SPECIES RECOVERY PLAN

(DRAFT)

# RED-FRUITED EBONY

## Diospyros mabacea (F. Muell.) F. Muell.

by A. S. Murray



Prepared for the NSW National Parks and Wildlife Service,
Northern Region, 1995



Under grant from the
Australian Nature Conservation Agency
Endangered Species Recovery Project #


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# Draft Recovery Plan for *Diospyros mabacea*

**Explanatory Note**

The following draft recovery plan was prepared prior to the introduction of the *Threatened Species Conservation Act, 1995* (TSC Act) on 1/1/96. A complete review of the plan will be undertaken to ensure provisions of the TSC Act are met.

The information contained within this draft recovery plan was correct at the time of printing. Therefore this information should not be regarded as the definitive work available for this species.

To reduce damage to sites and impacts on the species, site specific information (including text and maps) which is considered to be sensitive by NSW National Parks and Wildlife Service, has been deleted from this draft plan.



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# SUMMARY

## *Diospyros mabacea* (F. Muell.) F. Muell. RED-FRUITED EBONY

### Current Species Status:

2ECi Endangered. (Recommended: 2VCi Vulnerable)

*Diospyros mabacea* is a small to medium-sized rainforest tree restricted to the Tweed Valley in northern NSW. The main population is within Limpinwood Nature Reserve west of Tyalgum (about 140 specimens) and a small population is reserved at Stotts Island Nature Reserve.

### Habitat Requirements and Limiting Factors:

Occurs in warm lowland subtropical rainforest on basalt at the headwaters of the Oxley River, between 220 and 400 metres above sea level and as a few scattered trees on alluvial flats of the Tweed and Oxley Rivers. There is a clear preference for well-watered and well-drained alluvial sites. Most of the suitable lowland habitat in the original range has been cleared.

Regeneration appears only to occur within mature rainforest and the margins of adjacent wet sclerophyll forest. Lack of regeneration at other sites is attributable to ongoing disturbance, limited seed resources and dispersal mechanisms and the severe fragmentation and limited availability of the most favourable sites for colonisation (mature lowland subtropical rainforest).

### Recovery Objectives:

The recovery plan aims to increase secure wild populations of *Diospyros mabacea* to a level of adequate reservation and allow downlisting to rare and adequately reserved (2RCa) within 10 years.

### Recovery Criteria:

Recovery will be achieved when:

- the major unreserved population is secured by acquisition or conservation agreement;
- population and habitat enhancement actions produce a combined population of more than 1000 individuals occurring in stable habitat within reserves, and
- the reserved populations contain the full range of genetic diversity known for the species.

### Actions Needed:

1. Administration and project management
2. Liaison and public education
3. Secure unreserved populations
4. Research: Monitor & survey
5. Research: Genetics
6. Research: Breeding systems
7. Research: Germination
8. Protection of habitat
9. Site access
10. Population enhancement
11. Habitat enhancement
12. *Ex situ* conservation
13. Monitoring and reporting



### Biodiversity benefits:

The lowland subtropical rainforest where *Diospyros mabacea* occurs is a core area for rainforest biodiversity and supports at least 18 additional nationally rare or threatened plant species. Habitat protection and rehabilitation actions in this plan will benefit important reserves of this habitat type and promote re-establishment and regeneration of alluvial rainforest areas in public reserves and on private land.

Acquisition of land adjacent to Limpinwood Nature Reserve will ensure protection of a small creek supporting lowland rainforest contiguous with the reserve and improve management options for this vulnerable edge of the reserve.

**Estimated Cost of Recovery:**

| Year | Action 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | 11 | | 12 | | 13 | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP | TC | ESP |
| 1996 | ?5 | 1.5 | | 2 | | 2 | | 6 | | 4 | | 4 | | 3.5 | 6 | 3 | | 4.5 | | 4 | | 12 | | | | 4 | | 50.5 |
| 1997 | ?5 | 1.5 | | 2 | | 2 | | | | 4 | | 4 | | 2 | 6 | 3 | | 1.3 | | 4 | | 10 | | | | 4 | | 37.8 |
| 1998 | ?5 | 1.5 | | 2 | | | | | | | | 4 | | 2 | 9 | 6.2 | | 1.3 | | 7 | | 10 | | | | 3 | | 37 |
| 1999 | ?5 | 1.5 | | 2 | | | | 4 | | | | | | | | | | 1.3 | | 5 | | 8 | | 3 | | 3 | | 27.8 |
| 2000 | ?5 | 1.5 | | 2 | | | | | | | | | | | | | | 1.3 | | 3 | | 5 | | 2 | | 3 | | 17.8 |
| 2001 | ?5 | 1.5 | | 2 | | | | | | | | | | | 6 | 3 | | 1.3 | | 3 | | 5 | | 2 | | 3 | | 17.8 |
| 2002 | ?5 | 1.5 | | 2 | | | | 4 | | | | | | | | | | 1.3 | | | | 2 | | | | 3 | | 16.8 |
| 2003 | ?5 | 1.5 | | 2 | | | | | | | | | | | | | | 1.3 | | | | 2 | | | | 3 | | 9.8 |
| 2004 | ?5 | 1.5 | | 2 | | | | | | | | | | | | | | 1.3 | | | | 2 | | | | 3 | | 9.8 |
| 2005 | ?5 | 1.5 | | 2 | | | | 4 | | | | | | | | | | 1.3 | | | | 2 | | | | 3 | | 13.8 |
| TOTAL | ?50 | 15 | 20 | 20 | 4 | 4 | 18 | 18 | 8 | 8 | 12 | 12 | 7.5 | 7.5 | 27 | 15.2 | 16.2 | 16.2 | 26 | 26 | 58 | 58 | 7 | 7 | 32 | 32 | ?285.7 | 236.9 |

# 1. INTRODUCTION

This recovery plan is based on research into the known distribution, ecology and conservation status of *Diospyros mabacea* combined with site surveys of known locations and potential suitable habitats within the known range. The lack of previous conservation research work on this species means that this recovery plan incorporates both research and recovery information, and that the recovery plan requires a number of further research activities to be undertaken in addition to the management-oriented recovery actions.



## 1.1 Taxonomy:

Division: **Magnoliophyta (Flowering plants)**

Class: **Magnoliopsida (Dicotyledons)**

Order: **Ebenales**

Contains the families Sapotaceae (including Sapodilla, Chicle and Gutta-percha), Ebenaceae (Persimmons and Ebonies) and Styracaceae (Silverbell and Snowbell trees).

Family: **Ebenaceae**

The family has 2 genera and around 450 species worldwide. *Diospyros* is the major genus (combining many previously recognised genera such as *Maba* and *Lissocarpa*) and the small genus *Euclea* (14 species) is confined to eastern and southern Africa.

Genus: ***Diospyros***

The distribution of *Diospyros* is generally tropical and subtropical, centred in the Indomalesian rainforests and best known for ebony, the hard, black heartwood timber produced by many species, most commonly *D. reticulata* (Mauritius) and *D. ebenum* (Sri Lanka). Edible fruits are known throughout the range of the family, with a small group of outlying northern temperate species being the best known in cultivation; *Diospyros kaki* (Persimmon) of eastern Asia, *D. lotus* of Eurasia (Date plum) and *D. virginiana* of North America (Heywood, 1978). *Diospyros ebenaster* (Black Sapote) from Mexico and *D. discolor* (Mabolo) from Malaysia are the best known tropical fruits.

The genus *Diospyros* has 15 described species in Australia, occurring mainly in the tropical and subtropical regions of Queensland, Northern Territory and Western Australia and with 5 species extending to the coastal districts of New South Wales. *D. mabacea* is the only *Diospyros* species listed as nationally rare or threatened.

Species: ***Diospyros mabacea***

The species was first described as *Cargillea mabacea* by F. von Mueller in 1866, from material collected by C. Moore somewhere on the Tweed River.
The name *Diospyros mabacea* (F. Muell.) F. Muell.was applied by von Mueller in his "Systematic Census of Australian Plants" p.92 (1883).

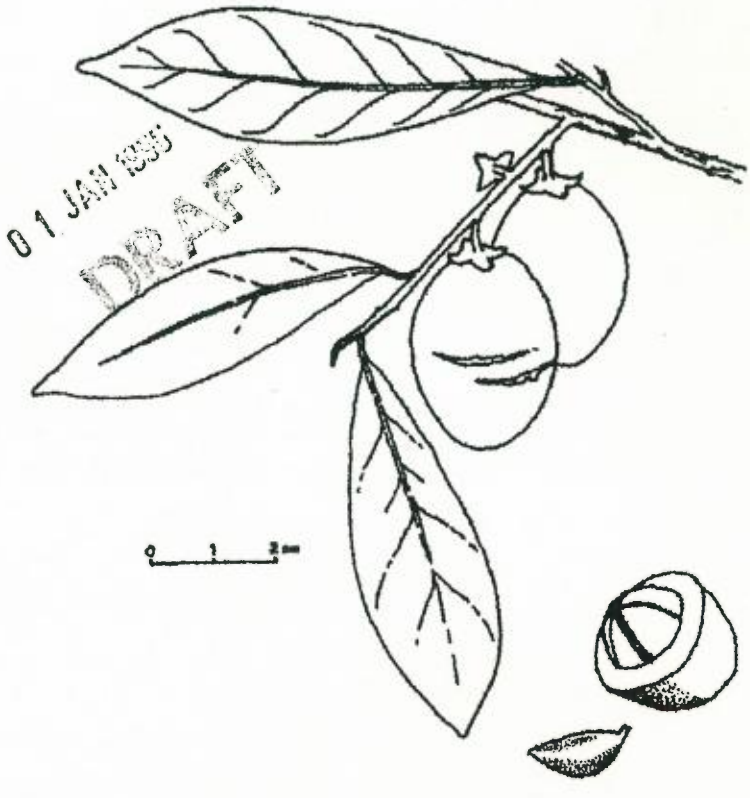
## 1.2 Description:

(adapted from Floyd, 1989)

*Diospyros mabacea* is a small to medium rainforest tree up to 25 metres tall and 55 centimetres diameter. The trunk is often crooked, fairly cylindrical and without buttresses. The black bark is very scaly or fissured, shedding in narrow vertical strips or flakes, with a blaze revealing thin black underbark over creamy yellow live bark. The black bark is distinctive and characteristic in the field.

Branchlets are moderately thick, brown and smooth, with fine pale streaks, becoming dark green and densely hairy within about 20cm of the tip. The young shoots and branchlets are pale brown and pubescent to silky hairy.

The alternate and occasionally complanate leaves are elliptic to elliptic-oblong or oblanceolate in outline, 6-15cm long, 2-5cm wide, protracted into a blunt point at the tip and tapering into a hairy brown petiole 3-9mm long. The upper surface of the leaf is dull green or slightly glossy, the underside is paler green, moderately glossy and bears soft fawn hairs on the distinct midrib and curving lateral veins.




The flowers are monoecious, 4-merous, silvery fawn and borne singly (female) or in clusters of up to 4 flowers (male) on rusty-hairy stalks up to 4mm long in the leaf axils. The calyx is 3-5mm long, four-lobed, rounded and reflexed at the tips, and often persistent and slightly enlarged on the mature fruit.

The distinctive shiny, scarlet fruits are 2.5 to 4.5cm long, globular to elliptic and often shortly pointed. A white, mealy and tasteless flesh surrounds 4 cells containing up to two seeds each, but more usually each fruit has two to six seeds. The seeds are spindle-shaped, finely roughened, brownish-black, three-sided and 1.7 to 2 cm long.

## 1.3 Distribution

Natural occurrences of *Diospyros mabacea* are confined to the Oxley and Tweed Rivers in far northeastern NSW, which form the northern catchment of the erosion caldera of the ancient Tweed shield volcano. The geographical range of *Diospyros mabacea* is extremely limited, with all known records occurring within 5 minutes of latitude (8km) and 20 minutes of longitude (33km).

### 1.3.1 Past distribution

The previously recorded locations of *Diospyros mabacea* are shown in Table 1, compiled from herbarium records and the ROTAP database (28.4.94)[1].

None of the records prior to 1957 can be accurately located from the available information, but all are from the Tweed River or Murwillumbah districts. An herbarium specimen collected by W. Bauerlen in 1895 bears the enigmatic label "Mullumbimby, Tweed River". The absence of any other records outside the Tweed suggests that the labeller confused Mullumbimby with Murwillumbah and that Tweed River is the more likely locality. This is reinforced by the subseqent collection in 1896 by Bauerlen labelled "Murwillumbah, Tweed River".

One record, from Brays Scrub in 1960, indicates that the original distribution included at least some of the Rous River floodplain (the northern arm of the Tweed River). Apart from a small (and rather elusive) population on Stotts Island, no occurrences of *Diospyros mabacea* now remain on the lowland alluvial flats downstream from the junction of the Oxley and Tweed Rivers.

Since 1976, when the major population was found at the head of the Oxley River, all new records of *Diospyros mabacea* have been along the Oxley River west from Eungella.

**Table 1: Past locations of *Diospyros mabacea***

| Location | AMG E | AMG N | Recorder (Date) | Comment |
|---|---|---|---|---|
| • Tweed River | | | C. Moore | Type specimen (Mueller, 1866) |
| • Murwillumbah District | | | W.Bauerlen (1895,1896); R.A.Campbell (1900,1901) | |
| • North Arm, Tweed River (Murwillumbah) | | | G.E. Rummery (1917) | |
| • Stotts Island | [redacted] | | L.A.S. Johnson & E.F. Constable (1957) | |
| • Brays Scrub, Murwillumbah | [redacted] | | A.G. Floyd (1960) | Cleared for cane |
| • Portion 153, Butlers Rd. (Limpinwood NR) | [redacted] | | A.G. Floyd (1976); G.P. Guymer & L.W. Jessop (1981); J. Hunter (1986, 1991); F. Davies (1990) | Formerly owned by W. Godden. Aquired by NPWS as addition to Limpinwood NR |
| • Tyalgum Showground | [redacted] | | A.G. Floyd (1983) | |
| • Everest's Rd., Eungella | [redacted] | | A.G. Floyd (1983); J. Hunter (1986,1991) | |

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[1] Several of the records in the ROTAP database were found to be dubious or obviously mislocated. These are:

| Recorder: | First Date | AMG E | AMG N | Comment |
|---|---|---|---|---|
| Unknown, ? | 01 NOV 1991 | [redacted] | | unsuitable habitat - delete |
| Floyd, A.G. | 01 DEC 1983 | [redacted] | | wrong co-ordinates - A. Floyd confirms as Everest's. |
| Sansom, M | 01 SEP 1993 | [redacted] | | wrong co-ordinates - M. Sansom confirms as Everest's. |
| Unknown, ? | 01 NOV 1991 | [redacted] | | Swamp forest, unsuitable habitat |

Two additional locations along Hopping Dicks Creek (a tributary of the Oxley River) in Limpinwood Valley have been known to local rainforest nurserymen for several years (J. Turnbull, R. Costin, H. Nicholson; pers.comm.), but were not registered by collection or ROTAP listing.



### 1.3.2 Survey

Survey work to investigate the distribution of *D. mabacea* concentrated on these previously known localities and a number of additional potential sites, identified using 1:25000 topographic maps and 1991 aerial photographs and a 1:62500 geological survey map (Chesnut, 1975).

These potential sites were chosen to focus on remnant lowland subtropical rainforest occurring on basaltic benches at low elevations and rich alluvial soils along the Oxley River and its tributaries, the Rous and Tweed Rivers at Murwillumbah.

Targeted areas for field work were:

- around Limpinwood NR at elevations betweed 200 and 400 metres above sea level, including - the head of the Oxley River;
  - basaltic benches and slopes west of Tyalgum rubbish dump;
  - Hidden Creek, Finchs Creek, Worendo Creek and Hopping Dicks Creek.
- alluvial soils along the Oxley River from Tyalgum to Eungella;
- the banks of the Rous River near Murwillumbah.

Survey work at these potential sites concentrated on locating low gradient areas on basaltic or enriched alluvial soils supporting suitable patches of rainforest habitat and then systematically searching on a series of traverses. The survey areas are indicated on Figure 1, along with the past and present distribution range for *Diospyros mabacea.*

Survey work to locate further populations of *Diospyros mabacea* has covered only the most obvious sites of a presumed optimum habitat within the general known geographical range. It is possible that more wild populations occur in this area and will be found in the future, but the discovery of a new individual or small population of a rare tree often relies heavily on serendipity. Other areas of lowland subtropical rainforest around the base of the Tweed Range where suitable habitat for *Diospyros mabacea* may be present include the basalt benches below Springbrook in Numinbah Nature Reserve [redacted] These areas are generally above 400 metres elevation, but still support areas of rainforest with a species mix indicating affinity with lowland suballiances (Floyd, 1990).

An occurence of *Diospyros mabacea* at Chinderah, reported in the 1990 Environmental Impact Statement for the Chinderah Bypass, was dismissed as misidentification after thorough survey of the area. Reports by local naturalists of occurrences at Pat Smiths Creek, Numinbah and at Goonengerry, were also investigated without success.

### 1.3.3 Known locations of *Diospyros mabacea*

[redacted]

These seven locations were surveyed to record vegetation structure and floristics, physiography, geology and soil types and population structure. [redacted]

Two hundred and four individuals of *Diospyros mabacea* have been found at seven localities. The two areas at the head of the Oxley River west of Tyalgum (localities 1 & 2) support 96% of the total population, with all the remaining sites containing isolated individuals or a few trees.

**Table 2: Present known locations of *Diospyros mabacea* (1995)**

| Location | AMG E | AMG N | No. of individuals (% of total) | Tenure |
|---|---|---|---|---|
| • [redacted] Tyalgum | [redacted] | | 56+ (27%) | Private (van der Broek) |
| • [redacted] (Limpinwood Nature Reserve) | [redacted] | | 140+ (69%) | NPWS |
| • Tyalgum Showground, [redacted] | [redacted] | | 1 (0.5%) | Crown Reserve |
| • [redacted] Limpinwood | [redacted] | | 1 (0.5%) | Private (Holstein) |
| • [redacted] Limpinwood | [redacted] | | 1 (0.5%) | Private (Edwards) |
| • [redacted] Eungella | [redacted] | | 4 (2%) | Private (Everest) |
| • Stotts Island Nature Reserve | [redacted] | | 1+ (0.5%) | NPWS |

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## 1.4 Habitat

The characteristic habitat of *Diospyros mabacea* is lowland subtropical rainforest and riverine rainforest (Floyd, 1990), growing at low altitudes on fertile soils.

The eroded shield of the ancient Tweed Shield volcano is one of the most important refugia and centres of speciation for rainforest on the Australian continent. The lowland rainforests of the Tweed are recognised as the core area for moist warm subtropical rainforest.

*Diospyros mabacea*, with its restricted distribution in the inner erosion caldera, appears to be a typical refugia species, occuring only in the species-rich lowland subtropical rainforest alliances. Poorly adapted to disturbance and with limited dispersal potential, the species is now reduced to a refuge at the head of the Oxley River.

### 1.4.1 Climate

The climate over the range of *Diospyros mabacea* is warm, wet and subtropical with a distinct summer-autumn wet season, characterised by prevailing north-easterly winds and periodically influenced by tropical cyclones bringing intense downpours, floods and strong winds. Annual rainfall is generally greater than 2000mm, and may exceed 3000mm in peak rainfall years. Winter

rain is less reliable, but may be substantial. The driest months are August and September, influenced by dry west and northwesterly winds. Mild winter and spring frosts occur at the more exposed Tyalgum, Limpinwood and Eungella sites in most years.

### 1.4.2 Geology and soils

The main habitat area at the head of the Oxley river is on Lismore Basalt, the earliest flows of the Lamington volcanics which began forming the old Tweed Shield Volcano in the Early Tertiary period. Massive, randomly-jointed and columnar fine-grained basalts are the predominant rock type, but wide variation was noted in outcrops along the creek and tributaries, including porphyrtic trachyte and interbedded quartz-rich conglomerates.

Soils are rich red-brown to black weathered basalt, tending to krasnozem where well-developed but generally shallow and lithic. At the lower limit of the occurrence of *Diospyros mabacea* at Locality 2, it occurs on a pocket of basaltic stream alluvium.

The remaining sites are on Quaternary stream alluvium, which varies from highly basaltic at the Limpinwood sites, to clay loam derived from mixed basaltic, sedimentary and metamorphic components at Tyalgum and Eungella, to deep basalt-enriched alluvial loam on Stotts Island.



### 1.4.3 Physiography

At the head of the Oxley River within Limpinwood NR, *Diospyros mabacea* appears to favour benches in the otherwise steep rocky terrain. The majority of the population, including the largest known specimen, occurs on a bench from 50 to 200 metres wide at between about 300 to 350 metres above sea level. This bench has a low gradient (5 - 10°) and extends both sides of the main creek from a SW to SE aspect. *Diospyros mabacea* also occurs at this locality on steeper gradients (up to 20°) and smaller, dissected benches with a SW aspect down to around 200 metres above sea level.

The nearby population at [redacted] adjacent to Limpinwood NR, occurs on and around a small bench at about 250 metres above sea level with an easterly aspect. The largest trees and a large proportion of juveniles at this locality are concentrated on the lower gradient (5 - 10°) areas along the creek, but *Diospyros mabacea* also occurs upslope on both sides of the creek on steeper gradients (15 - 25°) with a southerly to northeast aspect, extending to about 400 metres above sea level.

The occurrences at Limpinwood, Tyalgum, Eungella and Stotts Island are all on alluvial flats on valley floors, where gradients are less than 5° and aspect is variable. Elevation at these sites varies from around 5 metres above sea level at Stotts Island to 155 metres at Upper Hopping Dicks Creek, Limpinwood.

### 1.4.4 Associated vegetation types and plant species

(see Appendix 2)

*Diospyros mabacea* occurs in greatest numbers in relatively undisturbed, typically diverse lowland subtropical rainforest characterised broadly by Webb (1968) as complex notophyll vine forest or more specifically as suballiance no.1: *Argyrodendron trifoliolatum* (= *Heritiera trifoliolata*) by Floyd (1990).

The forest canopy is multilayered, with emergent figs (*Ficus watkinsiana, F. obliqua*) up to 40 metres tall overtopping the dense crowns and tangled vines of the main canopy at between 18 and 30 metres tall. The main canopy trees include *Heritiera trifoliolata, Dendrocnide excelsa,*

*Cryptocarya erythroxylon, C. obovata, Toona ciliata, Castanospora alphandii, Syzygium crebrinerve* and *Pseudoweinmannia lachnocarpa*. Common understorey trees include *Sloanea woollsii, Cinnamomum oliveri, Bosistoa pentacocca, B. selwynii, Randia chartacea, Syzygium hodgkinsoniae, Cryptocarya laevigata, Endiandra pubens, Neolitsea* spp. and *Triunia youngiana.*

Epiphytes are locally abundant and diverse, and a large variety of vines bind the canopy and forest edges, commonly including *Piper novae-hollandiae, Cissus* spp., *Milletia megasperma* and *Ripogonum album.*

At Locality 1 and to a lesser extent at Locality 2, *Diospyros mabacea* also occurs on the margins of adjacent wet sclerophyll forest dominated by *Lophostemon confertus* with well developed subtropical rainforest understorey.

At the eastern end of its range at Stotts Island, a small population of *Diospyros mabacea* occurs in lowland subtropical rainforest characteristic of well-drained fertile alluvial flats (suballiance no. 2: *Toona - Flindersia* of Floyd, 1990). The main canopy is generally around 15 to 20m tall with emergent figs (*Ficus macrophylla, F. obliqua*) to 30m. Main canopy trees include *Flindersia schottiana, Cryptocarya obovata, Harpullia pendula, Elaeocarpus obovatus, E. grandis, Diospyros pentamera* and *Toona ciliata. Aphananthe philippinensis, Streblus brunonianus* and *Cleistanthus cunninghamii* are common as smaller trees. Occasional canopy gaps are commonly covered with dense vine curtains of *Flagellaria indica, Calamus muelleri, Ripogonum elseyanum* and *Hoya australis.*



At the remaining sites, isolated individuals of *Diospyros mabacea* and one group of trees occur in regrowth subtropical rainforest typical of the cleared alluvial flats along the Oxley River and its tributaries. Here it is often associated with riverine forests of *Casuarina cunninghamiana*, and scattered or localised clumps of rainforest trees. The number of rainforest species at these sites is low in comparison to the relatively undisturbed localities at the head of the Oxley River and at Stotts Island, with a higher incidence of typical early secondary trees or nomads (such as *Mallotus philippinensis, Jagera pseudorhus, Guioa semiglauca* and *Pittosporum undulatum*) and late secondary trees including *Diploglottis australis, Toona ciliata* and *Flindersia schottiana.* The Tyalgum stand is relatively well-drained and supports species typical of drier sites (*Aphananthe philippinensis, Streblus brunonianus, Notolaea longifolia*) while at Eungella, the restricted drainage has promoted species typical of moist sites (*Elaeocarpus grandis, Sloanea australis, Glochidion ferdinandi*).

Eighteen nationally rare or threatened plants (1 endangered, 8 vulnerable and 9 rare) were found growing at sites where *Diospyros mabacea* occurs, and are listed below in **Table 3.** Locality 2 in Limpinwood Nature Reserve supported the highest number of rare or threatened plants (14), including large populations of *Bosistoa selwynii* and *Fontainea australis*. These two species were also frequent nearby at Locality 2.

Two rare species, *Archidendron hendersonii* and *Cryptocarya foetida* are more typically found in littoral rainforest, and occur only at the Stotts Island locality.

**Table 3 ROTAP species found at *Diospyros mabacea* sites**

| Species | Risk code | Locality |
|---|---|---|
| *Archidendron hendersonii* | 3RC- | 7 |
| *Archidendron muellerianum* | 3RCa | 2,6 |
| *Argophyllum nullamense* | 3RCa | 1,2 |
| *Bosistoa selwynii* | 3VCi | 1,2 |

| | | |
|---|---|---|
| *Cassia marksiana* | 2RCi | 6,7 |
| *Cryptocarya foetida* | 3VCi | 7 |
| *Floydia praealta* | 3VC- | 1,2 |
| *Fontainea australis* | 2VCi | 2 |
| *Hicksbeachia pinnatifolia* | 3RC- | 1,2 |
| *Lepiderema pulchella* | 2RC- | 1,2,3 |
| *Macadamia tetraphylla* | 2VC- | 1,2,4,6 |
| *Marsdenia lissae* | 3RC- | 2 |
| *Ochrosia moorei* | 2ECi | 2 |
| *Quassia sp. A* | 3RC- | 1,2 |
| *Symplocos bauerlenii* | 2VC- | 2 |
| *Syzygium hodgkinsoniae* | 3VC- | 1,2 |
| *Syzygium moorei* | 2VCi | 6,7 |
| *Trichosanthes subvelutina* | 3RC- | 2 |



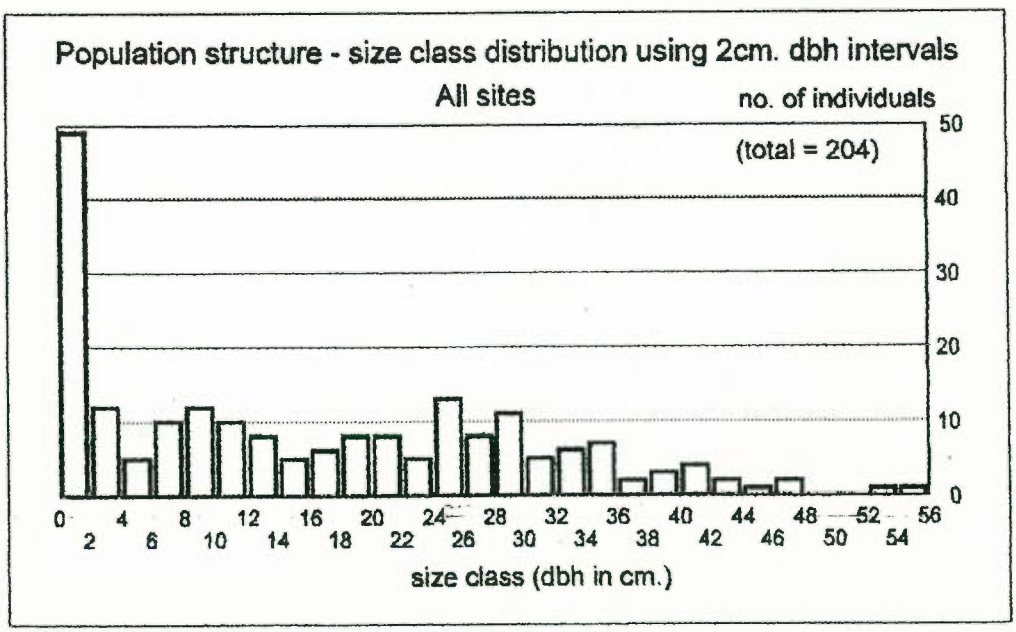
### 1.4.5 Population structure

The height and diameter at breast height (DBH) of each *Diospyros mabacea* found in site surveys are listed in Appendix 1. For each locality, a size class distribution graph based on DBH shows the population structure in terms of the number of individuals of a given size, a character which can, with the following reservations, be use to interpret the age structure of each population and indicate whether regeneration is occurring:

- the correlation between size and age of rainforest trees is generally poor, since the growth of many species, especially mature stage species like *Diospyros mabacea*, is subject to periods of dormancy related to light availability.
- the data will be biased towards larger size classes because of their ease of recognition during survey.

The size class distribution graph for all *Diospyros mabacea* localities combined is shown as Figure 2, below.

**Figure 2**



A distinctive feature of the data collected is the high proportion of large (and presumably reproductively mature) specimens, with about one third of all known individuals greater than 20cm DBH. The largest trees recorded, at around 55cm DBH, are nearly double the size of the previously recorded maximum for this species (Floyd, 1990). Despite the reservations on sampling bias expressed above, the population appears top heavy with older trees. This could indicate that a low rate of recruitment is typical for this species, or that suitable regeneration conditions are limited

Only three localities support seedlings, juveniles or young trees of *Diospyros mabacea*. Mixed age populations of *Diospyros mabacea* occur only at the head of the Oxley River. Both sites have high numbers of mature trees compared to seedlings and juveniles (>30% over 20cm DBH). Seedlings and young trees (under 5cm DBH) make up about one quarter of the population at Locality 2 within the Limpinwood Nature Reserve and about one half of the records at Locality 1 (outside the Nature Reserve).

The survey of appropriate habitat at Stotts Island recorded only one young individual, though it has been found there as a low tree in 1957 and as several juveniles in the late 1970's. Further survey may be necessary before concluding that no mature trees occur, but on present indications, it is possible that the occurrence of *Diospyros mabacea* on Stotts Island is a very small population with regeneration dependent on seed transport from upstream sites.

Four sites (at Tyalgum, Limpinwood Valley and Eungella) support one or few mature trees ranging in size from 10 to 40cm DBH. All these trees produce irregular but occasionally prolific fruit and viable seed, but no seedlings or juveniles. All these sites are regrowth vegetation following clearing and have an open disturbed understorey adjoining grazed pasture (or ex-pasture, in the case of Tyalgum Showground).



## 1.5 Life history / ecology

### 1.5.1 Flowering and fruiting



*Diospyros mabacea* flowers in September and fruits ripen from late January to March.

Flowering has been observed in planted trees at Chick Park, Stotts Island and Knox Park, Murwillumbah about 5 years after germination at about 1-2 cm DBH. Planted trees (up to 10 years old) have not been known to set fruit, and it appears *Diospyros mabacea* is typically slow to mature. The smallest known fruiting tree is the regrowth stem (about 10cm DBH) at Tyalgum Showground, but the tree has suffered severe reduction (to ground level) in the past, and is estimated to be at least 30 years old.

Fruiting has been regularly observed at the Limpinwood valley and Eungella sites, and appears to occur on a supra-annual pattern of 2 to 5 years between seasons of abundant fruit development (J. Turnbull, W. Everest, pers. comm.). The trees occuring in these open sites appear to fruit more abundantly than the closed forest sites.

Only three sparsely fruiting trees were observed at Butlers Rd., Limpinwood in January 1995 but previous collectors at this location in 1990 reported abundant fruit.

### 1.5.2 Pollination

No information is available on pollination mechanisms or vectors for *Diospyros mabacea*.

The presence of 2 species of ants, 2 wasp species and feral bees was noted in the tree at Locality 4 (Holstein's) in September 1994. Some evidence of protandry (precocious male flowering) was observed at that time, but different stages of flower development on the tree also indicated that self-pollination may occur.

The isolation of the known fruiting tree at Tyalgum (which is about 6.5 km distant from the nearest sites at Butlers Rd and Limpinwood Valley) further suggests the possibility of self-compatiblity.

### 1.5.3 Breeding system

It is likely that *Diospyros mabacea* has a mixed breeding system, allowing both self- and cross-pollination to result in seed set. If so, the extent of inbreeding becomes an important factor in the management of isolated plants and small groups of individuals.

It is interesting that the only regenerating populations occur at localities where significant numbers of mature trees are present. It may be that some selection for heterozygous progeny is occurring and that the absence of regeneration in localities 3 - 6 is related to poor vigour in inbred progeny.

Because most of the seedlings raised to date have come from isolated trees, it is possible that a limited subset of the genetic resource is being used for *ex situ* conservation plantings. Some of the difficulties encountered in germination and seedling establishment may even be a result of using seed from a limited genetic base which induces reduced vigour.

Because of the lack of any detailed research into the breeding systems and genetics of *Diospyros mabacea*, these observations must remain speculative until some investigation of pollination mechanisms and of genetic variation between individual trees and their progeny is undertaken over the full range of sites.



### 1.5.4 Seed dispersal

The moderately large fruits have not been observed to be taken by any animal vectors such as frugivorous birds or mammals, and all fallen fruits examined in February 1995 at Limpinwood (Holstein's) and Limpinwood Nature Reserve appeared whole and unmarked. At 2.5 to 4.5 cm diameter, the size of the fruits makes them a poor candidate for dispersal by birds, and the flesh, although substantial, is mealy and light. The fleshy fruits rotted quickly under the moist seasonal conditions to expose the seeds.

Seedling distribution within the Butlers Road sites was noticeably clustered around mature trees, with no seedlings found further than 50 metres from a potential source tree.

These factors, in combination with the limited dispersal observed in regenerating areas, indicate that gravity and water may be the major forms of seed dispersal. This is consistent with dispersal strategy evolved to take advantage of favourable sites nearby and enable the downstream dispersal to alluvial habitats favoured by the lower elevation populations.

This dispersal strategy is not particularly effective in promoting colonisation of new sites, especially in new catchments.

### 1.5.5 Germination

Two distinct germination patterns have been observed by nurserymen attempting to raise seedlings. The most common experience is seeds taking nearly one year to begin germination, with 30 to 50 % germinating in the period 11 to 14 months after sowing (J. Turnbull, M. Healey, B. Chick, pers. comms.).

Occasionally, seeds cleaned and soaked for a few days before sowing will germinate in 4 - 6 weeks after harvest. The best germination of this type known to have occurred under nursery conditions was from fresh and partially rotted fruits and seeds collected under the trees at Eungella in February 1992, resulting in over 1000 seedlings. The same batch of seeds also produced another crop of seedlings about 12 months after sowing (L. Fitzgerald, pers. comm.)

Germination is hypogeal, the shoot emerging from the soil surface without cotyledons. After sowing seeds remain viable for 1 to 2 years.

Under nursery conditions, seedlings are slow to establish, and are susceptible to fungus attack in early stages of growth.

The seasonal response indicates that temperature may be a strong factor in initiating germination, but further trials will be necessary to determine the relative importance of temperature, moisture, nutrients and light availability in promoting germination.

Seedlings were not locally prolific in any wild population surveyed. Poor germination rates and damping off observed in nursery germination to date are also likely to affect germination in the wild populations. The species' rarity may be partly related to limited regeneration potential due to poor germination and early growth.



### 1.5.6 Successional status

*Diospyros mabacea* is shade tolerant in seedling and sapling stages, grows slowly, bears moderately large fruits at irregular intervals and has limited dispersal vectors, characterisitics which are typical of mature phase ("Stage 4") rainforest trees (Floyd, 1988, 1990).

Mature trees of *D. mabacea* occuring as isolated individuals in disturbed secondary rainforest regrowth (as at Tyalgum, Limpinwood valley and Eungella) do not appear to be remnant trees surviving from the original forest, with the possible exception of the large old tree at Locality 5 (Edwards'). These occurrences indicate that the species is able to establish adventitiously in disturbed open sites, an observation supported by the occasional presence of saplings and small trees in either disturbed secondary regrowth or large canopy openings at both Butlers Rd. sites.

### 1.5.7 Regeneration

Natural regeneration of *Diospyros mabacea* is limited to the two Butlers Rd. localities. It appears that *Diospyros mabacea* only competes effectively in the mature subtropical lowland rainforest, where mild temperatures, abundant rainfall and enriched soils provide the protected and ecologically stable habitat conditions necessary for successful regeneration.

Because population structure data gathered to date is likely to be biased towards larger trees, seedling numbers are probably higher than those currently known. However the following general observations are made from random observations of the two main mixed age populations and from two 1000m$^2$ plots within these localities where intensive searches for *Diospyros mabacea* seedlings were carried out (see Appendix 1).

- Large trees at Limpinwood Nature Reserve appear well distributed throughout the area supporting suitable habitat, a pattern which, if verified by more accurate plotting, indicates a long association of this species and vegetation type at this location.
- Seedlings and juveniles (less than 2m) are generally found within 30m radius of a large (greater than 25cm DBH) tree, a pattern of distribution typically associated with seed-limited regeneration, and supporting the observation of limited seed dispersal by gravity and water.
- A few juveniles and young trees occur in more open sites associated with disturbance, including canopy breaks from tree falls, ecotones with wet sclerophyll forest and sites affected by previous logging or clearing, but the majority of juveniles and all young seedlings were found in relatively undisturbed mature tall closed forest.

- Seedlings (plants with <10 leaves) are scarce, which could indicate that the species is regenerating at below replacement levels. More detailed survey for seedlings and better knowledge of the growth and mortality rates and age distribution of the population may moderate this view.

The lack of regeneration at other sites is most likely to be attributable to ongoing disturbance, especially browsing and trampling by cattle. Other factors such as soil nutrient status, light and moisture levels or inbreeding may also play a role in limiting germination and seedling establishment, but above all these factors, the severe fragmentation and limited availability of the most favourable sites for colonisation (mature lowland subtropical rainforest) appears to be the major factor controlling regeneration potential.



## 1.6 Reasons for listing

### 1.6.1 Current conservation status

The current conservation status of *Diospyros mabacea* is 2ECi , indicating that the species has a maximum geographic range of less than 100km and is considered endangered and in serious risk of disappearing from the wild state within one or two decades. It occurs in Limpinwood Nature Reserve and Stotts Island Nature Reserve, but ~~the adequacy of~~ its reservation in these reserves is considered inadequate (Briggs & Leigh, 1994).

This conservation status requires revision on the basis of improved current knowledge of populations within Limpinwood Nature Reserve.

Briggs & Leigh (1988) suggest that the Endangered category should only be applied to species occurring in a national park or reserve "if the population is very small (about 100 plants or less) and is otherwise at serious risk. ... Species have been coded Vulnerable if there is an identifiable threat to the plant, or if the total population level within conservation reserves is particularly low (i.e. less than about 200 plants for trees or shrubs) even though no immediate threats may be evident."

With 140 mixed-age specimens (including 57 large mature trees) recorded in an area of 17 hectares within Limpinwood Nature Reserve, reservation at this site is still inadequate by the arbitrary but well-accepted minimum of 1000 plants. However, the reserved population is neither very small nor at serious risk and the species should be considered "vulnerable and inadequately reserved", with a concomitant risk code of 2VCi.

### 1.6.2 Historical rarity

Early records of *Diospyros mabacea* (1866 - 1917) are all from the Tweed River and the Murwillumbah District and give no indication of its abundance. The paucity of records suggests that it was never a common tree, and has always been restricted in its distribution and abundance. The records of Alex Floyd collected in 1960 from the now-cleared "Brays Scrub" near Murwillumbah list *Diospyros mabacea* as 'occasional' (as opposed to rare, common or very common). The Brays Scrub record is of special interest because it is the only recorded locality on the Rous River, the Tweed's northern tributary.

Assuming Floyd's observations at Brays Scrub were typical, *Diospyros mabacea* may have occurred occasionally throughout the lowland warm subtropical rainforests which were once extensive on alluvial flats around the Murwillumbah area and along the tidal reaches of the Tweed, Rous and Oxley Rivers. The clearance of these lowland alluvial sites for agriculture was nearly complete when the Brays Scrub was surveyed, and Stotts Island is now the only significant remnant. At Stotts Island, the low numbers of *Diospyros mabacea* and the failure to locate any mature trees indicate that the species is not well-established as a breeding population.

With increased knowledge of the western occurrences of *Diospyros mabacea* in the last 20 years, it now appears that the species has its strongest known association with warm subtropical rainforest on the lower altitude basalt substrates around the northwestern margin of the Oxley River catchment, where they outcrop down to their lowest level in the eroded landscape (around 100m above sea level in the Limpinwood Valley). The highest altitude at which *Diospyros mabacea* occurs (around 400m) coincides with the change in rainforest species composition to the "cooler" *Argyrodendron actinophyllum* (Black Booyong) Alliance.

## 1.7 Threats



Threats to the continued occurence of *Diospyros mabacea* as a viable regenerating wild population are:



### Reduction or loss of habitat:

Loss of habitat has been the major historic threat to *Diospyros mabacea* and has accounted for the severe reduction of populations in the known range. The fragmented and degraded condition of the optimum habitat for *Diospyros mabacea*, combined with the limited seed resource and dispersal mechanisms have limited potential for recolonisation.

### Degradation of habitat:

Fire: Periodic fires on a five to twenty year cycle can be expected to burn to the edges of the rainforest where the main population occurs, setting back rainforest regrowth to earlier successional stages and, in more severe or frequent events, promoting sclerophyll incursions into the rainforest margins.

Weeds: Weeds are present at all sites (though not particularly frequent or threatening at the main population at the head of the Oxley River). Invasive and rampant weed species such as madeira vine, cat's claw vine, privet, lantana, camphor laurel, ochna and asparagus fern present significant threats to the areas where they occur, with their potential for altering the structural and floristic character of rainforest areas and limiting natural regeneration (Dunphy, 1991).

Grazing: Three sites where *Diospyros mabacea* occurs are affected by cattle grazing around the trees, trampling and browsing seedlings, compacting the soil and limiting natural regeneration. No regeneration of *Diospyros mabacea* is occurring at these sites.

### Loss of vigour due to small population size and limited genetic base:

The severe reduction in the natural range of *Diospyros mabacea* may have reduced the species' genetic diversity. While it remains to be seen whether there is discernible genetic variation between or within the remaining populations, it is possible that loss of the major part of the alluvial habitat along the Tweed and Oxley Rivers has reduced the ability of the species to adapt to climatic changes, habitat degradation and fragmentation.

## 1.8 Existing conservation measures

*Diospyros mabacea* is reserved at the limits of its known geographical range in Limpinwood Nature Reserve and Stotts Island Nature Reserve. The Limpinwood Nature Reserve population is the largest and most stable population in terms of area, population size and habitat quality and contains 69% of all known individuals. The land on which it occurs was acquired as an addition to the nature reserve in the mid-1980's on the basis of the presence of warm subtropical rainforest and the significant populations of *Diospyros mabacea, Fontainea australis* and *Bosistoa selwynii*.

Some habitat enhancement work has taken place at Stotts Island Nature Reserve (weed control) and at Tyalgum showground (fencing and revegetation) but the other localities are essentially unmanaged. Land use zoning provides some protection for the unreserved population at Locality 1

(zoned 7d - Environmental Protection, Scenic/Escarpment), but does not reduce existing threats from weeds or degradation by periodic fire.

### 1.8.1 Propagation and establishment outside range.

Concerted efforts to propagate of *Diospyros mabacea* from seed have been undertaken since the discovery of fruiting trees at Tyalgum showground and Eungella in 1983 (B. Chick, pers. comm.) and at Limpinwood valley in 1987 and 1990 (J. Turnbull, pers. comm.).

From discussions with growers, it is estimated that more than 2000 seedlings have been raised in the last 10 years, though detailed records of collection dates, germination rates and planting sites are not available. The majority of these seedlings are from the Eungella population, where at least 2 heavily fruiting trees have provided abundant seed. Trees at Limpinwood Valley are the other major sources for local nurseries, the Portion 23 tree (Holstein's) being the favoured collecting site. The main population at Limpinwood Nature Reserve has provided just one known crop of seedlings, from an abundant seed fall in 1990.

Some locations where *Diospyros mabacea* has been planted for conservation are listed in **Appendix 3.** One of the most important ex situ coservation sites is the Mt Warning Arboretum, established in 1990 as part of the National Rainforest Conservation Program to preserve genetic material from populations of rare or threatened rainforest plants. About fifty young trees of *Diospyros mabacea* are established there, with potential for further plantings to increase representativeness of the collection.

Cuttings from leafy shoots have been used to propagate trees at Royal Botanic Gardens, Sydney and at Limpinwood Gardens Nursery, but they are slow to establish and prone to losses through damping off.

*Diospyros mabacea* is now regularly included in 'rare rainforest tree kits' prepared for the Tweed-Brunswick Reafforestation Committee, and is available as planting stock and advanced trees from several rainforest nurseries including Tweed Council nursery.

Establishment of planted seedlings is slow and requires protection against weed competition, excessive exposure or moisture loss. However on protected and moderately well-drained volcanic and alluvial soils, trees in mixed rainforest plantings typically appear hardy about 5 years after planting.

The widespread *ex situ* planting of *Diospyros mabacea* in parks, gardens, farm plantings and reafforestation plots is dispersing the species well outside its natural range and into a variety of habitats and substrates where it has not previously been known to grow. Regeneration potential at most of these *ex situ* sites is likely to be limited, but they provide some degree of protection against catastrophic loss of wild populations and may serve to extend viable populations well beyond the current restricted geographical range.



## 1.9 Strategy for Recovery

Recovery Plans are principally management-oriented and the immediate aim of this recovery plan is management of the existing population to improve the short term species survival in terms of the number of plants and their potential to successfully regenerate. To this end, the recovery plan proposes land acquisition of the major unreserved population, conservation agreements with landholders where small numbers or individual trees occur, and substantial habitat protection and enhancement activities to reduce threats to the *Diospyros mabacea* population and improve conditions for regeneration. The propagation of seedlings for population enhancement and ex situ conservation plantings is the major strategy for achieving a rapid increase in numbers.

There is also a longer term goal of retaining the species' potential for evolutionary change through maintaining the extent and pattern of genetic diversity. Without a better understanding of the species' breeding system and some analysis of genetic variation in the known wild populations, it is difficult to ensure that management strategies effectively conserve the genetic resource. Research into populations genetics will be necessary to find out whether isolated populations (localities 3 - 7) differ significantly from the major population and to gain some idea of the levels of heterogeneity present in the species.

The cost of any detailed examination of genetic variation in this species is likely to be significant and warrants some analysis of its possible benefit to the recovery process.Goodall (1994) identifies several circumstances where genetic research is warranted in conservation management of rare plants. Basic decisions about land aquisition and the relative importance of isolated trees can be made more effectively by collecting information on the extent of genetic variation within the species and its pattern of distribution in the population. Propagation for *ex situ* conservation needs to ensure representative genetic diversity by collections based on sufficient knowledge of the species' genetic base.

Given the limited numbers and reproductive success of *Diospyros mabacea*, genetic research could also elucidate aspects of the breeding system and identify which wild stands or individual trees are producing the greatest numbers of heterozygous progeny, and thus aid in selection of prime collecting sites for propagation material.

Seed will be collected from all sites and propagated for population enhancement and *ex situ* plantings. Germination trials from as many seed collections as is possible at each locality will determine whether any environmental factor or particular provenance provides higher rates of germination and seedling survival.



The recovery program will run for a ten year period from 1996 to 2005 inclusive.

# 2. RECOVERY

## 2.1 Objectives and Criteria

The objective of this recovery plan is to increase secure wild populations of *Diospyros mabacea* to a level of adequate reservation, and allow downlisting to rare and adequately reserved (2RCa) within 10 years of implementation of this plan.

This objective will be achieved when:

- the major unreserved population is secured by aquisition or by conservation agreement;
- population and habitat enhancement actions produce a combined population of more than 1000 individuals occurring in stable habitat within reserves; and
- the reserved populations contain the full range of genetic diversity known for the species.



## 2.2 Recovery actions

The recovery plan actions are listed below.

### 2.2.1 Administration

The existing Endangered Rainforest Plants Recovery Team is the appropriate body to coordinate the implementation of this plan. Administration costs have been incorporated into some of the individual actions, but a further amount has been allocated to cover a part of the cost of running the recovery team.

A contract botanist will need to be employed to undertake population monitoring and reporting, collection of material for propagation and research and some further survey work. Research activities into breeding systems, genetic variation and germination trials are proposed here to be offered to suitable universities for projects suited to honours or postgraduate students, with the aim of providing funding for supervision, travel and materials and utilising laboratory and field equipment available from the institutional resources.

Site rehabilitation, weed control and population enhancement will be done by a contract bush regenerators under the supervision of a project manager contracted to NPWS.

There is some potential for contributions to the project from community-based Landcare volunteers, youth training programs and NPWS weeding and rehabilitation teams, primarily in site works listed below under population protection and enhancement, habitat enhancement and *ex situ* conservation. Liaison and administration input will be required to maximise these resources.

ESP funds will be required to cover some travel, accommodation, reporting and liaison costs associated with recovery team administration; and to provide a proportion of the cost of a project officer/ manager to supervise and coordinate the researchers and site works.

### 2.2.2 Liaison and public education

Successful recovery will depend on the assistance and goodwill of landowners. Many of the proposed management actions will depend on their approval and cooperation. Liaison with CaLM and Tweed Council is available through their representatives on the recovery team and their continued assistance to recovery projects will facilitate management actions at Locality 3 and the proposed ex-situ plantings at Eungella and [redacted], Stotts Island.

Landowners and local conservation and reforestation societies will be encouraged to contribute to various activities in the plan, and all participants will need to be kept informed of the recovery

process. A public education program to raise awareness of rare plants (including *Diospyros mabacea*) and their significance in the region will assist in promoting local involvement in the recovery process. Interpretative signs highlighting recovery actions furthering population enhancement and *ex situ* planting will be located at the Eungella and Tyalgum.

General publicity, public information material and education programs will be prepared and coordinated by NPWS.

ESP funds are required for liaison and administration and to prepare displays and information for the education program. NPWS will contribute staff resources to publicity and preparation of education materials.



### 2.2.3 Secure unreserved populations against adverse land use.

Negotiations with landholders at localities 1,3,4,5 and 6 will be required to formalise access for research and management activities and to co-ordinate management actions aimed at eliminating adverse landuse and securing the population by land aquisition or conservation agreement.



Locality 1, adjacent to Limpinwood Nature Reserve, is the highest priority for acquisition, containing more than a quarter of known individuals in a mature regenerating population. The northwestern corner of the property should be referenced to investigate potential for a boundary adjustment or subdivision of about 20 ha. to add the rainforest area and an adjacent buffer of wet sclerophyll forest to the nature reserve. Further management actions such as weed control, population enhancement and even regular monitoring and collecting will depend on the success of negotiations with Mr. van den Broek (the current owner).

Locality 3 is a part of a crown reserve managed by a crown lands Trust and is being rehabilitated by a local Landcare group and trainee workers supervised by local employment training schemes. Negotiations with the Trust should investigate changing the status of the reserve to a "reserve for flora and fauna", and provide input to the current management plan for the area to improve habitat conditions for *Diospyros mabacea* regeneration and population enhancement.

Localities 4, 5, and 6 are currently grazed and subject to general farm management of weeds and/or slashing of regrowth. During preliminary discussions with the owners, none were inclined to isolate the area where *Diospyros mabacea* occurs from its current use, though all expressed interest in the health of their trees and their propagation. Actions for these sites in the management categories below (habitat protection, population enhancement) are contingent on the agreement of the owners and have been scheduled for 1998 funding (year 3).

Land aquisition and conservation agreements are the responsibility of the NPWS head office.

ESP funds will be required for liaison between landholders, the recovery team and the NPWS.

### 2.2.4 Monitoring and Survey

Monitoring of existing populations is essential to assessment of the effectiveness of the recovery actions and will provide important reference data for evaluation of growth rates, disturbance factors and habitat preferences. Permanent quadrats will be established at sites chosen to cover the environmental and geographic range of the species where potential exists for measuring changes in *Diospyros mabacea* populations and response to recovery actions. Eight monitoring sites are recommended, to be repeated at three year intervals:

Locality 1 2 sites
Closed forest; Wet sclerophyll ecotone

Locality 2 3 sites
Closed forest; Closed forest with canopy opening(s); Wet sclerophyll ecotone

Locality 3 Closed forest edge with weedy grassland and reforestation

Locality 6 Closed forest with canopy openings and grazing access

Locality 7 Closed forest with canopy openings

Permanent markers should be installed at each monitoring site at the corner of a standard quadrat (minimum 50 x 20m) where vegetation structure and floristics are recorded along with location, height and size (leaf counts for seedlings and juveniles, DBH for trees) of all *Diospyros mabacea* individuals and of all other trees greater than 10cm DBH.

Sites where management activities are being undertaken will also be monitored as part of the population and habitat enhancement actions (see below).

Some additional survey is required at the following locations:

Locality 1: further survey to determine the extent of the population in relation to the nature reserve boundary

Locality 7: further survey to locate more *Diospyros mabacea* on Stotts Island by intensive grid searching.

Further searching of areas within and adjoining Numinbah Nature Reserve is also warranted by the presence of some extensive and poorly surveyed patches of warm lowland subtropical rainforest on the southern edges of the reserve and adjacent lands.

ESP funds will be required for a contract botanist to monitor existing populations and survey further potential sites.



### 2.2.5 Genetics

Genetic research will aim at determining the degree of outcrossing and genetic variation within *Diospyros mabacea* populations and between the dispersed occurrences. This information will be necessary as early as possible in the recovery process, since the results will guide management decisions regarding conservation priorities at the different localities.

Allozyme analysis is proposed as the research method, because of its cost-effectiveness. An initial sample program will fine tune laboratory procedures and determine whether allozymes will be informative for this species, followed by a further stage intensively sampling all sites. The progeny of the Eungella population planted at Mt. Warning arboretum will also be tested.

ESP funds will be required to contribute to material and labour costs for a research laboratory to undertake allozyme analysis of approximately 200 samples, and for a contract botanist to collect material. Transport equipment (portable refrigeration) may also be required.

### 2.2.6 Breeding systems

Research into breeding systems and reproductive strategies will be required in the first stage of the recovery process with the aim of elucidating the degree of self- and cross-pollination occurring at the various localities and examining resource limitations that may affect reproductive success.

Standard procedures should be utilised, such as bagging, floral visitor assessments, pollen-ovule ratios, pollen supplementation, measuring successful fruit/seed set and subsequent seed dispersal and/or consumption. The research will be undertaken by a university researcher, probably as a postgraduate project, since it is likely to take at least three years to complete meaningful data collection over the range of sites.

ESP funds will be needed to provide research supervision and reporting, and a part of travel and field expenses.

### 2.2.7 Germination trials

Germination trials to determine factors limiting germination and subsequent establishment success will be conducted in conjunction with breeding systems research and population enhancement actions. Controlled glasshouse experiments are appropriate to examine germination and growth response in varied conditions of light, temperature, water and nutrient availability. Seeds collected for propagation (2.2.9 below) and in breeding system studies (above) will be used for these trials and raised to provide planting stock for population enhancement and *ex situ* plantings.

ESP funds will be required to provide ecophysiological research supervision, reporting and materials.



### 2.2.8 Protection of habitat



#### Fencing

Localities 4, 5, & 6 will benefit from fencing to exclude stock from around the trees and provide areas to promote regeneration and/or population enhancement. This will be contingent on negotiations with landowners and will determine whether further population enhancement and weed control programs will follow. Locality 6 is the highest priority for protection and enhancement actions, since it contains 4 mature individuals in a well-developed regrowth forest.

Locality 1 may require fencing if acquired as part of the nature reserve, but this is more a management issue for the NPWS rather than an action required for the protection of *Diospyros mabacea* habitat. The area is currently unfenced and appears to be unaffected by cattle due to difficult terrain and dense lantana and regrowth on forest margins.

Fencing will be done by local contractors with supervision by NPWS.

#### Protection from fire

Fire is absent from the core habitat of *Diospyros mabacea* and fire exclusion should be the priority in managing all populations. Localities 3 - 7 have only minimal fire risk and will not require hazard reduction. At the head of the Oxley, both localities (1 & 2) are flanked by wet sclerophyll forest and weedy regrowth with a moderate to high fire hazard, though the rainforest areas where *Diospyros mabacea* occurs are resistant to fire intrusion by virtue of low levels of combustible ground vegetation, high decomposition rates and fire retardant characterisitcs of the rainforest vegetation.

Hazard reduction work in this steep and rocky country is difficult and expensive. Some protection against low intensity fires in rainforest margins and secondary regrowth on Portion 153 (Godden's) could be achieved through lantana removal and reduction of ground fuel by hand in a 50 metre wide band along the southern margin of the plateau where Godden's hut is located amongst secondary rainforest regrowth. The southeastern margins of Locality 1 would also benefit from a similar fuel reduction program. This would also provide protection for the population enhancement plantings proposed for these areas.

This method of hazard reduction is appropriate for the involvement of semi-skilled or trainee bushworkers under supervision by bush regenerators involved in the habitat and population enhancement actions at these sites.

ESP funds will be required for supervision and equipment costs for hazard reduction at Localities 1 & 2. Hazard reduction work will be supervised by contract bush regenerators and the NPWS.

### 2.2.9 Site Access

Access to Localities 1 & 2 at the head of the Oxley River currently requires about one to two kilometers of moderately difficult walking through weedy regrowth. This will hamper efficient transport of equipment for both researchers and rehabilitation and planting teams. It is proposed to reopen a walking track from the existing end of Butlers Rd. to allow easier walking access to these sites. This will involve clearing of weeds and trimming overhanging vegetation, and may require some stabilisation and simple erosion control works on the steeper grades.

Access to Stotts Island (Locality 7) requires a boat to be available to the project. The NPWS(?) will be responsible for providing a suitable craft on an occasional basis.

ESP funds will be required for labour, materials and supervision to provide adequate access to localities 1 & 2 for implementation of management and research actions. An annual allowance has also been made for boat hire for access to Stotts Island.



### 2.2.10 Population enhancement

Population enhancement is the main strategy proposed to achieve the aim of adequate reservation for this species, concentrating on the reserves at the head of the Oxley River and at Stotts Island. This part of the program will aim to establish young populations of at least 1000 individuals (total) at Localities 1 & 2 and at least 200 individuals at Stotts Island, and to consolidate populations at two other existing occurrences, at Tyalgum Showground and Eungella, where there is some potential for expansion of the *Diospyros mabacea* population.

#### Seed collection and propagation

Seed will be collected where available at all wild localities during January and February over three seasons from 1996-98, with additional collections resulting from breeding systems fieldwork. Seed from each tree should be stored in separate batches in moist peat or sphagnum for transport and propagation as part of germination trials (2.2.7 above) before selecting the most vigorous for growing to planting stock. Seedlings are generally ready for planting at around 18 months from germination, but can be successfully grown on for a further one or two years in larger containers to provide hardy advanced planting stock. There is likely to be difficulty in obtaining sufficient seed from the existing plants at Localities 3 and 7 to provide enough stock and, if so, the results of the genetic and breeding system research will need be considered before choosing stock from other sites for enhancement plantings. About 2000 seedlings will need to be raised for the proposed plantings, with any excess stock being made available to plant conservation networks, botanic gardens, local reforestation committees and nurseries.

In addition to acquiring *Diospyros mabacea* seeds, the seed collector should also seek to acquire seeds from pioneer and secondary stage species around the target sites and the wider district for propagation by local nurseries. These will ensure a supply of suitably representative local stock for use in habitat enhancement plantings required at most of the sites.

ESP funds are required for seed collection and propagation. A contract botanist will do the seed collection and local nurseries will be contracted to grow on planting stock.

#### Re-introduction

Seedlings of *Diospyros mabacea* will be planted out at Locality 2 over the period 1998 - 2000, aiming to establish at least 800 plants over an area of around 15 hectares in and around the existing population, which includes both mature rainforest and secondary regrowth on the previously cleared benches around Godden's hut.

At Locality 1, about 250 seedlings will be planted in and around the existing population over the period 1999 - 2000, dependent on the outcome of negotiations with the owner.

At Locality 7, the lack of a known seed resource means that stock will need to be selected from other sources based on evaluation of genetic similarities. It is proposed to establish at least 200 seedlings at Stotts Island in areas of existing habitat on the western side of the island in conjunction with habitat enhancement works.

At the remaining localities (3 - 6), it is proposed to establish populations of at least 50 *Diospyros mabacea* seedlings in the vicinity of existing trees, contingent on the agreement of the landholders. At Locality 3, the availability of seed may again influence the selection of planting stock and the timing of enhancement plantings.

Planting strategies will need to take advantage of seasonal rains for successful establishment at localities 1, 2 and 7, since access is difficult and local water sources minimal.

ESP funds will be required for planting out and maintenance of seedlings over a five year period.

### 2.2.11 Habitat enhancement



#### Weed control

Weed control will be required at all sites to eliminate threats to natural forest succession and increase competitive advantage for native seedlings. The nature of the weeds present at each locality will dictate the methods used and the follow-up requirements to minimise re-establishment. Some sites have open and disturbed areas which will benefit from additional planting to accelerate succession using secondary phase rainforest trees. This will be necessary in order to establish a partial canopy cover to provide sufficient protection for the *Diospyros mabacea* seedlings.

At Localities 1 & 2, lantana will be the main target of weeding work, with the aim of improving growth conditions around the margins and canopy gaps of the *Diospyros mabacea* population and to prepare many of these areas for enhancement plantings. A small occurrence of madeira vine (*Anredera cordifolia*) at Godden's hut will require careful removal and regular follow-up over a number of years to ensure its complete eradication.

Locality 3 requires substantial weeding and replanting of rainforest pioneer and secondary phase species to provide suitable habitat for enhancement planting of *Diospyros mabacea*. The existing Landcare and trainee workers' activities are likely to undertake some of this work, but it is proposed that funds be allocated for weeding and rehabilitation at this site to ensure priorities for *Diospyros mabacea* are achieved.

Localities 4 & 5 have limited potential for expansion of *Diospyros mabacea* population due to the adverse landuse and limited occurrence of suitably protective habitat. Weed control and establishment of suitable cover to protect *Diospyros mabacea* plantings will be contingent on the negotiations to acquire or conserve a sufficient area around the existing trees.

Locality 6 will require regular weed control as soon as fencing of the site is complete. Some reduction of heavy vine loads on mid-stratum trees may improve canopy formation and provide opportunities for additional planting.

Locality 7 requires a substantial weed control program to prevent the spread of highly degrading exotic vines and ground covers which are widespread within the potential habitat of *Diospyros mabacea*. The most serious threats are madeira vine (*Anredera cordifolia*), cat's claw vine (*Macfedyana unguis-cati*), mother-of-millions (*Bryophyllum pinnatum*) and *Tradescantia albiflora*.

ESP funds are required for contract bush regenerators to undertake weed control at all sites.

### Associated species

At all rehabilitation sites where sparse canopy cover or open ground exists, rainforest pioneers and secondary phase trees will need to be established to provide protection for mature phase seedlings such as *Diospyros mabacea*. Planting densities will depend on the abundance and distribution of natural regeneration present. At each site, a representative selection of fast-growing pioneers, 'nomads' and secondary phase species should be used for plantings. Where possible, stock should be raised from seeds collected in the monitoring, survey and research activities, or acquired from local nurseries growing from locally-collected seed.

ESP funds will be required for stock, labour, transport and supervision involved in planting approximately 2000 trees for habitat enhancement.

## 2.2.12 *Ex-situ* conservation

Expansion and consolidation of *ex situ* conservation sites for *Diospyros mabacea* is advisable in order to reduce the potential for extinction of any of the wild populations through catastrophic loss such as fire, flood or cyclonic storm. Three existing sites at Mt. Warning Arboretum, Chick Park (Stotts Island) and Eungella Dip are proposed for additional plantings under this plan with the aim of achieving populations of at least 50 well-grown plants from representative genotypes at each location.

Selection of stock for these plantings will be guided by the results of genetic and breeding systems research.

ESP funds are required for planting and maintenance of *ex situ* plantings by contract labour under supervision by the project manager.



## 2.2.13 Monitoring and reporting

At each site where population and habitat enhancement work is done, monitoring of the *Diospyros mabacea* plantings will be undertaken at six month intervals to assess their condition, growth and potential threats. Site photographs, vegetation structural characteristics, species cover ratings, weed assessments and growth measurements are all recommended and additional permanent quadrats may be appropriate in large sites such as Locality 2.

ESP funds will be required for a contract botanist to monitor and report on the effects of management actions.

# 3. IMPLEMENTATION SCHEDULE

Cost estimates are in 1995 dollars and no allowance has been made for inflation.
a = ESP funds; b = other contributions. Potential contributions by the NSW NPWS have been indicated with the symbol ?.

| TASK | PRIORITY | FEASIBILITY | RESPONSIBILITY | | COST ESTIMATES ($000/yr.) 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Administration | 1 | 100% | NPWS | a | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 15 |
| | | | | b | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ?NPWS |
| Liaison and public education | 1 | 100% | NPWS | a | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | | | | b | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ?NPWS |
| Secure unreserved populations | 1 | 50% | NPWS | a | 2 | 2 | | | | | | | | | 4 |
| | | | | b | ? | ? | | | | | | | | | ?NPWS |
| Research - monitor and survey | 1 | 100% | Cont. botanist | a | 6 | | | 4 | | | 4 | | | 4 | 18 |
| | | | | b | | | | | | | | | | | |
| Research - genetics | 1 | 90% | Univ. researcher Cont. botanist | a | 4 | 4 | | | | | | | | | 8 |
| | | | | b | | | | | | | | | | | |
| Research - breeding system | 1 | 90% | Univ. researcher | a | 4 | 4 | 4 | | | | | | | | 12 |
| | | | | b | | | | | | | | | | | |
| Research - germination trials | 1 | 100% | Univ. researcher / contract nursery | a | 3.5 | 2 | 2 | | | | | | | | 7.5 |
| | | | | b | | | | | | | | | | | |
| Protection of habitat - fencing | 2 | 50% | Contract fencer | a | | | 3.2 | | | | | | | | 3.2 |
| | | | | b | | | ? | | | | | | | | |
| Protection of habitat - fire hazard reduction | 2 | 80% | NPWS | a | 3 | 3 | 3 | | | | 3 | | | | 12 |
| | | | | b | | | | | | | | | | | |
| Site access | 1 | 100% | Contract labour & NPWS | a | 4.5 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 16.2 |
| | | | | b | ? | ? | ? | ? | ? | ? | ? | ? | ? | ? | ?NPWS |
| Population enhancement - seed collection and propagation | 1 | 100% | Contract botanist and nurseries | a | 4 | 4 | 4 | 2 | | | | | | | 14 |
| | | | | b | | | | | | | | | | | |

| TASK | PRIORITY | FEASIBILITY | RESPONSIBILITY | | COST ESTIMATES ($000/yr.) 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population enhancement - reintroduction | 1 | 90% | Contract labour & NPWS | a<br>b | | | 3 | 3 | 3 | 3 | | | | | 12 |
| Habitat enhancement - weed control and regeneration / replanting | 1 | 90% | Contract regeneration team & NPWS | a<br>b | 12 | 10 | 10 | 8 | 5 | 5 | 2 | 2 | 2 | 2 | 58 |
| Ex situ conservation - | 2 | 90% | Contract labour & NPWS | a<br>b | | | | 3 | 2 | 2 | | | | | 7 |
| Monitor & Reporting | 1 | 100% | Cont. Botanist & NPWS | a<br>b | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 32 |
| TOTAL | | | | | 50.5 | 37.8 | 37 | 27.8 | 17.8 | 17.8 | 16.8 | 9.8 | 9.8 | 13.8 | 236.9 |

No allowance has been made for land aquisition costs.

0 1 JAN 1996

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# APPENDIX 2

## Plant species lists

## *Diospyros mabacea* sites

### Relative abundance ratings:



| | |
|---|---|
| VC | very common |
| C | common |
| F | frequent |
| O | occasional |
| + | present in small numbers/ rare |
| ( ) | at Locality 2, records in brackets were found predominantly in previously cleared regrowth areas south east of the undistrubed rainforest |

### Sites

| | | |
|---|---|---|
| 1 | [redacted] Butlers Rd. | survey 11/6/94, 19/11/94, 19/1/95 |
| 2 | Limpinwood NR | survey 4/6/94, 5/10/94, 20/1/95 |
| 3 | Tyalgum Showground | survey 23/5/94, 13/1/95 |
| 4 | [redacted] Limpinwood | survey 23/5/94, 13/1/95, 17/2/95 |
| 5 | [redacted] Limpinwood | survey 13/1/95 |
| 6 | [redacted], Eungella | survey 23/5/94, 6/1/95 |
| 7 | Stotts Island NR | survey 27/12/95, 2/1/95, 2/2/95 |
| 8 | Brays Scrub, Murwillumbah | - historic records - Floyd, 1960 [original abundance ratings used: VC - very common; C - common; O - occasional; R - rare] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Ferns** | | | | | | | | | |
| Adiantaceae | Adiantum aethiopicum | | | F | | F | F | O | |
| | Adiantum hispidulum | | O | O | | O | F | O | |
| Aspleniaceae | Asplenium australasicum | F | F | + | | | O | O | |
| | Asplenium polyodon | | O | | | | | | |
| Athyriaceae | Diplazium assimile | | + | | | | | | |
| | Lunathyrium japonicum | | + | | | | | | |
| Blechnaceae | Doodia aspera | | (O) | C | | | | F | |
| | Doodia caudata | | O | | | | O | | |
| | Doodia media | | + | | | | | | |
| Cyatheaceae | Cyathea cooperi | | O | | | | O | | |
| | Cyathea leichhardtiana | O | O | | | | O | | |
| Davalliaceae | Davallia pyxidata | + | O | | | | | O | |
| | Arthropteris tenella | + | O | | | | O | | |
| | Arthropteris beckleri | | + | | | | | O | |
| Dennstaedtiaceae | Dennstaedtia davallioides | | + | | | | | | |
| | Hypolepis muelleri | | + | | | | O | | |
| | Hypolepis punctata | | + | | | | | + | |
| | Pteridium esculentum | | (+) | | + | | | | |
| Dicksoniaceae | Culcita dubia | | (+) | | | | | | |
| Dryopteridaceae | Lastreopsis marginans | F | O | | | | O | O | |
| | Lastreopsis munita | | + | | | | | F | |
| | Lastreopsis microsora | | + | | | | | | |
| Polypodiaceae | Dictymia brownii | | O | | | | | | |
| | Microsorium scandens | | + | | | | | | |
| | Platycerium bifurcatum | O | F | O | | O | O | C | |
| | Platycerium superbum | O | O | | | | | O | |
| | Pyrrosia confluens | F | C | C | | C | C | O | |
| | Pyrrosia rupestris | F | F | | | | | O | |
| Pteridaceae | Pteris comans | | + | | | | | | |
| | Pteris tremula | | + | | | | | | |
| | Pteris umbrosa | + | O | | | | | | |
| Sinopteridaceae | Pellaea falcata var. falcata | | + | | | | | | |
| | Pellaea falcata var. nana | O | O | | | | | | |
| Thelypteridaceae | Christella dentata | + | (+) | | | | | O | |
| | Pneumatopteris sogerensis | | (+) | | | | | | |
| Vittariaceae | Vittaria elongata | + | O | | | | | | |
| **Trees, shrubs, vines** | | | | | | | | | |
| Acanthaceae | Pseuderanthium variabile | F | O | F | | F | | | |
| Akaniaceae | Akania lucens | + | O | | | | | | C |
| Alangiaceae | Alangium villosum ssp. polyosmoides | + | + | | | | | + | |
| Amaranthaceae | Deeringia arborescens | | + | | | | | | |
| Anacardiaceae | Euroschinus falcata | | | | | | | O | |
| Annonaceae | Ancana leptopetala | F | F | | | | O | O | VC |
| | Rauwenhoffia leichhardtii | | O | | | | | O | |
| Apiaceae | Hydrocotyle pedicellosa | | + | | | | | | |
| Apocynaceae | Melodinus australis | | F | | | | | O | |
| | Ochrosia moorei 2ECi | | + | | | | | | R |
| | Parsonsia fulva | + | O | | | | | | |
| | Tabernaemontana pandacqui | O | O | | | | | O | C |
| Araceae | Alocasia brisbanensis | O | O | | | | O | O | |
| | Gymnostachys anceps | | O | | | | | + | |
| | Pothos longipes | F | F | | | | O | F | |
| Araliaceae | Polyscias elegans | + | + | | | | | O | O |
| Araucariaceae | Araucaria cunninghamii | | + | | | | | | |
| Arecaceae | Archontophoenix cunninghamiana | O | F | | | | | O | |
| | Calamus muelleri | F | C | | | | | F | |
| | Linospadix monostachyus | O | F | | | | | O | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Aristolochiaceae | Aristolochia praevenosa | | | + | | | | | | |
| Asclepiadaceae | *Asclepias curavassica | | | | O | O | O | | | |
| | Hoya australis | | + | | | | | | + | |
| | Tylophora paniculata | | | + | | | | | | |
| | Marsdenia lissae(?) | 3RC- | | + | | | | | | |
| Asparagaceae | *Protasparagus aethiopicus | | | | O | | | | | |
| | *Protasparagus plumosus | | | | | | O | | | |
| Asteliaceae | Cordyline petiolaris | | O | + | | | | | | |
| | Cordyline rubra | | O | O | | | | | O | |
| Asteraceae | *Ageratina adenophora | | | | | | | | O | |
| | *Ageratina riparia | | | | O | O | O | C | | |
| | *Ageratum houstonianum | | | | | O | | O | | |
| | *Baccharis halimifolia | | | | | | + | | + | |
| | *Bidens pilosa | | | | | O | | | | |
| | *Cirsium vulgare | | | | O | F | | | | |
| | *Conyza bonariensis | | | | | C | | | | |
| | *Crassocephalum crepidioides | | | | O | | | | | |
| Basellaceae | *Anredera cordifolia | | | (+) | | | | | O | |
| Bignoniaceae | *Macfadyena unguis-cati | | | | F | | | | O | |
| | Pandorea jasminoides | | O | O | | | | | | |
| | Pandorea pandorana | | | | | | | | O | |
| Boraginaceae | Ehretia acuminata | | F | F | O | | | | | R |
| Capparaceae | Capparis arborea | | O | O | | | | + | O | C |
| Caprifoliaceae | Sambucus australasica | | | O | | | | | | |
| Caryophyllaceae | *Drymaria caudata | | | | | | | | O | |
| Casuarinaceae | Casuarina cunninghamiana | | | | | C | C | | | |
| Celastraceae | Cassine australis | | | + | | | | | O | |
| | Celastrus subspicata | | + | F | | | | | | |
| | Hedraianthera porphyropetala | | | O | | | | | | |
| Commelinaceae | Commelina cyanea | | | | | | | O | | |
| | Pollia crispata | | + | O | | | | | | |
| | *Tradescantia albiflora | | | | | | | | O | |
| | *Tradescantia zebrina | | | | | F | | | | |
| Convolvulaceae | *Ipomoea cairica | | | | | | | | O | |
| | *Ipomoea purpurea | | | | | | | | + | |
| Crassulaceae | *Bryophyllum pinnatum | | | | | | | | O | |
| Cucurbitaceae | Diplocyclos palmatus | | | | O | | | | | |
| | Trichosanthes subvelutina | 3RC- | | O | | | | | | |
| Cunoniaceae | Caldcluvia paniculata | | | O | | | | | | |
| | Geissois benthamii | | | + | | | | | | |
| | Pseudoweimannia lachnocarpa | | O | F | | | | | | |
| Cyperaceae | *Cyperus brevifolius | | | | | F | | | | |
| | Cyperus gracilis | | | | | | F | O | | |
| | Gahnia aspera | | | (+) | | | | | | |
| Dioscoreaceae | Dioscorea transversa | | + | O | | | | | | |
| Ebenaceae | Diospyros australis | | + | | | | | | O | |
| | Diospyros fasciculosa | | | | | | | | O | |
| | Diospyros mabacea | 2ECi | F | F | + | + | + | O | + | O |
| | Diospyros pentamera | | O | O | | | | + | C | C |
| Elaeocarpaceae | Elaeocarpus grandis | | F | O | | O | O | O | C | R |
| | Elaeocarpus kirtoni | | | | | | | | + | |
| | Elaeocarpus obovatus | | | O | O | | | F | C | |
| | Sloanea australis | | C | F | | | | VC | | O |
| | Sloanea woollsii | | | + | | | | O | | R |
| Epacridaceae | Trochocarpa laurina | | | + | | | | | | |
| Escalloniaceae | Argophyllum nullamense | 3RCa | + | O | | | | | | |
| | Polyosma cunninghamii | | | O | | | | | | |
| Euphorbiaceae | Actephila lindleyi | | | O | | | | | + | R |
| | Baloghia inophloia | | O | F | | | | | | O |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Breynia oblongifolia | | O | O | | | | | O | |
| | Bridelia exaltata | | | | O | | O | O | | |
| | Claoxylon australe | | | O | | | | | | |
| | Cleistanthus cunninghamii | | F | O | O | | | C | C | VC |
| | Croton acronychioides | | | + | | | | | | |
| | Croton verrauxii | | O | (O) | | | | | O | R |
| | Drypetes australasica | | | O | | | | | C | |
| | Fontainea australis | 2VCi | | F | | | | | | |
| | Glochidion ferdinandii | | | O | | | O | VC | + | C |
| | Macaranga tanarius | | | | + | O | O | | + | |
| | Mallotus philippinensis | | O | O | VC | | F | C | O | C |
| | Mallotus discolor | | | | | | | | O | |
| | Omalanthus nutans | | + | O | | | | + | + | |
| Eupomatiaceae | Eupomatia bennettiana | | O | O | | | | + | | C |
| | Eupomatia laurina | | O | F | | | | O | | |
| Fabac. -Mimosoidae | Acacia maidenii | | | | | | | | | O |
| | Acacia melanoxylon | | | O | O | | | | | C |
| | Archidendron grandiflorum | | | O | | | | | + | R |
| | Archidendron hendersonii | 3RC- | | | | | | | + | O |
| | Archidendron muellerianum | 3RCa | | O | | | | O | | O |
| | Pararchidendron pruinosum | | | + | + | | | + | + | O |
| Fabac.- Faboideae | Austrosteensia blackii | | O | O | | | | F | | |
| | Austrosteensia glabristylis | | + | + | | | | | O | |
| | Castanospermum australe | | | | O | | | | | VC |
| | Mucuna gigantea | | | | | | | | O | |
| | Derris involuta | | O | O | | | | | | |
| | Milletia megasperma | | O | F | | | | | O | |
| Fabac.- Caesalpinioideae | Caesalpinea subtropica | | | O | | | | O | | |
| | Cassia marksiana | 2RCi | | | | | | O | + | O |
| | *Senna pendula | | | | O | | | O | O | |
| Flacourtiaceae | Scolopia braunii | | | O | | | | | + | |
| Flagellariaceae | Flagellaria indica | | | F | | | | O | C | |
| Geitonoplesiaceae | Geitonoplesium cymosum | | O | O | | + | | + | | |
| Hippocrateaceae | Hippocratea barbata | | | F | | | | | O | |
| Icacinaceae | Citronella moorei | | O | O | | | | | | |
| | Pennantia cunninghamii | | | + | | | | + | | O |
| Lauraceae | Beilschmedia elliptica | | O | O | | | | | | O |
| | Beilschmedia obtusifolia | | F | F | | | | | O | O |
| | *Cinnamomum camphora | | | | O | | | C | | |
| | Cinnamomum oliveri | | F | F | | | | C | | O |
| | Cinnamomum virens | | | O | | | | | O | |
| | Cryptocarya erythroxylon | | | F | | | | | | |
| | Cryptocarya foetida | 3VCi | | | | | | | + | |
| | Cryptocarya laevigata | | O | C | O | | | F | O | VC |
| | Cryptocarya obovata | | O | F | + | | O | C | C | O |
| | Cryptocarya triplinervis var. pubens | | O | O | | | O | F | | O |
| | Endiandra discolor | | | | | | O | | | O |
| | Endiandra hayesii | 3VC- | | | | | | | | O |
| | Endiandra muelleri | | | O | | | | | + | O |
| | Endiandra pubens | | O | F | | | | F | O | C |
| | Litsea australis | | | + | | | | | O | |
| | Litsea reticulatus | | | O | | | | | + | R |
| | Neolitsea australiensis | | | F | | | | | | |
| | Neolitsea dealbata | | O | F | | | | F | | VC |
| Loranthaceae | Amylotheca dictyophleba | | | | | | | O | | |
| Malvaceae | *Sida rhombifolia | | | | O | O | O | O | | |
| Meliaceae | Anthocarapa nitidula | | O | O | | | | | | VC |
| | Dysoxylum fraserianum | | O | O | | | O | | + | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dysoxylum mollisimum | | | O | | | | F | + | C |
| | Dysoxylum rufum | | | | | | | | C | |
| | Melia azederach var. australasica | | C | O | | | | O | O | O |
| | Synoum glandulosum | | | O | | | | O | O | |
| | Toona ciliaris | | O | F | | O | O | C | O | |
| Menispermaceae | Carronia multisepala | | | O | | | | F | O | O |
| | Legnephora moorei | | | O | | + | | | | |
| | Stephania japonica var. discolor | | | | | | | | O | |
| Monimiaceae | Daphnandra micrantha | | | | | | | | | R |
| | Daphnandra tenuipes | | C | F | | | | | | |
| | Palmeria scandens | | | O | | | | | | |
| | Wilkiea austro-queenslandica | | | C | | | | | | |
| | Wilkiea huegeliana | | | O | | | | | O | |
| | Wilkiea macrophylla | | | + | | | | | + | |
| Moraceae | Ficus coronata | | O | F | F | | | VC | O | |
| | Ficus fraseri | | | + | | | F | | O | VC |
| | Ficus macrophylla | | | | | | | | VC | C |
| | Ficus obliqua | | O | C | | | | C | O | C |
| | Ficus superba var. henneana | | | | | | | | O | |
| | Ficus virens | | O | | | | O | | O | |
| | Ficus watkinsiana | | F | C | | | | C | | C |
| | Maclura cochinchinensis | | O | O | C | | O | C | O | |
| | Malaisia scandens | | F | F | | | | O | | |
| | *Morus alba | | | | | | | | + | |
| | Streblus brunonianus | | | | F | | O | O | VC | C |
| Myrsinaceae | Embelia australiana | | O | O | | | | | O | |
| | Rapanea howittiana | | | | | | | + | | |
| | Rapanea subsessilis | | O | F | | | | | | |
| | Rapanea variabilis | | | O | | | | O | | R |
| | Tapeinosperma pseudojambosa | | + | + | | | | | | |
| Myrtaceae | Acmena ingens | | O | O | | | | | | O |
| | Acmena smithii | | | | | | | O | | R |
| | Acmena smithii var. minor | | | | O | | | | | |
| | Austromyrtus acmenoides | | | O | | | | F | O | O |
| | Austromyrtus bidwillii | | O | O | | | | | O | O |
| | Decaspermum humile | | | + | | | | | | |
| | Lophostemon confertus | | C | O | | | | O | | |
| | Pilidiostigma glabrum | | | O | | | | | | |
| | Rhodamnia argentea | | | O | | | | O | O | R |
| | Rhodamnia rubescens | | O | O | | | | O | | |
| | Rhodomyrtus psidioides | | | | | | | O | | |
| | Syzygium australe | | | O | O | | F | C | | |
| | Syzygium coryanthum | | | | | | | | | R |
| | Syzygium crebrinerve | | F | F | | | | VC | | |
| | Syzygium francisii | | O | O | C | | | | O | R |
| | Syzygium hodgkinsoniae | 3VC- | F | C | | | | | | |
| | Syzygium moorei | 2VCi | | | | | | + | + | O |
| Ochnaceae | *Ochna serrulata | | | | F | | | | | |
| Oleaceae | Jasminum singuliflorum | | | O | | | | | | |
| | Jasminum volubile | | | | + | | | | O | |
| | *Ligustrum sinense | | | | F | | | | O | |
| | Notolaea longifolia | | | | F | | | | | |
| | Olea paniculata | | O | O | O | | O | | | |
| Orchidaceae | Bulbophyllum auranticum | | | + | | | | | | |
| | Calanthe triplicata | | + | O | | | | | | |
| | Dendrobium gracilicaule | | | + | | | | | | |
| | Dendrobium monophyllum | | | | | | | O | O | |
| | Dendrobium speciosum | | | + | | | | | | |
| | Dendrobium teretifolium | | | + | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Dendrobium tetragonum | | | + | | | | | | |
| | Peristanthus hillii | | | | | | | | + | |
| | Plectorrhiza tridenta | | | + | | | | | | |
| | Rhinerrhiza divitiflora | | | + | | | | | | |
| | Sarcochilus falcatus | | | + | | | | | | |
| | Zeuxine oblonga | | | | | | | | O | |
| Passifloraceae | *Passiflora suberosa | | | | | | | | O | |
| | *Passiflora subpeltata | | | | O | | O | | O | |
| Peperomiaceae | Peperomia leptostachya | | | O | | | | | | |
| | Peperomia tetraphylla | | | F | | | | | | |
| Phormiaceae | Dianella caerulea | | | | O | O | O | | | |
| Phytolaccaceae | *Rivina humilis | | | | | | | | O | |
| | *Phytolacca octandra | | | | | C | | | | |
| Piperaceae | Piper novae-hollandiae | | O | F | | | | | | |
| Pittosporaceae | Citriobatus pauciflorus | | | O | O | | | O | O | |
| | Pittosporum revolutum | | | | O | | | | + | R |
| | Pittosporum undulatum | | | O | | | | + | | |
| Poaceae | *Axonopus compressus | | | | F | F | F | | | |
| | *Bromus unilioides | | | | | | O | | | |
| | Panicum pygmaem | | | O | | | | | | |
| | *Paspalum conjugatum | | | | | C | | C | + | |
| | *Paspalum urvillei | | | | C | | | | | |
| | *Paspalum wettsteinii | | | | C | | C | C | | |
| | *Pennisetum clandestinum | | | | | C | | | | |
| | Oplismenus aemulus | | | | F | | | O | | |
| | Oplismenus undulatifolius var. mollis | | | F | F | O | F | | O | |
| Podocarpaceae | Podocarpus elatus | | | + | O | | O | + | O | |
| Proteaceae | Floydia praealta | 3VC- | + | + | | | | | | |
| | Grevillea robusta | | | | O | | O | | | R |
| | Helicia glabriflora | | | O | | | | | | |
| | Hicksbeachia pinnatifolia | 3RC- | O | O | | | | | | |
| | Macadamia tetraphylla | 2VC- | + | O | | C | | C | | |
| | Stenocarpus sinuatus | | | | | | | | | O |
| | Triunia youngiana | | O | F | | | | | | |
| Rhamnaceae | Alphitonia excelsa | | | (F) | | | | F | O | O |
| Ripogonaceae | Ripogonum album | | F | F | | | | | | |
| | Ripogonum elseyanum | | | | | | | | F | |
| Rosaceae | Rubus rosifolius | | | O | O | O | O | O | | |
| | Rubus ?moorei | | | O | | | | | | |
| Rubiaceae | Canthium coprosmoides | | | | | | | | + | |
| | Canthium lamprophyllum | | | | | | | | O | |
| | Hodgkinsonia ovatiflora | | | O | | | | | + | R |
| | Ixora beckleri | | O | O | | | | O | + | O |
| | Morinda jasminoides | | O | F | | | | O | | |
| | Randia benthamii | | | | | | | | | R |
| | Randia chartacea | | O | F | | | | | F | C |
| Rutaceae | Acronychia oblongifolia | | + | | | | | | + | O |
| | Bosistoa pentacocca | | O | C | | | | | | |
| | Bosistoa selwynii | 3VCi | O | C | | | | | | |
| | *Citrus limon | | | | | | | O | | |
| | Flindersia schottiana | | | | | | | O | C | O |
| | Flindersia xanthoxyla | | | | | | | | O | C |
| | Geijera salicifolia var. latifolia | | + | O | | | | | | |
| | Medicosma cunninghamii | | | O | | | | | | |
| | Melicope elleryana | | | | | | | | | VC |
| | Melicope micrococca | | + | O | | | | + | | |
| | Melicope octandra | | + | O | | | | | | |
| | Microcitrus australasica | | O | F | O | | O | O | O | C |
| | Pentaceras australis | | | | | | | | | R |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sarcomelicope simplicifolia | | + | | | | | | + | O |
| Sapindaceae | Alectryon subcinereus | | O | O | | | | | O | O |
| | Arytera distylis | | | O | O | | | O | O | |
| | Atalaya salicifolia | | | O | | | | | | |
| | Castanospora alphandii | | O | C | | | | | | |
| | Cupaniopsis anacardioides | | | | | | | | O | |
| | Cupaniopsis flagelliformis | | | O | | | | | + | |
| | Cupaniopsis serrata | | | + | | | | | | O |
| | Diploglottis australis | | O | F | O | | O | F | O | C |
| | Elattostachys nervosa | | | O | | | | | O | O |
| | Elattostachys xylocarpa | | + | + | | | | | | |
| | Guioa semiglauca | | | O | O | O | O | O | O | R |
| | Harpullia alata | | | + | | | | | | |
| | Harpullia hillii | | | | | | | | O | |
| | Harpullia pendula | | | F | | | | | C | O |
| | Jagera pseudorhus | | | + | | | | F | O | O |
| | Lepiderema pulchella | 2RC- | O | O | + | | | | O | |
| | Mischocarpus anodontus | | | + | | | | | | R |
| | Mischocarpus australasicus | | | O | | | | | | |
| | Mischocarpus pyriformis | | | | | | | | O | R |
| | Rhysotoechia bifoliolata | | + | + | | | | | | |
| | Sarcopteryx stipata | | O | F | | | | | | O |
| | Toechima dasyrrache | | | | | | | F | | |
| | Toechima tenax | | | | | | | | O | |
| Sapotaceae | Planchonella australis | | | O | | | | | O | C |
| | Planchonella chartacea | | | | | | | | O | |
| | Planchonella laurifolia | | | | | | | | + | |
| Simaroubiaceae | Ailanthus triphysa | | O | O | | | | | | |
| | Guilfoylia monostylis | | O | O | | | | | | |
| | Quassia sp. A | 3RC- | + | + | | | | | | |
| Smilacaceae | Smilax australis | | | O | | | | | | |
| Solanaceae | *Physalis peruviana | | | | O | | O | | | |
| | Solanum callium | | + | | | | | | | |
| | *Solanum capsicoides | | | | | O | | O | | |
| | Solanum inaequilaterum | | + | | | | | | | |
| | *Solanum nigrum | | | | | O | | O | | |
| | *Solanum mauriteanum | | | (O) | O | O | O | F | O | |
| | *Solanum seaforthianum | | | | F | | | | | |
| | Solanum stelligerum | | | O | O | | | | | |
| Sterculiaceae | Brachychiton acerifolium | | | O | | | | | | R |
| | Brachychiton discolor | | + | | | | | | | |
| | Commersonia bartramia | | | (O) | | | | | O | O |
| | Heritiera actinophylla ssp. actinophylla | | + | + | | | | | | |
| | Heritiera trifoliolata | | C | VC | | | | C | + | VC |
| | Sterculia quadrifida | | | | | | | | + | |
| Symplocaceae | Symplocos bauerlenii | 2VC- | | + | | | | | | |
| | Symplocos thwaitesii | | | O | | | | | + | O |
| Ulmaceae | Aphananthe phillipinensis | | O | O | C | O | C | O | VC | C |
| | Celtis paniculata | | | | | | | | O | |
| | Trema aspera | | O | O | | | | | | |
| Urticaceae | Boehmeria platyphylla var. austroqueenslandica | | O | O | | | | | | |
| | Dendrocnide excelsa | | F | C | | | | | | VC |
| | Dendrocnide photinophylla | | + | O | | | | | + | VC |
| | Elatostemma stipitatum | | + | O | | | | | | |
| | Pipturus argentea | | O | O | | | | | | |
| | Callicarpa pedunculata | | + | O | | | | | | |
| Verbenaceae | Clerodendrum floribundum | | | O | O | | | | | |

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|---|---|---|---|---|---|---|---|---|---|
| | Gmelina leichhardtii | | + | | | | | | O |
| | *Lantana camara | O | O | O | | O | O | O | |
| Vitaceae | Cayratia clematidea | | O | | | | | O | |
| | Cissus antarctica | O | C | | | - | O | O | |
| | Cissus hypoglauca | | F | | | | | O | |
| | Tetrastigma nitens | + | O | | | | | O | |
| Winteraceae | Tasmannia insipida | | O | | | | | | |
| Zingiberaceae | Alpinia arundelliana | | O | | | | | | |
| | Alpinia caerulea | O | O | | | | + | O | |