Department of
Environment and Conservation

Our environment, our future

Resource Condition Report for a Significant Western Australian Wetland

Lake Logue

2008

Figure 1. A view of Lake Logue when inundated in 2003. Photo: R. Webb

This report was prepared by:

Robert Susac, Technical Officer, Department of Environment and Conservation, PO Box 51, Wanneroo 6946

Anna Nowicki, Technical Officer, Department of Environment and Conservation, PO Box 51, Wanneroo 6946

Stephen Kern, Botanist, Department of Environment and Conservation, Locked Bag 104 Bentley Delivery Centre 6983

Adrian Pinder, Senior Research Scientist, Department of Environment and Conservation, PO Box 51, Wanneroo 6946

Glen Daniel, Environmental Officer, Department of Environment and Conservation, Locked Bag 104 Bentley Delivery Centre 6983

Acknowledgments:

For invertebrate sorting and identification:

Nadine Guthrie, Research Scientist, Department of Environment and Conservation, PO Box 51, Wanneroo 6946

Ross Gordon, Project Officer, Department of Environment and Conservation, PO Box 51, Wanneroo 6946

Reviewing:

Holly Smith, Environmental Officer Department of Environment and Conservation, Locked Bag 104 Bentley Delivery Centre 6983

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Contents

1. Introduction

This Resource Condition Report (RCR) was prepared by the Inland Aquatic Integrity Resource Condition Monitoring (IAI RCM) project to summarise information pertaining to the ecology of Lake Logue. It describes the key drivers of, and threats to, the system and provides a snapshot of the ecological character and condition of the site. This will provide context for future monitoring of the site.

Lake Logue is the largest feature of the Lake Logue-Indoon System, which includes a number of shallow seasonal wetlands and intermittent creeks and drainage lines. Lake Logue has a surface area of 425 hectares and fills only occasionally, following heavy rain in the catchment. The lake is fed by fresh surface water and has been known to reach a depth of over two metres. When dry, approximately three quarters of its bed is covered by low grasses and shrubs (Figure 2) while the remainder is wooded (Figure 6) (Halse *et al.* 1993).

Lake Logue was selected as a study site in the current project because the Logue-Indoon System is listed in the Directory of Important Wetlands in Australia (DIWA) (Environment Australia 2001) and because there are considerable historical data available for the site. The IAI RCM project visited the site in October 2008, when it was dry. As such, no water chemistry, aquatic invertebrates or water bird data were collected. The last comprehensive biodiversity study of Lake Logue was a Salinity Action Plan funded survey conducted between 1997 and 2004.

Figure 2. The dry lakebed of Lake Logue in October 2008.

1.1. Site Code

Directory of Important Wetlands in Australia: WA036 (GS002WA).

Register of the National Estate Place ID: 9571.

Inland Aquatic Integrity Resource Condition Monitoring Project (DEC): RCM024.

Salinity Action Plan Wetland Monitoring Program (DEC): SPM002.

Waterbirds in Nature Reserves of South-West WA (DEC/RAOU): CALMWNRSWA_149_1.

Waterfowl Counts in the South-West WA (DEC/RAOU): CALMWCSWWA_LOGL.

South West Wetlands Monitoring Program (DEC): SWWMP_LOGU.

1.2. Relevant Legislation and Policy

The following is a summary of some of the legislation and policy that are relevant to the management of Lake Logue.

International Treaties

Migratory bird bilateral agreements and conventions

The Lake Logue-Indoon system is an important feeding and refuge area for waterbirds. Australia is committed to a number of bilateral agreements, initiatives and conventions for the conservation of migratory birds which may be relevant to Lake Logue. These agreements include:

JAMBA - The Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment, 1974;

CAMBA - The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986;

ROKAMBA - The Agreement between the Government of Australia and the Republic of Korea for the Protection of Migratory Birds and their Environment, 2006;

The Bonn Convention on Migratory Species - The Bonn Convention adopts a framework in which countries with jurisdiction over any part of the range of a particular species co-operate to prevent migratory species becoming endangered. For Australian purposes, many of the species are migratory birds.

National Legislation

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is the Australian Government's primary piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the Act as matters of national environmental significance. Any actions that are anticipated to have a significant impact on any matter of national environmental significance require environmental assessment and approval under the EPBC Act.

Lake Logue is protected by the EPBC Act because it is listed as a national heritage place and supports migratory species listed under international treaties.

Australian Heritage Council Act 2003

Lake Logue has been placed on the Register of the National Estate. The Australian Heritage Council Act protects places of National and Commonwealth significance.

Western Australia Legislation

Wildlife Conservation Act 1950

This Act provides for the protection of wildlife. All fauna in Western Australia is protected under section 14 of the *Wildlife Conservation Act 1950*. The Act establishes licensing frameworks for the taking and possession of protected fauna. The Act also affords means of prosecution and penalties for prohibited interactions with fauna.

Conservation and Land Management Act 1987

This Act is administered by the State Department of Environment and Conservation (DEC) and applies to public lands. It sets the framework for the creation and management of marine and terrestrial parks, reserves and management areas in Western Australia, and provides protection for flora and fauna within reserve systems.

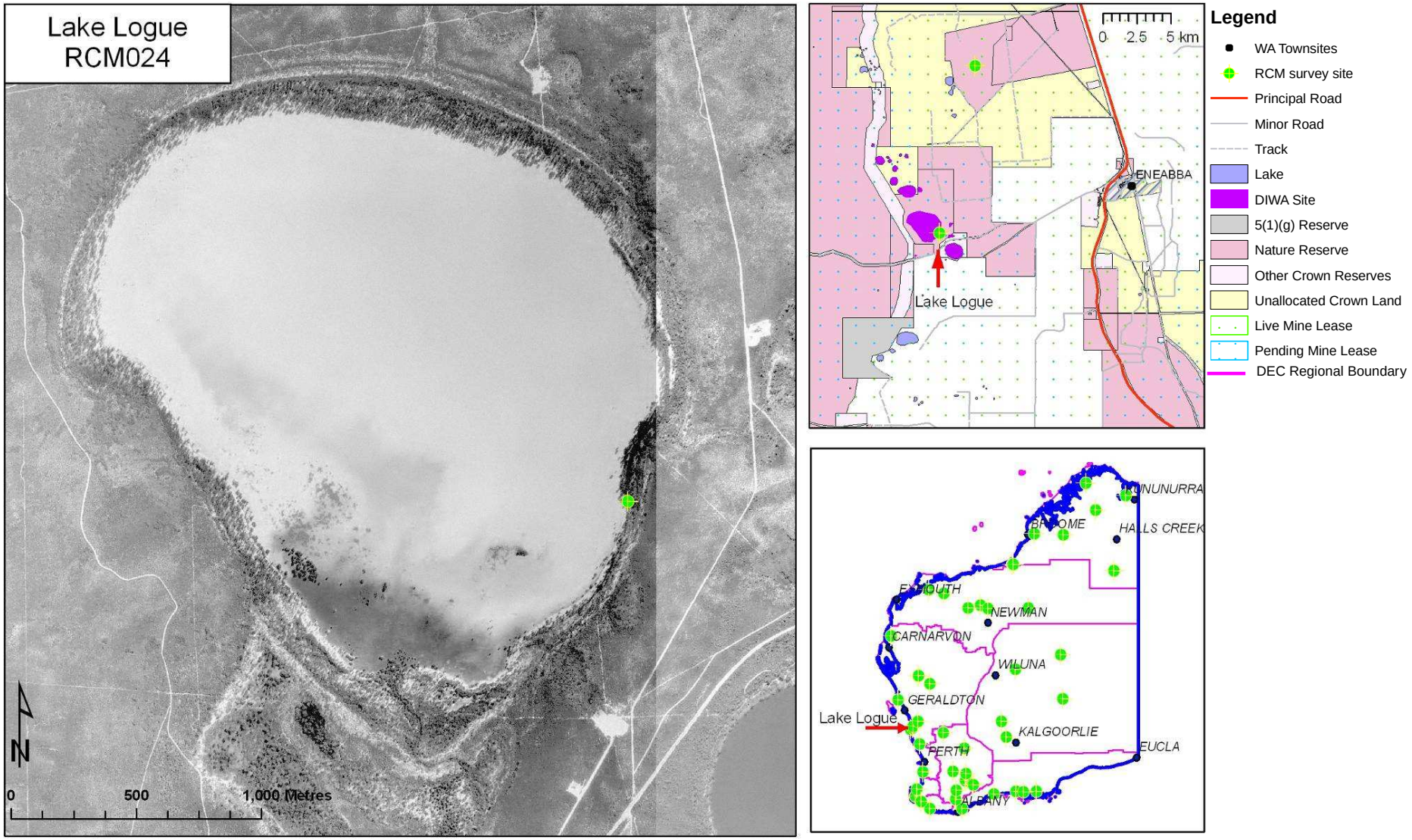

Figure 3. Aerial photograph showing the position of the survey location at Lake Logue. The upper insert shows the tenure of land surrounding the site. The lower insert shows the lake relative to other IAI RCM survey sites in Western Australia.

2. Overview of Lake Logue

2.1. Location and Cadastral Information

Lake Logue lies approximately 13 km west-southwest of Eneabba, within the Lake Logue Nature Reserve (Figure 3). The Lake Logue Nature Reserve was gazetted for the purpose of conserving flora and fauna. The area is bordered to the west by Beekeepers Nature Reserve, to the north by Unallocated Crown Land and to the east and south by freehold agricultural land.

2.2. IBRA Region

Lake Logue is in the Lesueur Sandplain (GS3) subregion of the Geraldton Sandplain Interim Bioregionalisation of Australia (IBRA) region. This subregion is characterised by coastal aeolian sands overlying limestone, siltstone and sandstone. There are extensive yellow sandplains in the southeast of the subregion, especially where it overlaps the western edge of the Yilgarn Craton. The predominant vegetation is endemic-rich shrub-heath (Desmond and Chant 2002).

According to Beard's (1976) vegetation mapping system Lake Logue is situated at the junction of two broad landform/vegetation associations: the Ilyarrie to the west and Eridoon System to the east. The Ilyarrie System is a coastal limestone belt with undulating hilly country of lithified calcarenite overlain by yellow siliceous sands. It is characterised by proteaceous scrub heath with patches of low, open woodland (Beard, 1976). The Eridoon System occurs on the flat coastal plain between the coastal limestone deposits and the Pleistocene shoreline. There are numerous small lakes and swamps in depressions and a few alluvial flats. The vegetation structure is predominately scattered small trees over tall shrubs and a closed layer of small heath-like shrubs (Beard, 1976).

2.3. Climate

The nearest Bureau of Meteorology weather station to Lake Logue is at Eneabba (approximately 13 km away), where records have been kept since 1964 (Bureau of Meteorology 2009). Climatic conditions at Lake Logue are not expected to differ appreciably from those at Eneabba.

Eneabba experiences a Mediterranean climate, with mild winters and hot, dry summers. It receives a mean annual rainfall of 503 mm with most (~70%) falling between May and August (Figure 4). Annual evaporation at Eneabba is approximately 2,439 mm. Temperatures peak in February, with a mean annual minimum/maximum of 19.5 ºC/36.1 ºC and fall to 9.0 ºC/19.6 ºC in July.

The IAI RCM project surveyed Lake Logue on the 7th of October 2008. In the nine months preceding the IAI RCM survey, Eneabba received 435 mm of rain. Most of this fell in July, when 153 mm was recorded, but occasional light falls were received throughout winter and spring.

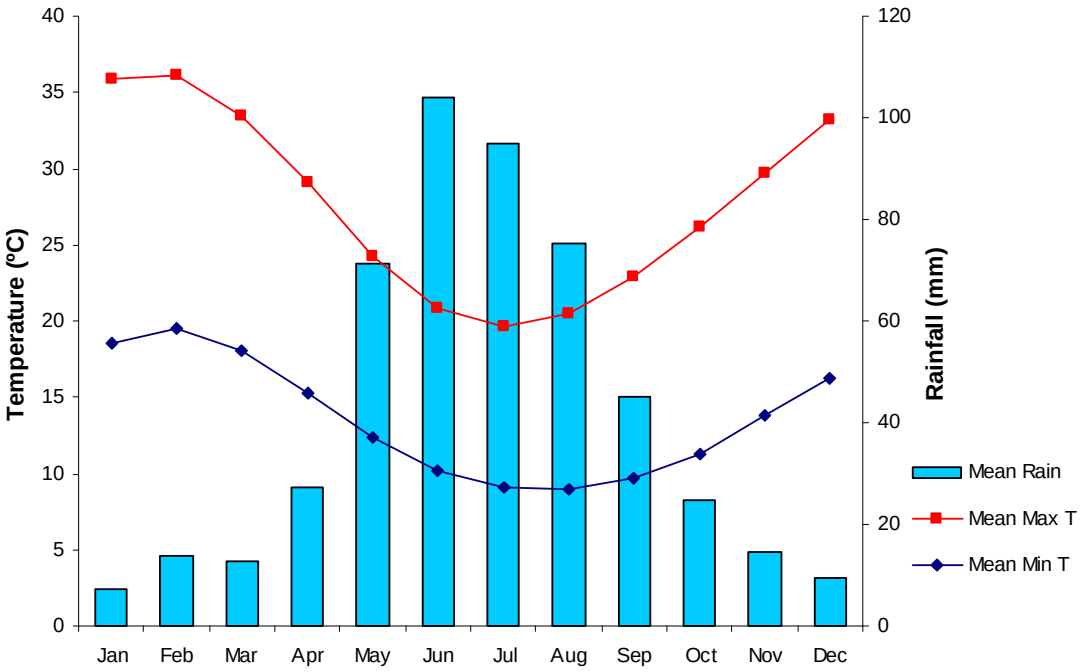

Figure 4. Climatic averages for Eneabba, approximately 13 km east-northeast of Lake Logue.

2.4. Wetland Type

The Directory of Important Wetlands in Australia (Environment Australia 2001) describes several wetland types within the Lake Logue-Indoon System:

- Type B6 – seasonal/intermittent freshwater lakes (>8 ha), floodplain lakes.
- Type B2 – seasonal and irregular rivers and streams.
- Type B10 – seasonal/intermittent freshwater ponds and marshes on inorganic soils.
- Type B7 – permanent saline/brackish lakes.

Lake Logue is type B6. It has also been described as a large, perched, fresh to brackish seasonal wetland (Cale *et al.* 2004) and as a macroscale circular sumpland (Jaensch 1992).

The system of Pinder *et al.* (2004) classifies Lake Logue as a Group 1 (species rich freshwater) wetland, based on its aquatic invertebrate assemblage. However, this classification is subject to change with water quantity at the time of survey. It could also be classified as Group 3 (Northern Tree Swamp) when the water level is higher (Pinder *et al.* 2004).

Geomorphic wetland mapping by Semenuik (2007) classifies the southwest area of Lake Logue as a 'barlkarra', an intermittently inundated flat surrounding isolated playa landforms.

2.5. Directory of Important Wetlands in Australia Criteria

The Lake Logue-Indoon System is designated as a wetland of national importance under criteria 1, 3, and 5 of the Directory of Important Wetlands in Australia (Environment Australia 2001). These criteria are as follows:

1. It is a good example of a wetland type occurring within a biogeographic region in Australia. *The Lake Logue-Indoon System is a good example of a suite of linked seasonal freshwater/brackish basins that occur in the bioregion.*

3. It is a wetland that is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail. *The Lake Logue-Indoon System is a major feeding stop-over, staging area for dispersal and a drought refuge for waterbirds.*

5. The wetland supports native plant or animal taxa or communities that are considered endangered or vulnerable at the national level. *The Lake Logue-Indoon System supports a population of the declared vulnerable plant* Eremophila microtheca*, which occurs on seasonally waterlogged flats.*

2.6. Values of Lake Logue

Values are the internal principles that guide the behaviour of an individual or group. Value systems determine the importance people place on the natural environment and how they view their place within it. Divergent values may result in people pursuing different objectives in relation to nature conservation, having different reasons for desiring a commonly agreed outcome, or favouring different mechanisms to achieve it. Because of this, it is important to be explicit about the values that are driving conservation activities at a wetland.

The Conceptual Framework for Managing Natural Biodiversity in the Western Australian Wheatbelt (Wallace 2003) identified eight reasons that humans value natural biodiversity:

a. Consumptive use

Consumptive use is gaining benefit from products derived from the natural environment, without the products passing through a market place, for example, the collection and personal use of firewood or 'bushtucker'. While Lake Logue is likely to have been used historically by local Aboriginal people, the lake supports no consumptive use in the present day.

b. Productive use

Productive use values are derived from market transactions involving products derived from the natural environment. The same firewood that is collected for personal use may instead be exchanged for money or another commodity. Lake Logue supports no productive use in the present day.

c. Opportunities for future use

Not all uses of the natural environment may be apparent at the present time. The potential for future benefit from the natural environment is maximised by maintaining the greatest possible biodiversity. The loss of taxa or ecosystems represents lost opportunities. Lake Logue may support endemic or rare taxa. It exhibits a diverse flora, including *Banksia elegans*, (P4) for which Lake Logue is needed as a seed source (Australian Government 1995). The rare *Grevillea althoferorum* occurs here as well as a population of the declared vulnerable plant *Eremophila microtheca* and the priority 1 plant *Calandrinia* aff. *composita* (SAP) (Lyons *et al.* 2004). Such unique features increase the potential for future opportunities.

d. Ecosystem services

There are many naturally occurring phenomena that bring enormous benefit to mankind. For instance, plants generate oxygen, insects pollinate food crops and wetlands mitigate floods by regulating water flows. The term 'ecosystem services' is used as a broad umbrella to cover the myriad of benefits delivered, directly or indirectly, to humankind by healthy ecosystems. Lake Logue is part of a suite of linked seasonal wetlands that provide a major feeding stop-over, dispersal area, and drought refuge for waterbirds (Jaensch 1992). The location of Lake Logue in relation to the Tamala Limestone karst of Beekeepers Nature Reserve makes it important to significant stygofauna and troglofauna communities that occur in the area.

e. Amenity

Amenity describes features of the natural environment that make life more pleasant for people, for example, pleasant views, shade and wind shelter from a stand of trees. It is difficult to quantify the amenity value of a site such as Lake Logue, but it is certainly valued by the local community for the amenity it provides.

f. Scientific and educational uses

Parts of the natural environment that remain relatively unmodified by human activity represent great educational opportunities. Such sites allow us to learn about changes occurring elsewhere in the natural world. They also act as 'control' sites that allow us to benchmark other, altered habitats. Several research projects have included Lake Logue in recent years. The Royal Australasian Ornithologists Union (now Birds Australia) conducted waterbird surveys at the lake between 1981 and 1992 (Jaensch *et al.* 1988; Halse *et al.* 1990; Halse *et al.* 1992; Halse *et al.* 1994). Lake Logue was also included in the South West Wetland Monitoring Program conducted by the Department of Conservation and Land Management (now DEC). The lake was monitored from 1979 until 2000 for water depth and salinity (Lane *et al.* 2004). DEC has also been conducting ongoing long-term monitoring of the waterbirds, aquatic invertebrates and water quality of Lake Logue, with a particular emphasis on the effects of salinisation, as part of the Salinity Action Plan (Cale *et al.* 2004; Pinder *et al.* 2004, 2005; Lyons *et al.* 2007). The flora of the species-rich heathlands has been surveyed by consultants (Jaensch 1992). Additionally, a new species of tube-worm (Clitellata: Tubificidae: *Ainudrilus angustivasa*) described from Lake Logue highlights the conservation value of the wetlands in this area (Pinder & Halse, 2002).

g. Recreation

Many recreational activities rely on the natural environment (bird watching, canoeing, wildflower tourism, etc.) or are greatly enhanced by it (hiking, cycling, horse riding, photography, etc.). Recreation may deliver economic benefit derived from tourism and also delivers spiritual and physical health benefits to the recreator. Lake Logue is used by the local community as a recreation site; it provides birdwatchers views of large flocks of swans and numerous other waterbirds. It is also possible to observe brumbies, the last of the thousands of wild horses that roamed the Eneabba area in the fifties (Tsurikov 2008). The Lake Logue-Indoon System is of value to wildflower tourism, as licensed wildflower picking is allowed on Unallocated Crown Land (Jaensch 1992). The nearby Lake Indoon is also a popular location for camping, picnicking, swimming and water skiing (Jaensch 1992). Lake Logue is not accessible by two wheel drive vehicles, making Lake Logue Nature Reserve and the adjoining Beekeepers Nature Reserve popular destinations for off road driving enthusiasts.

h. Spiritual/philosophical values

People's spiritual and philosophical reasons for valuing natural environment are numerous and diverse. One commonly cited is the 'sense of place' that people derive from elements of their environment. This is evident in many Aboriginal and rural Australians, who strongly identify themselves with their natural environment. Many people also believe that nature has inherent value or a right to exist; independent of any benefit delivered to humans. A sense of spiritual well-being may, therefore, be derived from the knowledge of healthy environments, even if the individual has no contact with them. Lake Logue is of cultural significance to the local Aboriginal people. The lake is an archaeological site of significance and contains artefacts (Jaensch 1992). The nearby Wunneroo Cave (site Id; 4660) is also of Aboriginal ceremonial significance (DIA 2009).

The intent of nature conservation is usually to maintain the ecosystem service values, opportunity values and scientific and educational values at a given site. Doing so is likely to have positive effects on the amenity values, recreational values and spiritual/philosophical values to which the site's natural environment contributes. Consumptive and productive uses of the natural

environment are not usually considered, as these are often incompatible with nature conservation.

3. Critical Components and Processes of the Ecology of Lake Logue

The objective of the Lake Logue RCR is to document the critical components and drivers of the wetland's natural environment. These components and processes determine the site's ecological character and are the variables that should be assessed in any ongoing monitoring.

Climate and geomorphology are the most important drivers of wetland ecosystems. Between them, these factors determine the position of a wetland in the landscape and the type and hydrological regime of that wetland. In turn, a wetland's position, type and hydrology exert a strong influence on its biota and biochemical properties and processes.

A summary of Lake Logue's critical ecosystem components is presented in Table 1. This is followed by a description of the results of the IAI RCM 2008 survey and of previous studies conducted on the wetland.

Table 1 – Summary of critical ecosystem components at Lake Logue

Component	Summary description
Geomorphology	Macroscale irregular perched claypan within the Tamala Limestone of the Spearwood Dune System, situated in the sumpland of an inter-dune swale of aeolian sands from broadly undulating, Pleistocene upland karst.
Hydrology	Inflow via Eneabba, Erindoon and Bindoon Creeks, and from overflow from Weelawadgi Lake and the chain of wetlands to the north. Catchments extensively cleared. Drainage occurs through percolation into superficial sediments of the karst system. Water is lost rapidly through evaporation.
Water Quality	Fresh to increasingly brackish as the lake dries out (subhaline).
Benthic Vegetation	Alga species *Lamprothamnium papulosum*.
Littoral Vegetation	*Casuarina obesa*, *Melaleuca strobophylla* and *M. rhaphiophylla.*
Invertebrates	A total of 137 species of invertebrate have now been recorded from Lake Logue. The lake was dry at the time of the IAI RCM survey.
Fish	No records of fish.
Waterbirds	>47 species recorded historically; see table 9.

3.1. Geology and Soils

Lake Logue lies on superficial aeolian sandy soils and Tamala Limestone. The soil is predominately inorganic, light-coloured and reflective. It also has high pH and buffers the system against acidification. The limestone substrate allows significant hydrological conductivity into the underlying karst. This transmission of water is reduced as the water level subsides, because clay and silt become impermeable.

3.2. Hydrology

The Lake Logue–Indoon System consists of Lake Logue (a large seasonal freshwater lake), Lake Indoon (a smaller semi-permanent brackish lake), smaller shallow ephemeral wetlands to the north and south of Lake Logue, intermittent creeks and drainage lines. Recharge occurs via direct precipitation, surface runoff and discharge from ephemeral drainage (Environment Australia, 2001). Lakes Logue and Indoon are linked by a groundwater connection through karst conduits. (Rutherford *et al.* 2005).

Lake Logue is known to be perched >10 m above the water table (Kern 1997; Rutherford *et al.* 2005). However, groundwater monitoring in the early 2000s suggested the lake was interacting

with groundwater. This is likely to be due to the porosity of the underlying Tamala Limestone matrix.

Lake Logue is naturally a seasonal – intermittent wetland. It began to hold water permanently from the 1960s, after extensive clearing in the catchment. The natural water regime appears to have re-established in recent decades (Environment Australia, 2001). Lake Logue had a maximum recorded water depth of 2.20 m in September 1983. The September mean depth is 1.10 m. In eleven of fifteen years of monitoring, the September water level was more than 0.3 m. There is a correlation between water depth and salinity (Table 2).

Table 2 – October depth and salinity at Lake Logue (Cale et al. 2004).

Year	Water Depth (m)	Salinity (mS cm^{-1})
1997	0.36	12,040
1999	3.65	1,929
2000	2.52	3,390
2002	0.28	35,700

3.3. Water Quality

Water quality was not measured as part of the 2008 IAI RCM survey, as Lake Logue was dry at the time. However, Lake Logue was sampled as part of the Salinity Action Plan (Cale *et al.* 2004; Pinder *et al.* 2004, 2005) (Table 3). The Lake has been included in previous monitoring programs and is considered fresh to brackish (Halse et al. 1993). This groundwater area corresponds with baseline information described by URS (2009b) as being very saline and containing concentrations of ions of aluminum, copper, molybdenum and zinc that exceed ANZECC guidelines for both end users and aquatic ecosystems.

Cale *et al*. (2004) described the following water chemistry and physico-chemical parameters. Water levels were low in 1997, when the lake was first surveyed, but the lake filled well beyond its normal floodline in May 1999 after extensive autumn rains. Water tended to be turbid, particularly at low water levels (maximum 210 NTU). Immediately after filling, lake-water was highly coloured (280 TCU), probably as a result of leaching from terrestrial vegetation and debris, and iron concentrations were higher, reflecting leaching from previously dried sediments. Total nitrogen and phosphorus concentrations were moderate to high (maxima of 2,500 µg L^{-1} and 140 µg L^{-1}, respectively) in all surveys despite increased water levels in 1999, suggesting high levels of input from floodwaters or flooded sediments.

Table 3 – Water quality parameters of Lake Logue as sampled by the Salinity Action Plan Wetland Monitoring Programme.

Date	15/08/1997	1/10/1997	27/10/1999	14/11/2000	24/10/2002
Field pH	8.59	8.82	8.18	8.125	9.175
Field Conductivity (mg L^{-1}	3,730	12,017.5	1,929	3,390	34,500
Nitrate (µg L^{-1})	0.05	1.3	0.26	0.01	0.05
Chlorophyll-a		38 (<88)	7.5	1.25	4.5
Chlorophyll-b		6	0.75	0.5	0.5
Chlorophyll-c		5	1	0.5	0.5
Turbidity (NTU)	1.3	210	70	58	1.3
Colour (TCU)	29	17	280	33	29
Salinity (g L^{-1})					
Alkalinity (mg L^{-1})	330	300	80	145	330
Hardness(mg L^{-1})	3,000	1,000	200	340	3,000
SiO_2 (mg L^{-1})	2.7	7	11	13	2.7

Date	15/08/1997	1/10/1997	27/10/1999	14/11/2000	24/10/2002
Na^- (mg L^{-1})	7,450	2,300	327	574	7,450
Ca^{2-} (mg L^{-1})	125	100	24	42	125
Mg^{2-} (mg L^{-1})	718	190	34	56	718
K^- (mg L^{-1})	123	53	14	22	123
Manganese	0.01	0.01	0.01	0.025	0.01
Cl^- (mg L^{-1})	13,400	4,000	530	910	13,400
HCO_3^- (mg L^{-1})	403	370	98	177	403
CO_3^{2-} (mg L^{-1})	1	1	1	1	1
SO_4^{2-} (mg L^{-1})	352	280	69	97	352
Temperature (℃)	20.4	18.5	23.6	26.6	26.5

3.4. Benthic Vegetation

No aquatic plant samples were collected during the 2008 IAI RCM survey, as Lake Logue was dry at the time. The alga *Lamprothamnium papulosum* has previously been collected.

3.5. Littoral Vegetation

The vegetation of Lake Logue consists of low open-woodland and stands of cane grass (*Eragrostis curvula*) on the lakebed, which is herbland when dry, and fringing low woodland over open shrubland. A population of the declared vulnerable plant, *Eremophila microtheca*, may be found on seasonally waterlogged flats on freehold land to the south of Lake Logue (Jaensch 1992). Scattered *Casuarina obesa* occur on raised mounds in the lake and further into the lake to the northwest.

The lake is fringed by live *C. obesa* woodland and scattered, mostly dead, Flooded Gum (*Eucalyptus rudis*) with a sedge understorey. Paperbarks (*Melaleuca rhaphiophylla*) occur outside the *C. obesa* zone, as saplings or trees, with an open understorey of *Wilsonia rotundiflora* and *Alyogyne hakeifolia*. An open shrubland with occasional *Banksia prionotes* occurs on dune slopes around the lake (Jaensch 1992; Halse *et al.* 1993; V & C Semeniuk Research Group 1994). This vegetation zoning is most evident on the southern and eastern portions of the lake where dense communities of *Melaleuca strobophylla* preside.

Gurner *et al*. (1999) undertook initial vegetation monitoring for the Salinity Action Plan through Edith Cowan University, in March 1999. This monitoring used a survey design of four transects. Additional monitoring conducted in February 2002 showed increased salinity and a decrease in the crown condition of *M. strobophylla* and *Austrostipa elegantissima* abundance, along with an increase in *Atriplex* sp. and *Enchylaena tomentosa* var. *tomentosa* (Barrier Saltbush), which has not been otherwise recorded (Kabay, 2002).

Other native plant species previously recorded at Lake Logue (Lyons *et al.* 2004) include the Priority 1 species *Calandrinia* aff. *composita*, and clustered coneflower (*Isopogon polycephalus*), which is normally found only on the south coast.

Two vegetation transects were established on the eastern side of Lake Logue for the IAI RCM project (Table 4). The first was representative of the lakebed community, which was consistent across the lake. The other transect was representative of the *Melaleuca cuticularis*/*Casuarina obesa* woodland that surrounded Lake Logue.

Table 4 – Site attributes of the Lake Logue vegetation transects.

Transect		R1	R2
Datum		WGS84	WGS84
Zone		50	50
Easting		320981	321077
Northing		6695921	6695955
Length		30 m	50 m
Bearing		190	0
Wetland state		Dry	Dry
Soil state (%)	Dry	100	100
	Waterlogged	0	0
	Inundated	0	0
Substrate (%)	Bare	30	20
	Rock	0	0
	Cryptogam	0	0
	Litter	1	20
	Trash	0	10
	Logs	0	5
Time since last fire		no evidence	decades- some burnt stumps
Community condition		Impacted	Impacted
Upper Stratum	Cover (%)	-	25.0165
	Height (m)	-	8
Mid Stratum	Cover (%)	-	3.28
	Height (m)	-	1.5
Ground Cover	Cover (%)	56.2857	22.7143
	Height (m)	<0.3	<0.3

Transect RCM024-R1

The first transect was established on the lakebed, towards the eastern side of Lake Logue (Figure 5). The lake was completely dry at the time of survey. Vegetation was composed of low shrubs, grasses and herbs (56.3% cover <0.3 m tall), predominantly *Atriplex amnicola*, *Wilsonia rotundifolia*, and weed species *Hordeum geniculatum*, *Lolium rigidum*, *Polypogon monspeliensis* and *Spergularia marina.* Table 5 provides a complete list of taxa recorded along the transect RCM024-R1.

The four weeds recorded contributed the majority of the vegetative cover across the transect. As such, the community condition was considered ‘impacted’ (Table 12 in Appendix 1).

Figure 5 – Lake Logue vegetation transect RCM024-R1.

Table 5 – Plant taxa recorded along transect RCM024-R1 (in order of stratum then dominance).

Genus	Species	Height (m)	Stratum[1]	Growth Form
Atriplex	*amnicola*	0.2	G1	Chenopod
Wilsonia	*rotundifolia*	0.05	G1	Shrub
**Hordeum*	*geniculatum*	0.2	G1	Grass
**Lolium*	*rigidum*	0.2	G1	Grass
**Polypogon*	*monspeliensis*	0.2	G1	Grass
**Spergularia*	*marina*	0.2	G1	Forb
Lachnagrostis	*filiformis*	0.2	G1	Grass
?Cressa	*australis*	0.1	G1	Forb

1 In an NVIS description, 'U' denotes the upper storey, 'M' the mid storey and 'G' the under storey (ground cover). Numerals to denote substrata from tallest (ESCAVI 2003).
* Introduced species.
? Limited confidence in identification.

According to the National Vegetation Information System (NVIS), the vegetation community may be described as (ESCAVI 2003):

G1+ ^*Atriplex amnicola*, *Wilsonia rotundifolia*, **Hordeum geniculatum*, **Lolium rigidum*, **Polypogon monspeliensis*, **Spergularia marina*\shrub, grass, forb\1\c.

Transect RCM024-R2

Transect R2 was established in the fringing vegetation of Lake Logue, approximately 50 m from the edge of the dry lakebed (Figure 6). The sandy soils were dry at the time of survey. Vegetation was dominated by *Melaleuca strobophylla*, *Casuarina obesa* low woodland (25% cover, 8 m tall) over *Rhagodia preissii* subsp. *obovata* mid-high sparse shrubs (3.3% cover, 1.5 m tall) over *Ehrharta longiflora*, *Hypochaeris glabra*, *Wahlenbergia capensis* low open introduced grasses and herbs (22.7% cover, <0.3 m tall). Table 6 provides a complete list of taxa recorded along the transect RCM024-R2.

Approximately 30% of trees were dead, with no evidence of recruitment. Six weed species were recorded, comprising the majority of vegetative ground cover along the transect. The overall community condition was considered 'impacted' (Table 12 in Appendix 1).

Figure 6 – Lake Logue vegetation transect RCM024-R2.

Table 6 – Plant taxa recorded along vegetation transect RCM024-R2 (in order of stratum then dominance).

Genus	Species	Height (m)	Stratum[1]	Growth Form
Melaleuca	*Strobophylla*	8	U1	Tree
Casuarina	*Obesa*	8	U1	Tree
Rhagodia	*preissii* subsp. *obovata*	1.5	M1	Chenopod
**Ehrharta*	*Longiflora*	0.4	G1	Grass
**Hypochaeris*	*Glabra*	0.4	G1	Forb
**Wahlenbergia*	*Capensis*	0.4	G1	Forb
Calandrinia	*Granulifera*	0.1	G1	Forb
Crassula	*colorata* var. *acuminata*	0.05	G1	Forb
Austrostipa	*Compressa*	0.3	G1	Grass
Trachymene	*Pilosa*	0.2	G1	Forb
**Ursinia*	*Anthemoides*	0.3	G1	Forb
**Arctotheca*	*Calendula*	0.2	G1	Forb
Ptilotus	*polystachyus*	0.5	G1	Forb
**Anagallis*	*Arvensis*	0.1	G1	Forb
Podotheca	*gnaphalioides*	0.3	G1	Forb
Podotheca	*angustifolia*	0.2	G1	Forb
Carpobrotus	*modestus*	0.1	G1	Shrub
Atriplex	*?amnicola*	0.2	G1	Chenopod

1 In an NVIS description, 'U' denotes the upper storey, 'M' the mid storey and 'G' the under storey (ground cover). Numerals to denote substrata from tallest (ESCAVI 2003).
* Introduced species.
? Limited confidence in identification.

According to the National Vegetation Information System (NVIS), the vegetation community may be described as (ESCAVI 2003):

U1+ ^*Melaleuca strobophylla*, ^*Casuarina obesa*\tree\6\i; M1 ^*Rhagodia preissii* subsp. *obovata*\3\r; G1 ^**Ehrharta longiflora*, **Hypochaeris glabra*, **Wahlenbergia capensis*, *Calandrinia granulifera*, *Crassula colorata* var. *acuminata*\grass, forb\1\i.

3.6. Aquatic Invertebrates

Lake Logue was dry at the time of the 2008 IAI RCM survey. Historical records are presented below. A total of 137 species of invertebrate have now been recorded from Lake Logue.

Table 14 (Appendix 3) shows a representative sample of the results of previous surveys. Included in the list are three new species not identified from any other location, these most notably include a Tubificidae worm (Clitellata: *Ainudrilus angustivasa*), a cladoceran (Chydoridae: *Alona* sp. nov. e nr. *pulchella* SAP) and a rotifer (Ploimida: *Cephalodella* sp. nov. a Logue SAP). It is unlikely that the rotifer and cladoceran would be restricted to the Lake Logue wetlands. However, it is possible that the tube-worm may have a dependence on the benthic sediments that restrict its distributions. Further species may be distinguished with future taxonomic investigation.

A total of 84 invertebrate species were collected from Lake Logue during monitoring by Cale *et al.* (2004). In 1997, there were 31 species, of which 17 (54%) were insects and 11 species (35%) were crustaceans. After flooding in 1999, 63 species were collected with 31 (49%) insects and 19 (30%) crustaceans. Invertebrate samples from 1997 and 1999 were quite significantly different (Cale *et al.* 2004). Few species were common to both sampling occasions, with only four of 25 crustaceans and four of 44 insects occurring twice. The fauna of 1999 had a greater number of planktonic species (eight cladocerans and six rotifers compared with one cladoceran species in 1997), suggesting an increased primary productivity of the lake waters following filling. In contrast, the 1997 fauna had a greater proportion of species typical of drying or ephemeral wetlands, such as the dipteran families Stratiomyidae and Syrphridae (Cale et al. 2004).

Stygofauna sampling from the superficial aquifer beneath the headwaters of the Erindoon Creek, was conducted in 2007 and yielded a Syncarida: Bathynellid - a potential Short Range Endemic (SRE) species, cyclopoid copepods, including Cyclopiidae: *Australoeucyclops* n sp. and ostracods of the genus *Sarscypridopsis* (Rockwater, 2007). The syncarid (potential SRE) was sampled from a bore 9 km southeast of Lake Indoon.

Table 7 – Aquatic invertebrate richness at Lake Logue (sampling location: Lat -29.85177, Long 115.13949).

Diversity measure	Oct 1997	Oct 1999	Nov 2000	Oct 2002
Total invertebrate species richness	29	52	49	13
Macroinvertebrate species richness	20	39	28	7
Total invertebrate family richness	21	27	28	11
Macroinvertebrate family richness	16	20	16	6

3.7. Fish

No fish were observed during the 2008 IAI RCM survey as Lake Logue was dry at the time and there are no previous accounts of fish.

3.8. Waterbirds

The Lake Logue-Indoon System is a major feeding stop-over, area for dispersal and drought refuge for waterbirds. The wetland system is one of the first major feeding sites for migratory birds entering the southwest region from the north. Eight species have been recorded breeding at Lake Logue (Table 8) (Jaensch 1992).

At times, Lake Logue can support large numbers of waterbirds. Approximately 6,420 waterbirds (including 160 Hardheads) were observed at the lake in March 1989 and 418 Straw-necked Ibis were observed roosting at the lake in November 1995 (Halse *et al.* 1990; Jaensch 1992).

No waterbirds were observed during the 2008 IAI RCM survey, as Lake Logue was dry at the time. However, previous waterbird surveys have been conducted at Lake Logue by DEC and RAOU (Royal Australasian Ornithologists Union, now Birds WA) under the projects 'Waterfowl Counts in the South-West WA' (WCSW) and 'Waterbirds in Nature Reserves of South-West WA' (WNRSW). At least 47 species of waterbirds, listed in Table 8, were observed at Lake Logue during these surveys (Jaensch *et al.* 1988; Halse *et al.* 1990; Halse *et al.* 1992; Halse *et al.* 1994; Halse *et al.* 1995; Cale *et al.* 2004).

Additionally, Marsh Terns (*Chlidonias hybrida*) and over fifty Stubble Quail (*Corturnix novae-zelandiae*) have been recorded from Lake Indoon (Foulds & McMillan, 1983).

Table 8 – Waterbirds observed at Lake Logue.

Organisation/Project **Duration of project**		**DEC/RAOU** **WNRSW** **1981 - 1987**	**DEC/RAOU** **WCSW** **1988 - 1992**	**DEC** **SPM** **1997 - ongoing**
Common name	**Latin name**			
Australasian Grebe	*Tachybaptus novaehollandiae*			✓
Australasian Shoveler	*Anas rhynchotis*	✓	✓	✓
Australian Pelican	*Pelecanus conspicillatus*	✓		✓
^ Australian Shelduck	*Tadorna tadornoides*	✓	✓	✓
Australian White Ibis	*Threskiornis molucca*			✓
Australian Wood Duck	*Chenonetta jubata*	✓	✓	✓
Banded Lapwing	*Vanellus tricolor*	✓		
Banded Stilt	*Cladorhynchus leucocephalus*			✓
Black-tailed Native Hen	*Gallinula ventralis*	✓		✓
Black-fronted Dotterel	*Elseyornis melanops*			✓
Black-winged Stilt	*Himantopus himantopus*	✓		✓
Black Swan	*Cygnus atratus*	✓	✓	✓
[3] Blue-billed Duck	*Oxyura australis*	✓		✓
Chestnut Teal	*Anas castanea*		✓	✓
* Common Greenshank	*Tringa nebularia*			✓
* Curlew Sandpiper	*Calidris ferruginea*			✓
Darter	*Anhinga melanogaster*			✓
^ Eurasian Coot	*Fulica atra*	✓	✓	✓
Freckled Duck	*Stictonetta naevosa*		✓	✓
* Glossy Ibis	*Plegadis falcinellus*			✓
Great Cormorant	*Phalacrocorax carbo*	✓		
Great Crested Grebe	*Podiceps cristatus*			✓
* Great Egret	*Egretta alba*	✓		✓
^ Grey Teal	*Anas gracilis*	✓	✓	✓
Hardhead	*Aytha australis*	✓	✓	✓
^ Hoary-headed Grebe	*Poliocephalus poliocephalus*	✓		✓
Little Black Cormorant	*Phalacrocorax sulcirostris*			✓
Little Pied Cormorant	*Phalacrocorax melanoleucos*			✓
Musk Duck	*Biziura lobata*	✓	✓	✓
Nankeen Night Heron	*Nycticorax caledonicus*			✓

Organisation/Project Duration of project		DEC/RAOU WNRSW 1981 - 1987	DEC/RAOU WCSW 1988 - 1992	DEC SPM 1997 - ongoing
Common name	**Latin name**			
^ Pacific Black Duck	*Anas superciliosa*	✓	✓	✓
^ Pink-eared Duck	*Malacorhynchus membranaceus*	✓	✓	✓
Red-capped Plover	*Charadrius ruficapillus*			✓
Red-kneed Dotterel	*Erythrogonys cinctus*			✓
[1] Red-necked Avocet	*Recurvirostra novaehollandiae*			✓
* Red-necked Stint	*Calidris ruficollis*			✓
* Sharp-tailed Sandpiper	*Calidris acuminata*			✓
Silver Gull	*Larus novaehollandiae*			✓
Spotless Crake	*Porzana tabuensis*			✓
Straw-necked Ibis	*Threskiornis spinicollis*	✓		✓
Swamp Harrier	*Circus approximans*	✓		✓
* Terek Sandpiper	*Xenus cinereus*			✓
Unidentified Grebe		✓		
Unidentified Stilt-type		✓		
Whiskered Tern	*Sterna hybrida*	✓		✓
^ White-faced Heron	*Egretta novaehollandiae*	✓		✓
^ White-necked Heron	*Ardea pacifica*	✓		
* Wood Sandpiper	*Tringa glareola*			✓
^ Yellow-billed Spoonbill	*Platalea flavipes*	✓		✓

* Listed under Migratory Bird Agreements JAMBA, CAMBA and/or ROKAMBA.
^ Found breeding at Lake Logue.
1 & 3 Indicate conservation status.

3.9. Terrestrial Vertebrates

Evidence of diggings, possibly made by an echidna, was observed during the IAI RCM survey in 2008. No other evidence of terrestrial vertebrate fauna was sighted. Eight species of frog are reported for the area (Meagher & Assoc. 1981).

Carnaby's Cockatoos (*Calyptorhynchus latirostris*; Schedule 1; Endangered) have been recorded roosting in river gums on Woodada Rd, located around 500 m north of Lake Logue (Johnstone & Kirkby, 2007).

Table 9 – Western Australian Museum records for fauna collected within 5 km of Lake Logue (WA Museum 2009).

Accession ID/s	Common Name	Latin name	Year/s
R72909 R72910 R72911 R72929	Blunt-tailed West-coast Slider	*Lerista praepedita*	1980
R25819	Bobtail	*Tiliqua rugosa*	1965
R119384	Bynoe's Gecko	*Heteronotia binoei*	1993
R72907 R72908 R72978 R72979	Coastal Slender Bluetongue	*Cyclodomorphus celatus*	1980
R73100	Common Dwarf Skink	*Menetia greyii*	1980
R37713	Common Scaly-foot	*Pygopus lepidopodus*	1970
R73095 R88768 R88769	Dotted-line Robust Slider	*Lerista lineopunctulata*	1980 1984
R88770	Elegant Slider	*Lerista elegans*	1984

Accession ID/s	Common Name	Latin name	Year/s
R72998 R72999	Fence Skink	*Cryptoblepharus plagiocephalus*	1980
R96104	Gwardar Snake	*Pseudonaja nuchalis*	1987
R73099	Moaning Frog	*Heleioporus eyrei*	1980
R71935 R106297 R108523	Mulga Snake	*Pseudechis australis*	1980 1991
R73107	Side-barred Delma	*Delma grayii*	1980
R71937 R72963 R73106	Spotted Sand Dragon	*Ctenophorus maculatus*	1980
R72976 R119382 R119383	Variegated Tree Dtella	*Gehyra variegata*	1980 1993
R44548 R100898	West Coast Banded Snake	*Simoselaps littoralis*	1973 1989
R71925 R72959 R72980 R73098	West-coast Laterite Ctenotus	*Ctenotus fallens*	1980
R72960 R72961 R72962	Western Heath Dragon	*Rankinia adelaidensis*	1980
R72985	Western Limestone Ctenotus	*Ctenotus australis*	1980
R72977	Woodland Flecked Skink	*Morethia obscura*	1980

4. Interactions between Ecological Components at Lake Logue

An appreciation of the interactions between the elements of a wetland ecosystem is essential to understanding the condition of the system. Although components of a wetland are often monitored and managed as discrete entities, they exist as nodes in a complex ecological web. Documenting the full extent of the interactions that occur at a wetland would be impractical. However, it is essential to identify key interactions that define the system's ecological character.

Hale and Butcher (2007) justified the equivalence of Ramsar nomination criteria and primary determinants of ecological character. This justification may also be extended to nomination for the Directory of Important Wetlands in Australia, as the criteria are very similar. Accordingly, the primary determinants of ecological character at Lake Logue are:

- The characteristics that make the site a good example of a wetland type occurring within a biogeographic region in Australia.
- The animal taxa that utilise the site as habitat at a vulnerable stage in their life cycles, or as a refuge when adverse conditions such as drought prevail; and the characteristics of the site that allow it support these populations.
- The native plant or animal taxa or communities, which are considered endangered or vulnerable at the national level and are supported by the wetland.

Table 10 summarises the interactions between key components and processes at Lake Logue. The table lists the components that are directly responsible for the provision of each service or benefit of the wetland and the biotic and abiotic factors that support or impact these components. Also listed are the key threats that may affect the components or processes. This information assists in the identification of the primary determinants of ecological character.

Table 10 – The relationship between the services and benefits delivered by Lake Logue and the key components and processes that support them.

Benefit or Service	Component	Factors Influencing Component		Threats and Threatening Activities
		Biotic	Abiotic	
Opportunity Value Potential future use of unique flora and fauna	Endemic flora Endemic fauna	Pollinators Aquatic invertebrate fauna Vegetation communities	Habitat extent and distribution Hydrological regime Fire regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora* Predation by introduced fauna
Ecosystem Service Value Good example of a wetland type occurring within a biogeographic region in Australia	Suite of linked seasonal freshwater/brackish basins	Vegetation communities	Hydrological regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Weeds & introduced organisms; *Phytophthora* Erosion
Ecosystem Service Value Habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail	Major feeding stop-over for 8 species of migratory waterbirds Staging for dispersal area and drought refuge for domestic waterbirds	Invertebrate populations (food source) Phytoplankton (food source) Benthic plant biomass Vegetation communities	Habitat extent and distribution Hydrological regime Fire regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora* Predation by introduced fauna Loss of migratory bird populations due to offsite factors
Ecosystem Service Value Native plant or animal taxa or communities which are considered endangered or vulnerable at the national level and are supported by the wetland	Rare flora, *Banksia elegans*	Pollinators	Hydrological regime Fire regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora*

Benefit or Service	Component	Factors Influencing Component		Threats and Threatening Activities
		Biotic	**Abiotic**	
Ecosystem Service Value Native plant or animal taxa or communities which are considered endangered or vulnerable at the national level and are supported by the wetland	Declared vulnerable flora, *Eremophila microtheca*	Pollinators	Hydrological regime Fire regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora*
Recreational Value Bird watching Wildflower tourism Bush walking Photography	Landscape amenity Waterbird populations Vegetation communities Significant flora Significant fauna	Invertebrate populations (food source) Phytoplankton (food source) Benthic plant biomass Vegetation communities	Habitat extent and distribution Hydrological regime Fire regime Water quality Sediments	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora* Predation by introduced fauna Loss of migratory bird populations due to offsite factors
Spiritual Value The wetland is of outstanding historical or cultural significance	Geomorphology of lake and surrounds Native flora and fauna communities Aboriginal artefacts	Flora and fauna populations Pollinators and food sources for above	Sediments Hydrology Water quality	Alteration to hydrology due to climate change, groundwater extraction or catchment perturbation Salinisation Nutrient enrichment Inappropriate fire regimes Weeds & introduced organisms; *Phytophthora* Erosion Predation by introduced fauna Loss of migratory bird populations due to offsite factors

5. Threats to the Ecology of Lake Logue

The aim for management at Lake Logue is to maintain those elements of the ecology that resulted in its nomination as a DIWA site. The critical components of the ecology of Lake Logue are the geomorphologic, hydrologic and water quality factors that make the lake a suitable stopover and feeding area for migratory birds and provide habitat for *Eremophila microtheca.* Therefore, the factors to be protected include hydrology, water quality, plant communities and aquatic invertebrate communities. Also of importance are the elements of the system that contribute to its cultural and scientific value.

Threats to Lake Logue must be considered in relation to their likelihood of causing failure of the above management goal. An assessment is made of the probability that goal failure will result due to the impacts of each threatening process identified at the site, or potentially acting there. The results of this assessment are presented in Table 11. In summary, failure to achieve the management goal for Lake Logue is most likely to result due to the impacts of agriculture, particularly nutrient enrichment of the water body due to over–application of fertiliser in the catchment. Plant pathogens, altered hydrological regimes, mining, weeds, feral animals and recreational vehicle use are also major threats.

Eutrophication and salinisation have become a problem for neighbouring Lake Indoon. This is a result of over use of fertilisers in the lakes' catchment and extensive clearing. These threats may also impact Lake Logue, potentially killing fringing vegetation, reducing the diversity and richness of aquatic invertebrates and decreasing the habitat value of the lake.

Iluka is proposing an expansion of its mineral sands mine to the east of Lake Logue. The proposed expansion is 14,945 ha; including 1,869 ha of remnant native vegetation. This may further alter the hydrology of the Logue-Indoon System. Also, mineral sands mining involves dewatering and groundwater abstraction. This is currently occurring at the headwaters of the Erindoon Creek. These activities could potentially change the water quality in Lake Indoon and Lake Logue.

Associated with the mine expansion is a pair of Heavy Mineral Concentrators, to be located upstream of the Logue-Indoon System (Iluka, 2009). The discharge from these could contaminate Eneabba Creek, if not managed carefully. Alterations to surface water flow also pose a direct threat to the Lake Logue system.

A coal fired power plant is also proposed at the headwaters of the Erindoon and Bindoon Creeks. It will use sub-bituminous coal from the Catamarra Coal Measures as its main fuel source supplemented by natural gas. The project requires the clearing of 49 ha of native vegetation, 30 ha of which are located in South Eneabba Nature Reserve. If this power plant is to be constructed, the hydrology of the nearby creek lines should be considered.

There are also groundwater contamination issues regarding the burying of heavy metal laden evaporative salts (<75% NaCl): 20,000 tonnes per annum (tpa), bottom and fly ash: 820,000 tpa and mining overburden (URS, 2009a). The heavy metal component includes As, B, Cr, Cu, Mo, Se, Zn and very low concentrations of soluble uranium and thorium (Terrenus Earth Sciences, 2008). Groundwater in this area flows from the powerplant directly towards the Logue-Indoon Wetland System and it is expected that eventually the minerals will mobilise into the surrounding aquifers.

Seismic exploration for new well sites to supplement the nearby Woodada gas field is ongoing and may result in the discovery of gas reserves beneath the wetland area. Seismic blasting may disturb nesting waterbirds (Desmond and Chant 2002).

There are records of *Phytophthora cinnamomi* and *P. citricola* in Lake Logue and wetlands to the north and *P. drechsleri* in Lake Indoon (Jaensch 1992). These pathogens may be spread by 4x4 vehicles which are commonly used in the area. Mapping of diseased areas should be undertaken and every effort made to exclude traffic from them.

Feral animals known to occur at Lake Logue include introduced bees (*Apis mellifera*), rabbits (*Oryctolagus cuniculus*), goats (*Capra hircus*), foxes (*Vulpes vulpes*), cats (*Felis catus*), horses (*Equus caballus*) and pigs (*Sus scrofa*). All of these are impacting the area to varying degrees, although some management action is being undertaken.

Table 11 – Threat assessment for Lake Logue.

An estimate is provided of the perceived likelihood of goal failure resulting from the impacts of each identified threat category.

Goal: to maintain the geomorphology, hydrology, physiochemical character and biota of Lake Logue, thus ensuring it remains a suitable feeding and refuge area for waterbirds, provides habitat for *Eremophila microtheca* and retains its cultural and scientific values.

Threat category	Management issue	Probability that threat will cause goal failure with:		Assumptions underlying initial probability assessment and explanatory notes
		Existing management	Extra management	
Altered biogeochemical processes	Hydrological processes, particularly salinity	15%	10%	Salinisation is a threat due to extensive clearing in the catchment.
	Carbon cycle and climate change	5%	5%	Decreased rainfall may compromise the integrity of the wetland, although the wetland is adapted to dry periods.
Impacts of introduced plants and animals	Environmental weeds	10%	5%	A broad array of weeds has been identified in the lake area, but due to the fluxing saturation state of the lake; weeds are generally not able to singly dominate before conditions change to favour other species.
	Herbivory, wallowing and trampling by introduced species	10%	5%	Pig numbers have increased in the Reserve but not to such an extent that significant impacts are evident. Wild Horses have also been identified as a threat and this requires further monitoring. Rabbit are present.
Impacts of disease	Plant pathogens	20%	10%	*Phytophthora cinnamomi, P. citricola* and *P. drechsleri are* known to occur in the vicinity and the risk of spread is significant due 4x4 traffic.
Detrimental regimes of physical disturbance events	Fire regimes	4%	2%	Fires facilitate the establishment of exotic grasses and other weeds. They also create the potential for erosion of soils with the next rainfall event.
	Drought	5%	5%	Currently the Logue –Indoon system has been subjected to drier seasons. Due to the ephemeral & seasonal nature of the wetlands most species would be considered naturally adapted to these prolonged periods.
	Flood	5%	5%	Alteration to rainfall and hydrological fluxes, associated with global climate change may impact on the vegetation of Lake Logue. The nature of the impacts is not clear and should be monitored.
Impacts of pollution	Herbicide, pesticide or fertiliser use and direct impacts	25%	10%	Eutrophic conditions are currently a seasonal problem in Lake Indoon (see nutrient enrichment below), the concentrations of toxic compounds requires monitoring.
Impacts of competing land uses	Recreation management	10%	4%	The main risk evident is the unrestrained use of 4x4 vehicles on the lake beds when dry; this locally destroys the benthos layer through disturbance & alters the surface flow of water. This also increases the risk of spread of soil-borne pathogens.

Threat category	Management issue	Probability that threat will cause goal failure with:		Assumptions underlying initial probability assessment and explanatory notes
		Existing management	Extra management	
	Nutrient enrichment of water body.	20%	10%	This is a major threat to the wetland system occurring at Lake Indoon at present, through eutrophication and subsequent mass fish deaths from algal blooms (see pollution above).
	Urban and industrial development	10%	5%	Current plans include the expansion of the Iluka Eneabba Mineral Sands Mine & the construction of the Coolimba Power Plant at the headwaters of the Erindoon & Bindoon creeks. These plans need to be sympathetic to the natural episodic water-flow through this area. The level of threats will reflect the alteration to flows & vegetation structure.
	Consumptive uses	0%	0%	Not applicable
	Illegal activities	10%	4%	Such activities may include the dumping of rubbish, lighting fires & shooting of native animals. Off road 4x4 usage is currently the most significant threat in this category.
	Mines and quarries	20%	10%	Minerals are mined nearby at Eneabba & this is proposed to be expanded which may further impact on the integrity of Eneabba Creek. Gas extraction occurs at the Woodada Gas Field. An increase in dewatering, contamination & seismic activities could produce impacts that should be closely monitored.
Insufficient ecological resources to maintain viable populations	Habitat, genetic exchange	1%	1%	Lake Logue is fairly well connected to areas of natural or near natural environment. Populations are likely to self-supporting in this setting. Off-site impacts on migratory birds could potentially reduce their population size to unsustainable levels, but this could not be addressed at a site level.

6. Knowledge Gaps and Recommendations for Future Monitoring

More information is required to understand the resilience to desiccation and aestivation periods of organisms associated with ephemeral wetlands. This is particularly important in regards to the species that are though to be endemic to Lake Logue.

Local information on the hydrology in this area is also deficient. The use of dye tracers may be considered to determine the nature of water fluxes through the underlying karst and landscape connectivity.

There is currently no quantitative data on the effects of exotic predators, weed colonisation, fragmentation, farming impacts, fires and the impacts of mineral extraction on gypsum and lime surfaces (Desmond and Chant 2002).

There is currently $2.46 million (+ GST) available for a National project to assess the vulnerability of Groundwater Dependent Ecosystems (GDE) in the Midwest. The project will define the ecological, social and cultural values of groundwater-dependent ecosystems and will use representative GDE sites to obtain information on their susceptibility to groundwater regime change based on distribution, deposition and age of sedimentary rocks and vegetation water requirements found at those sites. A groundwater monitoring network and vegetation transects will be established, allowing managers to understand water requirements including information on ecological condition. A risk analysis of GDEs will then be carried out, based on scenarios of groundwater regime change due to climate variability and/or development pressures.

This project is scheduled to end July 2011 and it is anticipated that the project's findings will compliment the suite of work already undertaken in Western Australia in the other high-priority areas. Together, these studies will result in improved groundwater-management guidelines for these vulnerable areas.

In addition to providing essential understanding about groundwater-dependent ecosystems in the Midwest region and the hydrology that supports them, this project will significantly contribute to the revision of water management plans in keeping with National Water Initiative and state water reform requirements. It will assist in the assessment of water required for the environment and water available for use, and will define areas at risk of abstraction to inform licensing decisions.

The information gathered will support the development of environmental water provisions and a statutory groundwater management plan for the Northern Perth Basin. The monitoring program established will be used to evaluate the effectiveness of water management and use strategies in meeting environmental and management objectives, enabling an adaptive approach to management of the lake system. This is fundamental to achieving the sustainable outcome of maximising water development while minimising environmental impact (National Water Commission 2009).

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Appendix 1 – Vegetation condition

Table 12 – Overall Vegetation Community Condition Rating as adapted from Thackway and Lesslie (2005). Shading indicates the condition of Lake Logue.

Overall Community Condition Rating					
	0	1	2	3	4
Community Condition Class	RESIDUAL BARE	NATURAL	IMPACTED	DEGRADED	REMOVED/REPLACED
	Areas where native vegetation does not naturally persist	Native vegetation community structure, composition and regenerative capacity intact - no significant perturbation from land management practices	Native vegetation community structure, composition and regenerative capacity intact but perturbed by land management practices	Native vegetation community structure, composition and regenerative capacity significantly altered by land management practices	Species present are alien to the locality and either spontaneous in occurrence or cultivated. Alternatively, vegetation may have been removed entirely
Regenerative Capacity	Natural regenerative capacity unmodified - ephemerals and lower plants	Regenerative capacity intact. All species expected to show regeneration are doing so	Natural regenerative capacity somewhat reduced, but endures under current/past land management practices	Natural regenerative capacity limited and at risk due to land management practices. Rehabilitation and restoration possible through removal of threats	Regenerative potential of native vegetation has been suppressed by ongoing disturbances. There is little potential for restoration
Vegetation Structure	Nil or minimal	Structural integrity of native vegetation is very high. All expected strata, growth forms and age classes are present	Structure is altered but persists, i.e. some elements of a stratum are missing	Structure of native vegetation is significantly altered, i.e. one or more strata are missing entirely	All structural elements of native vegetation are missing or highly degraded
Vegetation Composition	Nil or minimal	Compositional integrity of native vegetation is very high. All species expected at the site are present	Composition of native vegetation is altered. All major species are present, although proportions may have changed. Some minor species may be missing	Significant species are missing from the site and may have been replaced by opportunistic species. Loss of species affects structure of vegetation	Native vegetation removed entirely +/- replaced with introduced species

Appendix 2 – Herbarium plant records

Table 13 – Herbarium Records for Lake Logue.

Search Coordinates: NW corner 29.7929°S, 115.0956°E , SE corner 29.8935°S, 115.1905°E

Family	Species	Alien	Cons. Status
Anthericaceae	*Arnocrinum preissii*		
	Hensmania turbinata		
	Thysanotus arenarius		
	Thysanotus manglesianus		
	Thysanotus patersonii		
	Thysanotus spiniger		
	Thysanotus teretifolius		
	Thysanotus thyrsoideus		
Apiaceae	*Platysace* sp. Eneabba (R. Hnatiuk 770001)		
	Platysace xerophila		
	Trachymene pilosa		
Asteraceae	*Calotis erinacea*		
	Dittrichia graveolens	Y	
	Hyalosperma cotula		
	Millotia myosotidifolia		
	Myriocephalus appendiculatus		P3
	Olearia dampieri subsp. *dampieri*		
	Podolepis gracilis		
	Podotheca chrysantha		
	Podotheca gnaphalioides		
	Pterochaeta paniculata		
	Waitzia acuminata var. *albicans*		
Boraginaceae	*Heliotropium curassavicum*	Y	
Campanulaceae	*Wahlenbergia capensis*	Y	
	Wahlenbergia preissii		
Casuarinaceae	*Casuarina obesa*		
Centrolepidaceae	*Aphelia brizula*		
	Centrolepis aristata		
	Centrolepis drummondiana		
	Centrolepis polygyna		
Colchicaceae	*Burchardia congesta*		
	Burchardia multiflora		
Convolvulaceae	*Wilsonia rotundifolia*		
Crassulaceae	*Crassula natans*	Y	
Cunoniaceae	*Aphanopetalum clematideum*		
Cyperaceae	*Caustis dioica*		
	Cyperus gymnocaulos		
	Isolepis cernua var. *setiformis*		
	Isolepis congrua		
	Isolepis marginata	Y	
	Isolepis stellata		
	Mesomelaena pseudostygia		
	Schoenus andrewsii		
	Schoenus grandiflorus		
	Schoenus humilis		
	Schoenus plumosus		
	Schoenus rigens		
	Schoenus sp. A3 Ciliate Sheaths (K. Newbey 9402)		

Family	Species	Alien	Cons. Status
Dasypogonaceae	*Calectasia narragara*		
Dilleniaceae	*Hibbertia acerosa*		
	Hibbertia aff. *helianthemoides* (Northern)		
	Hibbertia aff. *hypericoides*		
	Hibbertia crassifolia		
	Hibbertia desmophylla		
	Hibbertia huegelii		
	Hibbertia racemosa		
	Hibbertia spicata		
Droseraceae	*Drosera heterophylla*		
	Drosera menziesii subsp. *thysanosepala*		
Emblingiaceae	*Emblingia calceoliflora*		
Epacridaceae	*Andersonia heterophylla*		
	Andersonia lehmanniana		
	Astroloma glaucescens		
	Leucopogon insularis		
	Leucopogon sp. South Eneabba (E.A. Griffin 8027)		
	Lysinema ciliatum		
Gentianaceae	*Centaurium erythraea*		
Goodeniaceae	*Dampiera carinata*		
	Dampiera sp.		
	Dampiera spicigera		
	Goodenia coerulea		
	Goodenia pulchella subsp. Coastal Plain A (M. Hislop 634)		
	Lechenaultia stenosepala		
	Scaevola canescens.		
	Scaevola repens var. *angustifolia*		
Gyrostemonaceae	*Gyrostemon racemiger*		
	Gyrostemon ramulosus		
Haemodoraceae	*Anigozanthos manglesii* subsp. *quadrans*		
	Conostylis aculeata subsp. *breviflora*		
	Conostylis aurea		
	Conostylis candicans subsp. *candicans*		
	Conostylis canteriata		
	Conostylis crassinervia subsp. *absens*		
	Conostylis hiemalis		
	Conostylis teretifolia subsp. *teretifolia*		
	Tribonanthes australis		
Iridaceae	*Patersonia argyrea*		P3
Juncaceae	*Juncus bufonius*	Y	
	Juncus kraussii subsp. *australiensis*		
Juncaginaceae	*Triglochin ? minutissima*		
	Triglochin mucronata		
	Triglochin sp. A Flora of Australia (G.J. Keighery 2477)		
	Triglochin sp. B Flora of Australia (P.G. Wilson 4294)		
Lamiaceae	*Hemiandra* sp.		
Lauraceae	*Cassytha aurea* var. *hirta*		
	Cassytha aurea var. *aurea*		
	Cassytha flava		
Lecanoraceae	*Lecanora sphaerospora*		
Lobeliaceae	*Isotoma hypocrateriformis*		
Loranthaceae	*Amyema linophylla* subsp. *linophylla*		
Malvaceae	*Alyogyne huegelii* var. *huegelii*		

Family	Species	Alien	Cons. Status
Megalariaceae	*Megalaria grossa*		
Menyanthaceae	*Villarsia congestiflora*		P3
Mimosaceae	*Acacia ? chrysella*		
	Acacia blakelyi		
	Acacia cavealis		
	Acacia fagonioides		
	Acacia lineolata subsp. *lineolata*		
	Acacia Plurinerves-Microneurae Phyllodes >8-nerved, flat (Miscellaneous)		
	Acacia rostellifera		
	Acacia saligna subsp. *lindleyi*		
	Acacia sp.		
	Acacia spathulifolia		
	Acacia telmica		P3
	Acacia vittata		P2
	Acacia xanthina		
Molluginaceae	*Macarthuria australis*		
Myoporaceae	*Eremophila microtheca*		P4
Myrtaceae	*Baeckea grandiflora*		
	Beaufortia aestiva		
	Beaufortia elegans		
	Calothamnus hirsutus		
	Calothamnus quadrifidus forma *obtusus*		
	Calothamnus quadrifidus		
	Calothamnus sanguineus		
	Calytrix chrysantha		P3
	Calytrix eneabbensis		P3
	Calytrix flavescens		
	Calytrix fraseri		
	Calytrix sapphirina		
	Calytrix strigosa		
	Calytrix superba		P3
	Conothamnus trinervis		
	Darwinia neildiana		
	Darwinia sp.		
	Darwinia speciosa		
	Eremaea beaufortioides		
	Eremaea violacea		
	Eucalyptus camaldulensis var. *obtusa*		
	Eucalyptus camaldulensis/rudis var. *obtusa*		
	Eucalyptus erythrocorys		
	Eucalyptus sp. Badgingarra (D. Nicolle & M. French DN 3515)		
	Hypocalymma gardneri		P2
	Hypocalymma xanthopetalum		
	Melaleuca aspalathoides		
	Melaleuca brevifolia		
	Melaleuca cf. *urceolaris*		
	Melaleuca dichroma		
	Melaleuca lanceolata		
	Melaleuca rhaphiophylla		
	Melaleuca ryeae		
	Melaleuca strobophylla		
	Melaleuca systena		

Family	Species	Alien	Cons. Status
Myrtaceae	*Scholtzia chapmanii*		
	Scholtzia laxiflora		
	Scholtzia sp. Wongonderrah (M.E. & M.R. Trudgen MET 12000)		
	Scholtzia umbellifera		
	Thryptomene hyporhytis		
	Thryptomene sp.		
	Verticordia aurea		P4
	Verticordia blepharophylla		P2
	Verticordia densiflora var. *caespitosa*		
	Verticordia densiflora var. *densiflora*		
	Verticordia eriocephala		
	Verticordia nobilis		
	Verticordia ovalifolia		
	Verticordia pennigera		
Orchidaceae	*Caladenia flava* subsp. *flava*		
	Drakaea glyptodon		
	Eriochilus dilatatus subsp. *dilatatus*		
	Paracaleana dixonii		
Papilionaceae	*Bossiaea eriocarpa*		
	Chorizema racemosum		
	Daviesia divaricata subsp. *divaricata*		
	Daviesia oxyclada		
	Daviesia pedunculata		
	Daviesia pteroclada		P3
	Gastrolobium obovatum		
	Gastrolobium spinosum		
	Gompholobium tomentosum		
	Isotropis cuneifolia subsp. *cuneifolia*		
	Jacksonia calcicola		
	Jacksonia floribunda		
	Jacksonia furcellata		
	Jacksonia sternbergiana		
	Leptosema aphyllum		
	Mirbelia trichocalyx		
	Sphaerolobium gracile		
Parmeliaceae	*Flavoparmelia rutidota*		
	Punctelia ? subalbicans		
	Rimelia reticulata		
Pertusariaceae	*Ochrolechia* sp.		
	Pertusaria gibberosa		
	Pertusaria sp.		
Physciaceae	*? Dirinaria picta*		
	Buellia pruinosa		
	Hafellia disciformis		
	Pyxine cocoes		
	Pyxine subcinerea		
	Rinodina australiensis		
Pittosporaceae	*Marianthus ringens*		
Poaceae	*Austrostipa macalpinei*		
	Eragrostis australasica		
	Poa porphyroclados		
	Sporobolus virginicus		

Family	Species	Alien	Cons. Status
Polygalaceae	*Comesperma integerrimum*		
	Comesperma rhadinocarpum		P2
Portulacaceae	*Calandrinia calyptrata*		
	Calandrinia corrigioloides		
	Calandrinia granulifera		
	Calandrinia sp. Blackberry (D.M. Porter 171)		
	Calandrinia sp. Kenwick (G.J. Keighery 10905)		
Proteaceae	*Adenanthos cygnorum* subsp. *cygnorum*		
	Banksia carlinoides		
	Banksia elegans		P4
	Banksia hookeriana		
	Banksia hookeriana x prionotes		
	Banksia leptophylla var. *melletica*		
	Banksia leptophylla		
	Banksia menziesii		
	Banksia nivea subsp. *nivea*		
	Banksia prionotes		
	Banksia vestita		
	Conospermum boreale subsp. ascendens		
	Conospermum boreale		
	Conospermum canaliculatum subsp. *canaliculatum*		
	Conospermum crassinervium		
	Conospermum unilaterale		
	Conospermum wycherleyi		
	Grevillea althoferorum		R
	Grevillea biformis subsp. *cymbiformis*		P2
	Grevillea integrifolia		
	Grevillea olivacea		P4
	Grevillea pinaster		
	Grevillea polybotrya		
	Grevillea preissii subsp. *glabrilimba*		
	Hakea candolleana		
	Hakea eneabba		
	Hakea obliqua		
	Hakea psilorrhyncha		
	Hakea spathulata		
	Isopogon divergens		
	Isopogon tridens		P3
	Petrophile axillaris		
	Petrophile drummondii		
	Petrophile macrostachya		
	Petrophile megalostegia		
	Stirlingia abrotanoides		
	Stirlingia latifolia		
	Xylomelum angustifolium		
Ramalinaceae	*Ramalina glaucescens*		
Restionaceae	*Anarthria laevis*		
	Anarthria polyphylla		
	Chordifex sinuosus		
	Desmocladus asper		
	Desmocladus elongatus		P3
	Harperia lateriflora		
	Hopkinsia anoectocolea		P3

Family	Species	Alien	Cons. Status
Restionaceae	*Hypolaena exsulca*		
	Lepidobolus preissianus		
	Lepidobolus preissianus subsp. *preissianus*		
	Leptocarpus canus		
Rhamnaceae	*Stenanthemum notiale* subsp. *notiale*		
Rubiaceae	*Opercularia vaginata*		
Santalaceae	*Exocarpos sparteus*		
Sapindaceae	*Diplopeltis huegelii* subsp. *huegelii*		
Scrophulariaceaea	*Stemodia florulenta*		
Solanaceae	*Anthocercis littorea*		
Stackhouseaceae	*Tripterococcus brunonis*		
Sterculiaceae	*Guichenotia alba*		P3
	Guichenotia ledifolia		
	Guichenotia sarotes		
	Keraudrenia hermanniifolia		
	Lasiopetalum drummondii		
Stylidiaceae	*Stylidium carnosum* subsp. Narrow leaves (J.A. Wege 490)		P1
	Stylidium crossocephalum		
	Stylidium dichotomum		
	Stylidium elongatum		
	Stylidium flagellum		
	Stylidium maitlandianum		
	Stylidium scariosum		
Surianaceae	*Stylobasium australe*		
Teloschistiaceae	*Teloschistes chrysophthalmus*		
Thymelaeaceae	*Pimelea floribunda*		
	Pimelea villifera		
Violaceae	*Hybanthus calycinus*		
Viscaceae	*Korthalsella arthroclada*		P1
Xanthorrhoeaceae	*Xanthorrhoea drummondii*		
Zamiaceae	*Macrozamia fraseri*		
Zannichelliaceae	*Lepilaena preissii*		

Plant specimens submitted to the WA Herbarium

Caryophyllaceae *Spergularia marina* (RCM024-R1-03) lesser sandspurry -*Alien sp.

Appendix 3 – Aquatic invertebrate data

Table 14 – Aquatic invertebrate species collected at Lake Logue (Oct 1997 – Oct 2002).

Class	Order	Family	Lowest ID	Oct 1997	Oct 1999	Nov 2000	Oct 2002
Lobosea	Arcellinida	Arcellidae	*Arcella discoides*				
		Centropyxidae	*Centropyxis* sp.				
Desmospongiae	-	Spongillidae	Spongillidae			1	
Hydrozoa	-	Hydridae	*Hydra* sp.				
Turbellaria	-	-	Turbellaria	1			
Nematoda	-	-	Nematoda	1		1	1
Rotifera	Bdelloidea	-	Bdelloidea			1	
			Bdelloidea med-large contracted of RJS (SAP)				
	Floscullariacea	Filiniidae	*Filinia pejleri*			1	
			Filinia terminalis				1
			Filinia australiensis			1	
		Floscullariidae	*Sinantherina procera*				
		Hexarthridae	*Hexarthra intermedia*			1	
			Hexarthra mira			1	
	Ploimida	Asplanchnidae	*Asplanchna* sp.		1		
		Brachionidae	*Brachionus angularis*				
			Brachionus plicatilis s.l.				1
			Brachionus urceolaris s.l.			1	
			Brachionus sp.		1		
			Keratella australis			1	
		Dicranophoridae	*Dicranophorus epicharis*			1	
		Lecanidae	*Lecane bulla*			1	
			Lecane hamata		1		
			Lecane ludwigii			1	
			Lecane luna			1	
			Lecane halsei			1	
		Notommatidae	*Cephalodella megalocephala*			1	
			Cephalodella sp. nov. a (Logue) (SAP)*				
Aphanoneura	-	-	Aphanoneura				
Oligochaeta	Tubificida	Naididae	*Chaetogaster diastrophus*		1		
			*Ainudrilus angustivasa**		1		
			Naididae (ex Tubificidae)	1			
Arachnida	Acariformes	Eylaidae	*Eylais* sp.		1		
		Pionidae	*Acercella* sp.		1		
		Arrenuridae	*Arrenurus balladoniensis*		1		

Class	Order	Family	Lowest ID	Oct 1997	Oct 1999	Nov 2000	Oct 2002
Arachnida	Parasitiformes	-	*Mesostigmata*				
Crustacea	Cladocera	Chydoridae	*Alona cambouei*				
			Alona rigidicaudis		1		
			Alona setigera				
			Alona sp.			1	
			Alona sp. nov. e (nr. *pulchella*) (SAP)*		1		
			Chydorus sphaericus				
			Leberis diaphana iheringi			1	
			Leydigia sp.				
			Leydigia cf. *leydigii* (SAP)		1		
			Pleuroxus inermis		1		
			Pleuroxus cf. *foveatus* (SAP)				
			Rak cf. *labrosus* (SAP)		1		
			Pseudomonospilus diporus				
			Armatalona macrocopa				
		Daphniidae	*Ceriodaphnia* n. sp. b (Berner sp.#2) (SAP)		1		
			Daphnia carinata	1			
			Daphnia cf. *cephalata*		1		
			Daphniopsis wardi				1
		Ilyocryptidae	*Ilyocryptus smirnovi*			1	
		Macrothricidae	*Macrothrix breviseta*			1	
			Macrothrix cf. *breviseta* (SAP)		1		
		Moinidae	*Moina micrura* s.l.		1	1	
		Neothricidae	*Neothrix armata*				
	Ostracoda	Ilyocyprididae	*Ilyocypris* '*spiculata*' (ms name) (SAP)	1	1	1	
		Cyprididae	*Alboa worooa*	1			
			Bennelongia australis	1			
			Bennelongia barangaroo		1		
			Bennelongia sp.				
			Candonocypris novaezelandiae	1	1	1	
			Mytilocypris mytiloides				
			Zonocypretta kalimna			1	
			Cypricercus salinus		1		
			Caboncypris nunkeri	1			
		Cypridopsidae	*Sarscypridopsis aculeata*	1	1	1	1
	Copepoda	Centropagidae	*Boeckella triarticulata*	1	1		1
			Calamoecia ampulla	1			
			Calamoecia sp.				

Class	Order	Family	Lowest ID	Oct 1997	Oct 1999	Nov 2000	Oct 2002
Crustacea	Copepoda	Centropagidae	*Calamoecia* sp. 342 (*ampulla* variant) (CB)		1	1	
		Cyclopidae	*Microcyclops varicans*		1		
			Metacyclops sp. 442 (*salinarum* in Morton) (CB)			1	1
			Metacyclops sp. 462 (SAP)	1			
			Australocyclops australis		1		
			Mesocyclops brooksi		1	1	
			Eucyclops australiensis			1	
			Apocyclops dengizicus				1
	Amphipoda	Ceinidae	*Austrochiltonia subtenuis*	1	1	1	1
Insecta	Coleoptera	Dytiscidae	*Allodessus bistrigatus*	1	1		
			Liodessus inornatus		1		
			Antiporus gilberti		1		
			Sternopriscus multimaculatus		1	1	
			Necterosoma penicillatus				
			Platynectes sp.				
			Cybister tripunctatus			1	
		Hydrophilidae	*Berosus munitipennis*	1			
			Berosus sp.		1		1
	Diptera	Culicidae	*Anopheles annulipes* s.l.	1	1		
		Ceratopogonidae	*Bezzia* sp. 1 (SAP)			1	
			Culicoides sp.				
			Nilobezzia sp. 1 (SAP)	1		1	
			Atrichopogon sp. 3 (SAP)		1		
		Stratiomyidae	Stratiomyidae		1	1	
		Dolichopodidae	Dolichopodidae	1			
		Syrphidae	Syrphidae		1		
		Ephydridae	Ephydridae sp. 3 (SAP)	1			
		Chironomidae	*Coelopynia pruinosa*				
			Procladius paludicola	1		1	1
			Ablabesmyia notabilis		1		
			Paramerina levidensis		1	1	
			Cricotopus albitarsus		1		
			Orthocladiinae				
			Tanytarsus fuscithorax/semibarbitarsus	1			1
			Tanytarsus sp. C (bispinosus) (SAP)				
			Paratanytarsus sp. B (SAP)		1		
			Chironomus occidentalis	1			
			Dicrotendipes conjunctus		1		

Class	Order	Family	Lowest ID	Oct 1997	Oct 1999	Nov 2000	Oct 2002
Insecta	Diptera	Chironomidae	*Dicrotendipes jobetus*		1	1	
			Dicrotendipes 'CA1' wheatbelt (was *lindae*) (SAP)			1	
			Kiefferulus intertinctus			1	
			Polypedilum nubifer		1	1	
			Cryptochironomus griseidorsum		1	1	
			Cladopelma curtivalva	1			
	Hemiptera	Saldidae	Saldidae	1			
		Corixidae	*Agraptocorixa eurynome*		1		
			Agraptocorixa hirtifrons	1	1	1	
			Micronecta robusta		1	1	
			Micronecta gracilis		1		
			Micronecta sp.				1
			Corixidae				
		Notonectidae	*Anisops thienemanni*		1	1	
			Anisops hyperion	1		1	
			Anisops gratus	1		1	
	Odonata	Coenagrionidae	*Ischnura aurora aurora*				
			Xanthagrion erythroneurum			1	
		Lestidae	*Austrolestes annulosus*	1			
		Aeshnidae	*Hemianax papuensis*		1		
		Libellulidae	*Orthetrum caledonicum*				
		Hemicorduliidae	*Hemicordulia tau*				
	Trichoptera	Ecnomidae	*Ecnomus pansus/turgidus*			1	
		Leptoceridae	*Oecetis* sp.			1	
			Triplectides australis		1		
			Leptoceridae				

Shading indicates microinvertebrates.
* Indicates organism only ever sampled from Lake Logue.
The SAP sample each consisted of a 50 m benthic sweep using a net with 250 µm mesh plus a 50 m plankton sample using a net with 50 µm mesh.
1 = presence indicated