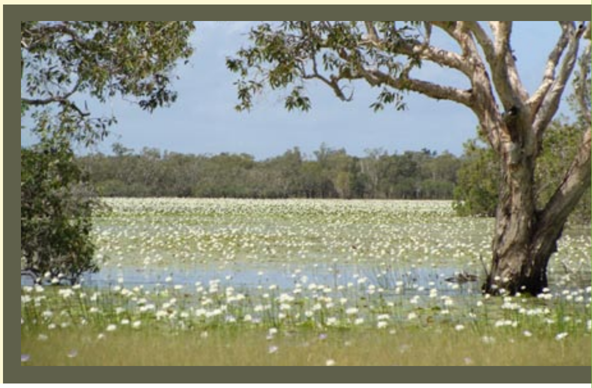
Jack Lakes Wetlands Biodiversity Assessment, November 2007 & June 2008

CYMAG Environmental Inc.

March 2009

APPENDICES



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These appendices accompany the Jack Lakes Wetlands Biodiversity Assessment, November 2007 & June 2008. Copies are available from:

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Cover photo: Top Lake, Jack Lakes (April 2008)

APPENDIX A:

Jack Lakes Vegetation and Fauna from Qld Museum and Wildlife Online Searches (25/10/07) and not Observed During the CYMAG Surveys

Class	Family	Scientific Name	Common Name	Records
Aves	Climacteridae	*Cormobates leucophaeus*	White-throated Treecreeper	Wildlife Online
Aves	Psittacidae	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	Wildlife Online
Reptilia	Colubridae	*Stegonotus cucullatus*	Slaty-grey Snake	Wildlife Online
Reptilia	Scincidae	*Carlia dogare*	Four-fingered Skink	Qld Museum
Magnoliopsida	Mimosaceae	*Acacia leptocarpa*		Wildlife Online
Magnoliopsida	Myrtaceae	*Corymbia hylandii,*		Wildlife Online
Magnoliopsida	Myrtaceae	*Corymbia nesophila*		Wildlife Online
Magnoliopsida	Myrtaceae	*Eucalyptus cullenii*		Wildlife Online
Liliopsida	Poaceae	*Chrysopogon sp.*		Wildlife Online

APPENDIX B:

Full Vegetation Survey Report - Dr John Dowe (ACTFR)

A SURVEY OF THE VEGETATION OF JACK LAKES,

NOVEMBER 2007

ACTFR Report No. 07/33

December 2007

A SURVEY OF THE VEGETATION OF JACK LAKES, NOVEMBER 2007

ACTFR Report No. 07/33, December 2007

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EXECUTIVE SUMMARY

- A vegetation survey of the Jack Lakes area was conducted 19-22 November 2007. As this was at the end of the dry season, many aquatic species were in a state of quiescence and were either present only as dried remnants or not detectable. It is recommended that another survey be conducted at the end of the wet season to record the seasonal species.

- This present survey brings the number of plant species recorded at Jack Lakes to 137. The most speciose families include Myrtaceae (22 spp.), Poaceae (18 spp.), Cyperaceae (9 spp.), Mimosaceae (8 spp.) and Euphorbiaceae (6 spp.).

- The dominant structural trees on the margins of Jack Lakes and associated connecting and drainage lines were, by order of prevalence, *Melaleuca leucadendra*, *Melaleuca viridiflora*, *Melaleuca stenostachya* and *Lophostemon suaveolens*. The lake margins are otherwise dominated by herbaceous species of Cyperaceae (sedges), and Poaceae (grasses).

- Areas of High Habitat Value were determined, based on intactness and resilience to the impacts of pigs and cattle. These areas included:

1. margins and adjoining forest on the eastside of Top Lake, where areas of Cyperaceae spp. are intact.
2. seasonally dry drainage channels and adjacent forests between Top Lake and Middle Lakes, where fringing *M. leucadendra* and *M. fluviatilis* populations are relatively healthier than other areas, and with little evidence of decline or stress.
3. sandy ridges on the east side of Middle Lakes, particularly in the areas between ‘Fish Lake’ and the eastern branch of Middle Lakes, where patches of open forest and *Acacia* thickets occur, and where populations of *Lomandra banksii* and *Thryptomene oligandra* show considerable development and lack of disturbance.
4. eastern side of Lower Lakes, particularly on the margins and adjacent inflow channels and creeks on the most eastern section, where a number of very tall (~25 m tall) *M. leucadendra* populations occur.

5. at the confluence of Jack River and the drainage channels of the Lower Lakes, where the *Melaleuca* dominated fringing vegetation meets riparian vegetation [evergreen notophyll vine forest] including *Buchanania arborescens*, *Dillenia alata*, *Leptospermum longifolium*, *Melaleuca fluviatilis*, *Syzygium papyraceum* and *S. eucalyptoides*. The contiguousness of these two significantly different types of habitats is unusual and worthy of listing as a high value ecosystem in its own right.

- Variation among the dominant species of *Melaleuca* was determined at a number of sites. It was found that *Melaleuca leucadendra* and *Melaleuca stenostachya* displayed little variation in morphology at a number of moisture gradient locations regards of moisture levels, whilst *Melaleuca viridiflora* showed considerable variation with increasing size with increasing water availability.

- A study of species distributions adjacent to the lakes revealed that most species occurrences are controlled by soil moisture levels, particularly with regard to the upper limits of seasonal inundation.

- Recommendations for *Habitat Condition Assessment* and *Biodiversity Values Maintenance* include:

1. that effective control of pigs and the limiting of access to cattle must be initiated and achieved.
2. that vigilance be maintained for Rubber Vine, and that if detected, an eradication program be put in place.
3. that the role of fire at Jack Lakes is investigated and that a fire management program is put in place.
4. that species of conservation significance be further investigated and that a program for their conservation be established.

1.0 INTRODUCTION

A broad assessment of the vegetation associated with the Jack Lakes aggregation was provided by Blackman *et al*. (1996), based on the survey work undertaken by Nelder & Clarkson (1995), in which they documented both aquatic and terrestrial species. These authors reiterated the conservation significance of the area as first proposed by McFarland (1993). The catchment area associated with Jack River [to include Jack Lakes] had previously been designated with high 'wilderness quality' (Lesslie *et al*. 1992). An overview of pre-settlement vegetation was provided by DPI (1993) and was described, at that time, as 'relatively undisturbed'. The Jack Lakes area contains one 'of concern' bioregional ecosystem (Nelder, 1999) [RE 3.3.66], this being palustrine wetland, i.e. 'permanent lakes and lagoons frequently with fringing woodlands', which provides habitat for rare aquatic species and has local high diversity. Rubber Vine (*Cryptostegia grandiflora*) was listed as a 'threatening process' (ANRA, 2007), but that species otherwise has not yet been recorded for Jack Lakes although it occurs in nearby river systems.

Nelder & Clarkson (1995) described the surrounding vegetation as *Eucalyptus* woodlands and *Melaleuca* low open woodlands. The vegetation in the four permanent lakes was described as composed of free floating plants, bottom-rooted species and emergent grasses and sedges, and the margins with seasonally inundated woodlands and/or shrublands with a sparse understorey.

This report aims to summarise what is presently known about the vegetation associated with Jack Lakes, to add to the list of species already developed, and to provide information on vegetation structure, ecological character and distribution of species within the Jack Lakes system. Special focus has been placed on the structurally dominant trees associated with the seasonally inundated lake margins.

2.0 METHODS

A desktop assessment of both the aquatic and terrestrial vegetation associated with Jack Lakes was undertaken prior to field work, of 18-22 November 2007. Primary references included DPI (1993), Nelder & Clarkson (1995) and Nelder (1999). A list of species collected in the general area was supplied by EPA (2007). To my knowledge, there have been no recent vegetation surveys in the immediate vicinity of Jack Lakes.

For survey purposes, Jack Lakes can be divided into three zones (Fig. 1), and will be referred to as Top Lake, Middle Lakes and Lower Lakes in this report. A fourth zone, where Jack Lakes join

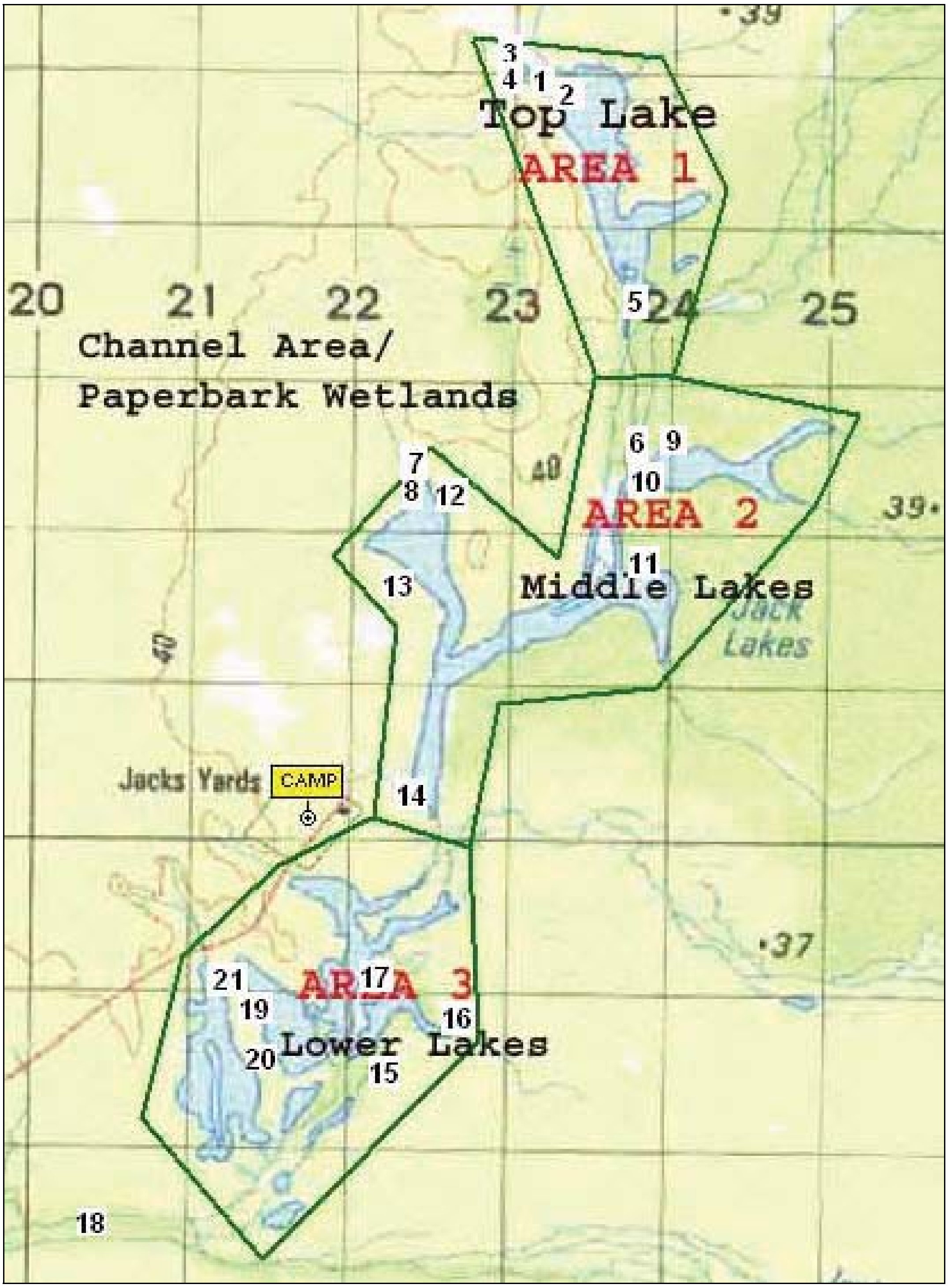

Figure 1. Map of Jack Lakes with vegetation survey transects indicated by number.

Jack River and the associated downstream riparian forest, can also be included, as this area offers a distinct vegetation type that is otherwise not found anywhere else within the Jack Lakes area. Twenty-one transects were established, ranging from 110 m to 1380 m long, and with each being 10 m wide. Five transects were on Top Lake, nine in the Middle Lakes, six in the Lower Lakes and one on Jack River downstream of the lake confluence. The positions of transects are indicated on the map in Figure 1. A summary of transects, including description, survey methods and GPS co-ordinates, is provided in Appendix 1. A plant species list for Jack Lakes is presented in Appendix 2.

Data derived from the transects included species presence, population structure, species distributions, and demographics of the dominant trees. Data were recorded at 10 m intervals along each transect, therefore quadrats were effectively 100 m^2 each. Voucher specimens of appropriate species were collected for deposition in Queensland Herbarium, Brisbane (BRI) (Appendix 3), and photographs, included on an accompanying CD, of habitat and species were taken at each transect.

3.0 RESULTS

3.1 Dominant Tree Species

Melaleuca leucadendra, *M. viridiflora*, *M. fluviatilis* and *Lophostemon suaveolens* were identified as the dominant tree species on the seasonally inundated margins of Jack Lakes, with *M. leucadendra* being the most ubiquitous species (Fig. 2). Other common tree/shrub species included, in order of prevalence, *Barringtonia acutangula*, *Calycopeplus casuarinoides*, *Asteromyrtus symphyocarpa*, *Leptospermum longifolium*, *Acacia auriculiformis*, *Livistona muelleri*, *Melaleuca stenostachya*, and *Acacia holosericea*. In November, at the end of the dry season, very few understorey and/or ground cover species were present. Many species in these strata were in a senescent and/or dried state, including *Eleocharis* spp., *Cyperus* spp., and Poaceae spp. The only grass that was actively growing, either on the lake margins or on dried lake pans, was *Cynodon dactylon*. Persistent macrophytes and other aquatic plants included *Nymphaea* spp., *Nyphoides* spp., *Marsilea mutica* and *Azolla pinnata*. A list of previously recorded species and newly recorded species is presented in Appendix 3.

3.2 Distribution and physiognomy of *Melaleuca* species

The four *Melaleuca* species recorded on the margins of Jack Lakes (i.e. *M. leucadendra*, *M. viridiflora*, *M. fluviatilis* and *M. stenostachya*) occurred in either monospecific stands or in

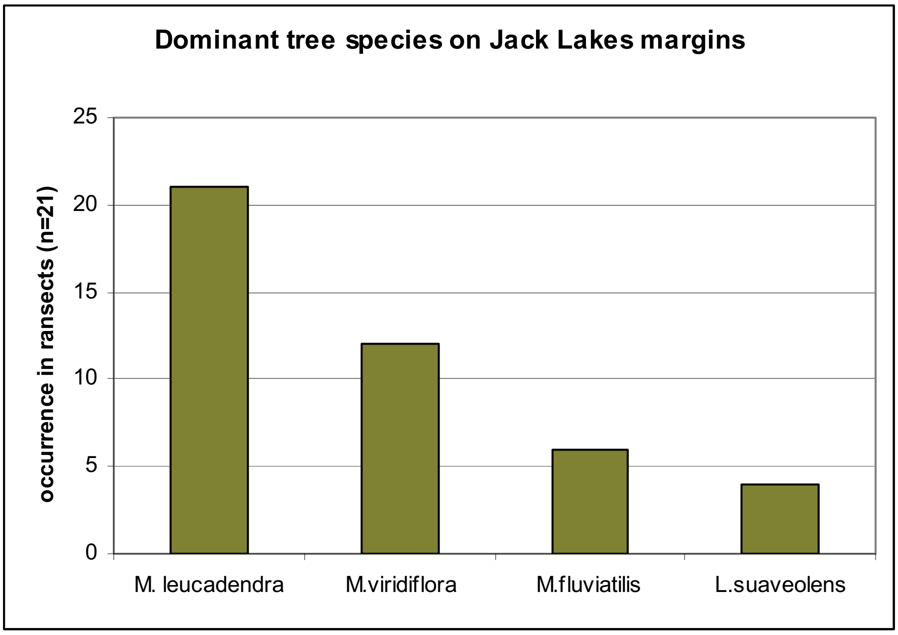

Figure 2. Relative abundance of dominant tree species on the margins of Jack Lakes, as recorded in 21 transects.

various associations of up to three of the species. The presence of both surface and ground water is among the primary factors influencing the distribution of these *Melaleuca* species. The moisture gradient from Top Lake, through the Middle Lakes to the Lower Lakes indicated an increase in water availability in a southerly direction, with the Top Lake retaining proportionally less surface water than the Middles Lakes or the Bottom Lakes, into the dry season (Appendix 4). The density of *M. leucadendra*, as measured at the vegetation transects along this gradient indicated that the relative densities of stems per unit area increased along this gradient from north to south, i.e. density increased with increasing water availability (Fig. 3). It may also be possible that the level of nutrient availability also increases along this gradient, but to resolve this question requires further investigation.

Variation in stem diameter (measured at breast height) was recorded in the individual *Melaleuca* species along a north/south moisture gradient of 1.38 km from the north-western in-flow point of Top Lake to the limit of surface water (Transect 4, see Appendix 1) (Fig. 4). Of the three species observed along that transect (*M. leucadendra*, *M. viridiflora* and *M. stenostachya*), both *M. leucadendra* and *M. stenostachya* showed relatively limited variation to stem diameter relative to distance away from surface water, whilst *M. viridiflora* showed a marked decrease in stem

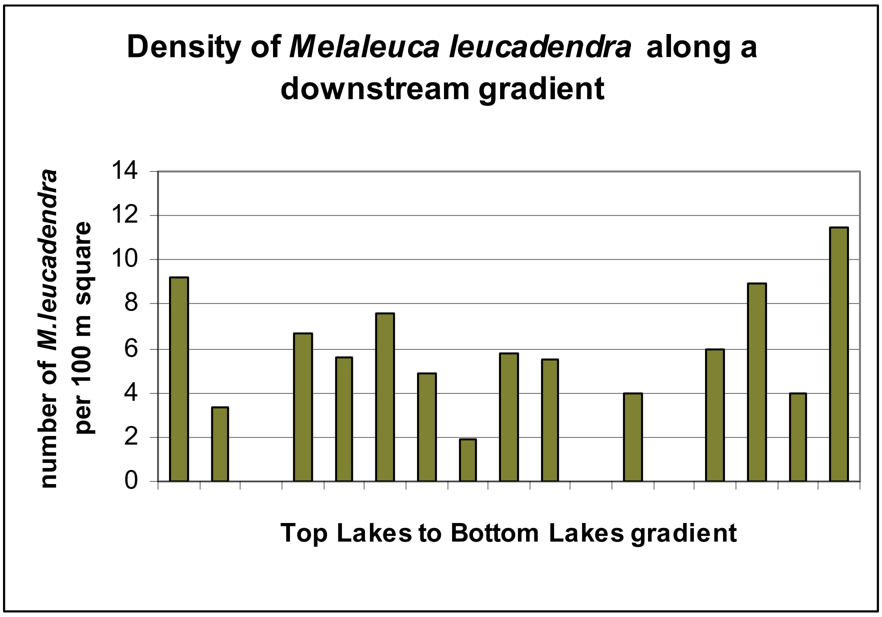

Figure 3. The relative density of *Melaleuca leucadendra* individuals per unit area from Top Lake to the Lower Lakes.

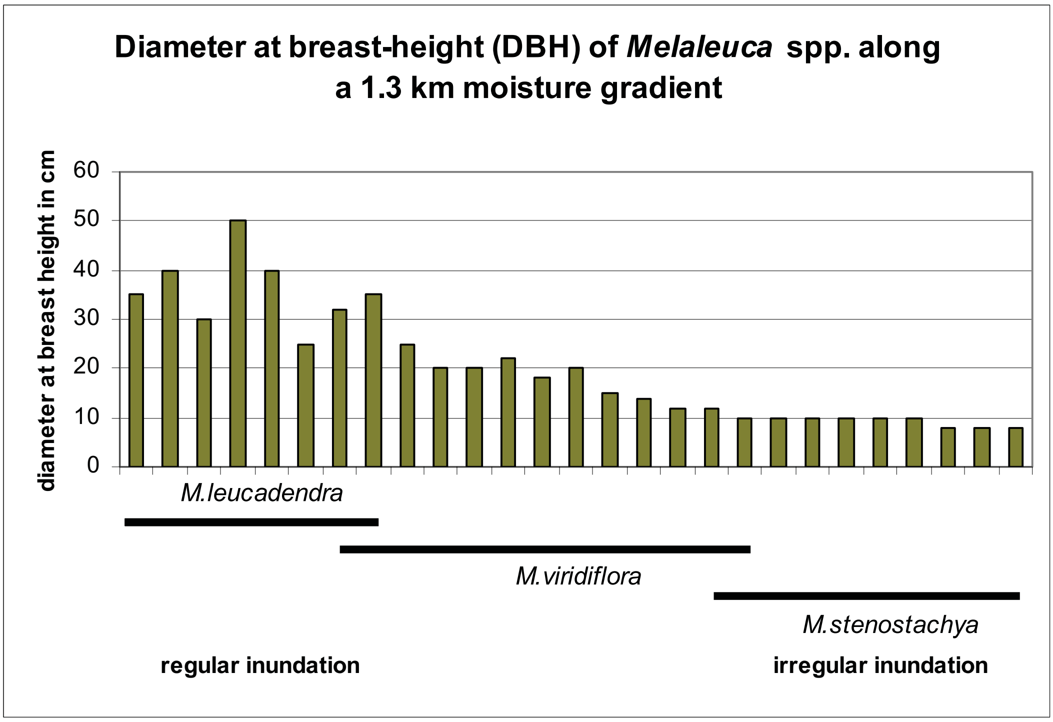

Figure 4. The average diameter at breast-height of stems of *Melaleuca leucadendra*, *M. viridiflora* and *M. stenostachya* along a moisture gradient of 1.38 km (Transect 4), at Top Lake.

diameter of up to a factor of three when growing increasingly further away from the limit of surface water and zone of regular inundation (Fig. 4).

At a site on Middle Lake (Transect 13), the relative variation in stem diameter of *M. viridiflora* was even greater (Fig. 5). This transect was perpendicular to the lake edge and proceeded from the regularly inundated lake margin into *M. viridiflora* woodland, which was beyond the limits of inundation. The limits of inundation were determined, and there was a strong relationship between average stem diameter and limits and duration of inundation. In this transect, individuals of *M. viridiflora* that were growing in inundated sites had stem diameters ranging from 20 cm to 60 cm at breast height, whilst those in un-inundated sites had stem diameters ranging from 5 cm to 10 cm. There was a regular progression from the large stemmed individuals to the small stemmed individuals along the transect (Fig. 5).

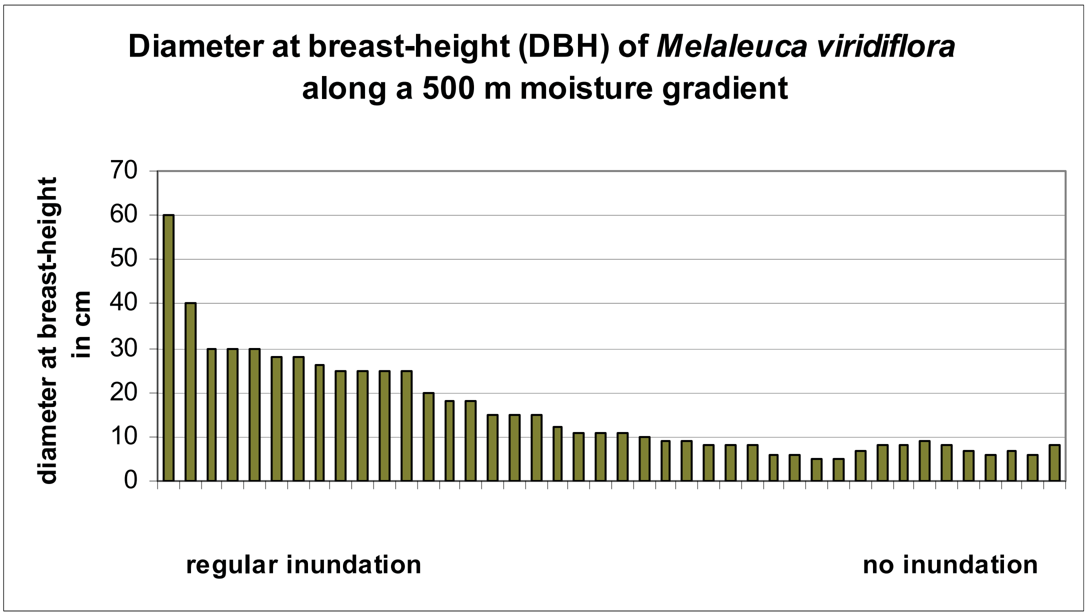

Figure 5. The average diameter at breast-height of stems of *Melaleuca viridiflora* along a moisture gradient of 500 m (Transect 13), at Middle Lake.

3.3 Distribution of lake margin species

The distribution of species relative to distance from the lake margins was determined at a number of transects (see Appendix 1). At Transect 20 in the Lower Lakes, which traversed a distance of 230 m between two of the lakes in that area, the distribution of species occurring in regularly inundated to infrequently inundated zones was recorded (Fig. 6). Of the species recorded at Transect 20, four (*Lophostemon suaveolens*, *Asteromyrtus symphyocarpa*, *M. leucadendra* and *Barringtonia acutangula*) displayed a positive response to occurrence in regularly inundated zones; two species (*Calycopeplus casuarinoides* and *M. viridiflora*) showed no particular preference and occurred in more or less equal densities in both regularly inundated and infrequently inundated zones.

In another transect in the Lower Lakes (Transect 21), species occurrence along a regularly inundated to never inundated gradient of 900 m length was recorded (Fig. 7). The preference of species relative to inundation regimes was established. There were four species (*Acacia auriculiformis*, *L. suaveolens*, *B. acutangula* and *M. leucadendra*) that were strictly confined to the regularly inundated zone. Two species (*Asteromyrtus symphyocarpa* and *Acacia holosericea*) displayed preference for the infrequently inundated zone, whilst two species (*Corymbia* sp. and *M. foliolosa*) displayed a strict preference to the never inundated zone.

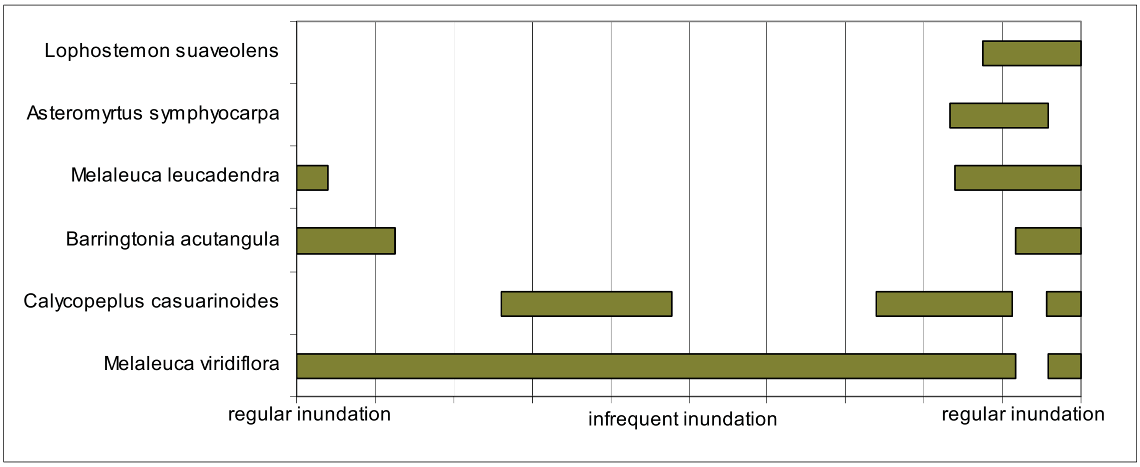

Figure 6. Presence of tree and shrub species along a 230 m transect between two lakes at Jack Lakes, Lower Lakes area (Transect 20), recorded on a presence/absence basis in 100 m² quadrats.

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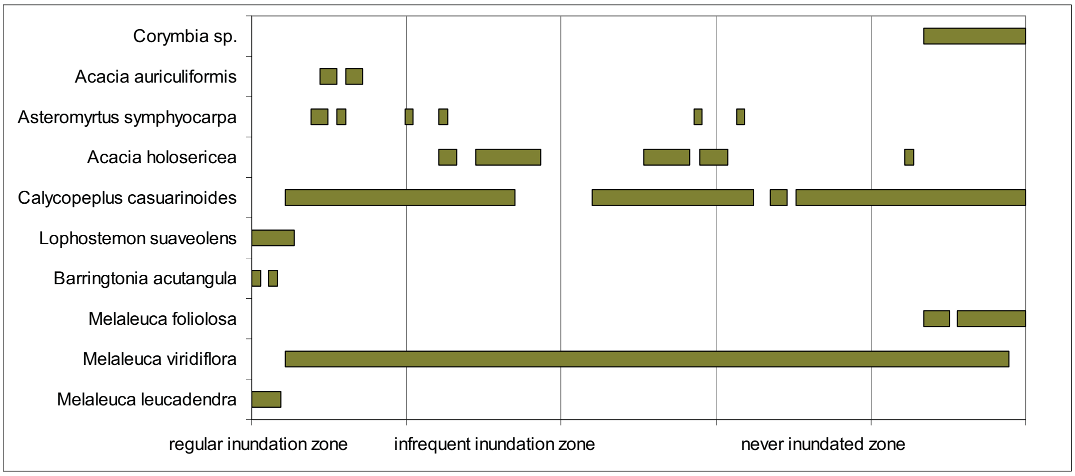

Figure 7. Presence of tree and shrub species along a 900 m transect along a moisture gradient on a ridge between two lakes at Jack Lakes, Lower Lakes area (Transect 21), recorded on a presence/absence basis in 100 m² quadrats.

4.0 DISCUSSION

4.1 Rare species

Given the preliminary nature and short duration of the present survey, no rare or threatened species were directly observed. However, some aquatic species such as *Aponogeton* spp., Cyperaceae spp. (e.g. *Lepironia articulata*, *Schoenus calystachyus* and *Baumea teretifolia*) and Restionaceae (*Dapsilanthus elatior*) may have been in a state of seasonal quiescence, as the survey time was in late dry season and with water levels at their lowest. Conversely, these species may also have been consumed by pigs, which were observed in large numbers and whose impact on aquatic vegetation is unknown but strongly evident. Evidence of pig activities were prevalent at all the vegetation transects, with the most severe levels of impact on the lake margins and in shallow water zones.

4.2 Regeneration

Regeneration of the dominant tree species was recorded in most transects. Dense swathes (>50 per 1 m²) of *M. leucadendra* saplings were present at what were the limits of previous high inundation events. Seedlings and juveniles of *M. viridiflora* were otherwise observed scattered throughout the populations, although the densest aggregations of these were in the irregularly inundated or never inundated zones, rather than at the limits of high inundation events.

Significant levels of regeneration of secondary species such as *Barringtonia acutangula* and *Calycopeplus casuarinoides* were observed.

4.3 High Value Habitat Areas

Considering the results of the 21 vegetation survey transects, a number of High Value Habitat areas can be recognized. These areas are indicated on the map in Figure 8.

1. margins and adjoining forest on the eastside of Top Lake, where areas of Cyperaceae spp. are intact.
2. seasonally dry drainage channels and adjacent forests between Top Lake and Middle Lakes, where fringing *M. leucadendra* and *M. fluviatilis* populations are relatively healthier than other areas, and with little evidence of decline or stress.
3. sandy ridges on the east side of Middle Lakes, particularly in the areas between 'Fish Lake' and the eastern branch of Middle Lakes, where patches of open forest and *Acacia* thickets occur, and where populations of *Lomandra banksii* and *Thryptomene oligandra* show considerable development and lack of disturbance.
4. eastern side of Lower Lakes, particularly on the margins and adjacent inflow channels and creeks on the most eastern section, where a number of very tall (~25 m tall) *M. leucadendra* populations occur.
5. at the confluence of Jack River and the drainage channels of the Lower Lakes, where the *Melaleuca* dominated fringing vegetation meets riparian vegetation [evergreen notophyll vine forest] including *Buchanania arborescens*, *Dillenia alata*, *Leptospermum longifolium*, *Melaleuca fluviatilis*, *Syzygium papyraceum* and *S. eucalyptoides*. The contiguousness of these two significantly different types of habitats is unusual and worthy of listing as a high value ecosystem in its own right.

Of considerable interest was the high density of the uncommon orchid *Cepobaculum (Dendrobium) trilamellatum*, which occurred on *Melaleuca* spp. throughout the Jack Lakes area, but with significant high density in the areas adjacent to the northern margins of Top Lake on host trees of *M. stenostachya* and *M. clarksonii*. It was otherwise uncommon on other, more dominant species such as *M. leucadendra* and *M. viridiflora*, and with another orchid *Cepobaculum (Dendrobium) canaliculatum*, being common on the latter species.

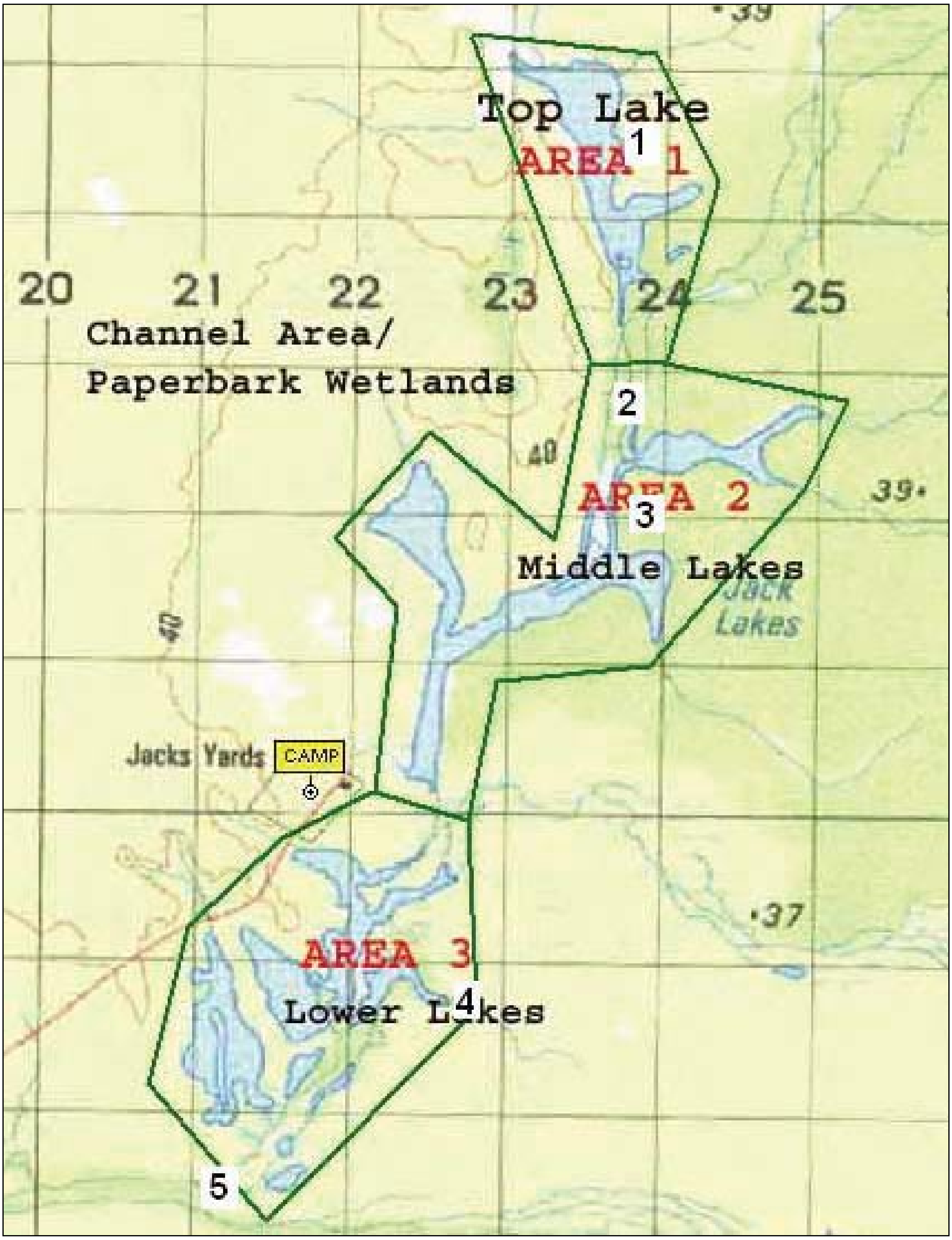

Figure 8. Map indicating High Value Habitat areas as determined during the November 2007 vegetation survey.

4.4 Habitat Condition and Biodiversity Values

Overall, the impact of pigs is severely negatively affecting the condition of habitats throughout the Jack Lakes area. With seasonal reduction is surface water, and greater accessibility to aquatic plants that have grown during the inundation period, pigs are capable of consuming and trampling vast areas of sedge beds and aquatic grass swards. In addition, the impact of cattle on the margins has a similar, though less detrimental, effect. To effectively maintain the existing biodiversity values, effective control of pigs and the limiting of access to cattle must be initiated and achieved.

In general, the eastern portion of Jack Lakes is in a much better ecological condition than the western portion. It may be that the impact of cattle has been greater on the western areas as access to the east is restricted during the wet season inundation, a time when vegetation is more sensitive to disturbance.

During this survey, no weeds of significance were observed within the Jake Lakes system. However, the potential for Rubber Vine (*Cryptostegia grandiflora*) to become established is high. This species has the propensity to invade disturbed areas, particular those where cattle impacts are prevalent. It is recommended that vigilance be maintained for Rubber Vine, and that if detected, an eradication program be put in place.

During this survey, the evidence of past fires was observed in a number of transects. It is not known whether fires have had a detrimental effect on regeneration and distribution of lake margin species, or whether they are exacerbating or assisting in maintaining ecological integrity that is being threatened by pig and cattle impacts. It is recommended that the role of fire at Jack Lakes be investigated and that a fire management program be put in place.

There are a number of plant species of conservation significance within the Jack Lakes system. These include a suite of aquatic macrophytes including *Aponogeton elongatus*, *A. queenslandicus*, *Astonia australiense* and *Vallisneria gracilis*. Vulnerable species known to occur in adjacent forests and woodlands include *Gardenia psidioides*, *Acacia fleckeri*, *Archidendron hirsutum*, *Croton brachypus* and *Macrostelia grandiflora*, among others. During this survey, an extensive population of the orchid *Cepobaculum (Dendrobium) trilamellatum* was observed, with very high density in the lake margin *Melaleuca* forest associated with Top Lake. An effort to conserve the species of conservation significance is highly recommended.

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APPENDIX 1: Descriptions and positions of vegetation transects (n=21) that were established at Jack Lakes 19-22 November, 2007.

Top Lake - Transects 1-5

Middle Lakes – Transects 6-14

Bottom Lakes – Transects 15-21

Transect	Description	GPS co-ordinates
1	across lake, 260 m long, perpendicular to edges, population density of *Melaleuca* spp.	S14° 51.469', E144° 25.586' S14° 51.547', E144° 25.703'
2	across lake, 310 m long, perpendicular to edges, ± parallel to Transect 1, population density of *Melaleuca* spp.	S14° 51.621', E144° 25.680' S14° 51.592', E144° 25.535'
3	along drainage line into lake, parallel to edge, 1380 m long, population density of *Melaleuca* spp.	S14° 51.000', E144° 25.584' S14° 51.650', E144° 25.605'
4	along drainage line into lake, parallel to edge, 1380 m long, height and DBH of *Melaleuca* spp., presence of species	S14° 51.000', E144° 25.584' S14° 51.650', E144° 25.605'
5	parallel to edge, 300 m long, population density of *Melaleuca leucadendra*	S14° 51.384', E144° 26.090' S14° 52.567', E144° 25.964'
6	parallel to edge, 300 m long, population structure of *Melaleuca leucdadendra*	S14° 53.619', E144° 25.437' S14° 53.477', E144° 25.416'
7	perpendicular to edge, 260 m long, population structure of *Melaleuca leucadendra*	S14° 53.155', E144° 25.198' S14° 53.252', E144° 25.000'
8	parallel to edge, 200 m long, density of *Melaleuca* spp.	S14° 53.252', E144° 25.267' S14° 53.346', E144° 25.193'
9	parallel to edge, 200 m long, density of *Melaleuca* spp.	S14° 53.320', E144° 25.918' S14° 53.498', E144° 25.921'
10	parallel to edge, 200 m long, density of *Melaleuca* spp.	S14° 53.121', E144° 26.115' S14° 53.210', E144° 26.068'
11	parallel to edge, 200 m long, density of *Melaleuca* spp.	S14° 53.561', E144° 26.094' S14° 53.633', E144° 26.022'
12	parallel to edge, 200 m long, density of *Melaleuca* spp.	S14° 53.576', E144° 25.258' S14° 53.508', E144° 25.172'
13	perpendicular to edge, 500 m long, density of *Melaleuca* spp., and presence of other species	S14° 53.481', E144° 25.199' S14° 53.700', E144° 25.126'
14	parallel to edge, 200 m long, *Melaleuca* spp. density, and presence of other species	S14° 54.310', E144° 25.243' S14° 54.235', E144° 25.166'
15	parallel to edge, 200 m long, *Melaleuca* spp. density, and presence of other species	S14° 55.298', E144° 25.075' S14° 55.310', E144° 25.181'
16	parallel to edge, 200 m long, *Melaleuca leucadendra* density, and presence of other species	S14° 55.188', E144° 25.370' S14° 55.100', E144° 25.315'
17	parallel to edge, 200 m long, *Melaleuca leucadendra* density, and presence of other species	S14° 54.973', E144° 25.216' S14° 54.905', E144° 25.286'
18	across Jack River, 110 m long, presence of species	S14° 55.922', E144° 24.434' S14° 55.800', E144° 24.438'
19	parallel to edge, 200 m long, population structure of *Melaleuca leucadendra*, presence of other species	S14° 55.076', E144° 24.720' S14° 55.177', E144° 24.762'
20	between lakes, 230 m long, presence of all species	S14° 55.32', E144° 24.712' S14° 55.384', E144° 24.834'
21	along ridge between lakes (parallel to edges), 900 m long, presence of all species	S14° 55.384', E144° 24.834' S14° 54.901', E144° 24.569'

APPENDIX 2: Plant species recorded in the Jack Lakes area. Compiled from data in DPI (1993), Nelder & Clarkson (1995) and Nelder (1999), and vegetation surveys done 18-22 November, 2007. Family abbreviations are included in brackets.

Abrus precatorius (Fab.)
Acacia auriculiformis (Mimos.)
Acacia fleckeri (Mimos.)
Acacia midgleyi (Mimos.)
Acacia polystachya (Mimos.)
Acacia salicina (Mimos.)
Acacia torulosa (Mimos.)
Albizia canescens (Mimos.)
Alyxia spicata (Apocyn.)
Aponogeton elongatus (Aponogeton.)
Aponogeton queenslandicus (Aponogeton.)
Archidendron hirsutum (Mimos.)
Aristida sp. (Poa.)
Asteromyrtus symphyocarpa (Myrt.)
Astonia australiense (Alismat.)
Atracocarpus sessilis (Rubi.)
Austrosteenisia blackii (Fab.)
Azolla pinnata (Azoll.)
Banksia dentata (Prote.)
Barringtonia acutangula (Lecythid.)
Baumea teretifolia (Cyper.)
Blepharocarya involucrigera (Anacard.)
Blyxa sp. (Hydrocharit.)
Brachychiton garrawayae (Stercul.)
Buchanania arborescens (Anancard.)
Calycopeplus casuarinoides (Euphorb.)
Carallia brachiata (Rhizophor.)
Cepobaculum canaliculatum (Orchid.)
Cepobaculum trilamellatum (Orchid.)
Chionanthus ramiflora (Ole.)
Choriceras tricorne (Euphorb.)
Chrysophyllum lanceolatum (Sapot.)
Cleistanthus apodus (Euphorb.)
Corymbia clarksonii (Myrt.)
Corymbia polycarpa (Myrt.)
Croton brachypus (Euphorb.)
Cymbidium canaliculatum (Orchid.)
Cynodon dactylon (Poa.)
Cyperus spp. (Cyper.)
Dapsilanthus elatior (Restion.)
Dichanthium sericeum (Poa.)
Dillenia alata (Dillen.)
Diospyros sp. (Eben.)
Diplatia tomentosa (Loranth.)
Dischidia nummularia (Asclepiad.)
Dolichandrone heterophylla (Bignon.)
Dysoxylum oppositifolium (Meli.)
Eleocharis (Cyper.)
Endiandra glauca (Laur.)
Epaltes australis (Aster.)
Eragrostis sp. (Poa.)
Eremochloa bimaculata (Poa.)
Eriachne sp. (Poa.)
Erythrophleum chlorostachys (Caesalpin.)
Eucalyptus chlorophylla (Myrt.)
Eucalyptus hylandii (Myrt.)
Eucalyptus phoenicea (Myrt.)
Eucalyptus tetradonta (Myrt.)
Eustrephus latifolius (Geitonoples.)
Ficus virens (Mor.)
Fimbristylis spp. (Cyper.)
Flagellaria indica (Flagellar.)
Flindersia brassii (Rut.)
Flueggea virosa (Euphorb.)

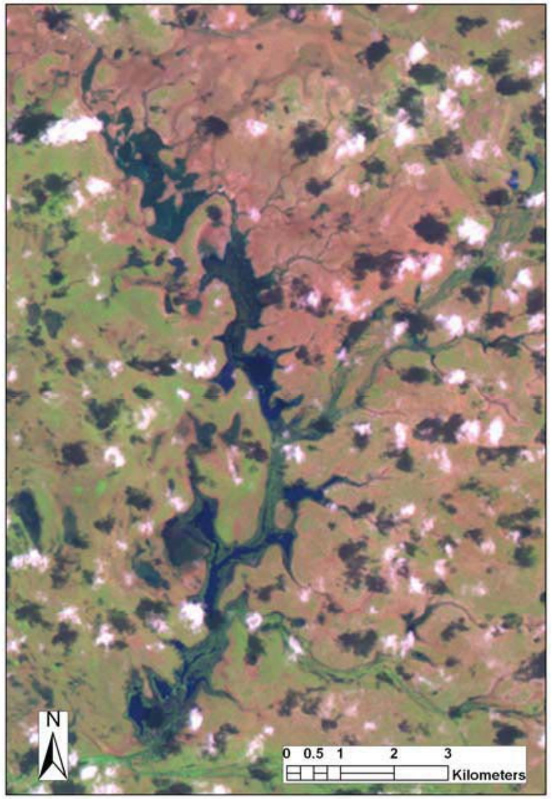
Gardenia psidioides (Rubi.)
Grevillea glauca (Prote.)
Grevillea pteridifolia (Prote.)
Grevillea striata (Prote.)
Grewia retusifolia (Tili.)
Hakea persiehana (Prote.)
Heteropogon contortus (Poa.)
Heteropogon triticeus (Poa.)
Hyptis suaveolens* (Lam.)
Hypserpa decumbens (Menisperm.)
Lagerstroemia archeriana (Lythr.)
Lepironia articulata (Cyper.)
Leptocarpus sp. (Restion.)
Leptospermum longifolium (Myrt.)
Leptospermum madidum (Myrt.)
Litsea macrophylla (Laur.)
Livistona muelleri (Arec.)
Lomandra banksii (Laxmann.)
Lophostemon suaveolens (Myrt.)
Ludwigia perrenis (Onagra.)
Lygodium fexuosum (Lygod.)
Macrostelia grandiflora (Malv.)
Mallotus polyadenos (Euhorb.)
Marsilea mutica (Marsil.)
Melaleuca arcana (Myrt.)
Melaleuca clarksonii (Myrt.)
Melaleuca fluviatilis (Myrt.)
Melaleuca foliolosa (Myrt.)
Melaleuca leucadendra (Myrt.)
Melaleuca saligna (Myrt.)
Melaleuca stenostachya (Myrt.)
Melaleuca viridiflora (Myrt.)
Memecylon pauciflorum (Melastomat.)
Millettia pinnata (Fab.)
Monochoria cyanea (Ponteder.)
Myrsine porosa (Myrsin.)
Najas tenuifolia (Hydrocharit.)
Nauclea orientalis (Rubi.)
Nelumbo nucifera (Nelumbon.)
Nymphaea gigantean (Nymphae.)
Nymphoides sp. (Menyanth.)
Oplismenus spp. (Poa.)
Oryza australiensis (Poa.)
Oryza rufipogon (Poa.)
Owenia venosa (Meli.)
Pandanus spiralis (Pandan.)
Panicum sp. (Poa.)
Parinari nonda (Chrysobalan.)
Parsonsia sp. (Apocyn.)
Paspalidium sp. (Poa.)
Petalostigma banksii (Euphorb.)
Philydrum lanuginosum (Philydr.)
Rhynchospora heterochaeta (Cyper.)
Sarga plumosa (Poa.)
Schizachyrium sp. (Poa.)
Schoenus calostachyus (Cyper.)
Schoenus sparteus (Cyper.)
Scleria sp. (Cyper.)
Siphonodon pendulus (Celast.)
Strychnos lucida (Logan.)
Syzygium argyropedicum (Myrt.)
Syzygium forte (Myrt.)
Syzygium papyraceum (Myrt.)
Terminalia platyphylla (Combret.)
Themeda arguens (Poa.)
Themeda triandra (Poa.)
Thryptomene oligandra (Myrt.)
Triumfetta rhomboidea* (Tili.)
Utricularia sp. (Lentibular.)
Vallisneria gracilis (Hydrocharit.)
Vandasina retusa (Fab.)
Vetiveria sp. (Poa.)
Vitex helogiton (Lami.)

APPENDIX 3. List of Voucher Specimens collected at Jack Lakes, 18-22 November 2007.

Species	Family	Date	GPS	Notes
Albizia sp. ?	Mimos.	191107	Top Lake S14° 52.503', E144° 25.866'	Flowering
Asteromyrtus symphyocarpa	Myrt.	181107	Middle Lakes S14° 53.576', E144° 25.258'	Fruiting
Atractocarpus sessilis	Rubi.	221107	Jack River S14° 55.800', E144° 24.438'	Fruiting
Barringtonia acutangula	Lecythid.	221107	Lower Lakes, Lake 3b S14° 55.177', E144° 24.762'	Flowering and fruiting
Baumea sp.	Cyper.	221107	Jack River S14° 55.800', E144° 24.438'	Flowering
Calycopeplus casuarinoides	Euphorb.	221107	Jack River S14° 55.800', E144° 24.438'	Fruiting
Cepobaculum canaliculatum	Orchid.	221107	Lower Lakes, Lake 3c S14° 55.272', E144° 24.752'	Fruiting, growing on Melaleuca viridiflora
Cepobaculum trilamellatum	Orchid.	181107	Top Lake S14° 50.923', E144° 25.527'	Flowering and fruiting, growing on Melaleuca stenostachya
Cyperus sp.	Cyper.	221107	Top Lake S14° 51.547', E144° 25.703'	Flowering
Diplatia furcata	Loranth.	221107	Jack River S14° 55.800', E144° 24.438'	Flowering, growing on Melaleuca leucadendra
Dischidia mammalaria	Asclepiad.	221107	Jack River S14° 55.800', E144° 24.438'	Flowering
Eleocharis sp.	Cyper.	191107	Top Lake S14° 51.592', E144° 25.535'	Sterile
Epaltes australis	Aster.	191107	Top Lake S14° 51.592', E144° 25.535'	Fruiting
Erythrophleum chlorostachys	Caesalpin.	191107	Top Lake S14° 52.503', E144° 25.866'	Flowering
Grevillea glauca	Prot.	221107	Top Lake S14° 52.503', E144° 25.866'	Fruiting
Grevillea striata	Prot.	221107	Top Lake S14° 52.503', E144° 25.866'	Fruiting
Leptospermum longifolium	Myrt.	221107	Jack River S14° 55.800', E144° 24.438'	Flowering and fruiting
Livistona muelleri (1)	Arec.	191107	Top Lake S14° 52.567', E144° 25.964'	Sterile
Livistona muelleri (2)	Arec.	221107	Jack River S14° 55.922', E144° 24.434'	Fruiting
Lomandra banksii	Laxmann.	201107	Middle Lakes, east side S14° 53.350', E144° 26.099'	Flowering and fruiting
Melaleuca foliolosa	Myrt.	221107	Bottom Lakes S14° 54.901', E144° 24.569'	Sterile
Melaleuca leucadendra	Myrt.	221107	Top Lake S14° 51.547', E144° 25.703'	Flowering
Melaleuca stenostachya	Myrt.	191107	Top Lake S14° 51.000', E144° 25.584'	Fruiting, host tree of Cepobaculum trilamellatum

Melaleuca viridiflora	Myrt.	191107	Top Lake S14° 51.650', E144° 25.605'	Flowering
Siphonodon pendulus	Meli.	191107	Top Lake S14° 52.503', E144° 25.866'	Fruiting
Syzygium eucalytoides	Myrt.	211107	Jack River S14° 55.800', E144° 24.438'	Flowering
Syzygium papyraceum	Myrt.	221107	Jack River S14° 55.800', E144° 24.438'	Flowering
Vandasina retusa ?	Fab.	221107	Jack River S14° 55.800', E144° 24.438'	Fruiting

APPENDIX 4. Satellite imagery showing wet and dry season inundation levels.



February 1996 (wet season)

April 1997 (post wet season)

August 2003 (dry season)

Sources: Archival Landsat TM images: Maps prepared by L. Lymburner, ACTFR.

APPENDIX C:

Terrestrial Invertebrates Report - Stephanie Seuss (Griffith University)

Invertebrates of Jack Lakes

Stephanie Suess
Griffith University
25/9/08

Trapping methods

Flying insects were targeted for sampling using malaise trapping techniques. Malaise traps are made of combination white and black polyamide textile, designed to be suspended in the terrain and fixed by steel pins (26.61 height 120 cm, breadth 100 cm, length 150 cm). Malaise, are a flight interception trap, which is placed 90 degrees to a natural insect flight line. A flying invertebrate once stopped by the netting instinctively flies upward towards the roof and into the collection bottle, which in this case contained tissues covered in household fly spray as the insecticide. A Malaise trap is used to ascertain the diversity within orders on the sites and, being a 'flight intercept' trap, it is particularly good at catching orders of flying insect, which tend to feature; Diptera (flies), Lepidoptera (moths & butterflies), Neuroptera (lacewings), Coleoptera (beetles), Orthoptera (grasshoppers & crickets), Odonata (damselflies & dragonflies).

Insect sampling design

Traps were left on each site, top, middle, and lower lakes of Jack Lakes. One was placed in the riparian zone, which is close to and influenced by the body of water, and the other in the woodland, which is further away from the water. The Malaise traps were left out for approximately 24 hours on each site and collected at as close to the same times as possible. The collected samples were preserved in methylated spirits.

Traps were set at the top lake on the 17/6/18, one in the riparian (close to water) and one in the woodland (further from water) zone. On the 18/6/08 both were moved to the middle site, then the bottom site on the 19/6/08. Traps were set in the afternoon, and removed at around the same time of day, 24 hours later, preserving collected samples in methylated spirites. Once preserved and labeled, samples were transported to Griffith University (Brisbane), and sorted into the taxonomic orders: Collembola; Blattodea; Orthoptera; Heteroptera; Neuroptera; Coleoptera; Diptera; Trichoptera; Lepidoptera; Hymenoptera; Araneae; and Odonata. Numbers were tallied and used as raw data.

Results

Table 1. Raw data table of orders at each site from Malaise traps

	Bottom Lake (3C)		**Middle Lake**		**Top Lake**	
Orders	***Woodland***	***Riparian***	***Woodland***	***Riparian***	***Woodland***	***Riparian***
Collembola	0	12	1	0	0	4
Blattodea	2	2	0	0	0	4
Orthoptera	0	1	0	0	0	1
Heteroptera	10	10	26	11	6	3
Neuroptera	5	5	0	0	0	2
Coleoptera	3	10	2	3	0	4
Diptera	113	233	247	200	141	44
Trichoptera	2	9	0	0	0	0
Lepidoptera	5	15	3	7	11	16
Hymenoptera	11	16	10	9	24	6
Araneae	2	0	0	2	0	2
Odonata	0	0	1	0	0	0

Using the raw data table, graphs were produced using the Windows Excel program to visually show the comparisons between lakes, each looking at different Orders with ample abundance, which are depicted on figures 1 to 5.

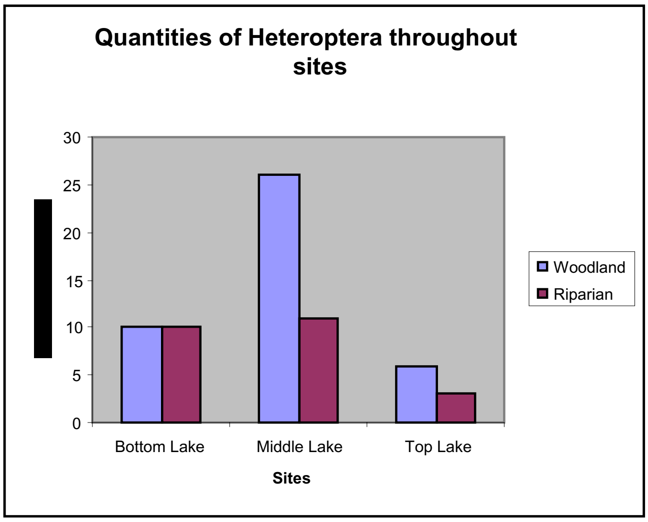


Figure 1. Quantities of Heteroptera at Lakes

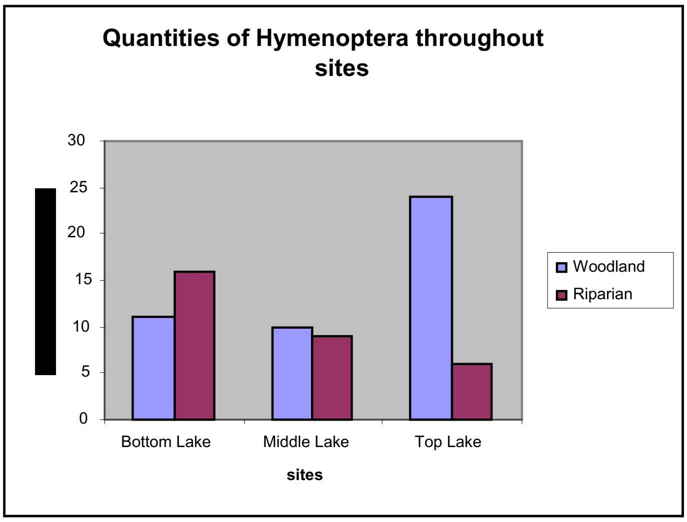


Figure 2. Quantities of Hymenoptera at Lakes

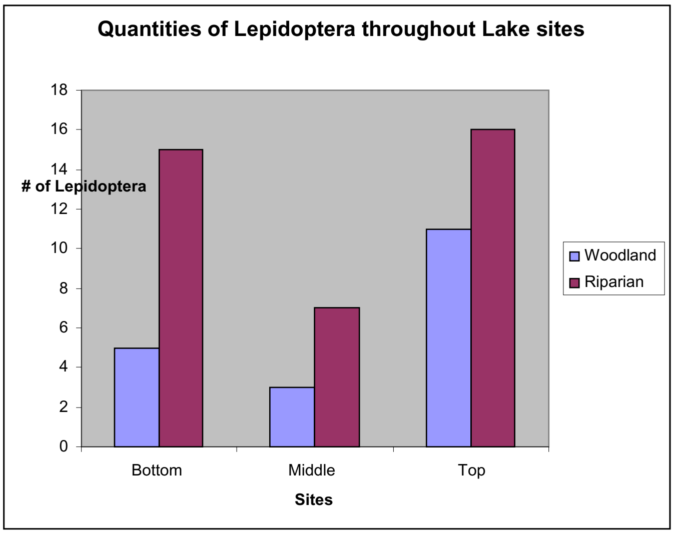


Figure 3. Quantities of Lepidoptera at Lakes

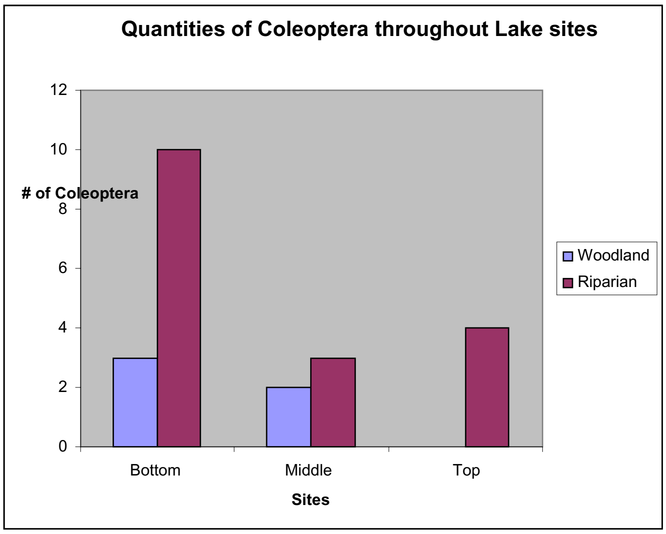


Figure 4. Quantities of Coleoptera at Lakes

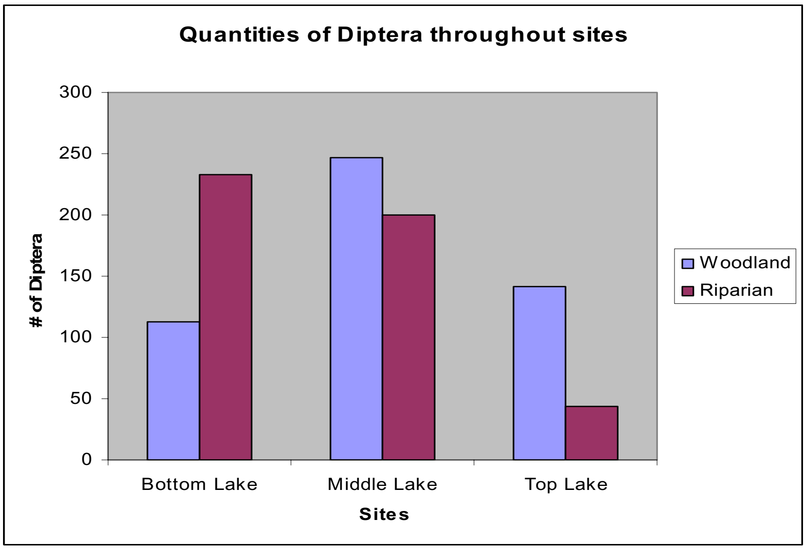


Figure 5. Quantities of Diptera at Lakes

Using the Statistical Analyst System, SAS, a table of means shows there is larger variance and higher abundance closer to the water as shown in figure 6.

Figure 6. SAS table of means for Diptera comparing riparian and woodland

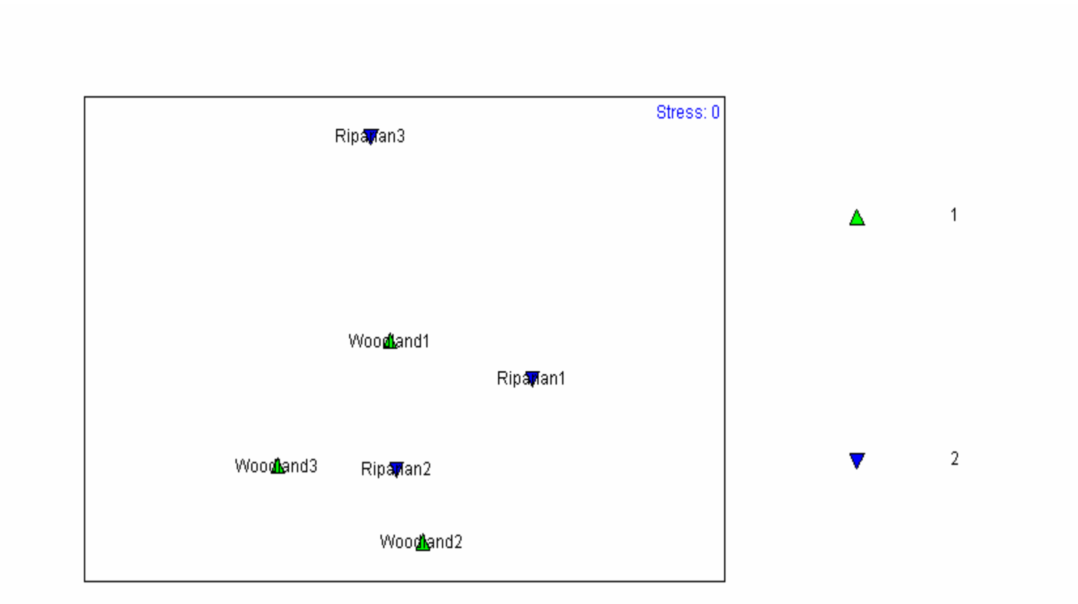


Figure 7. Multi Dimensional Scaling, using square root Bray, Curtis dissimilarity (PRIMER)

4

Cluster analysis was conducted using a PRIMER algorithm, using each site as an a-priori cluster. Multi-dimensional scaling (MDS) was used to produce ordination plots illustrating the relationship between sites, using the Bray-Curtis dissimilarity measure. This figure depicts the similarities of all of the sites, illustrating that riparian and woodland sites are not clearly distinguished from each other.

Discussion

Invertebrates constitute a major component of diverse ecosystems and play a lead roll in functioning of ecosystem processes, and are known to be one of the most important groups in the natural world (Kim 1993). As insects are easier to catch, track, more abundant and diverse, and be as trackers of ecosystem health, it is of most importance that they are studies in a methodical way for a comprehensive look at particular ecology health. They are rarely addressed effectively within biodiversity monitoring programs, although they are given overwhelmingly dominant contribution in the tracking of changes of biological integrity of ecosystems (Anderson et al 2004), referring to the ecological complexity of the entire body of organisms and their environment, and the related ecological processes (You et al 1993).

As Malaise traps are biased toward winged invertebrates, they are expected to collect high of Diptera, Hymenoptera, Coleoptera, Heteroptera, and Lepidoptera seen in Table 1. Because of timeframe requirements, Orders were the only identification level possible at this time

Time restrictions also effected the sampling, so two replicates were placed on each site (woodland and riparian), or looking at it differently; only one at each division. This causes major problems when trying to perform statistical analysis upon the data, because it gives the samples incredibly low power. Statistical Power reflects the ability to detect real effects as the size of the study sample is critical to producing meaningful results (Williams, 1997). Low power produces little chance to detect a significant effect when looking at a hypothesis test (High 2000), therefore statistical analysis was unable to be run upon this data.

Using the raw data (Table 1), the Diptera are evidently the higher in abundance throughout all the lake sites, dominating in the Woodland zones in the Middle and Top Lakes (Figure 5). The Diptera also had the largest variety in species diversity compared to any other of the orders

The Woodland Zone shows higher abundance in Hymenoptera, Heteroptera, and Diptera, with each order dominating a different lake sites (figures 1, 2, & 5). Lepidoptera however, show significantly higher numbers in the Riparian zone in the Bottom and Top Lakes (figure 3).

The surprising find, is the lack of Odonata (dragonflies) found in the traps within the riparaian zones because of the huge numbers observed on site, which suggests that dragonflies are not easily trapped using this particular method. Although the lack of replications prevented statistical analysis, the presentation of data shows at this small scale of information attained doesn't give enough information and the whole representation of each sites. It is clear that any further investigation into the diversity of insects in this area, and the patterns associated with the riparian and woodland zones, requires further sampling effort.

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APPENDIX D:

Report on the Aquatic Invertebrate Fauna of Jack Lake - Dr Fiona McKenzie-Smith (Griffith University)

Report on the aquatic invertebrate fauna from various habitats of Jack Lakes

Fiona McKenzie-Smith

December 2008

Background

The Jack Lakes occur in tropical north Queensland and are located in southern inland Cape York. They are known to be typically variable in their water regimes and largely permanent. The lakes flow into the Jack River which forms part of the Normanby River catchment. During the wet season the lakes and surrounding floodplains are inundated and the aggregation forms a single large waterbody. The context of this survey is as one component of various terrestrial and aquatic surveys and assessments of biodiversity and water quality to provide knowledge for the guidance of management of this ecosystem as a national park. The specific aim of this survey was to determine aquatic invertebrate taxon abundance and richness in different habitats and compare across the three lakes comprising the Jack Lakes aggregation.

Methods

Aquatic macroinvertebrate samples were collected on 17, 18 and 19 June 2008 from Jack Lakes, North Queensland (14°54'24.84"S, 144°25'1.47"E)). For June, the mean maximum temperature is 20.3^{0}C and the mean minimum 4.9^{0}C. The mean rainfall for June is 43.3mm (Kalpowar Forestry Station, Bureau of Meteorology 2008). The measured maximum water depth at the approximate centre of each lake during the sampling period was 1.7m (top lake), 2.9m (middle lake), 2.5m (bottom lake). The habitats sampled were chosen to reflect typical zones of distinct aquatic habitat (e.g. vegetated littoral, benthic, pelagic) or obvious areal abundance in the whole lake (e.g. trunks/snag habitat).

Field Collection

- Samples were collected from the shallow littoral zone (usually amongst vegetation) using a 250µm D net. For each sample the net was swept through the habitat for 60 seconds. A total of five samples were collected from this habitat.
- Samples were collected from submerged trunks, roots and snags of freshwater mangroves using a 250µm D net. For each sample the net was swept through water and against the edges of the wood for 90 seconds. A total of five samples were collected from this habitat.
- Samples were collected from the shaded benthic zone at the edges of the lakes which were predominantly roots and detritus associated with paperbark and eucalyptus trees. These samples were collected using a Van Veen sediment grab with a capacity of 0.5L. A total of five samples were collected from this habitat.
- Samples were collected from the centre of the lake using a Van Veen sediment grab with a capacity of 0.5L. A total of five samples were collected from this habitat.

- Samples were collected from the subsurface pelagic zone using a 75µm plankton trawl net. Three replicate trawls (each 60m) were conducted in the morning and afternoon on each lake.

In the field samples were stained with rose bengal and preserved in 70% alcohol.

Laboratory Processing

Samples were evaluated for processing by examining a subset of habitats. This evaluation indicated that a subsampling procedure would be required. Samples were rinsed into a 250µm sieve and the sample was floated in water and then evenly distributed in a shallow dish. A 32 section grid was then applied and 8 random sections were selected and the sample contents removed using a pipette. The selected sample sections were then recombined to produce a subsample comprising of a total of 25% of the original sample. Samples were then picked for fauna using a stereo (dissecting) microscope. All fauna macroinvertebrate fauna were removed, however, in some samples the abundance of microcrustacea meant that organisms remained after 1.5 hours picking.

Due to the high number of individuals per sample and time constraints, for each lake, fauna were enumerated and identified to family or a practicable taxonomic level from three samples from the following habitats; littoral vegetation, submerged trunks and snags, centre benthic sediment and shaded littoral benthic roots.

Univariate and multivariate analyses were performed on fourth root transformed taxonomic abundance data. The data are coded and samples with the prefix 1000 are top lake; 2000 middle lake; 3000 bottom lake. The habitats are coded using a suffix so that 1 represents the vegetated littoral zone; 2 trunk/snag habitat; 3 benthic centre; 4 shaded benthic roots. For example, 1003 is the top lake benthic centre.

Results

The composition of organic material and sediments in samples was variable for each habitat type and between lakes. For example, benthic centre samples from top lake were observed to be rich in silt and clay, apparently more so than middle lake, and both contained more silt and clay than bottom lake samples. For the vegetated littoral zone, a typical sample contained fine particulate organic matter and detritus (approximately 80%) with the remainder being macrophyte or coarse particulate matter. Benthic roots and trunk/snag samples contained wood, bark, whole leaves and roots comprising up to 80% or 20% of sample organic material respectively. The remainder of these samples was fine particulate organic material and detritus. Benthic root samples from middle lake contained gravel whereas samples from this habitat in the top lake contained silt and clay.

Samples from the benthic centre were generally not well preserved compared to all other samples, this may have been due to a chemical or physical aspect of the sediment. Therefore, these samples are thought to have been an underestimate of abundance at least and, perhaps, richness.

Microcrustacea, and sometimes chironomids, were so abundant in many samples that after 1.5 hours of picking 100’s and 1000’s still remained in subsamples. This was particularly noted for samples collected from trunk/snag habitat from the top and middle lakes.

Table 1 (attached excel document) provides a list of the taxa that were identified during this survey. For some taxa, gross morphology or known characteristics were used as a guide to separation beyond the family level.

The microcrustacea and acarina are noted to be taxonomically diverse however due to time constraints these fauna were enumerated but identified only to a coarse taxonomic level.

Univariate diversity indices are provided in Table 2. The indicies are S : the total species - the number of species in each sample. i.e. species with non zero counts. N : total individuals - the number of individuals in each sample representing accumulated species counts. D : Margalef's species richness for each sample. It is a measure of the number of species present, making some allowance for the number of individuals. J′ : Pielou's evenness- this is a measure of equitability, a measure of how evenly the individuals are distributed among the different species. H′ : Shannon-Wiener diversity index.

Table 2

Sample	S	N	d	J'	H'(loge)
1001	35	64	8.173	0.9637	3.426
1002	39	62	9.214	0.9746	3.57
1003	14	19	4.454	0.9861	2.602
1004	24	37	6.376	0.9732	3.093
2001	55	88	12.05	0.978	3.919
2002	41	67	9.503	0.977	3.628
2003	14	19	4.444	0.9745	2.572
2004	21	33	5.717	0.9758	2.971
3001	40	67	9.288	0.9805	3.617
3002	29	50	7.16	0.9777	3.292
3003	10	13	3.543	0.9778	2.252
3004	33	43	8.487	0.9888	3.457

The highest numbers of taxa were observed in samples from the vegetated littoral zone and the snag/trunk habitats from all lakes. The lowest numbers of taxa were from the benthic centre habitat from all lakes. There were relatively high numbers of taxa observed in samples from the shaded benthic root zone of the bottom lake. Taxon richness was high in samples from the vegetated littoral zone and the trunk/snag habitat, except for the latter habitat in the bottom lake. In the bottom lake, the taxon richness was higher in the shaded benthic root zone compared with the other lakes and to the trunk/snags samples from this lake. There was no significant difference amongst the diversity measures (ANOVA $F_{(2,9)} = 0.1237$ $p>0.05$). The most variability in taxon richness observed amongst habitats within lakes was from middle lake. Evenness was lowest in the vegetated littoral zone of the top lake and high amongst samples from the benthic centre habitats from all lakes. Evenness was also high amongst samples from the shaded benthic root zone in the bottom lake. Diversity was lowest in samples from the benthic centres of all lakes. Diversity was highest in samples from the vegetated littoral zone and trunk/snag habitat from all lakes and in the shaded benthic root zone of the top and bottom lakes.

The degree of association between lakes and habitats is represented in a dendogram shown in Figure 1. This figure illustrates that samples from benthic centre habitat are unique from other habitats, with the top lake being more distinct from the other two lakes. Samples from the benthic root zone are linked with other habitats but also distinct for the top and bottom lakes whereas this habitat from the middle lake was most similar to the trunk/snag habitat from the bottom lake. Samples from the vegetated littoral zone from the top lake were most similar to each other and closely associated with the same habitat type from other lakes. The vegetated littoral zone samples from the bottom lake were most similar to the middle lake vegetated littoral zone and trunk/snag habitat.

A plot of multi-dimensional scaling based on a bray-curtis similarity measure (Figure 2. MDS stress 0.03) illustrates a similar pattern to that described above for the dendogram where the strongest cluster of similarity occurs amongst samples from the vegetated littoral zone. This figure also illustrates that the middle and bottom lake have samples that are relatively interspersed for the vegetated littoral and trunk/snag habitat and compared with the top lake. The most dispersed samples overall are associated with the bottom lake.

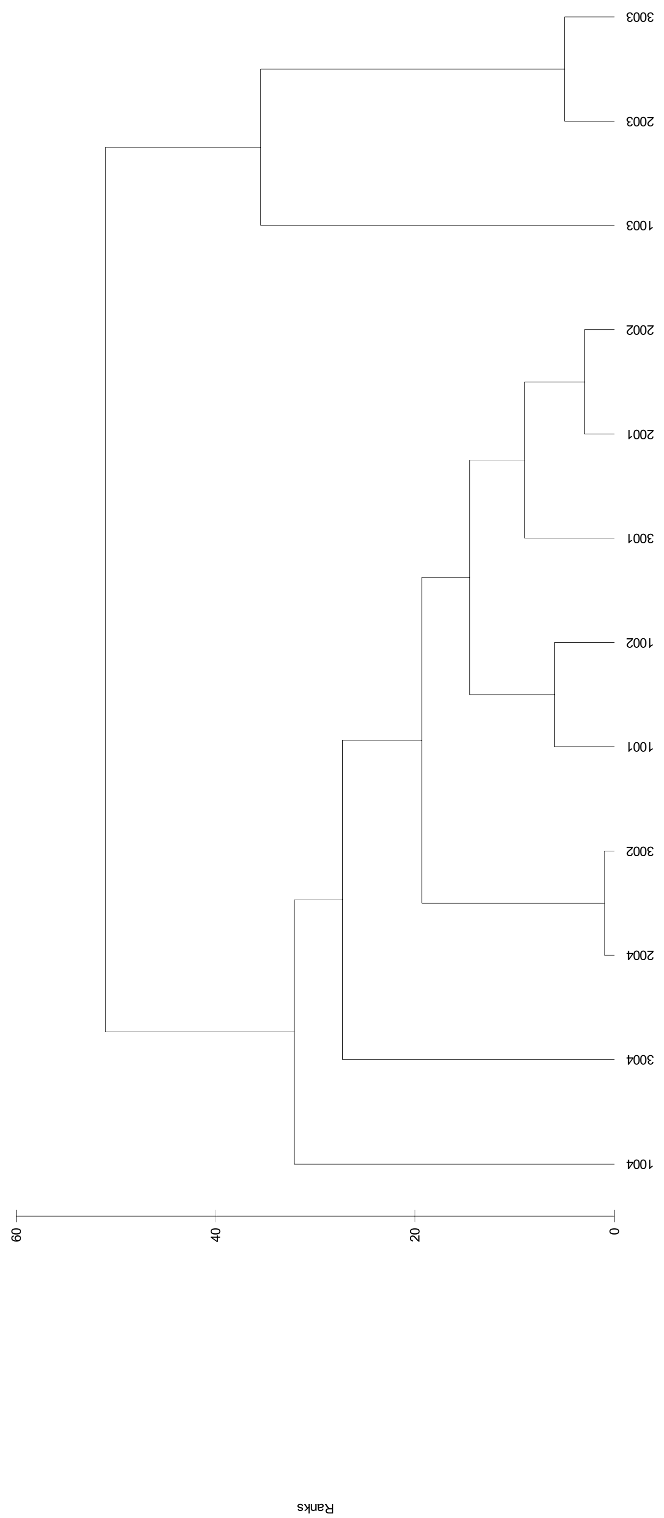
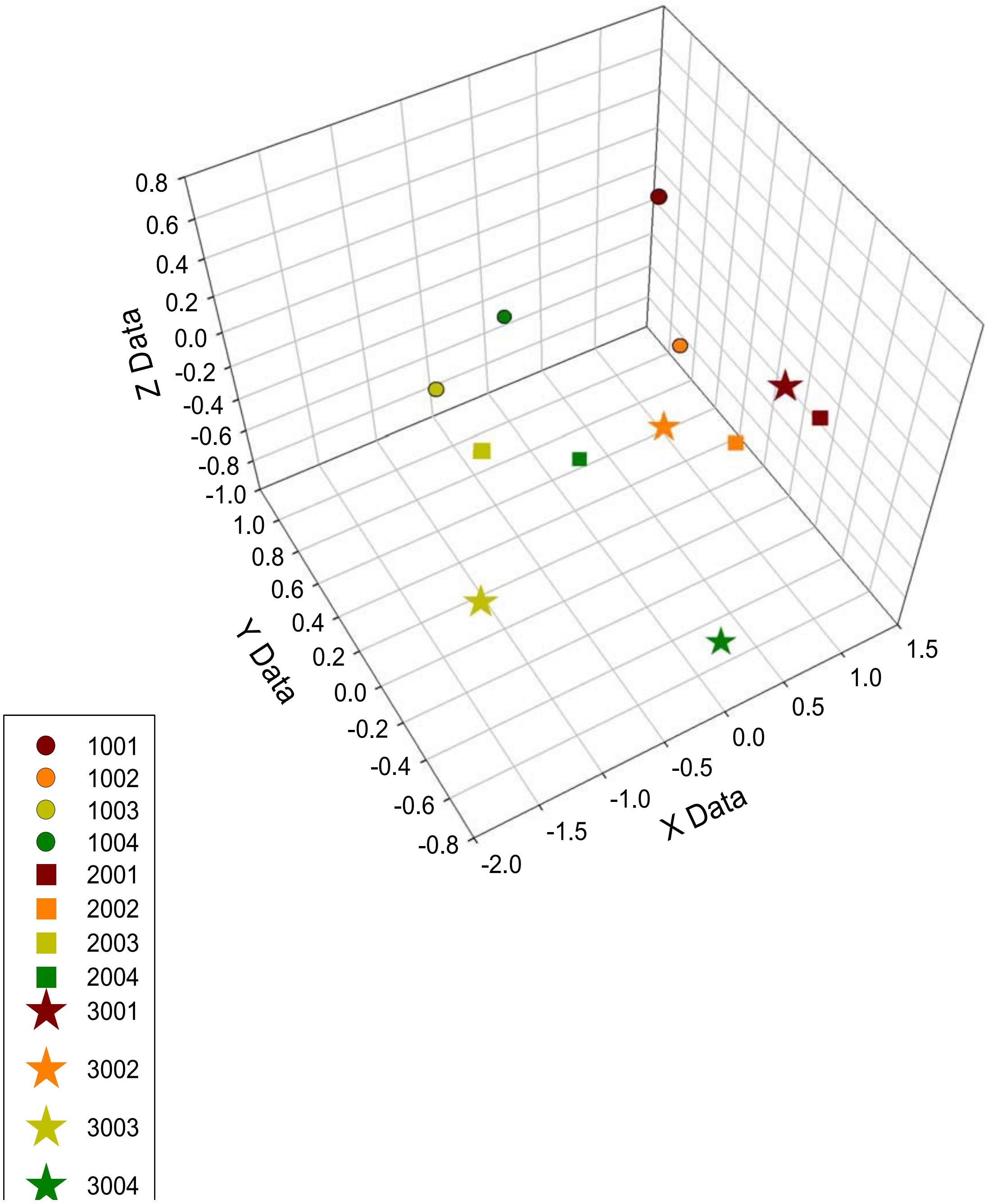


Figure 1 Dendogram representing proximity of relationships of different habitats from each lake.

Figure 2

3D MDS plot of aquatic taxa from top, middle and bottom lakes
from 4 different habitat types



Discussion

Taxa observed represented a variety of trophic levels and dynamics and clear distinction between habitats. There was a high representation of taxa that have desiccation resistant life stages or those that are able to relocate to suitable habitat through an aerial adult stage. These features are typical of Australian wetlands. Invertebrate fauna represented a range of functional groups including bactivores (e.g. microcrustacea, algal/diatom grazers (e.g. gastropods, chironomids, caddisflys, mayflys) and detritivores (e.g. mayflys, caddisflys) along with predators (e.g. beetles, dragonflys, true bugs).

The observed diverse and species rich littoral vegetated zone reflects the complexity of this habitat resource. A less obvious but similarly diverse and species rich habitat was the trunk/snag habitat which was prevalent in areal extent at the time of sampling. Due to water regimes, both habitats are variable in terms of availability and extent yet potentially provide abundant food and refuge to support bacteria, algae and other primary, secondary and higher order trophic consumers. The richness and diversity observed is comparable with other Australian intermittent aquatic habitats.

Samples collected from middle lake's vegetated littoral zone were the most taxon rich and diverse. During the sampling period this lake was the most extensive in terms of aquatic habitat and the indicies noted are comparable with other healthy, permanent freshwaters in Australia. This lake was also observed to have the most dense and extensive stands of trees associated with the shore lines, compared to other lakes where dense tree growth was patchy.

Dense fringe of vegetation on shore of middle lake

The top lake had different faunal characteristics from other lakes and interpretation and understanding of these differences will require further consideration of physical and chemical processes, including features of the water regime (timing, frequency, duration, extent and depth). This lake was highly turbid at the time of sampling which was observed on a previous end of wet season survey. There was one obvious temporal variation in the lake characteristics being the vast extent of coverage by emergent macrophytes across the surface of the lake that were not observed during the end of wet season survey.

Emergent macrophytes in the turbid waters of top lake

The bottom lake showed some overlap of taxon characteristics in samples collected in the shaded benthic root zone and the trunk/snag habitats of the middle lake (Figure 1). This may be attributable to the factors associated with water regime (inundation more recent in middle lake samples) or a decreased siltation in the shaded benthic roots of the bottom lake compared with other lakes.

A further observation was the areal extent of subsurface macrophytes due to the extensive photic zone in the bottom lake which would have extended the range of resources which in other lakes was limited to a narrow band of littoral zone vegetation. Water clarity would also increased foraging efficiency of predatory fauna. Numerous schools of small sized fish were observed foraging in littoral and extended macrophyte zone of the bottom lake. A comparative study of the morphology of the lakes along with knowledge of the key components of their water regimes would further inform hypotheses about the overlap in characteristics between bottom and middle lake habitats. The occurrence of a particular fish assemblage is likely to be determined by chance as waterbodies contract and become separated following wet season floodplain inundation. This may result in unique spatial and temporal assemblage characteristics and consequent pressures on the invertebrate prey which are a key food resource for small bodied fish.

Submerged macrophytes in clear waters of bottom lake.

This survey has highlighted the diversity and richness of invertebrate fauna associated with the vegetated littoral zone and trunk/snag habitat in particular, and interrelationships with the shaded benthic root zone. Whilst natural variation will be a prominent factor in the condition and extent of these habitats they are also highly vulnerable to management practices as there are strong links between terrestrial and aquatic environments. Primary factors include grazing and trampling (cattle and pigs), the impacts of human visitation and land management including vegetation removal and fire regimes. Water resource use and allocation would be expected to be a key factor if this was to be altered by humans.

Recommendations for further work to enhance the findings of this survey and increase scientific knowledge for management purposes include determining water regimes; investigating morphology and physical and chemical processes; temporally based surveying of invertebrates and fish (particularly quantifying the distribution and occurrence of key species and resources).

Terrestrial surrounds (near shores of bottom lake)

TABLE 1: Aquatic Invertebrates

Jack Lakes (14°54'24.84"S, 144°25'1.47"E) aquatic invertebrate fauna assemblage from 3 lakes and 4 habitats
Collectors F. McKenzie-Smith, Stephanie Suess & Malcolm McCollum. Identified by F. McKenzie-Smith

CODE

1001 = Top Lake littoral vegetation
1002 = Top Lake trunk/snag
1003 = Top Lake benthic centre sediment
1004 = Top Lake shaded benthic roots 16/6/2008

2001 = Middle Lake littoral vegetation
2002 = Middle Lake trunk/snag
2003 = Middle Lake benthic centre sediment
2004 = Middle Lake shaded benthic roots 17/6/2008

3001 = Bottom Lake littoral vegetation
3002 = Bottom Lake trunk/snag
3003 = Bottom Lake benthic centre sed
3004 = Bottom Lake shaded benthic roots 18/6/2008

PHYLUM	CLASS	ORDER	FAMILY	Sub-FAMILY	GENUS & SPECIES	COMMON NAME	1001	1002	1003	1004	2001	2002	2003	2004	3001	3002	3003	3004
Nematophora			Gordiidae			horsehair worm	0	0	0	0	1	0	0	0	0	0	0	0
Nematoda						round worms	36	6	0	27	1	2	1	1	0	3	0	0
Playhelminthes	Turbellaria					flatworm	19	5	0	1	0	4	0	3	1	28	1	5
Annelida	Oligochaeta				*Chaetogaster sp.*	segmented worm	43	6	1	1	0	1	1		3	2	0	0
Annelida	Oligochaeta		type A			segmented worm	51	47	3	20	7	24	2	23	1	15	0	0
Annelida	Oligochaeta		type B			segmented worm	9	3	0	0	0	0	0	0	1	0	0	0
Annelida	Oligochaeta		type C			segmented worm	0	0	0	0	0	2	0	0	9	35	0	2
Annelida	Oligochaeta		Tubificidae			segmented worm	0	0	1	0	0	0	0	1	0	0	0	3
Annelida	Hirudinea		Glossiphoniidae			leech	0	0	0	0	0	0	0	0	1	0	0	0
Cnidaria	Hydrozoa		Hydridae			hydra	7	1	0	0	1	1	0	0	1	6	0	2
Mollusca	Gastropoda		Planorbidae		*Amerianna*	snails	0	0	0	1	10	17	0	6	2	9	0	7
Mollusca	Gastropoda		Planorbidae		*Helicorbis*	snails	0	6	0	0	9	0	0	0	0	13	0	6
Mollusca	Gastropoda		Ancylidae			snails	0	0	0	1	0	2	0	0	0	0	0	0
Arthropoda	Crustacea (branchiopoda)	Diplostraca			Cladocera & Conchostraca	water fleas & clam shrimps	360	230	14	102	17	98	35	23	27	85	18	11
Arthropoda	Crustacea	Ostracoda			Taxon A spp.	seed shrimps	38	5	1	2	49	13	0	1	27	27	0	1
Arthropoda	Crustacea	Ostracoda			Taxon B spp.	seed shrimps	3	14	3	43	4	7	0	22	12	10	0	19
Arthropoda	Crustacea (copepoda)	Cyclopoida				copepods	1121	106	21	44	87	137	2	39	35	41	1	12
Arthropoda	Crustacea (copepoda)	Calanoida				copepods	58	0	0	0	1	6	0	0	0	0	1	0

PHYLUM	CLASS	ORDER	FAMILY	Sub-FAMILY	GENUS & SPECIES	COMMON NAME	1001	1002	1003	1004	2001	2002	2003	2004	3001	3002	3003	3004
Arthropoda	Crustacea (copepoda)	Harpacticoida				copepods	66	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Crustacea (malacostraca)	Decapoda	Atyidae			shrimp	1	5	0	0	8	38	0	0	7	0	0	5
Arthropoda	Arachnida		Araenae (terr.)			spider	0	1	0	0	0	1	0	0	0	0	0	0
Arthropoda	Acarina					water mites	26	45	2	0	21	4	1	2	89	6	1	1
Arthropoda	Insecta	Ephemeroptera	Caenidae			mayfly	1	3	0	0	17	67	2	0	41	1	1	1
Arthropoda	Insecta	Ephemeroptera	Baetidae			mayfly	5	3	3	0	68	38	13	0	54	36	1	0
Arthropoda	Insecta	Odonata (Zygoptera)	Coenoagrionidae			damselfly	0	4	0	0	10	27	0	0	7	0	0	2
Arthropoda	Insecta	Odonata (Zygoptera)	Protoneuridae			damselfly	0	0	0	0	2	0	0	0	0	0	0	0
Arthropoda	Insecta	Odonata (Zygoptera)	Calopterygidae			damselfly	0	0	0	0	0	0	0	0	1	0	0	0
Arthropoda	Insecta	Odonata (Zygoptera)	Diphlebiidae			damselfly	0	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Odonata (Zygoptera)			Immature specimens	damselfly	1	2	0	1	8	10	0	0	21	0	0	3
Arthropoda	Insecta	Odonata (Epiproctophora)	Lindeniidae			dragonfly	0	0	0	0	1	3	0	0	0	0	0	0
Arthropoda	Insecta	Odonata (Epiproctophora)	Hemicordulia			dragonfly	1	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Odonata (Epiproctophora)	Libellulidae			dragonfly	2	25	0	0	13	14	0	0	0	0	0	1
Arthropoda	Insecta	Odonata (Epiproctophora)	Gomphidae			dragonfly	1	1	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Odonata (Epiproctophora)	Austrocorduliidae			dragonfly	0	0	0	0	0	0	0	0	1	0	0	0
Arthropoda	Insecta	Odonata (Epiproctophora)	Macromiidae			dragonfly	0	6	0	0	9	1	0	0	0	0	0	1
Arthropoda	Insecta	Odonata (Epiproctophora)			Immature specimens	dragonfly	2	1	0	5	1	3	0	0	8	0	0	1
Arthropoda	Insecta	Hemiptera	Notonectidae			backswimmer	0	0	0	0	0	0	0	0	10	2	0	0
Arthropoda	Insecta	Hemiptera	Mesoveliidae			water treader	2	0	0	0	12	0	0	0	3	0	0	0
Arthropoda	Insecta	Hemiptera	Veliidae			small water treader	3	1	0	0	31	0	0	1	3	0	0	0
Arthropoda	Insecta	Hemiptera	Corixidae			waterboatmen	1	1	0	1	1	0	0	1	11	8	0	0
Arthropoda	Insecta	Hemiptera	Gelastocoridae		Taxon A	toadbug	3	0	0	0	5	1	0	0	6	1	0	0
Arthropoda	Insecta	Hemiptera	Gelastocoridae ?		Taxon B	toadbug	0	0	0	1	0	0	0	0	1	0	0	0
Arthropoda	Insecta	Hemiptera	Hydrometridae			water measureer	1	0	0	0	1	0	0	0	0	0	0	0
Arthropoda	Insecta	Hemiptera	Nepidae			needle bug	0	1	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Hemiptera	Naurocoridae			creeping water bug	0	1	0	0	0	0	0	0	0	0	0	0

PHYLUM	CLASS	ORDER	FAMILY	Sub-FAMILY	GENUS & SPECIES	COMMON NAME	1001	1002	1003	1004	2001	2002	2003	2004	3001	3002	3003	3004
Arthropoda	Insecta	Hemiptera	Pleidae			pygmy backswimmer	0	0	0	0	0	1	0	0	15	0	0	0
Arthropoda	Insecta	Hemiptera	Gerridae			true bug	0	0	0	0	1	1	0	0	0	0	0	0
Arthropoda	Insecta	Trichoptera	Hydroptilidae		Taxon A ?*Tricholeiochiton*	caddisfly	0	1	0	0	6	2	0	2	0	1	0	1
Arthropoda	Insecta	Trichoptera	Hydroptilidae		Taxon B	caddisfly	0	0	0	0	6	4	0	2	0	3	0	1
Arthropoda	Insecta	Trichoptera	Hydroptilidae		*Orthotrichia*	caddisfly	0	0	0	0	1	0	0	0	12	0	0	0
Arthropoda	Insecta	Trichoptera	Ecnomidae			caddisfly	0	0	0	0	7	5	0	7	0	0	0	2
Arthropoda	Insecta	Trichoptera	Hydropsychidae			caddisfly	1	0	0	0	18	1	0	0	1	1	0	2
Arthropoda	Insecta	Trichoptera	Leptoceridae		Taxon A	caddisfly	2	0	0	0	2	0	0	0	0	0	0	0
Arthropoda	Insecta	Trichoptera	Leptoceridae		Taxon B	caddisfly	0	3	0	0	1	0	0	1	0	1	0	2
Arthropoda	Insecta	Trichoptera	Leptoceridae		Taxon C	caddisfly	0	0	0	0	0	0	0	0	0	0	0	2
Arthropoda	Insecta	Trichoptera			Immature specimens	caddisfly	0	0	0	0	3	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Hydrophilidae (adult)		sp. A	water scavenger beetle	0	3	0	0	1	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Hydrophilidae (adult)		sp. B	water scavenger beetle	0	2	0	0	1	1	0	0	0	1	0	0
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. A	diving beetle	0	1	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. B	diving beetle	0	0	0	0	0	0	0	0	0	0	0	16
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. C	diving beetle	0	0	0	0	0	0	0	0	0	0	0	1
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. D	diving beetle	0	0	0	45	0	0	0	0	0	0	0	1
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. E	diving beetle	0	0	0	1	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Dytiscidae (adult)		sp. F	diving beetle	0	0	0	1	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Staphylinidae (adult)			beetle	0	0	0	0	1	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Hydrochidae (adult)			beetle	0	0	0	2	1	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	UNIDENTIFIED (adult)			beetle	0	1	0	0	1	0	0	0	0	1	0	0
Arthropoda	Insecta	Coleoptera	Gyrinidae (adult)			whirligig beetle	0	0	0	0	1	0	0	0	0	2	0	0
Arthropoda	Insecta	Coleoptera	Hydrophilidae (larvae)		sp. A	water scavenger beetle	0	0	0	3	3	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Hydrophilidae (larvae)		sp. B	water scavenger beetle	0	1	0	0	1	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Dytiscidae (larvae)		sp. A	diving beetle	1	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Dytiscidae (larvae)		sp. B	diving beetle	0	0	0	0	2	2	0	0	4	0	0	1
Arthropoda	Insecta	Coleoptera	Noteridae			beetle	0	0	0	0	0	1	0	0	0	0	0	0
Arthropoda	Insecta	Coleoptera	Curculionidae (larvae)			aquatic weevil	0	1	0	1	1	0	1	0	2	0	0	0

PHYLUM	CLASS	ORDER	FAMILY	Sub-FAMILY	GENUS & SPECIES	COMMON NAME	1001	1002	1003	1004	2001	2002	2003	2004	3001	3002	3003	3004
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae		non-biting midge	13	9	8	3	100	60	2	42	108	73	1	1
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladinae		non-biting midge	38	25	1	2	30	16	0	3	13	4	0	11
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae		non-biting midge	29	187	7	10	223	146	1	86	111	147	0	38
Arthropoda	Insecta	Diptera	Chironomidae		damaged specimens	non-biting midge	0	0	0	0	169	0	42	0	0	0	16	2
Arthropoda	Insecta	Diptera	Ceratopogonidae			biting midge	21	31	0	19	50	11	1	17	6	8	0	0
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae		biting midge	0	2	0	0	0	2	0	0	0	0	0	0
Arthropoda	Insecta	Diptera	Dixidae			midge	1	0	0	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Diptera	Culicidae			mosquito	4	0	0	0	4	0	0	0	15	0	0	0
Arthropoda	Insecta	Diptera	Dolichopodidae				0	0	1	0	0	0	0	0	0	0	0	0
Arthropoda	Insecta	Diptera	Tabanidae (L)			march fly	0	0	0	0	4	0	0	0	0	0	0	0
Arthropoda	Insecta	Diptera	Chaoboridae			phantom midges	0	0	0	0	0	0	1	1	0	0	7	0
Arthropoda	Insecta	Lepidoptera	Pyralidae			moth	0	0	1	0	0	1	0	0	1	0	0	0
Arthropoda	Insecta	Collembola				springtails	0	0	0	0	0	0	0	0	0	0	0	1
Chordata	Osteichthyes	Perciformes	Apogonidae		*Glossomia aprion*		0	0	0	0	0	0	0	0	1	0	0	0
Chordata	Osteichthyes	Atheriniformes	Atherinidae		*Craterocephalus stercusmuscarum*		0	0	0	0	1	0	0	0	0	0	0	0
Chordata	Osteichthyes	Perciformes	Chandidae		*Denariusa bandata*		0	0	0	0	1	0	0	0	1	0	0	0
Chordata	Osteichthyes	Perciformes	Terapontidae		*Amniataba percoides*		0	0	0	0	0	1	0	0	0	0	0	0

APPENDIX E:

Freshwater Fish Report - Dr Damien Burrows (ACTFR)

Freshwater Fish Report

Dr Damien Burrows
Australian Centre for Tropical Freshwater Research,
James Cook University, Townsville.

The survey was very brief and only intended to identify the fish species resident in Jack Lakes and their potential management issues.

Given the survey occurred at the end of the dry season, water levels in the lakes were very low. This prevented sampling in all but the top lake as the water level was too low for boat work and use of gill nets, and its is too dangerous (crocodile are present) to undertaken seine netting, backpack electrofishing or other forms of fishing that require entry into water. In addition, water clarity was poor, limiting visual observations.

Even within the top lake, only an area approx. 150m long by 50m wide was able to be accessed by boat for electrofishing. Electrofishing was conducted using an ETS boat-mounted electroshocker. A total of two 15-minute electrofishing shots were conducted totalling 801 seconds of on-time. The water was so turbid, that stunned fish could not easily be observed, and certainly not identified in the water. The dip net was used as a beam trawl in front of the boat while power was applied. This is not a particularly effective method, limiting the number of fish caught, but the extreme turbidity necessitated this approach. The limitations to the sampling method (including being unable to identify fish in the water) meant that no estimate of abundance could be applied and the data remain as presence/absence data.

Results and Discussion

In general, the site is greatly impacted by cattle and pig activity. This has resulted in the loss of much of the grass and sedge community around the wetland margins and shallow areas and aquatic macrophytes throughout, which would provide useful fish habitat. Cattle and pigs are known to increase sediment resuspension, thus increasing water turbidity. Their impacts may also include increased ammonia levels and reduced dissolved oxygen levels.

A total of 12 fish species were caught in the top lake (Table 1). This included archerfish, which, being highly visual hunters, are normally assumed to avoid turbid water. Bony bream, a fish normally thought to be sensitive to low dissolved oxygen, was present. Unfortunately, no barramundi were captured. The Lakefield area is renowned for its barramundi fishing, but these lakes may not be optimal barramundi habitat.

No species of conservation value were caught, with all those caught being common species with wide distributions. Red claw crayfish (*Cherax quadricarinatus*) were also caught in Top Lake. Tissue samples were taken from several fish to contribute to other studies examining the genetics of northern Australian freshwater fish.

Table 1 also list fish caught from other scientific surveys that have been conducted in the Normanby River catchment (with most of the sites being within Lakefield National Park itself). This records a total of 29 species.

During the wet season, this whole area would be underwater and fish would disperse across the floodplain including throughout the Jack Lakes system. However, once surface flow ceases, fish are confined for the remainder of the year, to the waterholes they remained in when they become disconnected. Many waterholes in this area dry up during the dry season. Jack Lakes are permanent, but with the low water level, which makes the lakes vulnerable to disturbance, and the effects of cattle and pigs, they are not likely to be suitable habitat for all fish species.

No barramundi were caught in this survey, though it is possible that some were present. Given the condition at the end of the dry season, it is not likely that many (or even possibly any) barramundi would survive the year. Thus the nursery or refuge value of Jack Lakes for barramundi may be limited. However, this does not mean that it is not valuable as a fishing location as good fishing occurs during the year, only that the system may not be suitable dry season refuge habitat. This possibility reflects on any management limitations imposed upon the lake.

It would be highly instructive to survey the Jack Lakes shortly after the wet season, early in the dry season and late in the dry season to see what fish are present at the beginning versus the end of the dry season.

The other big management issue is the extent to which the extreme turbidity is natural or influenced by other factors such as cattle and/or pigs. The role of pigs in accelerating the rate of evaporation from these lakes via exposed pug holes is also worth pursuing. It is highly likely that control of pig numbers would benefit the aquatic values and functioning of this lake system.

Table 1 Fish Species Recorded from Lakefield National Park.

Common name	Scientific name	Kennard 1995	Pusey unpub.	Burrows and Perna 2006	This survey
Sailfin glassfish	*Ambassis agrammus*		X		X
Macleay's glassfish	*Ambassis macleayi*	X	X	X	
Barred grunter	*Amniataba percoides*	X	X	X	
Pacific short-finned eel	*Anguilla obscura*	X		X	
Marbled eel	*Anguilla reinhardtii*	X	X	X	X
Lesser salmon catfish	*Ariopsis graeffei*			X	
Carpentaria catfish*	*Ariopsis paucus*	X	X		
Fly-specked hardyhead	*Craterocephalus stercusmuscarum*	X	X	X	
Pennyfish	*Denariusa bandata*	X		X	
Mouth almighty	*Glossamia aprion*	X		X	X
Golden goby	*Glossogobius aureus*	X	X		
Stringray	*Himantura chaophrya*		X		
Carp Gudgeon	*Hypseleotris compressa*		X		
Barramundi	*Lates calcarifer*	X	X	X	
Spangled perch	*Leiopotherapon unicolor*	X	X	X	X
Tarpon	*Megalops cyprinoides*	X	X	X	X
Eastern rainbowfish	*Melanotaenia splendida splendida*	X	X	X	X
Purple-spotted	*Mogurnda adspersa*	X			

Common name	Scientific name	Kennard 1995	Pusey unpub.	Burrows and Perna 2006	This survey
Gudgeon					
Northern trout Gudgeon	*Mogurnda mogurnda*		X		
Bony bream	*Nematalosa erebi*	X	X	X	X
Black catfish	*Neosilurus ater*	X	X	X	X
Hyrtl's tandan	*Neosilurus hyrtlii*	X	X	X	X
Sleepy cod	*Oxyeleotris lineolatus*	X	X	X	
Giant Gudgeon	*Oxyeleotris selheimi*				X
Rendahl's tandan	*Porochilus rendahli*	X	X	X	X
Speckled goby	*Redigobius bikolanus*	X	X		
Spotted scat	*Scatophagus argus*		X		
Longtom	*Strongylura krefftii*	X	X	X	
Seven-spot archerfish	*Toxotes chatareus*	X	X	X	X

**=the taxonomy of these species has changed since the original reports were produced*
Kennard (1995) sampled 8 lagoon sites in the Lakefield National Park
Dr. Brad Pusey (Griffith University - unpub. data) sampled 7 sites in the Lakefield/Kalpowar area
Burrows and Perna (2006) sampled 5 sites in the Lakefield National Park

Reference List

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APPENDIX F:

Jacks Lakes Amphibian, Reptile, and Mammal Survey - Kim Stephan (CYMAG)

Jacks Lakes Amphibian, Reptile, and Mammal Survey

Kim Stephan
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In November 2007 and June 2008 a survey of the amphibians, reptiles and mammals from Jack Lakes was conducted by K. Stephan (CYMAG), Russell Best (QPWS) and C. Howley (CYMAG).

Survey Methodology

The biodiversity of amphibians, reptiles and mammals was assessed by compiling a list of all the species confirmed to be present at Jack Lakes. The data collected was used to calculate the abundance (count) of each species observed during the surveys. Search efforts were made in a variety of specific habitat types during the day and night to detect new species unlikely to be trapped (e.g., geckos, monitor lizards).

Site location

One site at each of the Top, Middle and Lower Lakes was chosen. The field methodology was designed according to the National Fauna Survey Standards and the quadrat design was recommended by Dr Alex Kutt. For the November survey two 100m transects were set up at each site. The survey effort was increased for the June survey to two 50x50m quadrats per site (total of 6 quadrats) set 200m apart. The quadrats were selected to include the Regional Ecosystem 3.3.66. As this ecosystem is often a thin ribbon of vegetation around the edge of the wetland the quadrats also included a section of adjacent woodland. This approach incorporated the ecotone of melaleuca riparian vegetation and eucalypt woodland vegetation and intended to increase the number of species detected. It is reported that ecotones (i.e., the zone where two ecosystems meet) tend to support relatively high diversity of species by providing greater vegetative complexity than either community surrounding it (Yahner, 1988; Harris, 1988; Andren, 1994).

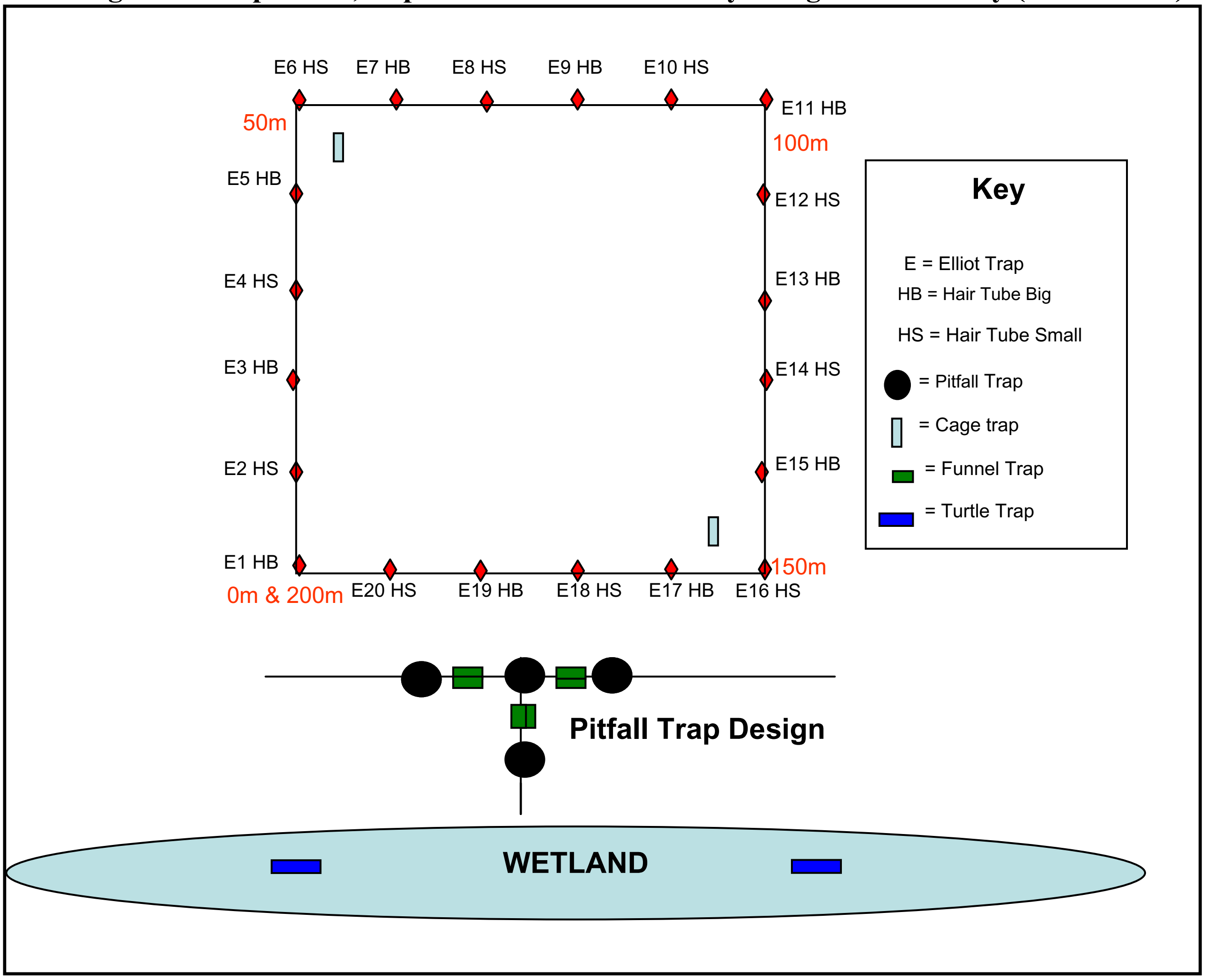
Where possible the localities of the November sites were used for June. However, as a result of inundation with water the June sites were set further back into the riparian zone. The methodology for the June survey was altered in an effort to improve the effectiveness of the survey. Therefore, the sites used for June and November are not considered to be replicates of each other, and cannot be statistically compared to determine differences between the seasons.

Fauna survey techniques

Trapping and Hair Tubes- In June (Figure1) each quadrat contained 20 Elliott traps, 2 cage traps, 10 hair tubes (5 big and 5 small), 4 pitfall traps, 6 funnel traps and two turtle/yabby traps. In November the transects contained 6 Elliott traps, 6 Hair tubes (3 big and 3 small), 4 pitfall traps and one turtle/yabby trap.

The Elliott traps and hair tubes were baited with a mixture of peanut butter, oats, pistachio oil and salami rolled into balls. The bait in the Elliott and cage traps was removed in the morning and replaced at dusk when the traps were set. The bait in the hair tubes was left for the duration of the survey to avoid contaminating the tape. The two cage traps were placed at opposite corners of the quadrat, and baited with the peanut butter mixture, and chicken frames. Turtle traps were baited with a perforated tin of sardines, and thrown into the lake with approximately 10cm remaining out of the water. Pitfall traps were positioned outside the quadrats, closer to the waters edge and consisted of four 20L buckets in a T-shape pattern connected by 15-20m of drift line fence. Funnel traps were placed in between the buckets (June survey only). The traps were cleared in the morning and the pits, funnels and turtle traps were cleared morning, noon and afternoon. Water was added to the pitfall traps to prevent dehydration of caught animals. The traps were left in place for four consecutive nights.

Figure 1. Amphibian, Reptile and Mammal Survey Design June Survey (Not to scale)



Targeted Surveys - Spotlighting and diurnal (pre-dusk) searches for reptiles, amphibians and mammals were undertaken two times at each site outside of the quadrats. Diurnal searches involved searching under logs, bark and leaf litter for 30 minutes at each site. Spotlighting involved a 15 minute scan across the surface of the lakes for crocodile eye shine and a 30 minute spotlight walk parallel to the water body shining the light on tree tops, tree trunks and surrounds. Additional spotlighting also occurred when driving between sites and in habitats of interest (e.g., flowering *Eucalyptus phoenicia* woodland for fruit bats).

Opportunistic Observations- Opportunistic sightings of fauna were recorded throughout the survey period. The date, time, GPS coordinate and habitat of the animal were noted.

Indirect Detection –Scats, turtle shells, regurgitated pellets, tracks and other signs were recorded or collected for analysis by Robyn Carter Hair Identification. Carter classifies the hair and scat results into three levels of reliability - Definite, Probable and Possible. Only 'Definite' results were included in the species list. They were given a count of one for abundance.

Sound – During the November survey bat echolocation calls were recorded overnight at each site with an AnabatII bat detector. The box was set up at dusk near the water bodies and left to record overnight. The calls were identified by Anabat Call Analysis Specialist Greg Ford and noted as Definite, Probable or Possible. Only definite identifications were included in the species list. The calls were also reviewed by Dr Roger Coles who was later contracted to undertake the June bat survey. Bat species recorded by sonar detection were given a count of one for abundance for each record.

Taxonomy

Where necessary voucher specimens of reptiles, amphibians and mammals were collected using humane methods and sent to experts Keith McDonald (QP&W), Alistair Freeman (QP&W) or the Queensland Museum for identification.

Results

Eight species of amphibians, seventeen species of reptiles and twenty one mammals were identified during the survey. An additional forty six species were added to the amphibian, reptile and mammal species records for Jack Lakes and entered into the EPA's WildNet database. In addition to this list one introduced amphibian (Cane toad (*Rhinella marina))* and five introduced mammals (Dog (*Canis familiaris),* Feral Pig (*Sus scrofa),* Cattle (*Bos sp.),* Black Rat (*Rattus rattus),* Horse (*Equus caballus*)) were recorded.

Table 1. Amphibian, Reptile and Mammal Species List for Jack Lakes November 2007 and June 2008 * = Species not native to Australia

Class	Family	Scientific name	Common name	June 2008	Nov 2007	Total Abundance
Amphibia (Frogs)	Bufonidae	*Rhinella marina**	Cane Toad*	46	19	65
	Hylidae	*Litoria nasuta*	Striped Rocket Frog	9	3	12
		Litoria pallida	Pallid Rocket Frog	64	3	67
		Litoria rothi	Northern Laughing Tree Frog	3	1	4
		Litoria rubella	Red Tree Frog		1	1
	Limnodynastidae	*Limnodynastes convexiusculus*	Marbled Frog	4		4
		Notaden melanoscaphus	Northern Spadefoot Toad	1		1
		Opisthodon ornatus	Ornate Burrowing Frog	27	10	37
	Myobatrachidae	*Crinia remota*	Northern Froglet	535		535
Reptilia (Reptiles)	Crocodylidae	*Crocodylus johnstoni*	Australian Freshwater Crocodile	3		3
		Crocodylus porosus	Saltwater Crocodile	1		1
		Crocodylus sp.	Crocodile	5	14	19
	Agamidae	*Diporiphora sp.*	Dragon	1	1	2
		Diporiphora bilineata	Northern Two-lined Dragon		1	1

	Colubridae	*Tropidonophis mairii*	Freshwater Snake	3	1	4
	Gekkonidae	*Gehyra dubia*	Tree Dtella	1	1	2
		Oedura rhombifer	Velvet Gecko		1	1
	Scincidae	*Carlia aerata*	Rainbow Skink	5		5
		Carlia munda	Rainbow Skink	1		1
		Cryptoblepharus virgatus	Striped Snake-eyed Skink	2		2
		Ctenotus spaldingi	Striped Skink	1		1
		Glaphyromorphus pardalis	Skink	1		1
		Cryptoblepharus sp.	Skink	1	1	2
	Varanidae	*Varanus panoptes*	Yellow-spotted Monitor	1		1
		Varanus sp.	Monitor Lizard		1	1
	Chelidae	*Emydura macquarii krefftii*	Krefft's River Turtle	17	1	18
		Macrochelodina rugosa	Northern Snake-necked Turtle	1	1	2
Mammalia (Mammals)	Canidae	*Canis lupus dingo*	Dingo	2		2
		*Canis familiaris**	Dog*		1	1
	Macropodidae	*Macropus agilis*	Agile Wallaby	2	3	5
		Macropus giganteus	Eastern Grey Kangaroo		1	1
		Onychogalea unguifera	Northern Nailtail Wallaby		5	5
	Suidae	*Sus scrofa**	Pig*	1	46	47
	Bovidae	*Bos sp.*	Cattle*	20	3	23
	Pteropodidae	*Pteropus scapulatus*	Little Red Flying Fox	7		7
		Pteropus sp.	Flying fox	300		300
	Vespertilionidae	*Scotorepens sanborni*	Northern Broad-nosed Bat	5	3	8
		Chalinolobus nigrogriseus	Hoary Wattled Bat	2	1	3
		Miniopterus australis	Little Bent-winged Bat	2	1	3
		Nyctophilus sp.	Unknown Long-eared Bat		1	1
		Miniopterus schreibersii	Common Bentwing Bat	2		2
		Vespadelus troughtoni	Troughton's Forest Bat	2		2
		Myotis macropus	Large-footed Myotis	4		4
		Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat	4		4
		Nyctophilus bifax	Eastern Long-eared Bat	4		4
	Molossidae	*Mormopterus loriae ridei*	Little Northern Free-tailed Bat	2		2
		Chaerophon jobensis	Northern Free-tailed Bat	3		3
		Mormopterus beccarii	Beccari's Free-tailed Bat	2		2
	Emballonuridae	*Saccolaimus saccolaimus*	Bare-rumped Sheathtail-bat	1		1
	Muridae	*Rattus rattus**	Black Rat*		1	1
		Rattus fuscipes	Bush Rat		1	1
	Equidae	*Equus caballus**	Horse*		3	3
	Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot		1	1
	Phalangeridae	*(blank)*	Possum	1	1	2

Amphibians (Frogs)

Eight species of amphibians were identified (Table 1) from the surveys. A total of 662 frogs were recorded. Frogs were more abundant in June with 644 individuals recorded compared with only 18 frogs recorded in November. An additional three species (*Crinia remota, Limnodynastes convexiusculus and Notoden melanoscaphus)* were recorded in the June survey. The only species recorded in November and not June was the Red Tree Frog (*Litoria rubella*). The most abundant amphibian species in June was the Northern Froglet (*Crinia remota*) with 535 individuals recorded. In November many frogs were juveniles and the most abundant frog was the Ornate Burrowing Frog with 10 individuals (*Opisthodon ornatus*).

Most of the frogs identified are reasonably widespread and common in the region. One exception was the Northern Spadefoot frog (*Notaden melanoscaphus*) which is not frequently seen because it spends most of its life underground. Suspected threats to this species include habitat modification and degraded water quality (Australian Frog Database, 2005). This frog was caught on the Lower Lakes which are considered to have the least disturbance and the best water quality in the Jack Lakes system.

The raw data (Table 1) indicates a shift in the abundance and species of frogs between the wet and dry seasons. The greater abundance of frogs in June is attributed to the after effects of the wet season and the end of the breeding season when more water and habitat is available. Some frog species may also have been dormant (e.g., burrowing species) in November and harder to detect.

There was a marked difference in the condition of the Lakes between the end of the dry and wet seasons. Many frogs breed on the edges of lake margins where there is food for tadpoles, safety from predators and easy access to land once they have metamorphosed. In June the flood waters had receded leaving nutrient rich soil and thick aquatic vegetation. Ample habitat was available in the dense carpets of Green Couch Grass, Azolla Waterfern, Water Lilies and Bulkaru reeds. The sediment had dropped, the water was clearer and the conditions for breeding had improved. In contrast to June the exposed lake margins of the Top and Middle Lakes in November had been devastated by Feral Pig and cattle activity. The vegetation along the shoreline had been dug out, eaten or trampled and the water was fouled and heavy with sediment. Fine particles of clay remained suspended in the water giving the lakes a chocolate milk appearance. These conditions are not ideal for amphibian reproduction and may be disadvantaging certain species.

In June the vegetation around the Lakes had restablished after the flush of the wet season. However, long term damage such as increased evaporation (drying up of the Lakes), and loss of species could be occurring as a result of introduced animal pressures on the Lakes. Feral pigs have previously been reported to contribute to the decline of frogs through predation and habitat destruction in rainforest areas (Richards *et al*. 1993).

A study at nearby Wakooka Outstation revealed a number of frog species additional to this survey including *Crinia deserticola*, *Cyclorana brevipes, Cyclorana novaehollandiae, Litoria alboguttata, L. caerulea, Uperolia mimula* and the first Queensland record of *Cyclorana cryptotis* (McDonald, 1998). It is possible these species are present at Jack Lakes and could be revealed in future surveys.

The introduced amphibian Cane Toad (*Rhinella marina*) was widespread across the Lakes and abundant in the pitfall traps. In a study by Catling et. *a*l (1999) *Litoria rothii* (present at Jack Lakes) was one of three amphibian species considered seriously at risk of being poisoned by Cane Toads. Other species that occur at Jack Lakes and 'probably' at risk from Cane Toads include the Ornate Burrowing Frog, Desert Tree Frog (*Litoria rubella*), Slaty-grey Snake (*Stegonotus cucullatus*), Black Bittern (*Ixobrychus flavicollis*), and Blue-winged Kookaburra (*Dacelo leachii*) (Catling *et. a*l,1999). Many dead Cane Toads were observed. Some of these had been turned over and eaten, presumably by crows or raptors.

Reptiles

Seventeen species of reptiles were identified (Table 1) and recorded as new species for Jack Lakes. A range of reptile families including geckos, dragons, goannas, skinks, turtles, snakes and crocodiles were recorded. Nine additional species from the June survey were added to the November species list.

Moderate numbers of crocodiles were observed in all of the Lakes during both surveys. Both Freshwater (*Crocodylus johnstoni)* and Saltwater (*Crocodylus porosus*) Crocodile species were present.

Given the amount of survey effort, the low number of reptile species possibly reflects the fact that the entire area floods annually, so the reptiles present (with the exception of the burrowing *Glaphyromorphus pardalis*) are all either small tree-climbers or strong swimmers able to escape the flood (pers.comm. Russell Best, 17 Nov., 2008).

The turtle recorded as Krefft's River Turtle (*Emydura krefftii*) had characteristics of a Northern Yellow-faced Turtle (*Emydura tanybaraga*), but lacked the diagnostic dark streak through the pupil (pers.comm. Mike Trennery, 25 June, 2008). This anomaly could suggest it is a different species. However the record remains as *E. krefftii* due to taxonomic uncertainty of the chelids at this time. The Northern Snake-necked Turtle *(Macrochelodina rugosa*) was identified from carapace remains. The carapace had a bite taken from the front presumably by a pig or dog. An additional two empty carapaces and two dead turtles were found in the November survey. Feral Pigs are known to eat Northern Snake-necked Turtles. Feral Pigs depleted turtle populations in Maningrida, Northern Territory, in excess of levels that could be replaced by surviving hatchlings (Fordham *et. al.,* 2007). Projective models predicted certain elimination of affected populations within 50 years. In the absence of pigs the increase in hatchling survival was sufficient enough to allow an annual indigenous harvest of up to 20% without causing substantial population pressure.

The previous records of the Slaty-grey Snake *(Stegonotus cucullatus*) (Wildlife Online) and Four Fingered Skink (*Carlia dogare*) (Qld Museum) were not observed during the survey (Table 1). There were no previous mammal records for Jack Lakes in the Qld Museum and Wildlife Online searches.

Mammals

Twenty one species of mammals were identified. Fourteen of these were bats. There were no previous mammal records for Jack Lakes in the Qld Museum and Wildlife Online searches.

The Bush Rat (*Rattus fuscipes*) and Northern Brown Bandicoot (*Isoodon macrourus*) were identified from hairs in a Feral Dog scat. The Northern Brown Bandicoot is reported to be susceptible to predation by canines (Vernes *et al,* 2001). 'Definite' possum underhairs were identified from large hair tubes in both the November and June surveys. The species was a 'probable' Common Brush-tail Possum (*Trichosurus vulpecular),* but due to insufficient hairs could not be identified to species level. There are anecdotal reports of Common Brushtail Possums at the nearby Kalpowar Station. The Common Brushtail Possum is considered to have a generally low population throughout Cape York Peninsula with some areas of relatively high density (Winter, 2007). The IUCN (2008) notes the population trend of the Common Brushtail Possum to be decreasing, sparse and declining in monsoonal northern Australia.

Macropods including the Eastern Grey Kangaroo *(Macropus giganteus),* Agile Wallaby *(Macropus agilis*) and Northern Nailtail Wallaby *(Onychogalea unguifera*) were seen frequently throughout the study especially in the lightly wooded channel country and paperbark floodplain of the Top Lakes. Although the Northern Nailtailed Wallaby has suffered some local extinctions and its distribution is patchy, it is regarded as common in its range (Strahan, 1983).

Little Red Flying Foxes (*Pteropus scapulatus*) were identified from a spotlight search in flowering Scarlet Gum (*E. phoenicia*) forest. A small group were seen actively feeding and flying throughout the forest. A cloud of over 300 Flying Fox flew over the Lower Lakes during a spotlighting session. The species could not be confirmed.

The low number of mammal species, especially small mammals, maybe due to annual flooding events in the riparian zone of Jack Lakes. Most of the mammal species (macropods and bats) recorded are highly mobile. Smaller mammals were detected in predator scats or regurgitations that could have come from dogs or birds outside of Jack Lakes. The small mammals detected in hair tubes were sparse. It may be more productive in future mammal surveys of Jack Lakes to conduct the survey in woodland areas on the higher ground around the Lakes.

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APPENDIX G:

Anabat Analysis Summary, Jack Lakes, November 2007. Prepared by Greg Ford.

Anabat Analysis Summary, Jack Lakes, November 2007. Prepared by Greg Ford.

Data received for analysis

Three compressed file folders (*batsite 1.zip, batsite 2.zip, batsite 3.zip*) containing Anabat sequence files recorded at Jack Lakes on 20th, 21st and 22nd November 2007.

Call identification standard

No keys or descriptions have been published for bat calls of north-eastern Queensland, and access to reliable locally recorded reference calls is limited. However, many species likely to be present are covered in keys published for southern Queensland (Reinhold *et al.* 2001) and the Northern Territory (Milne 2002).

The extent of geographic variation in call characteristics is poorly known, but the available evidence suggests that calls of most species do not vary significantly between regions. Therefore, it is deemed sufficient to refer to the above-named keys and reference calls collected from other regions in determining the identity of calls recorded in the present survey.

Please note, however, that neither reliable reference calls nor call descriptions from other regions exist for some of the species likely to occur in the survey area, including several rare or threatened species. Where there is a possibility that calls may represent those species, they are listed in the results (Table 1) and descriptions of the calls and reliability of identity are discussed in the 'Species Notes" section below Table 1.

Analysis results

Recording quality was good, with most sequence files containing recognisable bat calls. Many call sequences included clearly defined call features, thereby affording reliable identification for some species; however, the lack of local reference material meant that even some good calls could not be reliably identified.

Four microbat species were positively identified from the call data. At least four, and perhaps as many as ten other species may also have been present but reliability of identification was lower for those species.
Table 1 lists the species recorded and shows the reliability of identification attributed to the best calls available for each species. Detailed discussion of the reliability of call identification and likely presence of particular species, where several species use similar calls, is provided in the 'Species Notes' section, following the table.

Rare or threatened species potentially present during survey

Of particular note amongst the species listed in Table 1, is the possible presence of two species that are scheduled as rare or threatened under Queensland and/or Australian government nature conservation legislation.

The critically endangered bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus*) was possibly present, but cannot be confirmed due to strong similarity between its calls and those of the more common yellow-bellied sheath-tailed bat (*S. flaviventris*). *S. saccolaimus* roosts primarily in hollow eucalypts, such as *E. alba* (Churchill 1998), and very likely inhabits woodlands in the survey area.

There is a slight possibility that the coastal sheath-tailed bat (*Taphozous australis*), a vulnerable species, may also have been present. Some reference calls are available for this species, but similarities to several other species make identification difficult (see "Species Notes"). This species is "rarely found more than a few kilometres from the sea" (Churchill 1998), so the likelihood of its presence at Jack Lakes is very low.

Table 1. Bats recorded at Jack Lakes, 20th – 22nd November 2007.

Species presence is coded according to highest level of confidence achieved in call identification. Identification confidence is coded as follows:

A Definite one or more calls where absolutely no doubt about identification of bat
B Probable most likely the species named; low probability of confusion with species that use similar calls
C Possible call is comparable with the listed species, but moderate to high probability of confusion with species with similar calls

Species	Common name	Site 1	Site 2	Site 3
Saccolaimus flaviventris	yellow-bellied sheath-tailed bat	B	B	B
Saccolaimus saccolaimus	bare-rumped sheath-tailed bat	C	C	C
Taphozous australis	coastal sheath-tailed bat	C	C	C
Taphozous georgianus	common sheath-tailed bat	B	B	B
Chaerephon jobensis	northern free-tailed bat	C	C	
Mormopterus beccarii	Beccari's free-tailed bat		C	
Mormopterus loriae ridei	eastern little free-tailed bat		C	
Chalinolobus nigrogriseus	hoary wattled bat	C	A	B
Miniopterus australis	little bent-winged bat		A	C
Miniopterus schreibersii oceanensis	eastern bent-winged bat		B	C
Nyctophilus species	unknown long-eared bat		A	
Pipistrellus adamsi	forest pipistrelle		C	C
Scoteanax rueppellii / *Scotorepens* sp.	greater / inland / eastern broad-nosed bat		B	
Scotorepens sanborni	northern broad-nosed bat	A	A	A

Species notes

Saccolaimus flaviventris; S. saccolaimus; Taphozous australis; T. georgianus

This group of species use calls in the frequency range 18-25 kHz. Reference calls from other regions show subtle differences in frequency and pulse shape may be used to separate *Saccolaimus* species from *Taphozous* species, although differentiation is not always absolute. Recent evidence from the Northern Territory (D. Milne, pers. comm.) suggests that it is not possible to differentiate the calls of the two *Saccolaimus* species. Some reference calls of the two *Taphozous* species have slightly different frequency and pulse shapes, but the range within both is such that differentiation is not easy.

Calls recorded at Jack Lakes spanned virtually the full range of frequencies and pulse shapes expected from this group of species and proved very difficult to identify.

A large portion of calls over all sites, with distinctly curved pulse shape at 18-20 kHz, were almost certainly from one of the *Saccolaimus* species. It is highly likely that many of these were from *S. flaviventris*, but *S. saccolaimus* may also have been present.

At Site 2 there was a small subset of calls with short, flat 24 kHz pulses that were probably from *Taphozous*. These were similar to reference calls from *T. georgianus* in north-western Queensland. *T. australis* reference calls are at similar frequency, but the few reference calls available have longer pulse-duration than that exhibited in this data set.

Published distributional information suggests that *T. georgianus* does not occur this far north on Cape York (Churchill, 1998; Jolly *et al.*, in press), but this may simply be an artefact of poor historical survey effort. *T. australis* has a predominantly coastal distribution in the region (Churchill, 1998; Richards, in press *a*); however, little is known about this species and it is possible that *T. australis* may occur inland as far as the survey site.

The presence of either *Taphozous* species at Jack Lakes would depend on the availability of suitable roosting caves within about 10 km of the survey sites. An inspection of satellite imagery and terrain layers available on "Google Maps" (http://maps.google.com.au/maps) indicate a paucity of landscape features likely to provide such caves.

Chaerephon jobensis
This species' calls overlap in frequency with those of the above group; however, it is usually easy to differentiate due to erratic changes in frequency and pulse shape. *C. jobensis* was not positively identified for this survey, but it was possibly responsible for a few lower quality calls recorded at Sites 1 & 2.

Mormopterus beccarii
Calls are generally around the upper end of the frequency range used by the *Saccolaimus/Taphozous* group, but pulse shape is diagnostic in most cases. However, in poorer quality calls (short duration, weak and noisy sequences) it is possible to confuse *M. beccarii* with those other species. Several such calls, at around 24 kHz, were recorded at site 2 and may have been from *M. beccarii* or *Taphozous* species.

Mormopterus loriae ridei
This species uses a range of call types, usually around 30 kHz; pulse shape is typically flat (Milne, 2002), but some calls have a more curved pulse shape (T. Reardon, pers. comm.) that may be confused with some vespertilionid bats (e.g. *Scotorepens balstoni*). Short duration calls or those with poor signal quality are not reliably differentiated between these species; however, *S. balstoni* apparently does not occur in the survey area (Churchill, 1998; Parnaby, in press).
Several calls from site 2 were possibly from *M. l. ridei*. The curved pulse shape and 32 kHz frequency of these calls was more suggestive of *Scotorepens balstoni* but *M. l. ridei* cannot be discounted.

Chalinolobus nigrogriseus* and *Scotorepens sanborni
These two species' calls are very similar, although pulse shape is diagnostic in better quality recordings.
More than 50% of all calls recorded during the Jack Lakes survey were attributable to this pair of species, many of which were positively identified as *S. sanborni*. *C. nigrogriseus* was definitely present at site 2, but no clearly identifiable calls from this species were present at sites 1 or 3.

Miniopterus australis
Has highly distinctive calls above 55 kHz; readily differentiated from other species likely to occur in this survey area. *M. australis* was definitely present at site 2; possibly also at site 3 but only very brief and low quality sequences recorded so not possible to be certain.

Miniopterus schreibersii oceanensis and Pipistrellus adamsi

M. s. oceanensis calls often exhibit a distinctive pulse shape, with erratic pulse repetition rate and variable characteristic frequency within a single call. Several sequences from site 2 showed evidence of these characteristics and were considered most likely attributable to *M. schreibersii.*

P. adamsi calls overlap in frequency and sometimes have similar pulse shapes those of *M. s. oceanensis* (Milne 2002), thereby making identification difficult in lower quality calls. Based on published distributional information (e.g. Churchill 1998; Hoye & Milne, in press), *P. adamsi* would be at beyond the south-eastern limit of their known range in the Lakefield region. Some calls from this survey show a striking similarity to reference calls of *P. adamsi* from the Northern Territory (Milne 2002), so it is possible that this species was also present during the survey at Jack Lakes.

Nyctophilus species

The long-eared bats use very low amplitude calls (i.e. weak signal strength) that rarely result in good quality Anabat call files. *Nyctophilus* calls are similar to those of *Myotis macropus*, but can be differentiated by subtle differences in pulse shape in better quality calls.

Two calls at site 2 were positively attributable to *Nyctophilus*. It is not possible to differentiate the species of *Nyctophilus* from their calls, but *N. bifax* is the most likely species responsible for these calls, based on published distributional information for the genus (e.g. Churchill, 1998).

Scoteanax rueppellii, Scotorepens balstoni and S. orion

According to published distribution maps (Churchill, 1998; Hoye & Richards, in press; Parnaby, in press; Tidemann & Parnaby, in press) none of these three species should occur in the survey area. However, a number of calls from site 2 bear a striking resemblance to those of *S. balstoni*.

Calls of the three species are often difficult to distinguish, although *S. balstoni* is easier to differentiate than the other two.

It is possible that these calls were made by *Mormopterus loriae ridei* (see above), but insufficient reference material exists to support positive differentiation of this and the broad-nosed species on calls alone. However, unlike the broad-nosed species, *M. l. ridei* is known to occur on this part of Cape York. This actuality lends support to the consideration of *M. l. ridei* being more likely responsible for the problematic calls than any of the broad-nosed bats.

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APPENDIX H:

Avian Survey Report and Data - Drs Clifford & Dawn Frith

Avifauna Survey Reports and Data for Jack Lakes- Drs Clifford & Dawn Frith

Clifford B. Frith PhD and Dawn W. Frith PhD.

From observations made during 17th to 24th November 2007 and 14th to 19th June 2008, with comparative notes

Introduction

During both survey periods systematic records were made at each specified lake or lakes during four-hour periods of direct observation, typically performed during 06:00 to 10:00 during mornings and 14:00 to 18:00 during afternoons of the November 2007 survey and during 0630 to 1030 in the mornings and 1330 to 1730 in the afternoons during the June 2008 survey.

During the four hour survey periods we walked slowly and silently through vegetation around lake edges to count bird species and numbers seen and heard on their shores and water/plant surfaces and within the woodland habitats within c. 50 metres of the higher lake shoreline. During these walks we both used high quality Leica binoculars and we also made observations from advantageous, sheltered, viewing sites on lake edges using a tripod-mounted high quality powerful Leica spotting scope. Nightbirds heard and identified by their calls near and around the camp are included in the species list as species records.

For a comprehensive listing of all species seen or heard and indications of their relative abundance for both the November 1007 and the June 2008 surveys, and their combined totals, see our tabulated survey results (Table 1 below).

Comparative observations between the two major survey periods are as follows:

A total of 101 bird species (32 waterbirds and 69 bush birds) were recorded for the November 2007 survey.

A total of 91 species (23 waterbirds and 68 bush birds) were recorded for the June 2008 survey.

A total of 117 bird species (33 waterbirds and 84 bush birds) were identified during the combined November 2007 and June 2008 surveys.

Of the 117 species, 75 of them (22 waterbirds and 53 bush birds) were recorded during both the November 2007 and June 2008 surveys (i.e. were common to both surveys).

A total of 26 species (10 waterbirds and 16 bush birds) were recorded during November 2007 that were not recorded in June 2008.

A total of 16 species (1 waterbird and 15 bush birds) were recorded during June 2008 that were not recorded in November 2007.

A greater diversity of both water and bush bird species were recorded during the November survey than during the June one.

A conspicuously lower density of many waterbird species was recorded during the June than during the November survey. Conversely, a greater density of nectarivorous species, i.e. lorikeets and honeyeaters, were present during the June survey than during the November one (Table 1)

Waterbirds

In November, at the end of the dry season, the density of waterbirds such as the Magpie Goose, Wandering Whistling-Duck, Radjah Shelduck and Pacific Black Duck was notably high. During June, following the wet season, their numbers were, however, dramatically reduced. Magpie Geese, Little Egrets, Glossy Ibis, and Black-winged Stilt were entirely absent and a number of other species (e.g. Green-Pygmy Goose, White-necked Herons, Pied Herons, Nankeen Night-Herons, Royal Spoonbills, Comb-crested Jacana, and Brolga) present in but relatively small numbers albeit that some samples are small (see Table 1). During the November survey the estimated 3000 Magpie Geese on the lakes may represent an over-estimated because the large number of them seen early one morning on Top Lake had clearly roosted there for the night and were not feeding – where those seen on the Lower lakes were actively feeding. Thus the population may have been a single one moving between roost and feeding locations.

As no Magpie Geese were present in June it is clear that the extensive and widespread wetlands produced by the wet season rains had resulted in this, and other waterbird, species dispersing from Jacks Lakes.
In November we recorded only two Green Pygmy-Geese and no Comb-crested Jacana on the Top and Middle Lakes, whereas on the Lower Lakes we estimated there to be > 200 on both Lake 3a and 3 b and > 100 on Lake 3c. We suggested that such significant differences were because the Lower Lake shores were better protected than those at Top and Middle Lakes and had extensive water lily beds. In this regard we noted that the Green-Pygmy Goose is dependant upon floating small plants and the Comb-crested Jacana upon invertebrates associated with aquatic plants for food – both resources in November were apparently lacking to any significant extent on Top and Middle Lakes. In June, however, water lilies covered the Top Lake extensively and we estimated there to be more than 100 Green Pygmy-Goose and more than 100 Comb-crested Jacana; in marked contrast to the previous survey.
Not surprisingly the migrant species of waders that were seen in small numbers, mostly around the exposed sandy shores of Fish Lake, during November were entirely absent in June.
In June Black-necked Storks and White-bellied Sea Eagles were found to have young in the nest.

Bushbirds

The most noteworthy difference between the November and June surveys was the lack of migrant species and the considerable and conspicuous increase in the number of nectarivorous birds. The former group (migrants) includes the Pied Imperial-Pigeon, Asian Koel, and Dollarbird and the latter group (nectarivores) the Rainbow Lorikeets and a number of honeyeater species including the Yellow, Brown-backed, White-throated, Blue-faced, Little Friarbird, and Silver-crowned Friarbirds. The latter species, a notable nomad nectarivore was not sighted in November. The notable increase in nectarivore species and numbers was due to flowering Scarlet Gum *Eucalyptus phoenicea,* melaleucas and grevilleas that in the woodlands immediately about the Lakes. At least the Brown-backed and White throated Honeyeaters were nesting (nests and juveniles seen to be attended by adults).
There was a noticeable decline in flocks and numbers of Red-tailed Black-cockatoos, while Sulphur-crested Cockatoos were more abundant.
Laughing Kookaburras, Forest and Sacred Kingfishers were also notably more abundant in trees around the Lakes during June than in November. The Forest Kingfisher was conspicuously feeding over the Lakes' littoral zones and in the immediately adjacent shallows of the Lakes and thus appeared to be obtaining much foraging advantage by seasonally initial water evaporation. Over the littoral zone they were eating adult dragonflies and other insects and invertebrates while in the shallow water they were taking small fishes.
Male Great Bowerbirds were active at bowers during both surveys. Drongos, Leaden Flycatchers, and Rufous Songlarks were more common or more conspicuous in June than in November.

Other comments

Given the extremely limited nature of extensive tall, dense, shallow water vegetation, such as reed beds, it is not surprising that we did not see a single species of rail – not even a Purple Swamp-hen during either survey. It is also remarkable that we recorded only a single individual Black-fronted Plover during November, and no other plover species save some Masked Lapwings over the many kilometres of lake shoreline surveyed. This is far less surprising for June, given the high water at that time, but remains so for November. Equally as remarkable is that only one record of a single Willie Wagtail was made and none or next to no individuals of the various species of the swift/swallow/martin/woodswallow aerial insect feeding ecological guild that we might expect to be present and taking airborne insects so typically associated with tropical lake habitats were seen. It would be significantly interesting to know if this situation is in fact typical of such lakes prior to the introduction of exotic mammals or if the absence of such birds reflects their detrimental ecological impact (i.e. upon what should possibly be naturally-occurring insect populations now lacking as a result of microhabitat disturbance/destruction by, or resulting from, pig and cattle activities).

November 2007

THE JACK LAKES AVIFAUNA
Report on results of a survey performed, during 17-21 November 2007, and prepared by
Clifford B. Frith PhD & Dawn W. Frith PhD

Introduction

The enclosed tabulated results of our survey of the avifauna of the Jack Lakes study area during 17th to 21st November 2007 provide our resulting comprehensive raw data. These tables present the actual number of individual birds seen or heard for the majority of species recorded, with but a limited number of species being sufficiently abundant for us to describe them as "common" or "abundant".

Systematic observations were made at each specific lake or lakes (see Tables) during timed four-hour periods of direct observation, and these were typically performed during 06:00 to 10:00 in the mornings and 14:00 to 18:00 in afternoons. During these periods we walked slowly and silently through vegetation around lake edges to survey birds seen and heard on their shores and water/plant surfaces and also through woodland habitat within 50 metres of the upper lake shoreline in order to survey the avifauna of this lake-associated woodland zone. During these walks we both used high quality Leica binoculars. We also made observations from advantageous, sheltered, viewing sites on lake edges using a tripod-mounted high quality powerful Leica spotting scope (enabling us to record species that would undoubtedly have otherwise been overlooked).

Given the limited time available at the study site and the, appropriate, methods employed we can provide but a snapshot impression of the avifauna present at the study site at that time of the year in 2007 under the prevailing ecological and climatic conditions. This was at the end of the dry season when the surface areas of the lakes were much reduced by lack of precipitation and their evaporation.

The environments

The most conspicuously striking aspect of our overall observations was the apparently profound ecological differences between the relatively 'barren' Top and Middle Lakes on the one hand compared with the more biologically diverse Lower Lakes on the other as expressed by both their gross appearance and avifaunas:

The Top and Middle lakes supported very limited floating vegetation (e.g. water lilies) and their shallows/banks were all but completely lacking in aquatic plants (e.g. reed beds etc, see image 7637 of Top Lake) and were predominantly devoid of sheltering vegetation and/or cover. While the banks of the Lower Lakes also lacked significant aquatic plants they had far more shelter and cover present (see images 7610 & 7616 of Lower Lake (a)), in the form of fallen heavy timber and dense copses of thick lakeside vegetation of approximately 4 to 6 metres tall. While these factors are possibly significant with respect to the striking avifaunal differences between Top and Middle Lakes versus the Lower Lakes it is perhaps also possible that the latter have on average both deeper water and steeper banks and that these might possibly limit access by foraging pigs and cattle. This theoretical scenario remains to be studied/tested however.

The shore of all lakes readily accessible to cattle and pigs had obviously been progressively deeply trodden and rooted as their water levels fell, thus leaving the ploughed mud so severely disturbed and then sun-dried to rock-hard as to be difficult for us to traverse on foot. Birds cannot probe this hard mud. The intense pig foraging in the seasonally ever-lowering wet zone of the lake shores presumably significantly increases evaporation rates and leaves even these briefly moist areas devoid of aquatic plants and other organic matter, including numerous and diverse aquatic animals.

Even in areas of the Lower Lakes it was apparent that pigs and/or cattle has grossly disturbed and damaged extensive areas of water lily beds in contrast to other areas they had/could not reach perhaps due to deeper water (see image 7628 of Lower Lake (a)).

The avifauna

Given the significant surface areas and shore-lines of these lakes the avifauna directly associated with their habitats (i.e. aquatic and shore birds) stuck us as relatively poor in species diversity and in the numbers of individuals of those species present at the time of our survey. This situation was far more apparent at Top and Middle Lakes than at the Lower Lakes, where better-protected shores and extensive water lily beds supported species in large numbers not seen on Top and Middle Lakes, such as Green Pygmy-Goose *Nettapus pulchellus* and Comb-crested Jacana *Irediparra gallinacea*. It is noteworthy in this regard that the former bird is dependant upon floating small plants and the latter upon invertebrates associated with aquatic plants for food – both resources apparently lacking to any significant extent on Top and Middle Lakes (where these species were absent or all but so). Also notable in this context was that while hundreds of Magpie Geese *Anseranus semipalmata* were seen to be night-roosting on Top Lake we did not see them feeding there, whereas many of them were travelling to the Lower Lakes to feed during daylight.

We strongly suspect that had the shores of these lakes been undisturbed by pigs and cattle, and thus their wet zones more extensive, flat, and rich in surface and subsurface plant and invertebrate life, many more shorebirds might have been present during the survey period. We recorded extremely small numbers of both resident and migratory shorebird species, notwithstanding that the period of our survey was during that time of year when most adult shorebirds migrating to Australia should be present and when their juveniles are continuing to arrive in northern Australia en route to the south. Again, we cannot be sure to what extent the brief nature of our survey biased our shorebird results, but we remain surprised by the small numbers of species and individuals we encountered over these lakes given their significant location to these bird species.

Given the near total lack of dense shallow water vegetation, such as reed beds, it is not surprising that we did not see a single species or individual of rail – not even a Purple Swamp-hen. It is most remarkable, however, that we recorded but a single individual Black-fronted Plover and no other plover species save notably few Masked Lapwings *Vanellus miles*, over the many kilometres of lake shoreline surveyed. Equally as remarkable is that we did not record a single Willie Wagtail *Rhipidura leucophrys* on the shorelines and immediately adjacent vegetation or a single individual of any species of the swift/swallow/martin/woodswallow aerial insect feeding ecological guild that we might expect to be present and taking airborne insects so typically associated with tropical lake habitats. While this total lack of this ecological guild of passerine birds could conceivably reflect a natural local seasonal phenomenon it should be considered a matter of real concern until properly understood – because it could equally possibly reflect a fundamental problem of insect populations lacking as a result of microhabitat disturbance/destruction by, or resulting from, pig and cattle activities.

Concluding observations

Our brief, qualitative, observations suggest to us that fundamental ecological damage to high and seasonally subsequently falling wet zones by pigs and cattle is having a profound detrimental effect upon plant and animal biodiversity on all of these lakes, but dramatically more so on Top and Middle Lakes than on the Lower Lakes.

Of particular concern is the possibility that these lakes might represent a significant ecological resource and resting reserve to migrant shorebirds during their southward and northward passage to and from Australia respectively. As this migrating avifauna is a matter of international importance, and several binding intergovernmental agreements, its movements and rest-over needs must be given serious consideration in the context of the conservation status and ecological quality of these lakes.

With respect to the latter issues, we witnessed several vehicles carrying numbers of people and many hunting dogs literally driving around the actual and entire shoreline of several lakes. These were obviously pig hunters that were looking for fresh pig activity before putting their dogs to the chase. Their progress around the shoreline disturbed and flushed to flight every single one of many hundreds of water birds present and feeding. If frequent, as vehicle tracks present would suggest to us, this level of disturbance to feeding (not to mention nesting) birds, and in particular to migrant ones, would undoubtedly be extremely detrimental to the lakes as an avifaunal reserve and would greatly reduce the viability of them as a tourist attraction.

In our view some parts of the Lower Lakes, even in their present state, show real potential for birding-based tourist development. This would, however, undoubtedly have to be restricted to extremely carefully located, designed, and constructed world-class-style bird hides with extensive concealed foot/wheelchair access from vehicle parking well removed from them. With appropriate ecological management, and theoretically resultant improvements, these lakes could offer birding experiences of world class that might, if appropriately marketed and managed, generate significant income to local communities.

Given the above, we think that consideration should be given to small scale (and thus relatively economical) studies of pig and cattle exclusion along some easily fenced straight lengths of shorelines of all of these lakes in order to assess what ecological improvements might result that might prove advantageous to their significance as wildlife refuges and/or tourist attractions. Certainly pig hunting activities could continue in the general area but, without any doubt whatsoever, would have to be fully and firmly excluded from a defined area about all lakeshores of some half a kilometre or so.

The Jack Lakes area clearly requires further significant study at other times of year and, thus, under different climatic conditions. Moreover high water levels of typical wet seasons would need to be studied in order to appreciate where bird hides could and should be located that would remain accessible and usable throughout the year should bird-based tourism be further considered.

Clifford B. Frith and Dawn W. Frith, December 2007

AVIFAUNAL SURVEY LIST FOR JACKS LAKE 17th-24th NOVEMBER 2007 AND 14th-19th JUNE 2008

Observed and prepared by Clifford B. Frith and Dawn W. Frith [1]

				Water (W) & Bush (B) Birds	2007 Nov	2007 Breeding records [3] (BR)	2008 June	2008 Breeding records (BR)
Galliformes	Megapodiidae	*Alectura lathami*	Australian Brush-turkey	B [2]	1		0	
Anseriformes	Anseranatidae	*Anseranas semipalmata*	Magpie Goose	W	3131		0	
	Anatidae	*Dendrocygna eytoni*	Plumed Whistling-Duck	W	1		0	
		Dendrocygna arcuata	Wandering Whistling-Duck	W	539		59	BR
		Tadorna radjah	Radjah Shelduck	W	263		41	BR
		Nettapus pulchellus	Green Pygmy-goose	W	502		316	
		Anas superciliosa	Pacific Black Duck	W	100		5	
Podicipediformes	Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	W	8	BR	4	
Columbiformes	Columbidae	*Chalcophaps indica*	Emerald Dove	1 [2]	1			
		Geopelia striata	Peaceful Dove	B	220		197	
		Geopelia humeralis	Bar-shouldered Dove	B	82		84	
		Ducula bicolor	Pied Imperial-Pigeon	B	10		0	
Caprimulgiformes	Podargidae	*Podargus strigoides*	Tawny Frogmouth	B [4 2]	1		1	
		Podargus papuensis	Papuan Frogmouth	B [4]	1		3	
	Caprimulgidae		Large-tailed Nightjar	B [4 2]	1		0	
Phalacrocoraciformes	Anhingidae	*Anhinga novaehollandiae*	Australasian Darter	W	18		32	
	Phalacrocoracidae	*Microcarbo melanoleucos*	Little Pied Cormorant	W	25		10	
		Phalacrocorax sulcirostris	Little Black Cormorant	W	3		7	
Ciconiiformes	Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	W	24		31	
	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	W	10		7	BR
	Ardeidae	*Ixobrychus flavicollis*	Black Bittern	W	2		1	
		Ardea pacifica	White-necked Heron	W	13		1	
		Ardea modesta	Eastern Great Egret	W	18		16	
		Ardea intermedia	Intermediate Egret	W	37		139	
		Ardea ibis	Cattle Egret	W	45		42	
		Butorides striata	Striated Heron	W	0		3	
		Egretta picata	Pied Heron	W	6		0	
		Egretta novaehollandiae	White-faced Heron	W	6		2	
		Egretta garzetta	Little Egret	W	6		0	
		Nycticorax caledonicus	Nankeen Night-Heron	W	11		3	
	Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	W	32		0	
		Threskiornis molucca	Australian White Ibis	W	24		23	
		Threskiornis spinicollis	Straw-necked Ibis	W	4		7	
		Platalea regia	Royal Spoonbill	W	97		8	
Accipitriformes	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-eagle	B	7		10	BR

				Water (W) & Bush (B) Birds	2007 Nov	2007 Breeding records [3] (BR)	2008 June	2008 Breeding records (BR)
		Haliastur sphenurus	Whistling Kite	B	75		46	
		Haliastur indus	Brahminy Kite	B	1		2	
		Milvus migrans	Black Kite	B	0		2	
		Accipiter novaehollandiae	Grey Goshawk	B [2]	0		1	
		Circus assimilis	Spotted Harrier	B	0		1	
		Aquila audax	Wedge-tailed Eagle	B	2		0	
Falconiformes	Falconidae	*Falco cenchroides*	Nankeen Kestrel	B [2]	0		2	
		Falco longipennis	Australian Hobby	B	2		3	
Gruiformes	Gruidae	*Grus rubicunda*	Brolga	B	36		6	
Charadriiformes	Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	B	1		1	
	Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt	W	7		0	
	Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel	W	1		0	
		Vanellus miles C100	Masked Lapwing	W	43		34	
	Jacanidae	*Irediparra gallinacea*	Comb-crested Jacana	W	303	BR	212	
	Scolopacidae	*Tringa stagnatilis*	Marsh Sandpiper	W	5		0	
		Calidris ruficollis	Red-necked Stint	W	4		0	
		Calidris acuminata	Sharp-tailed Sandpiper	W	2		0	
Psittaciformes	Cacatuidae	*Calyptorhynchus banksii*	Red-tailed Black-Cockatoo	B	112		5	
		Eolophus roseicapillus	Galah	B	31		23	
		Cacatua galerita	Sulphur-crested Cockatoo	B	39		78	
	Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet	B	220		1299	
		Aprosmictus erythropterus	Red-winged Parrot	B	15		30	
		Platycercus adscitus	Pale-headed Rosella	B	33		14	
Cuculiformes	Cuculidae	*Eudynamys scolopaceus*	Asian Koel	B	8		0	
		Scythrops novaehollandiae	Channel-billed Cuckoo	B	2		0	
		Chalcites basalis	Horsfield's Bronze-Cuckoo	B	0		3	
		Cacomantis pallidus	Pallid Cuckoo	B	2		0	
		Cacomantis variolosus	Brush Cuckoo	B	1		0	
Strigiformes	Strigidae	*Ninox connivens*	Barking Owl	B [4]	0		1	
		Ninox novaeseelandiae	Southern Boobock	B [4]	0		1	
Coraciiformes	Alcedinidae	*Ceyx azureus*	Azure Kingfisher	B	2		1	
	Halcyonidae	*Dacelo novaeguineae*	Laughing Kookaburra	B	21		90	
		Dacelo leachii	Blue-winged Kookaburra	B	9		12	
		Todiramphus macleayii	Forest Kingfisher	B	30		95	
		Todiramphus sanctus	Sacred Kingfisher	B	0		7	
	Meropidae	*Merops ornatus*	Rainbow Bee-eater	B	93		128	
	Coraciidae	*Eurystomus orientalis*	Dollarbird	B	24		0	
Passeriformes	Ptilonorhynchidae	*Ptilonorhynchus nuchalis*	Great Bowerbird	B	20		6	
	Maluridae	*Malurus melanocephalus*	Red-backed Fairy-wren	B	4		3	
	Acanthizidae	*Smicrornis brevirostris*	Weebill	B	1		7	

	Family	Scientific name	Common name	Water (W) & Bush (B) Birds	2007 Nov	2007 Breeding records[3] (BR)	2008 June	2008 Breeding records (BR)
		Gerygone magnirostris	Large-billed Gerygone	B	10		17	
		Gerygone albogularis	White-throated Gerygone	B	24		59	BR
	Pardalotidae	*Pardalotus rubricatus*	Red-browed Pardalote	B	1		5	
		Pardaltis straitus	Striated Pardelote	B[2]	0		1	
	Meliphagidae	*Lichenostomus flavus*	Yellow Honeyeater	B	20	BR	80	
		Ramsayornis modestus	Brown-backed Honeyeater	B	78		84	BR
		Ramsayornis fasciatus	Bar-breasted Honeyeater	B	9		6	
		Conopophila albogularis	Rufous-banded Honeyeater	B	8		2	
		Myzomlea obscura	Dusky Honeyeater	B	0		2	
		Cissomela pectoralis	Banded Honeyeater	B	1		17	
		Lichmera indistincta	Brown Honeyeater	B	6		8	
		Melithreptus albogularis	White-throated Honeyeater	B	77		130	BR
		Entomyzon cyanotis	Blue-faced Honeyeater	B	56		118	
		Philemon citreogularis	Little Friarbird	B	9		99	
		Philemon argenticeps	Silver-crowned Friarbird	B	0		5	
	Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	B	14		10	
	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	B	1		23	
	Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	B	3		5	BR
		Coracina papuensis	White-bellied Cuckoo-shrike	B	70		62	BR
		Coracina tenuirostris	Cicadabird	B	1		0	
		Lalage sueurii	White-winged Triller	B	1		0	
	Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	B	3		4	
	Oriolidae	*Oriolus flavocinctus*	Yellow Oriole	B	1		0	
		Oriolus sagittatus	Olive-backed Oriole	B	0		5	
.	Artamidae	*Artamus leucorynchus*	White-breasted Woodswallow	B[2]	2		0	
		Artamus cinereus	Little woodswallow	B	0		7	
		Cracticus mentalis	Black-backed Butcherbird	B	9		24	
		Cracticus tibicen	Australian Magpie	B	2		2	
	Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	B	2		8	
	Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail	B	2		0	
		Rhipidura leucophyrs	Willie Wagtail	B[2]	0		1	
	Corvidae	*Corvus coronoides*	Australian Raven	B[2]	4		0	
		Corvus orru	Torresian Crow	B	62		45	
	Monarchidae	*Myiagra rubecula*	Leaden Flycatcher	B	2		20	
		Grallina cyanoleuca	Magpie-lark	B	76		81	
	Petroicidae	*Microeca flavigaster*	Lemon-bellied Flycatcher	B	34	BR	42	
	Megaluridae	*Cincloramphus mathewsi*	Rufous Songlark	B	0		4	
	Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	B	18		23	
		Nectarinia jugularis	Olive-backed Sunbird	B	12		1	
	Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch	B	125		18	
		Poephila cincta	Black-throated Finch	B	10		25	
		Poephila personata	Masked Finch	B	10		11	BR
		Total numbers	**117 species**	**33W & 84B**	**7161**		**4219**	
		Number of species (total and for each survey)			**101**		**91**	
		Number of species common to each survey			**75**		**75**	
		Number of species recorded during only one survey			**26**		**16**	

1 = Taxonomic order and nomenclature from Systematics and Taxonomy of Australian Birds by Les Christidis and Walter E. Boles 2008
2 = Identified by people other than C. & D. Frith
3 = Parents observed at nests, with fledglings or juveniles
4 = Recorded calling at night

APPENDIX I:

Water Quality Analytical Results

Jack Lakes Water Quality Data- Nutrients, Iron and Aluminium

Sample Location	Date	Time	Total Phosphorus	Filt Reac Phosphorus	Ammonia Nitrogen	Nitrogen Oxides	Total N	Total Al	Dissolved Al	Total Fe	Dissolved Fe
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
JL-Top Lake	23/07/07	934	0.12	< 0.002	0.025	0.056	1.60	NA	NA	NA	NA
JL-Channel	26/06/07	1600	0.087	0.005	0.041	0.020	1.10	NA	NA	NA	NA
JL-Top Lake	23/11/07	1630	0.82	NA	NA	NA	8.90	12.1	NA	25.2	NA
JL-Middle Lake	23/11/07	1400	0.73	NA	NA	NA	6.70	19	NA	27.4	NA
JL-Lower Lake	24/11/07	930	0.16	NA	NA	NA	1.80	3.16	NA	5.94	NA
JL-Top Lake	15/04/08	1300	0.056	0.013	0.013	0.004	1.10	NA	NA	NA	NA
JL-Lower Lake	15/04/08	1400	0.016	0.002	0.006	0.003	0.39	0.04	0.1	0.9	0.72
JL-Top Lake	19/06/08	1500	0.126	NA	NA	NA	1.33	1.08	NA	3.06	NA
JL-Channel	17/06/08	1320	0.097	NA	NA	NA	0.99	NA	NA	NA	NA
JL-Middle Lake	17/06/08	1500	0.078	NA	NA	NA	0.86	1.6	NA	4.92	NA
JL-Lower Lake	18/06/08	1430	0.036	0.004	0.020	0.003	0.59	0.1	0.03	2.9	1.36
ANZECC 2000 Tropical wetlands guidelines			**.01 to .05**	**.005 - .025**	**0.01**	**0.01**	**.35 -1.2**				

Sample Location	Date	Time	pH	temp	cond	DO	DO	turbidity
					(uS/cm)	**(mg/L)**	**(%SAT)**	**NTU**
JL-Top Lake	23/07/07	934	5.97	21.77	75.33	7.67	87.43	217.67
JL-Channel	26/06/07	1600	5.73	23.80	68.23	2.67	33.80	108.50
JL-Top Lake	23/11/07	1630	4.39	31.40	295.55	5.51	77.10	>800
JL-Middle Lake	23/11/07	1400	4.60	36.50	217.03	4.32	63.57	>800
JL-Lower Lake	24/11/07	930	5.61	29.22	122.70	1.19	17.66	205.50
JL-Top Lake	15/04/08	1300	NA	NA	NA	NA	NA	NA
JL-Lower Lake	15/04/08	1400	6.94	29.33	53.20	2.50	33.33	6.65
JL-Top Lake	19/06/08	1500	5.54	22.46	54.50	1.06	12.11	71.44
JL-Channel	17/06/08	1320	6.06	23.50	53.37	2.52	29.47	33.70
JL-Middle Lake	17/06/08	1500	5.97	24.00	102.94	4.94	59.08	128.50
JL-Lower Lake	18/06/08	1430	6.04	25.22	62.15	5.30	64.90	8.49
ANZECC 2000 Tropical wetlands guidelines			**8.00**				**90- 120**	

Items highlighted in red exceed the ANZECC 2000 Water Quality Guidelines.