Jack Lakes Wetlands Biodiversity Assessment, November 2007 & June 2008

CYMAG Environmental Inc.

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CYMAG
Environmental

Natural Heritage Trust
Helping Communities Helping Australia

Queensland Government
Environmental Protection Agency

CYMAG Environmental Inc.

Cooktown, Queensland

(CYMAG Environmental is the operational sector of CYMAG - Cape York Marine Advisory Group)

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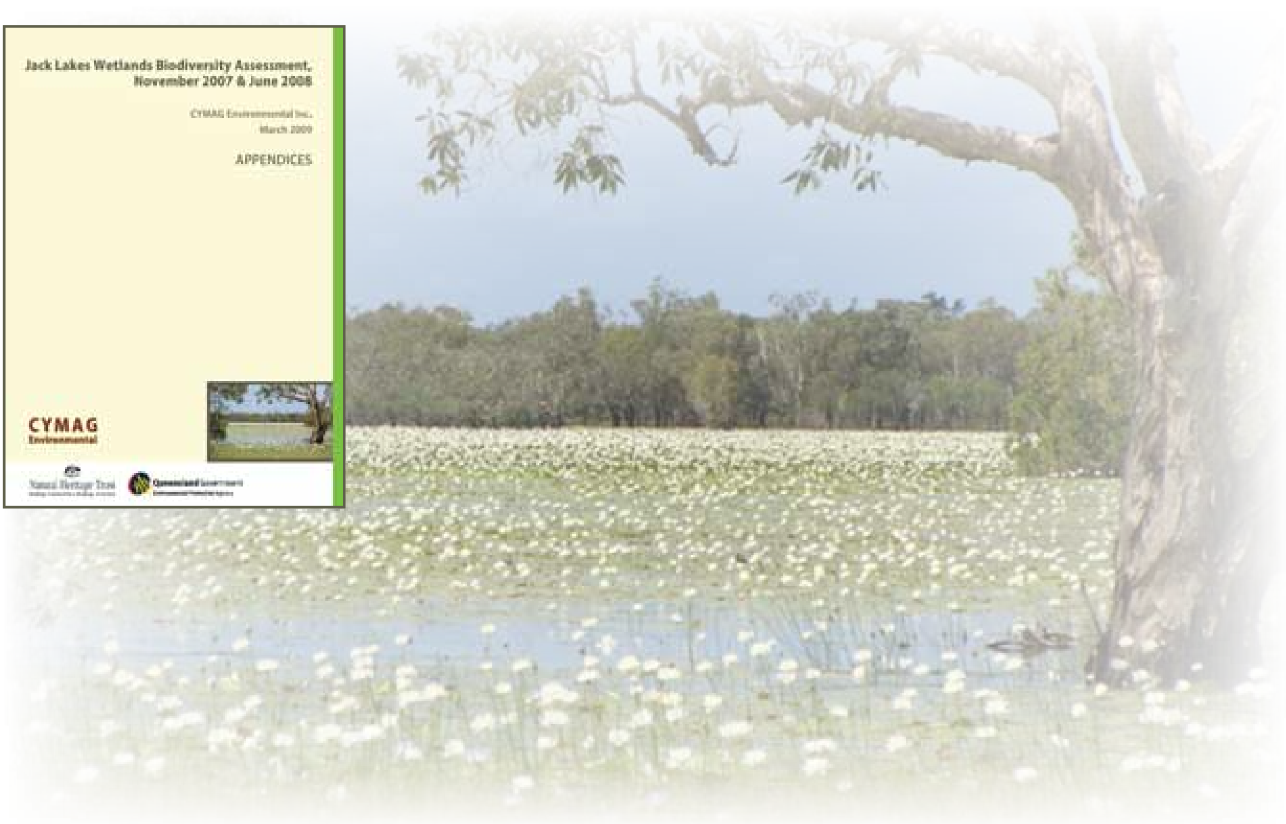


ACRONYMS AND ABBREVIATIONS

ACTFR	Australian Centre for Tropical Freshwater Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSC	Cook Shire Council
CYMAG	Cape York Marine Advisory Group
CYP	Cape York Peninsula
CYPDA	Cape York Peninsula Development Association
CYWAFAP	Cape York Weeds and Feral Animals Program
DEWHA	Department of the Environment, Water, Heritage and Arts
DNR&W	Department of Natural Resources and Water
DPI&F	Department of Primary Industries and Fisheries
EPA	Environmental Protection Agency
GIS	Geographical Information Systems
IUCN	International Union for Conservation of Nature
KLNRMO	Kowanyama Land & Natural Resource Management Office
NRW	Department of Natural Resources and Water
pers. comm.	personal communication
Qld	Queensland
QPW	Queensland Parks and Wildlife
UQ	The University of Queensland
WONS	Weed of National Significance

GLOSSARY

Biodiversity - The variety of plants, animals and other living organisms that occur in a particular area or region. Biodiversity includes habitat diversity, species diversity and genetic diversity

Biota - The plant and animal life of a region

Ecotone - A transitional area or zone between two different forms of vegetation, i.e forest and plain

Keystone Species - Species that mediate biodiversity levels by altering ecosystem function

Littoral Zone - Extends from the shoreline of a lake and continues to a depth where sufficient light for plant growth reaches the sediments and lake bottom

Macroinvertebrates - Animals without a back bone that are visible to the naked eye. Includes terrestrial and aquatic invertebrates

Macrophytes - Conspicuous plants that dominate wetlands, shallow lakes, and streams

Palustrine - Swamps, marshes etc. that are generally non-tidal areas dominated by vegetation (> 30% cover) or if lacking vegetation an area less than 8 ha

Pugging - The breaking of the sod's surface by animal's hooves in wet conditions

Regional Ecosystem - Vegetation communities that are consistently associated with a particular combination of geology, landform and soil

GLOSSARY cont.

Riparian Zone - land adjacent to the normal high water line in a stream, river, lake or pond

Species / Taxon Abundance – The actual number of organisms of a species per unit of area or volume (Density).

Species / Taxon Richness - Number of species in community (Species Diversity)

Species Evenness - Relative abundance of species

Turbidity – the amount of suspended sediment in the water, a measure of water clarity

ABSTRACT

Jack Lakes is one of the most extensive wetland systems on South-eastern Cape York Peninsula. Biodiversity surveys of Jack Lakes were conducted by CYMAG scientists, Queensland Parks & Wildlife (QPW) and flora and fauna consultants at the end of the dry season (November 2007) and the end of the wet season (June 2008). The major objectives of the survey were to assess biodiversity through fauna and flora surveys, to identify threats to the biodiversity and to provide recommendations for the future management of Jack Lakes.

Two hundred and forty three native species were recorded comprising 63 plants, 17 fish, 8 amphibians, 17 reptiles, 117 birds and 21 mammals. Three of these - the Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*), Estuarine Crocodile (*Crocodylus porosus*) and Grey Goshawk (*Accipiter novaehollandiae*) - are listed as threatened species in Queensland. Some groups appear to be diverse (e.g. Diptera invertebrates), some appear low in diversity (e.g. migratory wading birds) and others require more intensive sampling (ie aquatic plants, fish, small mammals). A shift in species composition and abundance was observed from November to June.

Feral pigs (*Sus scrofa*) were identified as representing the biggest threat to the biodiversity of Jack Lakes through direct predation, habitat modification and habitat degradation. The impacts on the wetland were greater at the end of the dry season when resources were scarce. Cattle were also observed to impact on wetland condition.

Recommendations for management include implementing a pest management plan, preventing the introduction of weeds through a vehicle wash-down program and cattle quarantine period, limiting cattle access to the wetlands, regulating visitor numbers and supporting the development of small-scale tourism operations by Traditional Owners.

INTRODUCTION

In November 2007, CYMAG Environmental was contracted to conduct a Biodiversity Assessment of the Jack Lakes Wetlands by DEWHA and DNRW under the Natural Heritage Trust. A team of CYMAG scientists, QPW rangers, Indigenous rangers and consultants carried out surveys of the flora, fauna and wetland condition. The project was managed by Kim Stephan and Christina Howley (CYMAG). The initial field work took place at the end of the dry season between the 17th and 24th November, 2007. In order to gain a more comprehensive representation of the species present, the fauna survey was repeated after the wet season, between the 15th and 21st June, 2008.

Jack Lakes comprise an extensive system of open freshwater lakes and paperbark swamps in South-eastern Cape York. The Jack Lakes Aggregation (14°54’24.84”S, 144°25’1.47”E) is listed and described in the Directory of Important Wetlands in Australia (Environment Australia, 2001). Jack River National Park was created on 15 December 2005 and includes most of the Jack Lakes wetlands except for the top lake (Figure 1). The top lake and 200,000 hectares of surrounding land are owned and managed by the Kalpowar Land Trust. Jack River National Park is jointly managed by QPW and the Kalpowar Land Trust Traditional Owners. The National Park is currently closed to the public.

The Muunthiwarra/Muunjiwarra clan (Jack Lakes Traditional Owners) have a strong connection to Jack Lakes as a hunting, fishing, story and ceremonial place. The Traditional Owners were consulted on their cultural values and aspirations for the future use of the area and provided assistance with the field surveys.

The primary objectives of this project were to assess biodiversity at the species level, document the habitat values and assess the condition of the Jack Lakes Wetlands. Assessing the diversity of species is central to understanding the degree of risk to that community, should environmental changes occur. Biodiversity assessment is typically used as a comparative study between sites and to monitor changes over time (Magurran, 2004). The information gathered at Jack Lakes will be available to assist the EPA and Kalpowar Land Trust in developing appropriate management plans.

The Objectives - The specific objectives of this study were to:

1. Assess the biodiversity of the Jack Lakes system through flora and fauna surveys;
2. Identify high value habitat areas and potential threats to biodiversity;
3. Identify potential indicators of biodiversity for future monitoring;
4. Establish baseline condition of the wetlands (through wetland assessments, soil and water quality tests);
5. Identify management needs and sustainable land use opportunities; and
6. Develop rigorous and repeatable survey designs.

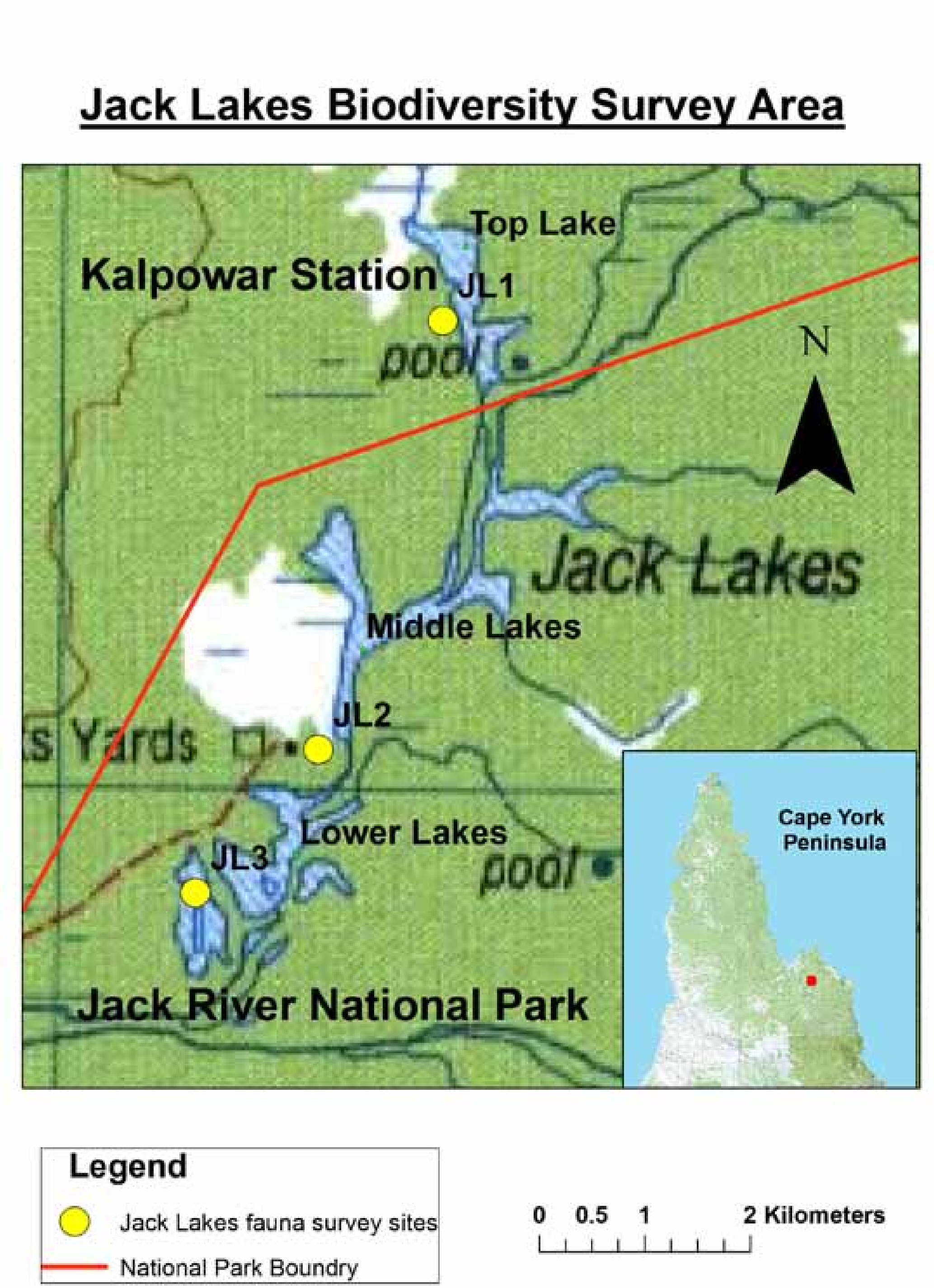
SITE DESCRIPTION

Jack Lakes is an inland freshwater lake system covering approximately 808ha. The Lakes are located in the middle of the Laura Basin in the Cape York Peninsula Bioregion, Queensland, Australia (Figure 1). The lakes overlie alluvial soils and are characterised by predominantly summer rainfall and a winter dry season. The mean maximum temperature for November is 35.5°C and for June is 29.6°C. The mean minimum temperature for November is 20.8°C and for June is 15.0°C. Mean rainfall for November is 57.7 mm and for June is 9.8 mm (Bureau of Meteorology, 2009).

Numerous lakes are connected by a series of channels vegetated primarily by paperbark trees. The direction of flow is from the northernmost (top) lake to the south into the middle and lower lakes, then into the Jack River. Jack River flows south-east into the Normanby River, which flows north to Princess Charlotte Bay and the Coral Sea. Flow into the lakes is primarily from intermittent tributaries to the north and east and surface water run-off to the west. The top and middle lakes are highly turbid, while the lower lakes are smaller and less turbid with steeper banks. The measured maximum water depth at the approximate centre of each lake during June 2008 was 1.7m (top lake), 2.9m (middle lake), 2.5m (lower lake).

Six different Regional Ecosystems have been classified in the vicinity of Jack Lakes. For the purpose of this assessment, consultants were asked to focus their surveys on Regional Ecosystem RE 3.3.66. This ecosystem has been described as a Palustrine wetland containing permanent lakes and lagoons fringed by narrow bands of paperbark forest (*Melaleuca leucadendra* and *Melaleuca viridiflora*). The Biodiversity Status and the Vegetation Management Act Status of RE 3.3.66 has been assigned "of concern" due to the remnant extent being less than 10,000ha (EPA, 2008).

Figure 1: Jack Lakes location, tenure and survey areas



SURVEY DESIGN

The Jack Lakes region was sectioned into three areas (Figure 1): top, middle and lower lakes. Replicate flora and fauna surveys were conducted at each of the three areas to assess species diversity and wetland condition across a representative cross-section of the Jack Lakes Wetlands.

Where possible, each survey was repeated in both November (end of the dry season) and June (end of the wet season) in order to assess the full range of species and shifts in species composition. Due to limited resources and/or the availability of consultants, detailed vegetation and fish surveys were only conducted in November. Fish were also recorded opportunistically (i.e. in turtle traps, dip nets) during the June survey period. Detailed invertebrate surveys were only conducted in June.

The methodology for each survey is detailed in the relevant section and in the appendices.

Table 1: Surveys and Consultants

SURVEY TYPE	NOVEMBER 2007	JUNE 2008
Vegetation	Dr John Dowe (ACTFR)	Not surveyed
Aquatic Invertebrates	Not surveyed	Dr Fiona McKenzie-Smith (Griffith University)
Terrestrial Insects	Not surveyed	Stephanie Suess (Griffith University)
Fish	Colton Perna & Dr Damien Burrows (ACTFR)	Opportunistic
Birds	Dr Clifford B. Frith & Dr Dawn W. Frith	Dr Clifford B Frith & Dr Dawn W. Frith
Amphibians, Reptiles & Mammals	Russell Best (QPW) and Kim Stephan	Russell Best (QPW) and Kim Stephan
Bats	Greg Ford (Anabat Echolocation Call Specialist)	Dr Roger Coles (UQ)
Hair & Scats	Robyn Carter Hair Identification	Robyn Carter Hair Identification
Wetland Condition & Water Quality	Christina Howley & Kim Stephan	Christina Howley & Kim Stephan

THE SURVEY SITES

Top Lake (Site 1) S-14.87298 E144.43120 (WGS 84)

Weeping Paperbark (*Melaleuca leucadendra*) was identified as the dominant tree species. Other trees and shrubs included *Melaleuca stenostachya*, Swamp Mahogany (*Lophostemon suaveolens*), *Calycopeplus casuarinoides*, Pendulous Paperbark (*Melaleuca fluviatilis*), Broad-leaved Paperbark (*Melaleuca viridiflora*), *Hibiscus sp.*, and the Northern Cabbage-tree Palm (*Livistona muelleri*). Green Couch (*Cynodon dactylon*) and other Poaceae species formed the dominant ground cover. Aquatic plants including Water Lily (*Nymphaea spp.*), Bulkaru (*Eleocharis spp.*), Water Fern (*Azolla pinnata*), Marshwort (*Nymphoides spp.*) and *Marsilea mutica* were present in shallow lake margins. In June, Water Lilies covered most of the surface of the lake (cover photo). The substrate consisted of clay and silt. Deep sand was present further back into the riparian zone.

Photo 1: Top Lake aquatic vegetation

Photo 2: Top Lake riparian vegetation

Middle Lake (Site 2) S-14.90506 E144.41885 WGS 84

Weeping Paperbark was identified as the dominant species. The following trees and shrubs were also present: *C. casuarinoides*, Clarkson's Bloodwood (*Corymbia clarksoniana*), Freshwater Mangrove (*Barringtonia acutangula*), *Acacia brassii*, Brown Gardenia (*Endiandra glauca*), *Leptospermum longifolium*, *Atractocarpus sessilis*, *Asteromyrtus symphyocarpa*, *L. muelleri*, Screw Pandanus (*Pandanus whitei*) and *Parsonia sp.* Green Couch and Water Fern formed dense mats on the water's edge and water lilies covered some areas. Clay soils were present and outcrops of ironstone were observed in woodland areas.

Photo 3: Middle Lake aquatic vegetation

Photo 4: Middle Lake riparian vegetation

Photo 5: Middle Lake woodland vegetation

Photo 6: Pitfall traps Middle Lake

Lower Lake (Site 3) S -14.910500 E 144.41600 WGS 84

The riparian vegetation was similar to Site 2, with Weeping Paperbark the dominant species. Freshwater Mangrove, *C. casuarinoides*, *A. brassii*, *Terminalia platyphylla* and *L. longifolium* were also present. Green Couch and Water Fern formed a carpet of vegetation across and along the edges of the lake. The topography was steeper at Site 3, rising up from the wetland to an ironstone ridge with Cooktown Ironwood (*Erythrophleum chlorostachys*). The substrate contained less clay and silt than top and middle lakes.

Photo 7: Lower Lake aquatic vegetation

Photo 8: Lower Lake riparian vegetation and pitfall traps

Weather conditions

November experienced hot weather conditions with frequent cloud cover and occasional showers. The lakes were shallow and turbid and the channels connecting them were dry. In June, the lakes had receded after the wet season. However, the level of water in the lakes was much higher than during the November dry period. Weather conditions were milder in June with frequent cloud cover and occasional showers. The moon was full or approaching full for both survey periods.

SUMMARY OF SPECIES RECORDED

A total of 243 species (63 plants and 181 animals - excluding introduced species) were recorded during the two surveys. This included 140 species that had not been recorded in the Jack Lakes area prior to the CYMAG survey. In terms of fauna, the most abundant species was the Magpie Goose (*Anseranas semipalmata*), with some flocks estimated at over 1000 birds. Three threatened species were identified: the Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*), Estuarine Crocodile (*Crocodylus porosus*), and Grey Goshawk (*Accipiter novaehollandiae*). The species records will be entered into the WildNet Database, Queensland Museum and Queensland Herbarium records.

The total number of species recorded at Jack Lakes during the two CYMAG surveys and previous surveys is listed in Table 2. The complete vegetation species lists are in Table 3 while Tables 4-9 cover each of the different fauna groups. Vegetation and fauna species recorded from previous surveys and not detected during the CYMAG surveys are listed in Appendix A.

Table 2: Numbers of native species recorded at Jack Lakes by CYMAG and previous surveys

GROUP	Number of species November 2007 survey	Number of species June 2008 survey	Total number of species recorded from CYMAG surveys	Number of species recorded from previous surveys	Grand total number of species recorded (all surveys)
Vegetation	63	Not surveyed	**63**	131**	**137**
Fishes	12	8	**17**	1***	**17**
Amphibians	5	7	**8**	0*	**8**
Reptiles	10	14	**17**	2*	**19**
Birds	101	91	**117**	56*	**126**
Mammals (excl. Bats)	6	3	**7**	0*	**7**
Bats	4	13	**14**	0*	**14**
TOTAL NUMBERS OF SPECIES	201	136	**243**	190	**328**

* From Wildlife Online (25/10/2007) and Qld Museum searches defined area for Jack Lakes
** Compiled from data in DPI (1993), EPA (2007), Nelder & Clarkson (1995) and Nelder (1999)
*** Anecdotal reports

Introduced Species

In addition to the above list of native species, seven species of introduced animals were recorded including the Cane Toad (*Rhinella marina*), Horse (*Equus caballus*), Feral Pig (*Sus scrofa*), Cow (*Bos sp*), Dog (*Canis familiaris*), Black Rat (*Rattus rattus*) and Red-claw Crayfish (*Cherax quadricarinatus*). Two introduced plant species - Horehound (*Hyptis suaveolens*) and Chinese Bur (*Triumfetta rhomboidea*) - were recorded. Green couch was also present, which is listed as an introduced species by the Queensland Herbarium, but is considered native by some authors.

Invertebrates

Invertebrates were identified to order, family or genus and are listed in Appendices C and D. They have not been included in the total number of species.

SUMMARY OF ALL SURVEYS

The following is a summary of the findings from each survey. The full consultants' reports are located in the separate Appendices document.

FLORA

A vegetation survey of the Jack Lakes area was conducted by Dr John Dowe (ACTFR) from 19-22, November 2007 (Full Vegetation Report Appendix B). This survey brings the number of plant species recorded at Jack Lakes to 137 (Table 2), with the most common families being

Myrtaceae (22 spp.), Poaceae (18 spp.), Cyperaceae (9 spp.), Mimosaceae (8 spp.) and Euphorbiaceae (6 spp.). *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* the most ubiquitous species. Other common tree/shrub species include, in order of prevalence, *Barringtonia acutangula*, *Calycopeplus casuarinoides*, *Asteromyrtus symphyocarpa*, *Leptospermum longifolium*, *Acacia auriculiformis*, *Livistona muelleri*, *Melaleuca stenostachya* and *Acacia holosericea*.

Photo 9: *Livistona muelleri* (Photos: Dr John Dowe)

Photo 10: *Barringtonia acutangula*

In November, at the end of the dry season, many understorey and/or ground cover species were in a senescent and/or dried state, including *Eleocharis* spp. (bulkuru), *Cyperus* spp. (sedges), and Poaceae spp. (grasses). 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*.

Jack River and the associated downstream riparian forest supports a distinct vegetation type not found anywhere else within the Jack Lakes area. At the confluence of Jack River and the lower lakes drainage channels, *Melaleuca* dominated vegetation meets riparian 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 habitat types is unusual.

No rare or threatened plant species were directly observed. However, 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*. Of considerable interest was the high density of the uncommon orchid *Cepobaculum (Dendrobium) trilamellatum*, with extensive populations observed in the northern margins of Top Lake on host trees of *M. stenostachya* and *M. clarksonii*.

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. Grader Grass (Themeda quadrivalvis) also poses a high threat to the area.

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 adversely affecting or assisting in maintaining the ecological integrity that is threatened by pigs and cattle.

Table 3: Complete plant species list for Jack Lakes

Compiled from data in DPI (1993), Nelder & Clarkson (1995) and Nelder (1999), and surveys conducted for CYMAG in November 2007. Family abbreviations are included in brackets. Specific locations, where known, are indicated as: T = Top Lake; M = Middle Lakes; B= Bottom (Lower) Lakes. # =Species not previously recorded from Jack Lakes.

Abrus precatorius (Fab.) [B]	Buchanania arborescens (Anancard.) [B]
Acacia auriculiformis (Mimos.) [T,M,B]	Calycopeplus casuarinoides (Euphorb.) [T,M,B]
Acacia fleckeri (Mimos.)	Carallia brachiata (Rhizophor.) [B]
Acacia midgleyi (Mimos.)	Cepobaculum canaliculatum (Orchid.) [M,B]
Acacia polystachya (Mimos.)	Cepobaculum trilamellatum (Orchid.) [T,M,B]
Acacia salicina (Mimos.) [T,M,B]	Chionanthus ramiflora (Ole.) [B]
Acacia torulosa (Mimos.)	Choriceras tricorne (Euphorb.)
Albizia canescens (Mimos.) [T] #	Chrysophyllum lanceolatum (Sapot.)
Alyxia spicata (Apocyn.)	Cleistanthus apodus (Euphorb.)
Aponogeton elongatus (Aponogeton.) [T,M,B]	Corymbia clarksonii (Myrt.) [T]
Aponogeton queenslandicus (Aponogeton.) [T,M,B]	Corymbia polycarpa (Myrt.)
Archidendron hirsutum (Mimos.)	Croton brachypus (Euphorb.)
Aristida sp. (Poa.)	Cymbidium canaliculatum (Orchid.)
Asteromyrtus symphyocarpa (Myrt.) [T,M,B]	Cynodon dactylon (Poa.) [T,M,B] #
Astonia australiense (Alismat.)	Cyperus spp. (Cyper.) [T,M,B]
Atracocarpus sessilis (Rubi.) [B]	Dapsilanthus elatior (Restion.) [T,M,B]
Austrosteenisia blackii (Fab.) [B] #	Dichanthium sericeum (Poa.)
Azolla pinnata (Azoll.) [B]	Dillenia alata (Dillen.) [B]
Banksia dentata (Prote.)	Diospyros sp. (Eben.) [B]
Barringtonia acutangula (Lecythid.) [T,M,B]	Diplatia tomentosa (Loranth.) [B] #
Baumea teretifolia (Cyper.)	Dischidia nummularia (Asclepiad.) [T,M,B]
Blepharocarya involucrigera (Anacard.)	Dolichandrone heterophylla (Bignon.)
Blyxa sp. (Hydrocharit.) [T,M,B]	Dysoxylum oppositifolium (Meli.)
Brachychiton garrawayae (Stercul.) [T] #	Eleocharis (Cyper.) [T,M,B]
Endiandra glauca (Laur.)	Melaleuca clarksonii (Myrt.) [T]
Epaltes australis (Aster.) [T,M]	Melaleuca fluviatilis (Myrt.) [T,M,B]
Eragrostis sp. (Poa.)	Melaleuca foliolosa (Myrt.) [B]
Eremochloa bimaculata (Poa.)	Melaleuca leucadendra (Myrt.) [T,M,B]
Eriachne sp. (Poa.)	Melaleuca saligna (Myrt.) [T]
Erythrophleum chlorostachys (Caesalpin.) [T]	Melaleuca stenostachya (Myrt.) [T]
Eucalyptus chlorophylla (Myrt.)	Melaleuca viridiflora (Myrt.) [T,M,B]
Eucalyptus hylandii (Myrt.)	Memecylon pauciflorum (Melastomat.)
Eucalyptus phoenicea (Myrt.)	Millettia pinnata (Fab.)
Eucalyptus tetradonta (Myrt.)	Monochoria cyanea (Ponteder.)
Eustrephus latifolius (Geitonoples.) [B]	Myrsine porosa (Myrsin.)
Ficus virens (Mor.) [M,B]	Najas tenuifolia (Hydrocharit.)
Fimbristylis spp. (Cyper.) [T,M,B]	Nauclea orientalis (Rubi.)[B]
Flagellaria indica (Flagellar.) [B]	Nelumbo nucifera (Nelumbon.)

Table 3 cont.: Complete plant species list for Jack Lakes CONT.

Flindersia brassii (Rut.)	Oplismenus spp. (Poa.)
Flueggea virosa (Euphorb.)	Oryza australiensis (Poa.)
Gardenia psidioides (Rubi.)	Oryza rufipogon (Poa.)
Grevillea glauca (Prote.) [T]	Owenia venosa (Meli.)
Grevillea pteridifolia (Prote.) [T]	Pandanus spiralis (Pandan.) [T,M,B]
Grevillea striata (Prote.) [T]	Panicum sp. (Poa.)
Grewia retusifolia (Tili.)	Parinari nonda (Chrysobalan.) [T]
Hakea persiehana (Prote.)	Parsonsia sp. (Apocyn.)
Heteropogon contortus (Poa.)	Paspalidium sp. (Poa.)
Heteropogon triticeus (Poa.)	Petalostigma banksii (Euphorb.)
Hyptis suaveolens* (Lam.) [M]	Philydrum lanuginosum (Philydr.) [M]
Hypserpa decumbens (Menisperm.)	Rhynchospora heterochaeta (Cyper.)
Lagerstroemia archeriana (Lythr.)	Sarga plumosa (Poa.)
Lepironia articulata (Cyper.) [T,M,B]	Schizachyrium sp. (Poa.)
Leptocarpus sp. (Restion.)	Schoenus calostachyus (Cyper.)
Leptospermum longifolium (Myrt.) [T,M,B]	Schoenus sparteus (Cyper.)
Leptospermum madidum (Myrt.)	Scleria sp. (Cyper.)
Litsea macrophylla (Laur.)	Siphonodon pendulus (Celast.) [T,M]
Livistona muelleri (Arec.) [T,M,B]	Strychnos lucida (Logan.) [B]
Lomandra banksii (Laxmann.) [M]	Syzygium argyropedicum (Myrt.)
Lophostemon suaveolens (Myrt.) [T,M,B]	Syzygium eucalyptoides (Myrt.) [B] #
Ludwigia perrenis (Onagra.)	Syzygium forte (Myrt.)
Lygodium fexuosum (Lygod.)	Syzygium papyraceum (Myrt.) [B]
Macrostelia grandiflora (Malv.)	Terminalia platyphylla (Combret.) [M,B]
Mallotus polyadenos (Euhorb.)	Utricularia sp. (Lentibular.)
Marsilea mutica (Marsil.) [M,B]	Vallisneria gracilis (Hydrocharit.)
Melaleuca arcana (Myrt.) [T]	Vandasina retusa (Fab.) [B]
Triumfetta rhomboidea* (Tili.)	Vetiveria sp. (Poa.)
Themeda arguens (Poa.)	Vitex helogiton (Lami.)
Themeda triandra (Poa.)	
Thryptomene oligandra (Myrt.) [M]	

The List of Vouchered Vegetation Species collected by Dr John Dowe (18-22 November 2007) is in Appendix B with the Complete Jack Lakes Botanical Survey Report.

Photo 11: Fruits from Jack Lakes (Photo: Dr John Dowe)

FAUNA

Terrestrial Invertebrates

Invertebrates constitute a major component of diverse ecosystems, play a lead role in the functioning of ecosystem processes and are known to be one of the most important groups in the natural world (Kim, 1993). They are rarely addressed effectively within biodiversity monitoring programs, although they can contribute to the tracking of changes of ecosystems (Anderson *et al,*, 2004) and related ecological processes (You *et al,*, 1993).

Photo 12: Chalky Percher Dragonfly (*Diplacodes trivialis*) (Photo: Russell Best, June 2008)

Flying insects around the lakes' margins were sampled by Stephanie Seuss and Dr Fiona MacKenzie-Smith (Griffith University) during the June 2008 survey period using malaise trapping techniques (full report Appendix C). Two malaise traps were set up at each site for 24 hours, one in the riparian zone along the water's edge and one approximately 50m back from the water in the woodland area. Samples were sorted into taxonomic Order. The number of insects within each Order is listed in Table 4. The low number of replicate samples for each site meant statistical analysis was unable to be run upon the data.

Of the terrestrial invertebrates trapped, the Order Diptera (flies, mosquitoes etc) recorded the highest abundance throughout all the lake sites. The Diptera also showed the largest variety in species diversity compared with any other of the Orders. Lepidoptera (moths and butterflies), however, were present in higher numbers in the riparian zone in the lower and top lakes.

Although no conclusions can be drawn due to the low number of sample replicates, it is of interest that the lowest number of flying insects was found at the top lake riparian area while the highest number was captured at the lower lakes riparian area. This may reflect a correlation with wetland condition. Improved condition of aquatic vegetation and lower water turbidity was observed at the lower lakes where more flying insects were caught. In contrast, the top lakes - where fewer flying insects were caught - appeared to have the greatest pig impact in the riparian area and the highest water turbidity (wetland condition assessments are discussed later in this report).

Table 4: Number of insects trapped at each site listed by Order

	Lower 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
TOTALS / SITE	**153**	**313**	**290**	**232**	**182**	**86**

The surprising find is the lack of Odonata (dragonflies) found in the traps near the riparian zones. Huge numbers were observed on site suggesting that dragonflies are not easily trapped using the malaise trap method. It is clear that the diversity of insects in this area and the patterns associated with the riparian and woodland zones and wetlands condition, requires further sampling effort.

Aquatic Invertebrates

Aquatic Invertebrates were sampled and identified by Dr Fiona McKenzie-Smith in June 2008. The aim of the aquatic invertebrate survey was to determine aquatic invertebrate taxon abundance and richness in different habitats. 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. The habitats sampled were chosen to reflect typical zones of distinct aquatic habitat.

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. Benthic root samples from the middle lake contained gravel whereas samples from this habitat in the top lake contained silt and clay.

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

There was no significant difference amongst the diversity measures (ANOVA $F_{(2,9)} = 0.1237$ $p>0.05$). 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. Diversity was lowest in samples from the benthic centres of all lakes. However, samples from the benthic centre were not well preserved and may have been underestimated.

Overall, taxa observed represented a variety of trophic levels and dynamics and clear distinction between habitats. There was a high representation of taxa with desiccation (drought) resistant life stages or those 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, dragonflies, 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. Due to water regimes, both habitats are variable in terms of availability 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 the middle lakes' 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 indices 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 shorelines, compared to other lakes where dense tree growth was patchy.

The Top Lake exhibited different faunal characteristics from other lakes; interpreting and understanding 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 and there was a vast extent of coverage by emergent macrophytes across the surface of the lake.

Decreased siltation and higher taxon richness was observed in the shaded benthic roots of the lower lakes compared with the other lakes. The extensive photic zone in the lower lake would extend the range of resources which in other lakes was limited to a narrow band of littoral zone vegetation. Water clarity would also increase foraging efficiency of predatory fauna. Numerous schools of small-sized fish were observed foraging in littoral and extended macrophyte zone of lower lake. 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.

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 also be expected to be a key factor if this was to be altered by humans.

Freshwater Fish

Fish were surveyed in Top Lake in November 2007 by Colton Pernu (ACTFR) using electrofishing boat. (The complete report by Dr Damien Burrows is located in Appendix E.) The middle and lower lakes were too shallow and inaccessible during that period. Fish were caught opportunistically (i.e. in turtle traps and invertebrate dip nets) during the June 2008 survey.

A total of 17 fish species was caught during the November and June surveys.

Photo 13: Mouth Almighty (*Glossamia aprion*)

One of the species - archerfish - is a highly visual hunter, normally assumed to avoid turbid water. Bony bream, a fish normally thought to be sensitive to low dissolved oxygen, was present. An additional five species of fish - Snakehead Gudgeon (Giurus margaritacea), Fly Speckled Hardy Head (*Craterocephalus stercusmuscarum*), Penny Fish (*Denariusa bandata*), Barramundi (*Lates calcarifer*) and Barred Grunter (*Amniataba percoides*) were recorded in the June survey. Table 5 lists the identified fish species.

Table 5: Fish species identified during the Nov 2007 and June 2008 surveys

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007
Atherinidae	*Craterocephalus stercusmuscarum*	Fly Speckled Hardy Head	1	
Apogonidae	*Glossamia aprion*	Mouth Almighty	3	X
Eleotridae	*Oxyeleotris selheimi*	Giant Gudgeon		X
	Giurus margaritacea	Snakehead Gudgeon	1	
Latidae	*Lates calcarifer*	Barramundi	1	
Terapontidae	*Leiopotherapon unicolor*	Spangled Perch	1	X
	Amniataba percoides	Barred Grunter	1	
Ambassidae	*Ambassis agrammus*	Sailfin Glassfish		X
Toxotidae	*Toxotes chatareus*	Seven-spot Archerfish		X
Chandidae	*Denariusa bandata*	Penny Fish	1	
Plotosidae	*Neosilurus ater*	Black Catfish	1	X
	Neosilurus hyrtlii	Hyrtl's Tandan		X
	Porochilus rendahli	Rendahl's Tandan		X
Anguillidae	*Anguilla reinhardtii*	Marbled Eel		X
Megalopidae	*Megalops cyprinoides*	Tarpon		X
Melanotaeniidae	*Melanotaenia splendida splendida*	Eastern Rainbow fish	1	X
Clupeidae	*Nematalosa erebi*	Bony Bream		X

X = Numbers of fish caught were not reported during the November survey

No species of conservation value were caught, all of those caught being common species with wide distributions. Red claw crayfish (*Cherax quadricarinatus*) were also caught in the Top Lake. This species is not native to this area. Tissue samples were taken from several fish to contribute to other studies examining the genetics of northern Australian freshwater fish.

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 provide suitable habitat for all fish species.

No barramundi were caught in the November survey, though it is possible that some were present. In June 2008, barramundi were commonly observed breaching the surface of the middle lake. Given the condition at the end of the dry season, it is not likely that many 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.

In general, the cattle and pig activity 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.

It is not known whether the extreme turbidity of the lakes 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.

Amphibians

Amphibians were surveyed by Kim Stephan (CYMAG) and Russell Best (QPW) during the November and June survey periods. (Full report located in Appendix F). Eight species of native amphibians were identified (Table 6) from the surveys. A total of 660 frogs were recorded. Frogs were more abundant in June with 642 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.

Photo 14: Northern Spadefoot Toad (*Notaden melanoscaphus*)

In November, many frogs were juveniles and the most abundant frog was the Ornate Burrowing Frog (*Platyplectrum ornatum*), which recorded ten individuals.

Most of the frogs identified are reasonably widespread and common in the region. One exception is the Northern Spadefoot Toad (*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; these are considered to have the least disturbance and the best water quality in the Jack Lakes system.

Table 6: Frog species identified during the Nov 2007 and June 2008 surveys

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
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	2	1	3
	Litoria rubella	Red Tree Frog		1	1
Limnodynastidae *= introduced species	*Limnodynastes convexiusculus*	Marbled Frog	4		4
	Notaden melanoscaphus	Northern Spadefoot Toad	1		1
	Platyplectrum ornatum	Ornate Burrowing Frog	27	10	37
Myobatrachidae	*Crinia remota*	Northern Froglet	535		535

The raw data (Table 6) 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 are available. Some frog species may also have been dormant (e.g. burrowing species) in November and therefore 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. These conditions are not ideal for amphibian reproduction and may be disadvantaging certain species.

In June, the vegetation around the lakes had re-established 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 as contributing 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 al* (1999), *Litoria rothii* (present in small numbers 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, Red Tree Frog (*Litoria rubella*), Slaty-grey Snake (*Stegonotus cucullatus*), Black Bittern (*Ixobrychus flavicollis*), and Blue-winged Kookaburra (*Dacelo leachii*) (Catling *et al,*, 1999). Many dead Cane Toads were observed. Some of these had been turned over and eaten, presumably by crows or raptors.

Reptiles

Reptiles were surveyed by Kim Stephan (CYMAG) and Russell Best (QPW) during the November and June survey periods. (Full report is located in Appendix F). Fifteen species of reptiles were identified (Table 7) 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 (*C. 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. As a result, 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). However, it is not possible to say what the diversity and abundance might be in the absence of pig damage.

The turtle recorded as Krefft’s River Turtle (*Emydura macquarii krefftii*) showed 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.

Photo 15: Krefft's River Turtle (*Emydura macquarii krefftii*) (Photo: Russell Best)

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 to allow an annual indigenous harvest of up to 20% without causing substantial population pressure.

The previously recorded species of the Slaty-grey Snake (*Stegonotus cucullatus*) (Wildlife Online) and Rainbow Skink (*Carlia dogare*) (Qld Museum) were not observed during the survey.

Table 7: Reptile species identified during the Nov 2007 and June 2008 surveys

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
Crocodylidae	*Crocodylus johnstoni*	Australian Freshwater Crocodile	3		3
	Crocodylus porosus	Saltwater Crocodile	1		1
	Crocodylus sp.	Crocodile	5	13	18
Agamidae	*Diporiphora sp.*	Dragon	1	1	2
	Diporiphora bilineata	Northern Two-lined Dragon		1	1
Colubridae	*Tropidonophis mairii*	Freshwater Snake	2	1	3
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

Birds

Bird surveys were conducted in November 2007 and June 2008 by Dr Clifford and Dr Dawn Frith (the complete report is located in Appendix H).

Comparative observations between the two major survey periods (November and June) 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.
- A greater diversity of both water and bush bird species was recorded during the November survey, compared with June.
- A conspicuously lower density of many waterbird species was recorded during June, compared with the November survey. Conversely, a greater density of nectarivorous species, i.e. lorikeets and honeyeaters, were present during the June survey, compared with November.

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 reduced dramatically. Magpie Geese, Little Egrets, Glossy Ibis and Black-winged Stilts were entirely absent and a number of other species (e.g. Green-Pygmy Geese, White-necked Herons, Pied Herons, Nankeen Night-Herons, Royal Spoonbills, Comb-crested Jacanas and Brolgas) were present in relatively small numbers (Table 8). During the November survey, an estimated 3000 Magpie Geese were recorded on the lakes. However, this may represent an over-estimate because the large numbers observed early one morning on the top lake had clearly roosted there for the night and were not feeding – whereas those seen on the lower lakes were actively feeding. Thus, the sightings may have been of a single population moving between roosting 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 support their presence, along with other waterbird species.

Photo 17: Pig and cattle damage to water lily beds (Photo: Dr Clifford B. Frith, 2007)

Photo 16: Bush Stone-curlew chick (*Burhinus grallarius*), Nov 2007 (Photo: Russell Best)

In November, only two Green Pygmy-Geese were recorded and no Comb-crested Jacanas on top and middle lakes, whereas the lower lakes received estimates of more than 200 on both lower lake 3a and 3 b and more than 100 on lower lake 3c. Such significant differences may be due to the better protection offered by the lower lake shores, compared with the top and middle lakes, and lower lakes' extensive water lily beds. The Green-Pygmy Goose is dependant upon floating small plants and the Comb-crested Jacana upon invertebrates associated with aquatic plants for food – in November, both resources were apparently significantly lacking or damaged (Photo 17) on top and middle lakes. In June, however, water lilies covered Top Lake extensively and it was estimated that there were more than 100 Green Pygmy-Geese and more than 100 Comb-crested Jacanas; in marked contrast to the November survey.

The migrant species of waders that were seen in small numbers, mostly around the exposed sandy shores of Fish Lake (part of middle lakes), 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.

The extremely limited amount of shallow water vegetation, such as reed beds, is likely to explain the lack of any rail species – not even a Purple Swamp-hen was observed during either survey. It is also thought remarkable that only an individual Black-fronted Plover was recorded during November, and that no other plover species were observed save some Masked Lapwings over the many kilometres of lake shoreline surveyed.

In terms of bush birds, 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 nomad nectarivore, was not sighted in November. The notable increase in nectarivorous species and numbers was due to flowering Scarlet Gum (*Eucalyptus phoenicea*), melaleucas and grevilleas 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, compared with 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 seasonal 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.

It is remarkable that only one record of a single Willie Wagtail and virtually no members of the swift/swallow/martin/woodswallow aerial insect feeding ecological guild so typically associated with tropical lake habitats were seen. While the total lack of this ecological guild of passerine birds could reflect a natural local seasonal phenomenon it should be considered a matter of real concern – because it could possibly reflect a fundamental problem of insect populations lacking as a result of microhabitat disturbance/destruction by pig and cattle activities.

The results from these surveys indicate that fundamental ecological damage 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 the relatively 'barren' top and middle lakes compared with the more biologically diverse lower lakes.

In November, the shores 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 severely disturbed and sun-dried to rock. Birds cannot probe this hard mud. The intense pig foraging in the wet zone of the lake shores presumably increases evaporation rates and leaves these briefly moist areas devoid of aquatic plants and other organic matter.

It is possible that had the shores of these lakes been undisturbed by pigs and cattle, and thus more rich in plant and invertebrate life, many more shorebirds might have been present during the survey period. Extremely low numbers of both resident and migratory shorebird species were recorded, even though the November 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. These lakes might represent a significant ecological resource and resting reserve for migrant shorebirds. 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.

Several vehicles carrying numbers of people and many hunting dogs were observed driving around the actual and entire shoreline of the top lake during the surveys. Their progress around the shoreline disturbed and flushed to flight every single one of many hundreds of water birds present and feeding. This level of disturbance to feeding, nesting, and in particular to migrant birds, would undoubtedly be extremely detrimental to the lakes as an avifaunal reserve and would greatly reduce the viability of them as a tourist attraction.

Some parts of the lower lakes, even in their present state, show real potential for birding-based tourist development. With appropriate ecological management these lakes could offer birding experiences of world class that might, if appropriately marketed and managed, generate significant income for local communities.

Table 8: Bird species identified during the November 2007 and June 2008 surveys*

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
Anatidae	*Tadorna radjah*	Radjah Shelduck	41	263	304
	Anas superciliosa	Pacific Black Duck	5	100	105
	Dendrocygna arcuata	Wandering Whistling-Duck	59	539	598
	Nettapus pulchellus	Green Pygmy-goose	316	502	818
	Dendrocygna eytoni	Plumed Whistling-duck		1	1
Anseranatidae	*Anseranas semipalmata*	Magpie Goose		3131	3131
Podargidae	*Podargus strigoides*	Tawny Frogmouth	1	1	2
	Podargus papuensis	Papuan Frogmouth	3		3
Caprimulgidae	*Caprimulgus macrurus*	Large-tailed Nightjar		1	1
Charadriidae	*Elseyornis melanops*	Black-fronted Dotterel		1	1
	Vanellus miles	Masked Lapwing	34	43	77
Jacanidae	*Irediparra gallinacea*	Comb-crested Jacana	212	303	515
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew	1	7	8
Scolopacidae	*Calidris acuminata*	Sharp-tailed Sandpiper		2	2
	Calidris ruficollis	Red-necked Stint		4	4
	Tringa stagnatilis	Marsh Sandpiper		5	5
Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt		7	7

Table 8: Bird species identified during the Nov 2007 and June 2008 surveys CONT.

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
Ardeidae	*Ardea modesta*	Eastern Great Egret	16	18	34
	Ardea ibis	Cattle Egret	42	45	87
	Ardea intermedia	Intermediate Egret	139	37	176
	Ardea pacifica	White-necked Heron	1	13	14
	Egretta novaehollandiae	White-faced Heron	2	6	8
	Nycticorax caledonicus	Nankeen Night Heron	3	11	14
	Egretta garzetta	Little Egret		6	6
	Egretta picata	Pied Heron		6	6
	Ixobrychus flavicollis	Black Bittern	1	2	3
	Butorides striata	Striated Heron	3		3
Threskiornithidae	*Platalea regia*	Royal Spoonbill	8	97	105
	Plegadis falcinellus	Glossy Ibis		32	32
	Threskiornis molucca	Australian White Ibis	23	24	47
	Threskiornis spinicollis	Straw-necked Ibis	7	4	11
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	7	10	17
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	31	24	55
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove	84	82	166
	Geopelia striata	Peaceful Dove	197	220	417
	Chalcophaps indica	Emerald Dove		1	1
	Ducula bicolor	Pied Imperial-pigeon		10	10
Halcyonidae	*Dacelo leachii*	Blue-winged Kookaburra	12	9	21
	Dacelo novaeguineae	Laughing Kookaburra	90	21	111
	Todiramphus macleayii	Forest Kingfisher	95	30	125
	Todiramphus sancta	Sacred Kingfisher	7		7
Meropidae	*Merops ornatus*	Rainbow Bee-eater	128	93	221
Coraciidae	*Eurystomus orientalis*	Dollarbird		24	24
Alcedinidae	*Ceyx azureus*	Azure Kingfisher	1	2	3
Falconidae	*Falco cenchroides*	Nankeen Kestrel	2		2
	Falco longipennis	Australian Hobby	3	2	5
Acanthizidae	*Gerygone albogularis*	White-throated Gerygone	59	24	83
	Gerygone magnirostris	Large-billed Gerygone	17	10	27
	Smicrornis brevirostris	Weebill	7	1	8
Artamidae	*Cracticus mentalis*	Black-backed Butcherbird	24	9	33
	Artamus leucorynchus	White-breasted Woodswallow		2	2
	Cracticus tibicen	Australian Magpie	2	2	4

Table 8: Bird species identified during the Nov 2007 and June 2008 surveys CONT.

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	5	3	8
	Coracina papuensis	White-bellied Cuckoo-shrike	62	70	132
	Coracina tenuirostris	Cicadabird		1	1
	Lalage sueurii	White-winged Triller		1	1
Corvidae	*Corvus orru*	Torresian Crow	45	62	107
	Corvus coronoides	Australian Raven		4	4
Dicruridae	*Dicrurus bracteatus*	Spangled Drongo	8	2	10
Meliphagidae	*Entomyzon cyanotis*	Blue-faced Honeyeater	118	56	174
	Lichenostomus flavus	Yellow Honeyeater	80	20	100
	Lichmera indistincta	Brown Honeyeater	8	9	17
	Melithreptus albogularis	White-throated Honeyeater	130	77	207
	Conopophila albogularis	Rufous-banded Honeyeater	2	8	10
	Philemon citreogularis	Little Friarbird	99	9	108
	Ramsayornis modestus	Brown-backed Honeyeater	84	78	162
	Ramsayornis fasciatus	Bar-breasted Honeyeater	6	9	15
	Cissomela pectoralis	Banded Honeyeater	17	1	18
	Myzomela obscura	Dusky Honeyeater	2		2
	Philemon argenticeps	Silver-crowned Friarbird	5		5
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	81	76	157
	Myiagra rubecula	Leaden Flycatcher	20	4	24
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	23	18	41
	Nectarinia jugularis	Olive-backed Sunbird	1	12	13
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	5		5
	Oriolus flavocinctus	Yellow Oriole		1	1
	Artamus cinereus	Little Woodswallow	7		7
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler	4	3	7
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	1		1
	Pardalotus rubricatus	Red-browed Pardalote	5	1	6
Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler	10	14	24
Rhipiduridae	*Rhipidura rufifrons*	Rufous Fantail		2	2
	Rhipidua leucophrys	Willie Wagtail	1		1
Maluridae	*Malurus melanocephalus*	Red-backed Fairy-wren	3	4	7
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	23	1	24
Ptilonorhynchidae	*Ptilonorhynchus nuchalis***	Great Bowerbird**	6	20	26

Table 8: Bird species identified during the Nov 2007 and June 2008 surveys CONT.

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
Estrildidae	*Poephila cincta atropygialis*	Black-throated Finch	25	10	35
	Poephila personata	Masked Finch	11	10	21
	Taeniopygia bichenovii	Double-barred Finch	18	125	143
Petroicidae	*Microeca flavigaster*	Lemon-bellied Flycatcher	42	34	76
Megaluridae	*Cincloramphus mathewsi*	Rufous Songlark	4		4
Psittacidae	*Trichoglossus haematodus moluccanus*	Rainbow Lorikeet	1299	220	1519
	Aprosmictus erythropterus	Red-winged Parrot	30	15	45
	Platycercus adscitus adscitus	Pale-headed Rosella	14	33	47
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	78	39	117
	Eolophus roseicapillus	Galah	23	31	54
	Calyptorhynchus banksii banksii	Red-tailed Black-cockatoo	5	112	117
Strigidae	*Ninox connivens*	Barking Owl	1		1
	Ninox novaesee landiae	Southern Boobook	1		1
Gruidae	*Grus rubicunda*	Brolga	6	36	42
Cuculidae	*Cacomantis variolosus*	Brush Cuckoo		1	1
	Cacomantis pallidus	Pallid Cuckoo		2	2
	Eudynamys scolopacea	Asian Koel		8	8
	Scythrops novaehollandiae	Channel-billed Cuckoo		2	2
	Chalcites basalis	Horsfield's Bronze-cuckoo	3		3
Megapodiidae	*Alectura lathami*	Australian Brush-turkey		1	1
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	4	8	12
Anhingidae	*Anhinga novaehollandiae*	Darter	32	18	50
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant	8	3	11
	Microcarbo melanoleucos	Little Pied Cormorant	9	25	34
Accipitridae	*Haliastur indus*	Brahminy Kite	2	1	3
	Haliastur sphenurus	Whistling Kite	46	75	121
	Aquila audax	Wedge-tailed Eagle		2	2
	Haliaeetus leucogaster	White-bellied Sea-eagle	10	7	17
	Milvus migrans	Black Kite	2		2
	Accipiter novaehollandiae	Grey Goshawk	1		1
	Cissus assimilis	Spotted Harrier	1		1

*Bird counts do not include additional sightings by Russell Best

** The Great Bowerbird is also known as Chlamydera nuchalis. Christidis and Boles (2008) refer to the Great Bowerbird as *Ptilonorhynchus nuchalis*, however there is some debate over this new nomenclature (Cliff & Dawn Frith, pers. comm, 2009).

Mammals

Mammals were surveyed by Kim Stephan (CYMAG) and Russell Best (QPW) during the November and June survey periods (Full report is located at Appendix F). Twenty-one species of mammals were identified, fourteen of which were bats. There were no previous mammal records for Jack Lakes in the Qld Museum and Wildlife Online searches.

Table 9: Mammal species identified during the Nov 2007 and June 2008 surveys

FAMILY	SCIENTIFIC NAME	COMMON NAME	JUNE 2008	NOV 2007	TOTAL NUMBER
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		7	7
Suidae	*Sus scrofa**	Pig*	1	43	44
Bovidae	*Bos sp.**	Cow*	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 nudicluniatus*	Bare-rumped Sheathtail-bat	1		1
Muridae	*Rattus rattus**	Black Rat*		1	1
	Rattus fuscipes	Bush Rat		1	1
Equidae	*Equus caballus**	Horse*		2	2
Peramelidae	*Isoodon macrourus*	Northern Brown Bandicoot		1	1
Phalangeridae	*(blank)*	Possum	1	1	2

*= introduced species

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 probable Common Brush-tail Possum (*Trichosurus vulpecula*), 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 (Darwall *et al,* 2008) notes the population trend of the Common Brushtail Possum to be 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 was seen actively feeding and flying throughout the forest. A cloud of over 300 Flying Foxes flew over the lower lakes during a spotlighting session. The species could not be confirmed.

The low number of mammal species, especially small mammals, may be 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.

Bats were surveyed in November using Anabat recordings of bat calls. These recordings were analysed by Greg Ford (for the full report see Appendix G). 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 could not be confirmed. The majority of bats were recorded from middle lakes.

Of particular interest was the possible presence of two species scheduled as rare or threatened under Queensland and/or Australian Government nature conservation legislation; the critically endangered Bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniatus*) and the Coastal sheath-tailed bat (*Taphozous australis*), a vulnerable species, may have been present. The Coastal sheath-tailed bat 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.

In June 2008, bats were surveyed by Dr Roger Coles using harp traps and bat call recordings. This survey identified 12 species of bat and confirmed the presence of the critically endangered Bare-rumped sheath-tailed bat (*Saccolaimus saccolaimus nudicluniatus*). The bare-rumped sheath-tailed bat roosts primarily in hollow eucalypts, such as *Eucalyptus alba* (Churchill 1998), and inhabits woodlands in the survey area.

Bats were identified around all of the survey locations, with the highest number of species recorded at the lower lakes.

Photo 18: *Miniopterus australis* (Photo: Dr Roger Coles, June 2008, Jack Lakes)

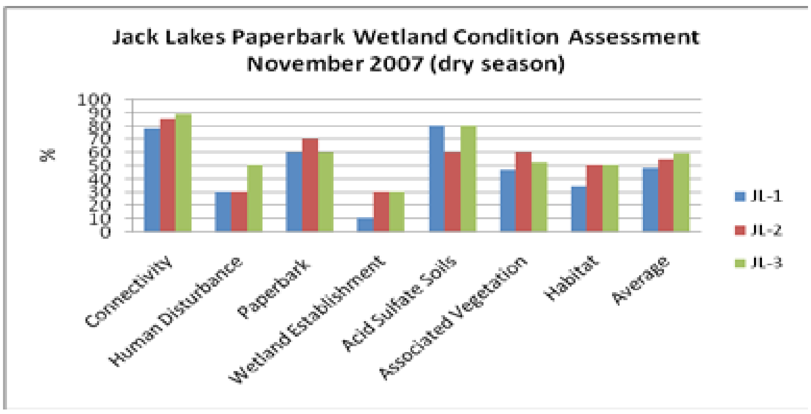
WETLAND CONDITION AND WATER QUALITY ASSESSMENT

Paperbark wetlands condition assessments were conducted by CYMAG scientists at the top lake, (JL-1) middle lake (JL-2) and lower lake (JL-3C). The assessment was conducted as per the North Coast Wetland Assessment Guide Manual: Paperbark Wetlands (Bolton, 2001). These methods include an assessment of wetland connectivity, human impact, paperbark condition, wetland establishment, acid-sulphate soils, habitat and associated vegetation. A water quality assessment was also conducted at each site. The assessments were conducted in both November 2007 (dry season) and June 2008 (post-wet season). Additional water quality data was collected in July 2007 and April 2008.

Photo 19: Surveying pig diggings around Top lake

In November 2007, the wetlands health rating (as per the North Coast Technique interpretations) ranged from “poor/average” (JL-1) to “medium” (JL-2 & JL-3). The lowest scores were found in the wetlands establishment category, which includes paperbark girth circumference measurements and peat depth (indicating that these are relatively young paperbark forests); however the human disturbance and habitat categories scored low primarily due to the influences of pigs and cattle. JL-1 and JL-2 showed the highest evidence of feral pigs and cattle damage to vegetation around the perimeter of the wetlands. There is also greater access for vehicles to these sites as there are roads to the top and middle lakes but no access to the bottom lakes. In June 2008, the influence of pigs and cattle on wetland vegetation was much less obvious and the wetlands condition scores were slightly higher because of this; however the difference was not significant.

Figure 2: Jack Lakes paperbark wetland condition assessment November 2007 (dry season)



Although the condition scores and health ratings have been developed for NSW wetlands, the low scores do indicate that there has been significant damage to the paperbark wetlands (primarily from feral pigs and cattle) and the scores reflect the higher degree of degradation that was evident at the top and middle lakes compared to the lower lakes.

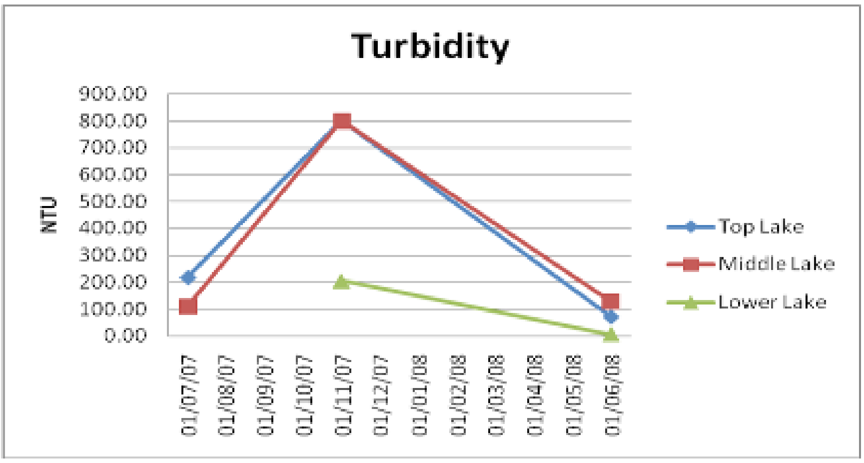
Soil samples were collected from the edges of each lake (JL-1, JL-2 and JL-3) from 0.5 to 1m below ground surface (bgs). Soil types ranged from a fine clay at JL-1, silty clay and clayey silt at JL-2, and clay and silty clay with some sandy areas and high organic content at JL-3. Particle size was also assessed using a 63 um sieve. Soil samples collected from the top lake (JL-1) were found to have the highest clay content (88% - 98%), while JL-2 ranged from 68% - 88%, and the lower lakes ranged from 8% - 60% clay content. When disturbed by wind, pigs and cattle, fine clay particles in lake sediments will become suspended and stay suspended, causing the high turbidity frequently observed at the lakes.

Field tests were conducted for acid sulphate soils (ASS) using a 1:5 soil to de-ionized water test and potential acid sulphate soils (PASS) using 1:5 soil to peroxide test. The results from peroxide tests ranged from a pH 2 to pH 3, indicating that PASS may be present at all sites at 0.5 m to 1.0 m bgs. ASS test results generally indicated a non-oxidised soil pH of between 4 to 5 at all sites. Soil samples from JL-2 showed the greatest acid sulphate potential.

Water quality indicators were monitored in June/July 2007, Nov 2007, April 2008 and June 2008 and included pH, dissolved oxygen, temperature, conductivity, turbidity, total and dissolved nutrients and metals concentrations. These parameters are highly variable in wetlands on both a temporal and spatial scale, therefore the results must be interpreted with caution. The full water quality results are listed in Appendix I.

Turbidity in the top and middle lakes was high at all times but peaked in November 2007. Extremely high turbidity levels were measured in November; particularly at the top (JL-1) and middle lakes (JL-2), where turbidity exceeded 800 NTU and could not be measured on the field turbidity meter. Turbidity was significantly lower at JL-3, averaging 205 NTU in November and dropping as low as 6 and 8 NTU in April and June 2008, after wet season flushing. The lower clay content in JL-3 sediments could help to explain the reduced turbidity in the lower lakes compared to the middle and top lakes.

Figure 3: Turbidity



Acid sulphate soils may be disturbed by feral pig diggings. This would release acids into adjacent waters, and could also result in elevated levels of aluminium (Al) and iron (Fe) in the water column. PH was almost neutral (6.94) during the wet season (April 2008) at the lower lakes, and became more acidic as the lakes dried up. The most acidic water conditions were observed at the top (pH 4.39) and middle (pH 4.60) lakes during November 2007, coinciding with elevated Fe and Al concentrations and high suspended sediments. However, even in the lower lakes, both total and dissolved Al concentrations exceeded water quality guidelines for the protection of freshwater aquatic species (ANZECC 2000, 95% Protection). Further analyses would be necessary to make any conclusions about the impact of acid sulphate soils on water quality and aquatic species at Jack Lakes.

Total metals concentrations (including Al & Fe) were significantly higher at JL-1 and JL-2 than at JL-3. As with Al and Fe, metals concentrations were greatest towards the end of the dry season when the lakes were the most turbid. The concentrations of metals such as cadmium, chromium, copper and zinc exceeded the ANZECC guidelines for the protection of freshwater species and therefore could be toxic to fish or other aquatic species. However these metals are likely to be attached to suspended sediments and may reflect natural conditions for turbid Cape York wetlands. Dissolved metals concentrations could not be recorded at most times due to the high turbidity.

Nutrient concentrations also were greatest at the top and middle lakes and during the dry season. Nutrients appear to be primarily associated with sediments in the water column, however dissolved nitrogen concentrations, particularly ammonia, exceeded the ANZECC 2000 water quality guidelines for tropical wetlands at both the top and lower lakes throughout the year. Cape York wetlands are likely to experience naturally high nutrient levels during some times of the year, however these concentrations may be elevated by cattle and pigs defecating around the wetlands and stirring up sediments.

The top and middle lakes recorded significantly higher levels of turbidity, nutrients and metals, and lower pH levels in comparison to the lower lakes. This is likely to be related to increased disturbance by pigs and cattle at the top lakes, as well as differences in sediment types and topography. Because of these factors the lower lakes would provide a healthier habitat for fish and other aquatic species.

DISCUSSION OF THE RESULTS

Biodiversity

This study provides a baseline for species diversity at Jack Lakes and an example of palustrine wetland biodiversity on Cape York Peninsula. It is not possible to conclude whether the overall biodiversity of Jack Lakes is high or low without comparing the study to other similar wetlands in the region or over time. Some taxonomic groups appear to be diverse (e.g. the Diptera invertebrates), some low in diversity (e.g. migratory wading birds) and others require more intensive sampling (e.g. aquatic plants, fish, amphibians, small mammals).

The change in the lakes from the end of the dry to the end of the wet was astounding. In November, the wetlands were stark, degraded and stressed. In June, they were lush and vegetated with few stressors apparent. In June, water lilies were thick on the top lake providing new microhabitat areas. There was a shift in species composition and abundance between June and November. More nectarivorous bird species (i.e. lorikeets and honeyeaters) were present in June and more waterbird species (i.e. ducks and geese) were present in November. Twenty-six more bird species were recorded in November than in June. The increase in species diversity was attributed to birds congregating around the wetlands at the end of the dry season for feeding, breeding and migratory purposes.

This study suggests that biodiversity surveys of dry tropical wetlands need to occur over both wet and dry seasons to assess the range of species present and to detect shifts in species composition and abundance. Threats to those species may also be more apparent in one season compared with the other, especially when resources are scarce (i.e. end of the dry).

It is apparent that some ecological guilds and species, such as waterbirds and potentially frogs, are being compromised by disturbance from introduced animals.

Diverse methods and assessors were employed to undertake this survey. As such, the information available for the different taxonomic groups varies in completeness. In particular, the aquatic plant, terrestrial invertebrate, fish and mammal species lists would benefit from further investigation.

Threatened Species

The Bare-rumped Sheathtail Bat (*Saccolaimus saccolaimus nudicluniatus*) is listed as 'Endangered' in Queensland (*Nature Conservation Act, 1992*) and 'Critically Endangered' nationally (Environment Protection and Biodiversity Conservation Act 1999). The *Nature Conservation Act, 1992* lists the Estuarine Crocodile (*Crocodylus porosus*) as 'Vulnerable' in Queensland. The Grey Goshawk (*Accipiter novaehollandiae*) is listed as 'Rare' and in need of re-assessment to determine which new category most adequately reflects its status (*Nature Conservation Act, 1992*).

Internationally, the IUCN upgraded the Bush Stone Curlew (*Burhinus grallarius*) from 'Least Concern' to 'Near Threatened' in 2008 due to likely overall rapid population declines in the future (IUCN, 2008).

High Value Habitat

The lakes support a variety of habitat types including permanent water, paperbark lagoons, ephemeral pools, ephemeral channels connecting the lakes, sedgelands, mudflats and accompanying microhabitats.

High value habitat was determined by the diversity and abundance of species present, degree of intactness, uniqueness of habitat type and resilience to threats. High value habitat areas could be seen as priorities for future conservation management such as fencing and feral animal control.

The most frequently reported high value habitat was the lower lakes. During both surveys the lower lakes exhibited clearer water and more intact aquatic and riparian vegetation than the top and middle lakes. Improved water clarity would increase foraging efficiency of predatory fauna and the more extensive photic zone would extend the range of resources. The top lake was considered to retain less surface water than the middle or lower lakes into the dry season. At all sites, the woodland vegetation is mostly intact in the immediate catchment of the lakes. Fallen timber, leaf litter and large trees (mostly under 20m) were present, some with hollows that could be utilised by arboreal mammals.

Habitat value was greater in the month of June. Extensive beds of water lilies and bulkaru were present. Thick mats of *Azolla* sp. and couch grass floated on the surface and edges of the lakes, providing rich habitat for species such as Salt and Freshwater Crocodiles, Spangled Perch, amphibians, Freshwater Snakes, *Macrobrachium* prawns and turtles. Pug holes made by the hooves of cattle were covered by couch grass providing ample habitat for tiny *Crinia* frogs. Tall grass in the woodland areas was available as habitat for species such as quail. Flowering Scarlet Gum (*Eucalyptus phoenicie*) provided food and shelter for the Little Red Flying Fox (*Pteropus scapulatus*) and nectarivorous birds.

A number of high value habitat areas were identified by Dr John Dowe (ACTFR) as part of the vegetation survey. These areas included:

- margins and adjoining forest on the eastside of the top lake, where areas of Cyperaceae spp. are intact.
- 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 show little evidence of decline or stress.
- 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 *Lomandra banksii* and *Thryptomene oligandra* are well developed and undisturbed.
- 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.

- at the confluence of Jack River and the drainage channels of the lower lakes. *Melaleuca* dominated vegetation meets riparian 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.

Threats to Biodiversity

The most obvious threat to the biodiversity of Jack Lakes is the destruction of the lake foreshores and the shallow littoral zone by feral pigs and cattle (Photo 20). The diversity and abundance of species might be different in the absence of pig damage. It is suspected that reduced aquatic vegetation and large amounts of suspended sediment is lowering the productivity of Jack Lakes resulting in fewer animal species.

Photo 20: Shore line at the top lake, with vegetation virtually non existent, Nov 2007

The November end of the dry season survey highlighted the impacts that feral pigs and cattle are having on the lakes. Large groups of pigs were seen foraging around the lake edges, grazing below the surface of the water and moving progressively inwards as the water level receded. The 3.3.66 Regional Ecosystem of Concern was decimated by introduced animals, particularly at top lake. Aquatic vegetation was largely absent or reduced to areas inaccessible to pigs. Little habitat was present for aquatic invertebrates, fish, frogs, turtles and waterbirds. The absence of migratory and shore birds was attributed to the near total lack of dense shallow water vegetation, such as reed beds. Tadpole and burrowing frog habitat around the shorelines of all lakes had been reduced by the pugging, trampling and compaction from feral pigs and cattle. Direct predation on bird, crocodile and turtle eggs and turtle hatchlings by feral pigs could be reducing population sizes. At the lower lakes, stands of large paperbark trees had toppled over from undermining around the base of the trees, presumably by pigs.

In June, with water widespread across Cape York Peninsula at this time of year, the pigs had dispersed from Jack Lakes. Only an individual feral pig was seen. The absence of feral pigs was also almost certainly due to a pig shoot the previous week for Jim Mitchell's pig control study. Forty-six pigs were shot at Jack Lakes and possibly many others scared off. Far fewer signs of pigs and their threatening processes were observed in June. Occasional fresh pig wallows were present and deep pig diggings were observed in the sandy woodland areas near top lake, perhaps excavated in search of turtle eggs.

It was encouraging in June to observe that the vegetation around the lakes had re-established after the flush of the wet season and a diverse range of invertebrate taxa were present in the vegetated littoral zone. However, long term damage such as increased evaporation (drying up of the lakes) and loss of species could be occurring as a result of increased pressure on the lakes from introduced animals. Compounding these threats are the predicted global impacts of climate change on freshwater ecosystems including temperature changes and shifts in rainfall and runoff patterns (Dudgeon *et al,* 2006).

Uncontrolled vehicle access to the lake foreshores could be contributing to soil erosion, vegetation damage and wildlife disturbance.

Although weeds are not currently believed to be impacting the Jack Lakes ecology, the threat of additional weed species being introduced to Jack Lakes by humans or cattle is of high concern.

Indicators of Biodiversity

Rather than assessing all attributes of biodiversity, the use of indicators has been suggested as a technique for rapid broad scale biodiversity assessment (Beggs, 2000). There is much discussion over the best way to use indicators and which taxon groups make the best indicators (e.g. top predators, keystone species). The choice of indicator depends on the objective of the assessment.

Based on the November assessment, a number of biodiversity indicators were suggested for Jack Lakes and trialled in the June survey (Table 10).

Table 10: Potential indicators of biodiversity at Jack Lakes

INDICATOR	JUSTIFICATION
Number of species	The total number of species is a direct measure of biodiversity
Invertebrate diversity and abundance	Some are keystone species that play an important role in maintaining the biota of a community. They are proven indicators of environmental health.
Migratory/Wading/Insectivorous birds	To find correlations within ecological guilds suspected to be low in biodiversity (e.g. insectivorous birds and flying insects)
Wetland Condition Assessment	Assess overall wetland health and threats as an indication of environmental and habitat condition
Aquatic plant diversity and abundance	Habitat and food source for numerous species

Preliminary studies of the suggested indicators in June reflect a healthy diversity and abundance of invertebrates, especially dragonflies. The bird aerial insect feeding guild remained low in the June survey with few individuals of swift, swallow, martin, wagtail and woodswallow (typically associated with tropical lake habitats) seen. Not surprisingly, as it was not migratory season, no migratory wading birds were observed in June. Ecological guilds, such as the insectivorous birds and flying insects, are also complex and require monitoring over long periods to determine correlations of diversity (if any) between groups.

Choosing reliable and useful indicators that have a direct correlation to the diversity of other taxa is important for meaningful results. Inferences made to broadscale biodiversity from the monitoring of indicators are hypothetical and should be viewed with caution. Using indicators to assess biodiversity could be more time consuming and less accurate than a direct inventory of species, particularly of common species.

To fill in information gaps, the IUCN has listed survey priorities for freshwater ecosystems. Assessments are being conducted into all known species of freshwater fishes, freshwater molluscs, dragonflies, damselflies, crabs and selected aquatic plant families (Darwall *et al*, 2008).

MANAGEMENT RECOMMENDATIONS AND LANDUSE OPPORTUNITIES

Specific recommendations resulting from the findings of the Jack Lakes Surveys include:

- Effectively control pigs and limit access to cattle;
- Adopt practices that prevent the invasion and spread of weeds from nearby Lakefield National Park, Kalpowar Station and eastern and southern parks;
- Maintain vigilance in detecting Rubber Vine and upon detection launch an eradication program;
- Investigate the role of fire at Jack Lakes and maintain fire management program;
- Further investigate species of conservation significance and if required, establish a program for their conservation;
- Investigate wetland morphology and physical and chemical processes;
- Carry out additional surveys of terrestrial invertebrates, fish, aquatic plants and mammals;
- Investigate the role of these lakes as a significant ecological resource and resting reserve for migrant shorebirds. (As a matter of international importance and several binding intergovernmental agreements, the movements and rest-over needs of migrating avifauna must be given serious consideration in the context of the conservation status and ecological quality of these lakes);
- Exclude pig hunting activities from a defined area around all lakeshores (e.g. half a kilometre or so as recommended by Dr Clifford Frith). Enforce the Jack River National Park closure to the public and regulations against pig hunting in National Parks ; and
- Investigate and design sustainable tourism opportunities in accordance with the aspirations of the Traditional Owners; aspirations which include controlling visitor numbers, conducting guided cultural tours and having a ranger presence at the park.

Following is a discussion of the recommendations and management options.

Feral animal control

By controlling feral pigs, the aquatic values and functioning of the Jack Lakes system is very likely to benefit. A Pest Management Plan would determine the best approach for reducing the impacts of introduced animals on Jack Lakes. Pig control programs experience greater success when they incorporate a combination of fencing, shooting, trapping and baiting.

Pig exclusion fencing could be an option for high habitat value areas such as the lower lakes. Dr Clifford Frith suggests small-scale experimental pig and cattle exclusion fencing along the shorelines of the top, middle and lower lakes. A minimum size of 45m x 45m for an exclusion plot/ fence is required to show differences between fenced and unfenced areas within a 12 month period (pers. comm. Dr John Dowe, 23 Nov., 2007). A fenced boundary will not protect the lakes from threats such as sedimentation, invasive weed species, pollution and altered flow regimes. Protected areas need to be designed specifically to protect upper catchments and to include entire wetland systems within their boundaries if they are to provide effective protection (Darwall *et al,*, 2008).

Sustainable grazing regimes

Unless animals are managed under sustainable grazing regimes, grazing by cattle is considered a high impact landuse.

Beef cattle grazing is a potentially important income for Kalpowar Station. Land managers can plan to eliminate or reduce damage to the wetlands from cattle trampling and grazing. Cattle also damage wetlands by polluting water and spreading weeds. Healthy wetlands can be achieved by restricting stock access to the lakes either permanently or at strategic times (e.g. when wetland plants are seeding and during the migratory bird season). Mixing upland and lowland grazing to 'spell' wetlands and providing water troughs at a distance from the lake can also reduce grazing pressure on wetlands (Saunders, 2006). Sustainable grazing regimes for inland regions have been outlined by Meat and Livestock Australia and the DPI&F.

Fire

Lakes are naturally fire tolerant, serve as natural firebreaks and provide a refuge for animals during bushfires (Saunders, 2006). The fire management strategy for the Regional Ecosystem 3.3.66 is to burn less than 10% of the total area in any year (EPA, 2008). Melaleucas were reported to regenerate one year after fires at Jack Lakes in 2003. QPW plans to mimic the way in which fires traditionally burned around the lakes (pers. comm. Tim White, Oct., 2007). It is recommended that land managers consider all of the impacts (Saunders, 2006) of a prescribed burn on the lakes and surrounding vegetation before burning.

Weeds

Jack Lakes appear to be remarkably weed free. The importance of weed hygiene to keep it this way cannot be emphasised enough. Wetlands on Cape York Peninsula are vulnerable to invasion by numerous weeds including *Hymenachne amplexicaulis* and *Salvinia molesta*. Cattle-grazed areas are especially susceptible to exotic weed invasion (Saunders, 2006). Weeds can be spread by vehicles, animals (native, domestic and feral), wind and flowing water. The two weed species recorded at Jack Lakes, *Hyptis suaveolens* and *Triumfetta rhomboidea*, are commonly associated with cattle and watercourses. *Hyptis* is unpalatable to cattle and listed as a weed of potential national significance. The exotic weed Rubber Vine (*Cryptostegia grandiflora*) has been listed as a potential threat to the Jack Lakes Aggregation (ANRA, 2007) and, fortunately, was not observed during these surveys. If detected, an eradication program should be put in place immediately.

Nearby Lakefield National Park contains numerous weeds, for example Rubber Vine and Grader Grass (*Themeda quadrivalvis*). Vigilance is needed in order to prevent their spread into Jack Lakes. Prevention methods could include such measures the introduction of a basic wash-down unit at Lakefield National Park Ranger Station for all vehicles travelling to Jack Lakes, limiting visitor numbers and setting a quarantine (yarding) period for new cattle brought into Kalpowar Station until any imported seed has been dropped or defecated.

Adequate resources need to be directed to the implementation of the Pest Management Plan.

Sustainable Land Use Opportunities

Traditional Owners have expressed an interest in operating cultural tours at Jack Lakes. It has been suggested that a "world class birding experience" (Dr Clifford Frith, 2007) could be offered at the lower lakes in combination with a cultural tour. Carefully-placed bird hides, trained guides and environmentally sound facilities would be needed in order for the enterprise be successful and have a minimal impact on the lakes. Bird hides would need to be located, designed, and constructed with extreme care to world-class standards. Foot/wheelchair access would need to be extensive and well concealed, with vehicle parking situated well away from the bird hides. The high water levels typical of wet seasons would need to be studied in order to appreciate where bird hides could and should be located to ensure they remain accessible throughout the year.

Camping and hunting with the use of vehicles and possibly dogs need to be strictly controlled. These activities are illegal in the National Park area and need to be limited in the the top lake which is outside of the National Park. Vehicles should be excluded from the lake shorelines to reduce the impacts on the wetland ecosystem. Removal of vegetation should be discouraged.

By taking heed of the recommendations and management options outlined in this report, the potential exists for Jack Lakes to support a range of sustainable land uses without detriment to the area's biodiversity and ecological values.

Photo 21: The Flora and Fauna Survey Team, Nov 2007

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