

Characteristics, Utilisation and Potential Markets for Cape York Peninsula Timbers



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1. Executive summary

The timber species occurring across Cape York Peninsular include some of the World's most versatile woods. Apart from traditional indigenous applications such as weapons, tools and instruments, and pastoral and mining utilisation for poles, fencing, building materials and sleepers, the timbers are not generally well known outside the north Queensland region. This report comprises the results of a literature review and domestic market survey and was undertaken on behalf of the Department of Primary Industries- Forestry (DPI-F), Atherton and the Queensland Forestry Research Institute (QFRI), Atherton Research Centre. Technical data and other important characteristics are combined with lists of past, current and potential uses and markets.

The nominated species for review were Darwin stringybark (*Eucalyptus tetradonta*), Cooktown ironwood (*Erythrophleum chlorostachys*), Melville Island bloodwood (*Corymbia nesophila*), brown salwood (*Acacia mangium*), lancewood (*A. shirleyi*), sandalwood (*Santalum* spp.) beefwood (*Grevillea striata*), grey mangrove (*Avicennia marina* var. *australasica*), red mangrove (*Rhizophora* spp.), cedar mangrove (*Xylocarpus* spp.), black mangrove (*Bruguiera* spp.), and tulip mangrove (*Heritiera littoralis*). All data presented has been obtained from QFRI timber species files (836-12 series), published references as listed in section 4 below, the World Wide Web, and through the conduct of a telephone survey. Summary tables are presented as Appendices for easy reference. The range of products and markets suggested has been derived from these references and also include the author's determinations based on published wood properties.

Of these species, Cooktown ironwood and sandalwood are perhaps the best known timbers outside the Cape and both have achieved high market prices in the past, despite the remoteness of the resource. Cooktown ironwood is one of the densest timbers in the World and is classified in the highest strength and durability groups for commercial timbers. In recent times it has achieved recognition for its suitability in musical instrument manufacture including woodwind, stringed and percussion sections of the industry. It has great potential as a flooring and furniture material. Sandalwood is an excellent carving timber and yields an essential oil. An industry based on the harvesting and trade of timbers of this Genus has had a long and colourful history in Western Australia and Queensland. Based on export to Asia, the sandalwood industry has ridden many highs and lows. Its predominant uses are for ceremonial incense (joss stick) manufacture and carving material. It is anticipated that there will always be a niche market for sandalwood, however oversupply and low quality stock influence market value. Darwin stringybark is the preferred fencing, yard-building, pole and sleeper species in its local area. It has the potential to be processed into flooring and furniture components. The mechanical properties of the timber lend it to tool handle manufacture, an industry currently dependent on spotted gum (*Corymbia* spp.) in Queensland. Melville Island bloodwood is virtually unknown in the timber industry south of Cairns. It has predominantly been used for structural and fencing applications but has the potential to join other highly featured eucalypts in the flooring and furniture markets. Brown salwood has been used in small volumes for specialty products such as fishing rods, archery bows and walking sticks. On a larger scale it has been processed for furniture (veneers and solid components), and used in general building construction. Lancewood is arguably one of the most attractive of the chocolate-hued timbers in the World. It is likely only to be available in small sections and will be suited to musical instrument components and turnery.

Beefwood offers timber users an attractive red-purple 'silky oak' timber. Recent veneer trials in Tasmania generated high interest. Maton Guitars and custom luthiers have undertaken other successful trials with the species. The timber has the potential to be processed into fine furniture and flooring products. The mangrove timber species group produce a range of interesting woods, potentially suitable for a range of products from tools, boatbuilding componentry, and non-timber uses such as honey, fish smoking, tannin, dye and rayon production. Cedar mangrove is strikingly similar to red cedar (*Toona* spp.), although stronger and firmer. If reasonable log sizes could be attained, these attributes offer great potential for the species in the furniture and joinery markets.

In many cases, important processing characteristics of these timbers are unknown. For example, graded recovery and seasoning behaviour are attributes which haven't been of primary concern to the Cape York timber industry who have predominantly been involved with poles, cross-arm, sleepers and fencing timber production. Accurate timber values are also difficult to attain without supplying representative samples to the industry for evaluation. Price estimates given by industry representatives during a telephone survey ranged from \$600/m³ (wholesale, green-off-saw) to \$10000/m³ (retail, seasoned, clear grade). The average rate quoted was \$2000/m³ (retail, sawn, seasoned).

2. Introduction and Background

Cape York Peninsular, covering a similar land area to the State of Victoria, but with a population of just 18,000 people, is practically the last frontier in terms of the Australian forest product industries. Currently, the principal industries in the Cape region are mining, grazing, fishing and tourism. Commercial timber production is a minor activity, whereby sleepers, poles, fencing and building timbers are being produced from the forest resource, and in earlier times sandalwood was harvested for export to Asian markets. The major timber species occurring on the Cape have long been considered of good repute, being hard, strong, durable and of aesthetically appealing colouring. Distances to markets and minimal transport infrastructure possibly lead to prohibitive freight costs, however a changing global timber resource and consumers' perceptions of this resource may enable an economically feasible timber industry to be established on the Cape. The aim of this paper is to appraise the qualities of the major commercial species growing on Cape York Peninsular and provide recommended markets and products for their wood. It is outside the scope of the report to provide feasibility analysis.

Forests and woodlands cover 84% of the area of Cape York Peninsular (Nelder and Clarkson, 1994). An assessment by Environment Science and Services North Queensland found that 14% of this area contains commercially valuable timber (CYRAG, 1996). This area, covering approximately 19,000 square kilometres, represents tall woodland forest type with Darwin stringybark (*Eucalyptus tetradonta*), Cooktown ironwood (*Erythrophleum chlorostacys*) and/or Melville Island bloodwood (*Corymbia nesophila*). Covering a range of tenures including State Forest, Timber Reserve, pastoral leasehold and Aboriginal reserves, 1.6 million hectares have been identified as available for harvesting, with a sustainable level estimated at 2m³/ha from an annual cutting area of 8416 ha (Wannan, 1994). Productivity data is lacking for these forests, but the Queensland Forest Service estimated that a 100-year cycle would provide sustainable production. This is similar to logging rotations in the southern ash-type eucalypt forests and the Western Australian karri forests (Wannan, 1994). A number of small sawmills exist in Cape York, including at least six Aboriginal community operations and several on pastoral holdings. Sawn recovery using existing equipment is approximately 20% to 30%. This is at the lower end of what modern hardwood mills are currently obtaining, probably due to the common incidence of termite 'pipe' and antiquated sawing equipment. Most timber produced stays in northern Queensland, with only small volumes being sold in southern markets, and negligible amounts exported.

There is potential for a range of secondary species to be developed and contribute to a Cape York forest product industry, including brown salwood (*Acacia mangium*), lancewood (*A. shirleyi*), mangroves (*Xylocarpus* spp., *Rhizophora* spp., *Avicennia marina* var. *australasica*, *Bruguiera* spp., and *Heritiera littoralis*), sandalwood (*Santalum* spp.) and beefwood (*Grevillea striata*). Where known, the properties and uses of these species have been included in this report.

2. Species Nomenclature, Properties and Uses

Below are detailed descriptions of the three predominant timber species and several lesser species. Data has been derived from QFRI files, other published literature and the World Wide Web. Background explanations of the properties are provided in the first description only (2.1 below), to prevent repetition. There are some gaps in the data due to the relative low level utilisation of some of these timbers in the past.

2.1. <u>Standard trade name</u>	Darwin stringybark.
<u>Botanical Name</u>	<i>Eucalyptus tetradonta</i> (F. Muell.). 'Tetradonta' often appears in the literature spelt ' <i>tetrodonta</i> ', however the correct epithet is <i>tetradonta</i> (Queensland Herbarium, pers. comm.).
<u>Derivation</u>	Genus- Greek, 'well-covered', referring to the tight fitting operculum of the flower buds; Epithet-referring to the four dominant teeth around the fruit's rim.
<u>Family</u>	Myrtaceae.
<u>Local names</u>	stringybark (Northern Territory, Western Australia), messmate (Northern Queensland, Western Australia).
<u>Description / occurrence</u>	<p>Small to medium sized hardwood, six to 30 metres in height, with a straight, relatively slender trunk. The open, straight-branched crown comprises 30 to 50 % of total tree height. The grey-coloured bark is fibrous, typical of 'stringybark' species, and extends through to the small branches. Pipe is common in mature trees, similar to other eucalypts, affecting sawn recovery.</p> <p>A monsoonal eucalypt, Darwin stringybark is widely distributed throughout Cape York, the Northern Territory (north from 17°S latitude) and the Kimberley region of Western Australia. From a commercial sawlog perspective the trees occurring through Cape York in Queensland are generally taller and of better form than those in the Northern Territory and Western Australia.</p>
<u>Wood appearance</u>	The heartwood is pale reddish-brown with contrasting yellow or light-brown sapwood. Darwin stringybark timber has a moderately fine and even texture, providing a good finish in dressed, sanded applications. Grain may be interlocking, but is generally straight.
<u>Density</u>	Density refers to a wood's weight per unit volume and is expressed in kg/m ³ . Three density states are considered useful by wood technologists when considering utilisation of a species or comparing properties between timbers. These are: basic density, the measure of the amount of actual wood substance; green density, the mass per unit volume at the time of felling or conversion; and air-dry density, the mass per unit volume when in a seasoned state, quoted at 12% moisture content in Australian references. CSIRO data for the species is given as: 895 kg/m ³ for basic density (the oven-dry weight divided by

the green or saturated volume); 1092 kg/m³ (before reconditioning), 1089 kg/m³ (after reconditioning) for air-dry density. These data were determined from a population of 57 specimen trees (Budgen, 1981). Data published in *Wood in Australia* (Bootle, 1983) cites basic density at 880 kg/m³ and air-dry density at 1050 kg/m³.

Queensland Department of Primary Industries have undertaken minimal testing in the past with a basic density result of 883 kg/m³. Published DPI air-dry data is 1170 kg/m³ (Cause *et al* 1989; Smith *et al*, 1991). Darwin stringybark is classified as 'very hard' in relation to resistance to indentation (a positive attribute) and working with machine or hand tools (a negative attribute, but can be overcome with sharp, modern tooling). There is approximately 0.85m³ of sawn, seasoned Darwin stringybark per tonne in mass. This data can be used to calculate freight and shipping loads.

Strength groups

Strength groups are classified in accordance with the principles set out in AS2878-1986 *Timber- Classification into strength groups*. When shown in brackets, eg. (SD2), these are provisional assessments based on density and are therefore relatively conservative. When used in conjunction with grade quality descriptions in Australian Standards, these groupings enable the allocation of 'stress grades', that is, defined working stresses. Strength group classifications for Darwin stringybark are given as: green S1; seasoned (SD2).

Stress grades

A stress grade or stress rating is the classification of a piece of timber for structural purposes. This can be determined by means of visual, mechanical or proof grading to the relevant Australian Standard, to indicate its basic working stress in bending. By implication other basic working stresses and stiffness, normally used in engineering design are indicated. For example, F14 indicates a basic working stress in bending of approximately 14 megapascals (MPa). Depending on grade quality, the following range of stress grades are achievable for Darwin stringybark: green F14, F17, F22, F27; seasoned F17, F22, F27, F34 when visually stress graded in accordance with Australian Standard AS2082-2000 *Timber- Hardwood visually stress graded for structural purposes*.

Modulus of Rupture

MOR (bending strength) is a measure of the ultimate short-term load-carrying capacity of a beam when the load is applied at a slow rate to the longitudinal axis of the beam. The MOR for Darwin stringybark (ex- Northern Territory) in an unseasoned condition is 145 MPa.

Janka Hardness

Janka hardness testing involves pressing an 11.28mm diameter steel ball into the timber specimen until it penetrates to half its diameter. The resultant measure provides a comparative figure implying the timber's resistance to indentation and consequently its suitability for applications such as flooring and bench tops. Published data for Darwin stringybark sourced from the Northern Territory lists a green Janka hardness of 9.6kN. This is significantly higher than that achieved by other stringybark species. Seasoned data has not been published but could be expected to be approximately 25% higher than the green figure.

<u>Crushing Strength</u>	Maximum Crushing Strength is the ultimate strength attained under a load slowly applied parallel to the grain. This figure provides an indication of the relative suitability of the species for columns. Published data is only available for unseasoned, Northern Territory material which attained 74 MPa.
<u>Impact Strength (Izod)</u>	The Izod test provides a measure of the energy required to break a standard-sized specimen with a pendulum. Published data for an unseasoned, Northern Territory sample is 28J. This provides a useful comparison of the suitability of a species for applications such as impact tool handles (hammers, axes, shovels, mattocks) and sporting goods.
<u>Shrinkage</u>	Unit shrinkage is the percentage shrinkage per 1% change in moisture content and is useful in calculating the anticipated 'movement' of timber in use, such as T&G flooring, chamferboards and furniture. For Darwin stringybark, unit shrinkage is 0.38% tangential and 0.31% radial after reconditioning. Shrinkage from green to air-dry (12%) is 5.1% tangential and 3.2% radial. Shrinkage after reconditioning and re-drying is 4.9% tangential and 3.2% radial. These figures are useful to enable calculation of green-milling sizes and to anticipate reduction of cross-section dimension as a result of drying.
<u>Durability</u>	Durability refers to the timber's natural resistance to decay, weathering and termite attack. The literature provides conflicting assessments of Darwin stringybark's durability. Several publications classify the species as 'moderately durable', which equates to class three on the standard four-class provisional scale used by wood technologists to describe timber durability. However anecdotal evidence based on the Queensland resource, collated by QFRI has enabled provisional classification of Darwin stringybark as durability class 1. This infers a timber of the highest natural durability, which may be expected to resist both decay and termite attack for at least 25 years and up to 50 years or more. Darwin stringybark resists the effects of weathering (ultraviolet degradation, etc) well.
<u>Lyctid susceptibility</u>	Lyctids, also known as powder-post beetles due to the ability of the larvae to reduce susceptible timber to a fine, flour-like powder, can attack the sapwood of some seasoned hardwoods. There have been no reported lyctid infestations of Darwin stringybark. Despite this, current legislation in Queensland requires that the sapwood of the species be given a provisional classification of 'susceptible' until proven otherwise by standard laboratory inoculation and observation. This legislated position means that sapwood of Darwin stringybark must be removed during processing or immunised with an approved lycticide prior to sale or use in Queensland. For appearance products this usually means the sapwood is treated with boron compounds which are colourless.
<u>Seasoning</u>	Seasoning is the reduction of moisture content of wood to suitable proportions for end-use. This is critical for many applications such as furniture, flooring and decking, where the timber needs to be 'pre-shrunk' prior to use. Different species exhibit different characteristics during the seasoning process and while some timbers dry well, many suffer degrade, resulting in reduced recovery. There is no recorded information regarding the seasoning behaviour of Darwin stringybark, apart from the shrinkage data quoted above. It appears to be a low to medium shrinkage timber. This characteristic combined with its high density would indicate that it should perform as well as comparable eucalypt hardwoods during drying. Green moisture

content may vary considerably depending on time of harvest (season), although it is assumed that harvesting operations would be conducted during the dry, at which time the green moisture contents could be expected to be relatively low. This is usually an advantage for drying processes. Green moisture contents of samples tested by QDPI in the past ranged from 26% to 36%, which is low compared to commercial hardwoods milled in south-east Queensland.

Machining

Limited information has been recorded regarding the machining of Darwin stringybark. Hard, dense timbers generally machine and turn well, provided sharp tools are used and the timber is straight grained. A reduced planing angle (15°) is recommended for pieces exhibiting interlocking grain.

Fixing

As the predominant utilisation of the species to date has been as poles, sleepers, etc, there is limited recorded information regarding the fixing of the Darwin stringybark. No difficulties are experienced using standard fittings and fastenings with heavy hard eucalypts generally, however one reference (Boland *et al*, 1984) describes the wood of Darwin stringybark as fissile, implying a tendency to splitting. If this was a characteristic of Cape York-sourced material then pre-drilling before nailing would be required for applications such as feature flooring and decking.

Gluing

Data is lacking for the gluing characteristics of Darwin stringybark. As a general rule, high-density timbers are considered difficult to glue. In recent years QFRI has done much work in gluing high density timbers and have had reasonable success under certain conditions, such as ensuring that gluing is undertaken immediately after surface preparation (planing/sanding). Adhesive research for high-density timber species is continuing and industry confidence in using glued joints or components from these timbers is increasing.

Finishing

As with machining, fixing and gluing, little or no information has been recorded pertaining to the finishing of Darwin stringybark. Most stringybarks and other high-density eucalypts take stain, paint and polish well, however they are classified as high staining timbers and water-soluble tannins can bleed through painted surfaces causing unsightly brown discolouration of adjacent surfaces. It is unknown whether Darwin stringybark is a high staining timber or not.

Engineering/Construction

house poles, stumps, posts, beams, bearers, joists, flooring, lintels, wall framing, exterior cladding, fascias, bargeboards, plywood, internal staircase construction, decking, external step treads and stringers, balustrading, joinery, transmission poles cross-arms, posts, wharf and bridge components, railway sleepers, mining timbers.

Decorative

feature flooring (strip, parquetry, overlay panels), lining boards, indoor and outdoor furniture, joinery, veneer, hard turnery, knife handles.

Others

yard building timbers (rails, posts), fencing posts and strainers, vehicle decks, tool handles, ladders, landscaping sleepers, potential for musical instruments and charcoal briquette production.

Indigenous

Darwin stringybark has been utilised for a great variety of applications by indigenous Australians: spears, woomeras, fighting and digging sticks, paddles, axe-handles, bull roarers, dance sticks, didgeridoos, coffins, drums, drone pipes.

Summary

A timber of good repute in the area in which it occurs, particularly for applications such as fencing, yard building, sleepers and poles. Cape York-sourced material is reported to be more durable than timber from the Northern Territory or Western Australia. An excellent structural timber, Darwin stringybark is also a desirable colour for aesthetic applications such as flooring and furniture. Much research and development has gone into the use of heavy Queensland hardwoods for fine furniture during the late 1990s. Some processing and seasoning problems traditionally associated with high-density timbers have been successfully overcome, providing confidence in the potential of Darwin stringybark for indoor and outdoor furniture.

It has excellent potential for tool handles, and may find favour over established species such as spotted gum, particularly as the spotted gum resource changes from natural-grown to plantation-grown timber which may have inferior wood properties. The major tool handle manufacturer in Australia currently processes 1200m³ of spotted gum per annum, however they currently pay only \$600/m³ for green-off-saw material.

There are currently several unknown factors which are critical to determine whether all the proposed utilisation applications discussed above would be viable. For example how the timber seasons, graded recovery, staining, presence of silica, and consistency of physical and mechanical properties across the resource. Generally, the likelihood of the species suffering from collapse during drying is unlikely, and if modern technology is employed in processing and reasonable grade quality timber can be produced, Darwin stringybark should be popular in the impact tool handle and appearance product markets. The species is virtually unknown outside of the North Queensland region so market values are difficult to determine until samples could be presented to industry representatives for comment.

2.2. <u>Standard trade name</u>	Cooktown ironwood.
<u>Botanical Name</u>	<i>Erythrophleum chlorostacys</i> (F. Muell) Baill. Syn. <i>E. laboucheri</i> .
<u>Derivation</u>	Genus- Greek, 'red+bark'; Epithet- Greek, 'green+spike', referring to the greenish, bottlebrush inflorescence.
<u>Family</u>	Caesalpineaceae (Leguminosae) (Orchard <i>et al</i> 1998).
<u>Local names</u>	ironwood, camel poison, red ironwood, red ebony (NT) and leguminous ironbark.
<u>Description/occurrence</u>	A medium-sized tree up to 20m in height and 1m diameter bole, typically with a dense crown, although it is a semi-deciduous species. Boles are variable in form with a hard, coarsely tessellated grey to black bark. All parts of the tree are thought to be toxic and stock losses have occurred through ingestion of the leaves. No records could be found to confirm that the wood or sawdust has caused health problems, however caution should be observed as with working any timber species.
<u>Wood appearance</u>	The heartwood is an attractive bright red with contrasting light-brown sapwood. Cooktown ironwood has a medium and even texture, providing a good finish in dressed, sanded applications. Grain is often interlocked, showing as wavy vessel lines on longitudinal surfaces.
<u>Density</u>	Data published in <i>Wood in Australia</i> (Bootle, 1983) cites basic density at 1030 kg/m ³ and air-dry density at 1220 kg/m ³ . Queensland Department of Primary Industries concur with 1220kg/m ³ (air-dry) in their literature (Cause <i>et al</i> 1989; Smith <i>et al</i> , 1991). Cooktown ironwood, as indicated by its standard trade name, is classified as 'very hard' in relation to resistance to indentation and working with hand tools. There is approximately 0.80m ³ of sawn, seasoned timber per tonne in mass.
<u>Strength groups</u>	green S1; seasoned provisionally (SD1).
<u>Stress grades</u>	green F14, F17, F22, F27; seasoned F22, F27, F34 when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Modulus of Rupture (MOR)</u>	The MOR for Cooktown ironwood (ex- Northern Territory) in an unseasoned condition is 140 MPa, which rates the species highly as a structural timber.

<u>Janka Hardness</u>	Published data for Cooktown ironwood sourced from the Northern Territory lists a green Janka hardness of 13kN. This is equal highest to only two other species in the literature, indicating that this species could provide one of the hardest wearing flooring and benchtop surfaces in the World.
<u>Crushing Strength</u>	Published data is only available for unseasoned, Northern Territory material which attained 85 MPa. This was higher than for any other engineering timber listed in the literature and means that Cooktown ironwood rates as one of the strongest column timbers in the World.
<u>Impact Strength (Izod)</u>	Published data for unseasoned, Northern Territory material is 22J, ranking Cooktown ironwood as one of the toughest timbers in the World.
<u>Shrinkage</u>	Unit shrinkage data are not available. Shrinkage from green to air-dry is approximately 3% tangential and 2% radial. This places Cooktown ironwood in a low shrinkage category.
<u>Durability</u>	Cooktown ironwood is durability class 1, that is, a timber of the highest natural durability which may be expected to resist both decay and termite attack for at least 25 years and up to 50 years or more.
<u>Lyctid susceptibility</u>	The unimmunised sapwood of Cooktown ironwood is lyctus susceptible.
<u>Seasoning</u>	Care must be taken to avoid surface checking during drying. This is particularly important for appearance grade products. Amelioration methods such as end sealing and hessian-shrouding are recommended. The highest volume usage of Cooktown ironwood to date has been for unseasoned products such as railway sleepers and fencing timbers and therefore little data has been accumulated regarding its seasoning behaviour.
<u>Machining</u>	The wood is hard to work due to its extremely high density and the presence of interlocking grain. Despite this, a good finish can be attained using low cutting angles (eg 15°) and sharp tools.
<u>Fixing</u>	As the predominant utilisation of the species to date has been for sleepers and fencing material, there is limited recorded information regarding the fixing of the timber.
<u>Gluing</u>	Data is lacking for the gluing capabilities of Cooktown ironwood, however as with other high-density species gluing procedures should be undertaken immediately after surface preparation.
<u>Finishing</u>	As with machining, fixing and gluing, little or no information has been recorded pertaining to the finishing of Cooktown ironwood.

Engineering/Construction

house poles, stumps, posts, beams, bearers, joists, flooring, lintels, wall framing, exterior cladding, plywood, internal staircase construction, external step treads and stringers, balustrading, transmission poles, cross-arms, posts, wharf and bridge components, railway sleepers, mining timbers.

Decorative

feature flooring (strip, parquetry, overlay panels), decking, lining boards, indoor and outdoor furniture, veneer, hard turnery, knife handles.

Others

handcrafted wooden flutes, drums, recorders, cricket bales, tool handles, yard building timbers (rails, posts), fencing posts and strainers, vehicle decks, landscaping sleepers, potential for charcoal briquettes.

Indigenous

spear and harpoon heads, woomera pegs, cooking and digging sticks, axe-handles, music sticks, pierced nose pegs and drone tubes.

Summary

Cooktown ironwood is one of the densest, hardest, commercial timber species in the World. Timber suppliers will require the latest technology in processing equipment to minimise the effects of the extremely high density and interlocking grain, however a fine finish can be achieved. It has excellent strength characteristics for beam and column structural applications. Its extremely high density renders it one of the most suitable timber surfaces for flooring in high traffic areas, benchtops, truck floors and utility traybacks. Red-coloured timbers have always enjoyed popularity with architects, specifiers and homeowners and Cooktown ironwood is renowned for its deep-red hue. This infers markets for appearance grade products such as flooring, furniture, and lining boards. Cooktown ironwood's

low shrinkage classification is another favourable attribute for these applications. As a musical instrument timber it has already found favour with several flute, drum and guitar manufacturers and several World Wide Web homepages testify to the timber's versatility in these niche markets. A resonator guitar featuring a Cooktown ironwood top and valued at \$2800 was recently awarded second prize in the high profile national *Outback Timbers 2000* woodworking competition. A specialty timber supplier in Brisbane holds approximately 4m³ in stock and sells an average of 2m³ per annum. They pay \$1300 to \$1700/m³ landed in Brisbane. Retail prices vary upwards from \$2000/m³. A laminated benchtop manufacturer estimates the value of kiln-dried timber at \$700-\$1200/m³ landed in Brisbane. A flooring specialist indicated that T&G flooring could attract a retail price of \$2600/m³. A Melbourne specialty timber supplier estimated that furniture grade stock could wholesale for between \$3000 and \$5000/m³ and retail for up to \$10000/m³.

Due to the well-known toxic attributes of parts of the plant, handling of the timber through all stages of harvesting and processing should be undertaken with caution, until it can be determined if any undesirable toxicants can affect timber handlers. Many renowned timbers can cause health problems, such as red cedar, red siris and black bean, and these have been safely utilised so it is anticipated that Cooktown ironwood could be handled safely. Cooktown ironwood is a native hardwood with huge potential across a diversity of markets, from high volume flooring and structural products to low volume, high value niche markets such as musical instruments.

2.3. <u>Standard trade name</u>	Melville Island bloodwood.
<u>Botanical Name</u>	<i>Corymbia nesophila</i> syn. <i>Eucalyptus nesophila</i> .
<u>Derivation</u>	Genus- Greek, bearing a corymb-type florescence; Epithet- Greek, 'island+loving'.
<u>Family</u>	Myrtaceae.
<u>Local names</u>	island bloodwood.
<u>Description/occurrence</u>	A medium to tall tree of reasonable form, generally 15 to 25m with occasional specimens attaining 30m and 1m diameter. The bark is rough, tessellated, grey to reddish-brown in colour and persists to the smaller branches. The species occurs through Cape York in Queensland, Coburg Peninsular, Bathurst and Melville Islands in the Northern Territory and the Kimberley region in Western Australia. In the Queensland and the Northern territory areas in which it occurs it is considered one of the superior mill log trees based on form and vigour.
<u>Wood appearance</u>	Heartwood is reddish-brown with a 25mm whitish sapwood band. Gum (kino) veins are a common feature of the wood. Texture is coarse due to the diameter of the vessels and the grain is often interlocked.
<u>Mechanical Properties</u>	Due to its limited utilisation in the past, no data is available regarding the mechanical and physical properties of the timber.
<u>Density</u>	Air-dry density is in the range 905kg/m ³ to 1010kg/m ³ .
<u>Strength Group</u>	Green (S4).
<u>Stress Grades</u>	Green F7, F8, F11, F14, when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber-Hardwood visually stress graded for structural purposes</i> .
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is ≤4% tangential and ≤2% radial.
<u>Durability</u>	Based on anecdotal information, Melville Island bloodwood is provisionally durability class 1.
<u>Lyctid susceptibility</u>	The unimmunised sapwood of Melville Island bloodwood is lyctus susceptible.

<u>Seasoning</u>	Sawn boards must be dried slowly and carefully to avoid degrade associated with the gum veins and surface checking. Mild collapse may occur in the early stages of drying. End sealing, hessian shrouding and close sticker spacing is recommended for appearance product stock.
<u>Machining</u>	The timber is relatively easily worked and planes to a good finish with sharp cutters.
<u>Fixing</u>	Melville Island bloodwood has proven to be more fissile than other bloodwoods and requires pre-boring to prevent splitting when nailing.
<u>Engineering/ Construction</u>	Poles, piles, stumps, structural timber.
<u>Decorative</u>	feature flooring (strip, parquetry, overlay panels), lining boards, indoor and outdoor furniture, veneer, hard turnery, knife handles.
<u>Others</u>	yard building timbers (rails, posts), fencing posts and strainers, mining timber, vehicle decks, landscaping sleepers, potential for charcoal briquettes.
<u>Summary</u>	A relatively unknown commercial species, Melville Island bloodwood has been successfully used in northern Australia for poles and fencing timber. The bloodwood group of hardwoods are generally hard, durable and appealing in colour. The timber could find a place in the growing high feature markets where gum veins and other defects are used to effect in flooring and furniture. Nothing is known about the true mechanical properties of the timber, however based on the published density data and subject to grade quality provisions, the timber could be used for structural members. Based on the limited information available, it could be assumed that in addition to past and current uses, Melville Island bloodwood could enter the landscaping and sleeper markets and value-added products such as furniture and flooring. Industry representatives were unwilling to comment on possible market values for the species without seeing samples.

2.4. <u>Standard trade name</u>	brown salwood.
<u>Botanical Name</u>	<i>Acacia mangium</i> .
<u>Derivation</u>	Genus- Greek, 'to sharpen' referring to an early description of a thorny Egyptian species.
<u>Family</u>	Mimosaceae.
<u>Local names</u>	black wattle, hickory wattle, sally wattle.
<u>Description/occurrence</u>	Medium sized hardwood attaining a height of 30 metres and a diameter up to 1m on favourable sites. Occurs from northern New South Wales along the eastern coast of Queensland to Cape York.
<u>Wood appearance</u>	Heartwood varies from light brown to brown, often streaked with darker markings. Sapwood is creamy-white to pale brown.
<u>Density</u>	Basic density data unavailable. Air-dry density is approximately 800 kg/m ³ . Brown salwood is classified as 'moderately hard' in relation to resistance to indentation and working with hand tools. There is approximately 1.25m ³ of sawn, seasoned timber per tonne in mass.
<u>Strength groups</u>	green (S5); seasoned (SD5).
<u>Stress grades</u>	green F5, F7, F8, F11; seasoned F8, F11, F14, F17 when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Modulus of Rupture (MOR)</u>	The MOR for brown salwood in a seasoned condition is 128 MPa.
<u>Janka Hardness</u>	Seasoned 5.9kN.
<u>Crushing Strength</u>	Seasoned 60MPa.
<u>Shrinkage</u>	Unit shrinkage: data not available. Approximate shrinkage from green to air dry is 4% tangential and 1.5% radial.
<u>Durability</u>	Class 3, moderately resistant to decay when fully exposed to the weather, clear of the ground and well drained with free air circulation. Not recommended for in-ground use.

<u>Lyctid susceptibility</u>	The unimmunised sapwood of brown salwood is lyctus susceptible.
<u>Seasoning</u>	Can be satisfactorily dried using conventional methods.
<u>Machining</u>	Relatively easy to machine and turns well to a smooth finish.
<u>Fixing</u>	No difficulties have been experienced with the use of standard fittings and fastenings.
<u>Engineering/Construction</u>	General house construction as framing, flooring, linings and mouldings.
<u>Decorative</u>	Plywood, furniture, shop and office fixtures, joinery, turning, walking sticks.
<u>Others</u>	Fishing rods, archery bows, tool handles (axes and hammers), light boat building.
<u>Summary</u>	A versatile timber with many favourable attributes including appearance, workability and performance. It has found several specialty applications and has no inherent problems in regard to seasoning, gluing, bending, etc. The only negative feature is the lyctid-susceptible sapwood which is required to be removed or immunised with an approved preservative for sale and use in Queensland, similarly to many other commercial hardwoods. Brown salwood is often marketed in the black wattle group in the furniture trade. Green sawn boards attract between \$1200-\$1600/m ³ landed in Sydney.

2.5. <u>Standard trade name</u>	sandalwood.
<u>Botanical Name</u>	<i>Santalum lanceolatum</i> (Qld, NT), <i>S. spicatum</i> (WA), <i>S. album</i> , <i>S. austrocaledonicum</i> (Pacific nations).
<u>Derivation</u>	Genus- Greek/Sanskrit 'fragrant'. Epithet- <i>lanceolatum</i> Latin 'small lance'; <i>spicatum</i> Latin 'spike'; <i>austrocaledonicum</i> Latin southern Caledonia.
<u>Family</u>	Santalaceae.
<u>Local names</u>	northern sandalbox, northern sandalwood, plum tree, plumwood, plumbush, bolan (Palmer River), tharra-gibberah (Cloncurry), eai and lanala (Pacific/Polynesia).
<u>Description/occurrence</u>	A semi-parasitic shrub or small hardwood tree attaining 6m in height and 30cm diameter on favourable sites, but more frequently 2m and 12cm. <i>S. lanceolatum</i> is widely distributed throughout Queensland and has been harvested for export to Asia for joss stick manufacture and carvings. This species produces a sweet, edible fruit which is suitable for jams. The wood derived from north of Hughenden in Queensland is more heavily scented. Other species of <i>Santalum</i> that may be of interest to the forestry industry in Cape York are <i>S. album</i> which occurs in the Northern Territory and is cultivated from India to Hawaii, and <i>S. austrocaledonicum</i> which occurs in the Pacific region and is reputedly higher in oil content than other species. The oil is distilled for use in soaps, perfumes and medicine and the foliage is palatable to stock. <i>S. spicatum</i> has been harvested for export since the earliest days of colonisation in Western Australia, providing a profitable supplementary income for prospectors and pastoralists for almost 200 years in that State.
<u>Wood appearance</u>	The heartwood is pale yellow to pale brown with creamy sapwood. Freshly cut wood has a distinctive and pleasant odour. The texture and colouring is similar to white cypress.
<u>Density</u>	Air-dry density is 930/m ³ . A heavy wood is usually a hard one but sandalwood is relatively soft despite its high density, which may be attributed to its high oil content. Approximately 1.08m ³ of seasoned wood per tonne in mass.
<u>Strength Group</u>	Green (S3), seasoned (SD3).
<u>Stress Grades</u>	Green F8, F11, F14, F17; seasoned F14, F17, F22, F27, when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is about 3.5% tangential and 2.5% radial.

<u>Durability</u>	No data or anecdotal comments were found regarding the durability of the timber, although this property is not considered relevant for the intended end-uses for sandalwood.
<u>Lyctid susceptibility</u>	The unimmunised sapwood of sandalwood is lyctus susceptible.
<u>Seasoning</u>	As with most small hardwoods from dry regions, sandalwood is prone to checking and splitting. Care needs to be taken when drying. The carving market represents the highest value for sandalwood based on past trade and this application demands the highest grade quality. Minimal seasoning defects will be acceptable for carving grade timber. Amelioration practices such as end-sealing and hessian-shrouding should be employed for the drying of carving and turning timber. This extra care won't be necessary for joss stick and mosquito coil manufacture, or timber destined for oil distillation.
<u>Machining</u>	Sandalwood machines well due to its inherent oiliness.
<u>Fixing</u>	No problems have been experienced with standard fixings and fasteners.
<u>Decorative</u>	A highly sought after carving timber, despite its high density; small boxes, napkin rings, fans, beads, joss sticks (Buddhist and Hindu ceremonial incense sticks), insect repellent coils and cones.
<u>Summary</u>	Harvesting of sandalwood is one of the oldest industries in the World due to the importance placed on it for Buddhist and Hindu ceremonies. Early file references quote sandalwood as being Queensland's most valuable timber (HJF, 192?) and 'well worth the attention of the Forestry Department'. Likewise, in Western Australia, sandalwood was the major export earner in the mid-1800's, earning more than wool or whale oil. The industry has a long and colourful history and at times has attracted an undesirable element of the timber industry (the sandalwood mafia!), both here and overseas. The industry has been characterised by boom and bust cycles, reflecting periodic oversupply. It is obtainable only in small sizes and therefore suited to specialty articles such as turnery, carvings and small boxes. Carving grade timber commands the highest price (Applegate, 1990). Oil quality and yield also influence price. <i>S. album</i> has maintained a reputation for yielding quality oil and hence has attracted much research interest, particularly by the Indian Forest Service. CALM in Western Australia have been involved in research projects investigating both <i>S. album</i> and the native species <i>S. spicatum</i> . Pacific species such as <i>S. austrocaledonicum</i> are worthy of trial in the Cape due to the potential for higher oil yields than native species. Expanding Asian populations and potential for marketing in western countries for craft wood (turnery and carving), pot-pourri and insect repelling coils auger well for a sandalwood industry based on a combination of managed native forest and plantation-grown timber. The marketing of sandalwood has proved to be complex. It is recommended that oil content and resource grade quality be determined by resource owners and merchants in order to achieve greater bargaining power and optimum utilisation. Supply levels need to be aligned to demand to avoid the cycles of oversupply which have depressed the market in

the past. Wholesale price indications were given as \$800-\$1600/m³. Retail prices for premium quality carving pieces attract \$3500/m³ upwards to \$9000/m³. It is usually sold by the kilogram.

2.6. <u>Standard trade name</u>	lancewood.
<u>Botanical Name</u>	<i>Acacia shirleyi</i> .
<u>Derivation</u>	Genus- Greek, 'to sharpen' referring to an early description of a thorny Egyptian species; Epithet- after Dr J. Shirley.
<u>Family</u>	Mimosaceae.
<u>Description/occurrence</u>	Erect tree to 15m, generally with a small diameter bole up to 20cm in diameter. It is often found in pure stands in dry pastoral areas west of the Great Dividing Range.
<u>Wood appearance</u>	An attractive, variegated red-brown heartwood with a contrasting bright yellow sapwood band.
<u>Janka hardness</u>	17.3kN.
<u>Density</u>	Air-dry density is 1020 kg/m ³ , green density 1105 kg/m ³ (moisture content approximately 25%) and basic density 835 kg/m ³ . Approximately 1m ³ of seasoned wood per tonne in mass, and 0.9m ³ per tonne of green wood.
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is 1.8% tangential and 1.0% radial.
<u>Durability</u>	durable, provisional rating of 2, suitable for weather-exposed applications clear of the ground.
<u>Lyctid susceptibility</u>	The unimmunised sapwood of lancewood is provisionally lyctus susceptible.
<u>Seasoning</u>	There is no information on the seasoning characteristics of lancewood. Care should be taken for timber destined for turnery or musical instrument componentry where the highest grade quality is required.
<u>Machining</u>	A hard and heavy timber requiring sharp tools, however an excellent finish can be achieved.
<u>Gluing</u>	Satisfactory: QFRI tests resulted in an average wood fibre failure of 85%.
<u>Construction</u>	Used extensively for rails in yard building in western Queensland on account of its straightness, durability and availability.
<u>Decorative</u>	An excellent turnery and craft timber when the contrasting sapwood is used for effect. Potential for musical instrument components such as violin bows, fingerboards and guitar fretboards.

<u>Summary</u>	A fine hardwood of rich colouring with the potential to replace imported musical instrument timbers such as rosewood and pernambuco. An excellent timber for wood turning although sharp tools are required to achieve desirable finish quality. Small, seasoned turnery pieces sell for up to \$10000/m ³ .
2.7. <u>Standard trade name</u>	beefwood.
<u>Botanical Name</u>	<i>Grevillea striata</i> .
<u>Derivation</u>	Genus- After C. F. Greville, a founding member of the London Horticultural Society; Epithet- striped, referring to the leaf venation. The trade name is derived both from the rich red colour of the wood and the pungent 'silverside/corned beef' odour of a freshly felled tree.
<u>Family</u>	Proteaceae.
<u>Local names</u>	beef oak, beef silky oak, western beefwood (note that five other species are known as beefwood, reinforcing the usefulness of standard trade names to avoid confusion).
<u>Description/occurrence</u>	A medium sized tree to 12m in height and 60 cm diameter, often vigorous but of poor form when compared to coastal forest trees. Beefwood is found scattered across extensive areas of northern Australia.
<u>Wood appearance</u>	As with all Proteaceae species, beefwood has the characteristic 'silky oak' appearance due to the high and wide medullary ray parenchyma. The heartwood is an attractive deep, purple-red. The sapwood is creamy-white.
<u>Janka hardness</u>	14.5kN.
<u>Density</u>	Air-dry density ranges from 880 to 990 kg/m ³ . Green density is 1200 kg/m ³ (moisture content 42%) and basic density 825 kg/m ³ . Approximately 1 to 1.1 m ³ of seasoned timber per tonne and 0.8m ³ per tonne of green wood.
<u>Strength Group</u>	Green (S3), seasoned (SD4).
<u>Stress Grades</u>	Green F8, F11, F14, F17, seasoned F11, F14, F17, F22 when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is 3.5% tangential and 1.5% radial.

<u>Durability</u>	Class 2, suitable for weather-exposed, above ground applications. In dry areas beefwood posts have given adequate service and the timber is used for fenceposts and strainers.
<u>Lyctid susceptibility</u>	The unimmunised sapwood of beefwood is lyctus susceptible.
<u>Seasoning</u>	Prone to splitting and checking therefore care must be taken with beefwood during drying. End-sealing and hessian shrouding are recommended.
<u>Machining</u>	A good finish can be achieved despite the timber's high density and abundant ray parenchyma.
<u>Fixing</u>	No problems have been encountered with the use of standard fasteners.
<u>Engineering/ Construction</u>	Can be used for structural applications but would be a poor utilisation choice for a Proteaceae timber of such aesthetic appeal. Suitable for fencing in the districts in which it occurs.
<u>Decorative</u>	Wood turning, walking sticks, musical instrument manufacture. Maton Guitars have trialed beefwood for guitar bridges with success. The winning entry in the <i>Outback Timbers 2000</i> musical instrument category was a beefwood concert harp valued at over \$30,000, giving the timber the high profile it deserves.
<u>Summary</u>	A hard, heavy, richly coloured oak-type timber with potential for furniture and feature flooring (parquetry), lining boards and bench tops. Degrade during seasoning impacts on saleable recovery and should be addressed through research to ensure effective utilisation. A relatively well-known species despite low levels of usage to date, beefwood is currently valued at \$900-\$2000/m ³ for rough-sawn boards, depending on grade quality and board dimensions. Recent trials undertaken in Tasmania have produced spectacular veneers and indications from the processor were that if veneer logs could be supplied on a continuous basis and in conjunction with solid timber of the species, beefwood has the potential to be a World-class furniture timber.

2.8 <u>Standard trade name</u>	grey mangrove.
<u>Botanical Name</u>	<i>Avicennia marina</i> var. <i>australasica</i> syn. <i>A. officinalis</i> .
<u>Derivation</u>	Genus- After a 10 th Century Persian philosopher and physician; Epithet- Latin 'of the sea'.
<u>Family</u>	Avicenniaceae (formerly classified under Verbenaceae).
<u>Local names</u>	white mangrove.
<u>Description/occurrence</u>	Usually a small tree 3 to 5m but often attaining 8m in height and 40cm diameter. Outstanding growth in the tropics has produced specimens 25m in height and over 1m in diameter. Grey mangrove has the widest distribution of the mangrove group (comprising species from four families), occurring in all mainland States and in the Indo-Pacific and Asian regions.
<u>Wood appearance</u>	Heartwood grey to brown, sapwood paler. Growth rings contribute to a distinctive figure. The timber is coarsely textured, often with interlocking grain.
<u>Density</u>	Air-dry density ranges from 800 to 880kg/m ³ . Green density is 1150 kg/m ³ and basic density 690 kg/m ³ . Approximately 1.2 m ³ of seasoned timber per tonne and 0.87m ³ per tonne of green wood.
<u>Strength Group</u>	Green (S4), seasoned (SD5).
<u>Stress Grades</u>	Green F7, F8, F11, F14, seasoned F8, F11, F14, F17 when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Modulus of Rupture (MOR)</u>	The MOR for grey mangrove in an unseasoned condition is 62 MPa, and seasoned 76 MPa.
<u>Janka Hardness</u>	Published data for grey mangrove sourced from the New South Wales lists a green Janka hardness rating of 5.9kN and for seasoned material 8.4kN.
<u>Crushing Strength</u>	Green 36 MPa, seasoned 45 MPa.
<u>Impact Strength (Izod)</u>	Published data for seasoned, New South Wales' material is 6.9J.
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is 4% tangential and 3.5% radial.

<u>Durability</u>	Class 4, non-durable: suitable for use in continuously dry situations, fully protected from the weather and other dampness. Not suitable for in-ground applications.
<u>Lyctid susceptibility</u>	The sapwood is lyctus susceptible.
<u>Seasoning</u>	Prone to splitting, checking and distortion during. End-sealing, weighting and hessian shrouding are recommended.
<u>Machining</u>	Dresses and turns to a clean finish and saws easily.
<u>Fixing</u>	No problems have been encountered with the use of standard fasteners.
<u>Decorative/Other</u>	Used in boatbuilding for knees, dead-eyes, crooks and breast hooks. Traditional coachbuilding timber for hubs and naves. Wood turning, mallets and mauls (carpenters', plumbers', printers' and boilermakers' tools). Excellent fuelwood.
<u>Indigenous</u>	Aborigines crafted defensive shields from grey mangrove, a good choice considering the wood's toughness; firewood; shoots used to treat cuts, sores, bites and marine stings.
<u>Summary</u>	A novelty timber from an anatomical perspective and a hard, unusually coloured wood, grey mangrove has the potential to provide feature parquetry and furniture material. Niche markets could be developed for tool handles and supply of boatbuilding timber where traditional construction methods are used. Reportedly difficult to season (Keating and Bolza, 1982) research into effective drying schedules and procedures would be necessary in order to maximise returns from harvested material. Traditional bush tucker and medicinal values should be investigated further for potential commercial value. Reportedly an excellent honey flora, imparting a distinctive yet pleasing flavour (Keating and Bolza, 1982). Grey mangrove could attain \$1200/m ³ , seasoned wholesale. Higher prices could be achieved for larger dimensioned, longer length stock.

2.9 <u>Standard trade name</u>	red mangrove (combined group).
<u>Botanical Names</u>	<i>Rhizophora</i> spp., including <i>R. mucronata</i> , <i>R. apiculata</i> , <i>R. stylosa</i> .
<u>Derivation</u>	Genus- Greek 'bearing roots'; Epithet- <i>mucronata</i> Latin 'sharp point', <i>apiculata</i> also 'sharp point', <i>stylosa</i> Greek 'column' or Latin 'style'=stilt.
<u>Family</u>	Rhizophoraceae.
<u>Local names</u>	<i>R. mucronata</i> loop root mangrove, black mangrove, <i>R. apiculata</i> , tall-stilted mangrove, <i>R. stylosa</i> small-stilted mangrove.
<u>Description/occurrence</u>	Single and multi-stemmed trees to 10m in height and 30cm in diameter. Exceptional trees can attain 30m and 60cm. Red mangroves are common across coastal northern Australia and also occur in Asia, Africa, tropical America and west Pacific nations.
<u>Wood appearance</u>	Heartwood colouring is variable, ranging from pink, purple-red, dark red-brown to yellowish-red. Sapwood is similarly coloured to the heartwood.
<u>Density</u>	Air-dry density ranges from 895 to 980kg/m ³ , therefore yielding approximately 1.0 m ³ of seasoned timber per tonne.
<u>Strength Group</u>	Green (S3), seasoned (SD4).
<u>Stress Grades</u>	Green F8, F11, F14, F17, seasoned F11, F14, F17, F22 when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Modulus of Rupture (MOR)</u>	MOR data for Papua New Guinea (PNG) red mangrove in an unseasoned condition is 108 MPa, and seasoned 157 MPa.
<u>Janka Hardness</u>	Published data for red mangrove (PNG) lists equivalent Janka hardness ratings for green and seasoned timber of 11kN.
<u>Crushing Strength</u>	Green 59 MPa, seasoned 85 MPa (PNG).
<u>Impact Strength (Izod)</u>	Green and seasoned conditions (PNG) both attain 20J.
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is 6% tangential and 2% radial.

<u>Durability</u>	Class 3, moderately durable: suitable for weather-exposed situations, well ventilated and clear of the ground. Used for marina structural applications such as piles, decking and buffers in south-east Asia, where it is claimed to give satisfactory perform in sub-surface environments.
<u>Lyctid susceptibility</u>	The sapwood is not lyctus susceptible.
<u>Seasoning</u>	Prone to splitting, checking and distortion during drying. End-sealing, weighting and hessian shrouding are recommended.
<u>Machining</u>	Despite its high density and hardness, red mangrove is easily worked.
<u>Fixing</u>	Pre-drilling is necessary to avoid splitting, but holds nails and screws well.
<u>Engineering/ Construction</u>	Used in marina construction, often in the round and in underwater environments.
<u>Decorative/Other</u>	Wood turning, fuel, charcoal, rayon pulp (south-east Asia); bark yields tannins and brown and black dyes.
<u>Indigenous</u>	<i>R. stylosa</i> bark used to prepare infusion to treat ulcers; infusion from suckers used to treat chicken pox.
<u>Summary</u>	Although the literature reports usage in high hazard marine environments in Asia, QFRI would not recommend red mangrove for these applications without further evidence or supervised trials under Australian conditions (different marine borer spectra, etc). The bark of red mangrove is very high in tannins, yielding between 30 and 40%, which is higher than most eucalypts and equivalent or higher than many <i>Acacia</i> species. They impart a red hue to the tanned material, unpopular with the trade in Australia, however in Malaysia red mangrove bark is one of the principal sources of a substitute tannin for catechunnatic acid. Rated highly as a fuel and charcoal timber. Potential for alternative medicine markets based on indigenous usage. Red mangrove is not known in the timber industry and samples would be required to ascertain feedback on potential timber value.

2.10 <u>Standard trade name</u>	black mangrove (combined group).
<u>Botanical Names</u>	<i>Bruguiera gymnorrhiza</i> syn. <i>B. rheedii</i> , <i>B. parviflora</i> .
<u>Derivation</u>	Genus- after J. G. Brugieres, member of the 18 th Century Keruelen Antarctic expedition; Epithet- <i>gymnorrhiza</i> naked roots; <i>parviflora</i> Latin 'small flowers'.
<u>Family</u>	Rhizophoraceae.
<u>Local names</u>	<i>B. gymnorrhiza</i> large-fruited orange mangrove, nobble-rooted mangrove, <i>B. parviflora</i> small-leaved orange mangrove.
<u>Description/occurrence</u>	Small to medium tree generally 5 to 10m high and 15 to 20 cm in diameter. Occurs around the northern Australian coastline, PNG, Timor, and tropical Asia.
<u>Wood appearance</u>	Colouring is pale red to reddish-brown. Texture fine.
<u>Density</u>	Air-dry density ranges from 975kg/m ³ , yielding approximately 1.0 m ³ of seasoned timber per tonne.
<u>Strength Group</u>	Green (S3), seasoned (SD3).
<u>Stress Grades</u>	Green F8, F11, F14, F17, seasoned F14, F17, F22, F27, when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Shrinkage</u>	Shrinkage from green to 12% moisture content is 5.5% tangential and 2.5% radial.
<u>Durability</u>	Class 3, moderately durable: suitable for weather-exposed situations, well ventilated and clear of the ground.
<u>Lyctid susceptibility</u>	The sapwood is provisionally lyctus susceptible under legislation in Queensland, however NSW data lists the species as non-susceptible. Supervised testing is recommended to formerly determine the susceptibility of the sapwood. The implications for processors are that under current Queensland legislation (TUMA) the sale and use of timber or timber articles containing unimmunised sapwood is generally not permitted. Therefore the sapwood must be removed during processing, reducing recovery and adding to processing costs, or immunised with an approved lycticide at a registered plant, also adding to processing costs.
<u>Seasoning</u>	Difficult to season due to disposition to checking. End-sealing and hessian shrouding are recommended.

<u>Machining</u>	Despite its high density and hardness, black mangrove is not difficult to work and planes to a glassy finish.
<u>Fixing</u>	Not available.
<u>Engineering/ Construction</u>	Used in Asia for house framing and joinery. Can be used for these applications in Australia (Smith <i>et al</i> , 1991), however no records of domestic utilisation for these applications were found in the literature.
<u>Decorative/Other</u>	Wood turning, fuel, charcoal, fish smoking; bark yields tannins.
<u>Summary</u>	As for red mangrove, the bark of black mangrove is very high in tannins, yielding approximately 35%. The resultant red hue could be prevented with new technology used in the tanning industry. Rated highly as a fuel and charcoal timber. Fish smoking material is a potential export product, with North America currently holding the market share of this niche. Black mangrove has great potential for feature timber products such as parquetry and furniture however it does present problems with seasoning degrade. Samples would be required to ascertain market value estimates.

2.11 <u>Standard trade name</u>	cedar mangrove (combined group).
<u>Botanical Names</u>	<i>Xylocarpus australasicum</i> , <i>X. granatum</i> (Genus syn. <i>Carapa</i>).
<u>Derivation</u>	Genus- Greek 'woody fruit'; Epithet- <i>australasicum</i> Australasian.
<u>Family</u>	Meliaceae.
<u>Local names</u>	apple mangrove, cannonball mangrove, cannonball-tree, mangrove.
<u>Description/occurrence</u>	Medium-sized, heavily branched tree generally 10m in height.. Cedar mangrove occurs along the Northern Territory and eastern Cape York coastlines and also in PNG, Asia and East Africa.
<u>Wood appearance</u>	Distinctive growth rings and attractive red colouring combine to give the timber its standard trade name, as the timber is very similar in appearance to red cedar (<i>Toona ciliata</i> , also Meliaceae). Heartwood is generally red brown, sapwood is pale brown but not sharply demarcated.
<u>Density</u>	Air-dry density 610 kg/m ³ , yielding approximately 1.6 m ³ of seasoned timber per tonne.
<u>Strength Group</u>	Green (S6), seasoned (SD7).
<u>Stress Grades</u>	Green F4, F5, F7, F8, seasoned F5, F7, F8, F11, when visually stress graded in accordance with Australian Standard AS2082-2000 <i>Timber- Hardwood visually stress graded for structural purposes</i> .
<u>Shrinkage</u>	not available.
<u>Durability</u>	Class 3, moderately durable: suitable for weather-exposed situations, well ventilated and clear of the ground.
<u>Lyctid susceptibility</u>	Sapwood is provisionally lyctus susceptible.
<u>Seasoning</u>	Wood from small diameter trees difficult to season without degrade, whilst that from larger trees reportedly seasons well.
<u>Machining</u>	Machines well, cutting easily and planing to a smooth finish. Material with interlocking grain may 'pick up'.

<u>Fixing</u>	No information.
<u>Engineering/ Construction</u>	Used in Asia for general house construction could be used for flooring and joinery.
<u>Decorative/Other</u>	furniture, tool handles, boatbuilding, small boxes, veneer,
<u>Summary</u>	As with all commercial Meliaceae timber, cedar mangrove is an attractive timber well suited to high value applications. It is essentially a firm red cedar in appearance giving it advantages over <i>Toona</i> spp. for utilisation such as flooring and furniture. The disadvantage compared to the commercial Meliaceae timbers such as cedar (<i>Toona</i> spp.), andiroba (<i>Carapa guianensis</i>) and the mahoganies (<i>Khaya</i> and <i>Swietenia</i> spp.), is log size and possible sawn board dimensions. As a general rule-of-thumb wider boards command a higher price. If veneer logs could be produced to complement solid joinery and furniture stock, high prices could be achieved. Sawn, seasoned timber could achieve wholesale rates of \$2000/m ³ and retail of \$3500/m ³ .

2.12 <u>Standard trade name</u>	tulip mangrove.
<u>Botanical Names</u>	<i>Heritiera littoralis</i> .
<u>Derivation</u>	After Charles l'Heritier de Brutelle, French Botanist; Epithet- Latin 'of the sea shore'.
<u>Family</u>	Sterculiaceae.
<u>Local names</u>	red mangrove.
<u>Description/occurrence</u>	A medium sized mangrove of the landward margin of riverine forests of the wet tropics. Mature trees are generally 15m in height with some specimens attaining 30m.
<u>Wood appearance</u>	Red hardwood with attractive ray fleck on quartersawn surfaces.
<u>Density</u>	Air-dry density 895kg/m ³ , yielding approximately 1.1m ³ of seasoned timber per tonne.
<u>Durability</u>	not available.
<u>Lyctid susceptibility</u>	The sapwood is lyctus susceptible.
<u>Seasoning</u>	Not available.
<u>Machining</u>	Difficult to work due to its high silica content. High volume hardwoods, such as brush box, well-known for the presence of silica, have been successfully processed and marketed into high value products such as feature flooring and cladding.
<u>Fixing</u>	Not available.
<u>Engineering/ Construction</u>	No records of past uses.
<u>Decorative/Other</u>	Stercules of similar density including the tulip oaks (<i>Argyrodendron</i> spp.) have long been used for flooring and internal step treads, where they hold a good reputation for their hard wearing surfaces and attractive appearance. Tool handles.
<u>Summary</u>	Not a well known timber, tulip mangrove has potential for parquetry and feature flooring, bench tops, furniture and veneering. Tooling will have to be suitable to handle the high silica content. There are many unknowns regarding how tulip mangrove

seasons and performs that should be ascertained before an accurate determination of suitable utilisation options can be undertaken with confidence. Sample material is required to attain an industry evaluation and price estimate.

3. Concluding Summary

The attributes of the three major sawlog species occurring on Cape York render them well-placed to enter commodity markets both in Australia and overseas. Secondary species also have desirable characteristics from a wood utilisation perspective. There is much to consider beyond the scope of this report, such as resource security, harvesting and processing economics, targeted domestic and export markets, environmental marketing, profitable technologies for processing and seasoning, to ensure the feasibility of a forestry and timber industry beyond the current level of activity. The rhetoric pertaining to a dwindling global wood supply would offer optimism for resource owners/processors in the Cape, however the forest and timber industry has a long history of boom and bust cycles and this is likely to continue. The building cycle plays a dominating role on structural wood production and consumption in Australia, ie consumption and production decline during downturns in the building industry and peak in line with housing cycle peaks. These cycles apply to other parts of the wood products industry and can impact on the feasibility of any forestry or timber processing operation.

If the intention of a Cape York enterprise is to extend its markets beyond north Queensland and target southern regions and export markets then early consideration should be given to effective marketing campaigning. This should incorporate the environmental attributes of the products, the frontier lifestyle and culture of the pastoralists and miners combined with the long history of indigenous culture. The timber industry is becoming increasingly customer focussed and a Cape York industry would need to be aware of grade quality issues for the range of products to be produced and the requirements at the market/end-user destination. These timber-producing species have many desirable qualities for a diverse range of applications and with further processing and wood property research, other suitable utilisation options would be realised.

Major population centres along eastern Australia provide the largest domestic markets. Around 95% of Australia's forest product exports are to countries in the Asia-Pacific region. Japan, New Zealand, South Korea, Chinese Taipei, Hong Kong, China and the west coast of North America are now major markets. Demand for Australian timber is projected to increase in coming decades to these countries, where population and income are expected to rise. North America is the largest per capita consumer of forest products and some Australian timber products are already popular in this region, for example white cypress flooring. Cape York timbers could build on the existing reputation of Australian wood products to gain entry into established export markets.

The forests of the Cape offer a range of useful hardwood timbers capable of providing timber suitable for niche applications, often with superior wood properties than the currently available range of high volume commercial species. There is a lack of critical data for some species, due to low levels of usage to the present day. Wood properties determination, lyctid susceptibility and market appraisal are highly recommended to assist in the establishment of a successful Cape York Peninsular forest product industry. It is difficult to attain industry feedback on potential market values of relatively new commercial species without offering sample material for evaluation.

Further work should focus on determination of sawn recoveries, graded recoveries, industry and market evaluation and appraisal, and establishing wood properties that are currently unknown or where conflicting data exists. Ideally 50 individuals representing the distribution and range of each of the species would be processed to standard QFRI sawing study specifications. The material from this study would provide samples for mechanical properties testing, veneering, workability testing, industry evaluation and market appraisal, for both domestic and export destinations.

Gary Hopewell
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Cooktown ironwood resophonic guitar by Des Anthony, Brisbane 2000

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Appendix 1.

Comparative wood properties of selected Queensland timbers.

Standard trade name	Botanical name	Air dry density kg/m ³	Strength groups	Green MOR MPa	Green MCS MPa	Green Impact (Izod) J	Green Hardness kN (Janka)	Lycid susceptibility	Unit shrinkage % (T)	Durability
Darwin stringybark	<i>Eucalyptus tetradonta</i>	1170	S1, (SD2)	145	74	28	9.6	(S)	0.38	1
Cooktown ironwood	<i>Erythrophleum chlorostacys</i>	1220	S1, (SD1)	140	85	22	13	S	-	1
Melville Island bloodwood	<i>Corymbia nesophila</i>	960	(S4), -	-	-	-	-	S	-	1
spotted gum	<i>Corymbia</i> spp.	1010	S2, SD2	99	50	20	8.0	S	0.38	2
grey ironbark	<i>Eucalyptus</i> spp.	1105	S1, SD1	120	60	24	11	NS	0.39	1
narrow-leaved red ironbark	<i>Eucalyptus crebra</i>	1090	S2, SD3	116	59	18	12	NS	-	1
blackbutt	<i>Eucalyptus pilularis</i>	930	S2, SD2	100	48	21	7.3	NS	0.37	2
forest red gum	<i>Eucalyptus tereticornis</i>	1010	S3, SD4	85	44	19	12	NS	0.34	1
red mahogany	<i>Eucalyptus</i> spp.	995	S2, SD3	70	50	14	9.0	S	0.34	2
Gympie messmate	<i>Eucalyptus cloeziana</i>	1010	S2, SD3	94	49	21	7.7	NS	0.37	1
white stringybark	<i>Eucalyptus</i> spp.	1010	S3, SD3	92	43	15	6.8	NS	0.36	1
turpentine	<i>Syncarpia glomulifera</i>	945	S3, SD3	83	42	14	6.5	NS	0.35	1
white cypress	<i>Callitris glaucophylla</i>	675	S5, SD6	71	40	7.8	5.6	NS	0.30	1
brush box	<i>Lophostemon confertus</i>	880	S3, SD3	85	38	17	11	NS	0.38	3
tallowwood	<i>Eucalyptus microcorys</i>	1010	S2, SD2	106	51	20	7.6	S	0.37	1

Notes: Parentheses indicate provisional classification due to absence of valid data.

Appendix 2

Data Summary –Cape York Timbers

Standard trade name	Botanical name	Air dry density kg/m ³	Strength groups	Seasoned MOR MPa	Green MOR MPa	Seasoned MCS MPa	Green MCS MPa	Green Impact (Izod) J,	Seasoned Hardness kN (Janka)	Green Hardness kN (Janka)	Lycid susceptibility	% Shrinkage green to 12%MC	Durability
Darwin stringybark	<i>Eucalyptus tetradonta</i>	1170	S1, (SD2)	-	145	-	74	28	-	9.6	(S)	4.9T, 3.2R	1
Cooktown ironwood	<i>Erythrophleum chlorostacys</i>	1220	S1, (SD1)	-	140	-	85	22	-	13	S	3T, 2R	1
Melville Island bloodwood	<i>Corymbia nesophila</i>	960	(S4), -	-	-	-	-	-	-	-	S	4T, 2R	1
Brown salwood	<i>Acacia mangium</i>	800	(S5), (SD5)	128	-	60	-	-	5.9	-	S	4T, 1.5R	3
Sandalwood	<i>Santalum spp.</i>	930	(S3), (SD3)	-	-	-	-	-	-	-	S	3.5T, 2.5R	-
Lancewood	<i>Acacia shirleyi</i>	1020	-	-	-	-	-	-	17.3	-	(S)	1.8T, 1.0R	(2)
Beefwood	<i>Grevillea striata</i>	880	(S3), (SD4)	-	-	-	-	-	14.5	-	S	3.5T, 1.5R	2
Grey mangrove	<i>Avicennia marina</i>	800	(S4), (SD5)	76	62	45	36	6.9	8.4	5.9	S	4T, 3.5R	4
Red mangrove	<i>Rhizophora spp.</i>	895	(S3), (SD4)	157	108	85	59	20	11	11	NS	6T, 2R	3
Black mangrove	<i>Bruguiera gymnorhiza</i>	975	(S3), (SD3)	-	-	-	-	-	-	-	(S)	5.5T, 2.5R	3
cedar mangrove	<i>Xylocarpus spp.</i>	610	(S6), (SD7)	-	-	-	-	-	-	-	(S)	-	3
Tulip mangrove	<i>Heritiera littoralis</i>	895	-	-	-	-	-	-	-	-	S	-	-

Appendix 3

Potential Uses and Markets of Cape York Timbers.

artefact souvenirs	panel flooring
balustrading	parquetry
beams	piles
bearers	plywood
building poles	posts
charcoal briquettes	rails
cross-arms	railway sleepers
decking	roof trusses
exterior cladding	staircases
fascias and bargeboards	step treads
indoor furniture	stringers
joists	stumps
knife handles	T&G flooring
ladders	tool handles
landscaping sleepers	transmission poles
lining boards	turnery
lintels	vehicle decks
mining timbers	veneer
musical instruments	wall framing
outdoor furniture	wharf and bridge components