Department of
Environment and Conservation

Our environment, our future

Resource Condition Report for Significant Western Australian Wetland

Coyrecup Lake

2009

Figure 1 – A view across the water body at Coyrecup Lake.

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Contents

1. Introduction

The current report considers the ecological character and condition of Coyrecup Lake, a near-permanent saline lake near Katanning in the South West of Australia. Coyrecup Lake is situated in a riverine floodplain with many smaller lakes and areas of saline marshes to its northwest and east, in the upper part of the Coblinine River drainage system.

Coyrecup Lake was selected as a study site in the current project due to its status as a Directory of Important Wetlands in Australia (DIWA) listed wetland (Environment Australia 2001). At times, the lake serves as a major drought refuge area for waterfowl in southwestern Australia. It also provides habitat for migrating waterbirds and the threatened Freckled Duck.

1.1. Site Code

Directory of Important Wetlands in Australia: WA001.

Register of the National Estate Place File No: 5/01/077/0003.

Inland Aquatic Integrity Resource Condition Monitoring Project: RCM036.

Salinity Action Plan Wetland Monitoring Program (DEC): SPM004.

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

Waterbirds in Nature Reserves of South-West WA (DEC/RAOU): CALMWNRSWA_79_1.

South West Wetlands Monitoring Program (DEC): SWWMP_COYR.

1.2. Purpose of Resource Condition Report

This Resource Condition Report (RCR) was prepared by the Inland Aquatic Integrity Resource Condition Monitoring (IAI RCM) project. The objective of the RCR is to set a benchmark against which future measures of condition can be assessed. This will allow the effectiveness of management planning and actions to be gauged. The report provides a summary of all available ecological information relevant to the site and describes the key drivers of, and threats to, the system. It provides a 'snapshot' of ecological character in 2008 that provides context for future monitoring of the site.

1.3. Objectives of the Resource Condition Report

The objective of the RCR is to produce a comprehensive description of the ecology of Coyrecup Lake that:

- describes critical components, processes and values of the wetland;
- identifies threats to the components and processes that support the wetland; and
- where possible, sets resource condition targets for key components of the wetland's ecology.

1.4. Relevant Legislation and Policy

This section provides a brief summary of the legislation and policy that are relevant to the management of Coyrecup Lake.

International

Migratory bird bilateral agreements and conventions

Australia is party to a number of bilateral agreements, initiatives and conventions for the conservation of migratory birds that may be relevant to Coyrecup Lake. The bilateral agreements are:

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; and

The Bonn Convention on Migratory Species (CMS) - 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 central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. These are defined in the Act as matters of national environmental significance.

There seven matters of national environmental significance to which the EPBC Act applies. Of these, three apply to Coyrecup Lake:

- national heritage places;
- nationally threatened species and ecological communities; and
- migratory species listed under international treaties JAMBA, CAMBA and CMS.

The EPBC Act regulates actions that will have or are likely to have a significant impact on any matter of national environmental significance. Such actions are subject to environmental assessment and approval under the EPBC Act. An 'action' includes a project, a development, an undertaking, or an activity or series of activities (http://www.environment.gov.au/epbc/index.html).

Australian Heritage Council Act 2003

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

Western Australian state policy

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, and establishes offences and penalties for 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 deals with the protection of flora and fauna within reserve systems.

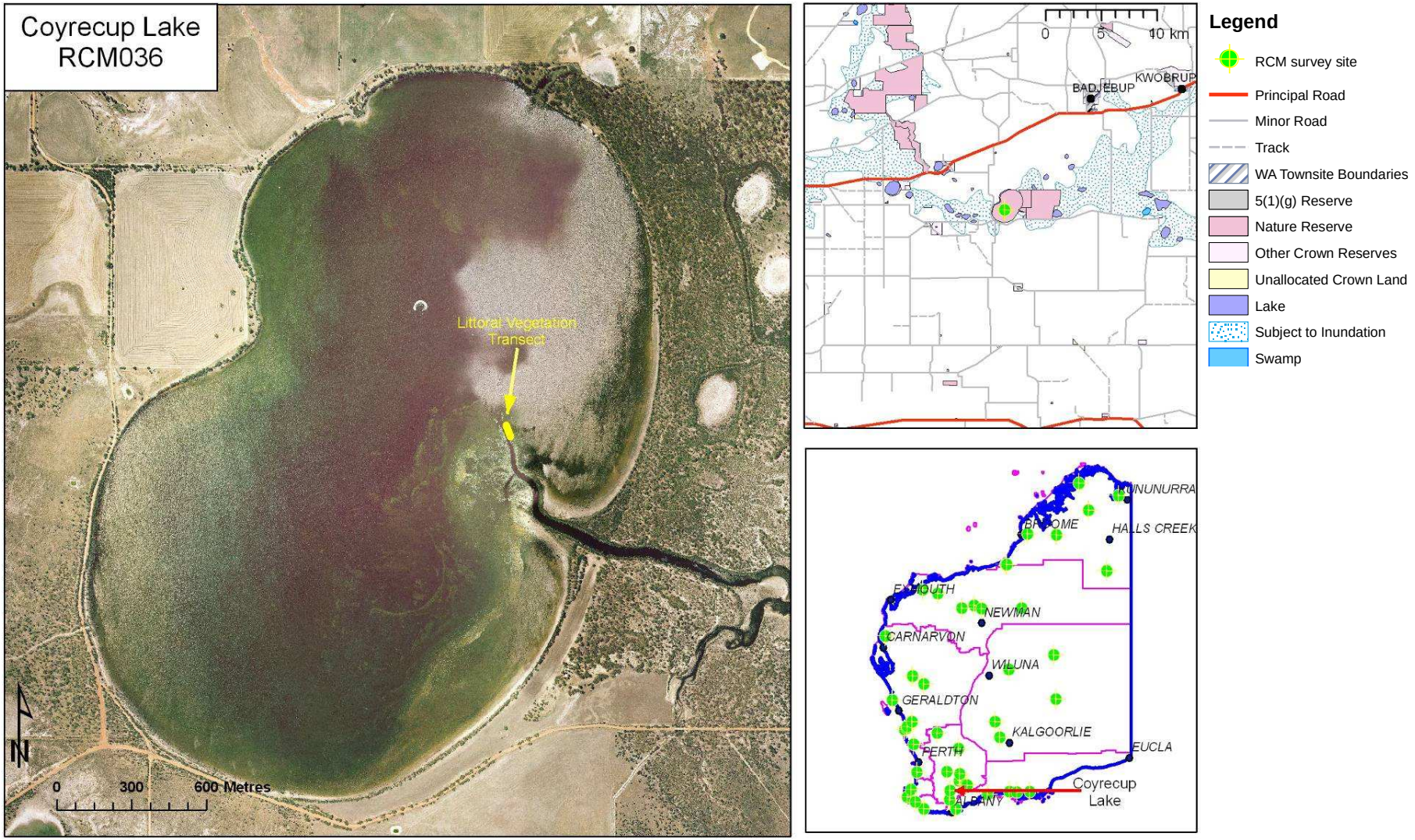

Figure 2 – Aerial photograph showing the location of the vegetation transect at Coyrecup Lake. Aquatic invertebrates and water quality were sampled adjacent to the transect. The insets on the right show the location of the lake in the state of Western Australia and in relation to other RCM sampling sites.

2. Overview of Coyrecup Lake

2.1. Location and Cadastral Information

Coyrecup Lake lies approximately 25 km east of Katanning, south of Katanning-Nyabing Road. The lake is contained within Coyrecup Nature Reserve (Class A, 28552), which was gazetted for the purpose of fauna and flora conservation and recreation (Figure 2).

2.2. IBRA Region

Coyrecup Lake lies within the western subregion of the Avon Wheatbelt Interim Bioregionalisation of Australia (IBRA) region. This region is a dissected plateau of Tertiary laterite in the Yilgarn Craton. The western subregion comprises gently undulating rises to low hills with abrupt breakaways. The vegetation consists primarily of proteaceous scrubheaths, rich in endemic species (Beecham 2003).

2.3. Climate

The nearest Bureau of Meteorology weather station to Coyrecup Lake is at Katanning. Records have been kept at Katanning since 1891. Weather conditions at Coyrecup Lake are not expected to differ appreciably from those at Katanning.

Katanning experiences a semi-arid warm Mediterranean climate. It receives a mean annual rainfall of 479 mm with approximately 58% falling between May and August (Figure 3). Annual evaporation at Katanning is c. 1,470 mm.

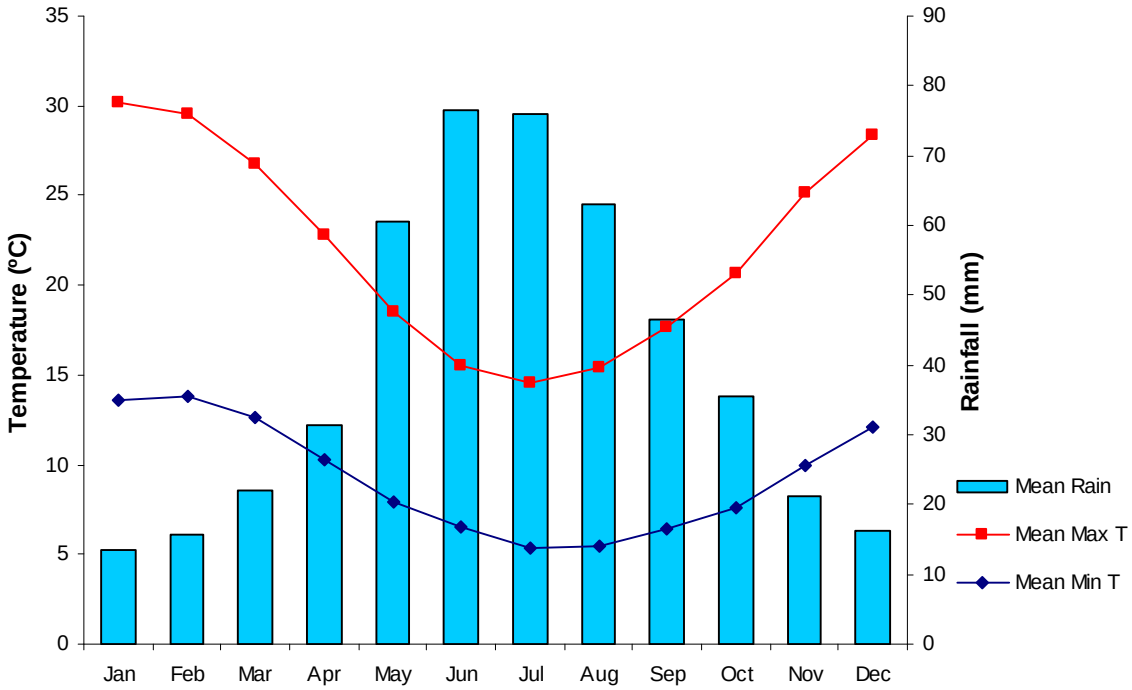

Figure 3 – Climatic averages for Katanning, approximately 25 km west of Coyrecup Lake.

Coyrecup Lake was sampled on the 10th of November 2008. In the eleven months preceding the IAI RCM survey (Dec 2007 – Nov 2008), Katanning received 474.2 mm of rain. The majority of this fell between April and July.

2.4. Wetland Type

Coyrecup Lake is a permanent saline or brackish lake (type B7 in the Directory of Important Wetlands in Australia) and channel and basin seasonal marshes (type B12 in the Directory of Important Wetlands in Australia) to the east, which are connected to the lake by a river-like channel. Coyrecup Lake is a macroscale irregular sumpland with surrounding microscale linear channels and microscale to mesoscale ovoid and irregular sumplands. Low islands for roosting by waterbirds were constructed in the east of Coyrecup Lake in 1980 (Jaensch 1992).

2.5. Directory of Important Wetlands in Australia Criteria

Coyrecup Lake is designated as a wetland of national importance under criteria 2, 3, 4 and 6 of the Directory of Important Wetlands in Australia. These criteria are as follows:

- Criterion 2: It is a wetland that plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.

  *The lake is an internationally important stop-over area for Great Egret (*Ardea alba*), Common Greenshank (*Tringa nebularia*), Common Sandpiper (*Tringa hypoleucos*), Curlew Sandpiper (*Calidris ferruginea*) and Red-necked Stint (*Calidris ruficollis*).*

- Criterion 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.

  It is a significant drought refuge area for waterbirds in the bioregion, and is a breeding area for at least five species of waterbirds.

- Criterion 4: The wetland supports 1% or more of the national populations of any native plant or animal taxa.

  *It has been known to support over 1% of the national population of Freckled Duck (*Stictonetta naevosa*).*

- Criterion 6: The wetland is of outstanding historical or cultural significance.

  Coyrecup Lake is valued by the local community and is presently used as a recreation area.

2.6. Values of Coyrecup Lake

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 that outcome. 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 these products going through a market place, for example, the collection and personal use of firewood or 'bushtucker'. While Coyrecup Lake is likely to have been used historically by local Aboriginal people, the lake supports no known consumptive use values 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 be

exchanged for money or another commodity. While Coyrecup Lake is likely to have been used historically by local Aboriginal people, the lake supports no productive use values in the present day.

c. Opportunities for future use

Not all uses of the natural environment may be apparent at present. The potential for future benefit from the natural environment is maximised by maintaining the greatest possible biodiversity. Every lost taxa or ecosystem represents lost opportunities. Coyrecup Lake may support endemic or rare taxa. Such unique features would increase the potential for future opportunities to present.

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. Coyrecup Lake serves as a major drought refuge for waterbirds in southwestern Australia.

e. Amenity

Amenity describes features of the natural environment that make life more pleasant for people. For instance, pleasant views and shade or wind shelter from a stand of trees. It is difficult to quantify the amenity value of a site such as Coyrecup Lake, 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 the changes that have occurred to the natural world. They can also be considered 'control' sites that allow us to benchmark other, altered habitats. Coyrecup Lake has been included in a number of research projects. As part of the State Salinity Strategy, the wetland has received ongoing, regular monitoring of salinity, depth, water quality, waterbirds and aquatic invertebrates with vegetation surveys also conducted. Coyrecup Lake has also been included in additional waterbird surveys conducted by the Royal Australasian Ornithologists Union (RAOU, now Birds Australia) and the Department of Conservation and Land Management (CALM, now DEC).

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. Coyrecup Lake is used by the local community as a recreation site. The lake is regularly used for water skiing when water level is adequate and was formerly very popular for recreational duck shooting, which is now banned in WA (Madden 1995). Today, the lake is used for passive bird watching and nature appreciation.

h. Spiritual/philosophical values

People's spiritual and philosophical reasons for valuing the 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 that is independent of any benefit delivered to humans. A sense of spiritual well-being may be derived from the knowledge of healthy environments, even if the individual has no contact with them.

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. Interactions between Ecological Components at Coyrecup Lake

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 Coyrecup Lake are:

- the contribution the site makes to the ecological or hydrological functioning of the wetland system/complex;
- 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 plant or animal taxa that have more than 1% of their national populations supported by the site; and
- the site's outstanding historical and cultural significance.

Table 1 summarises the interactions between key components and processes at Coyrecup Lake. 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 1 – The relationship between the services and benefits delivered by Coyrecup Lake 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 Food sources	Habitat extent and distribution Hydrological regime Water quality	Altered water regime Salinisation Excessive nutrient inputs from surrounding land use Weeds Erosion Predation by introduced fauna Inappropriate recreation
Ecosystem Service Value It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex	Migrating Great Egrets, Common Greenshanks, Common Sandpipers, Curlew Sandpipers and Red-necked Stints	Invertebrate populations (food source) Benthic plants and algae (food source) Vegetation communities (habitat)	Water regime Nutrient concentrations Water salinity and pH Habitat extent and distribution	Altered water regime Salinisation Excessive nutrient inputs from surrounding land use Weeds Erosion Predation by introduced fauna Inappropriate recreation Loss of migratory bird populations due to offsite factors
Ecosystem Service Value It is a wetland which 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	Waterbirds that utilise the site as a drought refuge	Invertebrate populations (food source) Benthic plants and algae (food source) Vegetation communities (habitat)	Water regime Nutrient concentrations Water salinity and pH	Altered water regime Salinisation Excessive nutrient inputs from surrounding land use Weeds Erosion Predation by introduced fauna Inappropriate recreation

Benefit or Service	Component	Factors Influencing Component		Threats and Threatening Activities
		Biotic	**Abiotic**	
Ecosystem Service Value The wetland supports 1% or more of the national populations of any native plant or animal taxa	Freckled Duck	Aquatic invertebrate populations (food source) Vegetation communities (habitat) Benthic plants and algae (food source)	Water regime (prefer permanent water) Nutrient concentrations Water salinity and pH Habitat extent and distribution	Altered water regime Salinisation Excessive nutrient inputs from surrounding land use Weeds Erosion Predation by introduced fauna Inappropriate recreation
Recreational Value Bird watching Picnicking Waterskiing Canoeing Bush walking	Landscape amenity Waterbird populations Vegetation communities Significant flora Significant fauna	Aquatic invertebrate populations Vegetation communities Benthic plants and algae	Hydrological regime (inc. water depth) Geomorphology Soils and sediments Water quality Habitat extent and distribution	Altered water regime Salinisation Excessive nutrient inputs from surrounding land use Weeds Erosion Predation by introduced fauna Loss of migratory bird populations due to offsite factors
Cultural/Spiritual Value The wetland is of outstanding historical or cultural significance	Recreational value	As above	As above	As above

4. Critical Components and Processes of the Ecology of Coyrecup Lake

The primary objective of the Coyrecup Lake RCR is to identify, describe and quantify 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 addressed 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 Coyrecup Lake's critical ecosystem components is presented in Table 2, followed by a detailed description of the results of the IAI RCM 2008 survey as well as of any previous studies conducted on the wetland.

Table 2 – Summary of critical ecosystem components at Coyrecup Lake.

Component	Summary Description
Geomorphology	Macroscale irregular sumpland situated in the Yilgarn Craton, in a riverine floodplain (alluvial valley-fill deposits) a few km wide, within broadly undulating upland.
Hydrology	Inflow via a poorly defined watercourse originating 20 plus km northeast and east, from Little Creek originating 15 km south, and from a creek originating 3 km north; catchments have been extensively cleared
Water Quality	Secondarily saline, poikilohaline; some nutrient enrichment
Benthic Plants	*Ruppia polycarpa* and algae (*Chara* sp.)
Littoral Vegetation	Low samphire shrubland, and low *Melaleuca* open forest and closed scrub; extensive tree death
Invertebrates	Total of seventy taxa recorded; eight families collected by RCM
Fish	None seen
Birds	Thirty-four species of waterbirds have been recorded, including twelve ducks and allies.

4.1. Geology and Soils

Coyrecup Lake overlies gneiss and granite of the Yilgarn Craton, in a riverine floodplain a few kilometres wide, within a broadly undulating upland (Jaensch 1992). The lake lies on Quaternary and Cainozoic alluvial and lacustrine deposits are common on the valley floors. These deposits consist of highly variable layers of sand, silt and clay (DAg 2001).

Soil landscape mapping identifies Coyrecup Lake as belonging to the Avon province, of which the broad alluvial plains of the Coblinine River and its tributaries are a central feature. The soils are predominantly deep and shallow sandy duplex with a large proportion of subsoil being alkaline and sodic. Saline wet soil, alkaline grey shallow loamy duplex and duplex sandy gravels are also common. The broad valleys of the Coblinine System incorporate the Coblinine River, Coyrecup Lake, Ewlyamartup Lake and associated wetlands (DAg 2001).

4.2. Hydrology

Coyrecup Lake is located on the Blackwood River Basin within the extensively cleared Hardy Estuary-Coblinine River Catchment. The area's hydrology is greatly influenced by the relatively low rainfall, subdued landscape and relatively deep weathering profile (20-60 m to bedrock). Annual surface run-off is about 20 mm, which is 4% of the annual rainfall (George and Bennett 1998). The low run-off rate is due to a combination of the gentle slopes, sandy surfaced soils and sluggish drainage. With the exception of the occasional summer thunderstorm, water only flows in drainage lines during winter. In most years, the broad valley

floors act as a sump for both run-off and salts, which accumulate in lakes and swampy depressions (DAg 2001).

There are relatively low rates of groundwater recharge in the area because of the low rainfall. However, recharge has increased dramatically, from less than 0.2 mm per year before clearing, to the current 10 to 50 mm per year (George and Bennett 1998). Groundwater recharge occurs throughout the landscape, with major contributions coming via gravelly and sandy soils on the broad hill crests and divides. Valley floors are also a major area of groundwater recharge (when discharge is not occurring) (DAg 2001).

Inflow to Coyrecup Lake occurs via a poorly defined watercourse originating over 20 km northeast and east, from Little Creek originating 15 km south, and from a creek originating 3 km north (Jaensch 1992).

The lake is near-permanent and dries for several months in approximately a one in three year event. Water depth may reach 3 m when overflowing but averages approximately 1.7 m in September (Jaensch 1992).

4.3. Water Quality

The water quality of Coyrecup Lake has been extensively surveyed by DEC (Table 1) and therefore a comprehensive dataset is available over a ten year time scale for interpretation of changes in water quality. The lake is secondarily saline and now less seasonal in water permanence than it would once have been. Salinity varies greatly with depth; it is almost fresh when full but hypersaline when water levels are low. Salinity does not seem to be increasing. Nutrient concentrations indicate some enrichment of Coyrecup Lake from surrounding farmland and chlorophyll concentrations are sometimes quite high. The total phosphorus concentration of 750 µg/L is extremely high and should be viewed with caution.

Table 3 – Water parameters at Coyrecup Lake as sampled by the Salinity Action Plan and by the Inland Aquatic Integrity Resource Condition Monitoring projects.

Project	Salinity Action Plan Monitoring																				
Date	Oct 97				Aug 99	Oct 99	Mar 00		Aug 01	Nov 01		Aug 03	Oct 03		Aug 05	Oct 05		Mar 06	Aug 07	Oct 07	
Sample	A1	A2	B1	B2	A	A	B	A	A	A	B	A	A	B	A	A	B	A	A	A	B
pH	9.05	9.03	9.27	9.27	9.15	9.51	8.8	7.48	9.02	7.9	7.9	8.75	8.07	8.04	7.61	7.87	7.92	10.05		7.6	
Alkalinity (mg/L)	130					113				255			155			135				205	
TDS (g/L)	40.9					42				100			30			5.9				70	
Turbidity (NTU)	6.1					16				6.9			0.4			5.1				1.3	
Colour (TCU)	24					20				22			25			150				46	
Total nitrogen (µg/L)																					
Total phosphorus (µg/L)																					
Total soluble nitrogen (µg/L)	2,700	2,700	2,800	2,800	2,600	3,000	3,100	11,000	2,400	7,000	7,200	3,100	2,500	2,500	5,800	4,200	2,800	3,500	7,100	5,700	8,4
Total soluble phosphorus (µg/L)	20	20	20	20	20	20	20	110	5	30	30	5	5	5	40	20	80	10	40	20	75
Chlorophyll (µg/L)		1	1	2	4.5	5.5	3	12.5	5	10	8	6.5	10.5	7.5	31	2.5	3	3.5	46	6.5	19.
Na (mg/L)	11,000					11,800				30,200			8,370			1,500				22,000	
Mg (mg/L)	1,800					1,950				4,860			1,400			230				3,820	
Ca (mg/L)	850					1,080				2,450			1,060			172				1,430	
K (mg/L)	86					107				328			69.3			16.6				213	
Cl (mg/L)	24,000					23,000				64,000			16,000			2,800				37,200	
SO4 (mg/L)	3,000					3,720				10,600			3,260			471				7,510	
HCO3 (mg/L)	160					88				311			189			165				250	
CO3 (mg/L)	1					24				1			1			1				0.5	

4.4. Benthic Plants

Ruppia polycarpa and algae (*Chara* sp.) formed a dense aquatic vegetative layer across the channel that drains into Coyrecup Lake. Macrophytes constituted approximately 20% cover in the inlet.

4.5. Littoral Vegetation

Coyrecup Lake is situated in the Dumbleyung Vegetation System within the South-west Botanical Province. This Vegetation System is gently undulating country with residual laterite capping, with salt flats and lakes occupying the principal valleys (DAg 2001). The main vegetation associations are:

- dryandra heath with blue, brown and silver mallee (*Eucalyptus gardneri*, *E. astringens*, and *E. falcata*) woodland on residual laterite areas;
- woodland of York gum (*E. loxophleba*), morrel (*E. longicornis*), salmon gum (*E. salmonophloia*) and wandoo (*E. wandoo*) on undulating country;
- small patches of mallee including sand mallee (*E. eremophila*), black marlock (*E. redunca*) and lerp mallee (*E. incrassata*); and
- tea-tree and samphire on salt flats, scrub-heath and low woodland on low sandplain.

The vegetation of Coyrecup Lake consists primarily of extensive low shrubland (samphire species) and low open forest and closed scrub. Coyrecup Lake lies within the Wheatbelt, where extensive clearing of native vegetation has occurred. Where remnant vegetation exists (usually in reserves), it is composed of open woodland (Jaensch 1992). The samphires are dominated by *Halosarcia pergranulata*, with *H. lepidosperma* and *Sarcocornia quinqueflora*. The closed scrub (thickets) and low open forest that fringe the lake are dominated by *Casuarina obesa* and *Melaleuca strobophylla* (which has a restricted distribution in southwestern Australia). *Melaleuca halmaturorum* is the dominant tree species of the lake basin, with a predominantly *H. pergranulata* understorey. Dead trees occur throughout the margins of the lake and in a broad area near the channel inflow (partly on stream levees) (Jaensch 1992).

Two rare flora species are known to occur within Coyrecup Nature Reserve: *Dryandra porrecta* and *Blennospora phlegmatocarpa* (DAg 2001).

A single transect was established in the vegetation surrounding Coyrecup Lake, within 10 m of the large channel that drains into the lake on the eastern side (Table 4, Figure 4).

Figure 4 – Channel that drains into Coyrecup Lake at the point of sampling.

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

Datum		WGS84
Zone		50
Easting		577830
Northing		6269884
Length		30 m
Bearing		152
Wetland state		Drying
Soil state (%)	Dry	0
	Waterlogged	100
	Inundated	0
Substrate (%)	Bare	50
	Rock	0
	Cryptogam	0
	Litter	5
	Trash	10
	Logs	1
Time since last fire		no evidence
Community condition		Degraded
Upper Stratum	Cover (%)	44.28
	Height (m)	<5
Mid Stratum	Cover (%)	-
	Height (m)	-
Ground Cover	Cover (%)	14.9333
	Height (m)	<0.3

Transect RCM036-R1

The 50-metre transect was established within 10 m of the water's edge (Figure 5). The site was selected as one of the few areas surrounding Coyrecup Lake where some of the overstorey plants have survived. The soils were waterlogged at the time of the survey. Vegetation was dominated by *Melaleuca halmaturorum* low woodland (44.3% cover, <5 m tall) over *Sarcocornia quinqueflora*, *Disphyma crassifolium*, *Spergularia marina* low sparse shrubs and forbs (14.9% cover, <0.3 m tall). Table 5 provides a complete list of taxa recorded along the transect RCM036-R1.

It was estimated that at least 50% of *Melaleuca halmaturorum* plants were dead along the transect, with no evidence of recruitment. However, much of the vegetation directly surrounding Coyrecup Lake in nearby areas had 100% death of the overstorey (Figure 6), including *Casuarina obesa* trees. The overall community condition was considered 'degraded' (Table 9 in Appendix 1).

Figure 5 – Coyrecup Lake vegetation transect RCM036-R1.

Figure 6 – Most of the *Melaleuca* overstorey surrounding Coyrecup Lake has died; samphires now dominate.

Table 5 – Plant taxa recorded along vegetation transect RCM036-R1 (in order of stratum then dominance).

Genus	Species	Height (m)	Stratum[1]	Form
Melaleuca	*halmaturorum*	5	U1	Tree
Sarcocornia	*quinqueflora*	0.3	G1	Chenopod
Disphyma	*crassifolium*	0.1	G1	Forb
**Spergularia*	*marina*	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.

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

U1+ ^*Melaleuca halmaturorum*\tree\6\i; G1 ^*Sarcocornia quinqueflora*, *Disphyma crassifolium*, **Spergularia marina*\samphire shrub, shrub\1\r.

4.6. Aquatic Invertebrates

A total of seventy taxa have been recorded from Coyrecup Lake over the past eleven years (Table 6, Table 11), largely as a result of biennial monitoring carried out as part of the State Salinity Strategy (see Cale *et al*. 2004). These are a combination of salt-tolerant freshwater species and species that prefer saline conditions (halophiles). Most samples contain about half macroinvertebrates and half microinvertebrates. Species richness on any one date largely reflects salinity. Therefore, richness was highest in October 2005 when the lake was full and had low salinity, and lowest in November 2001 when salinity was high (100 g/L). In October 2005, a range of more salt-sensitive species colonised the wetland such as the caddisflies *Notalina spira* and *Triplectides australicusi*, and ostracod *Alboa wooroa*. The eight macroinvertebrate families recorded during the Resource Condition Monitoring project concurs with expectations for a wetland with salinity of 34 g/L. All recorded species are widely distributed in southwestern Australia or more broadly throughout Western Australia.

Table 6 – Aquatic invertebrate diversity at Coyrecup Lake as measured by the Salinity Action Plan Monitoring and Inland Aquatic Integrity Resource Condition Monitoring projects.

	SPM004												RCM036
	Oct 97				Oct 99		Nov 01		Oct 03		Oct 05		Nov 08
Diversity measure	A1	A2	B1	B2	A	B	A	B	A	B	A	B	
Total invertebrate species richness	17	14	16	17	18	19	9	7	15	13	35	37	-
Macroinvertebrate species richness	9	6	8	8	8	9	4	4	8	6	23	27	-
Total invertebrate family richness	13	11	12	17	14	14	7	7	11	9	23	26	8
Macroinvertebrate family richness	8	6	7	12	8	9	4	4	7	5	15	17	8

4.7. Fish

No fish were observed during the IAI RCM survey in 2008.

4.8. Waterbirds

Coyrecup Lake regularly supports large numbers of waterbirds, often numbering in tens of thousands. Species that are particularly abundant at the wetland include Grey Teal, Pink-eared Duck and Pacific Black Duck. The site is also regionally significant for Maned Duck (Jaensch 1992). Significant species found at Coyrecup Lake include Freckled Duck, the most endangered waterfowl species in Australia, and Blue-billed Duck, which normally occur on fresh to brackish water (Jaensch 1992). At least five species of waterbirds have been found breeding at the lake (Jaensch *et al.* 1988).

The wetland has been extensively surveyed by the Department of Conservation and Land Management (CALM, now DEC) and the Royal Australasian Ornithologists Union (RAOU, now Birds Australia) as part of the Waterbirds in Nature Reserves of South-West Western Australia (WNRSSWA) project in October 1984 (Jaensch *et al.* 1988) and the Waterfowl Counts in the South-West Western Australia (WCSWWA) project (Halse *et al.* 1990; Halse *et al.* 1992; Halse *et al.* 1994; Halse *et al.* 1995), which ran from 1989 to 1992. Coyrecup Lake has also been included in DEC's ongoing Salinity Action Plan Wetland Monitoring Program (Cale *et al.* 2004), which commenced in 1997.

These projects collectively recorded a total of at least forty-one species of waterbirds at Coyrecup Lake (Table 7). This includes five species protected under international agreement for the protection of migratory birds (see section 1.4). All three of the species observed during the IAI RCM survey in 2008 had previously been recorded at the lake. The skeleton of an Australian Pelican (*Pelecanus conspicillatus*) was also found on the shore adjacent to the sampling site. Pelicans have not been previously observed at Coyrecup Lake, although this is certainly not an unusual occurrence for the area (D. Cale, pers. comm.).

Table 7 – Waterbirds observed at Coyrecup Lake (numbers indicate maximum abundance recorded).

Organisation/Project Duration of project		**RAOU WNRSWA 1982-1987**	**RAOU/DEC WCSWWA 1988-1992**	**DEC/SPM 1997-ongoing**	**DEC/RCM 10/11/2008**
Common name	**Latin name**				
Australasian Grebe	*Tachybaptus novaehollandiae*	31			
Australasian Shoveler	*Anas rhynchotis*	170	450	5	
Australian Wood Duck	*Chenonetta jubata*	540	102	3	
^ Australian Shelduck	*Tadorna tadornoides*	1,200	4,876	1,510	20
Australian White Ibis	*Threskiornis molucca*			1	
Banded Stilt	*Cladorhynchus leucocephalus*	50		148	
Black-fronted Dotterel	*Elseyornis melanops*	20			
Black-winged Stilt	*Himantopus himantopus*	80		66	
Black-tailed Native Hen	*Gallinula ventralis*	8			
^ Black Swan	*Cygnus atratus*	1,100	1,237	99	
Blue-billed Duck	*Oxyura australis*	55	62		
Chestnut Teal	*Anas castanea*	2	40	20	
Clamorous Reed-Warbler	*Acrocephalus stentoreus*	6			
* Common Greenshank	*Tringa nebularia*			1	
* Common Sandpiper	*Tringa hypoleucos*	3		1	
* Curlew Sandpiper	*Calidris ferruginea*			1	
^ Eurasian Coot	*Fulica atra*	500	2,000	194	

Organisation/Project Duration of project		RAOU WNRSWA 1982-1987	RAOU/DEC WCSWWA 1988-1992	DEC/SPM 1997-ongoing	DEC/RCM 10/11/2008
Common name	**Latin name**				
Exotic Waterfowl		6			
Freckled Duck	*Stictonetta naevosa*	4	5	121	
Great Cormorant	*Phalacrocorax carbo*	2			
Great Crested Grebe	*Podiceps cristatus*	1			
* Great Egret	*Ardea alba*	2			
^ Grey Teal	*Anas gracilis*	2,680	13,972	4,296	20
Hardhead	*Aytha australis*	7	150	6	
Hoary-headed Grebe	*Poliocephalus poliocephalus*	423		231	
Hooded Plover	*Thinornis rubricollis*			4	
Little Grassbird	*Megalurus gramineus*	4			
Little Pied Cormorant	*Phalacrocorax melanoleucos*	5		1	
Musk Duck	*Biziura lobata*	33	6	2	
Nankeen Night Heron	*Nycticorax caledonicus*	1			
Pacific Black Duck	*Anas superciliosa*	1,900	1,400	10	
^ Pink-eared Duck	*Malacorhynchus membranaceus*	200	6,393	689	
Red-capped Plover	*Charadrius ruficapillus*	30		275	
Red-necked Avocet	*Recurvirostra novaehollandiae*	4		8	
* Red-necked Stint	*Calidris ruficollis*	150		109	
Silver Gull	*Larus novaehollandiae*	12		50	4
Straw-necked Ibis	*Threskiornis spinicollis*			1	
Swamp Harrier	*Circus approximans*	2			
Unidentified Cormorant		2			
Unidentified Duck		500			
Unidentified Grebe		30			
Unidentified Small Wader		3			
Whiskered Tern	*Chlidonias hybridus*			1	
White-faced Heron	*Egretta novaehollandiae*	20		41	
Yellow-billed Spoonbill	*Platalea flavipes*	4		2	

* Listed under Migratory Bird Agreements JAMBA, CAMBA and/or ROKAMBA.
^ Recorded breeding.

4.9. Terrestrial Vertebrates

No evidence of other terrestrial vertebrates was observed at Coyrecup Lake during the IAI RCM survey. Records from the Western Australian Museum indicate the following species have been collected form within 5 km of the lake: Clawless Gecko (*Crenadactylus ocellatus*), Wheat-belt Stone Gecko (*Diplodactylus granariensis*), Southern Pale-flecked Morethia (*Morethia obscura*) and Dwarf Bearded Dragon (*Pogona minor*). The major species of mammals present in the Blackwood catchment are the western grey kangaroo (*Macropus fuliginosus*), and the introduced fox (*Vulpes vulpes*) and rabbit (*Oryctolagus cuniculus*). The major reptile species in the area is the bobtail skink (*Tiliqua rugosa*) (DAg 2001).

5. Threats to the Ecology of Coyrecup Lake

The ambition for management at Coyrecup Lake is to maintain those elements of the ecology that resulted in its nomination as a DIWA site. The critical components of the ecology are the geomorphologic, hydrologic and water quality factors that make the lake a suitable stopover for migratory birds and refuge site for resident waterbirds. These factors are the primary determinants of the lake's ecological character. They are influenced by, and exert an influence on, the vegetation communities that surround the water body, the aquatic invertebrate and benthic vegetation communities that inhabit it and the threatening processes that face all of these. Also of importance are the elements of the system that contribute to its cultural and scientific value. These are the same as the above listed influences on the primary determinants of ecological character, with the addition of landscape amenity.

Threats to Coyrecup Lake must be considered in relation to their likelihood of causing failure of the above management goal for the lake. 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 8. In summary, failure to achieve the management goal for Coyrecup Lake is most likely to result due to the impacts of land clearing and the associated changes to hydrology, particularly salinisation. While disturbed hydrology is a major driver of threats to the biodiversity of Wheatbelt wetlands, it is not the only threatening factor. In particular, clearing of riparian vegetation, weed invasion, diversion of water into wetlands through deep water drainage, nutrients and pesticides frequently result in the degradation of wetland communities.

Salinity

Coyrecup Lake lies within the Wheatbelt, a region broadly defined by the area of cleared vegetation and roughly delineated by the 300 mm and 600 mm rainfall isohyets (Halse *et al.* 2003). The land surrounding the wetland system is used for cereal cropping and pastoralism (stock grazing). Most of the lakes have retained only a degraded narrow fringe (0.5 m – 1 m) of remnant bush (South Coast Rivercare). As a result, the region is now subject to secondary salinisation, the primary threat affecting wetlands of the Wheatbelt region (George *et al.* 1995; Williams 1999; Halse *et al.* 2003).

Secondary salinisation involves rising water tables as a result of clearing of native perennial vegetation. Salt that was previously stored in the soils above the water table is dissolved in groundwater. As the saline groundwater rises to the surface, a combination of waterlogging and salinity causes vegetation death (Mulcahy 1978; Ruprecht and Schofield 1991; George *et al.* 1995; Halse *et al.* 2003). The effects of secondary salinisation on aquatic habitats include increased stream and wetland salinity, increased stream flow, more prolonged periods of inundation, loss and/or changes of vegetation, altered water chemistry (including a change to almost universal NaCl-dominated ionic composition) and formation of new wetlands where water-tables intersect the land surface (Pinder *et al.* 2005). Unfortunately, measures to control secondary salinisation, including drainage and the disposal of drainage water, often bring with them their on management issues and can adversely affect wetland biodiversity (Cale et al. 2004).

The effects of salinisation are evident at Coyrecup Lake, with the vegetation exhibiting stress in the form of mortality of the fringing paperbark (*Melaleuca cuticularis*) across the lake floor. Intensive rainfall events may also be contributing to the problem. Indeed, changed hydrology, namely altered flow regimes affecting riparian vegetation, are the primary threat facing Coyrecup Lake.

Acidification

Acidic groundwater has the potential to reduce the biodiversity of wetlands in the same manner as secondary salinisation (Halse *et al.* 2003). There are several pockets of naturally acidic groundwater in the Wheatbelt and rising groundwater often leads to further acidification (Cale *et al.* 2004). At present the process is not well-documented and the buffering effect of carbonate

soils has not been quantified. However, if rising watertables bring acidic groundwater into contact with surface water and pH within the wetland declines, it is likely to affect wetland fauna (and surrounding plant communities) detrimentally. There are comparatively few salt-tolerant acidophiles. Acidic groundwater was observed at several monitoring wetlands of the Wheatbelt, including Coyrecup Lake (Cale *et al.* 2004). Several soil types occurring in the Katanning soil-landscape zone are highly susceptible to acidification (DAg 2001).

Eutrophication

Potential threats to the ecology of Coyrecup Lake may involve changes to its water quality, such as eutrophication. Although Coyrecup Lake itself is contained within a nature reserve, land use of the surrounding area includes cereal cropping and pasture grazing. The lake has only a relatively narrow buffer of native vegetation. Eutrophication of the lake is therefore a possibility. Runoff containing agricultural fertilisers and herbicides may increase the nutrient content of the lake. This seems evident from the high levels of phosphorus recorded from the water quality testing. The consequences of eutrophication include algae blooms, fish kills, a reduction in diversity of aquatic invertebrates and a loss of amenity values (Harper 1992).

Recreation

Coyrecup Lake is used by the local community for recreation, particularly for waterskiing when the lake is full. Waterskiing has the potential to cause disturbance to waterbirds and reduce the usage of the area by waterbirds. The use of motorised boats and jet skis can also introduce pollutants into the lake.

Weeds

Only one species of weed was recorded at the vegetation transect during the 2008 IAI RCM survey. However, there is potential for weed invasion, particularly given the highly cleared surroundings of the lake. The vegetation should therefore be monitored for weed incursions.

Climate Change

Climate change modelling conducted by the CSIRO predicts that rainfall received by the south-west of WA will decline by as much as 20% by 2030 and 60% by 2070, relative to 1990 figures (EPA 2007). The hydrology of Coyrecup Lake is reliant on rainfall patterns as it receives inflow from ephemeral creeks. A reduction in rainfall could therefore result in changes to the overall hydrology and ecology of the lake. However, it is difficult to predict the extent of such impacts.

Table 8 – Threat assessment for Coyrecup Lake.

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 and hydrology of Coyrecup Lake, thus ensuring it remains a suitable drought refuge and migratory stopover for waterbirds 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	50	20	The catchment has been extensively cleared for agricultural use. As is characteristic of the Wheatbelt, the hydrology of Coyrecup Lake has been altered and the wetland is affected by salinisation. Considering the expected continuation of the surrounding land use, the threat of salinity will only worsen without management intervention. Altered hydrological regime and salinisation are the major threats facing Coyrecup Lake and are evident in the death of fringing paperbark.
	Carbon cycle and climate change	10	10	Annual rainfall is expected to decline by approximately 5-10% in the Coyrecup Lake area by 2070 but more frequent heavy rainfall events are also expected. Average annual temperatures are also expected to rise across WA. It is difficult to quantify the impacts this may have on the ecology of Coyrecup Lake.
Impacts of introduced plants and animals	Environmental weeds	5	1	Only one weed was recorded at Coyrecup Lake. However, there is potential for further weed colonisation and this should be monitored.
	Herbivory, wallowing and trampling by introduced species	2	0	No impacts evident. However, feral herbivores (rabbits) and stray stock (if fences are damaged) could potentially occur at the lake.
Impacts of problem native species	Overgrazing by native species	0	0	No impacts evident.
Impacts of disease	Plant pathogens	0	0	No impacts evident.

Threat category	Management issue	Probability (%) that threat will cause goal failure with:		Assumptions underlying initial probability assessment and explanatory notes
		Existing management	Extra management	
Detrimental regimes of physical disturbance events	Fire regimes	10	5	There is no evidence of past fires at Coyrecup Lake. The fringing woodland is susceptible to fire. Too frequent fires could add to the effect of altered hydrology and salinisation by causing further tree death and limiting regeneration.
	Drought	0	0	Coyrecup Lake occurs in an area of rising water tables where increased waterlogging and prolonged residence times of flooding are an issue. Drought is unlikely to impact on Coyrecup Lake.
	Flood	5	3	Increased flooding may impact on the fringing vegetation of Coyrecup Lake by causing further tree death.
Impacts of pollution	Herbicide, pesticide or fertiliser use and direct impacts	20	5	The dominant surrounding land use for Coyrecup Lake is agriculture. The lake's hydrology is affected by surface drainage. As such, Coyrecup Lake is susceptible to excessive nutrient input and pollution.
Impacts of competing land uses	Recreation management	20	0	Coyrecup Lake is used as a designated waterskiing area as well as for passive recreation. Waterskiing may disturb waterbirds and pollute the water. Inappropriate recreational use, such as off-track driving, may cause the loss of vegetation and soil erosion.
	Nutrient enrichment of water body	20	5	Nutrient enrichment may result from pollution from surrounding agricultural areas.
	Urban and industrial development	0	0	Land surrounding Coyrecup Lake is already extensively cleared for use by agriculture. It is unlikely further development would occur.
	Consumptive uses	0	0	There are no known consumptive uses of Coyrecup Lake
	Illegal activities	0	0	No evidence of any threat.
	Mines and quarries	0	0	No mineral potential.
Insufficient ecological resources to maintain viable populations	Habitat, genetic exchange	1	1	Although the area surrounding Coyrecup Lake is extensively cleared, the lake retains some connectivity with near-natural environment. Populations are likely to be 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

Coyrecup Lake is currently included in a long-term monitoring project as part of the Salinity Action Plan (SAP), which commenced in 1999. Data are collected on water quality, water depth, aquatic invertebrates and waterbirds on a regular basis. The information available on these aspects of the lake's ecology is therefore comprehensive. However, detailed information on the hydrology of Coyrecup Lake is limited, particularly in relation to groundwater interactions. This information is particularly valuable as threats to the wetland include rising water tables and alterations to its hydrology caused by climate change.

Salinisation and eutrophication of surface water are also threats affecting the Coyrecup Lake. The effects of these threatening processes should be monitored, if possible. The most appropriate way of doing so is by recording any changes to wetland extent. Coyrecup Lake Pleasant View has been delineated and mapped by DEC and is included in the Wheatbelt wetlands GIS layer. This information should be reviewed periodically. Changes to vegetation should also be monitored for this reason. Vegetation is currently not surveyed as part of the SAP monitoring.

It is recommended that the IAI RCM survey be expanded into long-term monitoring. There is scope for the IAI RCM methodology to be adjusted to complement SAP monitoring. Vegetation surveys could be timed to correlate with SAP monitoring, thus complementing the data already available to provide a more complete dataset and overview of Coyrecup Lake's ecology.

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Appendix 1 – Vegetation condition

Table 9 – Overall Vegetation Community Condition Rating as adapted from Thackway and Lesslie (2005). Shading indicates the condition of Coyrecup Lake.

Overall Community Condition Rating					
	0	1	2	3	4
	RESIDUAL BARE	**NATURAL**	**IMPACTED**	**DEGRADED**	**REMOVED/REPLACED**
Community Condition Class	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 records

Table 10 – Herbarium Records for Coyrecup Lake.

Search Coordinates: SW corner 33.7308°S, 117.8164° E; NE corner 33.6819°S, 117.8698°E

Family	Species	Alien	Cons. Status
Aizoaceae	*Disphyma crassifolium*		
Asteraceae	*Angianthus preissianus*		
	Podotheca angustifolia		
	Pogonolepis sp.		
Casuarinaceae	*Casuarina obesa*		
Chenopodiaceae	*Atriplex semibaccata*		
	Sarcocornia quinqueflora		
	Tecticornia lepidosperma		
Cyperaceae	*Isolepis cernua*		
	Isolepis congrua		
	Lepidosperma sp. A2 Flat island		
Dasypogonaceae	*Lomandra effusa*		
	Lomandra rupestris		
Dilleniaceae	*Hibbertia* aff. *inclusa*		
	Hibbertia rupicola		
Geraniaceae	*Pelargonium havlasae*		
Goodeniaceae	*Goodenia* aff. sp. Scaddan (C.D. Turley 41 VM/1099)		
Lauraceae	*Cassytha melantha*		
Mimosaceae	*Acacia ? mutabilis* var. *angustifolia*		
	Acacia acuminata		
Myoporaceae	*Eremophila lehmanniana*		
Myrtaceae	*Calytrix leschenaultii*		
	Darwinia halophila		
	Eucalyptus calyerup		P1
	Eucalyptus loxophleba subsp. *loxophleba*		
	Eucalyptus occidentalis		
	Eucalyptus orthostemon		
	Melaleuca acuminata subsp. *acuminata*		
	Melaleuca adenostyla		
	Melaleuca brophyi		
	Melaleuca halmaturorum		
	Melaleuca hamulosa		
	Melaleuca lateriflora subsp. *lateriflora*		
	Melaleuca scalena		
	Melaleuca torquata		
	Melaleuca uncinata		
	Verticordia chrysanthella		

Family	Species	Alien	Cons. Status
Orchidaceae	*Caladenia pendens* subsp. *pendens*		
Papilionaceae	*Gastrolobium calycinum*		
Poaceae	*Austrodanthonia acerosa*		
	Austrostipa exilis		
	Polypogon monspeliensis	Y	
	Puccinellia stricta		
Proteaceae	*Banksia porrecta*		P4
Santalaceae	*Santalum acuminatum*		
Solanaceae	*Nicotiana rotundifolia*		
Sterculiaceae	*Thomasia macrocalyx*		

Appendix 3 – Aquatic invertebrate data

Table 11 – Invertebrate records for Coyrecup Lake from the State Action Plan wetland monitoring program (see Cale et al. 2004) from 1997 to 2005 and from the Resource Condition Monitoring project in 2008.

				SPM004												RCM036
				Oct 97				Oct 99		Nov-01		Oct-03		Oct-05		Nov 08
Class	Order	Family	Lowest ID	A1	A2	B1	B2	A	B	A	B	A	B	A	B	
Turbellaria			Turbellaria	✓	·	✓	✓	✓	✓	·	·	·	·	·	·	
Nematoda			Nematoda	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	·	✓	
Rotifera	Bdelloidea		Bdelloidea	·	·	·	·	·	·	·	·	·	·	·	✓	
	Flosculariacea	Hexarthridae	*Hexarthra fennica*	·	·	·	✓	✓	✓	·	·	·	·	·	·	
	Ploimida	Brachionidae	*Brachionus plicatilis* s.l.	·	·	·	·	·	✓	·	·	·	·	·	·	
		Lecanidae	*Lecane ludwigii*	·	·	·	·	·	·	·	·	·	·	·	✓	
Gastropoda	Neotaeniglossa	Pomatiopsidae	*Coxiella* sp.	✓	✓	✓	✓	✓	✓	·	·	·	·	·	·	1,2,3
Oligochaeta	Tubificida	Naididae	Naididae (ex Tubificidae)	·	·	·	·	✓	·	·	·	·	·	✓	✓	
		Enchytraeidae	Enchytraeidae	·	·	·	·	·	✓	·	·	✓	✓	✓	·	
Arachnida	Acariformes	Halacaridae	Halacaridae	·	·	·	✓	·	·	·	·	·	·	·	·	
	Parasitiformes		Mesostigmata	·	·	·	·	·	·	·	·	·	·	✓	✓	
	Acariformes		Trombidioidea	·	·	·	·	·	·	·	·	·	·	·	✓	
Crustacea	Cladocera	Chydoridae	*Pleuroxus* cf. *foveatus* (SAP)	·	·	·	·	·	·	·	·	·	·	✓	✓	
		Daphniidae	*Daphnia carinata*	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Daphniopsis pusilla	✓	✓	✓	✓	·	·	·	·	·	·	·	·	
			Daphniopsis truncata	·	·	·	·	✓	✓	·	·	·	·	·	·	
			Daphniopsis sp.	·	·	·	·	·	·	·	·	✓	✓	·	·	
		Macrothricidae	*Macrothrix breviseta*	·	·	·	·	·	·	·	·	·	·	✓	✓	
	Ostracoda	Cyprididae	*Alboa worooa*	·	·	·	·	·	·	·	·	·	·	✓	·	
			Australocypris insularis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	·	·	

Class	Order	Family	Lowest ID	SPM004												RCM036
				Oct 97				Oct 99		Nov-01		Oct-03		Oct-05		Nov 08
				A1	A2	B1	B2	A	B	A	B	A	B	A	B	
			Australocypris sp.	·	·	·	·	·	·	·	·	·	·	✓	·	
			Cyprinotus edwardi	·	·	·	·	·	·	·	·	·	·	✓	·	
			Diacypris dictyote	·	·	·	·	·	·	✓	·	·	·	·	·	
			Diacypris spinosa	✓	✓	✓	✓	✓	✓	·	·	·	·	·	·	
			Diacypris compacta	·	·	·	·	·	·	·	·	✓	✓	·	·	
			Mytilocypris mytiloides	✓	✓	✓	✓	✓	✓	·	·	✓	✓	✓	·	
			Platycypris baueri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	·	·	
		Cypridopsidae	*Sarscypridopsis aculeata*	·	·	·	·	·	·	·	·	·	·	✓	·	
			Ostracoda (Unident.)	·	·	·	·	·	·	·	·	·	·	✓	✓	
		Centropagidae	*Calamoecia clitellata*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
		Cyclopidae	*Metacyclops* sp. 442	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Mesocyclops brooksi	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Apocyclops dengizicus	✓	✓	✓	✓	✓	✓	·	·	·	·	·	·	
			Meridiecyclops baylyi	·	·	·	·	·	·	✓	✓	✓	✓	·	·	
		Canthocamptidae	*Mesochra* nr *flava*	✓	✓	✓	✓	✓	✓	·	·	·	·	·	·	
			Harpacticoida sp	·	·	·	·	·	·	·	·	·	·	✓	✓	
	Amphipoda	Ceinidae	*Austrochiltonia subtenuis*	✓	✓	✓	✓	✓	✓	·	·	·	·	✓	✓	
			Ceinidae	·	·	·	·	·	·	·	·	·	·	·	·	1,2,3
	Isopoda	Oniscidae	*Haloniscus searlei*	✓	✓	✓	✓	✓	✓	✓	✓	·	·	·	·	
			Oniscidae	·	·	·	·	·	·	·	·	·	·	·	·	1,2
Insecta	Coleoptera	Carabidae	Carabidae	·	·	·	·	·	·	·	·	·	·	·	✓	
		Dytiscidae	*Allodessus bistrigatus*	·	·	·	·	·	·	·	·	·	·	✓	·	
			Antiporus gilberti	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Sternopriscus sp.	·	·	·	·	·	·	·	·	·	·	·	✓	
			Necterosoma penicillatus	·	✓	·	·	·	·	·	·	·	·	✓	✓	

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				Oct 97				Oct 99		Nov-01		Oct-03		Oct-05		Nov 08
				A1	A2	B1	B2	A	B	A	B	A	B	A	B	
			Megaporus howitti	·	·	·	·	·	·	·	·	·	·	·	✓	
			Rhantus suturalis	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Lancetes lanceolatus	·	·	·	·	·	·	·	·	·	·	✓	·	
		Hydrophilidae	*Berosus discolor*	✓	·	·	·	✓	·	·	·	·	·	·	·	
			Berosus sp.	·	·	✓	✓	·	✓	·	·	·	·	·	·	
			Limnoxenus zelandicus	·	·	·	·	·	·	·	·	·	·	✓	·	
		Staphylinidae	Staphylinidae	·	·	·	·	·	·	·	·	·	·	✓	·	
		Chrysomelidae	Chrysomelidae	·	·	·	·	·	·	·	·	·	·	✓	·	
	Diptera	Tipulidae	Tipulidae	·	·	·	·	·	·	·	·	✓	✓	·	·	3
		Culicidae	Culicidae	·	·	·	·	·	·	·	·	✓	·	·	·	1,2,3
		Ceratopogonidae	*Culicoides* sp.	·	·	·	·	·	·	·	·	·	·	·	✓	
			Monohelea sp. 1 (SAP)	✓	·	·	·	·	·	·	·	·	·	·	·	
			Ceratopogonidae	·	·	·	·	·	·	·	·	·	·	·	·	2,3
		Stratiomyidae	Stratiomyidae	·	·	·	·	✓	·	·	·	·	·	✓	·	1,2
		Ephydridae	Ephydridae sp. 3 (SAP)	·	·	·	·	·	·	·	·	·	·	✓	·	
			Ephydridae sp. 6 (SAP)	·	·	·	·	·	✓	·	·	✓	✓	·	·	
			Ephydridae sp. 7(SAP)	·	·	·	·	·	·	·	·	·	·	·	✓	
		Muscidae	Muscidae	·	·	·	·	·	·	✓	✓	·	·	·	·	
			Muscidae sp. A (SAP)	·	·	·	·	·	·	·	·	✓	·	·	✓	
		Chironomidae	Chironomidae	·	·	·	·	·	·	·	·	·	·	·	·	1,2,3
			Procladius paludicola	✓	✓	✓	✓	✓	✓	·	·	✓	✓	·	·	
			Procladius villosimanus	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Paramerina levidensis	·	·	·	·	·	·	·	·	·	·	·	✓	
			Corynoneura sp.	·	·	·	·	·	·	·	·	·	·	·	✓	
			Tanytarsus barbitarsis	·	·	·	·	·	·	✓	✓	✓	✓	✓	✓	

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				Oct 97				Oct 99		Nov-01		Oct-03		Oct-05		Nov 08
				A1	A2	B1	B2	A	B	A	B	A	B	A	B	
			Tanytarsus fuscithorax/semibarbitarsus	✓	·	·	·	·	·	·	·	·	·	·	·	
			Chironomus tepperi	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Chironomus aff. *alternans* (V24) (CB)	·	·	·	·	·	·	·	·	·	·	✓	✓	
			Dicrotendipes conjunctus	·	·	·	·	·	·	·	·	·	·	✓	✓	
	Hemiptera	Corixidae	*Agraptocorixa* sp.	·	·	·	·	·	·	·	·	·	·	✓	·	
			Micronecta sp.	·	·	·	·	·	·	·	·	·	·	✓	✓	
		Notonectidae	*Anisops* sp.	·	·	·	·	·	·	·	·	·	·	✓	✓	
	Odonata	Lestidae	*Austrolestes annulosus*	·	·	·	·	·	·	·	·	·	·	·	✓	
			Lestidae	·	·	·	·	·	·	·	·	·	·	✓	·	
		Aeshnidae	*Hemianax papuensis*	·	·	·	·	·	·	·	·	·	·	·	✓	
		Hemicorduliidae	*Hemicordulia tau*	·	·	·	·	·	·	·	·	·	·	·	✓	
	Trichoptera	Leptoceridae	*Notalina spira*	·	·	·	·	·	·	·	·	·	·	·	✓	
			Triplectides australis	·	·	·	·	·	·	·	·	·	·	✓	·	

Numbers indicate samples from the following habitats:

1. Mid-Channel of inlet creek
2. Bank of main waterbody
3. Edges of inlet creek.