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REMNANT VEGETATION SURVEY DARWIN TO PALMERSTON REGION

A REPORT TO GREENING AUSTRALIA N.T.

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DECEMBER 1995

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ACKNOWLEDGEMENTS

Major funding for the survey was provided by the Save the Bush project under the National Landcare Program, with further funding from the National Estate Program.

The NT Department of Lands Planning and Environment generously loaned sets of rectified and other aerial photography for use by Greening Australia, and staff provided valuable service.

Tim Offor and Mike Clark were responsible for initially setting up the project. Mike Clark, Libby Benson and Bill Panton provided valued advice and vital support throughout.

Steve Denney carried out map interpretation for the Palmerston to Shoal Bay area, and undertook field work in that region.

Karina Menkhorst assisted with interpretation and field work in the Darwin area. Others assisting with field work and plant identification included Bob Harwood, Ron Booth, Paul Munns, Joe Morrison and Alister Clark. Staff of the NT Herbarium provided backup support and assistance with plant identification.

Kristin Bardsley provided baseline data for mangrove communities of inner Darwin harbour, and the classification used in this report is largely adapted from her work.

Map production was carried out by Bart Edmeades, with assistance from Peter Brocklehurst who further provided invaluable expertise in vegetation mapping techniques.

Permission from land owners, property managers and Aboriginal communities to gain access to their land during the survey is gratefully acknowledged.

1.0 INTRODUCTION

1.1 Background

Remnant vegetation is defined as an area of land which contains native vegetation in a natural state. Much remnant vegetation has been lost or seriously degraded as a result of urban expansion, clearing and development. Poor land management practices have also contributed to long term deterioration of native bushland. Factors causing negative impact include uncontrolled fires, weed intrusion, stormwater runoff, unformed tracks with subsequent erosion, and indiscriminate dumping of household and industrial waste.

1.2 Aims

The main aim was to identify, describe and map areas of native remnant vegetation and to both determine and graphically represent their significance.

The broad objectives were:

- To develop the methodology for assessing significance of remnant vegetation.
- To produce a useable updateable vegetation map of the area.
- To catalogue areas of significance for consideration in future land management and planning decisions.
- To develop community based management strategies for remnant vegetation appropriate for both conservation and urban development.
- To provide an overall perspective of native vegetation in the greater Darwin region.

1.3 Scope

The first stages of a larger regional survey focused on the municipalities and environs of Darwin and Palmerston. This encompasses all land from Darwin city to the Howard River, south to Elizabeth River and north to Shoal Bay. (Darwin Municipality covered an area of approximately 15,000 hectares).

2.0 METHODS

2.1 Interpretation

Vegetation patterns of the survey area were interpreted from 1:5,000 colour and infra-red rectified aerial photography taken in 1985. Areas of similar photo-patterns were delineated on

tracing paper, with reference to existing vegetation and land resource maps. Final interpretation and boundaries of mapping units were modified according to ground truthing and data collection.

2.2 Survey

Field work involved the collection of data at sites within the survey area. Sites were located to sample representative areas within the major mapping units identified in the interpretation. At each site all plant species and an assessment of the vegetation structure were recorded. Upper storey (tree) heights were estimated using a clinometer. Upper storey crown covers and mid and lower storey foliage cover were visually estimated. Variation within and around unit boundaries was checked.

Variables were collected and rated to evaluate the status and condition of remnant vegetation. The environmental condition of the site was assessed. Intensity and form of disturbance was recorded, including impacts from fire or cyclone, degradation from erosion or clearing, and presence and abundance of weed species. The site and adjacent bushland was assessed as habitat and pathway for native fauna, in conjunction with regional vegetation corridors. Regeneration of woody species was scored. The site's potential as an educational or recreational resource was assessed subjectively. Evidence of fauna was noted, as well as features such as water, views or rocky outcrops. A colour photo was taken of each site.

Field work was largely undertaken during the wet seasons (Jan-Apr) of 1994 and 1995, with further visits depending on accessibility and sampling intensity. Access to sites was by 4WD vehicle or on foot. 130 20m x 20m sites were sampled. General vegetation structure, habitat variation, locally common species and environmental condition were noted along all tracks.

2.3 Vegetation classification and mapping units

Plant identification took place in the field and at the Northern Territory Herbarium. Taxonomy follows Dunlop, Leach and Latz (1995). Floristic groupings described are based upon the recurrence of recognisable species assemblages. Overall structure and life form classes are provided along with an estimate of the abundance of characteristic species. Mapping units were described by examination of the site data. Vegetation community classification follows the scheme used by Wilson et al (1990), whereby, in general, each community has a consistent

floristic group in at least the dominant stratum, but often some variation in the other strata.

Two diverse communities, monsoon rainforests and floodplains, were treated as environmental suites as distinct from other communities with only few common dominant species. Monsoon rainforests have a comparatively high diversity of species in the upper stratum, while dominant trees and populations vary considerably from one patch to another. On floodplains, landscapes subject to both saline and freshwater inundation, presence and dominance of a range of species is determined by length and depth of inundation and degree of salinity.

3.0 VEGETATION COMMUNITIES

MONSOON RAINFOREST

3.1 Mixed species monsoon rainforest associated with permanent moisture. Closed canopy 20-25m tall dominated by evergreen species, including *Acacia auriculiformis*, *Calophyllum soulattri*, *Carpentaria acuminata*, *Horsfieldia australiana* and *Syzygium nervosum*. The mid layer comprises a variety of smaller trees and shrubs, such as *Alphitonia excelsa*, *Macaranga tanarius* and *Leea indica*. Ground cover of ferns and vines is generally sparse whilst tree seedlings are commonly numerous in patches.

Sites include Holmes Jungle, Duke St. rainforest and sections of Rapid Ck.

3.2 Mixed species coastal monsoon rainforest associated with seasonally dry habitats. Deciduous species dominate, though a variety of deciduous and evergreen trees make up the seasonally closed canopy to 10m in height, with taller emergents 15-17m tall. Deciduous trees include *Ficus virens*, *Peltophorum pterocarpum* and *Terminalia microcarpa*, with evergreens such as *Myristica insipida*, *Alstonia actinophylla* and *Mimusops elengi*. Other trees present are *Celtis philippensis*, *Diospyros calycantha* and *Drypetes lasiogyna*. Vines are common and include *Flagellaria indica*, *Smilax australis*, *Pachygone ovata* and *Opilia amentacea*.

Sites include the Esplanade cliffs (especially Lameroo Beach), East Pt. Reserve and Casuarina Coastal Reserve.

Areas of beach and sand dunes may occur within this community, in particular Casuarina Coastal Reserve. (For greater detail of Casuarina Coastal Reserve, see Brocklehurst 1991).

3.3 *Acacia auriculiformis* open forest to closed forest. Other trees include *Pandanus spiralis, Melaleuca viridiflora* and *Lophostemon lactifluus.* Rainforest species are common in the mid and low stratum. The ground layer comprises a variety of herbs and grasses, as well as vines such as *Dioscorea transversa, Smilax australis* and *Gymnanthera nitida.*

3.4 A modified community allied to Community 2. Naturalised exotic species such as *Leucaena leucocephala* and *Pterocarpus indicus* may occur as co-dominants, with some enrichment planting of local native species. Floristically linked to coastal rainforest but the canopy and structure have been substantially modified.

3.4a Regeneration dry coastal monsoon rainforest, including areas of rehabilitation and enrichment planting of local native species.

This community is represented in regeneration areas of East Pt. Reserve.

MANGROVES

3.5 *Sonneratia alba* open forest to woodland to 12m tall. The seaward mangrove zone dominated by *Sonneratia alba*, with *Aegiceras corniculatum* and *Aegialitis annulata* as associated species.

3.6 Coastal *Rhizophora stylosa* closed forest to 16m tall, commonly in pure stands forming shoreline zone. *Bruguiera parviflora* also occurs.

3.7 *Rhizophora stylosa, Bruguiera exaristata, Camptostemon schultzii* closed forest to open forest. This community

grows along tidal creeks and includes adjacent transitional vegetation. Associated species include *Avicennia marina, Bruguiera parviflora, Aegiceras corniculatum* and *Ceriops tagal.*

3.8 *Ceriops tagal* low closed forest 2-6m tall. Commonly forms pure stands on tidal flats, decreasing in height close to salt pans. Other species include *Bruguiera exaristata* and *Avicennia marina.*

3.9 *Ceriops tagal, Avicennia marina, Lumnitzera racemosa, Excoecaria ovalis* low closed forest generally 2-7m tall. The species may occur together or as locally pure stands. This mixed community generally forms on landward or hinterland margins of mangrove vegetation. Rows of *Melaleuca* species are common on the landward fringe, occasionally *Pandanus spiralis* may occur. Narrow bands of grassland commonly occur in this area, with *Xerochloa imberbis* on the saline fringes and *Ischaemum australe* on the landward edge.

3.10 Salt flats. Hypersaline flats of bare sandy mud, with occasional shrubs such as *Batis argillicola* and *Suaeda arbusculoides*, and scattered stunted mangroves.

MELALEUCA COMMUNITIES

3.11 *Melaleuca cajuputi* closed forest swamp. This community may include occasional mangrove species in landward tidal areas. The fern *Acrostichum speciosum* may occur in the ground layer.

3.12 *Melaleuca leucadendra, M. cajuputi, M. viridiflora* open forest to closed forest, with *Asteromyrtus symphyocarpa* occasionally co-dominant in patches, and *Melaleuca dealbata* sometimes on fringes. Typically forming paperbark swamps on freshwater lowlands.

3.34 *Melaleuca leucadendra* stunted very low open woodland. Occurs patchily on low stony rises adjacent to hinterland mangrove zone.

3.38 *Melaleuca viridiflora* low open forest to low woodland with *Pandanus spiralis, Lophostemon lactifluus* and occasional *Melaleuca cajuputi.* Seasonal swamps are common. On areas subject to shorter periods of inundation, other species including *Terminalia pterocarya, Hakea arborescens* and *Petalostigma pubescens* may occur.

Areas of disturbance and localised mining e.g. sand mining are common.

EUCALYPTUS COMMUNITIES

3.13 *Eucalyptus tetrodonta, E. miniata* open forest. *Erythrophleum chlorostachys* is common in the tree layer. Mid layer includes *Eucalyptus clavigera, E. porrecta, Livistona humilis, Terminalia ferdinandiana and Xanthostemon paradoxus.* Dominant grasses include *Sorghum intrans, Heteropogon triticeus, Chrysopogon fallax* and *Mnesithea rottboellioides.* Understorey shrubs and seedlings vary in height and density with seasonal variation and recent fire history. Occurs on well drained soils on sideslopes, plateau surfaces and undulating rises.

Within this community, stands of vigorous uniform regrowth (*E. tetrodonta and E. miniata*) to 10m tall are found with emergents reaching 17m. This reflects forest recovery from extensive damage sustained during Cyclone Tracy in 1974.

3.14 *Eucalyptus papuana, Pandanus spiralis* open forest to woodland, with *Acacia auriculiformis, Eucalyptus polycarpa* and *Erythrophleum chlorostachys. Melaleuca* spp. may occur as locally co-dominant on fringes of coastal plains. Mid layer species include *Acacia aulacocarpa, Terminalia ferdinandiana, Lophostemon lactifluus* and *Breynia cernua.* Ground layer includes grasses *Heteropogon triticeus, H. contortus, Sorghum intrans, Ischaemum australe* and *Mnesithea rottboellioides.*

3.15 *Eucalyptus tetrodonta, E. miniata* woodland to low woodland. Other canopy trees include *Erythrophleum chlorostachys, Eucalyptus bleeseri* and occasional *E.*

tectifica on shallower soils. Species composition in mid stratum similar to Community 13 but generally denser cover. Grassland ground cover, with a variety of shrubs, herbs and occasional vines. Understorey shrubs, tree seedlings vary in height and density with seasonal variation and recent fire history.

A widespread community closely allied to community 13, varying in density and cover of upper and mid layers, and with generally denser, more varied ground cover.

3.15a Eucalyptus mixed species low woodland, including *Eucalyptus miniata, E. papuana* and *E. polycarpa*. *Pennisetum polystachion* is common in ground cover. Contains disturbed or cleared areas, some poorly degraded.

3.15b Disturbed or degraded Unit 15 woodland to open woodland. Disturbance events include fire and weed impacts following severe cyclone damage, partial or selective clearing over recent history, and networks of trails and tracks. Bare areas are common, with some shrubby regeneration.

3.16 *Eucalyptus miniata, E. tetrodonta, E. bleeseri* woodland to open woodland, with *E. tectifica* as an occasional sub-dominant tree. Commonly sparse mid layer with dense grassland ground cover. Occurs on shallow plateau surfaces, and is allied to Communities 13 and 15.

3.17 *Eucalyptus tectifica* low open woodland, with *E. clavigera* and *Xanthostemon paradoxus* as sub-dominant trees, and scattered *E. polycarpa* emergents. Mid stratum may be absent or if present includes such species as *Buchanania obovata* and *Grevillea decurrens*. Grasses dominate the ground layer, including *Sorghum intrans* and *Eriachne ciliata*, with a variety of herbs and shrubs.

3.33 *Eucalyptus papuana, E. polycarpa, Pandanus spiralis, Erythrophleum chlorostachys*, mixed species low woodland to low open woodland, with *Syzygium suborbiculare* and *Xanthostemon paradoxus*. The grassland/shrubland understorey includes *Eriachne burkittii* and *E. triseta*. This sometimes forms a

transition community adjacent to *Pandanus spiralis* low woodland.

3.39 *Eucalyptus foelscheana* low open woodland with *Pandanus spiralis* and *Xanthostemon paradoxus*. Other upper storey trees include *Eucalyptus tectifica, Erythrophleum chlorostachys, Terminalia grandiflora, Grevillea pteridifolia, Planchonia careya* and *Lophostemon lactifluus*.. Mid layer may be absent, or if present includes *Grevillea decurrens, Livistona humilis, Hakea arborescens, Acacia hemignosta*, and *Melaleuca viridiflora*. A dense grass layer is dominated by *Sorghum intrans*, with *Aristida* sp. and *Chrysopogon fallax*. Other ground layer species include *Petalostigma quadriloculare, Grevillea dryandri, Ampelocissus acetosa, Cartonema spicatum, Flemingia parviflorum, Waltheria indica* and *Helicteres* sp.

This association occurs on bottom slopes and flats with seasonally waterlogged soils and impeded drainage.

3.41 *Eucalyptus atrovirens, E. miniata, E. tetrodonta* woodland to open forest. Species composition in the mid and ground storeys is similar to units 13 and 15, however the presence of *E. atrovirens* in the upper storey distinguishes this association. Occurs on steep sideslopes and rocky hills associated with Mitchell Ck. catchment near Palmerston.

3.42 *Eucalyptus setosa* (one of an alliance of several species) low woodland to low open woodland, with scattered *Eucalyptus clavigera, E. foelscheana Erythrophleum chlorostachys* and *Xanthostemon paradoxus*. Understorey includes *Petalostigma quadriloculare, Sorghum intrans* and *Heteropogon triticeus*.

3.47 *Eucalyptus miniata, E. tetrodonta* woodland with mixed species mid and ground strata including various dry monsoon rainforest species such as *Breynia cernua, Miliusa brahei, Strychnos lucida* and *Vitex glabrata*.

(Patches occur off old Mickets Ck track WNW of Shoal Bay Naval Receiving Station).

LOPHOSTEMON COMMUNITIES

3.18 *Lophostemon lactifluus* mixed species open forest with *Acacia auriculiformis* and *Melaleuca leucadendra.* An interesting transition community with species allied to dry coastal monsoon rainforest present in all strata.

3.19 *Lophostemon lactifluus, Pandanus spiralis* woodland to open forest, sometimes forming closed forest, with *Eucalyptus polycarpa* and *E. alba* emergents. Mid layer may be absent, or if present includes *Pandanus spiralis* and *Melaleuca* spp. Grass layer is generally dominated by *Sorghum intrans* and *Eriachne triseta*, with *Pennisetum polystachion* if near urban areas. A variety of shrubs and herbs are found, often including *Lophostemon lactifluus* regeneration. Common on drainage lines or broad moist flats.

3.20 *Lophostemon lactifluus* mixed species very low open woodland to 5m tall with scattered emergents 10-15m tall. Other species include *Pandanus spiralis, Livistons humilis, Terminalia ferdinandiana, Xanthostemon paradoxus* and occasional *Melaleuca viridflora.* Mid layer is commonly absent, and dominant grasses include *Heteropogon triticeus, Themeda triandra* and *Eriachne burkittii.* Open depressions.

PANDANUS COMMUNITIES

3.21 *Pandanus spiralis* low woodland to very low open woodland, with *Lophostemon lactifluus, Grevillea pteridifolia, Terminalia ferdinandiana* and *Livistona humilis.* Scattered emergents *Eucalyptus alba* and *E. polycarpa* are found on more waterlogged sites. Mid stratum is commonly absent, and ground layer dominants include the grasses *Chrysopogon fallax, Eriachne burkittii, Eulalia mackinlayi, Heteropogon triticeus* and *Pseudopogonantherum contortum*, and sedges such as *Fimbristylis acuminata, F. furva, Rhyncospora submarginata* and *Scleria calicina.*

Typically on seasonally saturated soils occupying broad drainage floors and fringing coastal plains.

RIPARIAN COMMUNITIES

3.40 Lining freshwater streams, a mixed species association forms a narrow vegetation corridor. *Pandanus spiralis* is common throughout, and often grows in pure stands. Other riparian species are predominantly allied to rainforest communities. Common tree species include *Acacia auriculiformis, Barringtonia acutangula, Carallia brachiata, Lophostemon lactifluus, Melaleuca leucadendra, Nauclea orientalis, Syzygium armstrongii* and *Timonius timon.* Found occasionally are trees such as *Calophyllum sil, Canthium schultzii, Diospyros calycantha, Elaeocarpus arnhemicus, Euodia elleryana, Lophostemon grandiflora* and *Terminalia microcarpa.* Vines include *Alyxia ruscifolia; Flagellaria indica, Ichnocarpus frutescens.* and *Smilax australis.*

A variable but typically linear belt of vegetation growing along the edges of seasonal and perennial watercourses.

MIXED SPECIES WOODLAND TO SHRUBLAND

3.22 *Eucalyptus clavigera, E. polycarpa, E. tectifica, Erythrophleum chlorostachys, Pandanus spiralis* mixed species woodland to low open woodland. Other species include *Cochlospermum fraseri, Melaleuca viridiflora, Planchonia careya* and *Xanthostemon paradoxus.* Mid layer may be absent. Various shrubs and grasses are present in the ground layer.

3.23 *Buchanania obovata, Cochlospermum fraseri, Calytrix exstipulata* mixed species very low open woodland/shrubland. Includes grassland areas with dominants including *Sorghum intrans, Heteropogon contortus, Sehima nervosum* and *Pennisetum polystachion.* Regeneration communities with disturbed areas.

HERBLAND/GRASSLAND

3.28 *Murdannia vaginata, Bothriochloa bladhii* closed herbland/grassland, seasonal black soil swamp, with mixed species grasses, sedges and herbs. . Species include *Murdannia graminea, Ludwigia octovalvus,*

Abelmoschus moschatus, Merremia gemella and Cyperaceae spp.

GRASSLAND

3.24 Mixes species grassland, with regeneration low open woodland. Grass species include *Sorghum intrans, Sorghum stipoideum, Eriachne burkittii* and *Heteropogon contortus*. Trees include *Melaleuca viridiflora, Eucalyptus polycarpa* and *Pandanus spiralis.*

May contain areas of clearing or disturbance

3.25 *Sorghum intrans* grassland, with *Yakirra nulla, Mnesithea rottboellioides* and *Aristida holathera.*

3.26 *Plectrachne pungens* hummock grassland with *Eriachne contorta* and *Petalostigma quadriloculare.* Scattered very low open woodland trees include *Buchanania obovata* and *Gardenia megasperma.*

3.27 *Pennisetum polystachion, Eriachne burkittii, Fuirena ciliaris* and *Pseudopogonatherum contortum* closed grassland with scattered low trees.

3.29 *Themeda triandra* closed grassland with scattered very low open woodland. Other grasses include *Heteropogon triticeus* and *Eriachne burkittii*.. Low trees include *Pandanus spiralis, Planchonia careya, Terminalia ferdinandiana* and *Buchanania obovata.*

3.30 *Bothriochloa bladhii, Pseudoraphis spinescens* closed grassland, with *Eleocharis sundaica, E. dulcis, Vetiveria pauciflora, Sorghum stipoideum, Ectrosia agrostoides,* and *Eriachne burkitii.* Seasonally inundated fringes of permanent freshwater lagoons.

(In some areas viz upper tidal reaches of the Howard River, *Oryza rufipogon* may become co-dominant).

3.31 *Ischaemum australe* closed grassland with *Bothriochloa bladhii, Xerochloa imberbis* and sedges including *Fimbristylis littoralis* and *Eleocharis spiralis.* Seasonal freshwater swamp.

GRASSLAND/SEDGELAND

3.32 Closed grassland/sedgeland on coastal plains subject to both saline and freshwater flooding. Species presence and density are determined by depth and duration of inundation and degree of salinity.

In more saline areas *Sporobolus virginicus* grassland is common. On brackish areas *Xerochloa imberbis* is commonly dominant, with other sedges including the tall *Schoenoplectus littoralis, Fimbristylis dichotoma, F. ferruginea, F. rara* and *F. littoralis, Fuirena ciliaris* and *Cyperus difformis.*

Elaeocharis spiralis and *E. dulcis* occur in mostly freshwater depressions, where patches of *Oryza rufipogon* and *Typha domingensis* may also be found.

Common grasses on the slightly elevated landward margins include *Ischaemum australe, Imperata cylindrica, Eriachne burkittii, Bothriochloa bladhii* and *Panicum trachyrachis.* Other grasses include *Pseudoraphis spinescens* and *Pseudopogonantherum contortum,* with forbs such as *Sesbania cannabina* and *Malachra fasciata.*

3.43 *Leptocarpus spathaceus, Sorghum intrans, Sorghum stipoideum* closed grassland/sedgeland with *Xyris complanata* and *Eriachne burkittii.* Scattered emergent trees include *Grevillea pteridifolia, Banksia dentata, Melaleuca viridiflora, Verticordia cunninghamii* and *Asteromyrtus symphyocarpa.* Seasonally inundated freshwater swamps.

3.45 *Fimbristylis pallida* closed sedgeland/grassland with *Eriachne burkittii, Ischaemum australe* and *Sorghum intrans.* Other species include *Pseudopogonantherum irritans, Rhynchospora longisetis, Rhynchospora subtenuifolia, Xyris complanata, Fimbristylis tetragona, Scleria caricina, Utricularia leptoplectra, Eriocaulon* spp. and *Fuirena ciliaris.* Seasonal freshwater swamps.

INTRODUCED SPECIES

3.35 *Senna alata* tall closed shrubland 3-4m tall with *Senna obtusifolia, Crotalaria goreensis* and occasionally *Mimosa pigra.*

3.36 *Pennisetum polystachion* closed grassland, with *Pennisetum pedicillatum.* Other species may include *Andropogon gayanus*, shrub *Aeschynomene americana* and vines *Calopogonium mucunoides* and *Centrosema pubescens.*

3.37 *Leucaena leucocephala* tall closed shrubland to low closed forest, generally in pure stands to 12m tall. *Delonix regia* occurs as co-dominant in some sites.

3.44 *Gmelina arborea* woodland.

MINES AND QUARRIES

3.46 Degraded areas affected by mining activities, including sand, gravel, rock and topsoil extraction. Excavation has resulted in numerous shallow to deep waterholes, the shallower ones creating seasonal swamps which support localised populations of *Melaleuca* and *Grevillea* species. On cleared areas some shrub and small tree regeneration occurs, and includes various *Acacia* species and *Calytrix exstipulata.* Infestations of weeds are common in these degraded areas, with substantial eroded and run-off areas left unrehabilitated.

4.0 RESULTS and DISCUSSION

4.1 Remnant vegetation maps

On completion of the survey and mapping interpretation, the information was digitised and transferred to a GIS (ARC/INFO, Land Resource Survey, Dept. Lands Planning & Environment). Two remnant vegetation maps have been produced: **Darwin Municipality** and **Palmerston to Shoal Bay**, at 1:25,000, with accompanying plant community legend. The maps and data have provided reference material for bushland management projects by several landcare and community groups, including Rapid Ck., Duke St. rainforest, Ludmilla Ck. and Stuart Park.

4.2 Mitchell Creek catchment

A resource assessment and vegetation map of the catchment of Mitchell Ck., Palmerston (Denney and Brock 1995), was compiled for the Stategic Land Use Planning Branch, NT Department of Lands Planning and Environment. This report was prepared as part of Greening Australia NTs input to forward planning in urban bushland management, and has led to the Lands Department utilising the report as a resource document for development of the area.

4.3 Darwin Municipality

The area surveyed for Darwin Municipality and Darwin south region was 15,390 ha, of which 7,556 ha (49%) was identified as remnant vegetation (including mangroves and coastal flats). At first glance this represents a substantial bushland component.

However, this component is greatly reduced within areas of urban concentration. In the cleared areas occupied by suburbs and industrial development, remaining bushland cover is only approximately 10-15%. Significantly, in the Darwin city peninsula (south from Myilly Pt.), only about 20 ha of native bushland remain. (The situation was similar in the built up environment of Palmerston, where very little native bushland has been retained in the suburbs).

Mangrove communities, coastal flats and drainage areas are unsuited to clearing or development due to tidal influences, unstable soils and drainage flows. Mangroves (including salt flats) and adjacent seasonally flooded grassland-sedgelands occupy 3743 ha (50%) of the total native bushland of Darwin Municipality. Major drainage floors, creeklines and vegetation on

low lying landforms, (*Pandanus*, Paperbark and *Lophostemon* communities), occupy 663 ha (8.5%) of bushland.

Taking into account the natural limitations of these landforms, it becomes clear that nearly 60% of the total remnant bushland identified in the Darwin area is immediately unsuitable for concentrated human activities or major development considerations.

Of other remnant vegetation surveyed in Darwin Municipality, eucalypt communities cover 2060 ha (27% of bushland), mixed species woodland about 390 ha (5%), and grassland 205 ha (3%). Without further disturbance, many of these communities are stable and robust. In particular, the eucalypt open forest and woodland on sideslopes and plateaus, provide opportunities for a range of activities which allow for low key interaction at the same time as preserving natural values. Compatible passive recreation includes bushwalking, birdwatching and sightseeing, a feature being the expansive lowland and harbour views afforded from many upland locations. The diverse woodland habitats create ideal situations for naturalist studies and pursuits, without compromising the integrity of the environment.

TABLE 1
REMNANT VEGETATION
DARWIN MUNICIPALITY.

VEGETATION COMMUNITY	AREA (HA.)	%OF ALL REM. VEG.	LAND SUITABILITY. *
•Mangroves	2391.980	31.6	Not
•Eucalyptyus tetrodonta,E. miniata, E. bleeseri woodland.	1198.210	15.9	Yes
•Eucalyptus tetrodonta, E. miniata open forest	743.698	9.8	Yes
•Salt Flats	730.109	9.7	Not
•Grassland/Sedgeland	620.80	8.2	Not
•Pandanus	548.352	7.2	Not
•Mixed Species Woodland	389.162	5.2	Yes
•Monsoon Rainforest	377.074	5.0	Not
•Grassland	204.959	2.72	Yes
•Other Eucalyptus	117.833	1.6	Yes
•Introduced Species	68.218	0.9	Yes
•Lophostemon	58.973	0.8	Not
•Paperbark	55.922	0.7	Not
•Modified monsoon rainforest and regeneration	50.499	0.7	Not
•Total	7555.783	100	

* Land suitability for planning and development
Total remnant vegetation area suitable for planning and development =2721 ha (36%)
Total remnant vegetation area unsuitable for planning and development =4833 ha (64%)
Total survey area = 15390 ha
% of remnant vegetation = 49 %

4.4 Remnant monsoon rainforest

Patches of rainforest occur throughout the Darwin area. Monsoon rainforests of the N.T. are characterised by generally small patch size, fragmented distribution and relatively fire-sensitive vegetation (Russell-Smith 1991). Patches can be grouped into two broad categories - those occurring on wet sites, and those occurring on seasonally dry sites. Canopy cover is generally dense, though seasonally variable on dry sites containing a high proportion of deciduous species.

The flora has strong affinities with the rainforests of tropical northern Australia (Queensland and Western Australia) and the region from India to Papua New Guinea (Liddle et al 1994). Following extensive survey and mapping of the N. T. rainforest resource (Russell-Smith 1991, Liddle et al 1994), over 600 rainforest species are now identified, revealing a rich diversity of flora.

Species composition of the rainforests varies markedly with that of other major vegetation groups of the region. Whilst species mix and populations may vary considerably from one rainforest patch to another, a variety of plant families is represented, from which many genera and species are exclusive to rainforest vegetation. The range of some rainforest species, in particular those more fire-tolerant, extends into the more widespread eucalypt communities. By contrast, no eucalypts and few grasses are recognised as true components of the monsoon rainforests.

A detailed study of the recent changes in rainforest distribution in the Darwin area was undertaken by Panton (1993). He found a dramatic 60% reduction in rainforest area from that existing in 1945. His study identified the major causes of this contraction as urban development, cyclone damage, weed invasion and wildfire, and noted that disturbance of remaining rainforest was continuing. Reinforcing these findings, the current survey has highlighted ongoing encroachment to patches along the Darwin foreshore, particularly the Esplanade and Myilly Pt. cliffs, and potential impact on O'Ferral Rock, previously an isolated rainforest thicket surrounded by mangroves, now connected by land fill with the Bayview Haven development.

All monsoon rainforest should be protected and retained owing to the high conservation and biological values of such vegetation.

4.5 Native vegetation in planning and development

Vegetation holds the soil together, increases moisture infiltration and reduces the volume and velocity of run off. Soil erosion occurs as a natural process, but may be exacerbated by changes in land usage or drainage patterns, or poor land management practices. Undisturbed drainage systems are generally in a state of balance with respect to flow rate and channel size. When catchment systems and drainage lines are vegetated, erosion and siltation are reduced and water flows remain clear.

Sensitively managed natural systems require less regulation and maintenance compared with modified environments. As far as possible, riparian corridors, drainage lines, seasonally inundated areas including freshwater wetlands should retain their natural vegetation cover.

Certain vegetation communities act as buffer zones in the system, stabilising, settling soil and filtering water turbulence in dynamic regions of the landscape.

Future urban and rural planning should aim to maintain natural environments and address the values of remnant vegetation in any proposed developments. Regional planning should incorporate such areas into vegetation corridors which provide public access, link open space avenues, and importantly, maintain viable habitat for native fauna. These corridors should be designed to create natural linkages between districts, in contrast to the current situation where bushland is commonly left vulnerable in isolated remnants.

A comprehensive bushland strategy is needed to assess natural values in a regional context, taking full account of community interests, integrated open space, and existing native vegetation.

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6.0 APPENDIX

Summary of survey sites - Darwin Municipality

6.1 Darwin city cliffs and foreshore

6.1.1 Darwin Esplanade (Smith 1993; site 30).

The area, a strip of coastal cliffs between Doctor's Gully and Government House, was initially surveyed by N. Smith (1993). The vegetation represents coastal monsoon rainforest associated with dry sites (plant community 2), typical of many such coastal patches in the Darwin and northern N.T. region. The canopy consists of both evergreen and a variety of deciduous trees, and a total of 165 species were recorded, including about 40 exotic species, the most prevalent of which are *Leucaena leucocephala* (Coffee Bush) and *Antigonon leptopus* (Coral Vine). Major impacts identified by the 1993 and the current survey are - substantial woody weed invasion, in some places dominating both upper and mid tree layers, tree clearing especially along the cliff tops to afford sea views, rubbish dumping over the cliff face, and ineffectual Coffee Bush eradication programmes where many native species and regeneration are indescriminately removed. Further intrusion and loss of vegetation has occured with the construction of State Square, developmentof the old storage tanks, the lookout and cliff-top clearing associated with Bicentennial Park.

Proximity of coastal rainforest habitat to the Darwin CBD provides a unique situation for easy access and appreciation; high species diversity with prominent Banyan trees, Rock Figs and Bamboo add to the overall attraction. Valuable urban bushland, provides green corridor (albeit interrupted) from wharf area to Cullen Bay. Fauna habitat and refuge, including active Scrubfowl. High educational and recreational value, especially dense vegetation of Lameroo Beach (on National Heritage Listing?). Historic connections to early Darwin settlement and wartime activities (storage tunnels); strong links with local Aboriginal people.

Other features: seasonal waterfalls and seepage, splendid views over the harbour, prominent cliffs and rock faces, caves, green buffer against urban environs, seasonal changes e.g. deciduous species.

6.1.2 Kitchener Dve., Wharf Precinct Area (site 19)

Steep coastal cliffs beside Kitchener Dve. Plant community 2. General impacts as for 1.1.1 with severe erosion, woody weed invasion including *Delonix regia* (Poinciana), and erratic clearing/weed eradication.

Vegetation features - one large Banyan tree and one outstanding Milkwood tree about 14m high and 15m spread (on upper cliff slope near corner with Esplanade). Seasonal waterfall in small gully. Wartime tunnels at base of cliffs.

Much smaller area than the Esplanade cliffs but worthy of protection as part of foreshore corridor.

6.1.3 Doctor's Gully (site 28)

Very steep rocky cliffs forming horseshoe-shaped gully at rear of Aquascene (fish feeding). Plant community 2. Established woody weeds are dominant and include Coffee Bush, *Delonix regia* (Poinciana) and *Spathodea campanulata* (African Tulip) to 20m tall. The gully is in a badly degraded state with severe erosion compounded by an exposed stormwater drain discharging over the steep unprotected cliff face. There is extensive household and garden dumping over cliff edges from surrounding houses (Larrakeyah Tce., Packard St. and Mitchell St.) An offensive smell was present, probably from overflow from sewerage treatment plant on Mitchell St, combined with substsantial debris collected along creek line at the base of the gully.

Two outstanding trees, a Banyan and a *Maranthes corymbosa* are growing at the rear of the YWCA. One Milkwood on Sig. Tree Reg. (No. 100, Lot 5246). Seasonal and perhaps permanent seepage occur. *Artocarpus glauca* (seedling) recorded from site - not an uncommon rainforest species, but not common on Darwin foreshore (also found at Lee Pt. area) and indicative of moister sites.

The area requires major cleaning, weed eradication and rehabilitation to protect the vegetation and restore the habitat.

6.1.4 Larrakeyah Tce (site 29)

Coastal cliffs abutting Larrakeyah Tce. Substantially modified coastal rainforest vegetation (community 4) now largely cleared and overtaken (70-80%) by exotic Coffee Bush, which is also regularly cut at the cliff tops to afford sea views. In some places lawns and household gardens extend to cliff edges and garden rubbish is dumped over edges.

Several Banyan trees occur at intervals along the cliffs, in particular one site at eastern end of cliffs where 3-4 large Banyans cloak the cliff face and create a beautiful site (Sig. Tree Reg. No. 49).

6.1.5 Larrakeyah Military Barracks (site 24)

Coastal cliffs from end of Larrakeyah Tce. to southern end of Cullen Bay (Temira Cresc.) Vegetation community 2. Vegetation at southern side of Cullen Bay is generally in good condition, with Banyan and *Acacia auriculiformis* (Black Wattle) dominant in the upper layer, *Ficus platypoda* (Rock Fig) and *Myristica insipida* (Native Nutmeg) dominant in the mid layer, and a variety of other mid and ground layer species present. Heavy infestations of Coffee Bush and grassy weeds occur at some sites along the cliffs. Most of the cliff face is used for general household rubbish dumping.

Value as fauna habitat, corridor linkage, scenic and aesthetic qualities as for 1.1.1.

6.1.6 Myilly Pt. (site 25)

Substantial loss of vegetation and habitat has already occured with the development of the Cullen Bay Marina. Roadworks, clearings and restructuring of the area have severely impacted on the viability of the remnant vegetation.

Plant community on remaining cliffs from Cullen Bay breakwater to Gilruth Ave. is modified coastal rainforest vegetation (community 4) dominated by Coffee Bush (about 50% of upper layer) and Coral Vine. In some areas Coffee Bush forms mono-specific closed forest communities, whilst Coral Vine dominates the ground layer and smothers many shrubs and small trees. Recent clearing and tracks are causing erosion on the high areas; rubbish dumping over the cliff faces has occured.

Major weed eradication, long term rehabilitation and cleaning is required to restore the area to good condition.

6.2 Darwin city environs

6.2.1 Cnr. of Duke St. and Dinah Beach Rd. (site 21)

Small gully supporting a patch (less than 1ha) of coastal rainforest associated with permanent moisture (vegetation community 1). Evergreen closed community with several outstanding *Syzygium armstrongii* trees to 20m tall, and a very interesting combination of species, including *Euodia elleryana*, mature *Carpentaria acuminata* palms and the shrub *Leea indica* which are indicators of permanently moist habitats.

Substantial weed infestation is present, including Poinciana, Coffee Bush and Mango trees, date and fishtail palms, vines and grasses such as *Panicum maximum* on the margins. Rubbish dumping is severe, both on the margins and inside the patch, especially along the creek line and via the road culvert drain. Erosion is evident at the margins. Industrial waste such as oil and grease is very likely being discharged into the patch from the nearby Tour Bus Depot via the stormwater drain on Duke St.

Of historical interest is roofing iron embedded in one tree from the effects of Cyclone Tracy.

Despite its small size, intrusion on all exposed margins, weed invasion and rubbish dumping, the patch has maintained its viability, with high regeneration of woody species, and has good potential as both an educational and recreational resource. The *Syzygium armstrongii* trees are certainly the largest in the Darwin area, and together with *Leea indica* are uncommon locally, well worthy of protection in their own right. The patch is unique in the Darwin city environs as a spring fed rainforest community.

The land is owned by Darwin City Council, currently with unprotected tenure (O1 Open Space), and should be rezoned and managed to provide maximum conservation.

6.2.2 Dashwood Cresc. (site 23)

Small patch of eucalypt woodland (vegetation community 15), the tree layer dominated by *Eucalyptus tetrodonta* (Stringybark). Of

interest are several understorey shrubs and trees which are associated with dry coastal rainforest communities, e.g. *Sterculia quadrifida* (Peanut Tree) and *Antidesma ghaesembila* (Blackcurrant Bush). Severe infestation of weeds in ground layer - grasses *Panicum maximum* and *Pennisetum polystachion* (Mission Grass) and the vine *Clitorea ternatea.*

Though small in area it is one of the few remaining eucalypt communities in the Darwin city environs, and could be joined with nearby patches 1.2.3 and 1.2.4 as a corridor linking Dashwood Cresc. gully and the southern margin of the Gardens Golf Course.

6.2.3 Cnr. Dashwood Cresc. and Gardens Rd. (site 22)

Rocky slope and nearby gully. Small patch of modified vegetation (community 4) dominated by Coffee Bush, with mixed species associated with coastal dry rainforest. Several good specimen trees of Black Wattle and *Carallia brachiata*, and one interesting Rock Fig. The area is very disturbed and heavily invaded by weeds, however could be rehabilitated, including gully area and linked to nearby patches (see 1.2.2).

6.2.4 Gardens Park Golf Course nr. Beagle St. (site 26)

Slope overlooking southern part of Gardens Park Golf Course. Small patch largely modified vegetation (community 4), with mixed species generally associated with coastal dry rainforest. Ground layer dominated by weeds - grass *Panicum maximum* and vines *Centrosema pubescens* and ?*Mucuna* sp. Some established exotic *Phyllanthus emblica* (Indian Gooseberry) trees in the area. Nearby northern end of patch is a closed community of Coffee Bush.

One outstanding Banyan tree adjacent to patch (Sig. Tree Reg. No. 134). Potential for upgrading as green belt - refer 1.2.2.

6.2.5 Tiger Brennan Dve. opp. Frances Bay Mooring Basin

Patch of hinterland mangroves and mixed species (vegetation community 9). Mainly mangrove *Lumnitzera racemosa*, with weed Coffee Bush. Along moist drainage line is the weed *Senna alata* (Candle Bush), plus small clump of native *Typha* sp. (bullrush)

possibly indicative of source of permanent freshwater. Landfill on northern margin of patch.

6.2.6 One Mile Camp

Aboriginal community near Dinah Beach Rd., beside a large permanent dam. The vegetation does not really constitute remnant bushland, however the area supports a pleasant grove of trees, consisting mainly of *Acacia auriculiformis* (Black Wattle) and *Melaleuca cajuputi*. *Typha* sp. is also growing here. Severe infestation of *Brachiaria mutica* (Para Grass) occurs in moist overflow drainage area below dam.

6.3 Stuart Park

6.3.1 One patch was located adjacent to and east of Stuart Park Primary School, bounded by Ashley St. to the south and Woolner Rd. to the east. This area consists of an intertidal habitat with both mangroves and freshwater elements. The mangroves, including species such as *Lumnitzera racemosa* and *Avicennia marina*, are representative of the landward zone of the Darwin harbour mangrove complex, and are connected (via Tiger Brennan Drive) to the mangroves of Frances Bay. At the rear of the mangroves, a freshwater source supports a small monsoon rainforest association, this interface between saline and freshwater habitats being of special interest and unique to the Darwin peninsula.

The modified rainforest (community 4), however small, includes such species as *Carpentaria acuminata* (Carpentaria palm), *Terminalia microcarpa*, *Syzygium nervosum*, *Polyalthia australis* and *Myristica insipida* (Native Nutmeg), all typical of spring-fed habitats. Another species associated with freshwater, *Pandanus aquaticus*, has also been identified. Several exotic plants were found in the patch including African Tulip (*Spathodea campanulata*), and nearby, dense stands of Coffee Bush (*Leucaena leucocephala*) and Para Grass (*Brachiaria mutica*), a wetlands grass weed, have established. Such intrusion indicates habitat disturbance and highlights the need for rehabilitation of such sites.

6.3.2 Another patch was situated adjacent to and east of the NT Fleet buildings on the corner of Armidale and Iliffe Sts. overlooking Woolner Rd. to the east. The site is a steep upper

slope, covered with a healthy stand of eucalypt woodland reaching 14m in height, the canopy dominated by the local trees Stringybark (*Eucalyptus tetrodonta*) and Woollybutt (*E. miniata*). A varied understorey included Sand Palms (*Livistona humilis*) and Cycads (*Cycas armstrongii*), and the strong presence of Black Wattles (*Acacia auriculiformis*) in the mid layer indicated minor impact from recent fires. Several plants associated with monsoon rainforest thickets were located, adding diversity to the patch. A stand of paperbarks (*Melaleuca leucadendra*) was found nearby on the lower slopes. The site was in healthy condition, with minor disturbance or weed invasion within the patch boundaries; however to the east and south, severe infestations of Coffee Bush have established on previously disturbed sites.

6.4 Bullocky Hill (site 34)

Largely modified community (community 4) on sloping hillside, dominated by exotic tree *Pterocarpus indicus* (about 40-50% of canopy) with *Albizia lebbeck* as sub-dominant. *Sterculia quadrifida* and Bamboo are common in the understorey, with a diversity of other rainforest shrubs and trees (37 native species recorded). Between clumps of trees the area is mown and criss-crossed with grassy tracks leading to and from Darwin High School, creating a park-like effect and retarding much of the potential regeneration. Other exotic trees present include *Samanea saman* (Rain Tree) and *Cassia fistula* (Golden Shower Tree). Localised rubbish dumping.

Cliffs are a feature and at western end provide ocean views. High potential but requiring serious weed eradication and management program to restore patch to natural condition.

6.5 Bayview Haven

Most of the original vegetation and habitat has been removed during the Bayview Haven Estate and Marina development.

6.5.1 Gully on western side of Haven (site 75)

Small steep-sided gully supporting patch of rainforest (community 2). Trees are few and include Banyan, *Terminalia microcarpa* and *Myristica insipida*, with understorey species such as *Elaeocarpus arnhemicus*, *Drypetes lasiogyna* and *Strychnos lucida*, and vines *Pachygone ovata* and *Capparis sepiaria*. Ground

layer especially on margins has severe infestation of Mission Grass, and patch is severely damaged by fire and plant loss. Viability of patch very tenuous.

6.5.2 Frances Bay Explosives Storage Area Historic Site (site 33)

Slopes on western side of Haven, supporting *Lophostemon lactifluus* mixed species open forest (community 18). An interesting plant community with a variety of species, particularly in the ground layer, associated with coastal rainforest, e.g. shrub *Allophyllus cobbe*, yam *Dioscorea transversa* and ground orchid *Geodorum neo-caladonicum*. Mission Grass weed dominates the ground layer; damage from dry season fires is evident.

Good wildlife habitat and corridor linkage (although adjacent mangroves have been substantially cleared). Area could be further utilised for both educational and recreational purposes. Explosives Complex historic area on National Estate Register (ref Dames and Moore PER July 1990, p. 28). Delightful view overlooking mangroves and Frances Bay to Darwin harbour.

6.5.3 O'Ferral's Rock (site 48)

Rocky hill previously surrounded by mangroves, supporting rainforest thicket (community 2). Land fill associated with Bayview Haven marina development now connects western side of hill to mainland.

Small but quite diverse vine thicket community; about 45 native species recorded from site, including *Notalaea microcarpa* and *Allophyllus cobbe*. The dominant trees, about 10m high, are well separated, which, along with several fallen trunks, indicates substantial past storm and cyclone damage. The crown of the hill is covered in dense thicket 2-3m high consisting of vines and tree and shrub regeneration. (3 young exotic *Khaya senegalensis* (African Mahogany) trees were recorded, the seed presumably introduced by passing birds).

Distinctive rocky outcrop affording 360 o views from crown. Unusual relict rainforest habitat which should be preserved from further impact. Probably of historical significance? Previous isolation and protection from fire has now been compromised by

land connection, and may lead to disturbance and gradual degradation.

6.6 East Pt. Reserve

6.6.1 East Pt. rainforest

Fine example of coastal monsoon rainforest associated with dry sites (community 2). A community of high species diversity, a current checklist documents well over 100 species (R. Booth C.C.N.T. 1994). This area is already extensively utilised for bushwalking, birdwatching, educational activities and biological studies. Populations of Agile Wallaby and the Orange Footed Scrub Fowl inhabit the area and provide a wildlife feature for many locals and tourists.

However substantial infestations of woody exotics especially Poinciana and Coffee Bush are present, as well as many herb and grassy weeds.

6.6.2 Mangrove Boardwalk

Healthy population of mature Sandalwoods (*Santalum album*) beside pathway. Not rare but locally uncommon and these trees probably represent the largest population in the Darwin environs.

6.7 Gwalwa Daraniki Association Lease (Kulaluk) (sites 39-47)

Together with parts of the East Pt. peninsula and the tidal reaches of Ludmilla Ck., the Kulaluk lease area forms a more or less continuous bushland corridor from East Pt. to the southern suburbs of Nightcliff. A variety of habitats are found in this region which provide valuable protection for wildlife. Communities include beaches and foreshore dunes, coastal monsoon rainforest, mangroves, saltpans, woodland and grassy flats.

6.7.1 Coastal rainforest. Good example of dry coastal monsoon rainforest with some moister areas supporting trees and palms to 20m tall. Fine specimens of such species as *Albizia lebbeck*, *Bombax ceiba*, *Mimusops elengi*, *Ganophyllum falcatum* and *Terminalia microcarpa*. On drier sites the canopy is 10-12m tall and occasionally interrupted with exotics such as Poinciana. Midlayer growth and regeneration are generally high.

However substantial areas, including previous rainforest habitat, have been invaded by Coffee Bush, which in some cases form dense closed communities to the exclusion of all other vegetation. Other areas of severe Coffee Bush infestation occur on the margins of rainforest and shrub-grassland areas.

Other major weeds of this area are *Pennisetum polystachion* (Mission Grass) and *Pennisetum pedicillatum* both of which are present in dense infestations on open grassy flats, beside tracks and moist areas.

Areas north of Minmarara settlement have been previously cleared and now support a mixture of grassland-shrubland and low scattered woodland with dense grass layer. Narrow bands of hinterland mangroves and mudflats occur, cut by several man-made drains. A small grass-sedge swamp (site 42) occurs on the western side of Dick Ward Dve. near the Totem Rd. cnr., and provides a seasonal swamp habitat with surrounding seasonally inundated soil supporting numerous *Crinum* lilies in the wet season.

Kulaluk lease has a variety of habitats and vegetation communities, and with low density housing and population, is a valuable area for protection and movement of flora and fauna. However major problems are present with weed infestations and areas of degradation, and a comprehensive community-based management program would be highly desirable for long term rehabilitation.

6.8 "Correctional Services Block"

6.8.1 Substantial area of upland country (owned by N.T. Government) bounded on the north by Tiger Brennan Dve. and by mangroves on all other boundaries. Includes plateau surfaces, steep sideslopes, lower slopes, drainage floors, and intermarginal areas bordering mangroves. A few buildings currently used by Dept. of Correctional Services for guard-dog training are located in the northern area (near Tiger Brennan Dve.), while several disused bunkers are situated throughout the area linked by a network of sealed and unsealed tracks. A boundary track skirts the area just above high tide level.

Besides current low level government use, the area is uninhabited and provides relatively in tact habitats particularly with regard

to woodland environment. The connection with the mangroves secures protection for the transition from tidal to intertidal regions and provides a corridor for both flora and fauna. (Weed control and rehabilitation along the boundary track is required for future management.)

This area forms an extensive continuous tract to the east with the Hidden Valley and Rifle Range plateaus, slopes and drainage floors (see 1.9), and should be maintained as far as possible as natural bushland reserve.

Plateau surfaces, generally stony to rocky ground with cover of eucalypt woodland commonly including *Eucalyptus bleeseri* as co-dominant (plant communities 15 & 16), sometimes ranging to eucalypt open forest. A feature of these sites is the elevated open aspect commonly giving rise to wonderful views of the inner harbour, mangroves and occasionally Darwin city.

Site 61 on the rocky edge of a plateau surface represents a very small but interesting patch of stunted regenerating monsoon rainforest species allied to Community 2. Fire has reduced most of the species present to less than 2m tall, though trees, shrubs and vines continue to survive, and include Glochidion xerocarpum, Cupaniopsis anacardioides, Sterculia quadrifida, Bridelia tomentosa, Pachygone ovata and Dioscorea transversa. Fragile tenuous fragments highlight ongoing loss of rainforest habitat under current land management practices.

Steep sideslopes below plateau support mostly eucalypt open forest (Unit 13) with vigorous Woollybutt and Stringybark regrowth to 10-12m high and scattered emergents to 17m high. The uniform growth and height presumably represent the regrowth since the devastating effects of Cyclone Tracy in 1974, where only the current taller trees were left standing. These communities are consistent throughout the survey area and form impressive examples of their type; closely spaced trunks often feature, especially where the Woollybutt is the local dominant.

The open forest tracts stand out as representative of the community, the dominant eucalypt community across northern Australia, and while subject to regular fires and minor disturbance, are worthy of long term protection. Further they provide a suitable open environment for nature trails and passive open space activities, and enhance the urban fringes with natural bush characteristic of the region. The steep sideslopes are

vulnerable to erosion and disturbance and are stabilised by the vegetation cover.

At site 62, on lower footslopes on the southern side of the area, an interesting prostrate vine, *Dendrolobium* sp. (ref. A7716 N.T. Herbarium), was identified as a co-dominant in the ground layer vegetation. Recorded previously from the Pine Ck. and Litchfield Park areas, it is uncommon in the Darwin Municipality.

Near site 63 on south-eastern bottom slopes, a White-breasted Sea Eagle was sighted with nest perched in tall *Melaleuca leucadendra* tree adjacent to fringing mangroves.

Located on the eastern side of the 'block' (site 54 and 54a) is a permanent billabong fed by a seasonal creek, which forms small pools just upstream of the billabong. A Paperbark and Black Wattle forest surrounds it, with mixed rainforest vegetation in the understorey, including *Carallia brachiata*, *Euodia elleryana*, *Elaeocarpus arnhemicus* and *Melastoma affine*, with occasional *Carpentaria acuminata*. Exotic species occur as co-dominants in the upper layer (*Phyllanthus emblica*) and mid layer (*Mimosa pigra*), and Mission Grass is dense in the grassy margins. Removal of exotics, fire management and protection could restore this area to a healthy natural habitat.

6.8.2 Hinterland 'island' (site 49)

Slightly elevated land approx. 0.5 kms south of uplands area, surrounded by mangroves and salt flats. Gravelly soil with rocks on surface. Dry coastal monsoon rainforest thicket (Unit 2) covers the site, with somewhat open canopy to 10m, thicker understorey 5-7m, and dense tangled ground layer dominated by vines *Flagellaria indica* and *Capparis sepiaria*. Upper layer co-dominants are *Mimusops elengi*, *Acacia auriculiformis* and *Sterculia quadrifida*. *Strychnos lucida*, *Croton arnhemicus* and *Canthium* sp. D55756 (ref. Darwin Herbarium) are co-dominants in the mid-layer, while *Diospyros calycantha*, *Flacourtia territorialis*, *Premna odorata*, *Allophyllus cobbe* and *Vitex acuminata* are also present. Vines are dominant in the ground layer.

Limited weed outbreaks of *Lantana camara* are present, with minor *Pennisetum pedicillatum* and *Hyptis suaveolens* on the

margins. No fire damage was apparent, likewise disturbance from other factors was minor or absent.

Isolation and separation from dry mainland habitats have provided long term protection for the patch from fire and intrusion, at the same time giving good fauna habitat.

6.9 Hidden Valley complex (including Rifle Range area)

6.9.1 Very small rocky gully on eastern side of Rifle Range plateau (site 66, area approx. 500 sq. m). Dry monsoon rainforest pocket, with Banyans, Myristica insipida, Black Wattles and Calophyllum sil. 32 species were recorded. Severe fire damage was evident, with few (15-20) mature trees and struggling regeneration, and weedy grasses in lower part of patch and on margins. Another example of a tenuous rainforest patch dotted amongst the more widespread woodland.

6.9.2 The stands of eucalypt open forest on the sideslopes are of generally high quality and should be regarded as with comments in 1.8.

6.9.3 An extensive plateau dominates the eastern side of the region, largely covered with eucalypt woodland. Tracks and small scrapes are generalised over the surface, with sporadic household rubbish dumping. Much of the plateau edge affords pleasant outlooks, with particularly beautiful views from the south-western area overlooking the valley, mangroves and Darwin Harbour to the west.

6.9.4 The drainage creek begins near the Stuart Highway / Amy Johnson intersection, and flows to the south west into Reichhardt Ck. Severe weed infestations, especially dense swathes of Mission Grass and *Pennisetum pedicillatum*, occur beside the upper reaches and side arms of the creek. Along the creek line itself, *Pandanus spiralis* is dominant with associated *.Lophostemon lactifluus*, with scattered *Acacia auriculiformis*, *Euodia elleryana*, *Timonius timon* and *Melaleuca viridiflora* also present. Lower slopes adjacent to the creek are dominated by mixed *Pandanus spiralis* communities.

6.9.5 Several small industrial businesses are located along Farrell Cresc., Winnellie, which back onto a series of cliffs and gullies sloping down to the upper western reaches of the creek. **Extensive industrial waste especially car bodies and**

scrap metal has been dumped along and over the cliff edges, often beyond the boundaries of the lots, and in one instance car bodies form a large land fill at the head of one gully. Weed invasion is severe in all these gullies, and includes Coffee Bush, Mission Grass, Calopo, *Panicum maximum*, *Centrosema pubescens*, and occasional Poinciana and *Gmelina arborea* trees. Outside the disturbed and eroded areas, the upper sideslopes are covered with healthy stands of eucalypt open forest.

6.9.6 Coastal monsoon rainforest (site 84)

Slightly elevated 'island' thicket east of Reichhardt Ck. and west of Explosives Storage Reserve (Por. 1591 to 1596), surrounded by mangrove tidal flats. Dense rainforest thicket mostly 5-6m tall with occasional emergents such as *Mimusops elengi*, *Melaleuca leucadendra* and *Acacia auriculiformis* to 10m high. Dominant in the tree layer are *Dodonaea platyptera*, *Drypetes lasiogyna* and *Glycosmis trifolia*, with vines *Flagellaria indica*, *Ziziphus oenoplia* and *Alyxia spicata* prominent. 55 species were recorded, and tree regeneration was high. Protected and isolated, the patch showed little evidence of impact from fire, weeds or human disturbance. In the Darwin South project area, this is the largest of three such 'islands' in the mangrove hinterland supporting rainforest vegetation; all should be protected from potential encroachment.

6.9.7 *Melaleuca cajuputi* closed forest swamp (site 93), south of Hidden Valley Speedway and adjacent to mangroves of upper reaches of Bleesers Ck. (south west of 4WD Club). Dense seasonally inundated Paperbark forest to 14m tall, predominantly one species *M. cajuputi*, with occasional *Avicennia marina*, *Lumnitzera racemosa* and *Melaleuca argentea*. The ground cover is dominated by the fern *Acrostichum speciosum*. No impact from fire, weeds or disturbance was evident. An uncommon habitat for the region offering potential refuge for such animals as flying foxes and rodents, providing as well a protective buffer between the mangroves and the landward communities.

6.10 Berrimah south - TDZ area

6.10.1 Plateau and slopes south of Berrimah Farm. The plateau supports eucalypt community (Unit 16) including co-dominant *E. bleeseri*, probably the best representation of its type in the Darwin area, while high quality eucalypt open forest (Unit 13)

covers much of the surrounding slopes. Rubbish dumping occurs in localised sites. A small dump containing mostly farm type refuse mars the environment; the origin of the rubbish would appear to be Berrimah Farm.

6.10.2 (Site 89 and surrounds). Much of the higher ground surrounding the TDZ supports mixed eucalypt woodland to open woodland; fire impact is commonly severe, particularly with damage to ground layer vegetation. Undulating landscape to the west of the TDZ includes several small hills which afford pleasant outlooks and elevated views over the nearby mangroves and harbour.

6.11 Knuckey's Lagoons (site 94). A wonderful aquatic environment providing habitat and refuge for birdlife, snakes and rodents; vegetation includes aquatic plants, fringing grasses and sedges, and *Pandanus* clumps. String of permanent swamps seasonally connected depending on wet season topup. High recreation and birdwatching value. High probability of surrounding grasses (including Mission Grass) on higher ground being annually burnt.

6.12 CSIRO grounds, McMillan's Rd. (sites 16 & 17). These areas of high quality eucalypt open forest (community 13) have been fire protected for approximately 15 years (D. Braithwaite pers. comm.). At site 16, the mid layer to 6m tall was the dominant layer in projected foliage cover (60%), under sparser upper layer emergents to 17m tall, presumably a reflection of vigourous regrowth since Cyclone Tracy damage in 1974. Minor occurrence of exotics and low density of canopy regeneration in the ground layer were recorded, markedly less than other comparative sites. *Acacia auriculiformis*, a rainforest species, was present as seedlings in the ground layer and co-dominant in the mid layer, a situation unlikely to occur in a fire prone habitat. Leaf litter covers of 50-60% were much higher, often double those of other open forest sites. This area provides a good wildlife habitat, where approximately 30 reptile species including Carpet Snake have been recorded (N. Gambold pers. comm.).

6.13 Holmes Jungle Nature Park and environs
The Park is managed by the Conservation Commission of the N. T.

6.13.1 Monsoon rainforest (site 1, community 1). The largest wet rainforest patch of its kind in the Darwin area, sustained by spring fed Palm Creek which drains into the Leanyer Swamp flats. An outstanding jungle dominated by evergreen species including *Syzygium nervosum*, *Calophyllum soulattri* and *Horsfieldia australiana*, with large populations of *Carpentaria acuminata* and *Livistona benthamii*. Ferns dominate the ground layer, with such species as *Stenochlaena palustris* and *Piper novae-hollandiae*. Canopy cover and ground leaf litter cover are both very dense (90-100%), and combined with flowing water create a lush fertile environment. Fire intrusion was evident in localised but intense occurrences, resulting in occasional tree death. Intense late dry season fires fuelled by dense grassy swathes on the margins were encroaching inside the rainforest boundaries.

6.13.2 The western slopes of the Park are predominantly covered with eucalypt woodland (community 15), while denser open forest (community 13) forms along the upper slopes. At site 8, located on a gravelly slope, a particularly good population of *E. tetrodonta* open forest was recorded, and though regular fire effects retarded most woody regeneration to heights less than 2m, a total of 35 species was recorded on the ground layer.

6.13.3 Mission Grass is a common dominant or co-dominant component in much of the drainage and seepage areas in the Park, and provides abundant fuel mass in the event of late dry season fires. Control of this weed is of high priority in overall fire management of the Reserve.

A severe infestation of *Senna alata* (Candle Bush) was located along a stormwater drain on the western boundary of the Park, presenting a potential threat to downstream vegetation. Park management was notified and the site was inspected.

6.13.4 Drainage lines to the west of the rainforest support *Lophostemon* communities, amongst which several species allied to rainforest communities are found in the understorey.

6.13.5 The eastern lower slopes and depressions, commonly with seasonally waterlogged soils, are covered with a tract of mixed *Pandanus* woodland, with *Grevillea pteridifolia* and a dense grass/sedge ground layer. The source and upper reaches of Palm Ck., mostly outside and south of the Park, are lined with *Pandanus spiralis* forest and woodland.

6.14. South, south-east and east of Holmes Jungle Nature Park (Sects. 4328, 109, 118, 119)

This area should be considered with the Nature Park as part of a broader management plan to include the natural catchment of the landscape encompassing the creek and rainforest habitats.

6.14.1 A large tract of eucalypt open forest (community 13) occurs on the plateaus, side slopes and gentle slopes surrounding the Park.

6.14.2 Sec. 119 (site 14). Transition patch of *Acacia auriculiformis* open forest on seepage area on lower slope. This interesting isolated patch has a variety of rainforest species present in the mid and ground layer vegetation, including *Carpentaria acuminata*, *Terminalia microcarpa* and *Tarenna dallachiana*. Of note is a grassy herb recorded as co-dominant in the ground layer; it was not readily identified, and may be of botanical interest. Weeds were common, and Mission Grass in particular was dense on the patch margins. Fire impact was severe including tree death.

6.15 Leanyer Swamp

Much of this land is under RAAF tenure and includes the old bombing range north of Shoal Bay Dump.

6.15.1 Low-lying area between Buffalo and Micket Cks., marked by extensive salt and mud flats, which enclose an expanse of closed grassland/sedgeland community. Parts of the grassland/sedgeland were still moist at the time of the survey, but substantial areas were severely burnt, and nearby *Pandanus* woodland with Mission Grass understorey were subject to severe probably annual fires. Near Site 95, an Eastern Grass Owl was sighted, which is uncommon in the Darwin area (J. Woinarski pers. comm).

6.15.2 Environs of Shoal Bay Waste Disposal Dump - slightly elevated rise sloping on most sides to low-lying grassland/sedgeland. Tract of degraded and disturbed land with mostly regeneration low open woodland to shrubland. Common scattered species include *Buchanania obovata*, *Calytrix exstipulata* and *Cochlospermum fraseri*. Fire effects were severe, tracks and scattered clearings were recorded, and areas external to the main dump were used as dumping.

6.16 Lee Pt. - Buffalo Ck. area

6.16.1 A belt of coastal monsoon rainforest (community 2) stretches along the western margins of the Buffalo Ck.mangrove community. Deterioration has occurred through invasion of grassy weeds and fire damage.

Part of this belt, (a patch just north of the Leanyer Treatment Ponds), is currently under a protection and rehabilitation program with the Leanyer Landcare Group (ref. .....). The tree *Berrya rotundifolia* located in this patch represents an uncommon species for the Darwin region. Extensive swathes of Mission Grass occur in this area and present major fire management problems.

Slightly separated to the west of the Buffalo Ck. rainforest belt, another small patch (site 88) includes a healthy population of *Carpentaria acuminata* palms, and is dominated by *Acacia auriculiformis*, *Carallia brachiata*, *Lophostemon lactifluus* and *Melaleuca viridiflora*. A protected moist habitat, surrounded by a band of mainly *Melaleuca viridiflora*.

6.16.2 Disturbed mixed eucalypt woodland (community 15a) south and north-west of the Leanyer Sewerage Treatment Ponds. Scrapes and clearings are common in these areas, as are tracks, trail-bike paths and eroded sites. Mission Grass is widespread and commonly dominant on the ground layer; subsequent fires are hot and destructive. Household rubbish is scattered throughout.

These degraded communities represent areas subject to various unrestricted recreation and convenience uses by adjacent urban populations.

6.17 Casuarina Coastal Reserve

An extensive coastal tract under the management of the Conservation Commission of the N. T., and subject to the Casuarina Coastal Reserve Management Plan, 1991. A detailed vegetation map was prepared as part of the management plan, which describes the vegetation of the Reserve as a "valuable resource for scientific flora study, education and interpretation". Significant coastal monsoon rainforest (community 2) is found in