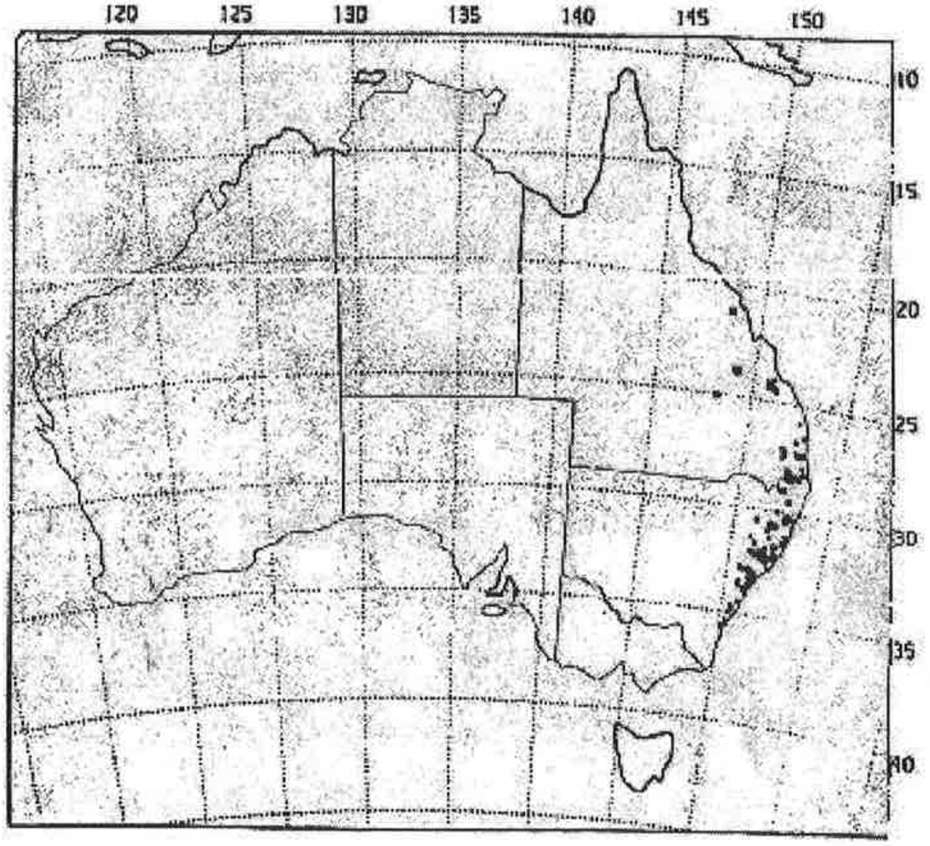


Figure 6. Distribution of *Eucalyptus saligna* Smith (after Boland *et al.,* 1984)

Figure 7. Locataion of trials

APPENDIX

BIOCLIM CLIMATIC DATA

LAT	LONG	EASTING	NORTHING	ROADNAME	ELEVATION	WIND _DEC	WIND_NOV
35-34	173-46.5	2580984.98	6625981.12	Carnation	195.000	10.600	10.700
35-31	173-49	2584822.90	6631488.99	Knudsen	180.000	11.200	11.500
35-48	173-54	2592015.84	6599964.55	Walker	75.000	9.300	9.000
35-44	173-54.5	2592856.05	6607353.36	Karaka	135.000	9.700	9.600

WIND_ OCT	WIND_ SEP	WIND_ AUG	WIND_ JUL	WIND_ JUN	WIND_ MAY	WIND_ APR	WIND_ MAR	WIND_ JAN	WIND_ FEB
11.500	10.800	9.600	9.500	8.900	8.900	9.000	9.200	10.000	10.400
12.200	11.700	10.700	10.700	10.000	9.800	10.000	10.000	11.000	11.000
9.800	8.800	7.100	7.000	6.200	6.800	7.100	7.600	9.000	8.800
10.400	9.500	8.000	7.800	7.100	7.500	7.800	8.100	9.000	9.300

SOLAR_ DEC	SOLAR_ NOV	SOLAR_ OCT	SOLAR_ SEP	SOLAR_ AUG	SOLAR_ JUL	SOLAR_ JUN	SOLAR_ MAY	SOLAR_ APR	SOLAR_ MAR
23.400	20.700	17.000	14.000	10.300	7.900	6.900	8.500	11.400	15.300
23.400	20.800	17.000	14.000	10.300	7.900	6.900	8.500	11.500	15.300
23.400	20.800	17.200	14.100	10.300	7.800	6.800	8.400	11.600	15.600
23.400	20.800	17.200	14.000	10.300	7.800	6.800	8.400	11.500	15.400

SOLAR_ JAN	SOLAR_ FEB	RAIN_ AUG	RAIN_ JUL	RAIN_ DEC	RAIN_ NOV	RAIN_ OCT	RAIN_ SEP	RAIN_ JUN	RAIN_ MAY
22.800	19.400	217.000	206.000	126.000	124.000	156.000	160.000	235.000	203.000
22.800	19.300	201.000	178.000	124.000	115.000	140.000	144.000	210.000	187.000
22.900	19.600	153.000	157.000	101.000	96.000	115.000	111.000	183.000	139.000
22.800	19.500	175.000	176.000	114.000	101.000	128.000	126.000	206.000	152.000

RAIN_ APR	RAIN_ MAR	RAIN_ FEB	RAIN_ JAN	MINT_ JAN	MINT_ DEC	MINT_ NOV	MINT_ OCT	MINT_ SEP	MINT_ AUG
153.000	124.000	124.000	89.000	13.300	11.900	10.600	9.100	7.900	6.900
139.000	123.000	123.000	89.000	13.600	12.100	10.800	9.300	8.100	7.300
119.000	102.000	102.000	80.000	13.500	12.100	10.700	9.400	8.000	6.900
136.000	112.000	112.000	85.000	13.200	11.900	10.500	9.100	7.700	6.700

MINT_ JUL	MINT_ JUN	MINT_ MAY	MINT_ APR	MINT_ MAR	MINT_ FEB	MAXT_ DEC	MAXT_ NOV	MAXT_ OCT	MAXT_ SEP
6.400	7.800	9.200	11.300	13.200	13.700	21.300	19.300	17.300	15.600
6.700	8.100	9.400	11.500	13.500	14.000	21.500	19.500	17.400	15.700
6.100	7.500	9.000	11.100	13.200	13.900	21.900	20.100	18.100	16.500
5.900	7.300	8.800	10.900	13.000	13.600	21.800	19.900	17.900	16.200

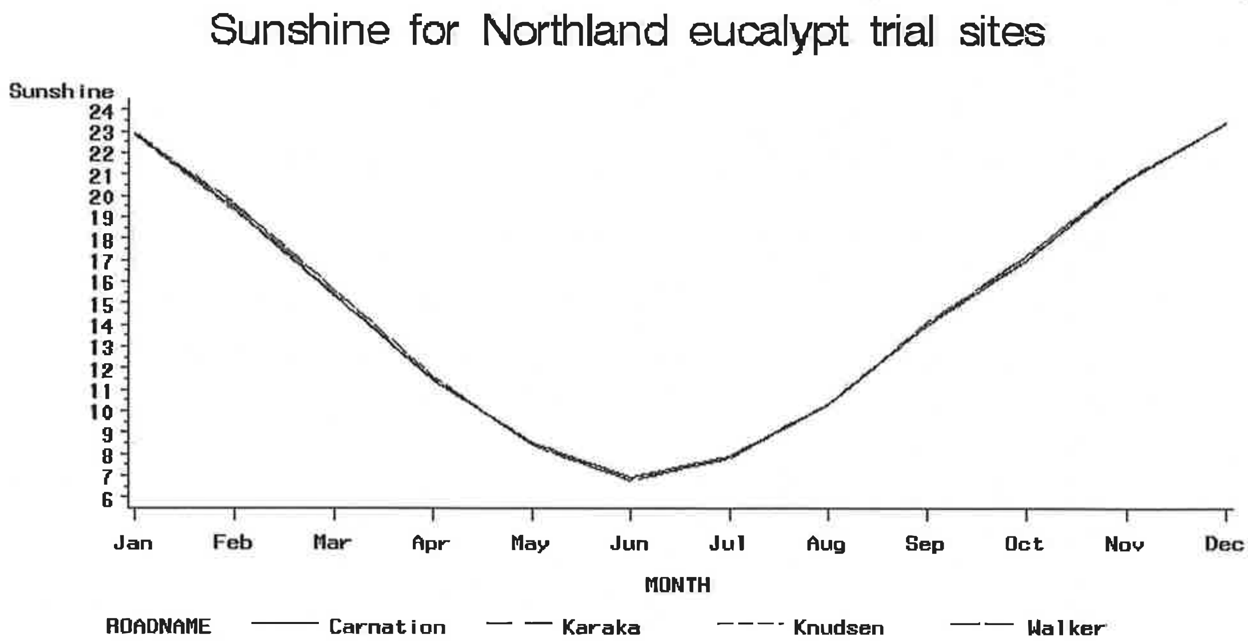
MAXT_ AUG	MAXT_ JUL	MAXT_ JUN	MAXT_ MAY	MAXT_ APR	MAXT_ MAR	MAXT_ JAN	MAXT_ FEB	HUM_ DEC	HUM _NOV
14.500	13.900	14.900	17.000	19.600	22.200	23.200	23.600	77.800	77.300
14.700	14.100	15.000	17.100	19.700	22.400	23.500	23.800	77.600	77.200
15.400	14.700	15.600	17.700	20.400	23.000	23.700	24.300	76.500	75.700
15.000	14.300	15.200	17.400	20.000	22.700	23.600	24.100	76.700	75.800

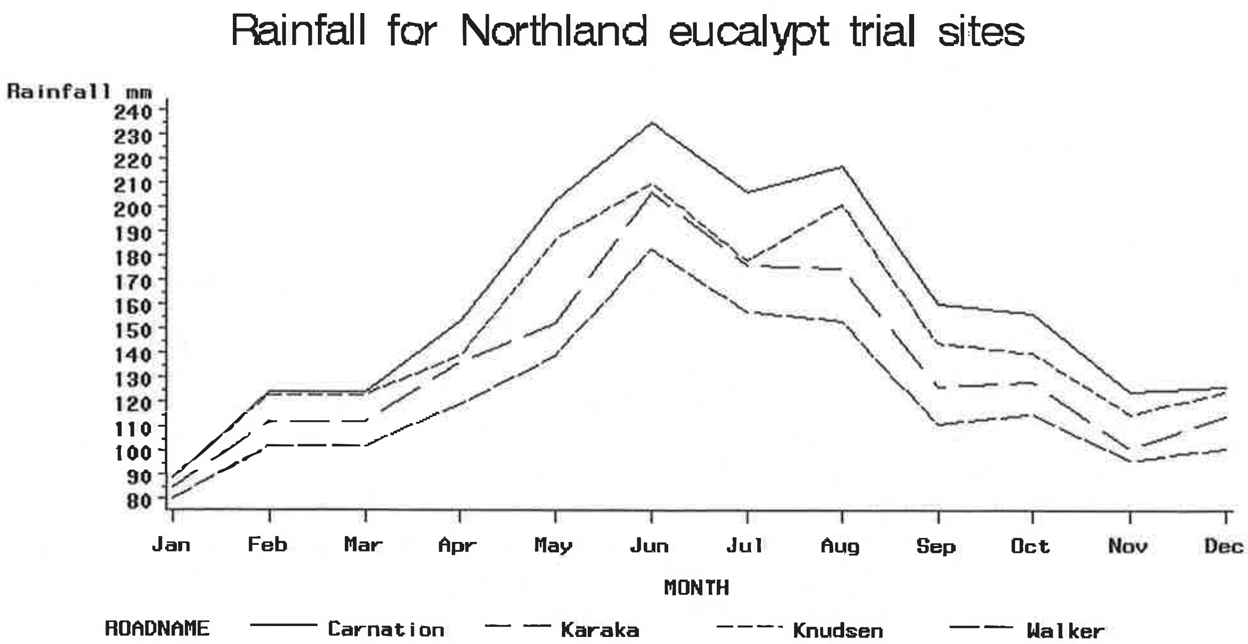
HUM_OCT	HUM_SEP	HUM_AUG	HUM_JUL	HUM_JUN	HUM_MAY	HUM_APR	HUM_MAR	HUM_JAN	HUM_FEB
77.500	84.800	88.500	89.700	89.200	89.200	88.100	85.200	78.900	83.000
77.300	84.300	88.400	89.700	89.000	89.000	87.700	84.900	78.600	82.800
77.300	83.300	86.900	87.900	87.000	87.000	87.000	84.200	76.700	81.000
76.900	84.100	88.000	89.000	88.200	88.200	87.900	85.000	77.600	81.900

AVET_DEC	AVET_NOV	AVET_OCT	AVET_SEP	AVET_AUG	AVET_JUL	AVET_JUN	AVET_MAY	AVET_APR	AVET_MAR
16.500	14.900	13.200	11.600	10.700	10.100	11.200	12.900	15.400	17.700
16.700	15.100	13.300	11.800	10.900	10.300	11.400	13.100	15.500	17.900
17.000	15.400	13.700	12.200	11.100	10.400	11.500	13.400	15.700	18.100
16.700	15.200	13.400	11.900	10.800	10.100	11.200	13.100	15.500	17.800

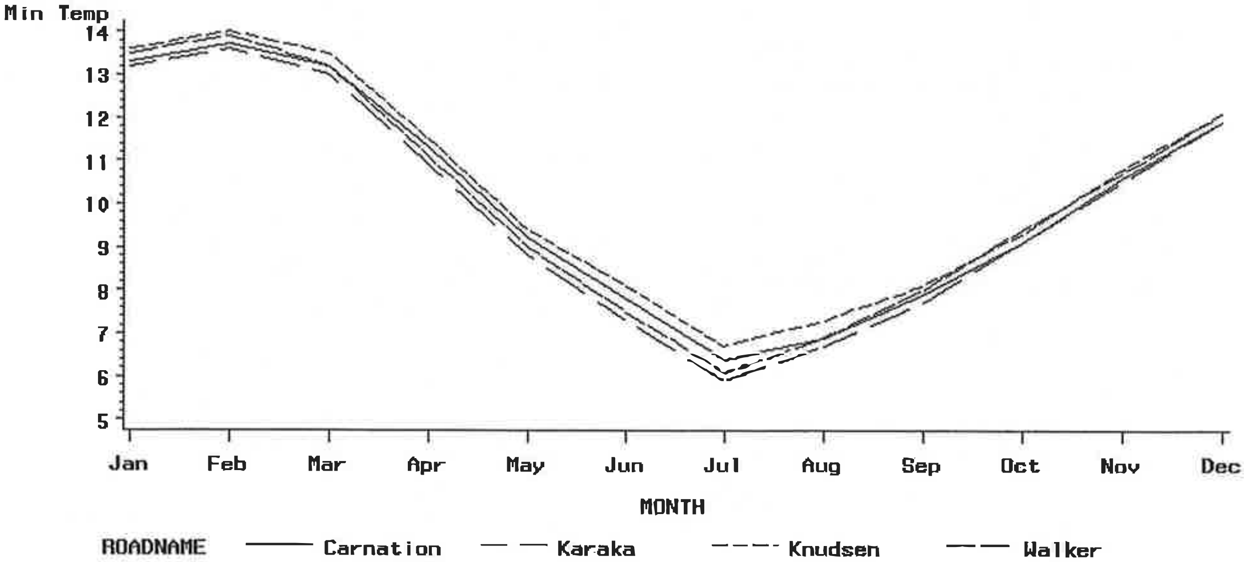
AVET_JAN	AVET_FEB	EVAPOR MAY	EVAPOR DEC	EVAPOR NOV	EVAPOR OCT	EVAPOR _SEP	EVAPOR AUG	EVAPOR _JUL	EVAPOR JUN
18.100	18.600	5.700	1.200	1.400	2.200	2.900	5.300	6.600	8.700
18.400	18.800	5.200	1.200	1.300	1.900	2.600	4.900	5.700	7.800
18.600	19.000	3.900	0.899	1.100	1.600	2.000	3.700	5.100	6.800
18.300	18.800	4.300	1.100	1.100	1.700	2.300	4.300	5.700	7.700

EVAPOR_APR	EVAPOR_MAR	EVAPOR_JAN	EVAPOR_FEB	SOIL_GR	SOIL GROUP NAME
3.100	1.700	0.800	1.800	NX	Granular Oxidic
2.800	1.700	0.800	1.700	NX	Granular Oxidic
2.400	1.400	0.699	1.300	BA	Brown Acid
2.700	1.600	0.800	1.500	BA	Brown Acid

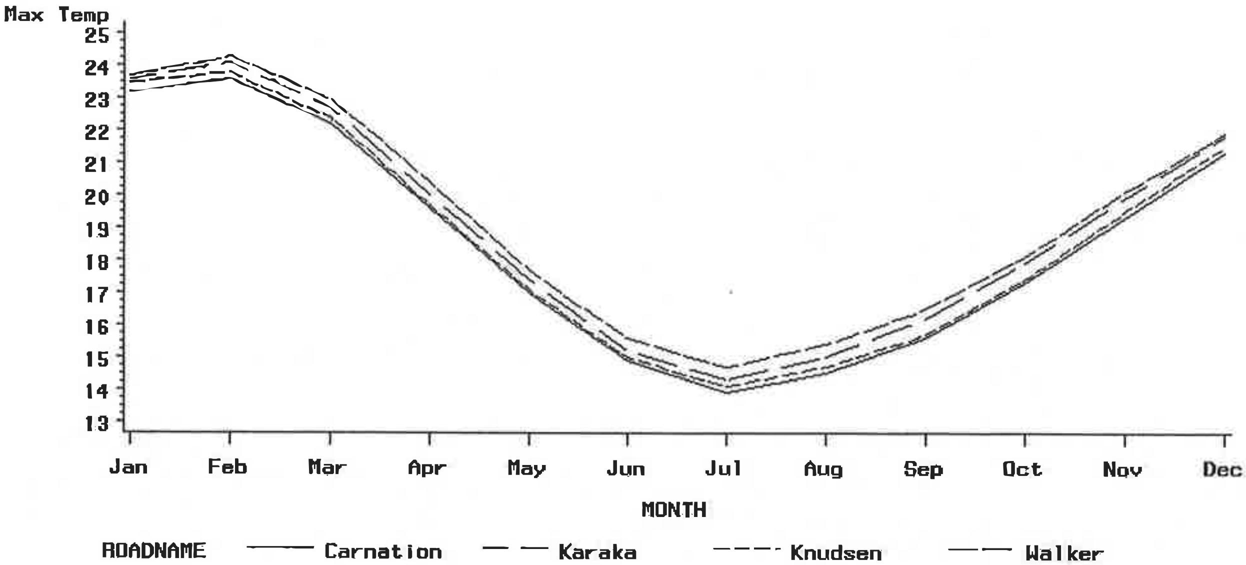

Sunshine for Northland eucalypt trial sites
Sunshine
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MONTH
ROADNAME
Carnation
Karaka
Knudsen
Walker


Rainfall for Northland eucalypt trial sites
Rainfall mm
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
MONTH
ROADNAME
Carnation
Karaka
Knudsen
Walker

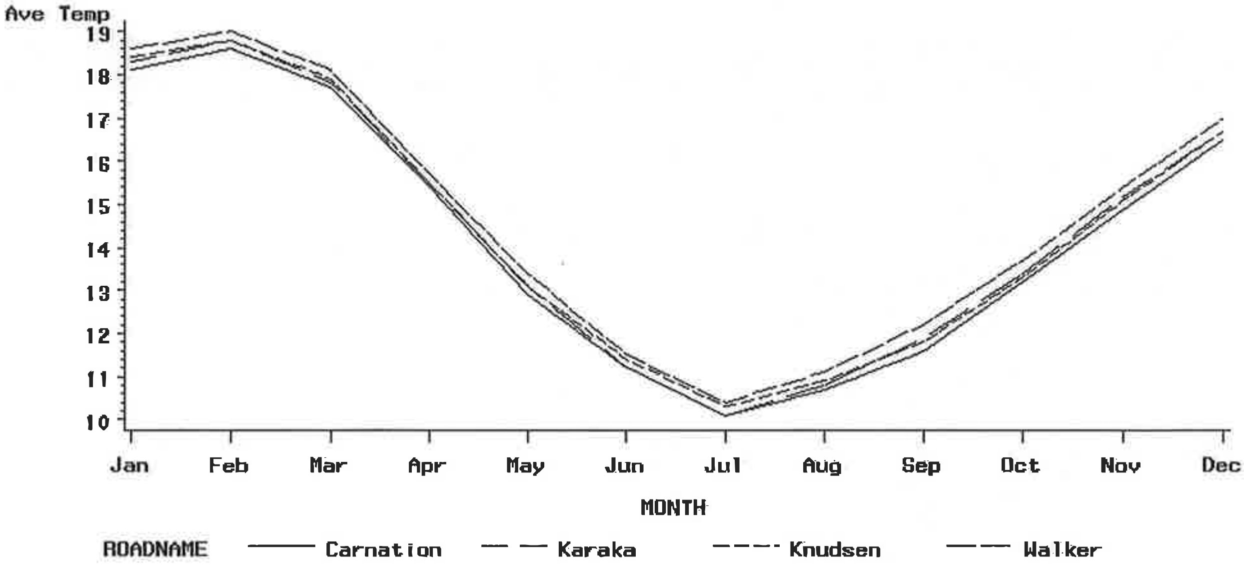
Minimum Temperature for Northland eucalypt trial sites



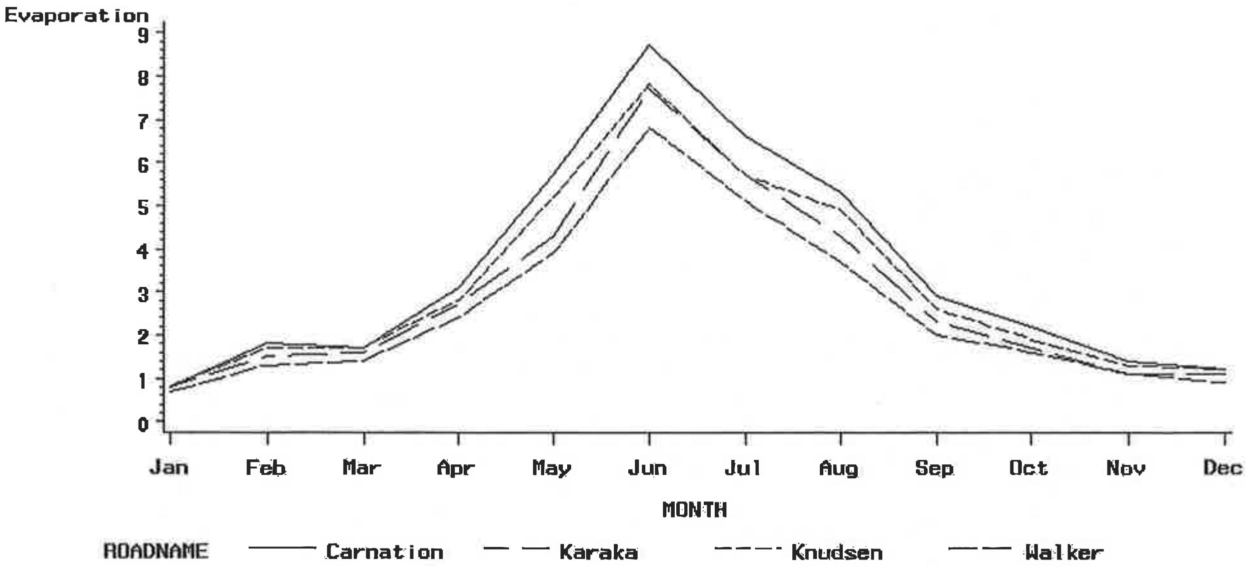
Maximum Temperature for Northland eucalypt trial sites



Average Temperature for Northland eucalypt trial sites



Evaporation at Northland eucalypt trial sites



Humidity at Northland eucalypt trial sites