NZDFI NEW ZEALAND DRYLAND FORESTS INITIATIVE

breeding tomorrow's trees today

Durable Eucalypt Leaflet Series

Eucalyptus bosistoana

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December 2012

Why grow durable eucalypts?

New Zealand's agricultural landscapes need sustainable land use options adapted to droughts and floods which complement pastoral farming while reducing soil erosion, improving water quality and habitat for native biodiversity.

Eucalypts are renowned for their adaptability to droughty and eroding landscapes. They also provide excellent habitat for nectar-feeding birds and insects. With over 400 eucalypt species to select from there is a great opportunity to select appropriate species for the planting objective.

With CCA (copper chrome arsenic)-treated wood now banned for many uses by the USA and several European countries, there are significant international and domestic markets for naturally-durable hardwoods. The wood properties of New Zealand grown durable eucalypts ensure they can replace CCA treated material for many uses and are also ideal for a wide range of agricultural and land-based industrial applications, particularly for posts, poles and utility cross-arms as well as heavy structural timbers.

NZDFI (New Zealand Dryland Forests Initiative) has selected eucalypt species which can be sawn to produce durable hardwood. Using these species, NZDFI is committed to developing viable best-practice forest management systems to complement livestock farming. NZDFI wants to encourage planting durable hardwood forests and woodlots to protect steeplands and waterways, for shade and shelter, and to generate income from carbon credits and sustainable timber harvesting.

Why NZDFI have selected *E. bosistoana*?

NZDFI have selected species that:

- Produce highly durable timber (Class 1 and 2 Australian Standard, AS5606-2005).
- Are drought tolerant.
- Coppice vigorously after fire and harvesting.
- Do not appear to spread as wildings
- Have the potential to sequester carbon faster than pine on drylands
- Provide nectar/pollen for native biodiversity

NZDFI have selected ***E. bosistoana*** as one of its suite of species because of its high durability (Class 1), its apparent wide site tolerance throughout New Zealand and because of its success in early and more recent Marlborough plantings.

SUPPORTERS: New Zealand Farm Forestry Association; Marlborough Research Centre; Marlborough District Council; Ministry for Primary Industries Manatū Ahu Matua; Gisborne District Council; UC University of Canterbury NZ School of Forestry; greater Wellington Regional Council; Proseed; Hawke's Bay Regional Council; Vineyard Timbers Ltd; Environment Canterbury Regional Council; Marlborough Lines; Bay of Plenty Regional Council

Figure 1: Successful planting of *E. bosistoana* near Blenheim

Natural distribution in Australia

The common name for *E. bosistoana* is Coast grey box or Gippsland grey box. In Australia, it is a medium sized to tall tree 30-40 m or up to 60 m in height, while the trunk may reach a diameter of 150 cm. The tree is often of good form with a trunk 1/2 of the tree height, the crown being relatively small and compact. The tree occurs naturally within the latitudinal range of 33-37.5°S at altitudes between sea level and 500 m. The distribution *of E. bosistoana* is confined to coastal mixed forests along the South East coast of Australia. It reaches the best development in small river flats (Boland et al.1984).

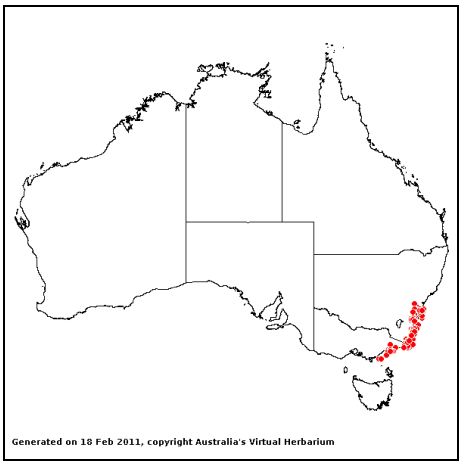

Figure 2: Map of Australia showing the natural distribution of *E. bosistoana* (source Australia's Virtual Herbarium)

Australian and New Zealand grown wood characteristics

The timber of *E. bosistoana* is described as; "Heartwood is dark brown/pink; sapwood pale brown/pink; fine even texture with interlocked grain" (BRANZ 2004). In Australia the wood is used for heavy engineering construction, poles, crossarms, railway sleepers and fences (Bootle 1983). The wood is very hard and durable, and because individuals can grow tall and straight, this species has been sought after for milling into poles and uses for heavy construction (Boland et al.1984).

Origin/species	Modulus of Rupture (MPa)	Modulus of Elasticity (GPa)	Compression Parallel (MPa)	Hardness (kN)	Density (kg/m^3)

Table 1: Strength and density values for core DFI eucalypt timbers

SUPPORTERS:

	Green	12%	Green	12%	Green	12%	Green	12%	Green	Air-Dry	Basic
Australia											
E. bosistoana	**103**	**163**	**17**	**21**	**50**	**73**	**10**	**13**	**1180**	**1100**	**880**
E. globoidea	92	133	14	17	43	68	6.8	8.8	1100	880	680
E. camaldulensis	64	101	8	11	33	55	5.3	7.5	1130	900	710
E. quadrangulata	98	163	17	18	47	71	8.2	14	1230	1030	800
New Zealand											
E. bosistoana	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**	**na**
E. globoidea	81	132	7.7	14.6	37.9	66.7	4.5	6.9	na	805	635
E. camaldulensis	na	na	na	na	na	na	na	na	na	na	na
E. quadrangulata	na	na	na	na	na	na	na	na	na	na	na
Pinus radiata	40	89	6.2	8.5	16	38	2.4	5.0	960	500	420

Market opportunities

Currently New Zealand relies on radiata pine which makes up 90% of our plantation estate. Eucalypts account for only 1% of timber production yet New Zealand imports over $30 million of hardwood sawn timber and $240 million of wooden furniture annually. New Zealand has nearly 25,000 ha of eucalypt plantations mostly of low durable species for short fibre pulp.

The banning of CCA-treated wood for many uses in the USA and parts of Europe opens up new opportunities for naturally-durable hardwoods. The substitution of CCA-treated pine with naturally durable hardwood will also reduce the production of hazardous timber waste. For example, in Marlborough broken posts from vineyard harvesting create up to 24,000 cubic metres of hazardous waste every year. There are no acceptable disposal facilities for this waste other than secure landfill, which in Marlborough costs $21 per cubic metre. Although more benign treatment methods are being actively researched to replace CCA, another advantage of the chemical free durable eucalypt posts (Figure 3) is their high strength.

NZDFI eucalypt hardwoods will match elite species like mahogany, rosewood and teak. They are highly durable and very stiff and strong. These properties ensure they are also ideal for a wide range of agricultural and land-based industrial applications, particularly for posts, poles and utility cross-arms as well as heavy structural timbers. Other applications include wharves, jetties, bridges and rail sleepers. Mature *E. bosistoana* in the King Country has been successfully sawn (Figure 5) with post material placed in some Marlborough vineyards.

SUPPORTERS:

Figure 3: Eucalypt hardwood post in Marlborough vineyard (photo credit P. Millen)

A further application for selected durable eucalypt species could be for land-based wastewater disposal to produce post and pole wood with biofuel produced from residues. Durable eucalypts also have potential for biofuel due to their high wood densities.

Durable eucalypts also have an advantage from their very high wood density which can result in a high rate of carbon sequestration. Their rapid growth rates combined with their wood being almost twice as dense, age for age as radiata pine makes them highly eligible as species for NZ's Emissions Trading Scheme.

New Zealand experience:

Although until recently *E. bosistoana* has not been part of formal research trials, several New Zealand books on eucalypts refer to *E. bosistoana*. Simmons (1927), McWhannell (1960), King (1980) and Barr (1996) all report favourably on its potential in the regions where the authors had the most experience. These included Northland, Waikato, Hawke's Bay and the Wairarapa, although not all agreed on its preferred site. Records from the National Forestry Herbarium indicate trees have been established in the Auckland, Waikato, King Country, Gisborne, Manawatu and Hawke's Bay regions. Jackson (1965) identified the siting preferences of *E. bosistoana* in Hawkes Bay as medium rainfall and limestone soils. Cutten (1964) also recommended *E. bosistoana* for limestone soils in Canterbury.

Farm foresters from the King Country, Hawkes Bay, Wairarapa, Manawatu, Northland and Taranaki have all reported on experiences with *E. bosistoana*. These range from successful sawing of large trees in the King Country (Figure 4 & 5) to failed plantings in upland Taranaki, although a large tree is present in Taranaki's Te Wera Forest arboretum. On a cold site in north Canterbury *E. bosistoana* had the highest survival of eleven eucalypt species tested.

Figure 4: *E. bosistoana* tree
(photo credit J. Nicholas)

Figure 5: *E. bosistoana* log sawn
(photo credit J. Rogers)

Plantings in the Wairarapa and Manawatu are reported to be growing well, but the comment is made they prefer better and moist soils. In Northland it has been less impressive in terms of growth compared to other potential eucalypt species. Cornwall Park in Auckland has a well-established shelterbelt of *E. bosistoana* (Figure 6). The recent discovery of large *E. bosistoana* near Waihi reinforces the species adaptability in New Zealand (Figure 7).

SUPPORTERS:

Figure 6: Corwall Park *E. bosistoana* (photo credit M. Wilcox)

Figure 7: Large *E. bosistoana* near Waihi (photo credit P. Millen)

Since the NZDFI project was initiated there has been increasing interest in planting *E. bosistoana* in many regions of New Zealand. As these stands mature the knowledge on growing *E. bosistoana* will improve.

Research trials:

Until recently *E. bosistoana* has been trialled with other species on only two known sites; in Para forest near Picton and on the Wither hills near Blenheim, but in recent years there have been more trials established in Marlborough and Canterbury. In 1970 an evaluation of *Eucalyptus* species for erosion control was planted on drought-prone hill country on the Wither Hills. A non-replicated trial with nine species was planted on three micro sites; (i) low fans along an intermittent stream, (ii) a re-contoured, stabilised mid slope gully, sheltered, (iii) an extremely exposed ridge line.

At age 10 years survival of *E. bosistoana* was 90 % on site i and iii (the most exposed), but only 20% on site ii. Although not documented by species there were cattle in the trial at one time. At age 18 years the survival was the same. The best performing species for growth at age 18 years was *E. bosistoana* (Figure 8).

SUPPORTERS:
NEW ZEALAND FARM FORESTRY ASSOCIATION
MARLBOROUGH RESEARCH CENTRE
MARLBOROUGH DISTRICT COUNCIL
Ministry for Primary Industries Manatū Ahu Matua
GISBORNE DISTRICT COUNCIL
UC UNIVERSITY OF CANTERBURY
NZ School of Forestry
greater WELLINGTON REGIONAL COUNCIL
PROSEED
HAWKE'S BAY REGIONAL COUNCIL
Vineyard Timbers Ltd
Environment Canterbury Regional Council
Marlborough Lines
Bay of Plenty REGIONAL COUNCIL

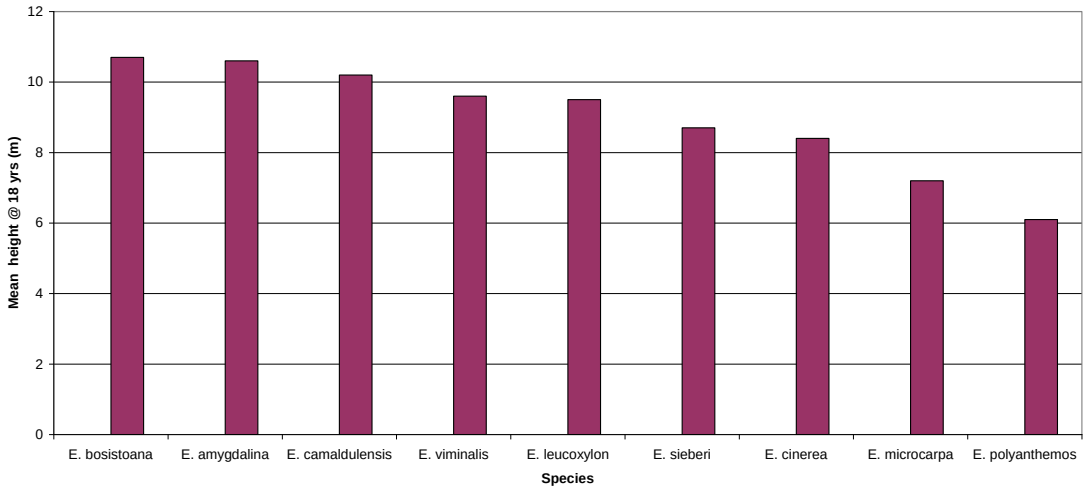

Figure 8: Mean height of eucalypt species in Wither hills trial.

Overall *E. bosistoana* along with *E. camaldulensis* were regarded as the best performing species in the trial. Insect damage, particularly the leaf chewing tortoise beetle was noted in the trial.

In 2003, Scion established a network of durable eucalypt trials through the North Island and Marlborough. One of these trials, in association with Vineyard Timbers and Marlborough Regional Forests, was established in the Para Valley between Blenheim and Picton. This was the only trial to include *E. bosistoana*. After only two years the *E. bosistoana* had one of the highest survival levels (98%), and was medium for growth rate (Figure 9).

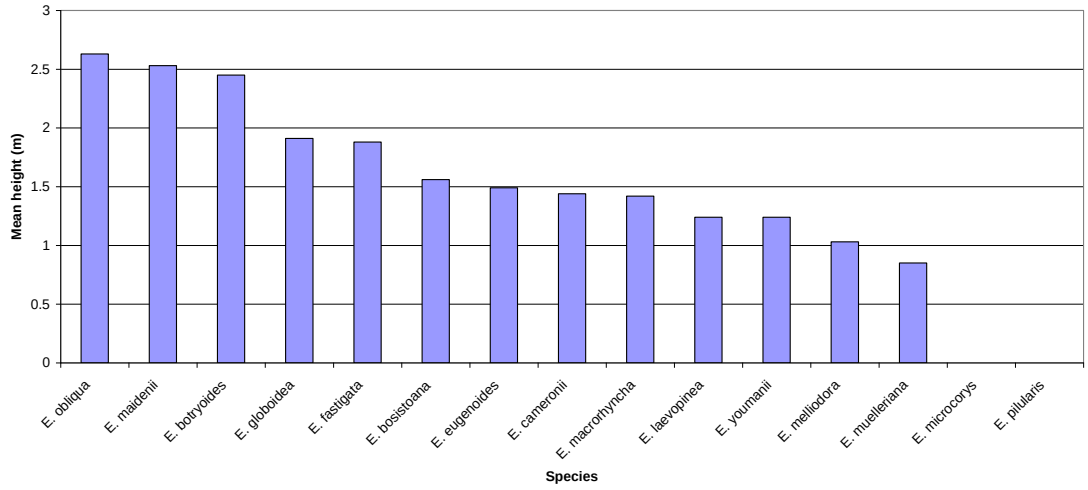

Figure 9: Height growth of 2 year old *E. bosistoana* in eucalypt trial at Para Valley Picton.

NZDFI *E. bosistoana* research programme

NZDFI has established large base breeding populations of several naturally-durable eucalypt species in dryland regions and select improved germplasm for commercial release. Individual provenances and trees with superior traits including wood properties, rapid growth and improved form will be selected at an early age for deployment. In collaboration with NZFFA members and regional land managers, NZDFI has planted breeding populations within Marlborough, Canterbury, Gisborne, Hawke's Bay and Wairarapa. Diverse sites will test the species across a range of environments and provide comparative data for screening individual families. Early screening for growth and form with selection of the best provenances and individuals will be completed in 2013. Plans are for these to be available progressively to commercial nurseries from 2015.

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greater Wellington Regional Council
Hawke's Bay Regional Council
Environment Canterbury Regional Council
Bay of Plenty Regional Council

Since 2008 Proseed has co-ordinated seed collection within Australia and NZ and donated this to the NZDFI. The target for each species is to collect seed from a minimum of 100 individual seed trees for each species from these remaining stands. Trees are very variable in their wild state therefore seed collections are made across a wide range of wild families in different areas to sample the full genetic diversity across climates and soil types. NZDFI seed collection sites extend across southern Queensland, New South Wales and Victoria. For some species, seed has been collected from NZ eucalypt plantations where the original provenance is known.

Successfully establishing large breeding populations of each species is critical to capture a broad range of genetic diversity from which to select multiple-traits and perhaps develop hybrids. For each species a target of 225 seedlings per family are grown. These have been planted to establish base populations of 7500 trees/species across three separate sites in the NZDFI regions. This will provide the broadest affordable genetic base to create elite breeding populations of the very best individual trees. For example, to have trees in the top 20% for growth, form, disease resistance, natural durability and drying, only one tree in up to 3000 is selected. Individual provenances and trees with superior traits including adaption to dryland conditions, fast growth, good form, early heartwood formation and ability to coppice can then be selected at an early age.

NZDFI completed planting on three South Island sites breeding populations representing 66 plus trees from the southern coastal distribution of *E. bosistoana* in 2009 (Figure 10). In 2011, early assessment of breeding populations gave results for both height growth and survival that confirmed genetic variation between and within seedlots that provides the opportunity for breeding improved material (Apiolaza *et al*. 2011).

Further *E. bosistoana* breeding populations were planted of another 35 plus trees in 2010 and another 66 in 2012. In addition, four small populations of 20 *E. argophloia* plus trees were planted in 2010/11 as a potential species for the production of hybrids with *E. bosistoana.*

Growth and form

There is insufficient experience with *E. bosistoana* to reach any firm conclusions on its growth potential and form compared with other eucalypt species. However it has consistently had high survival in the reported plantings.

Health

Without large plantations to inspect it is difficult to assess the health of *E. bosistoana* throughout New Zealand although the Wither hills trial noted damage from the leaf chewing insect *Paropsis charybdis*. A 2004 pilot study of *Acrocercops laciniella* (Blackbutt Leafminer) damage on eucalypts in Northland identified *E. bosistoana* as susceptible to damage in one of the study periods.

Flowering

The flowering of eucalypts can be influenced by season and probably more importantly by seed source. Blakely (1934) suggests the flowering period for *E. bosistoana* is November to January. Reports on the Wither Hills trial noted flowering in April and recent observations have been made of 7 year old trees flowering in Marlborough in February. More information is required to be able to predict flowering in New Zealand.

New Zealand management recommendations

Siting

There is insufficient information to define the best *E. bosistoana* sites; it has not performed well on very wet sites in the Wairarapa and in very cold conditions in upland Taranaki. Its performance in Northland has been variable. However it has been successfully established from Canterbury to Northland across a wide range of soil types. The performance of it in the dry Wither hills location near Blenheim suggests it can tolerate dryland situations. By observing the recent plantings in Marlborough and the Wairarapa, a better understanding of its site preferences will be developed. Nicholas (2008) suggests *E. bosistoana* can tolerate mild to sharp frosts of the order -7º to -3ºC. Both Jackson (1965) and Cutten (1964) report that *E. bosistoana* does well on limestone soils.

SUPPORTERS:

Establishment
Eucalypts will perform best when cultivation, weed control and fertiliser are used for establishment. **Effective cultivation** can be achieved by deep ripping, rotary hoeing or mounding. Mounding can also provide some protection from ground frosts. If mechanical cultivation is not possible, soil in the planting spot should be loosened thoroughly with a spade.

Eucalypts require **weed free sites** in the first year of growth. This is critical to achieving good survival and growth. It is preferable to use a pre-plant spray such as glyphosate, to kill existing ground cover two to eight weeks before cultivation and/or planting. Hormone sprays should not be used.

Eucalypts can be damaged by some standard forestry herbicides, their sensitivity can be influenced by species, the soil type temperature and whether plants are flushing. Gardoprim, Gallant and Versatill have been used successfully over eucalypts but care is needed in hot conditions and sandy soils. Spraying directly over plants is not recommended.

Planting stock options vary from bare-rooted stock to container grown plants. Either is acceptable if the plants are well-grown and robust for their growing season. Bare-rooted seedlings should be lightly branched, about 45 cm tall, have a root collar of at least 7 mm in diameter.

Ideally, container-grown stock should be planted out when the plants are 15-25 cm tall and have 6-8 pairs of leaves. Large plants receive a considerable check at transplanting, and the root system is often deformed and constricted in the container.

Eucalypt seedlings generally **respond to fertiliser** applied to individual seedlings about one month after planting on weed-free sites. A general recommendation is apply 60 grams of urea or 80 grams of diammonium phosphate (DAP), in a spade slit 20 centimetres to one side of the seedling.

Spacing
Although there are no specific post/pole trials with eucalypts in New Zealand, evaluation of a eucalypt planting comparing close spaced trees with standard forestry spacing indicated a much higher proportion of post quality material in the closer spacing. Therefore until further research data are available, it is recommended that pole crops be established at 3 m x 1.5 m (2222 stems/ha).

Silviculture
No clearwood pruning or thinning is anticipated in post stands, but a standard form pruning to remove double leaders and or heavy branches is recommended between ages two and three years, but not earlier.

Future research needs

The NZDFI's strategy is to breed and develop forest management systems to grow eucalypts that produce high value naturally-durable hardwoods by establishing large breeding populations for genetic improvement of four wild (unimproved) species in five NZ dryland regions.

Breeding Population Establishment
NZDFI has established large base breeding populations of several naturally-durable eucalypt species in dryland regions and select improved germplasm for commercial release. Individual provenances and trees with superior traits including wood properties, rapid growth and improved form will be selected at an early age for deployment. In collaboration with NZFFA members and regional land managers, NZDFI has planted breeding populations within Marlborough, Canterbury, Gisborne, Hawke's Bay and Wairarapa. Diverse sites will test the species across a range of environments and provide comparative data for screening individual families. Early screening for growth and form with selection of the best provenances and individuals will be completed in 2013. Plans are for these to be available progressively to commercial nurseries from 2015.

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Figure 10: Well-established one year old *E. bosistoana* breeding population at the Lawson's site in South Marlborough

After 2013, the focus will shift to applying novel early screening techniques to select trees with the best wood quality traits. The NZDFI tree breeding strategy will eliminate undesirable wood quality traits such as growth stress, brittleheart, checking, collapse and slow drying, and improve desirable traits such as early heartwood formation and intense colour.

Research will continue on a regular basis to collect and analyse data for predicting breeding values of each individual tree; to measure productivity and look at tree characteristics. Breeding values for different characteristics will be combined using selection indices. When the breeding populations commence flowering, it is planned to test and develop hybrids.

Acknowledgement

SUPPORTERS:

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Web links

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www.scionresearch.com
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