Technical Memorandum 46

Vegetation communities of five Magela Creek billabongs, Alligator Rivers Region, Northern Territory

CM Finlayson, K Thompson, I von Oertzen and ID Cowie

Supervising Scientist for the Alligator Rivers Region

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Abstract

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The major vegetation communities in three backflow (Coonjimba, Djalkmara and Georgetown) and two floodplain (Jabiluka and Leichhardt) billabongs are described. The descriptions are aided by the presentation of vegetation maps prepared during the 1987–88 Wet season. All macrophytic plant species known to occur in each billabong are listed and categorised into growth-strategy and growth-form types. The plant biomass (assessed qualitatively) in the backflow billabongs was dominated by the fringing perennial *Melaleuca* spp trees and the geophytic perennial *Eleocharis* spp sedges. The floodplain billabongs are deeper, have steeper banks than the backflow billabongs and have a narrower woodland fringe. A feature of the floodplain billabongs over the study period was the presence of floating mats of grass, sedge and herb species, that also contained the introduced floating fern *Salvinia molesta*. Forty-five plant species were recorded in Coonjimba Billabong, forty-three in Djalkmara, Georgetown thirty-six, Jabiluka forty-four and Leichhardt forty. The vegetation in the backflow billabongs has changed since buffalo numbers were reduced, with sedges becoming more widespread. This in turn appears to have led to an increase in silt deposition in these billabongs. At times, mats of *Salvinia molesta* have completely covered the surface of the floodplain billabongs.

Vegetation communities of five Magela Creek billabongs, Alligator Rivers Region, Northern Territory

Introduction

Interest in the Magela Creek and flood plain has risen since the discovery of uranium in the catchment in 1969, the commissioning of the Ranger uranium mine in 1980, and the inclusion of the flood plain within the World Heritage listed Kakadu National Park in 1984. It was envisaged that operating procedures at the Ranger mine may need to include release of waste water to Magela Creek, so a program to collect ecological information (such as description of species and population studies) was undertaken in the creek and billabongs near the minesite and on the flood plain.

Magela Creek is located within the area referred to by Fox et al (1977) as the Alligator Rivers Region (ARR) in northern Australia, about 250 km east of Darwin (fig 1). The creek is a seasonally flowing tributary of the East Alligator River and consists of five distinct sections: escarpment channels flowing through deep narrow gorges, braided sandbed channels with sandy levees, a series of billabongs and connecting channels, a seasonally inundated black-clay flood plain with permanent billabongs, and a single channel that discharges into the East Alligator River. In the context of the ARR, billabongs are pools or lagoons in or near the creek channel rather than the more conventionally defined ox-bow lakes. Walker et al (1984) categorised the billabongs of Magela Creek (see fig 2 for their location) into channel billabongs (depression in flow channels), backflow billabongs (located on small tributaries and filled initially by water from the main creek) and floodplain billabongs (generally remnants of deep channels on the flood plain) categories.

Over the previous 5–10 years, some of the Magela Creek billabongs (eg Georgetown) have undergone a number of observable vegetational changes, particularly in species composition and biomass dominance (plate 1, 2). These changes have been attributed to the removal of feral buffaloes (by conservation and mining authorities) and to the spread of the alien plant *Salvinia molesta*. Most records of these changes were anecdotal in nature, supplemented by photographs. A semi-quantitative vegetation monitoring program was commenced on five billabongs in 1984 and continued into 1986. Information on seasonal changes in plant presence, cover and ranked biomass, along with water depth measurements was recorded bimonthly across permanent transects (see Alligator Rivers Region Research Institute Annual Research Summaries 1985–1988) in order to record the species distribution and monitor changes in their occurrence, spatially and temporally. Three backflow billabongs (Coonjimba, Djalkmara and Georgetown) near the Ranger uranium mine and two floodplain billabongs (Leichhardt and Jabiluka) were studied. At this stage, a thorough analysis of the transect data has not been attempted. Further analysis of these data will enable detailed descriptions of the vegetation communities in each billabong to be presented and used as a basis for longer term monitoring.

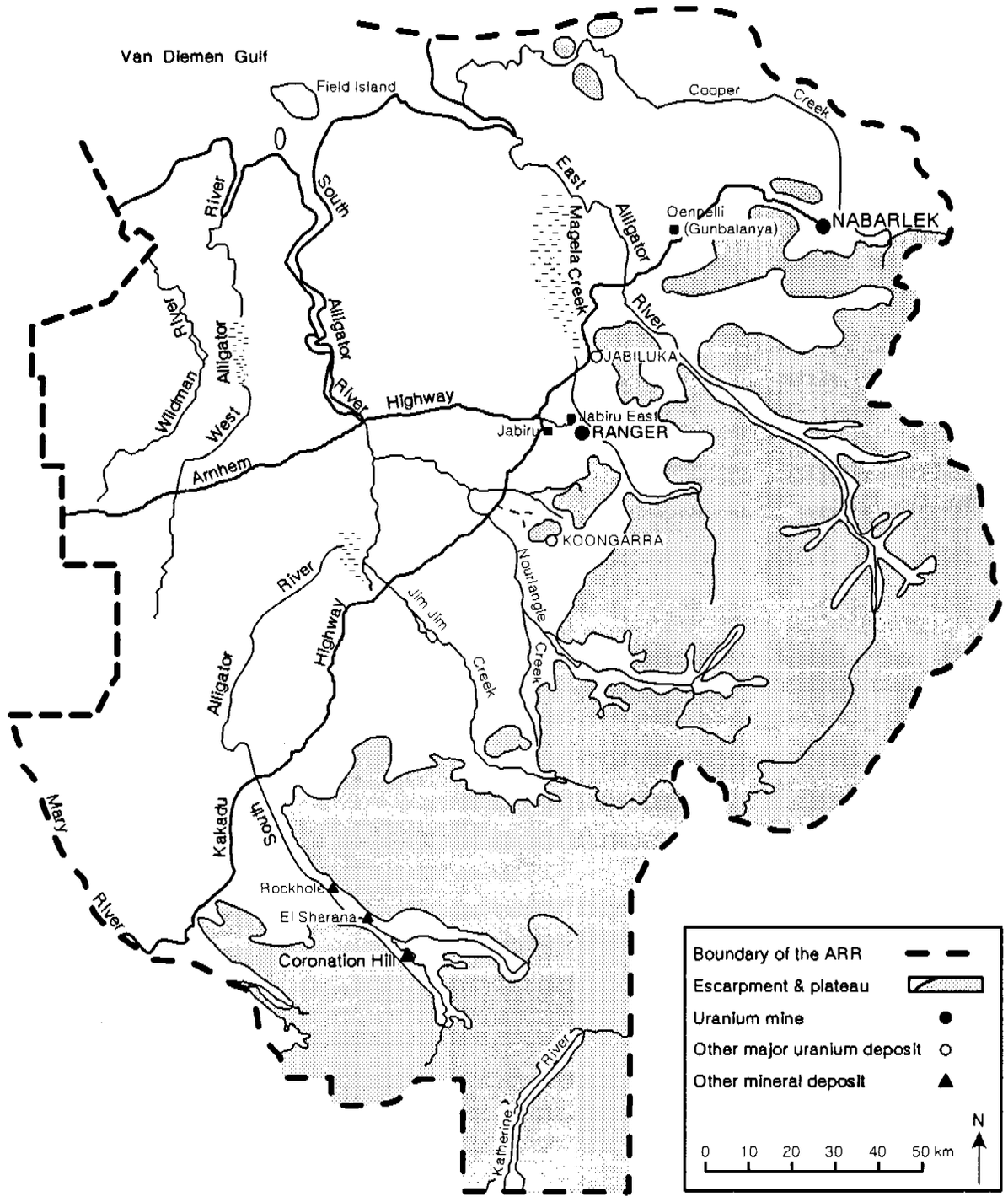

Figure 1 Alligator Rivers Region in northern Australia

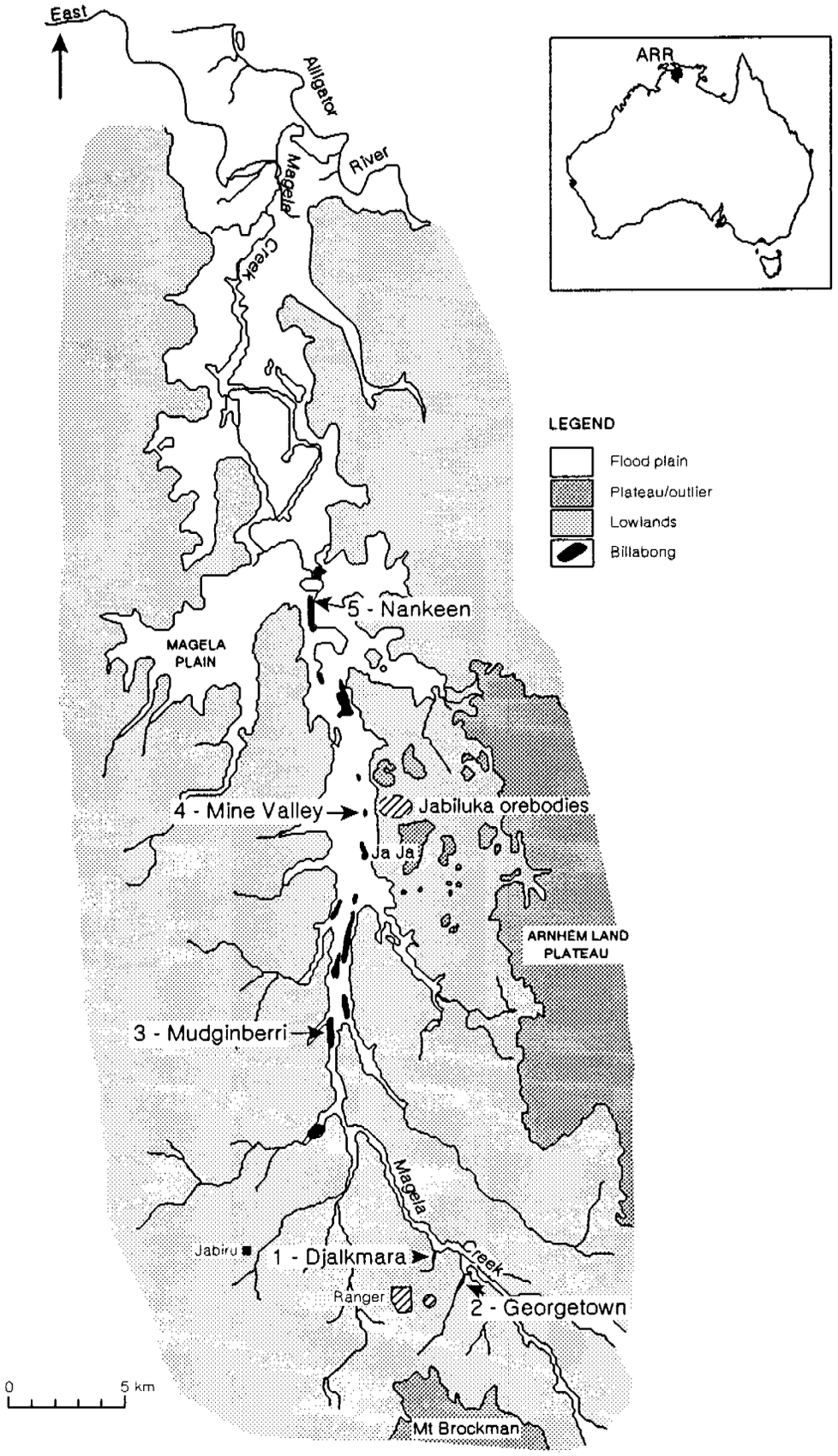

Figure 2 Magela Creek and flood plain with billabong locations marked

As part of the sampling program, a vegetation map of each billabong was prepared. The maps and a description of the vegetation communities are presented in this report, along with comment on the growth-strategies and growth-forms of the dominant plant species. The maps are presented as a prelude to this analysis, and as a resource for other groups interested in the vegetation changes that have occurred and that may occur in the future. The maps and vegetation community description also complement the floodplain vegetation description of Finlayson et al (1989), although vegetation maps of individual billabongs have not hitherto been published.

Methods

Vegetation maps of the five billabongs were prepared based on information collected during the 1987–88 Wet season. During the Wet season many of the aquatic plants flower and reach their peak biomass levels and are therefore easier to differentiate and map. Information for the maps was obtained by foot, boat and aerial reconnaissance. An inventory of species was made and indicator species for different communities selected. The selected indicator species for each community was not necessarily dominant throughout the complete annual cycle, but was the most abundant species present at the time of greatest plant biomass and diversity (ie towards the end of the Wet season, but before the creeks ceased flowing). Vegetation mapping units were derived from visual assessment of species distribution and dominance. The resultant maps therefore, take into account the temporal variations of species dominance within the 1987–88 Wet season but do not delineate the minor plant communities.

Each mapping unit (= community) was named according to an observed indicator plant species over the Wet to early-Dry season, or else given a general descriptive name, as done by Finlayson et al (1989) for the vegetation map produced for the entire Magela flood plain. The boundaries between plant communities are, by necessity, arbitrary, as the communities commonly intergrade and their margins vary with changes in water level.

In this vegetation analysis, the arbitrary limits to the backflow billabongs were the boundaries with the fringing terrestrial woodland communities, excluding areas considered to be groundwater seepage zones, but including the seasonally inundated woodlands (containing *Melaleuca* spp) and grass-sedgelands. In otherwords, the limits of the billabongs were considered to extend beyond the narrow band occupied by the aquatic plant species, and included the seasonally flooded areas containing terrestrial plant species. For the floodplain billabongs, the vegetation analysis included the fringing seasonally inundated woodland (containing *Melaleuca* spp), but not the floodplain grass communities.

All macrophyte species known to occur in the billabongs were listed and assigned to growth-strategy and growth-form categories. Two growth-strategy categories were used – annuals and perennials. The former includes all species that usually completed their life-cycle in one year and depended on seeds to survive to the next growing season. The perennials were sub-divided to provide a separate list of geophytic species, ie those with underground perennating organs. The growth-forms were firstly categorised as aquatic (A) or terrestrial (T), based on the definition of aquatic plants from Denny (1985): '...pteridophytes, charophytes and spermatophytes with vegetative parts that are permanently or seasonally submerged in or emergent from, or float on the water surface'. Then a second division into grasses (g), trees (t), herbs (h), sedges (z), shrubs (c) or palms (p) was made. This was based on the classification of Walker and Hopkins (1984). The aquatic species were also separated into emergent (e), floating-leaved (b) and free-floating submerged (d) categories. Where appropriate, a solidus (/) was used to indicate two possible growth forms for the one species.

The taxonomic nomenclature generally followed Cowie and Finlayson (1986), although the authors are aware that some taxa are under revision or require revision. One exception to the nomenclature adopted by Cowie and Finlayson (1986) is the change of *Brachiaria mutica* to *Urochloa mutica*.

Results

Coonjimba Billabong

Coonjimba Billabong covers about 14 ha. It is located on a small tributary of Magela Creek (fig 2) and receives runoff from its own catchment as well as inflow from Magela Creek (hence being classified as a backflow billabong by Walker et al (1984)). The woodland, dominated by *Melaleuca viridiflora*, at the north-eastern end of the billabong (fig 3) merges with the woodland fringing Magela Creek. Eight vegetation communities containing forty-five plant species (table 1) were recognised, although the *Alloteropsis/Eriachne* grassland occurs in an area of ground water seepage that, perhaps, by our definition, is not strictly part of the billabong (fig 3).

The most extensive communities were the woodland and the sedgeland dominated by *Eleocharis dulcis* and *Eleocharis sphacelata* (plate 3). The sedge community was very dense and completely dominated the zone from the edge of the billabong out to a depth of about 1.5 m, where it was replaced by submerged aquatic species (eg *Hydrilla verticillata, Utricularia* spp, *Najas tenuifolia, Certophyllum demersum*) and the waterlilies *Nymphaea violacea* and *Nymphoides indica.* The herbaceous species (eg *Crinum uniflorum, Ludwigia octovalvis*) that developed on the mudflats at the end of the Wet season were generally over-shadowed by the woodland canopy.

Of the forty-five species recorded from the billabong, twenty-four were annuals, sixteen were perennials and five geophytic perennials. The annuals included twelve aquatic and eleven terrestrial species; the perennial trees and geophytic sedges dominated the plant biomass in the billabong. The grass species *Alloteropsis semialata, Eriachne avenacea, Coelorhachis rottboelioides, Whiteochloa capillipes* and *Vetiveria pauciflora* that occur beneath the woodland canopy are less conspicuous than the sedge, tree and waterlily species.

Djalkmara Billabong

Djalkmara Billabong is located on a tributary of Magela Creek (fig 2) whose catchment has been reduced by the construction of water retention ponds on the Ranger mine site. The billabong covers 26 ha, of which 62% is made up of fringing woodland. During the Wet season, the billabong receives water backflowing from the Magela Creek, in addition to runoff from its own catchment (Walker et al 1984).

The existing vegetation was divided into nine communities (fig 4). Of the forty-three plant species recorded, twenty-three were annuals, fourteen perennials and six geophytic perennials (table 1). Both biomass and cover of the vegetation was dominated by the woodland trees *Melaleuca leucadendra* and *Melaleuca viridiflora* and the sedges *Eleocharis dulcis* and *Eleocharis sphacelata.* The woodland was more dense at the northern (plate 4) and southern ends of the billabong than along the eastern, and particularly the steeper, western banks of the billabong. Scattered amongst the trees on the western side were isolated clumps of the perennial grass *Vetiveria pauciflora.*

Eleocharis spp and *Pseudoraphis spinescens* mats dominated the area surrounding the open water (which is generally > 1.5 m deep). The waterlilies *Nymphaea violacea* and *Nymphoides indica* were scattered throughout the open water. Herbaceous species were not widespread with *Commelina lanceolata* on the drier areas and aquatic species such as *Najas tenuifolia* and *Myriophyllum dicoccum* in the wetter areas.

There are three areas of groundwater seepage containing the grasses *Alloteropsis semialata* and *Eriachne avenacea.* The north-western sward is almost pure *Alloteropsis semialata,* the western is mixed *Alloteropsis semialata* and *Eriachne avenacea,* while the southern sward is more complex – a mosaic of shallow ponds that, in addition to *Alloteropsis semialata* and *Eriachne avenacea,* also contain *Nymphoides indica, Maidenia rubra, Cyperus haspan, Fimbristylis clavata, Fimbristylis trachycarya, Paspalum scrobiculatum* and *Sacciolepis myosuroides.*

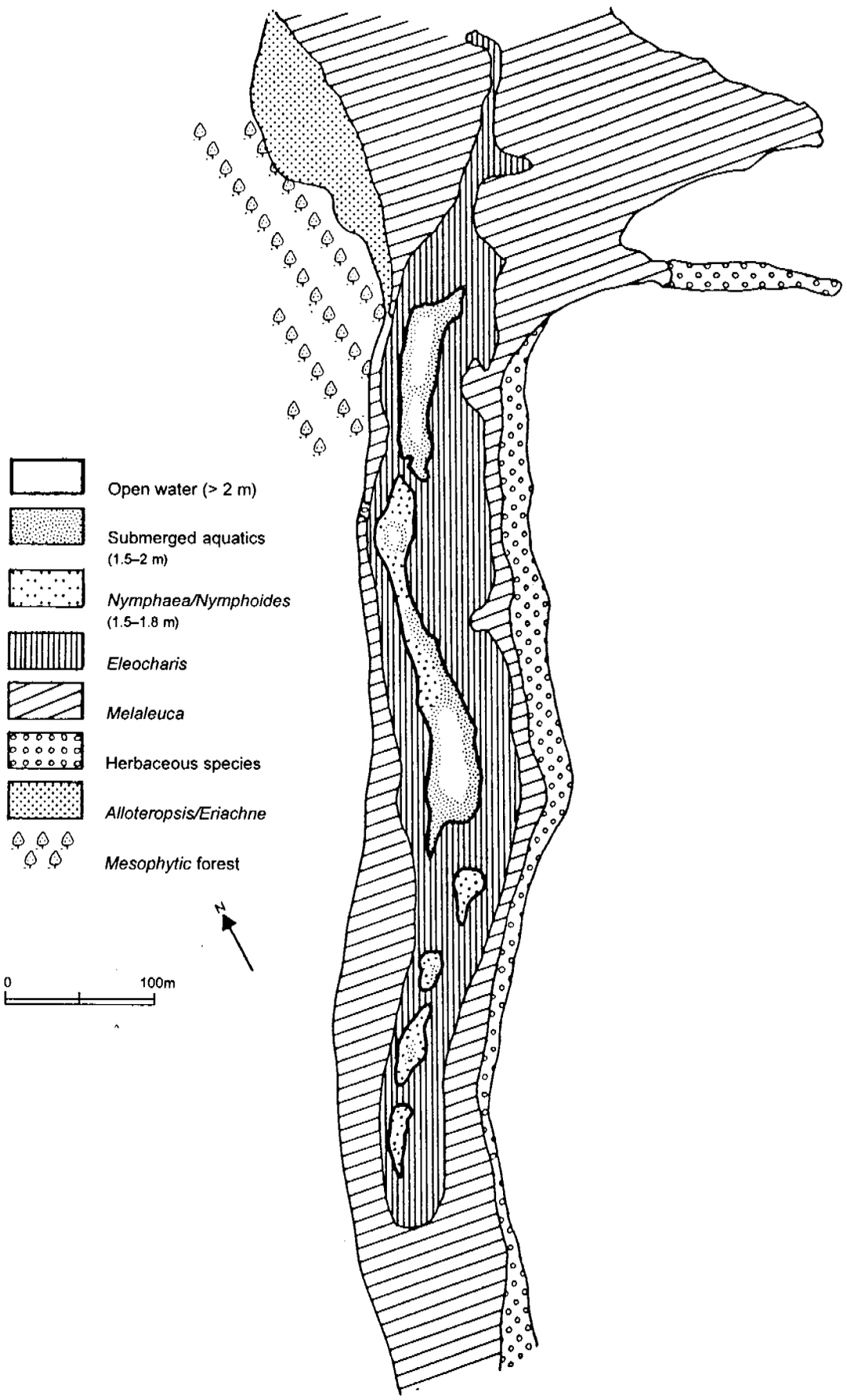

Figure 3 Vegetation communities in Coonjimba Billabong

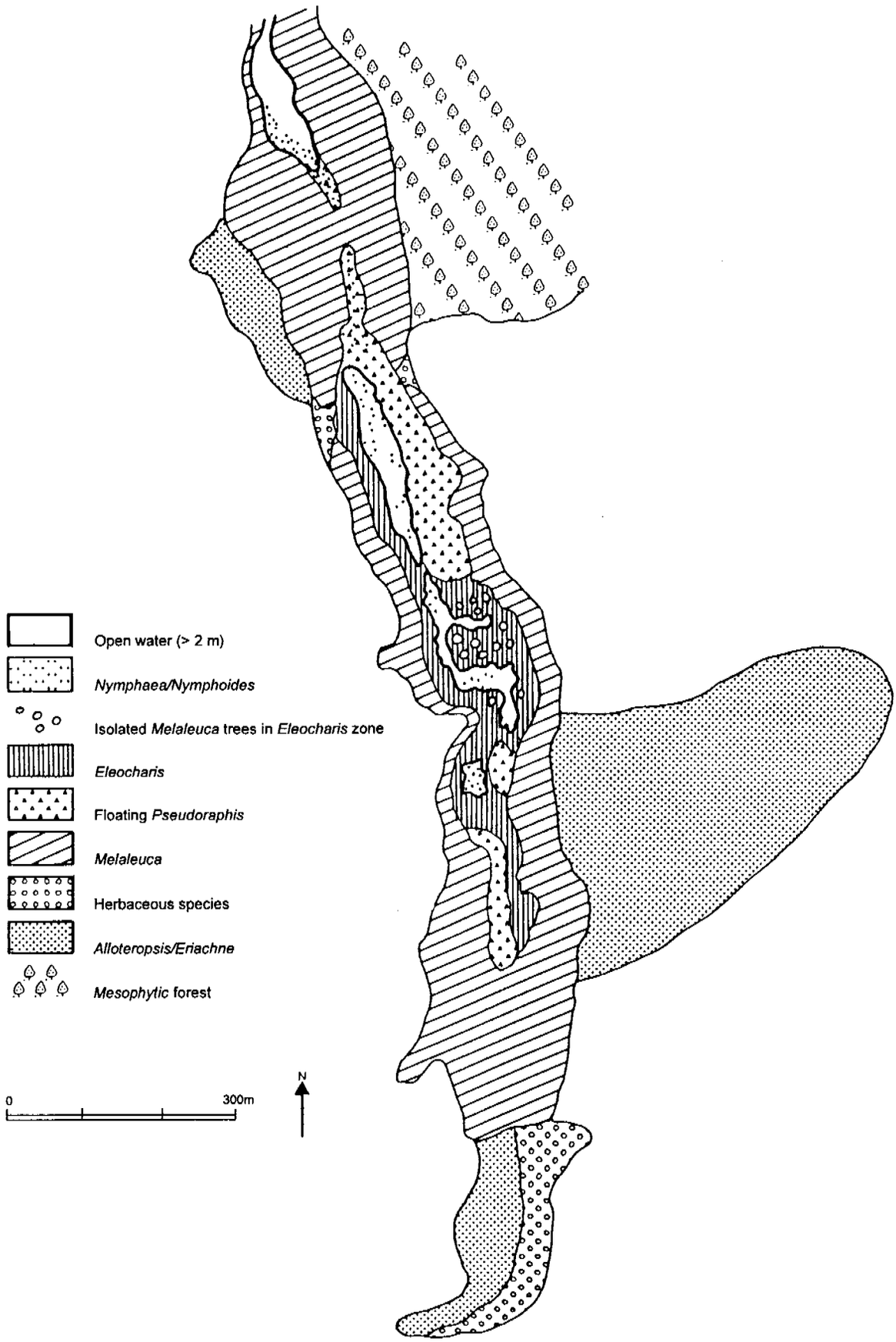

Figure 4 Vegetation communities in Djalkmara Billabong

Georgetown Billabong

Georgetown Billabong covers about 9 ha. It is also located on a small tributary of Magela Creek (fig 2), and receives runoff from its own catchment as well as inflow from Magela Creek. Eight vegetation communities, encompassing thirty-three plant species, were recognised (fig 5). There were fifteen annuals, fourteen perennials and four geophytic perennials. The perennial *Melaleuca* spp woodland and geophytic perennial *Eleocharis* spp sedgeland dominated the biomass of the billabong (plate 2). A narrow fringe of *Melaleuca viridiflora* and *Melaleuca nervosa* occurred along the western edge of the billabong, whereas on the eastern edge, this community was more widespread. However, it was not as widespread as it was at Coonjimba and Djalkmara Billabongs. The woodland at the south-western end of the billabong harboured a grass-waterlily community (*Pseudoraphis spinescens* and *Nymphaea violacea*, growing in water 1 m deep). Whilst the sedgeland, dominated by *Eleocharis dulcis* and *Eleocharis sphacelata*, was widespread in water up to 1.5 m in depth, it did not extend beneath the woodland canopy.

The small area of open water was 1.5–2.0 m deep and was fringed by the waterlily *Nymphaea violacea* with few submerged plants, except for the free-floating *Utricularia* spp. The flooded area, where the open water channel joined Magela Creek, had an almost pure stand of *Fimbristylis denudata* on the north-eastern side. On the north-western side, this community was more complex, with *Cyperus* sp and a mixture of herbs occurring with *Fimbristylis denudata.*

The grassland dominated by *Eriachne avenacea* and *Alloteropsis semialata* occurred in the unshaded zone behind the woodland. Within the woodland a number of sedges (eg *Fimbristylis pauciflora, Cyperus* sp) and grasses (eg *Coelorhachis rottboelioides, Germainia truncatiglume, Vetiveria pauciflora*) occurred.

Jabiluka Billabong

Jabiluka Billabong covers about 18 ha and is located on the eastern side of the Magela flood plain (fig 2). During the Wet season it is further inundated by floodwaters, being identified by a fringe of trees (*Melaleuca leucadendra, Barringtonia acutangula* and *Pandanus aquaticus*) along the western bank (plate 5) and the grass-sedgeland (*Digitaria bicornis* and *Vetiveria pauciflora*) and herbaceous community (including *Nymphoides* and *Nymphaea* species, *Polygonum attenuatum* and *Najas tenuifolia*) along the eastern bank (fig 6). The open water area was fringed by submerged aquatic plant species (*Najas tenuifolia, Ceratophyllum demersum, Utricularia* spp, *Vallisneria gigantea*) in water up to 1.5 m in depth (plate 5).

Salvinia molesta has been present in Jabiluka Billabong since the 1983–84 Wet season and, at times, completely covered the area designated as open water in fig 6. Water currents usually sweep a large proportion of these plants out of the billabong during the Wet season. Those plants that remained, were found in amongst the trees and grasses fringing the billabong. *Salvinia molesta* plants were also found in floating mats of grass, sedge and herb species.

The forty-four plant species recorded in Jabiluka (table 1) can be represented by seven vegetation communities, most dominated by perennial species. There were twenty-four annual, sixteen perennial and four geophytic perennial plant species. The geophytic species were not widespread. The perennial grasses *Hymenachne acutigluma* and *Pseudoraphis spinescens*, and the annual grass *Oryza meridionalis* intruded upon the billabong, but did not dominate large areas. The large reed *Phragmites karka* was found in a single stand in the south-eastern corner of the billabong.

Leichhardt Billabong

Leichhardt Billabong covers about 15 ha and is located on the western side of the Magela flood plain (fig 2). During the Wet season it is covered by floodwaters that spread across the plain; it is differentiated from the floodplain vegetation communities by a fringe of trees (*Melaleuca* spp, *Barringtonia acutangula* and *Pandanus aquaticus*) (plate 6) and an area of open water (fig 7).

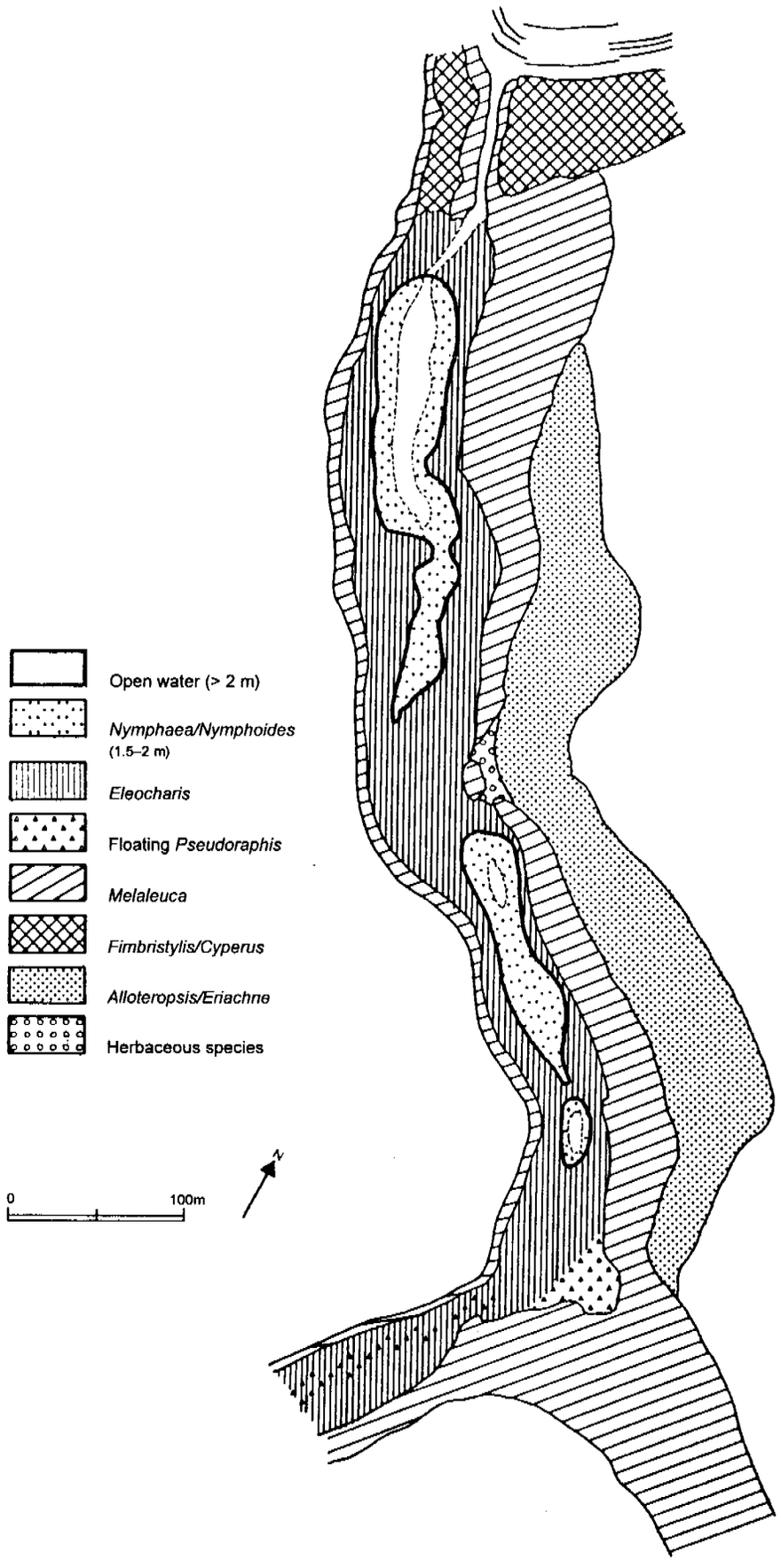

Figure 5 Vegetation communities in Georgetown Billabong

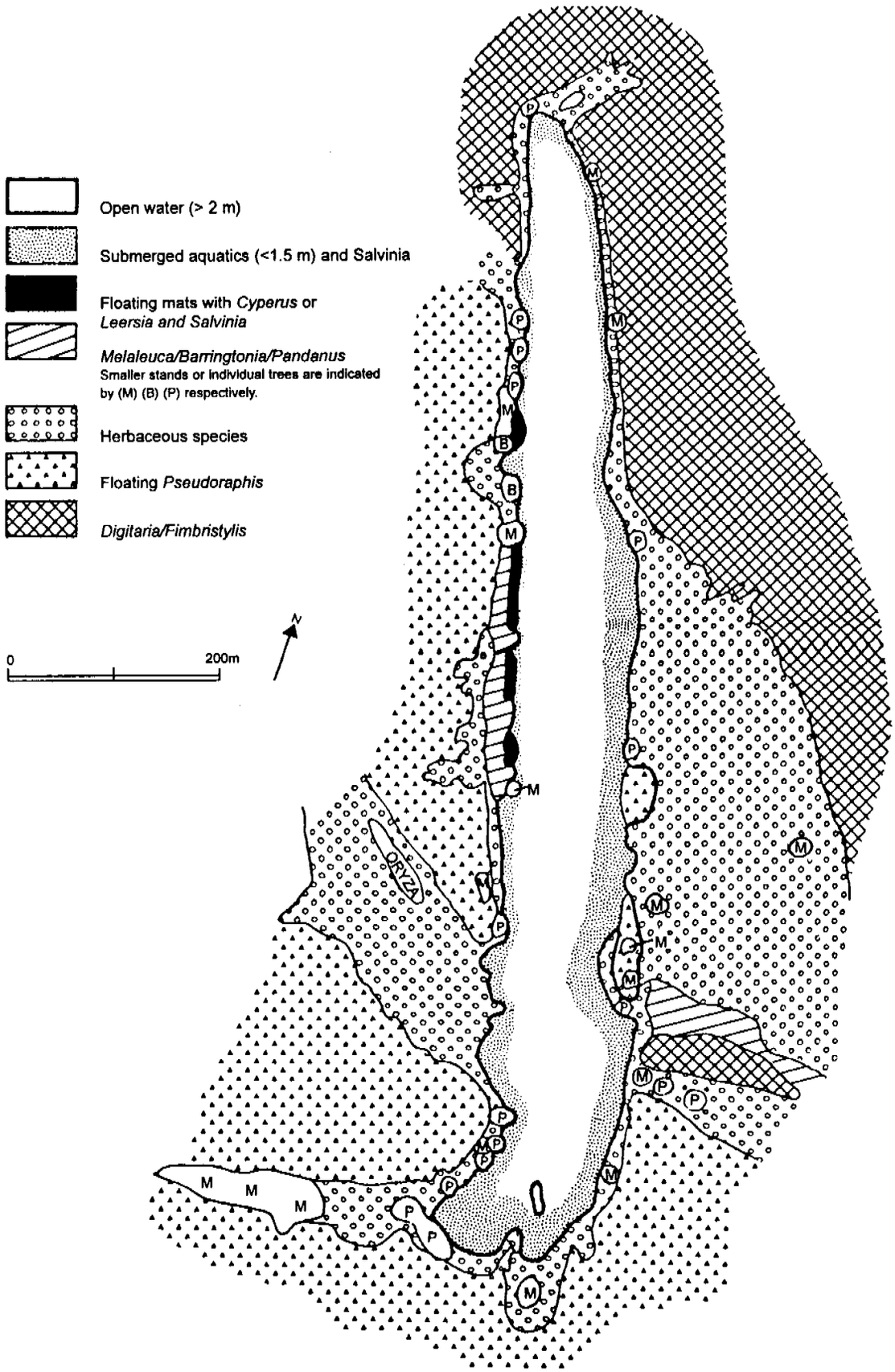

Figure 6 Vegetation communities in Jabiluka Billabong

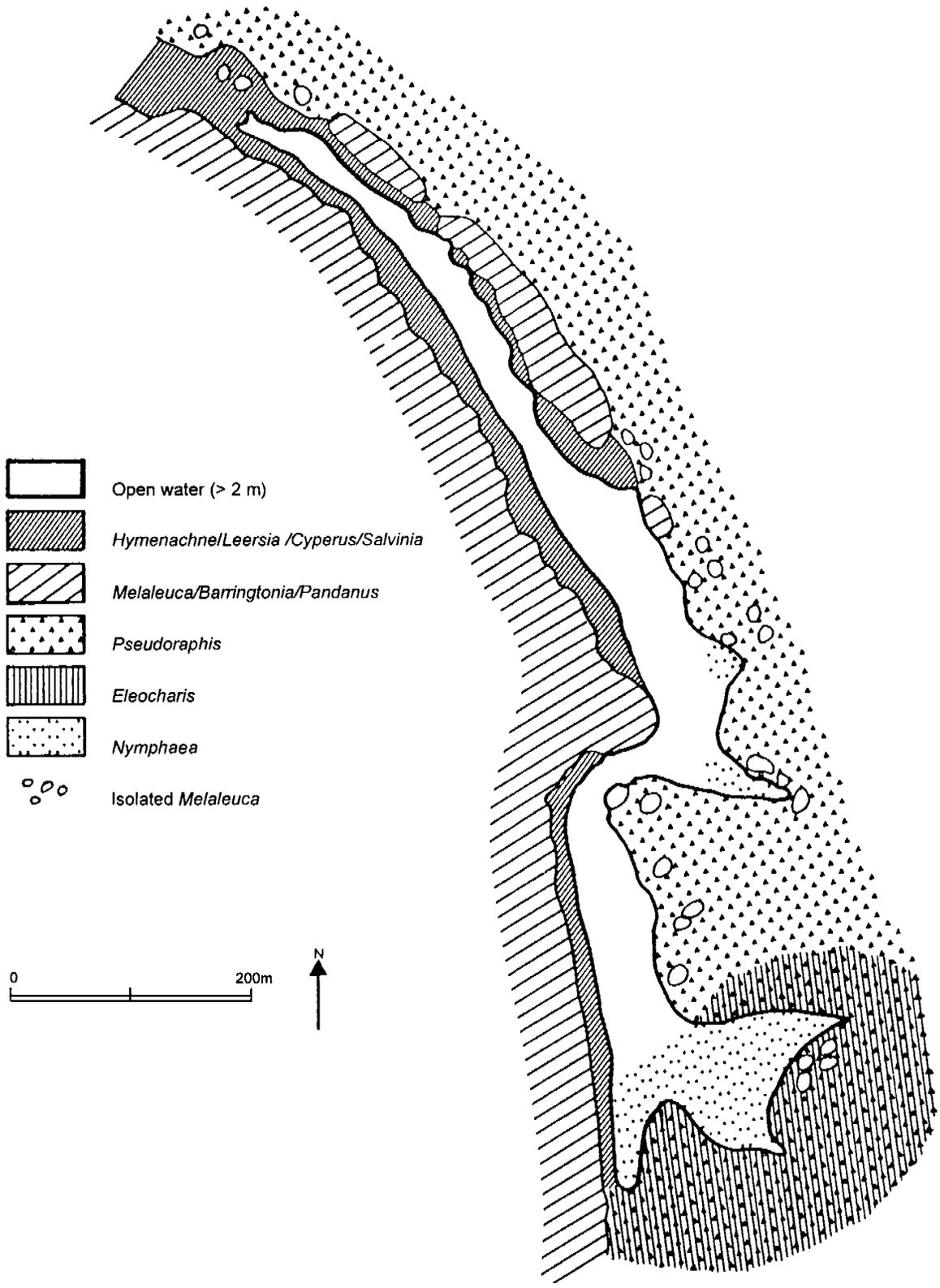

Figure 7 Vegetation communities in Leichhardt Billabong

The adjacent flood plain is dominated by *Pseudoraphis spinescens* with *Eleocharis* species towards the southern end of the billabong. The shallower water at the southern end of the billabong also supports an extensive area of the waterlilies *Nymphaea* spp.

Since 1983 the area of open water has been diminished by the expansion of a mat of plants from the western edge of the billabong (plate 6). The mat contained a mixture of species, with the perennial grasses *Hymenachne acutigluma* and *Leersia hexandra* forming a base for the sedge *Cyperus platystylis* and the herb *Ludwigia adscendens*. Clumps of the floating weed *Salvinia molesta* occurred in amongst these grasses. In previous years, this weed had completely covered the area designated as open water in fig 7 (plate 6). Floods early in the Wet season usually washed much of the *Salvinia molesta* out onto the adjacent flood plain, although plants that remained formed a base for the grasses and herbs that extended from the edge of the billabong.

The forty plant species recorded in Leichhardt Billabong (table 1) were represented by six vegetation communities. Of these species, seventeen were annuals, eighteen perennials and five geophytic perennials. The geophytic perennials *Nymphaea* spp and *Eleocharis* spp dominated the plant biomass towards the southern end of the billabong, but were not common in the northern end where water depth could exceed 7 m. The perennial grass *Pseudoraphis spinescens* intruded upon the billabong from the adjacent floodplain areas.

Discussion

Backflow billabongs

The three backflow billabongs had broad vegetation zones consisting of:

- fringing zone of *Melaleuca* spp woodland in seasonally inundated areas, particularly widespread at the northern and southern ends of Djalkmara and Coonjimba Billabongs;
- a mixture of grass and sedge species in seasonally inundated areas covered by the woodland canopy;
- a fringe of *Eleocharis* spp sedges in water generally up to 1.5 m deep during the Wet season;
- a small area of open water generally between 1.5–2.0 m deep during the Wet season;
- waterlilies and submerged plants scattered along the boundary between the sedges and open water.

The *Eleocharis* spp sedge zone was less well developed and the waterlilies *Nymphaea violacea* and *Nymphoides indica* were more widespread in Djalkmara Billabong than in Georgetown and Coonjimba Billabongs. Submerged plants, such as *Hydrilla verticillata* and *Maidenia rubra*, were relatively more common in Coonjimba than in the other backflow billabongs.

Forty-five plant species have been recorded from Coonjimba, forty-three from Djalkmara, and only thirty-three from Georgetown. Overall, the dominant plant biomass and cover in these billabongs (unpublished data) was provided by the perennial *Melaleuca* spp. trees and the geophytic perennial *Eleocharis* spp sedges. The annual species did not contribute greatly to the plant biomass present in the billabongs.

The increased abundance of *Eleocharis* spp is the most obvious change in the vegetation to have occurred over the previous 5–10 years (plate 1, 2). The increased abundance of these plants has been attributed primarily to the elimination of buffalo from the billabongs (C Humphrey, pers comm). Although conclusive quantitative evidence is lacking, it is likely that the absence of grazing, wallowing and pugging by these beasts has allowed *Eleocharis* spp to predominate over other herb, sedge and grass species. Changes in vegetation structure following the removal of buffaloes have also been demonstrated on the South Alligator flood plain (Braithwaite & Werner 1988). In this case though, the formerly sparsely distributed perennial grass *Hymenachne acutigluma* appears to be replacing *Eleocharis* spp on these flood plain habitats.

The dense stands of sedges in the backflow billabongs could impede water flow and result in further changes in the vegetation as a result of increased siltation. It is also possible, that as channels formerly kept open by buffalo infilled with sediment, more water could be retained (in the billabong) later into the Dry season (D Lindner, pers comm). The influence of increased siltation and longer water retention periods on the present macrophyte communities is not known, although Finlayson et al (1989) identified water depth and period of inundation as important factors influencing vegetation pattern on the Magela flood plain. At this stage, the stability and persistence of the vegetation present in these billabongs beyond that recorded over the study period is not known.

Floodplain billabongs

The two floodplain billabongs had broad vegetation zones consisting of:

- fringing zone of tree species (*Melaleuca* spp, *Pandanus aquaticus*, *Barringtonia acutangula*) along the western bank;
- mixture of grass and sedge species and a few trees forming an interface with the floodplain grass communities along the eastern bank;
- mixture of grass, herb and sedge species overlying a floating mat of *Salvinia molesta* plants extending from the banks towards the middle of the billabong;
- a discontinuous fringe of submerged plants and waterlilies along the edge of the floating mat.

The zone of tree species at Leichhardt Billabong was more dense than at Jabiluka and harboured a number of grass and sedge species, some growing over small mats of *Salvinia molesta*. The mat of floating vegetation along the western side of Leichhardt Billabong was particularly dense and extended out about 20 m from the bank. Mats elsewhere in Leichhardt and in Jabiluka Billabong were not as dense. The intertangled mats trapped *Salvinia molesta* plants and prevented them being washed out by floodwaters during the Wet season.

Jabiluka Billabong contained forty-four plant species, including twenty-four annuals, compared to forty species, including seventeen annuals, in Leichhardt Billabong (table 1). Despite the differences in species numbers the broad vegetation zones in the two billabongs were similar. The two floodplain billabongs, which are deeper and have steeper sides than the backflow billabongs, had more restricted woodland and sedge (particularly *Eleocharis* spp) communities. The backflow billabongs did not contain *Salvinia molesta* which is not found upstream of Mudginberri Billabong (fig 2).

Over the previous five years, dense mats of *Salvinia molesta*, with secondary colonisation by grass, sedge and herb species had completely covered the 'open-water' areas of both Leichhardt and Jabiluka Billabongs. As these mats were dispersed by flood waters (and also attacked by an introduced weevil *Cyrtobagous salviniae*) during the Wet season, they had not established as a stable component of the vegetation. There is, however, a permanent fringe of these plants left around the edges of the billabongs. The only noticeable influence of the mats on the vegetation was a decline in the waterlily populations in both billabongs and an extension of the width of the floating mat along the western edge of Leichhardt Billabong. The long-term effect of the almost annual occurrence of dense mats of *Salvinia molesta* on the biota of the billabongs has not been investigated. The introduced weevil had not established sufficient control over this plant to prevent the development of these mats.

The floodplain billabongs are much deeper than the backflow billabongs and have not been as drastically affected by buffaloes. Jabiluka Billabong contained the only known occurrence of the reed *Phragmites karka* on the Magela flood plain. A species reported by Braithwaite and Werner (1988) to have reappeared on the South Alligator flood plain following the removal of buffaloes.

Table 1 Growth-strategies and growth-form of plant species occurring (marked x) in Coonjimba, Djalkmara, Georgetown, Jabiluka and Leichhardt Billabongs

Growth-strategy	Coonjimba Billabong	Djalkmara Billabong	Georgetown Billabong	Jabiluka Billabong	Leichhardt Billabong
Annual species					
Alloteropsis semialata (Tg)	x	x	x		
Aneilema siliculosum (Th)				x	
Blumea tenella (Th)					x
Blyxa aubertii (Ahs)	x		x	x	x
Caldesia oligococca (Ahf)	x	x	x		
Centipeda minima (Th)			x		
Centrolepisexserta (Tc)					x
Ceratophyllum demersum (Ahs)	x		x	x	x
Commelina lanceolata (Th)		x			
Cyperus conicus (Tc)		x			
Cyperus cuspidatus (Tc)					x
Cyperus iria (Tc)	x				
Cyperus malaccensis (Tc)				x	
Cyperus serrotinus (Tc)	x				
Dentella dioeca (Th)				x	
Desmodium flagellare (Th)				x	
Digitaria bicornis (Tg)*		x	x	x	x
Dysophylla stellata (Ahe/s)		x	x		
Echinochloa colona (Tg)*	x	x			
Eleocharis caespitosissima (Ace)		x		x	
Epaltes australis (Th)				x	
Eragrostis tenellula (Tg)			x	x	
Eriachne avenacea (Tg)	x	x	x		
Eriocaulonsetaceum (Ahs)	x				
Eriocaulon spectabile (Th)	x				
Eulalia leschenaultiana (Tg)		x			
Fimbristylis aestivalis (Tc)	x			x	
Fimbristylis clavata (Tc)		x			
Fimbrisytlis slittoralis (Tc)				x	
Fimbristylis pachyptera (Tc)	x				
Fimbristylis pauciflora (Tc)	x	x	x	x	
Fimbristylis trachycarpa (Tc)		x			
Fuirena ciliaris (Tc)			x		
Glinus oppositifolius (Th)				x	
Hygrochloa aquatica (Agf)	x				
Hygrophila salicifolia (Th)					x

Growth-strategy	Coonjimba Billabong	Djalkmara Billabong	Georgetown Billabong	Jabiluka Billabong	Leichhardt Billabong
Annual species *(cont'd)*					
Ipomoea aquatica (Ave)				x	x
Isoetes coromandelina (Ahs)			x		
Limnophila gratioloides (Ahe)	x				x
Ludwigia octovalvis (Th)	x			x	
Maidenia rubra (Ahs)	x	x	x		
Microcarpaea minima (Th)					x
Myriophyllum dicoccum (Ahe)	x	x			
Najas tenuifolia (Ahs)	x	x	x	x	x
Nelsonia brunellodes (Th)				x	
Nymphoides hydrocharoides (Ahf)	x	x			
Nymphoides parviflora (Ahf)		x			
Oryza meridionalis (Age)				x	
Pseudopogonatherum collinum (Tg)				x	
Rhynchospora longisetis (Tc)	x				
Sacciolepis indica (Tg)		x			
Sacciolepis myosuroides (Tg)	x	x			
Scleria novae-hollandiae (Tc)		x			
Stylidium rotundifolium (Th)					x
Utricularia aurea (Ahd)		x		x	x
Utricularia exoleta (Ahd)	x	x	x	x	x
Utricularia muelleri (Ahd)	x	x	x	x	x
Vallisneria gigantea (Ahs)				x	x
Veronia cinera (Th)					x
Whiteochloa capillipes (Tg)	x				
Perennial species					
Aniseia martinicensis (Av)					x
Azolla pinnata (Ahb)		x		x	x
Barringtonia acutangula (A/Tt)				x	x
Coelorhachis rottboelioides (Tg)	x	x	x		
Cyperus haspan (Tc)		x			
Cyperus platystylis (Ace)				x	x
Eucalyptus alba (Tt)			x		
Fimbristylis denudata (Ace)	x	x	x		
Fimbristylis nutans (Tc)	x				
Germainea truncatiglume (Tg)	x	x	x		
Hydrilla verticillata (Ahs)			x	x	x
Hymenachne acutigluma (Age)	x			x	x

Growth-strategy	Coonjimba Billabong	Djalkmara Billabong	Georgetown Billabong	Jabiluka Billabong	Leichhardt Billabong
Perennial species *(cont'd)*					
Ischaemum australe (Tg)	x		x		
Leersia hexandra (Age/b)	x			x	x
Leptocarpus spathaceus (Th)	x				
Lophostemon lactifluus (Tt)		x			
Ludwigia adscendens (Ahe/b)				x	x
Melaleuca leucadendra (A/Tt)		x			x
Melaleuca nervosa (A/Tt)			x	x	
Melaleuca viridiflora (A/Tt)	x	x	x	x	x
Nymphoides indica (Ahf)	x	x	x	x	
Pandanus aquaticus (At)				x	x
Panicum paludosum (Age)		x	x		
Paspalum scrobiculatum (A/Tge)	x	x	x		
Philydrum lanuginosum (Ahe)	x				
Phragmites karka (Age)				x	
Polygonum attenuatum (Ahe)	x		x	x	x
Pseudoraphis spinescens (Age)	x	x	x	x	x
Salvinia molesta (Ahb)*				x	x
Scleria apiculata (Tc)		x			
Sida cordifolia (Ts)*					x
Stemodia viscosa (Th)					x
Urochloa mutica (Age/b)	x			x	x
Vetiveria pauciflora (Tg)	x	x	x		
Xanthostemon eucalyptoides (Tt)					x
Geophytic perennial					
Aponogeton elongatus (Ahs)			x		
Crinum uniflorum (A/Th)	x				
Eleocharis brassii (Ace)		x		x	
Eleocharis dulcis (Ace)	x	x	x		x
Eleocharis sphacelata (Ace)	x	x	x	x	x
Nymphaea hastifolia (Ahf)		x			
Nymphaea macrosperma (Ahf)	x	x		x	x
Nymphaea nouchali (Ahf)					x
Nymphaea violacea (Ahf)	x	x	x	x	x

* Alien species

Growth-form: T – terrestrial; A – aquatic; s – shrub; c – sedge; g – grass; v – vine; h – herb; t – tree; p – palm; e – emergent; f –floating-leaved; s – submerged rooted; b – free-floating; d – free-floating submerged

Plate 1 Georgetown Billabong, late-Dry season 1980

Plate 2 Georgetown Billabong, mid-Wet season 1986

Plate 3 Coonjimba Billabong, mid-Wet season 1985

Plate 4 Djalkmara Billabong, mid-Wet season 1985

Plate 5 Jabiluka Billabong, mid-Wet season 1988

Plate 6 Leichhardt Billabong, mid-Wet season 1984

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