

SFFA Site Monitoring and Analysis of Data.

The study involves comparative early growth rates of some subtropical rainforest species commonly grown in north-eastern New South Wales and south eastern Queensland and an assessment of potential economic returns.

It is based upon a paper written by Michael Bailey and Kevin Glencross which reported on the monitoring and analysis of data from Subtropical Farm Forestry Association assisted plantations in northeastern New South Wales.

Introduction

Research on the plantation performance of subtropical rainforest species other than Hoop Pine (*Araucaria cunninghamii*) and Silky Oak (*Grevillea robusta*) is not well developed (Herbohn *et al* 1999). There have been a number of rigorous scientific journal articles that highlight the potential of the rainforest cabinet timber species (Russell *et al* 1993, Keenan 1996, Herbohn *et al* 1999), yet unfortunately there is a profound lack of data from which to base management decisions. The SFFA has been involved in the collection of data from mixed species rainforest plantings on private land established by Association members.

The monitoring and analysis program was carried out over 14 sites in the Northern Rivers region of NSW. The subtropical rainforest plantings were measured by the Association initially in 1996-97, and the same trees have been re-measured again in August- September 2000. The monitoring of the same trees over time allows the Association to develop a database that can be used for quantitative analysis of plantation performance. The monitoring program was funded through the SFFA and coordinated by Robin Bell. A team of four Southern Cross University students carried out the fieldwork.

The data and site details was collected using the Subtropical Tree Site Management (STSM 1997) database produced by the School of Resource Science, Southern Cross University and community groups involved in reforestation. The STSM system was developed to encompass provenance and management details as well as tree performance and site characteristics. Data for STSM is collected from several sources such as interviews, maps, soil tests and field measurements.

Statistician, and Association Treasurer, Michael Bailey carried out the statistical analysis of the data. The analysis may be used in future as the basis of an academic journal article with the collaboration of fellow Association Committee member and Southern Cross University Forestry Lecturer Doland Nichols. Therefore, what follows is only a cursory look at the analysis carried out by Michael Bailey for the benefit of the newsletter readership.

The data analysis is based on the measurement of just over 2000 individual trees. The height, diameter at breast height (DBH), canopy radius and form of each tree are the parameters used for assessment. In the larger plantations sample populations of trees are measured along permanent transects established by the Association at the initial planting, in most cases.

The sites cover a geographical range from north west of Kyogle, in the upper Richmond River Catchment, to Billinuudgel near the coast. The majority of sites are clustered between Lismore and Bangalow on the volcanic soils, which originally carried rainforest prior to clearing. There is considerable variation between sites and even within sites in terms of soil, microclimate, aspect and species. Rainfall is one of the critical determinants of tree growth (Specht and Specht 1999) and given the wide variation in rainfall between sites (from 1200- 2400mm). Given this level of variability statistical comparisons between sites is problematic.

The establishment and management practices carried out at each site will fundamentally affect planting performance. All the sites contain a mixture of species, some with over 20, so this contributes further to variability and complexity regarding statistical analysis. As pointed out by Michael Bailey, " *where such variability exists a very much larger sample than the one under discussion (perhaps several hundred sites) will be required*". The potential to carry out analysis of a greater number of sites may be possible through connections with Southern Cross University and various community groups using the STSM system. Therefore, the continued collection of accurate data is to be encouraged by all relevant stakeholders interested in subtropical rainforest plantings.

Results

The key parameters of mean annual height and volume increase have been tabulated for each species across the 14 sites. The rate of mortality and the performance in terms of the form of the species has also calculated across the sites. Michael Bailey (2001) composed the tables and carried out all calculations.

1. Height

Table 1 shows the actual mean annual increase in height (in metres) for the species in the study across all sites, and also the standard deviation. The performance at the best and worse sites gives the range of values measured. (For those that are interested in the timber production performance of individual species it is important to consider the form as well as growth increment.) As the ages of the plantations vary, using the values in Table 1, the mean height of a given species at year 3 or year 7 can be determined. For example, Blue Quandong (*Elaeocarpus grandis*) height at year 7 can be calculated by multiplying the Mean Annual Increment by 7 ($2.01\text{m} * 7 = 14.07\text{ m}$).

Table 1 Mean and standard deviation of annual height (m) increase.

Species	Mean	St. Dev.	Worst site	Best site
<i>Acacia melanoxylon</i>	2.08	0.32	-	-
<i>Agathis robusta</i>	0.91	0.43	0.40	1.25
<i>Alphitonia excelsa</i>	1.58	0.20	1.52	1.60
<i>Araucaria bidwillii</i>	1.17	0.28	1.01	1.23
<i>Araucaria cunninghamii</i>	0.97	0.52	0.24	1.51
<i>Argyrodendron actinophyllum</i>	0.44	0.34	-	-
<i>Argyrodendron trifoliolatum</i>	0.72	0.31	0.34	0.96
<i>Caldcluvia paniculosa</i>	0.82	0.34	-	-
<i>Castanospermum australe</i>	0.89	0.43	0.28	1.08
<i>Cedrela odorata</i>	2.05	0.43	1.83	2.08
<i>Dysoxylum fraserianum</i>	0.77	0.32	0.58	0.96
<i>Dysoxylum muelleri</i>	0.92	0.38	0.68	1.06
<i>Elaeocarpus grandis</i>	2.01	0.86	1.02	3.51

<i>Eucalyptus grandis</i>	1.14	0.48	-	-
<i>Flindersia australis</i>	0.60	0.31	0.52	0.71
<i>Flindersia bennettiana</i>	0.86	0.36	0.52	1.12
<i>Flindersia brayleyana</i>	1.71	0.73	0.72	2.31
<i>Flindersia schottiana</i>	1.41	0.76	0.44	2.09
<i>Flindersia xanthoxyla</i>	0.89	0.50	0.62	1.14
<i>Geissois benthamii</i>	1.24	0.39	1.04	1.35
<i>Gmelina leichhardtii</i>	1.08	0.54	0.42	1.42
<i>Grevillea robusta</i>	1.55	0.64	0.91	2.26
<i>Lophostemon confertus</i>	1.27	0.62	1.20	1.32
<i>Melia azedarach</i>	0.61	0.36	0.13	0.84
<i>Podocarpus elatus</i>	0.47	0.13	0.44	0.49
<i>Polyscias murrayi</i>	2.39	0.37	-	-
<i>Rhodosphaera rhodanthema</i>	1.08	0.49	0.41	1.65
<i>Sloanea woollsi</i>	0.59	0.46	-	-
<i>Toona ciliata</i>	0.55	0.35	0.32	0.74

2. Volume

The stem volume for each species was determined by measuring the diameter of the tree at breast height (1.3 m above ground) and the height of the tree, then calculating the volume of a cone (to take into account taper). The results (Table 2) given are similar to those achieved using more detailed tables, and are accurate enough given the size of the sample (Bailey 2001). Volume is a parameter that is of particular interest in timber production, as it is a measure of wood in the stem, and allows for the calculation of yields of individual trees or across a prescribed area. To use an example from Table 2, for *Elaeocarpus grandis* the mean annual volume increase is 20.54 cubic decimetres. Over seven years the volume of an average tree would be 7 (time in yrs) * 20.54 = 143.78 cubic decimetres (0.144 cubic metres).

Table 2 Mean and standard deviation of annual volume increase. Volumes are given in cubic decimetres (thousandths of a cubic metre).

Species	Mean	St. Dev.	Worst site	Best site
<i>Acacia melanoxylon</i>	21.12	7.54	-	-
<i>Agathis robusta</i>	1.69	1.93	0.19	3.10
<i>Alphitonia excelsa</i>	2.93	1.39	0.68	1.06
<i>Araucaria bidwillii</i>	1.93	1.38	1.29	2.20
<i>Araucaria cunninghamii</i>	2.14	2.41	0.05	7.38
<i>Argyrodendron actinophyllum</i>	0.36	0.20	-	-
<i>Argyrodendron trifoliolatum</i>	0.80	0.61	0.45	1.22
<i>Caldcluvia paniculosa</i>	2.15	1.50	-	-
<i>Castanospermum australe</i>	0.76	0.67	0.09	0.94
<i>Cedrela odorata</i>	13.50	7.74	10.91	16.08
<i>Dysoxylum fraserianum</i>	0.84	0.80	0.52	1.23
<i>Dysoxylum muelleri</i>	1.57	1.67	0.66	3.16
<i>Elaeocarpus grandis</i>	20.54	17.22	1.51	42.53
<i>Eucalyptus grandis</i>	1.14	1.39	-	-
<i>Flindersia australis</i>	0.44	0.46	0.17	0.94
<i>Flindersia bennettiana</i>	1.50	1.25	0.31	2.39
<i>Flindersia brayleyana</i>	6.23	5.35	0.24	12.85
<i>Flindersia schottiana</i>	4.40	4.92	0.17	12.17
<i>Flindersia xanthoxyla</i>	1.08	1.66	0.24	1.65
<i>Geissois benthamii</i>	2.05	1.60	1.28	3.10

<i>Gmelina leichhardtii</i>	2.90	3.33	0.46	5.02
<i>Grevillea robusta</i>	8.32	9.08	0.69	19.60
<i>Lophostemon confertus</i>	11.29	6.74	7.88	15.73
<i>Melia azedarach</i>	1.19	1.92	0.05	3.34
<i>Podocarpus elatus</i>	0.17	0.11	0.15	0.20
<i>Polyscias murrayi</i>	35.38	7.46	-	-
<i>Rhodosphaera rhodanthema</i>	4.88	4.04	0.14	8.45
<i>Sloanea woollsii</i>	0.76	1.06	-	-
<i>Toona ciliata</i>	1.01	1.12	0.51	1.51

3. Survival and form

Table 3 shows the number of individuals of a species that died, as well as a qualitative analysis of the form of the tree stem. (Form can be described as the assessment of the straightness, and degree of major branching of a tree stem.) The survival rates generally are good across the sites. However, some species did struggle, such as the *Melia* (White Cedar), having a mortality rate of close to 1 in 4 (24%) and very poor form. The form of the stem across the species was extremely variable. Good form is assessed as a straight stem without major low branching. Poor form is the result of major and persistent low branching or curved or crooked stem. The occurrence of more than one stem (multi-stemmed) is classified as poor form. The development of a straight trunk (bole) relatively free of large branches is most desirable in terms of high value timber production.

Table 3: Tree form and survival across the 14 sites.

Species	Dead	Poor	Fair	Good	% good	Total
<i>Agathis robusta</i>	4	3	4	31	70	44
<i>Araucaria cunninghamii</i>	13	6	30	86	64	135
<i>Argyrodendron trifoliolatum</i>	4	5	25	15	31	49
<i>Casuarina australis</i>	6	11	10	9	25	36
<i>Cedrela odorata</i>	0	15	14	2	6	31
<i>Dysoxylum fraserianum</i>	3	13	20	6	14	42
<i>Dysoxylum muelleri</i>	0	9	11	9	31	29
<i>Elaeocarpus grandis</i>	8	19	39	81	54	151
<i>Eucalyptus grandis</i>	21	9	6	3	8	39
<i>Flindersia australis</i>	22	61	43	9	6	135
<i>Flindersia bennettiana</i>	9	7	31	11	19	58
<i>Flindersia brayleyana</i>	3	19	46	52	43	120
<i>Flindersia schottiana</i>	12	32	49	79	46	172
<i>Flindersia xanthoxyla</i>	6	13	19	42	53	80
<i>Geissois benthamii</i>	3	22	26	5	9	56
<i>Gmelina leichhardtii</i>	10	9	28	57	55	104
<i>Grevillea robusta</i>	18	38	61	64	35	181
<i>Lophostemon confertus</i>	3	12	6	7	25	28
<i>Melia azedarach</i>	28	79	8	2	2	117
<i>Podocarpus elatus</i>	1	7	16	5	17	29
<i>Rhodosphaera rhodanthema</i>	25	76	41	8	5	150
<i>Toona ciliata</i>	2	27	3	1	3	33

Discussion

The trees measured in this data set are only three to seven years old, and so the results are only valid for these initial stages of growth. As pointed out by Michael Bailey (2001) “*species that do not grow well initially may do better later*”. It would be expected that the “pioneers” and the more light tolerant species would perform better in the early stages of the planting. The more shade tolerant “mature phase” species such as the Mahoganies (eg. Rosewood- *Dysoxylum spp*) may grow more rapidly once the microclimate (protection from sun and wind exposure) across the site improves. Hoop Pine (*Araucaria cunninghamii*) can also be slow in the initial phase of growth in plantation.

It is noticeable that the white and red cedars (*Melia azedarach* and *Toona ciliata*) have particularly poor form due to insect attack. The Deep Yellowwood (*Rhodosphaera rhodanthema*) also has major problems in terms of form, with a high degree of low branches. The Red and Pink Ash (*Alphitonia sp*) also suffer defoliation by insects as well as severe stem damage by Cockatoos looking for grubs at a number of sites. The *Flindersia Australis* (Teak) performed poorly at all sites.

The *Agathis robusta*, *Elaeocarpus grandis*, *Grevillea robusta* and the *Flindersias* (Cudgerie and Queensland Maple) are among the better performers in terms of the key growth indicators of height, volume and form. The *Elaeocarpus grandis* being a standout performer in terms of height and volume growth, as well as form and survival. The *Acacia* performed well with regard to volume production and the provision of shade and wind protection, but the form and the tendency to die out relatively early reduce the plantation (timber) value.

The improvement of form through pruning was not widely practiced. A number of the valuable timber species tend to develop low branches, the removal of these branches may improve the form and the value of the timber produced. The SFFA offers training and information on stand management such as pruning for those interested in timber production.

The continued monitoring of mixed species subtropical rainforest plantings is essential if this extremely valuable ecological and commercial resource is to be developed. The performance of a number of the highly prized cabinet timber varieties in these initial stages is encouraging. The lack of data from well-managed trials may serve to limit the development of these types of plantings beyond the enthusiasts. Conventional plantations based on a narrow range of relatively low value tree species may not represent the best options on the rich, high rainfall ex-rainforest sites. The successful planting of rainforest trees on a larger scale relies on continued research and development.

Appendix Botanical and “Common” names

Botanical	“Common”	Botanical	“Common”
<i>Acacia orites</i>	Mountain Wattle	<i>Flindersia bennettiana</i>	Bennett’s Ash
<i>Agathis robusta</i>	Kauri Pine	<i>Flindersia brayleyana</i>	Queensland Maple
<i>Alphitonia excelsa</i>	Red Ash	<i>Flindersia schottiana</i>	Cudgerie
<i>Araucaria bidwillii</i>	Bunya Pine	<i>Flindersia xanthoxyla</i>	Yellowwood
<i>Araucaria cunninghamii</i>	Hoop Pine	<i>Geissois benthamii</i>	Red Carabeen
<i>Argyrodendron trifoliolatum</i>	Brown Tulip Oak	<i>Gmelina leichhardtii</i>	White Beech
<i>Castanospermum australe</i>	Black Bean	<i>Grevillea robusta</i>	Silky Oak
<i>Cedrela odorata</i>		<i>Lophostemon confertus</i>	Brush Box
<i>Dysoxylum fraserianum</i>	Rosewood	<i>Melia azedarach</i>	White Cedar
<i>Dysoxylum muelleri</i>	Red Bean	<i>Podocarpus elatus</i>	Brown Pine
<i>Elaeocarpus grandis</i>	Silver Quandong	<i>Rhodosphaera rhodanthema</i>	Deep Yellowwood
<i>Flindersia australis</i>	Teak, Crow’s Ash	<i>Toona ciliata</i>	Red Cedar

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