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# **Mallee Catchment Management Authority**

## **Report for Margooya Lagoon Monitoring Program**

October 2008



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- I Habitat Assessment Results and Field Data Sheets.



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- » Ray De Groot (Mallee CMA), for providing valuable site information and support to the project;
- » David Scammel and Darren Wilson (Mallee CMA), for providing additional site information and commentary on threatened species present at Margooya Lagoon. Deborah Bogenhuber for accompanying and assisting with trialling the new DSE method for assessing RRG condition.



## Abbreviations

AVW	Atlas of Victorian Wildlife
BB	Black Box ( <i>Eucalyptus largiflorens</i> )
CMA	Catchment Management Authority
DBH	Diameter at Breast Height
DSE	Department of Sustainability and Environment (previously NRE)
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EVC	Ecological Vegetation Class
FFG	<i>Flora and Fauna Guarantee Act 1988</i>
FIS	Flora Information System Database
GIS	Geographical Information System
NRE	Department of Natural Resources and Environment (now DSE)
RobP Bioregion	Robinvale Plains Bioregion
RRG	River Red Gum ( <i>Eucalyptus camaldulensis</i> )
STD	Standard deviation of the mean
VROT	Victorian Rare or Threatened Flora (Department of Sustainability and Environment Advisory list)



# 1. Introduction

## 1.1 Objectives

GHD were commissioned by the Mallee Catchment Management Authority (CMA) to design a monitoring program for the Margooya Lagoon. The objective of the monitoring program is to monitor the response of flora and fauna values at the Lagoon over time and in response to the proposed wetting and drying cycles for the lagoon.

This report provides the framework for the monitoring program and presents the results of phase one of the monitoring program, “monitoring of a dry phase”. The data presented here will provide the baseline from which to assess changes in vegetation composition, fauna habitat, tree health, presence of rare or threatened flora and fauna and threatening processes over time.

It should be noted that no monitoring occurred prior to the first draining of the lagoon in December 2007.

## 1.2 Proposed wetting and drying cycle

Introducing a wetting and drying phase to Margooya Lagoon has been identified as a priority water management option under Water Management Options for the River Murray. In December 2007, the Euston weir pool was lowered causing Margooya Lagoon to begin drying out. This wetland has historically been permanently inundated due to the regulation of Murray River water levels at the Euston Weir Pool. The wetland would benefit from a drying phase to both increase the ecological diversity of the lagoon, and decrease the impact of sulphidic sediments within the wetland bed.

In late December, the Mallee Catchment Management Authority (MCMA), in partnership with the Department of Sustainability and Environment (DSE), temporarily blocked off Margooya Lagoon with a piped earth embankment. This was a rare opportunity as the weir pool level was only going to be down for a few weeks. Plans to re-inundate the wetland in 2008 are currently being investigated.

While the opportunity to collect baseline data during the wet phase was missed, the Mallee CMA wish to collect data on the flora and fauna of the lagoon while the wetland is relatively dry in the month of April 2008, and again after the wetland has been re-inundated.

## 1.3 Study site

The Margooya Lagoon is located approximately 6 km southeast of Robinvale in north-western Victoria and is located about 100 m south of the Murray River. The lagoon occurs within the Robinvale Plains Bioregion (RobP Bioregion) and is approximately 35 Ha in size.

The Margooya Lagoon offers an excellent opportunity to monitor changes in flora and fauna over time because the lagoon is:

- » Easily accessible;
- » Currently in moderate to good condition;
- » Floristically diverse; and



- » Threatening processes are evident that require monitoring so that management action can be taken to reduce impact on biodiversity at the lagoon before threats become severe (e.g. weed invasion and River Red-gum (RRG) regeneration within the wetland bed).

## 1.4 Types of monitoring

Environmental monitoring can take many forms and be used to a number of ends. Sometimes it is defined so broadly as to include almost any observation of a system. It is useful, however, to distinguish among three types of data collection commonly considered as “monitoring” because only some types of observations are useful for explaining past patterns in vegetation response and predicting likely responses in the future (Hellowell 1991; Kennish 2004):

- » *Survey work.* Surveys are qualitative observations made without any preconceptions as to the findings. They may include, for example, collecting baseline data as part of an inventory process to describe the condition of a given water body;
- » *Surveillance sampling.* Surveillance sampling uses a time series of surveys to determine the variability or range of given variables in the environment. It may include, for example, repeated sampling over time to characterise ecological responses to natural variability in the physical environment, such as seasonal changes;
- » *Monitoring.* Monitoring is the systematic collection of data over time to gauge compliance with a pre-determined standard, model or prediction. The standard could be, for example, a legal compliance value, the quantitative objectives of a management program, or the predictions arising from a conceptual understanding of the system under study. In fact, in their review of current wetland monitoring programs, Finlayson and Mitchell (1999) proposed that monitoring differed from other data-collecting activities in two main ways:
  - Monitoring is underpinned by a specific reason for the collection of the data; and
  - The results are compared with a standard or model, which is used to interpret, check or test the data, and a set of actions then arise according to whether compliance is achieved or not.

Intervention monitoring seeks to assess how ecological responses to individual management actions result in changes at the asset scale (in this case management of wetting and drying regime of a wetland).

Where control or reference sites can be identified, experimental designs incorporating Before-After Control-Impact (BACI) data (or some of the more advanced modifications that use multiple Control sites) can and should be used (e.g. see Quinn and Keogh 2002). Where reference or control sites are not available, as is often the case with environmental studies, an intervention analysis (IA) or Before-After (BA) design may be possible. This approach is used where control sites are not available but it is necessary to monitor or demonstrate the ecological response of a system (Scholz *et al.* 2005).

The monitoring program proposed here is not a BACI design, as there are no proposed control sites and data was not collated before intervention in the strict sense (i.e. before the first draining of the lagoon). Direct cause and effect is therefore unlikely to be achieved through this monitoring program.

In designing the monitoring program, the following sources were consulted:

- » Tucker 2004. Your wetland: monitoring manual;
- » Wallace *et al.* 2007. A standardized protocol for assessing the suitability of permanent wetlands for disconnection. The Murray-Darling Freshwater Research Centre, Mildura;



- » Scholz *et al.* 2007. The Living Murray Initiative: Lindsay-Mulcra-Wallpolla Islands and Hattah Lakes Icon Sites condition monitoring program design; and
- » GHD 2008. Investigation of causes of localised degradation of wetland/floodplain condition. Report by GHD to the Mallee Catchment Management Authority.

The Mallee CMA (Ray De Groot) was also consulted regarding the proposed monitoring program.

## 1.5 Overview of monitoring program

This monitoring program is designed to monitor the following flora and fauna values at the Margooya Lagoon:

- » Vegetation composition (dominant flora species, cover abundance and height);
- » Vegetation condition (weed cover, dominant weed species);
- » Tree health of *Eucalyptus camaldulensis* (River Red-gum) fringing the lagoon;
- » Fauna diversity and abundance;
- » Threatening processes such as weed invasion and River Red-gum regeneration within the wetland bed.

In summary, the monitoring program incorporates the following measurements:

- » Seven 20 m X 20 m quadrats placed in either fringing Intermittent Swampy Woodland (ISW) or the edge of the wetland bed;
- » Two transects 20 m wide by approximately 100 m long, in which the health of 30 RRG trees was measured;
- » Permanent photo points located at each quadrat and other sites of interest throughout the Margooya Lagoon;
- » Compilation of an incidental list of flora and fauna species observed at the lagoon during the survey;
- » Assessments of the likelihood of occurrence of threatened flora and fauna within the study site (based on presence of suitable habitat); and
- » Timed bird surveys and active searching.

A desktop assessment of government databases and GIS data was also completed and included: Ecological Vegetation Class (EVC) mapping by Department of Sustainability and Environment (DSE), Flora Information System (FIS), Atlas of Victorian Wildlife (AVW) and the *Environment Protection and Biodiversity Conservation Act 1999* Protected Matters Search Tool (PMST).

It is proposed that the monitoring occurs twice a year to capture seasonal changes in species composition (autumn and spring) each year. Tree health could be measured only once a year, because changes in tree health are unlikely to be detected at shorter intervals.

The methods are described in detail in Chapter 2.

## 1.6 Limitations

It was beyond the scope of this monitoring program to monitor factors such as:

- » Soil salinity and groundwater salinity;



- » Detailed quantitative fauna survey such as pitfall and harp trapping; and
- » Aquatic fauna survey.

The addition to the monitoring program proposed here, the Mallee CMA is also monitoring the following at Margooya Lagoon:

- » Acid sulphate composition of soils;
- » Surface water salinity of residual pool water within the lagoon.





## 2. Methods

### 2.1 Desktop assessment

#### 2.1.1 Ecological Database Searches

The following government ecological databases were investigated as part of the desktop assessment:

- » The *Environment Protection and Biodiversity Act 1999 (EPBC Act)* '[Protected Matters Search Tool](#)<sup>1</sup>, was used to identify any issues listed under the *EPBC Act* within a 5 km buffer around the study area;
- » [Flora Information System \(FIS\)](#). The FIS database documents observations and herbarium records of flora throughout the state of Victoria, and is managed and maintained by the Victorian Department of Sustainability and Environment (DSE). A search of the FIS database was undertaken for a buffer distance of approximately 5 km around the study area; and
- » [Atlas of Victorian Wildlife \(AVW\)](#). The AVW database documents observations of vertebrate fauna recorded from throughout the state of Victoria, and is managed and maintained by the Victorian Department of Sustainability and Environment (DSE). Using this database, surveys from within a defined geographical area can be searched to produce species lists of fauna known to occur within the searched area (surveys include lists of fauna, incidental observations of unusual species, and museum specimens). Data within the AVW database were reviewed for a 5 kilometre radius around each defined study area.

The use of the AVW and FIS is subject to a data-sharing agreement between GHD and DSE. Data within the present report has been used and acknowledged in accordance with this data-sharing agreement. These lists are only as accurate as the quality and quantity of data that has been recorded and documented from the area.

#### 2.1.2 GIS Mapping of Ecological Values

The following GIS data was investigated as part of this desktop assessment:

- » Victorian BioSite Database: sites of biodiversity significance maintained by DSE.
- » Ecological Vegetation Class (EVC) mapping by DSE.

The use of the BioSite data and EVC mapping is subject to a data-sharing agreement between GHD and DSE. Data within the present report has been used and acknowledged in accordance with this data-sharing agreement.

## 2.2 Nomenclature

### 2.2.1 Flora Species

Common and scientific names for plants follow the Flora Information System (FIS) database (2005 version), managed by the Victorian Department of Sustainability and Environment (DSE).

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<sup>1</sup> Commonwealth Government, Department of Environment and Water Resources, [www.environment.gov.au](http://www.environment.gov.au)



## 2.2.2 Ecological Vegetation Classes

Native vegetation in Victoria is classified into units known as Ecological Vegetation Classes (EVCs). Ecological Vegetation Classes are described according to a combination of floristic, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC occurs under a common regime of ecological processes within a given biogeographic range, and may contain multiple floristic communities (NRE 2002).

## 2.2.3 Fauna Species

Common and scientific names for terrestrial vertebrate fauna (mammals, birds, reptiles, and amphibians) follow the Atlas of Victorian Wildlife (AVW) database, maintained by DSE.

## 2.3 Quadrat sampling

Seven 20 m X 20 m quadrats were established throughout the Margooya lagoon. Quadrats were either located at the edge of the wetland and within the wetland bed or located within the adjacent vegetation on the banks of the lagoon within Intermittent Swampy Woodland (EVC 813).

The cover abundance of all vascular flora species present within each 20 m X 20 m quadrat was measured using a modified Braun Blanquet scale of cover abundance as shown in Table 1. GPS coordinates (easting and northing in GDA 94) were taken at two points for each quadrat: the midpoint at the wetland end and the midpoint at the woodland end. This will enable the Mallee CMA to revisit quadrats, mark them permanently and measure changes in species composition and cover abundance over time as proposed in the monitoring program. Locations of quadrats are shown in Table 2 and Figure 2.

**Table 1 Modified Braun Blanquet method of measuring cover abundance**

Score	Cover Abundance	Cover class
+	Few individuals with small cover	Insignificant cover
1	Numerous individuals, but cover < 1/5 of the sample sites, or scattered with cover up to 1/5 of the sample site	< 5 %
2	Any number of plants covering between 1/5 and 1/4 of the sample site	5-25% cover
3	Any number of plants covering 1/4 to 1/2 of the sample site	25-50% cover
4	Any number of plants covering between 1/2 and 3/4 of the sample site	50-75% cover
5	Any number of plants covering more than 3/4 of the sample site	75-100% cover

**Table 2 Location of quadrats and photo points within the Margooya Lagoon**

Photo point number	Quadrat number (where relevant)	Easting	Northing
1	1	669214	6166719



Photo point number	Quadrat number (where relevant)	Easting	Northing
2	1	669196	6166741
3	2	669301	6166679
4	2	669279	6166663
5	3	669794	6166326
6	3	669774	6166330
7	4	669774	6166333
8	4	669756	6166339
9	5	669638	6165775
10	5	669634	6165755
11	6	669637	6165754
12	6	669636	6165735
13	7	669712	6165581
14	7	669708	6165598
15	na	669387	6166130
16	na	669393	6166139
17	na	669789	6166387
18	na	669451	6165943
19	na	669818	6165879

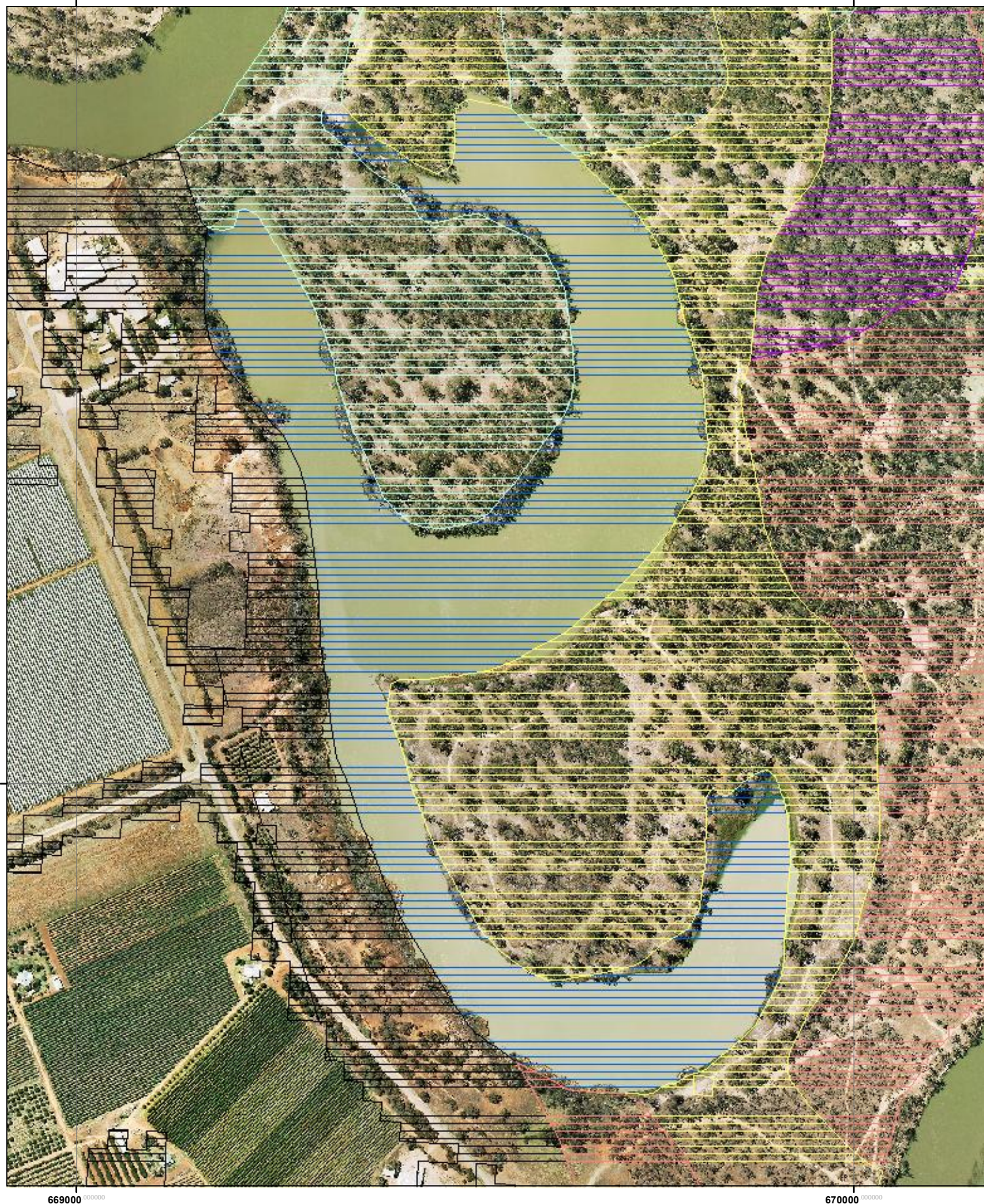
## 2.4 Incidental flora species

In addition to recording flora species within the quadrats, a list of additional flora species encountered whilst walking around the Margooya lagoon was compiled (flora species in addition to those recorded within quadrats).

## 2.5 Photo points

Photo points were established at the locations provided in Table 2 and Figure 2. The Mallee CMA will need to permanently mark these sites, if they are to be used as ongoing monitoring points. Photo points were established at either end of each quadrat and at other areas of interest around Margooya Lagoon. Photo points 15 to 19 are not in association with a vegetation monitoring quadrat and were selected as broad observational photo points to assess changes to Margooya Lagoon over time and depending on the water regime currently operating (e.g. wet or dry). Refer to Appendix G for photos of these sites.

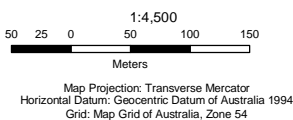




## Ecological Vegetation Classes

- |                            |                              |
|----------------------------|------------------------------|
| Semi-arid Parilla Woodland | Riverine Chenopod Woodland   |
| Shallow Freshwater Marsh   | Intermittent Swampy Woodland |

- |                        |                        |
|------------------------|------------------------|
| Floodway Pond Herbland | Lignum Swampy Woodland |
| Bare Rock/Ground       |                        |



Mallee CMA

Margooya Lagoon Monitoring  
-Ecological Vegetation Classes

Job Number	31-22928
Revision	A
Date	2 June 2008

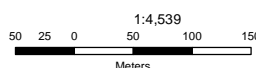


Figure 2 Location of flora quadrats, fauna habitat assessments, tree health transects and photo points at Margooya Lagoon



LEGEND

- |                           |                                       |                         |
|---------------------------|---------------------------------------|-------------------------|
| ! White-bellied Sea Eagle | [ Bird Surveys                        | E Photo Points          |
| ! Diamond Firetail        | ) Habitat Assessment and Bird Surveys | — Tree Health Transects |
|                           |                                       | □ Vegetation Quadrats   |



Map Projection: Transverse Mercator  
Horizontal Datum: Geocentric Datum of Australia 1994  
Grid: Map Grid of Australia, Zone 54



Mallee CMA

Margooya Lagoon Monitoring  
-Monitoring Sites

Job Number	31-22928
Revision	A
Date	2 June 2008



## 2.6 Tree Health

Two transects were erected within the fringing River Red-gums to measure tree health (locations of transects shown in Figure 2). Thirty trees were sampled at each transect. The transects were 20 m wide and approximately 100 m long. In total, the health of sixty trees was measured within the Margooya lagoon.

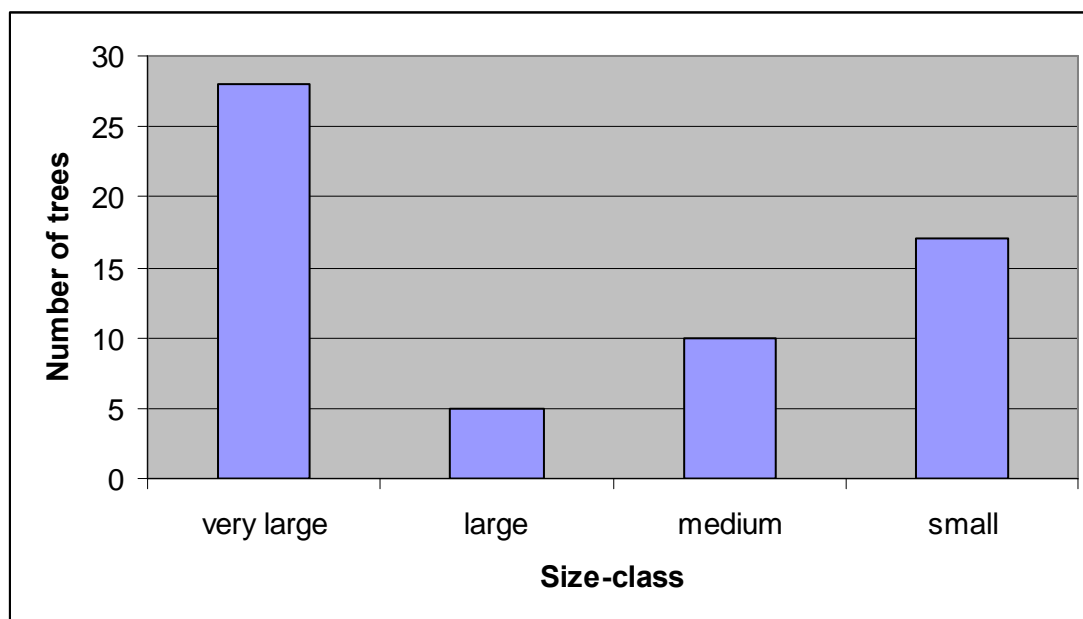
Two methods were used to assess tree health at each transect:

**Method 1:** Tree health method developed by Wallace et al. 2007 (as described in Wallace et al. 2007 and Scholz et al. 2007) and adapted by GHD 2008.

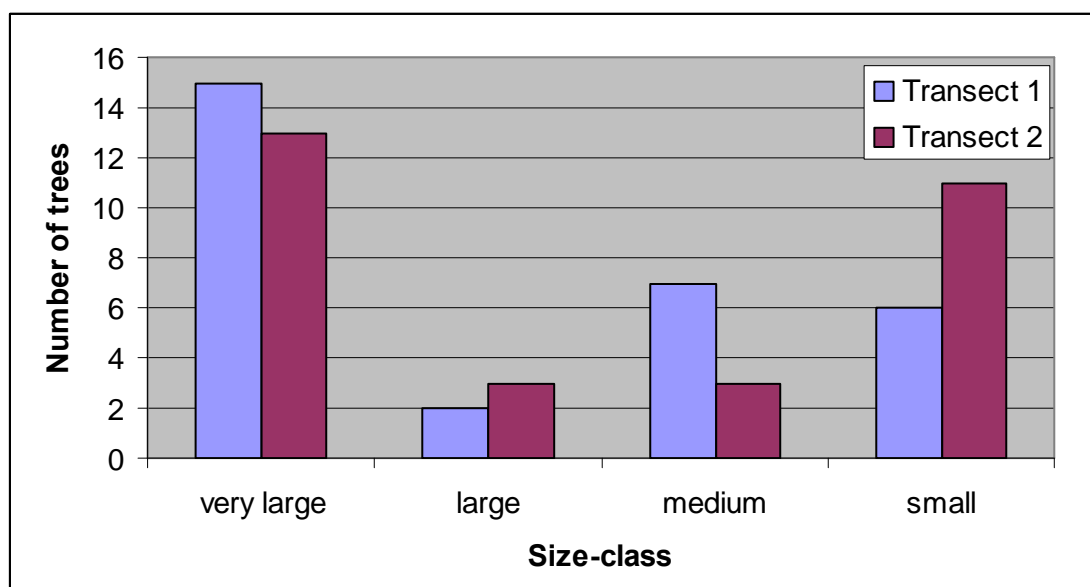
**Method 2:** Tree condition method recently developed by the Department of Sustainability and Environment (DSE) for the Living Murray Icon sites: The Living Murray Methodology for Field Assessment of Tree Condition (DSE in preparation).

Each of the two methods is described in detail below.

**Figure 3** Number of trees surveyed in each size-class at Margooya Lagoon (both transects)



**Figure 4** Number of trees surveyed in each size-class at Transect 1 and Transect 2 at Margooya Lagoon



### 2.6.1 Tree health method 1

Method 1 (Wallace et al. 2007) is based on a series of visual assessments of certain characteristics for individual trees. Each assessment is made against a hypothetical reference condition of a given tree as if it was in full “health”. The parameters are:

- » Bark condition;
- » Canopy cover;
- » New growth;
- » Canopy density;
- » Reproductive status;
- » Leaf condition;
- » Mistletoe load; and
- » Diameter at breast height.

This method is described in Wallace *et al.* 2007 and summarised here. A data sheet for recording data on tree condition in the field was compiled and is provided in Appendix A. A summary sheet describing the categories used in the field assessment is also provided. Wallace et al. 2007 provides categories for bark condition, canopy cover and new growth, but not for canopy condition, mistletoe load, reproductive status and leaf condition. The categories listed here for these additional parameters were devised by GHD based on our previous studies of measuring tree health/condition (GHD 2008). The tree health assessments using the Wallace et al. 2007 method were undertaken in April 2008.



### Assessment of Bark Condition

Long-term dead trees have no bark and have lost all of their medium and fine branches. Very stressed trees have cracked bark, which are vertical cracks in the bark, generally found on the trunk that exposes the heartwood. Trees with cracked bark have generally lost all of their leaves or only have dead leaves (Table 3).

**Table 3 Assessment of bark condition**

Category	Description and range
0	Long Term Dead (no bark or fine branches)
1	Cracked Bark
2	Intact Bark

### Assessment of Canopy Cover

Canopy cover is a measure of the spatial extent of the tree canopy. Canopy cover is assessed as the extent to which the existing canopy fills the hypothetical full extent of the canopy structure (Table 4). It is important to note that old trees may have substantial gaps in the canopy as the canopy structure (branches) spread apart. Table 4 lists the categories for canopy cover recommended by Wallace *et al.* 2007. Canopy cover was also recorded in 20% increments (Table 5). The reasoning for this is that the categories listed above were considered to be coarse (and may result in many trees falling into category 4: 26-75% cover).

**Table 4 Assessment of canopy cover**

Category	Description and range	% cover
0	No canopy or sparse dead leaves (near dead)	0%
1	Full or substantial canopy of dead leaves (near dead)	0%
2	Sparse canopy of live leaves (highly stressed)	<10%
3	Minimal cover (stressed)	10-25%
4	Moderate cover (moderately stressed)	26-75%
5	Full cover (healthy)	75-100%

**Table 5 Assessment of canopy cover (using 20% increments)**

Category	Description and range	% Cover
0	None	0%
1	Sparse	1-20%
2	Minimal Cover	21-40%
3	Moderate Cover	41-60%





4	Dense Cover	61-80%
5	Full cover	81-100%

### Assessment of New Growth

Records the presence of new growth, either new leaves, or epicormic growth, and is measured as the spatial extent of new or epicormic growth on the branches and trunk (Table 6).

**Table 6 Assessment of new growth**

Category	Description and range	% Cover
0	None	0%
1	Sparse	<10%
2	Minimal Cover	10-25%
3	Moderate Cover	26-75%
4	Dense Cover	75-100%

### Assessment of Reproductive Status

Reproduction status was determined by noting whether or not the tree had reproductive material present (e.g., woody capsules, buds and / or flowers).

### Assessment of Leaf Condition

Leaf condition was measured based on dominant colour of leaves: red brown dominant to some red brown present to green leaves (no red-brown leaves present) (Table 7).

**Table 7 Assessment of leaf condition**

Category	Description and range
0	Red-brown dominant
1	Some red brown
2	Green

### Assessment of Mistletoe Load

The presence of any mistletoe was noted and the severity of infestation was also noted.

**Table 8 Assessment of mistletoe load**

Category	Description and range
0	Present and severe infestation present
1	Present but low cover
2	None present

### Diameter at Breast Height

Establishing the age of eucalypts in semi-arid environments is problematic, where rainfall and seasonal temperatures constrain production of annual tree rings (George *et al.* 2005; Scholz *et al.* 2007). Instead, tree size as trunk (or bole) diameter is commonly used as a surrogate for tree age, and this approach is used here (George *et al.* 2005). The diameter at breast height was measured for each tree assessed.

For data analysis, trees were separated into the following size classes: very large, large, medium or small. Size classes were defined using the Benchmark for Intermittent Swampy Woodland (EVC 813) within the Robinvale Plain Bioregion. Definitions of size classes are provided in Table 9. Figure 3 shows the number of trees in each size-class for the entire sample pool (both transects). Figure 4 shows the number of trees surveyed in each size-class for each of the two transects. Almost half of the trees surveyed are very large trees.

**Table 9 Definition of size-classes of River Red-gum trees surveyed at Margooya Lagoon**

Size Class	Definition (DBH cm)
very large	$\geq 87.5$
large	70 – 87.5
medium	52.5 - 70
small	$< 52.5$

### Total number of trees

Note: size classes are determined according to the EVC Benchmark for Intermittent Swampy Woodland (EVC 813) within the RobP Bioregion.

### 2.6.2 Tree health method 2

Method 2, The Living Murray (TLM) Methodology for Field Assessment of Tree Condition, is currently being developed by DSE. There are eleven assessments that form the minimum requirements for TLM assessment of RRG condition:

- » Alive/dead
- » Bark condition
- » Crown extent
- » Crown density
- » Recovery: Epicormic growth



- » Recovery: New tip growth
- » Decline: Leaf die off
- » Decline: Mistletoe
- » Tree dominance
- » Reproduction
- » DBH

Each of these parameters is described in Appendix B.

## 2.7 Fauna Monitoring

The fauna assessment initially aimed to gain an understanding in regard to fauna habitat condition present at Margooya Lagoon as a whole, followed by descriptions of each of the three main sites assessed. The habitat descriptions are a means of gaining an appreciation for the fauna habitat types present, including habitats for threatened species and are not necessarily meant to be repeated in future monitoring events. The habitat assessment included the following steps:

- » A description of key habitat features within Margooya Lagoon;
- » A description of key habitat features surrounding Margooya Lagoon;
- » Key habitats for state<sup>2</sup> and commonwealth<sup>3</sup> listed threatened species;
- » Opportunistic fauna species observations;
- » Present threats to terrestrial fauna operating at each of the wetlands; and
- » Opportunities for improved management of the wetlands and surrounds, including recommendations for water regimes and land management to enhance general ecosystem processes and biodiversity (and threatened species habitat).

The objective for fauna monitoring is to focus on quantifiable means for measuring the impact of the changes to water regime (i.e. wetting/drying events) and focussing on activities such as timed bird surveys, pitfall/elliott/bat trapping and other activities that allow species abundance and diversity to be compared and analysed. For the current assessment, an initial description of fauna habitats, values (such as threatened species use of the area), threats and possible management considerations will assist with the broader management of Margooya Lagoon.

Quantifiable fauna assessment undertaken for the monitoring of the dry phase includes:

- » Timed woodland bird surveys. These were done for a period of approximately one hour and involved moving around the fringing habitat of the lagoon (a defined area of approximately 2-5 ha), recording all species and abundance as possible. During a wet phase, wetland birds would also be documented, including species observed and numbers;
- » Timed active searches for reptiles, small mammals and amphibians;
- » Observations of other incidental fauna.

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<sup>2</sup> Species listed as threatened under the Vic *Flora and Fauna Guarantee Act 1988*.

<sup>3</sup> Species listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*.



### 2.7.1 Field Assessment

Fauna assessment techniques were developed for the purpose of meeting the stated objectives of the project. They were developed based upon the knowledge and experience of GHD and with due consideration of survey guidelines developed by DEC [*Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities Working Draft* (DEC 2004)], documented techniques highly applicable to northern Victorian situations.

A GHD zoologist (Alex Holmes) conducted the field assessments from 14-15 of May. A general drive and walk around Margooya Lagoon on established tracks was followed by the selection of three monitoring sites based on the variation in condition and habitat features across the lagoon. Bird surveys were conducted in the early morning or late afternoon to take advantage of peak periods of activity. At each site, the following took place:

- » Habitat assessments, including documentation of available habitat, values (such as threatened species), current threats, a habitat score based on a method developed by GHD;
- » Timed bird survey, including a record of species and number (if possible as some species are identified on call alone and not observed);
- » Timed active searches for reptiles, amphibians and mammals;
- » Documentation of indirect faunal signs such as scats, tracks, burrowing activity and other traces;
- » Opportunistic observations of all terrestrial fauna species.

These techniques are described in greater detail below and survey effort is described in Table 10.

Weather during the assessment was variable, with fine, calm weather conditions experienced on 14 May 2008 (max 24°C, min 6°C), tending to showers the following day (max 18°C, min 7°C), which may have impacted upon the activity patterns of fauna.

### 2.7.2 Site Selection

Three sampling locations were selected at Margooya Lagoon to tie in with the vegetation condition monitoring sites. At each of the locations the following quantifiable fauna survey techniques were conducted:

- » One 40 to 60 min bird census; and
- » One 40 to 60 min active search for reptiles/mammals/amphibians.

The sampling locations were specific areas of 2 to 5 hectares that were thoroughly assessed for various fauna species and fauna habitat. Opportunistic fauna observations were also recorded between the documented survey sites.

The vegetation community surrounding Margooya Lagoon is comprised of a fringing band of River Red Gum woodland and a broader belt of Black Box community on the floodplain areas. The vegetation composition was generally similar at most sites, though sampling locations were established to account for subtleties such as shrub layer or ground layer composition (i.e. Black Box with lignum or chenopod understorey). Sampling locations were selected to appropriately assess habitat types and vegetation communities found throughout the wetland and surrounds, and were established to account for the variations in vegetation composition and spread sufficiently in order to increase the chances of detecting the majority of fauna species present.



### **2.7.3 Fauna Habitat Condition Assessment**

A fauna habitat description was made at each of the three sites and involved the assessment of the condition/presence of key features such as the presence of coarse woody debris, rocks, large hollow trees, dead standing trees (stags) and the presence of weeds, feral fauna species (e.g. feral pigs, rabbits, foxes, feral cats, honey bees), recreational / human impacts (removal of woody debris, vehicle / stock trampling) and salinity. This process is not designed to be repeated in the future, but to provide an initial assessment of fauna habitat condition and an indication of ecological values present (i.e. areas of good habitat and areas supporting threatened species).

Fauna habitat was assessed based on several attributes and rated as providing either high, moderate or low habitat value (refer to Appendix I for a detailed explanation on the habitat variables measured and the method by which each has been scored, in addition to habitat results for each of the three sites, one to three). Habitat attributes assessed for each site include:

- a) Large Trees;
- b) Hollows;
- c) Woody Debris;
- d) Stags;
- e) Vegetation Structural Diversity;
- f) Leaf Litter; and
- g) Connectivity.

### **2.7.4 Diurnal Birds**

Diurnal bird surveys were preferably conducted to incorporate either the early morning or late afternoon active period for local species. Bird surveys were conducted for a duration of between 40 to 60 minutes at three separate locations at Margooya Lagoon and over an area of between 2 to 5 hectares. All habitats and variation within vegetation communities were investigated for bird species. Various techniques were employed such as walking slowly through sampling sites and stopping periodically in areas of denser vegetation cover, to remaining still and waiting for species to pass by. Species were identified by direct observation through field binoculars or by call. Opportunistic observations were also recorded when moving between sampling locations.

The relatively low number of additional bird species identified after the completion of the timed bird surveys at each site, suggest that a comprehensive bird survey had been achieved (for this location, at this time).

### **2.7.5 Diurnal Reptiles, Amphibians and Mammals**

Reptile, amphibian and small mammal active searches were undertaken at a minimum of three separate locations at each wetland (generally conducted at same site as bird surveys). Active searches involved looking for animals under logs, lifting rocks, searching leaf litter, removing bark on dead and live trees and investigating tree hollows, burrows and fissures and other potential shelter sites. Binoculars were also employed to search for shy basking reptiles and for hollow inhabiting reptiles. Indirect evidence was also documented (e.g. scats, tracks, bones, diggings, etc.). Active searching was conducted throughout the day in conjunction with or following diurnal bird surveys. Opportunistic observations were also



recorded during traverses between sampling sites. The active search was undertaken in lieu of quantitative sampling techniques such as pitfall trapping. To introduce a quantifiable measure to the process, the active searching was timed over a period of 40 to 60 minutes.

### 2.7.6 Evidential Traces

Other signs indicative of faunal presence such as scratch marks, scats, den sites, nests, hairs, burrowing activity, feeding scraps, remains and tracks were actively searched for and recorded.

**Table 10 Summary of survey effort undertaken at each of the sites**

Site	Coords	Date Visited	Habitat Assessment	Bird Surveys	Mammal, Reptile, & Frog Surveys	Opportunistic Observations	Evidential Traces
Site 1	669256, 6166735	14/05/08	√	1 x 40-60 min	1 x 40-60 min	√	√
Site 2	669800, 6166349	15/05/08	√	1 x 40-60 min	1 x 40-60 min	√	√
Site 3	669736, 6165787	15/05/08	√	1 x 40-60 min	1 x 40-60 min	√	√
Site 4	669708, 6165602	15/05/08		1 x 40-60 min	1 x 40-60 min	√	√

## 2.8 Frequency and timing of surveys

GHD proposes that quadrat sampling takes place twice a year to capture seasonal changes in species composition (autumn and spring). The measurements of tree health should be conducted annually, as changes in tree health are unlikely to be detected if monitored at shorter intervals.

The fauna surveys should preferably be conducted in the spring, particularly pitfall trapping for reptiles (recommended in section 5.3) as this will take advantage of the peak in activity for these species. The fauna surveys will however, depend upon the condition of the wetland and whether it has been recently inundated or has been dried. Wet phase monitoring would preferably incorporate all of bird surveys (wetland and woodland), pitfall/Elliott trapping, Harp trapping/Anabat and aquatic sampling, however, depending upon when the wetting occurs, some elements may be incorporated (e.g. bird surveys, aquatic sampling), while others such as the pitfall trapping could be disregarded if the wetting occurs during autumn for example.

Monitoring of the dry phase would generally need to be conducted in spring, as you would generally only be monitoring the diversity and abundance of reptiles, amphibians, bats and woodland birds, with spring being the preferred time of year to undertake this exercise.

## 2.9 Ecological Limitations

This ecological assessment mostly covers vascular plant species (ferns, conifers and flowering plants) and vertebrate fauna (mammals, birds, reptiles and frogs), as most information is available on these groups. Terrestrial invertebrates have been considered as part of this assessment; however, there is



relatively little available information. Non-vascular flora (e.g. mosses, liverworts, lichens) and fungi have not been considered.

The flora assessment was conducted in autumn, which is generally not considered to be the most suitable time of year for conducting flora surveys in semi-arid areas. Spring is generally considered to be the most appropriate time as annual species may be more apparent at this time and reproductive material may be more available to facilitate easier identification. Consequently, not all flora species would have been recorded at each site, due to their seasonal nature and/or lack of reproductive material. Therefore, further species are likely to be recorded at other times of the year, particularly following good rainfall events and/or spring.

The fauna assessments were conducted during autumn, which is generally not considered an ideal time to record many fauna species. The cool daily temperatures specifically are not suitable for the detection of reptiles/amphibians and as fewer species are engaging in breeding activity at this time of year, less species are actively moving about their habitats. The field assessments did not involve pitfall, Elliot or bat trapping techniques, largely due to budgetary and time constraints. Due to the lack of intensive trapping, several species may not have been detected through the diurnal surveys. Additional species may not have been detected due to large home ranges, migratory or cryptic habits. Surveys during different seasons or for longer periods would allow other species to be detected that may be migratory, have seasonal movements or are generally more detectable at these times. This limitation is partially offset by the information available from the various databases and literature consulted during the desktop assessment.

In addition, the prevailing dry conditions (one of the most severe droughts of the past century) also precluded the observation of certain species. This limitation is partially offset by the information available from the various databases and literature consulted during the desktop assessment.

### 3. Flora results: Stage 1 of monitoring program

This Chapter summarises the flora results of the first stage of the monitoring program. Fauna species and habitats recorded during stage 1 of the monitoring program are provided in Chapter 4.

#### 3.1 Ecological Vegetation Classes

##### 3.1.1 Current mapping

Remnant vegetation in the study area has been mapped at a scale of 1:25 000 (DSE 2005). The EVCs that occur within the study area are shown together with their conservation status within the RobP Bioregion in Table 11 and illustrated in Figure 1.

The perimeter of the Margooya Lagoon is fringed by Intermittent Swampy Woodland (EVC 813) according to the EVC mapping. Riverine Chenopod Woodland (EVC 103) occurs at higher elevations on the floodplain on the eastern side of the Lagoon and Semi-arid Parilla Woodland occurs on the Parilla sands to the west of the Lagoon on higher elevations. According to the EVC mapping, the wetland bed is mapped as bare ground. The vegetation fringing the northern arm of the lagoon is mapped as Shallow Freshwater Marsh (EVC 200).

**Table 11 Ecological Vegetation Classes present within the Margooya Lagoon study area**

Ecological Vegetation Class	Conservation status
Intermittent Swampy Woodland (EVC 813)	Depleted
Shallow Freshwater Marsh (EVC 200)	Unknown
Riverine Chenopod Woodland (EVC 103)	Depleted
Semi-arid Parilla Woodland (EVC 828)	Vulnerable
Lignum Swampy Woodland (EVC 823)	Depleted

##### 3.1.2 Pre-European mapping

Pre-European mapping suggests that the Ecological Vegetation Classes present today are consistent with EVCs present pre 1750s.

##### 3.1.3 Current assessment

Overall, the current assessment concurred with the EVC mapping except for the following inaccuracies:

- » According to the EVC mapping, the wetland bed is mapped as bare ground. The edges of the wetland bed are likely to be more appropriately mapped as Tall Marsh (EVC 821) than bare ground as they are currently dominated by tall emergent graminoids (rushes, sedges and reeds) and tall and medium herbs; and
- » According to the EVC mapping, the vegetation fringing the northern arm of the lagoon is mapped as Shallow Freshwater Marsh (EVC 200): quadrat 2. This vegetation is similar to Intermittent Swampy



Woodland (EVC 813) that occurs on the eastern side of the Lagoon (e.g. quadrat 3). The vegetation is Woodland dominated by *Eucalyptus camaldulensis* (River Red-gum) with an understorey of small trees: *Acacia stenophylla* (Eumong). The ground layer supports medium tufted and non-tufted graminoids and medium to large herbs as described below.

### Intermittent Swampy Woodland (EVC 813)

According to the EVC Benchmark for the RobP Bioregion, Intermittent Swampy Woodland (EVC 813; ISW) is a eucalypt woodland to 15m tall with a variously shrubby and rhizomatous sedge – turf grass understorey, at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces (mostly at the rear of point-bar deposits or adjacent to major floodways) and lacustrine verges (where sometimes localised to narrow transitional bands). Soils often have a shallow sand layer over heavy clay and are frequently brackish.

Within the study site, ISW is a Woodland to 15 m tall dominated by *Eucalyptus camaldulensis* (River Red-gum), over an understorey tree layer of *Acacia stenophylla* (Eumong) to 10 m tall. The ground layer supports medium tufted and non-tufted graminoids such as *Cyperus gymnocaulos* (Spring Flat-sedge) and *Cynodon dactylon* (Native Couch). Medium to large herbs are scattered including *Wahlenbergia fluminalis* (River Bluebell), *Brachyscome basaltica* (Swamp Daisy), *Vittadinia cuneata* (Fuzzy New Holland Daisy), *Vittadinia dissecta* (Dissected New Holland Daisy) and *Atriplex semibaccata* (Berry Saltbush). Vegetation descriptions are provided for each quadrat in Table 13 to Table 19.

### Tall Marsh (EVC 821)

According to the EVC benchmark for the RobP Bioregion, Tall Marsh (EVC 821) is a wetland dominated by tall emergent graminoids (rushes, sedges, reeds), typically in thick species-poor swards. Occupies wetlands in usually associated with anabranches of creeks. Soils are almost permanently moist. Dominant species are tolerant of inundation, but not total immersion for extended periods.

Large and medium graminoids such as *Typha orientalis* (Broad-leaf Cumbungi), *Cyperus exaltatus* (Tall Flat-sedge) and medium herbs such as *Persicaria decipiens* (Slender Knotweed) dominate the wetland edges. The ground layer supports a thick carpet of *Glinus lotoides* (Hairy Carpet-weed), *Cynodon dactylon* (Native couch) and introduced *Polygonum aviculare* (Wireweed).

Regenerating River Red-gums (RRG) are prevalent along the edges of the wetland bed. The cover of regenerating RRG was typically 25-50 % within the 20 m X 20 m quadrats located on the edges of the wetland bed. Regenerating RRG is considered a threat to the wetland and should be monitored.

## 3.2 Flora species

### 3.2.1 Overview

The FIS database has records of 214 flora species (162 native species, 52 exotic species) from documented sites<sup>4</sup> within 5 km of the Margooya Lagoon.

<sup>4</sup> Including quadrats, local area lists, herbarium and incidental records.



### **3.2.2 Species of conservation significance**

Nineteen of the flora species recorded on the FIS database within 5 km of the Margooya Lagoon are of conservation significance (Table 12). The EPBC Act Protected Matters Search Tool (PMST) predicted the potential occurrence of an additional four nationally threatened flora species within the local area relevant to Margooya Lagoon.

The list of flora species that have been recorded (FIS) or predicted to occur within 5 km (PMST) of the Margooya Lagoon includes:

- » Four flora species listed as threatened under the *EPBC Act 1999*;
- » Two flora species listed as threatened under the *FFG Act 1988*; and
- » An additional eighteen flora species listed as rare or threatened on DSE's Advisory List of Rare or Threatened Flora (VROT's).



**Table 12 Likelihood of occurrence of threatened flora at Margooya Lagoon**

FFG	EPBC	VROTS	Source	Scientific Name	Likelihood of occurrence	Habitat description
	V	Not listed in Victoria	PMST	<i>Austrostipa metatoris</i>	Unlikely	Grows in sandy areas of the Murray Valley; habitats include sandhills, sandridges, undulating plains and flat open mallee country, with red to red-brown clay-loam to sandy-loam soils (DEC NSW website).  Associated species include <i>Eucalyptus populnea</i> , <i>E. intertexta</i> , <i>Callitris glaucophylla</i> , <i>Casuarina cristata</i> , <i>Santalum acuminatum</i> and <i>Dodonaea viscosa</i> (DEC NSW website).
	V	Not listed in Victoria	PMST	<i>Solanum karsense</i> Menindee Nightshade	Possible	Grows in occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man saltbush, and open treeless plains with solonized brown soils. Flowers chiefly in spring (DEC NSW website).
f	V	e	PMST	<i>Swainsona murrayana</i> Slender Darlingpea	Possible	Extremely rare in northern and western Victoria where found in seasonally inundated flats and around lakes. Flowers aug-nov (Walsh and Entwisle, 1996).
	V	v	PMST	<i>Swainsona pyrophila</i> Yellow Swainsonpea	Unlikely	In Victoria known only from far north-west where rare. Grows in mallee scrub on sandy or loamy soil and usually found only after fire). Flowers sep-dec (Walsh and Entwisle, 1996).
f			FIS	<i>Allocasuarina luehmannii</i> Buloke	Unlikely	Usually growing in woodland with <i>Eucalyptus microcarpa</i> , on non-calcareous soils. Flowers sep-nov (Walsh and Entwisle, 1996).
		v	FIS	<i>Acacia oswaldii</i> Umbrella Wattle	Unlikely	Widespread but rather uncommon through north-western Victoria, mainly in calcareous sands and loam. Flowers nov-jan (Walsh and Entwisle, 1996).
		v	FIS	<i>Chenopodium desertorum</i> subsp. <i>rectum</i> Frosted Goosefoot	Unlikely	Recorded from only three sites in north-west Victoria (Nandaly, Hattah, Tempy areas) where occurring in mallee scrub on sand or slightly heavier soils. Apparently locally common. Flowers sep-jan (Walsh and Entwisle, 1996).



FFG	EPBC	VROTS	Source	Scientific Name	Likelihood of occurrence	Habitat description
		v	FIS	<i>Eragrostis setifolia</i> Bristly Love-grass	Possible	Uncommon in Victoria, occurs on clayey soils of seasonally flooded areas, confined to the far north-west. Flowers sep-apr (Walsh and Entwisle, 1994).
		v	FIS	<i>Jasminum didymum</i> subsp. <i>lineare</i> Desert Jasmine	Unlikely	In Victoria, confined to dry woodlands in the far north-west. Flowers mainly mar-july (Walsh and Entwisle, 1999).
		v	FIS	<i>Marsdenia australis</i> Doubah	Possible	In Victoria, confined to the far north-west where occasional in dry woodland and scrubland, often near watercourses. Flowers late spring-summer. (Walsh and Entwistle, 1999).
		v	FIS	<i>Sida fibulifera</i> Pin Sida	Possible	Apparently confined to red loam or clay loam soils near the Murray river between Hattah-Kulkyne and Mildura, but depleted by clearing. Flowers spring or autumn (Walsh and Entwisle, 1996).
		r	FIS	<i>Acacia colletioides</i> Wait-a-while	Unlikely	In north-west of state growing mainly in mallee scrub or open woodland on sandy loam soils. Flowers aug-nov (Walsh and Entwisle, 1996).
		r	FIS	<i>Asperula gemella</i> Twin-leaf Bedstraw	Present	"Moist situations' associated with the vegetation fringing inland lakes and <i>Muelenbeckia florulenta</i> . Flooding requirements unknown.
		r	FIS	<i>Chenopodium desertorum</i> subsp. <i>desertorum</i> Frosted Goosefoot	Unlikely	In Victoria confined to the far north-west (Hattah and Wyperfeld National Pars, Annuello etc.) where occurring mainly on sand-ridges and apparently not common. Flowers sep-apr (Walsh and Entwisle, 1996).
		r	FIS	<i>Eremophila divaricata</i> subsp. <i>divaricata</i> Spreading Emu-bush	Present	In Victoria confined to woodland communities along the floodplain of the Murray River system north-west from Kerang. Flowers mostly nov-apr (Walsh and Entwisle, 1999).
		r	FIS	<i>Malacocera tricornis</i> Goat Head	Possible	Grows in clay pans and heavy alluvial flats on floodplains. Fruits Aug-Nov (Walsh & Entwistle 1996).



FFG	EPBC	VROTS	Source	Scientific Name	Likelihood of occurrence	Habitat description
		r	FIS	<i>Rhagodia ulicina</i> Spiny Goosefoot	Unlikely	Localised in the northern part of the Sunset Country (north and north-west of Hattah), but locally common. Occurring on red loamy soils, usually containing limestone, in dune swales and on flat ground. Flowers aug-nov (Walsh and Entwisle, 1996).
		r	FIS	<i>Sarcozona praecox</i> Sarcozona	Unlikely	Occasional in mallee and Callitris-Casuarina woodlands in north-west, usually on loamier soils. Flowers aug-nov (Walsh and Entwisle, 1996).
		k	FIS	<i>Haloragis glauca</i> f. <i>glauca</i> Bluish Raspwort	Possible	In Victoria, apparently confined to the north-west where it grows on heavy soils that are seasonally inundated. Flowers mainly jan-oct (Walsh and Entwisle, 1996).
		k	FIS	<i>Lepidium pseudohyssopifolium</i> Native Peppercreess	Possible	Uncommon plant, most recent reports from heavy soils of the Murray River floodplain in the far north-west. Flowers mostly spring-autumn (Walsh and Entwisle, 1996).
		k	FIS	<i>Lotus australis</i> Austral Trefoil	Unlikely	Scattered widely but discontinuously across the state, particularly in near coastal areas, mostly in grassland and open forest. Flowers mainly in spring (Walsh and Entwisle, 1996).
		k	FIS	<i>Ptilotus sessilifolius</i> var. <i>sessilifolius</i> Crimson Tails	Unlikely	Occasional on loamy, usually limestone-rich sands in far north-western Victoria (Mildura, Robinvale). Flowers mainly oct-mar (Walsh and Entwisle, 1996).
		k	FIS	<i>Teucrium albicaule</i> Scurfy Germander	Possible	Grows in grey clayey soils in herb-rich alluvial flats, usually in <i>Eucalyptus largiflorens</i> woodlands, or in chenopod-dominated shrublands. Flowers sep-jun (Walsh and Entwisle, 1999).

### Key to table

FFG	Victorian Flora and Fauna Guarantee Act 1988
EPBC Act	Commonwealth Environment and Biodiversity Protection Act 1999
VROTS	Victorian rare or threatened species
Data	Source of information
CE	Critically endangered in Australia (EPBC Act)



EN	Endangered in Australia (EPBC Act)
VU	Vulnerable in Australia (EPBC Act)
f	Listed as threatened in Victoria under the FFG Act
e	Endangered in Victoria (FIS)
v	Vulnerable in Victoria (FIS)
r	Rare in Victoria (FIS)
FIS	DSE Flora Information System (2005 version)
PMST	EPBC Act Protected Matters Search Tool

**Likelihood of occurrence of listed threatened flora is assessed on a 4-tier scale:**

- 1: Present - individuals recorded within the study site during the current assessment or any previous assessment within the boundaries of the study site
- 2: Possible - suitable habitat occurs within the study site
- 3: Unlikely - suitable habitat unlikely to occur within the study site, or suitable habitat present but species not recorded for over 50 years within 5 km of the site
- 4: Highly unlikely – no suitable habitat present within the study site and individuals not recorded within study site during current or any previous assessment

Study site: Boundary of the proposed works and/or investigation (e.g. area surveyed during field assessment)

Local area: The broader area surrounding the study site (i.e. 5 km radius) in which database searches of threatened species have been undertaken



### 3.2.3 Current assessment

During the flora surveys a total of 66 flora species were recorded at Margooya Lagoon (49 native and 17 exotic species). The following rare or threatened flora were recorded during stage 1 of the monitoring program:

- » *Eremophila divaricata* ssp. *divaricata* (Spreading Emu-bush) rare in Victoria; and
- » *Asperula gemella* (Twin-leaf Bedstraw) rare in Victoria

There is potential for an additional nine threatened flora species to also occur within the Margooya Lagoon, owing to the presence of suitable habitat (Table 12). Table 12 shows the likelihood of occurrence of each of the flora species previously recorded within 5 km of the study site or predicted to occur by the PMST within 5 km of the study site.



It should be noted that owing to limited survey time (1.5 days in total), the entire wetland area was not surveyed during stage 1 of the monitoring program. The current assessment did not include targeted surveys for the rare or threatened flora. As some of the threatened flora are seasonal, targeted surveys would be required at an appropriate time of year and preferably at a time when these flora are known to flower and can be identified to species level.

### 3.3 Flora quadrats

The following series of tables provide a summary of each of the seven quadrats sampled during phase one of the monitoring program (Table 13 to Table 19). The summary includes: location of quadrat, photographs taken from either end of the quadrat, vegetation description and structure, dominant species in each stratum (cover and height), cover abundance of: weeds, bare ground, leaf litter and bryophytes, dominant weed species and presence of any threatening processes. Figure 2 shows the location of flora quadrats.

The cover abundance data for each quadrat is provided in Appendix E.

**Table 13    Quadrat 1: summary**

Start: Easting 669196    Northing 6166741	Quadrat 1 was located at the edge of the wetland bed in the northern section of the lagoon, which is closest to the Murray River.
Finish: Easting 669214    Northing 6166719	
<p><b>Vegetation:</b> consists of dense cover of prostrate herbs generally &lt;0.5m high and tufted graminoids to 1m tall. Dense regeneration of <i>Eucalyptus camaldulensis</i> (River Red-gum) up to 2m high. Within an area of 10m x 5m patch there are approximately 28 individuals of juvenile River Red-gum to 2 m high. <b>Soil:</b> grey cracking clay.</p>	
	
<b>Quadrat 1 view looking across wetland (Photo point 1)</b>	<b>Quadrat 1 view looking towards bank (Photo point 2)</b>
Ecological Vegetation Class	Bare ground according to EVC mapping, could be considered as Tall Marsh (EVC 821)
<b>Dominant trees</b>	None recorded
<b>Canopy trees</b>	None recorded
<b>Small trees</b>	None recorded
<b>Dominant shrubs</b>	<b>Cover and height</b>
<i>Eucalyptus camaldulensis</i> (River Red-gum) regeneration	5-25% cover, generally <2m tall
<b>Dominant ground species</b>	<b>Cover and height</b>
<i>Persicaria decipiens</i> (Slender Knotweed)	5-25% cover, <1.5m tall
<i>Glinus lotoides</i> (Hairy Carpet weed)	25-50% cover, <0.5m tall
<i>Cyperus exaltatus</i> (Tall Flat-sedge)	25-50% cover, <1m tall
<i>Cynodon dactylon</i> (Native Couch)	25-50% cover, <0.5m tall
<b>Weed cover</b>	5-25%
<b>Dominant weed species</b>	<i>Polygonum aviculare</i> (Wireweed)
<b>Leaf litter</b>	<1%
<b>Bryophytes and lichens</b>	Not evident
<b>Surface crust</b>	Note evident
<b>Bare ground</b>	5-25%
<b>Vegetation condition</b>	good
<b>Potential habitat for threatened flora</b>	Possible
<b>Threats</b>	Dense eucalypt regeneration within the wetland bed



**Table 14    Quadrat 2: summary**

Start: Easting 669279    Northing 6166663  
Finish: Easting 669300    Northing 6166678

Quadrat 2 is located within River Red-gum woodland in the northern section of the lagoon, which is closest to the Murray River.

**Vegetation:** Open woodland of *Eucalyptus camaldulensis* (River Red-gum) to 20m tall over a small tree layer of *Acacia stenophylla* (Eumong) to 6m tall. Ground layer is sparse but includes medium tufted graminoids < 0.5m tall and small to medium herbs < 0.3m tall.



**Quadrat 2 view looking toward wetland (photo point 3)**



**Quadrat 2 view looking toward woodland (photo point 4)**

<b>Ecological Vegetation Class</b>	Intermittent Swampy Woodland (EVC 813)
<b>Dominant trees</b>	<b>Cover and height</b>
<b>Canopy trees</b>	
<i>Eucalyptus camaldulensis</i> (River Red-gum)	5-25% cover, up to 20m tall
<b>Small trees</b>	
<i>Acacia stenophylla</i> (Eumong)	5-25% cover, up to 6m tall
<b>Dominant shrubs</b>	<b>Cover and height</b>
<i>Glycyrrhiza acanthocarpa</i> (Southern Liquorice)	<5%, up to 0.3m tall
<i>Rhagodia spinescens</i> (Hedge Saltbush)	+, up to 0.3m tall
<b>Dominant ground species</b>	<b>Cover and height</b>
<i>Cyperus gymnocaulos</i> (Spiny Flat-sedge)	5-25% cover, up to 0.5m tall
<i>Atriplex semibaccata</i> (Berry Saltbush)	5-25% cover, up to 0.5m tall
<i>Vittadinia</i> spp. ( <i>V. cuneata</i> ; Fuzzy New Holland Daisy and <i>V. dissecta</i> ; Dissected New Holland Daisy)	<5% cover, up to 0.1m tall
<b>Weed cover</b>	5-25%
<b>Dominant weed species</b>	<i>Cirsium vulgare</i> (Scotch Thistle) <i>Phyla canescens</i> (Fog-fruit) <i>Bromus rubens</i> (Red Brome)
<b>Leaf litter</b>	25-50% cover
<b>Bryophytes and lichens</b>	Not evident
<b>Surface crust</b>	Not evident
<b>Bare ground</b>	<5% cover
<b>Vegetation condition</b>	Fair to good condition, although weed cover is moderate.





Start: Easting 669279 Northing 6166663  
Finish: Easting 669300 Northing 6166678

Quadrat 2 is located within River Red-gum woodland in the northern section of the lagoon, which is closest to the Murray River.

	Trees generally in good health (see Tree health transect 1)
<b>Potential habitat for threatened flora</b>	possible
<b>Threats</b>	Weed invasion Dieback of some River Red-gums

**Table 15     Quadrat 3: summary**

Start: Easting 669774    Northing 6166330 Finish: Easting 669794    Northing 6166326		Quadrat 3 is located within River Red-gum woodland on the eastern side of the Lagoon
<b>Vegetation:</b> Open woodland of <i>Eucalyptus camaldulensis</i> (River Red-gum), with an understorey tree layer of <i>Acacia stenophylla</i> (Eumong). Ground layer is sparse and supports medium tufted graminoids and small to medium herbs. Occasional chenopods e.g. <i>Rhagodia spinescens</i> (Hedge Saltbush).		
		
<b>Quadrat view looking toward wetland (photo point 5)</b>		<b>Quadrat view looking toward woodland (photo point 6)</b>
<b>Ecological Vegetation Class</b>		Intermittent Swampy Woodland (EVC 813)
<b>Dominant trees</b>		<b>Cover and height</b>
<b>Canopy trees</b>		
<i>Eucalyptus camaldulensis</i> (River Red-gum)		5-25% cover, up to 20m tall
<b>Small trees</b>		
<i>Acacia stenophylla</i> (Eumong)		5-25% cover, up to 10m tall
<b>Dominant shrubs</b>		<b>Cover and height</b>
<i>Rhagodia spinescens</i> (Hedge Saltbush)		<5% cover, <0.5m tall
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i> (Ruby Saltbush)		<5% cover, <0.5m tall
<b>Dominant ground species</b>		<b>Cover and height</b>
<i>Cyperus gymnocaulos</i> (Spring Flat-sedge)		5-25% cover, <0.3m tall
<i>Senecio</i> spp. (e.g. <i>Senecio runcinifolius</i> ; Tall fireweed).		5-25% cover, <0.3m tall
<i>Vittadinia</i> spp. (e.g. <i>V. cuneata</i> ; Fuzzy New Holland Daisy and <i>V. dissecta</i> ; Dissected New Holland Daisy)		<5%, <0.1m tall
<i>Wahlenbergia fluminialis</i> (River Bluebell)		<5%, <0.3m tall
<b>Weed cover</b>		<5% cover
<b>Dominant weed species</b>		<i>Cirsium vulgare</i> (Spear Thistle) <i>Sonchus oleraceus</i> (Sow Thistle)
<b>Leaf litter</b>		50-75% cover, abundant.
<b>Bryophytes and lichens</b>		<5% cover
<b>Surface crust</b>		<5% cover
<b>Bare ground</b>		5-25% cover



Start: Easting 669774 Northing 6166330  
Finish: Easting 669794 Northing 6166326

Quadrat 3 is located within River Red-gum woodland on the eastern side of the Lagoon

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**Vegetation condition**

Fair to good

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**Potential habitat for threatened flora**

rare *Asperula gemella* (Twinleaf Bedstraw) present  
Potential for other threatened flora

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**Threats**

Weeds

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**Table 16    Quadrat 4: summary**

Start: Easting 669756    Northing 6166339	Quadrat 4 is located adjacent to quadrat 3 within the wetland bed and edge of bank.
Finish: Easting 669774    Northing 6166333	
Vegetation: Edges of wetland bed are dominated by tall emergent graminoids (rushes and sedges) such as <i>Typha orientalis</i> (Broad-leaf Cumbungi). Some <i>Eucalyptus camaldulensis</i> (River Red-gum) regeneration in bed, approximately 16 individuals in a 10 m x 10 m area.	
	
<b>Quadrat 4 view looking across wetland (photo point 7)</b>	<b>Quadrat 4 view looking toward woodland (photo point 8)</b>
<b>Ecological Vegetation Class</b>	Bare ground according to EVC mapping, but could be considered as Tall Marsh (EVC 821)
<b>Dominant trees</b>	<b>Cover and height</b>
<b>Canopy trees</b>	None recorded
<i>Eucalyptus camaldulensis</i> (River Red-gum), overhanging	<5% cover, overhanging
<b>Small trees</b>	
<i>Acacia stenophylla</i> (Eumong), overhanging	<5% cover, up to 10m tall
<b>Dominant shrubs</b>	<b>Cover and height</b>
<i>Typha orientalis</i> (Broad-leaf Cumbungi)	50-75% cover, up to 3.5m tall
<b>Dominant ground species</b>	<b>Cover and height</b>
<i>Cyperus gymnocaulos</i> (Spring Flat-sedge)	5-25% cover, up to 1m tall
<i>Cynodon dactylon</i> (Native Couch)	<5% cover, up to 0.3m tall
<b>Weed cover</b>	<5% cover
<b>Dominant weed species</b>	<i>Sonchus oleraceus</i> (Sow Thistle)
	<i>Cyperus eragrostis</i> (Drain Flat-sedge)
	<i>Cirsium vulgare</i> (Scotch Thistle)
<b>Leaf litter</b>	<5% cover
<b>Bryophytes and lichens</b>	Not evident
<b>Surface crust</b>	Not evident
<b>Bare ground</b>	25-50% cover
<b>Vegetation condition</b>	Moderate condition owing to presence of high threat weeds and RRG regeneration.
<b>Potential habitat for threatened flora</b>	Possible



Start: Easting 669756 Northing 6166339  
Finish: Easting 669774 Northing 6166333

Quadrat 4 is located adjacent to quadrat 3 within the wetland bed and edge of bank.



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**Threats**

Weeds, although currently in low abundance  
RRG regeneration within the wetland bed

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**Table 17    Quadrat 5: summary**

Start: Easting 669634    Northing 6165755	Quadrat 5 is located at the southern end of the Lagoon within River Red-gum woodland.
Finish: Easting 669638    Northing 6165775	
<b>Vegetation:</b> Open woodland of <i>Eucalyptus camaldulensis</i> (River Red-gum) to 20m tall. Eucalypts young and tall, with DBH generally < 50 cm. Shrub layer is very sparse. Ground layer dominated by small to medium herbs such as <i>Senecio quadridentatus</i> (Cotton Fireweed) and occasional medium tufted graminoids.	
	
<b>Quadrat 5 view looking toward wetland (photo point 9)</b>	<b>Quadrat 5 view looking across woodland (photo point 10)</b>
<b>Ecological Vegetation Class</b>	Intermittent Swampy Woodland (EVC 813)
<b>Dominant trees</b>	<b>Cover and height</b>
<b>Canopy trees</b>	
<i>Eucalyptus camaldulensis</i> (River Red-gum)	5-25% cover, up to 20m tall
<b>Small trees</b>	
<i>Acacia stenophylla</i> (Eumong)	+, up to 8m tall
<b>Dominant shrubs</b>	<b>Cover and height</b>
<i>Rhagodia spinescens</i> (Hedge Saltbush)	<5% cover, up to 0.5m tall
<i>Atriplex semibaccata</i> (Berry Saltbush)	<5% cover, up to 0.3m tall
<b>Dominant ground species</b>	<b>Cover and height</b>
<i>Senecio quadridentatus</i> (Cotton Fireweed)	5-25% cover, up to 0.5m tall
<i>Wahlenbergia fluminalis</i> (River Bluebell)	5-25% cover, up to 0.3m tall
<i>Cynodon dactylon</i> (Native Couch)	5-25% cover, up to 0.3m tall
<b>Weed cover</b>	5-25% cover
<b>Dominant weed species</b>	<i>Dittrichia graveolens</i> (Stinkwort) <i>Sonchus oleraceus</i> (Sow Thistle) <i>Cirsium vulgare</i> (Spear Thistle)
<b>Leaf litter</b>	50-75% cover
<b>Bryophytes and lichens</b>	<5% cover
<b>Surface crust</b>	Not evident
<b>Bare ground</b>	5-25% cover
<b>Vegetation condition</b>	Fair, owing to weed cover.
<b>Potential habitat for threatened flora</b>	Possible
<b>Threats</b>	Weeds



Start: Easting 669634 Northing 6165755  
Finish: Easting 669638 Northing 6165775

Quadrat 5 is located at the southern end of the Lagoon within River Red-gum woodland.

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Tree dieback nearby, adjacent to quadrat.

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**Table 18    Quadrat 6: summary**

Start: Easting 669636    Northing 6165735	Quadrat 6 is located within the edge of the wetland bed in the southern arm of the Lagoon
Finish: Easting 669637    Northing 6165754	
<b>Vegetation:</b> consists of dense cover of large non-tufted graminoids to 3m tall, <i>Typha orientalis</i> ; Broad-leaf Cumbungi) medium tufted graminoids to 1m tall and prostrate herbs generally <0.5m high. Dense regeneration of <i>Eucalyptus camaldulensis</i> (River Red-gum) up to 2m high. <b>Soil:</b> grey cracking clay.	
	
<b>Quadrat 6 view looking across wetland (photo point 11)</b>	<b>Quadrat 6 view looking towards woodland (photo point 12)</b>
<b>Ecological Vegetation Class</b>	Bare ground according to EVC mapping, but more appropriately mapped as Tall Marsh (EVC 821)
<b>Dominant trees</b>	<b>Cover and height</b>
<b>Canopy trees</b>	None recorded
<b>Small trees</b>	
<i>Eucalyptus camaldulensis</i> (River red-gum) regeneration	5-25% cover, up to 3m tall
<b>Dominant shrubs</b>	None recorded
<b>Dominant ground species</b>	<b>Cover and height</b>
<i>Typha orientalis</i> (Broad-leaf Cumbungi)	50-75%, up to 3m tall
<i>Glinus lotoides</i> (Hairy Carpet-weed)	5-25% cover, up to 0.2m tall
<i>Persicaria decipiens</i> (Slender Knotweed)	5-25% cover, up to 1m tall
<i>Cynodon dactylon</i> (Native Couch)	5-25% cover, up to 0.3m tall
<i>Cyperus gymnocaulos</i> (Spring Flat-sedge)	<5% cover, up to 0.5m tall
<b>Weed cover</b>	5-25% cover
<b>Dominant weed species</b>	<i>Paspalum distichum</i> (Water Couch) <i>Aster subulatus</i> (Aster-weed)
<b>Leaf litter</b>	<5% cover
<b>Bryophytes and lichens</b>	Not evident
<b>Surface crust</b>	Not evident
<b>Bare ground</b>	25-50% cover
<b>Vegetation condition</b>	Fair to good
<b>Potential habitat for threatened flora</b>	Possible
<b>Threats</b>	Weed invasion



Start: Easting 669636 Northing 6165735  
Finish: Easting 669637 Northing 6165754



Quadrat 6 is located within the edge of the wetland bed in the southern arm of the Lagoon

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Eucalypt regeneration in wetland bed

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**Table 19    Quadrat 7: summary**

Start: Easting 669708    Northing 6165598 Finish: Easting 669712    Northing 6165581		Quadrat 7 is located immediately adjacent to quadrat 6 within the adjacent River Red-gum woodland.
<b>Vegetation:</b> Open woodland of <i>Eucalyptus camaldulensis</i> (River Red-gum) and <i>Eucalyptus largiflorens</i> (Black Box). Small tree layer absent. Shrub layer is sparse, consisting mostly of <i>Muehlenbeckia florulenta</i> (Tangled Lignum) and small to medium sized chenopods: e.g. <i>Rhagodia spinescens</i> (Hedge Saltbush) and <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> (Ruby Saltbush). <i>E. camaldulensis</i> (River Red-gum) are mostly dead. Very poor tree health at this location on the edge of the lagoon. <b>Soil:</b> clay loam.		
		
<b>Quadrat 7 view looking toward wetland (photo point 13)</b>		<b>Quadrat 7 view looking across woodland (photo point 14)</b>
<b>Ecological Vegetation Class</b>		Intermittent Swampy Woodland (EVC 813) but perhaps would be better mapped as Riverine Chenopod Woodland (EVC 103)
<b>Dominant trees</b> <b>Canopy trees</b> <i>Eucalyptus camaldulensis</i> (River Red-gum) <i>Eucalyptus largiflorens</i> (Black Box) <b>Small trees</b>		<b>Cover and height</b> <5% cover, up to 20m tall 5-25% cover, up to 20m tall None present
<b>Dominant shrubs</b> <i>Rhagodia spinescens</i> (Hedge Saltbush) <i>Muehlenbeckia florulenta</i> (Tangled Lignum)		<b>Cover and height</b> 5-25% cover, up to 0.5m tall 5-25% cover, up to 2m tall
<b>Dominant ground species</b> <i>Atriplex semibaccata</i> (Berry Saltbush) <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> (Ruby Saltbush)		<b>Cover and height</b> 5-25% cover, up to 0.3m tall 5-25% cover, up to 0.3m tall
<b>Weed cover</b>		+ cover
<b>Dominant weed species</b>		<i>Opuntia</i> sp. <i>Paspalum distichum</i> (Water Couch)
<b>Leaf litter</b>		25-50% cover
<b>Bryophytes and lichens</b>		<5% cover
<b>Surface crust</b>		<5% cover
<b>Bare ground</b>		5-25% cover
<b>Vegetation condition</b>		Fair to good as almost weed free, but trees are mostly dead



Start: Easting 669708 Northing 6165598  
 Finish: Easting 669712 Northing 6165581

Quadrat 7 is located immediately adjacent to quadrat 6 within the adjacent River Red-gum woodland.

or in very poor health

**Potential habitat for threatened flora**

Possible

**Threats**

Tree dieback  
 Possible invasion of species that prefer and tolerate dry conditions e.g. chenopods: *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush), *Rhagodia spinescens* (Hedge Saltbush). However, this may be of natural occurrence and the vegetation may be better described as Riverine Chenopod Woodland (based on species composition e.g. dominance of Black Box and chenopods).

### 3.4 Tree health using method 1

#### 3.4.1 Overview

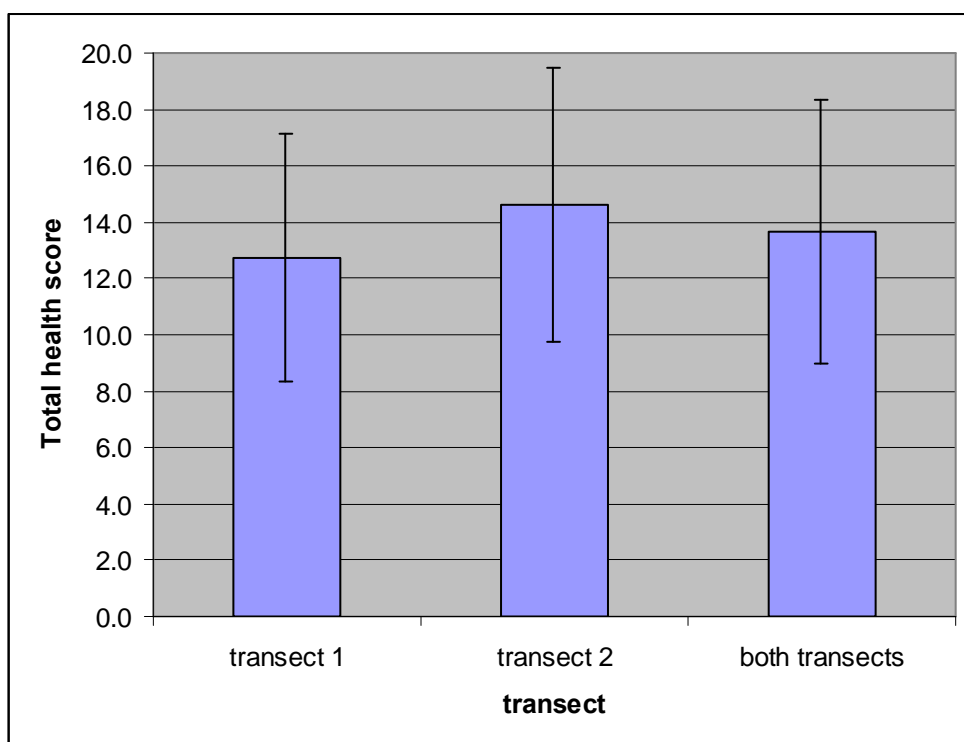
The mean tree health score for all sixty trees surveyed at Margooya lagoon was 13.7 out of a possible score of 20 ( $\pm$  SD 4.7). Trees were generally in fair to moderate condition showing few signs of bark cracking, no evidence of mistletoe attack, healthy leaf condition and moderate canopy cover. Very large and large old trees are showing signs of dieback. The raw data for all trees sampled is provided in Appendix F.

#### 3.4.2 Comparison of two transects

Tree health data for each of the two transects is summarised in Figure 5. According to the overall score for tree health, tree health was not significantly different between transect 1 and transect 2.

Tree health scores ranged from 8 to 17 at transect 1 and from 10 to 19 at transect 2. The data suggests that tree health is highly variable between trees within each of the two transects.

**Figure 5 Summary of tree health data for the two transects at Margooya Lagoon**

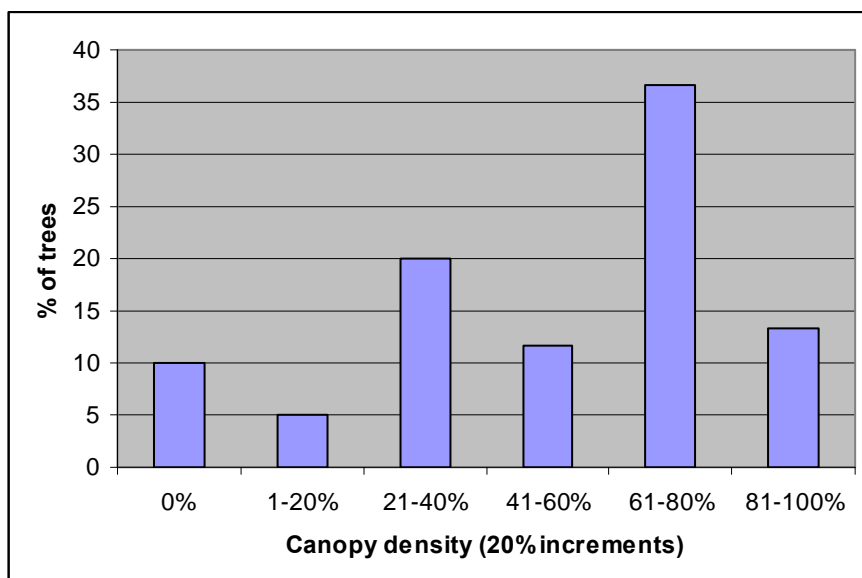


#### 3.4.3 Canopy cover

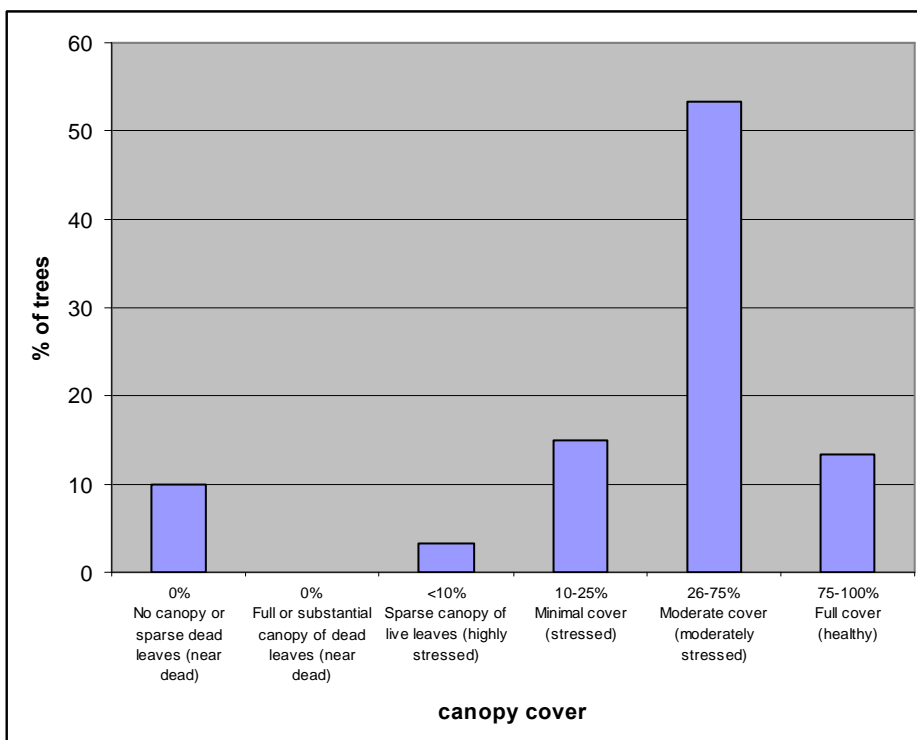
Using the broad scale of canopy cover described by Wallace et al. 2007, most trees scored a 4 out of 5 for canopy cover (26-75% cover) (Figure 6). This result is somewhat misleading as trees that have a canopy cover of 26% are treated the same as trees that have up to 75% canopy cover. Therefore, it is important to also consider the data for canopy cover collected at 20% increments. This data shows that

only half of the trees surveyed at Margooya lagoon had moderate canopy cover (i.e. canopy cover > 60%) (Figure 7). The remaining half of trees are showing signs of crown dieback with < 60% canopy cover. Of particular note is 35% of trees had crown cover < 40%.

**Figure 6 Canopy cover of trees surveyed at Margooya Lagoon using 20% increments**



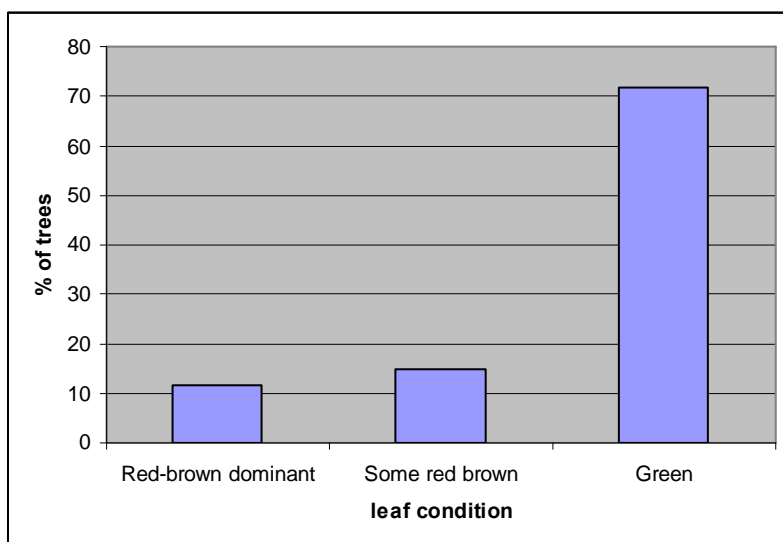
**Figure 7 Canopy cover of trees surveyed at Margooya Lagoon using method of Wallace et al. 2007**



### 3.4.4 Leaf condition and bark condition

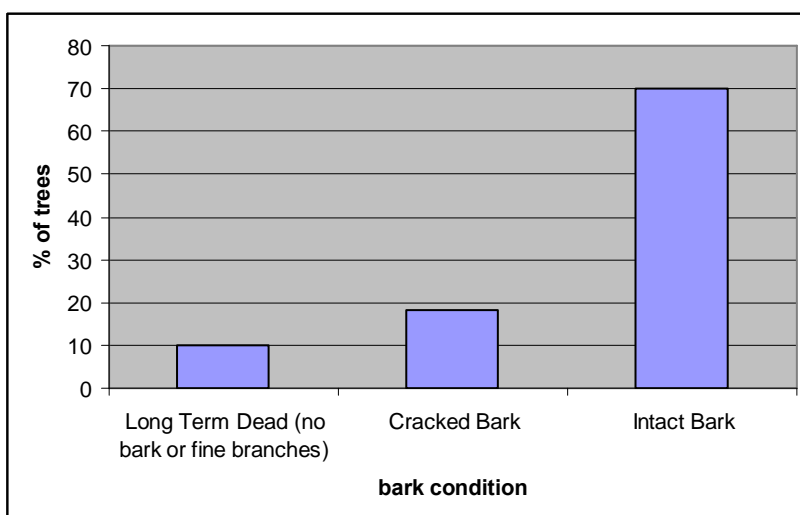
The majority of trees had green leaves and did not show signs of red-brown leaves (one of the symptomatic signs of dieback) (Figure 8).

**Figure 8 Leaf condition of trees surveyed at Margooya Lagoon**



The majority of trees had intact bark (70%) (Figure 9). Trees that were near dead or dead had cracked bark (28%).

**Figure 9 Bark condition of trees surveyed at Margooya lagoon**



### 3.4.5 Reproductive status

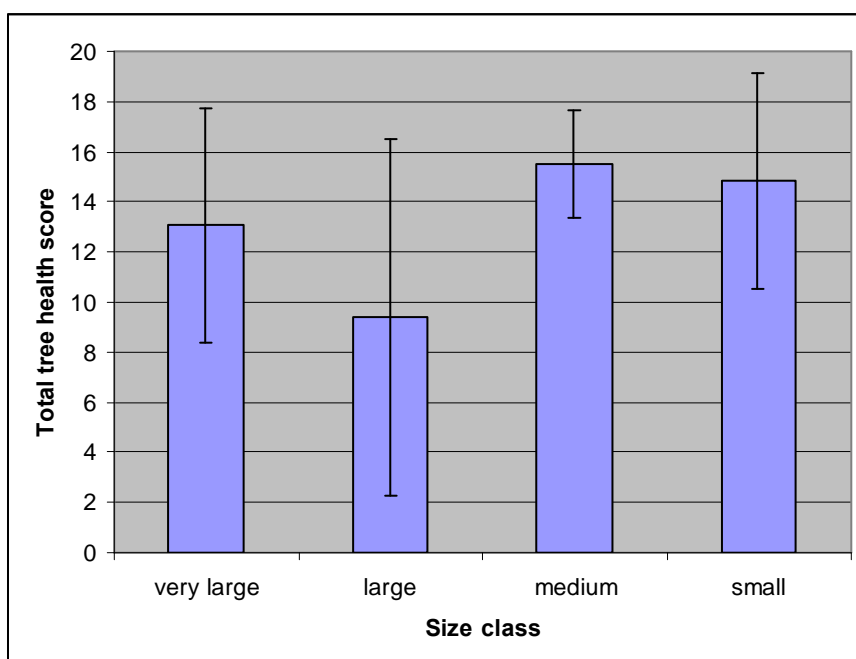
The majority of trees at transect 1 generally did not have buds, flowers or woody capsules present, whilst the majority of trees at Transect 2 had buds and woody capsules.

### 3.4.6 Size-classes

Size of RRG trees included in the sampling program at Margooya Lagoon ranged from 20.5 cm DBH to 240 cm DBH. The majority of RRG sampled at the Margooya Lagoon were very large trees ( $\geq 87.5$ ). The mean DBH of trees sampled was 91 cm ( $\pm 55$  cm = STD).

Comparing health of different sized trees (Figure 10), it would appear that medium and small sized trees are in better condition than large or very large trees at Margooya Lagoon. However, it should be acknowledged that the sample size would need to be larger to detect significant differences in health of different size-class trees at Margooya Lagoon.

**Figure 10 Tree health at Margooya Lagoon according to size-class**



### 3.5 Tree health using method 2

Using method 2, condition is measured as the sum of the crown cover and density scores, with cracked bark and intact bark trees recorded separately. Condition is presented as the frequency of cracked and intact bark trees within each of the condition categories (DSE in preparation). We have used condition categories of 0 to 7 (i.e. divided the sum of crown cover and density scores by 2).

Response is measured as the mean of the behavioural attribute scores for each condition category. The total response score is divided by six (the maximum response score possible) in order to convert to a number between 0 and 1.

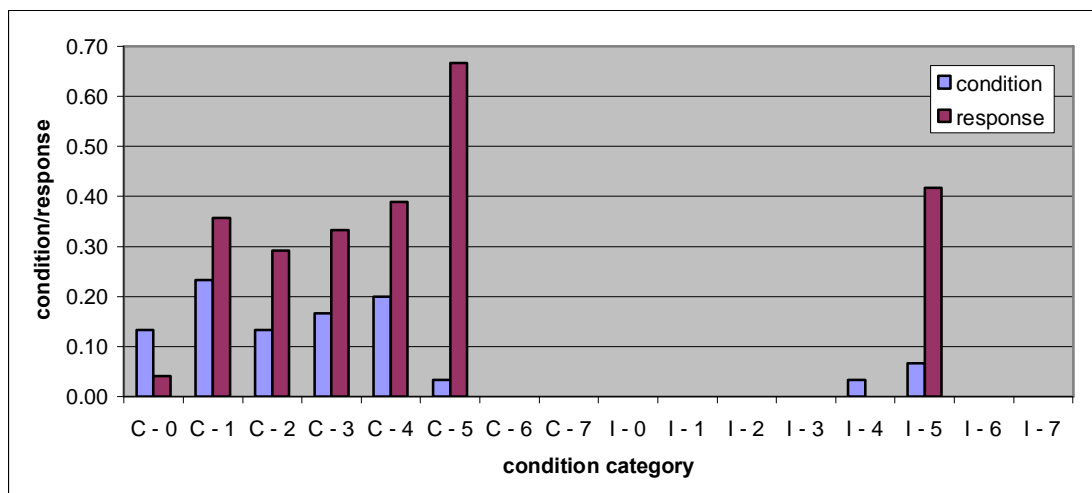
Condition and response are depicted together in a bar graph. The frequency of trees in each condition class describes the current status of the population. Response provides an indication of the likely future trajectory of condition.

The following series of figures shows the condition and response of trees within each transect (Figure 11; transect 1 and Figure 12; transect 2) and both transects combined (Figure 13).



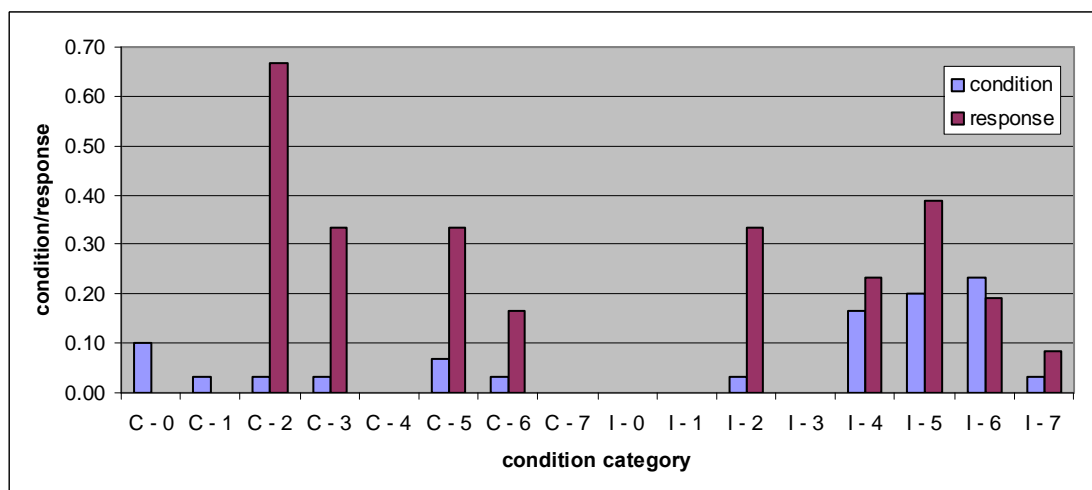
From the frequency histograms, it may be concluded that trees at Margooya range from severely stressed to healthy. The frequency distribution showed that a greater number of trees were in poorer health at transect 1 than transect 2. The response data shows that most trees are showing some signs of recovery (e.g. epicormic growth).

**Figure 11 Red gum condition and trajectory at Transect 1, Margooya Lagoon, Robinvale**



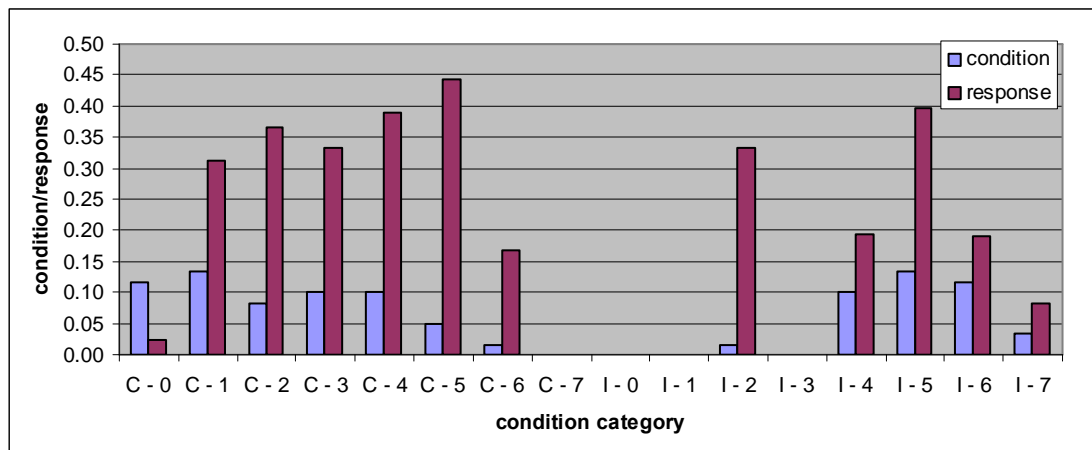
Blue bars are frequency of trees in each condition class (0-7, crown cover plus density score). Purple bars are mean response for each condition class (sum of three positive and three negative response variables scored as 0, scarce or absent; 1 present; 2 dominant). C = cracked bark, I = intact bark.

**Figure 12 Red gum condition and trajectory at Transect 2, Margooya Lagoon, Robinvale**



Blue bars are frequency of trees in each condition class (0-7, crown cover plus density score). Purple bars are mean response for each condition class (sum of three positive and three negative response variables scored as 0, scarce or absent; 1 present; 2 dominant). C = cracked bark, I = intact bark.

**Figure 13 Overall red gum condition and trajectory, Margooya Lagoon, Robinvale**



Blue bars are frequency of trees in each condition class (0-7, crown cover plus density score). Purple bars are mean response for each condition class (sum of three positive and three negative response variables scored as 0, scarce or absent; 1 present; 2 dominant). C = cracked bark, I = intact bark.

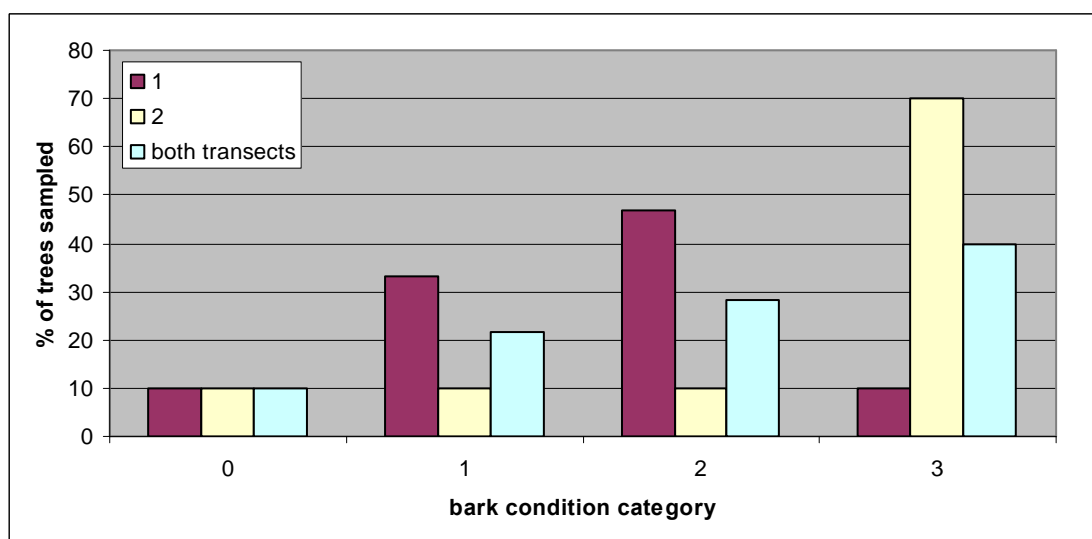
#### Percentage Live Basal Area

Percentage live basal area was 90% across all trees sampled (for both transects combined). At transect 1, percentage live basal area 95% and at transect 2, percentage live basal area was 86%.

#### Bark condition

Approximately half of the RRG trees sampled are showing signs of cracked bark, although for the majority of trees the cracked bark is currently not extensive.

**Figure 14 Bark condition using method 2**

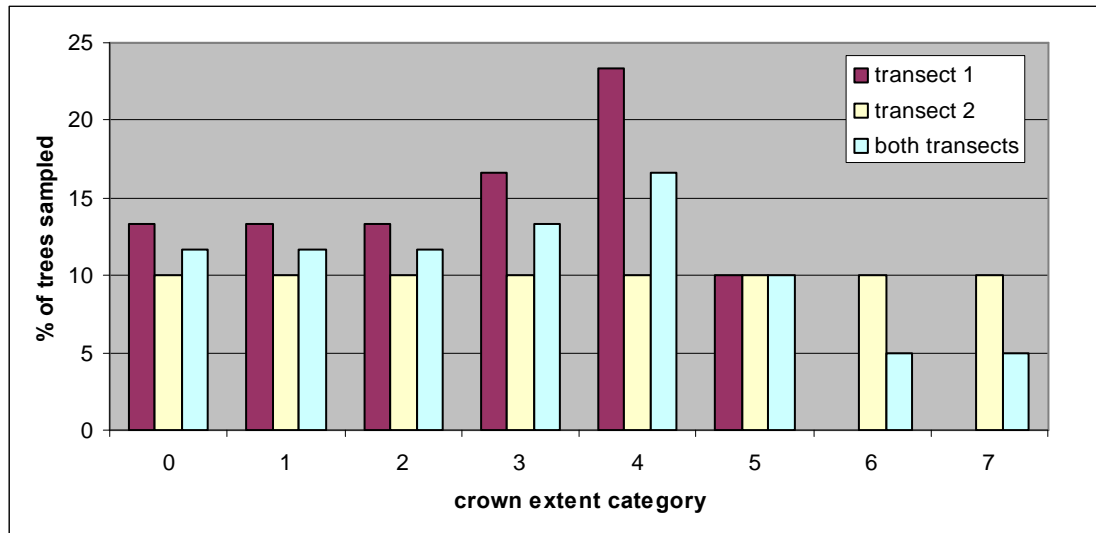


key to categories: 0=no bark (long-term dead), 1=extensive areas of cracked bark, 2=minor areas of cracked bark and 3=intact bark.

### Crown extent

Crown extent was highly variable between trees at each transect. The majority of trees had moderate cover (< 60% cover).

**Figure 15 Crown extent using method 2**

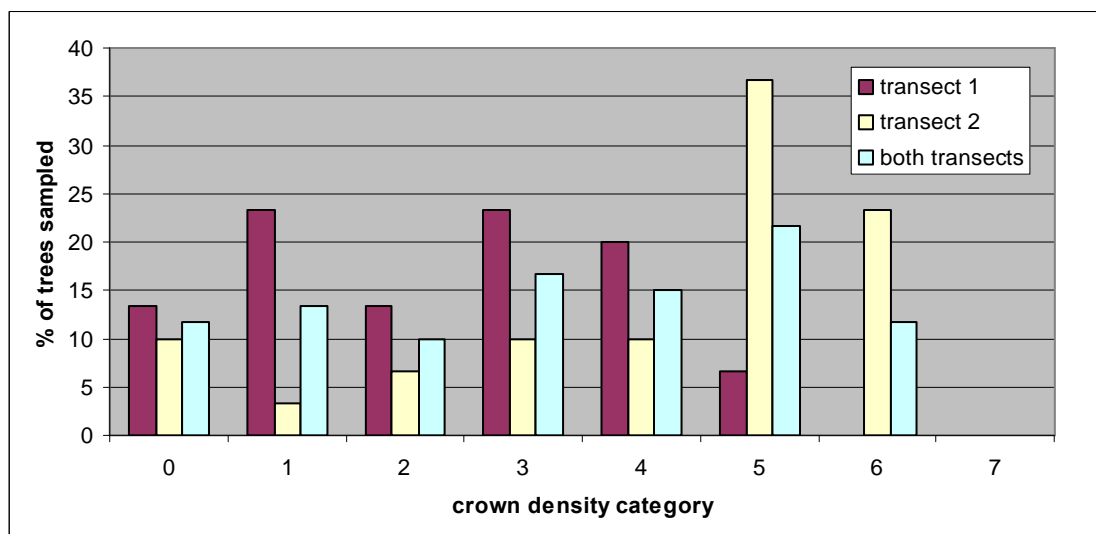


key to categories: 0=none (0% cover), 1=minimal (1-10% cover), 2=sparse (11-20% cover), 3=sparse to moderate (21-40% cover), 4=moderate (41-60% cover), 5=moderate to major (61-80% cover), 6=major (81-90% cover) and 7=maximum (91-100% cover).

### Crown density

Crown density was also highly variable amongst trees sampled. Crown density was higher in trees at transect 2 than trees at transect 1.

**Figure 16 Crown density using method 2**



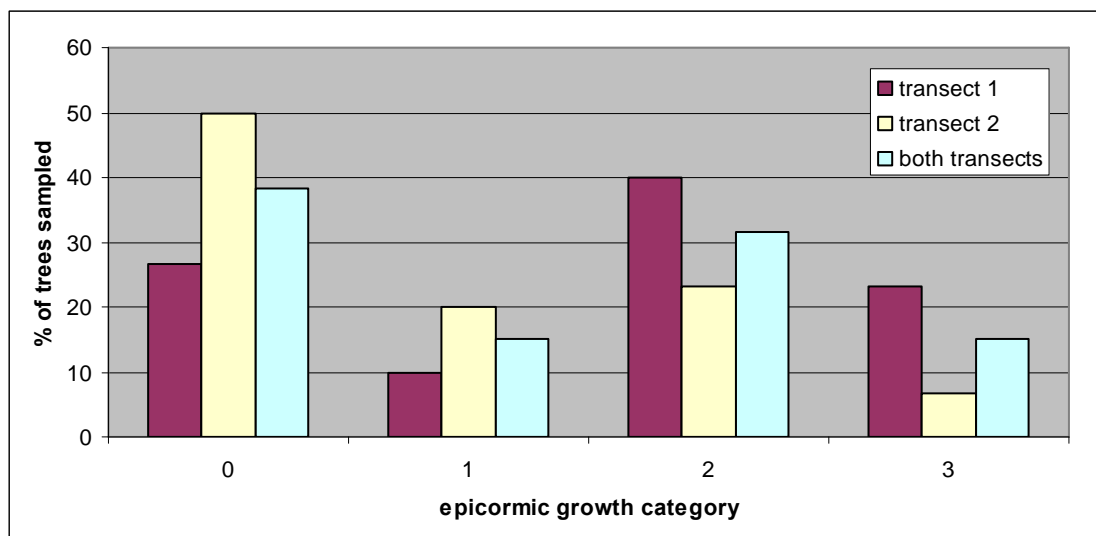
key to categories: 0=none (0% cover), 1=minimal (1-10% cover), 2=sparse (11-20% cover), 3=sparse to moderate (21-40% cover), 4=moderate (41-60% cover), 5=moderate to major (61-80% cover), 6=major (81-90% cover) and 7=maximum (91-100% cover).

### Recovery

Epicormic growth on trees was highly variable ranging from scarce (effect not readily visible) to common (effect is clearly visible).

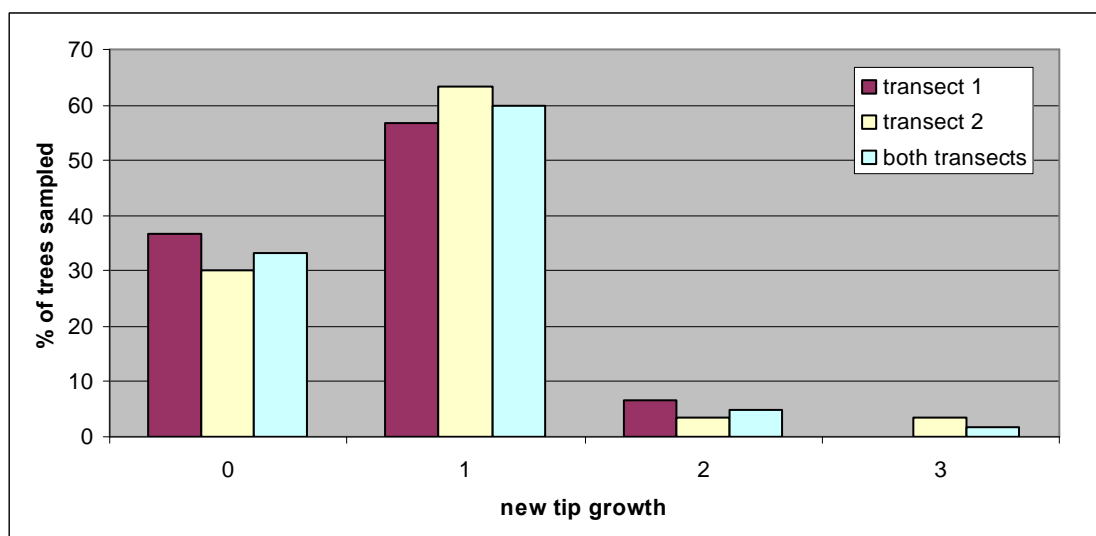
New tip growth was scarce: effect not readily visible on the majority of trees sampled.

**Figure 17 Epicormic growth using method 2**



key to categories: 0=absent, 1=scarce, 2=common and 3=abundant.

**Figure 18 New tip growth using method 2**

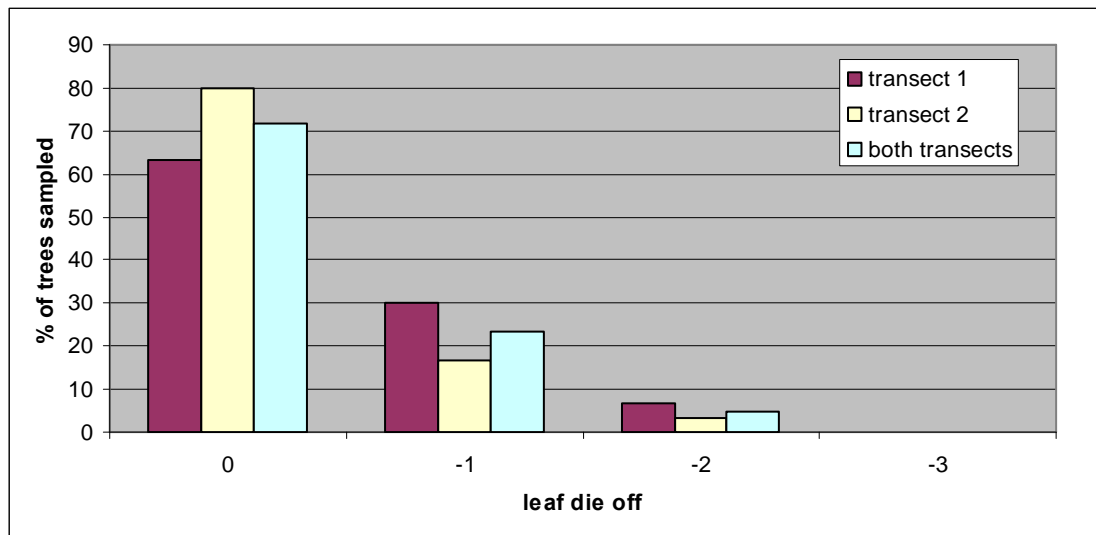


key to categories: 0=absent, 1=scarce, 2=common and 3=abundant.

### Decline: Leaf die off

Leaf die-off was not present or scarce for most trees sampled (i.e. effect is present but not readily visible).

**Figure 19 Leaf die off using method 2**



key to categories: 0=absent, -1=scarce, -2=common and -3=abundant.

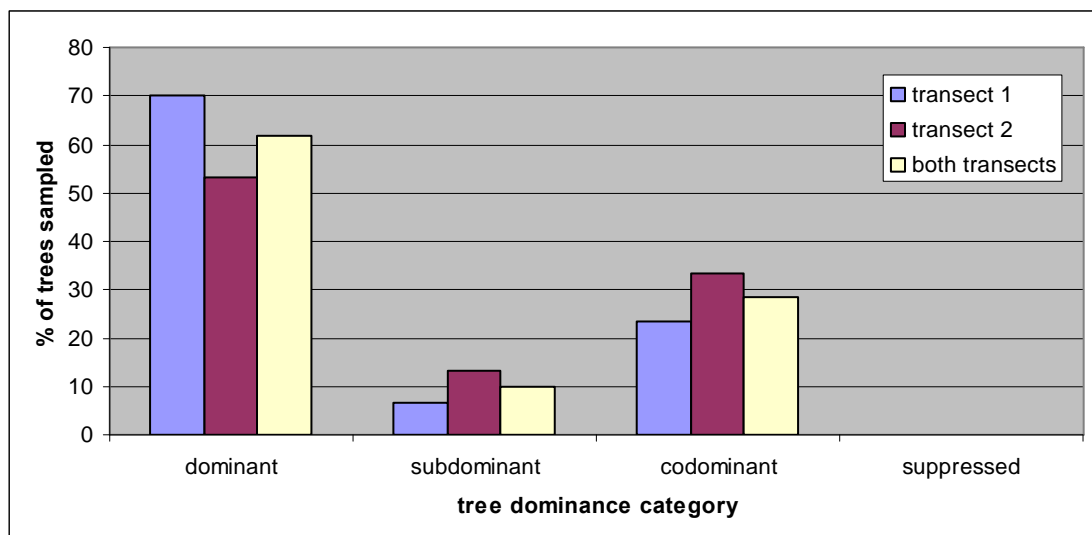
### Decline: Mistletoe

No mistletoe was present on any of the trees sampled at Margooya Lagoon.

### Tree dominance

The majority of trees were dominant trees or co-dominant trees. A dominant tree is a tree with a crown extending above the general canopy, receiving full light from above and partly from the sides; a larger than average tree in the stand. A co-dominant tree is a tree with crown forming part of the general canopy, receiving full light from above but comparatively little from the sides.

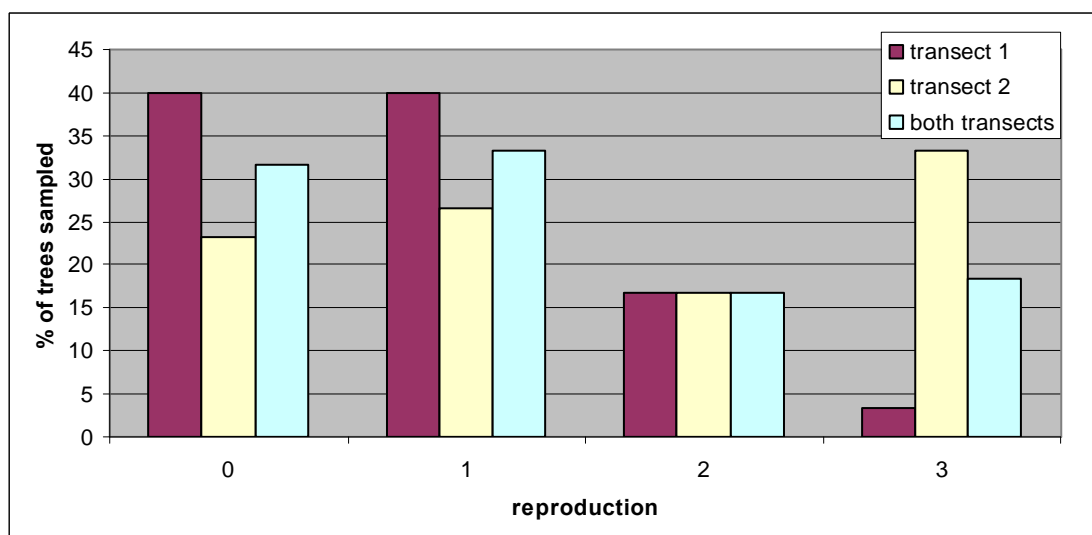
**Figure 20 Tree dominance using method 2**



### Reproduction

Reproductive behaviour was highly variable between trees at each transect. At transect 1, reproduction was generally absent or scarce (reproductive behaviour is present but not readily visible). Whilst at transect 2, reproduction was generally common (reproductive behaviour is clearly visible) or abundant (reproductive behaviour dominates the appearance of the tree). More trees were showing reproductive behaviour in the second sampling period (August) in comparison to the first sampling period (April).

**Figure 21 Reproduction using method 2**



key to categories: 0=absent, 1=scarce, 2=common and 3=abundant.

### DBH

Refer to section 3.4.6.

### Additional assessments

#### *Insect damage*

Insect damage was scarce at both transect 1 and 2 (i.e. some trees have scattered damage within the crown).

#### *Other biological stresses*

Weeds were common at Transect 1 but scarce at Transect 2. Common weeds included *Fumaria* sp. (Fumaria), *Olea europaea* (Olive), *Sisymbrium erysimoides* (Indian Mustard) and Thistles.

### **3.5.1 General observations of tree health**

Tree health is in severe decline at the following location within Margooya Lagoon (Figure 22). At this site the majority of trees have died. This may be the result of high salinity in soils and/or groundwater. The causes of this dieback warrant further investigation (refer to GHD 2008 for possible causes).

**Figure 22 Tree dieback at Margooya Lagoon (easting 669708 northing 6165602)**





## 4. Fauna results: Stage 1 of the monitoring program<sup>5</sup>

### 4.1 Margooya Lagoon – Habitat Assessment and Fauna Survey Site 1



#### 4.1.1 Fauna Values

A site visit was conducted on 14/05/08 at the north-western end of Margooya Lagoon where the lagoon inlet joins the Murray River. Fauna species recorded in the study area are listed in Appendix H. Thirty-two species were observed during the field assessment:

- » Twenty-six native birds (plus one exotic bird);
- » One native mammal (plus one exotic mammal);
- » Two reptiles; and
- » One frog.

Fauna habitats include numerous very large River Red Gum (*Eucalyptus camaldulensis*) (RRG) trees, with a range of large and small hollows present within the trunk and branches. The site also displays high levels of woody debris, with numerous fallen logs containing hollows. Deep litter is present at the base of RRGs and the shrub layer is comprised of scattered River Cooba (*Acacia stenophylla*). Dense vegetation

<sup>5</sup> Note that a bird survey only was conducted at fauna survey site 4 due to time constraints.



is present along the wetland fringe (Cumbungi *Typha* sp. and *Cyperus* sp.), which provides habitat for species preferring dense cover such as Superb Fairy Wren (*Malurus cyaneus*).

Trees within this site are in variable condition, with some appearing relatively healthy, while others are exhibiting varying degrees of dieback. This could be attributed to the natural ageing process in some cases, but is more likely to be related to high salt levels in the soil and possibly seepage of saline irrigation water from nearby agricultural properties to the west of the lagoon. A light salt crust and salty aroma was noted on walking out onto the wetland bed. The Mallee CMA is closely monitoring salt levels in the remaining residual pools of water in the wetland and is prepared to reintroduce water to the wetland to neutralise these impacts if necessary (R. De Groot pers. comm.).

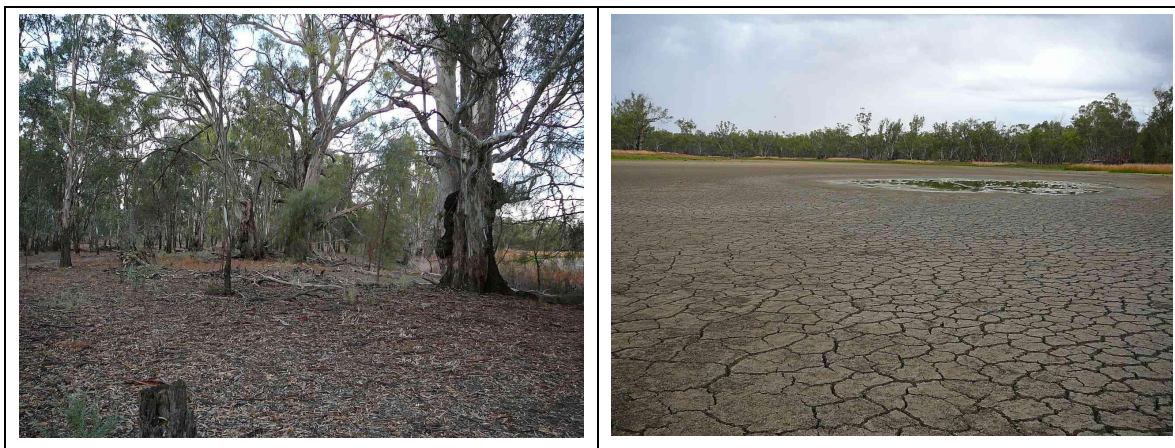
The habitat assessment demonstrated that site one provided (see Appendix I):

- » High numbers of large trees (primarily River Red Gum);
- » High abundance of hollows (primarily located within the trunk and branches of River Red Gum);
- » High levels of woody debris (although this may be a product of poor tree health, hence loss of limbs);
- » High abundance of large stags (this could be due to poor tree health);
- » Moderate structural diversity;
- » Moderate leaf litter levels;
- » Moderate connectivity to other fauna habitats (agricultural land exists nearby).

This site exhibits relatively good connections to other fauna habitats in the area; however, agricultural land to the west is in close proximity and interferes with the Murray River riparian vegetation corridor. There is good connectivity to the east of the lagoon however.

## 4.2 Margooya Lagoon – Habitat Assessment and Fauna Survey Site 2





#### 4.2.1 Fauna Values

A site visit was conducted on 15/05/08 along the southern side of the north-eastern arm of Margooya Lagoon. Fauna species recorded in the study area are listed in Appendix H. Twenty-nine species were observed during the field assessment:

- » Twenty-four native birds (plus one exotic bird);
- » One native mammal (plus one exotic mammal);
- » One reptile; and
- » One frog.

Similar to Site 1, the primary habitat feature relates to abundant very large hollow-bearing River Red Gum (*Eucalyptus camaldulensis*) trees, with many hollows both within the trunk and limbs. Woody debris was also noted as abundant, with many large branches also containing hollows. Scattered River Cooba (*Acacia stenophylla*) was present, although only very sparsely scattered throughout. Dense Cumbungi (*Typha* sp.) was present in clumps along the wetland inner fringe, although this was beginning to brown off and die in some places due to the recent drying of Margooya Lagoon. Tree health was again variable, with some trees in seemingly good health and others in severe stages of decline. This may be due in part to saline groundwater impacts that are being monitored by the Mallee CMA, but in some cases could be natural decline from old age in a number of extremely large River Red Gums.

The habitat assessment demonstrated that site two provided (see Appendix I):

- » High numbers of large trees (primarily River Red Gum);
- » High abundance of hollows (primarily located within the trunk and branches of River Red Gum);
- » Moderate to high levels of woody debris;
- » Low abundance of large stags;
- » Moderate structural diversity;
- » Moderate leaf litter levels;
- » High connectivity to other fauna habitats (habitat connectivity on all sides).



### 4.3 Margooya Lagoon – Habitat Assessment and Fauna Survey Site 3



#### 4.3.1 Fauna Values

A site visit was conducted on 15/05/08 along northern side of the southern arm of Margooya Lagoon. Fauna species recorded in the study area are listed in Appendix H. Nineteen species were observed during the field assessment:

- » Eighteen native birds; and
- » One exotic mammal.

This site is generally in relatively poor condition overall, with numerous River Red Gum (*Eucalyptus camaldulensis*) trees in poor health (e.g. exhibiting limb loss, cracking bark, loss of leaves), both along the fringe of the wetland and in isolated stands. This may be due to saline groundwater influences, or a range of other factors including the impacts of permanent wetland inundation. Some localised degradation of River Red Gum trees was noted on the upper bank of the wetland, but on closer inspection may have been the result of a fire. Fauna habitats are available, although less abundant than Sites 1 and 2 as the canopy vegetation is less dense, with fewer hollows, fewer large trees and lower levels of woody debris on the ground. The Black Box woodland further inland from the wetland fringe appeared to be supporting particularly high numbers of certain species of bird, including the Yellow subspecies of the Crimson Rosella (*Platycercus elegans*), Regent Parrot (*Polytelis anthopeplus*) and White-plumed Honeyeater (*Lichenostomus penicillatus*).



Dense stands of Cumbungi (*Typha* sp.) and *Persicaria* sp. exist along the wetland fringe, providing habitat for species preferring dense cover such as the Superb Fairy-wren (*Malurus cyaneus*) and possibly species such as the Australian Spotted Crake (*Porzana fluminea*).

The habitat assessment demonstrated that site three provided (see Appendix I):

- » Moderate numbers of large trees (primarily River Red Gum);
- » Low to Moderate abundance of hollows (primarily located within the branches of River Red Gum);
- » Low to moderate levels of woody debris;
- » High abundance of large stags (likely due to the overall poor health of River Red Gum trees in this area);
- » Low to moderate structural diversity;
- » Low to moderate leaf litter levels;
- » High connectivity to other fauna habitats (habitat connectivity on all sides).

## **4.4 Margooya Lagoon**

### **4.4.1 Incidental Fauna**

An additional list of incidental fauna species recorded in the study area (i.e. fauna species recorded between survey sites) is listed in Appendix H. Sixteen incidental species were recorded from the present assessment:

- » Fourteen native birds;
- » One exotic mammal; and
- » One exotic fish

### **4.4.2 Atlas of Victorian Wildlife (AVW) Records**

The Atlas of Victorian Wildlife (AVW) database (2005 version) was reviewed for fauna records up to 10 km around the study area. This search indicates that:

- » These surveys have recorded 187 fauna species, including:
  - 178 native species (160 birds, three mammals, three reptiles, seven frogs, four fish and one invertebrate);
  - Nine introduced species (six birds, two mammals and one fish); and
- » Some of these species recorded within the AVW, which were not recorded during the current field assessment, could also be expected to use the study area to some extent.

### **4.4.3 Species of conservation significance**

Thirty-nine of the fauna species recorded on the AVW database within 10 km of the Margooya Lagoon are of conservation significance. The EPBC Act Protected Matters Search Tool predicted the presence of, or suitable habitat for, 14 native fauna species (10 birds, one frog, one mammal and two fish) within a 10 km radius around the study area.



The list of fauna species that have been recorded (AVW) or predicted to occur within 10 km (PMST) of the Margooya Lagoon includes:

- » Four fauna species listed as threatened under the *EPBC Act 1999* (two birds and two fish);
- » Seventeen fauna species listed as threatened under the *FFG Act 1988* (14 birds, one invertebrate, one fish and one reptile); and
- » An additional eighteen fauna species listed as threatened on DSE's Advisory List of Threatened Vertebrate Fauna in Victoria (2007) (14 birds, one frog, one mammal, one fish and one reptile).

An assessment of the likelihood of each of these threatened species occurring within the study area is presented in Table 20.

**Table 20 Predicted use of the study area by threatened fauna species**

**Key to Table:**

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

FFG Victorian *Flora and Fauna Guarantee Act 1988*

DSE Advisory List of Threatened Vertebrate Fauna in Victoria (DSE 2007)

PMST Information sourced from the EPBC Protected Matters Search Tool

AVW Information sourced from the Atlas of Victorian Wildlife database (DSE 2005)

RH Information sourced from Robertson and Ahern 2006.

**Conservation Significance:**

CR Critically Endangered

EN Endangered

VU Vulnerable

NT Near Threatened

DD Data Deficient

L Listed as threatened in Victoria under the *Flora and Fauna Guarantee Act 1988*

Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
EPBC-listed fauna species					
			Birds		
VU	L	CR	Australian Painted Snipe <i>Rostratula australis</i>	PMST	<b>Unlikely.</b> Species may possibly visit the area following heavy flooding on a very rare or vagrant basis.
EN	L	EN	Black-eared Miner <i>Manorina melanotis</i>	PMST	<b>Unlikely.</b> Suitable habitat for this species is not present within the study site or in the immediate surrounds.
VU	L	EN	Malleefowl <i>Leipoa ocellata</i>	PMST	<b>Unlikely.</b> Suitable habitat for this species is not present within the study site or in the immediate surrounds.



Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
VU	L	EN	Mallee Emu-wren <i>Stipiturus mallee</i>	AVW/PMST	<b>Unlikely.</b> Suitable habitat not present within the study site or in the immediate vicinity.
VU	L	VU	Regent Parrot <i>Polytelis anthopeplus monarchoides</i>	AVW/PMST	<b>Recorded.</b> Species recorded to be locally common throughout study area and is likely to nest, forage and seek refuge at Margooya Lagoon and utilise vegetation corridors in the area to access areas of mallee away from the floodplain.
EN	L	EN	Swift Parrot <i>Lathamus discolor</i>	PMST	<b>Possible visitor on rare to vagrant basis.</b> Species likely to be only an occasion rare visitor to Margooya Lagoon when suitable flora species are flowering.
			<b>Mammals</b>		
VU	L	VU	Greater Long-eared Bat <i>Nyctophilus timoriensis</i> (South-eastern form)	PMST	<b>Possible rare visitor.</b> This species may very rarely visit the study site and is more likely to be located within mallee habitats nearby. The presence of hollow-bearing trees within the study area may suggest the availability of occasional roosting sites for this species.
			<b>Amphibians</b>		
VU	L	EN	Growling Grass Frog <i>Litoria raniformis</i>	PMST	<b>Likely visitor.</b> This species may occur within Margooya Lagoon during periods of inundation, as suitable habitat (fringing semi-aquatic vegetation) was observed during the assessment.
			<b>Fish</b>		
EN	L	EN	Macquarie Perch <i>Macquaria australasica</i>	AVW	<b>Possible rare visitor.</b> Species may occasionally enter Margooya Lagoon during inundation periods, although this would likely only very occasionally occur. Suboptimal habitats for this species exist within the study area.
VU	L	EN	Murray Cod <i>Maccullochella peelii peelii</i>	AVW/PMST	<b>Possible visitor.</b> Species may occasionally enter Margooya Lagoon during inundation periods, although this would likely only very occasionally occur. Suboptimal habitats for this species exist within the study area.
VU	L	CR	Murray Hardyhead <i>Craterocephalus fluviatilis</i>	PMST	<b>Unlikely.</b> Currently unlikely to be any habitat for this species during the dry phase and likely to be marginal during inundation periods. Species only currently known in area from nearby water storages near Mildura.

Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
Additional threatened fauna species					
			Birds		
	L		Apostlebird <i>Struthidea cinerea</i>	AVW	<b>Likely visitor.</b> Species likely to forage and utilise resources within the study area.
		VU	Australasian Shoveler <i>Anas rhynchotis</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.
		VU	Black Falcon <i>Falco subniger</i>	AVW	<b>Possible visitor.</b> Species may occasionally fly over or rest within the study area.
		NT	Black-chinned Honeyeater <i>Melithreptus gularis</i>	AVW	<b>Possible visitor.</b> Species may occasionally forage or rest within the study area.
		NT	Black-eared Cuckoo <i>Chrysococcyx osculans</i>	AVW	<b>Possible visitor.</b> Species may occasionally forage or rest within the study area.
	L	EN	Blue-billed Duck <i>Oxyura australis</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.
		NT	Brown Treecreeper <i>Climacteris picumnus</i>	AVW	<b>Recorded.</b> Species commonly observed within the study area during the field assessment, although unlikely to be the threatened subspecies <i>victoriae</i> .
		NT	Chestnut Quail-Thrush <i>Cinclosoma castanotus</i>	AVW	<b>Unlikely.</b> Suitable habitat not present within the study site or in the immediate vicinity.
	L	NT	Crested Bellbird <i>Oreoica gutturalis</i>	AVW	<b>Likely visitor.</b> Species likely to be present within the study area on occasion. Limited habitat available.
	L	NT	Diamond Dove <i>Geopelia cuneata</i>	AVW	<b>Possible rare visitor.</b> Species may occasionally fly over or rest within the study area.

Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
	L	VU	Diamond Firetail <i>Stagonopleura guttata</i>	AVW	<b>Recorded.</b> Species recorded during the present assessment and previously from Margooya Lagoon. Species likely to regularly visit the wetland.
	L	EN	Freckled Duck <i>Stictonetta naevosa</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.
	L	VU	Great Egret <i>Ardea alba</i>	AVW/PMST	<b>Likely visitor.</b> Species likely to occur within the study area following inundation.
	L	EN	Grey Falcon <i>Falco hypoleucos</i>	AVW	<b>Rare visitor.</b> Species may occasionally fly over or rest within the study site.
	L	EN	Grey-crowned Babbler <i>Pomatostomus temporalis</i>	AVW	<b>Possible rare visitor.</b> Core habitat unlikely to be present for this species, but there is a possibility of occasional use of the study area.
		VU	Grey-fronted Honeyeater <i>Lichenostomus plumulus</i>	AVW	<b>Possible visitor.</b> Species may occasionally forage or rest within the study area.
		VU	Hardhead <i>Aythya australis</i>	AVW	<b>Possible visitor.</b> Species likely to occur within the study area following inundation.
	L	NT	Hooded Robin <i>Melanodryas cucullata</i>	AVW	<b>Likely.</b> Species likely to be present within the study area, suitable habitat identified.
	L	CR	Intermediate Egret <i>Ardea intermedia</i>	AVW	<b>Possible rare visitor.</b> Species may be a rare visitor to the study area following inundation.
		NT	Latham's Snipe <i>Gallinago hardwickii</i>	PMST	<b>Unlikely.</b> Species may possibly visit the area following inundation on a very rare or vagrant basis.
	L	EN	Little Egret <i>Egretta garzetta</i>	AVW	<b>Possible rare visitor.</b> Species may be a rare visitor to the study area following inundation.
	L	VU	Major Mitchell's Cockatoo <i>Cacatua leadbeateri</i>	AVW	<b>Possible visitor.</b> Species habitat appears limited, however, may fly over or rest within study area on occasion.

Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
		VU	Musk Duck <i>Biziura lobata</i>	AVW	<b>Possible visitor.</b> Species likely to occur within the study area following inundation.
		NT	Nankeen Night Heron <i>Nycticorax caledonicus</i>	AVW	<b>Possible visitor.</b> Species likely to occur within the study area following inundation.
		NT	Pied Cormorant <i>Phalacrocorax varius</i>	AVW	<b>Possible visitor.</b> Species likely to occur within the study area following inundation.
		NT	Red-backed Kingfisher <i>Todiramphus pyrrhopygia</i>	AVW	<b>Possible rare visitor.</b> Core habitat for this species unlikely to be present within the study area, but species may occasionally be present, or fly over the study site on route to more suitable habitat.
		NT	Striated Grasswren <i>Amytornis striatus</i>	AVW	<b>Unlikely.</b> Suitable habitat for this species is not present within the study area or in the immediate vicinity.
		VU	Royal Spoonbill <i>Platalea regia</i>	AVW	<b>Possible visitor.</b> Species likely to occur within the study area following inundation.
	L	VU	White-bellied Sea-Eagle <i>Haliaeetus leucogaster</i>	AVW/PMST	<b>Recorded.</b> A pair of this species was observed on both days of the assessment and has been observed at Margooya Lagoon on other occasions (D. Scammel pers. comm.). The AVW also has four other records for this species. A sub-adult specimen was also observed during the second visit to the wetland.
			<b>Mammals</b>		
		NT	Red Kangaroo <i>Macropus rufus</i>	AVW	<b>Possible visitor.</b> Core habitat not present for this species within the study area, although the Red Kangaroo may be an occasional visitor.
			<b>Reptiles</b>		
	L	EN	Carpet Python <i>Morelia spilota metcalfei</i>	AVW	<b>Possible resident.</b> Species likely to be present within the study area due to the presence of very large hollow-bearing River Red Gum trees and other suitable habitat including fallen debris.

Conservation Significance			Species Name	Data Source	Likelihood of Occurrence within the Study Area
EPBC Act	FFG Act	DSE 2007			
		DD	Western Blue-tongued skink <i>Tiliqua occipitalis</i>	AVW	<b>Unlikely.</b> Species habitat likely to be limited within the study area.
			<b>Frogs</b>		
		DD	Barking Marsh Frog <i>Limnodynastes fletcheri</i>	AVW	<b>Possible.</b> Species likely to be present within Margooya Lagoon during periods of inundation.
			<b>Fish</b>		
		VU	Golden Perch <i>Macquaria ambigua</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.
	L	CR	Silver Perch <i>Bidyanus bidyanus</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.
			<b>Invertebrates</b>		
	L		River Snail <i>Notopala sublineata</i>	AVW	<b>Possible visitor.</b> Species may occur within the study area following inundation.

#### 4.4.4 Characteristic Fauna observed around Margooya Lagoon

Margooya Lagoon exhibits suitable habitat for several macropod species, including open areas in the wetland bed, open eucalypt woodlands with a grassy/chenopod understorey. The Western Grey Kangaroo (*Macropus fuliginosus*) is likely to be the most common species encountered, but the Eastern Grey Kangaroo (*Macropus giganteus*) may also be present. The abundance of large hollow-bearing River Red Gum trees would be expected to provide habitat for arboreal species such as the Common Brushtail Possum (*Trichosurus vulpecula*), a species that may be in decline within the Mallee catchment (Robertson and Ahern 2006). Habitat is available for a range of insectivorous bats in the form of mature hollow bearing trees/exfoliating bark/bark crevices for roosting sites and foraging opportunities due to the abundance of insects attracted to the water of the Murray River and habitats around the drying lagoon. Threatened bats such as the Greater Long-eared Bat (*Nyctophilus timoriensis*) may be present within the study area.

Woodland birds were relatively diverse, with 26 native species observed at Site 1 and 24 species observed at site 2 (refer to Appendix H). The diversity observed in avifauna is probably due to the presence of several habitat types converging in the one locality, River Red Gum forest, fringing River Red Gum, Black Box Woodland, wetland habitats of Margooya Lagoon and the nearby Murray River. Species observed were generally common species for the region including, Dusky Woodswallow (*Artamus cyanopterus*), Sulphur-crested Cockatoo (*Cacatua galerita*), Grey Shrike-thrush (*Colluricincla harmonica*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*), Grey Butcherbird (*Cracticus torquatus*), White-plumed Honeyeater (*Lichenostomus penicillatus*), Crimson Rosella (*Platycercus elegans*), Red-rumped Parrot (*Psephotus haematonotus*) and Willie Wagtail (*Rhipidura leucophrys*). An Olive-backed Oriole (*Oriolus sagittatus*) was observed at Site 1, the first sighting of this species within a 10 km radius of the study area.

Habitats for amphibians was generally limited compared to when Margooya Lagoon is inundated, however, during inundation events several species would be expected including Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Plain's Froglet (*Crinia parinsignifera*), Peron's Tree Frog (*Litoria peronii*) and Southern Bullfrog (*Limnodynastes dumerilii dumerilii*). The dense vegetation along the wetland edge remains sufficiently damp to support several species such as the Plain's Froglet (*Crinia parinsignifera*). Suitable habitats are widely available for reptiles, with scattered large mature hollow-bearing River Red Gum/Black Box trees, variable levels of woody debris (some hollow-bearing), exfoliating bark and deep litter layer. Species observed included, Carnaby's Wall Skink (*Cryptoblepharus carnabyi*), Boulenger's Skink (*Morethia boulengeri*) and Marbled Gecko (*Christinus marmoratus*). Several additional state threatened species likely to occur include, Inland Carpet Python (*Morelia spilota metcalfei*) and Tree Goanna (*Varanus varius*).

Several exotic species appear common in the Margooya Lagoon area, with evidence of Feral Pigs (*Sus scrofa*) observed. The Red Fox (*Canis vulpes*) is also common and was observed on several occasions scavenging on the carcasses of dead European Carp (*Cyprinus carpio*), another exotic species present at Margooya Lagoon. The close proximity of the lagoon to the town of Robinvale, permits easy access by exotic birds more commonly associated with urban environments, such as the Common Starling (*Sturnus vulgaris*) and the House Sparrow (*Passer domesticus*).



#### 4.4.5 Threatened Fauna

Margooya Lagoon appears to be an important refuge for a broad variety of relatively common species, but it also appears to provide a refuge for several threatened species, several of which have been commonly observed at the lagoon during previous assessments and again during the present visit:

- » The Regent Parrot (*Polytelis anthopeplus*), listed as vulnerable under the EPBC Act 1999, was observed on over 72 occasions during the present assessment. Margooya Lagoon and surrounds appears to provide important refuge, foraging and possibly breeding habitat for this species, placing an emphasis on the importance of maintaining the habitats present (particularly the large hollow-bearing River Red Gums);
- » A pair of White-bellied Sea-Eagle (*Haliaeetus leucogaster*) was observed on both days of the assessment perched in some tall, dead River Red Gums on the central western bank of the lagoon<sup>6</sup>. This species is listed as threatened under the FFG Act 1988 and is listed as a migratory species under the EPBC Act 1999. Four additional records of this species were noted in the AVW and on speaking with the Mallee CMA, a pair of the species (possibly the same pair) have been seen on other visits to Margooya Lagoon (D. Scammel pers. comm.). The lagoon and nearby Murray River appear to provide important habitat for this species and it is possible that they may breed in the area. The dead European Carp in the residual pools of the lagoon may be providing a short-term source of food for this pair of Sea-eagles;
- » A small group of Diamond Firetails (*Stagonopleura guttata*) were observed along the wetland fringe in the central part of the lagoon (just south of the junction of the three 'arms' of the lagoon). This species feeds on the ground, generally in grassy groundcover beneath woodlands (Pizzey and Knight 2003). This species may occur relatively regularly at Margooya Lagoon as there have been previous records in conjunction with the observations of the present assessment;
- » Brown Treecreeper (*Climacteris picumnus*), listed as near threatened under the DSE's Threatened Vertebrate Advisory List was commonly encountered throughout the study area. This species, however, is broken up into subspecies, with the Brown Treecreeper of the Mallee catchment likely to be the non-threatened subspecies *Climacteris picumnus picumnus*. The threatened subspecies *Climacteris picumnus victoriae* appears to occur further to the south-east of the state;
- » Additional EPBC Act 1999 listed threatened species that may utilise the habitat of the study area include, the Growling Grass Frog (*Litoria raniformis*), which may inhabit emergent vegetation during inundation events and the Greater Long-eared Bat (*Nyctophilus timoriensis*) (*South-eastern form*) may utilise hollow-bearing trees within the area;
- » Other FFG Act listed threatened species that potentially could utilise habitats within the wetland area and could be present as residents or visitors at other times include, Hooded Robin (*Melanodryas cucullata*), Red-naped Snake (*Furina diadema*) and Carpet Python (*Morelia spilota metcalfei*).

#### 4.4.6 Threatening Processes

The field investigation confirmed that the following FFG listed threats are currently, or have been occurring at Margooya Lagoon:

- » Alteration of the natural flow regime of rivers and streams leading to infrequent flooding of a shorter duration and extent than required to maintain healthy floodplain vegetation communities (i.e.

<sup>6</sup> A third sub-adult specimen was also observed during the second visit to the wetland.



terrestrial vegetation dominating wetland). This has been occurring at Margooya Lagoon, although the Mallee CMA are seeking to reinstate a wetting/drying regime; and

- » Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing.

Additional threats that are not FFG listed but are occurring at the site include:

- » Introduced fauna including rabbits, leading to grazing and suppression of recruitment. Feral Pigs causing the sedimentation of wetlands/waterways, disturbing soils and competing with native fauna. Red Fox, preying on native fauna and competing with native species;
- » Localised tree death and stress appears to be occurring throughout the wetland. This may be the result of saline groundwater influences resulting from the irrigation properties to the west of the wetland.

## 5. Conclusions and recommendations

### 5.1 Summary of results

#### 5.1.1 Vegetation composition

The perimeter of the Margooya Lagoon is fringed by Intermittent Swampy Woodland (EVC 813). Riverine Chenopod Woodland (EVC 103) occurs at higher elevations on the floodplain on the eastern side of the Lagoon and Semi-arid Parilla Woodland (EVC 828) occurs on the Parilla sands to the west of the Lagoon on higher elevations. The edges of the wetland bed are likely to be more appropriately mapped as Tall Marsh (EVC 821), as this area is currently dominated by large and medium graminoids such as *Typha orientalis* (Broad-leaf Cumbungi), *Cyperus exaltatus* (Tall Flat-sedge) and medium herbs such as *Persicaria decipiens* (Slender Knotweed). The ground layer supports a thick carpet of *Glinus lotoides* (Hairy Carpet-weed), *Cynodon dactylon* (Native couch) and introduced *Polygonum aviculare* (Wireweed).

Within the northern sections of the Lagoon, Intermittent swampy Woodland is a woodland to 15m tall dominated by *Eucalyptus camaldulensis* (River Red-gum), over an understorey tree layer of *Acacia stenophylla* (Eumong) to 10 m tall. The ground layer supports medium tufted and non-tufted graminoids such as *Cyperus gymnocaulos* (Spring Flat-sedge) and *Cynodon dactylon* (Native Couch) and scattered small to medium herbs, including *Wahlenbergia fluminalis* (River Bluebell), *Brachyscome basaltica* (Swamp Daisy), *Vittadinia cuneata* (Fuzzy New Holland Daisy), *Vittadinia dissecta* (Dissected New Holland Daisy) and *Atriplex semibaccata* (Berry Saltbush).

In the southern sections of the Lagoon, Intermittent Swampy Woodland is a Woodland dominated by flora species typical of drier conditions, such as *Eucalyptus largiflorens* (Black Box) and chenopods such as *Rhagodia spinescens* (Hedge Saltbush), *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush) and *Atriplex semibaccata* (Berry Saltbush). *Muehlenbeckia florulenta* (Tangled Lignum) is also present.

#### 5.1.2 Vegetation condition

In general, the vegetation at Margooya Lagoon is in moderate to good condition, given the overall low abundance of weeds and the diversity of indigenous flora species observed in the understorey. The following three parameters related to vegetation condition require monitoring and thus were included in the monitoring program:

- » Tree health;
- » Weed abundance; and
- » Other threatening processes e.g. RRG regeneration within the wetland bed.

#### Tree health

In general, the River Red-gum trees surveyed at Margooya Lagoon were in fair to moderate condition. More than half of the trees sampled had a canopy cover of < 60%, but most trees had healthy leaves (green and not red-brown), intact bark and no mistletoe attack. Tree health is highly variable within each of the two transects.

Some very large and large old trees have died or are showing signs of dieback (very large and large old trees were typically in poorer condition than medium and small trees). This could be the consequence of



natural senescence but may be the result of other factors such as increased soil salinity and/or groundwater salinity (GHD 2008). A rigorous monitoring program aimed at measuring these other factors as well as tree health is required to determine the causes of tree dieback at the lagoon. Such monitoring is beyond the scope of the monitoring program undertaken here but worthy of further investigation if budget permits.

### **Weeds**

The understorey of the Intermittent Swampy Woodland is diverse in indigenous flora species and weeds are generally in low to moderate abundance (typically 5-25 % cover in quadrats). Weed species of concern include: *Polygonum aviculare* (Wireweed), *Cirsium vulgare* (Scotch Thistle), *Phyla canescens* (Fog-fruit), *Bromus rubens* (Red Brome), *Sonchus oleraceus* (Sow Thistle), *Dittrichia graveolens* (Stinkwort), *Olea europaeum* (Olive) and *Paspalum distichum* (Water Couch). Control of these weeds is recommended before infestations spread/expand to other areas of the Lagoon.

### **Regenerating River Red-gums (RRG) in the wetland bed**

River Red-gum are prevalent along the edges of the wetland bed. The cover of regenerating RRG was typically 25-50 % within the 20 m X 20 m quadrats located on the edges of the wetland bed and trees are typically < 2m tall.

Soil moisture in the wet-dry littoral zone favours the recruitment of RRGs within this zone. Whilst RRG play an important role within floodplain and wetland systems through their provision of carbon (leaf litter) and habitat for fauna, regeneration within the wet-dry littoral zone may be considered a threat to the biodiversity and character of the wetland (Scholz et al. 2005). Reducing the abundance of RRG regeneration within the wet/dry zone may be one of the aims of the proposed wetting and drying regime through providing a more appropriate watering regime. However, there is evidence to show that this may be more effective in control of recent recruits (< 1 year old) than deeper-rooted older RRGs that are present within the wet/dry zone (Scholz et al. 2005).

#### **5.1.3 Threatened flora**

The following threatened flora were found at Margooya Lagoon during phase one of the monitoring program:

- » *Asperula gemella* (Twin-leaf Bedstraw) rare in Victoria; and
- » *Eremophila divaricata* ssp. *divaricata* (Spreading Emu-bush) rare in Victoria.

There is potential for numerous other threatened flora species to also occur at the study site, owing to presence of suitable habitat.

### **5.2 Potential benefits of proposed wet/dry cycle**

The absence of a drying cycle within the floodplain wetland can have a negative impact on flora and fauna (Kingsford 2000). Floodplain vegetation begins to die through prolonged inundation, productivity declines and although a few waterbirds may benefit (e.g. fish-feeding species), most decline.

Benefits of the re-introduction of a more “natural” wetting and drying regime at the Margooya Lagoon may include:

- » Maintenance and enhancement of fauna habitat values and periodic breeding opportunities for wetland species (e.g. frogs and waterbirds);
- » Improved regeneration of River Red-gum in riparian zone, which will support several threatened terrestrial species in the long term (e.g. Regent Parrot and possibly the Inland Carpet Python);
- » Stimulation of seed bank upon inundation leads to germination of aquatic and emergent plant species, resulting in greater diversity and abundance of wetland flora during inundation and on recession of floodwaters. This will in turn provide foraging and breeding habitats for wetland birds and frogs;
- » Provide an opportunity for nutrient cycling and carbon cycling;
- » Enhanced condition of RRG and reduction in evident stress symptoms;
- » Maintain RRG and Black Box adults, leading to a reduction in evident stress symptoms. It is important to maintain these habitat values as a variety of species are dependent for refuge, foraging and breeding habitat;
- » There is potential to increase water height in the wetland above pool level and flood adjacent areas of RRG and BB floodplain – this option would have great benefits for the entire area (Ray De Groot pers. comm.).

### 5.3 Recommendations – Monitoring Program

It is recommended that the monitoring program for Margooya Lagoon is undertaken as outlined below. It would be preferable to undertake the monitoring program in its entirety, although budgetary and time constraints are likely to impact upon the ability to include certain elements of the program whenever monitoring takes place. The program will also vary slightly in regard to the methods used depending upon the current condition of the wetland (wet or dry), but the general framework for monitoring vegetation and fauna abundance and diversity remain the same. A summary of the monitoring program is outlined in Table 21.

#### 5.3.1 Timing

GHD proposes that quadrat sampling ideally take place twice a year to capture seasonal changes in species composition (autumn and spring). The measurements of tree health should be conducted annually (preferably in Autumn to gauge tree stress following hot, dry Summer conditions), as changes in tree health are unlikely to be detected if monitored at shorter intervals.

The fauna surveys should preferably be conducted in the spring, particularly pitfall trapping for reptiles as this will take advantage of the peak in activity for these species. The fauna surveys will however, depend upon the condition of the wetland and whether it has been recently inundated or has been dried. Wet phase monitoring would preferably incorporate all forms of bird surveys (wetland and woodland), pitfall/Elliott trapping, Harp trapping/Anabat and aquatic sampling, however, depending upon when the wetting occurs, some elements may be incorporated (e.g. bird surveys, aquatic sampling), while others such as the pitfall trapping could be disregarded if the wetting occurs during autumn for example.

Monitoring of the dry phase would generally need to be conducted in the spring as you would generally only be monitoring the diversity and abundance of reptiles, amphibians, bats and woodland birds, with spring being the preferred time of year to monitor these species groups.



### 5.3.2 Flora

#### Quadrat sampling

Additional quadrats could be erected, if budget was available, to increase replication and to capture variation in vegetation composition throughout the Lagoon. For example, quadrats could be located at the north-eastern arm and south-eastern arm of the lagoon where sampling was not undertaken in this first assessment.

#### Targeted surveys for threatened flora

It would be beneficial to undertake targeted surveys for the threatened flora species listed in Table 12 that potentially occur within the Margooya Lagoon (owing to presence of suitable habitat). As many of these species are seasonal, they are unlikely to be encountered if sampling is not undertaken at the optimal time of year (e.g. spring). Furthermore, as some of these species are likely to be present in very low abundance, a survey specifically targeted at searching for them is required.

#### Tree health

The ongoing monitoring of the two tree health transects included in phase one of the monitoring program, will assist the CMA in monitoring changes in individual tree health at Margooya Lagoon in response to alteration of the current wetting and drying regime. GHD recommends the CMA tag these individuals so that they can clearly be identified in future sampling events.

Other transects could be erected as part of the ongoing monitoring of tree health at Margooya Lagoon to:

- » Increase the sample size of trees;
- » Include other locations around the lagoon where tree health appears to be in decline (such as quadrat 5 and 7) or in good health.

GHD also recommend investigating the cause of localised dieback of RRGs at the location shown in Figure 22. There are numerous possible causes of such localised degradation as outlined in GHD (2008). Potential factors include soil salinity, groundwater salinity and insect attack.

#### Next steps

The next steps are to:

- » Tag RRG trees at transects 1 and 2;
- » Permanently mark quadrat locations and photo points;
- » Undertake flora and fauna sampling in spring; and
- » Undertake sampling again after rewetting the Lagoon.

### 5.3.3 Fauna

#### Terrestrial Fauna

Terrestrial fauna surveys should be undertaken at the three sites assessed during the present assessment, with the possible inclusion of possibly two to three other sites in order to achieve a more comprehensive monitoring program. The field assessment methods described below incorporate techniques outlined in *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities Working Draft* (DEC 2004).





### **Frogs**

Frogs surveys will most likely be conducted during an inundation event within Margooya Lagoon and will generally involve nocturnal work. Hygiene protocols will need to be developed for handling frogs due to the risk of the spread of amphibian chytrid fungus. Frog surveys are best conducted during spring when they will be breeding and hence calling, as call identification is possibly the most effective technique for frog identification. The following activities should be undertaken for frogs:

- » Undertake frog surveys following an inundation event and preferably in Spring;
- » Visit the wetland sites at dusk and undertake 30 minutes of listening for calls and spotlighting potential habitat along the wetland fringe in groups of up to three surveyors. This should be undertaken in the general vicinity of each of the sites. Surveyors should commence the survey by initially listening for calls prior to conducting the active spotlighting;
- » Call playback could be conducted for the EPBC Act 1999 listed Growling Grass Frog (*Litoria raniformis*). This involves playing the recorded call of a target species through a specially designed megaphone and listening for a response. This should not be used excessively in the breeding season as it can disrupt this process.

### **Reptiles and Small Mammals**

A range of sampling techniques is available for the detection of reptiles and small mammals and a combination of several are needed to successfully detect the full range of species present. Pitfall trapping appears to be the most effective means for surveying small reptiles and mammals in the mallee region and should preferably be incorporated into this monitoring program as it provides quantitative fauna abundance and diversity data for future analysis. The pitfall-trapping program could also incorporate the use of several Elliot traps, which would complement the trapping program. Nocturnal spotlighting conducted for frogs could also incorporate some searching for reptiles if desired. The following activities should be conducted for reptiles and small mammals:

- » Establish a pitfall line with drift fence at each of the three monitoring sites, with the potential for an additional 1-3 trap lines in separate habitat types (e.g. Black Box Woodland). Pitfall lines should consist of at least six (can be up to 10) 20-litre buckets and placed five metres apart and located close to potential habitat;
- » Two Type-A Elliot traps should be placed within habitat at each end of the pitfall line and suitably baited;
- » The pitfall and Elliot trapping should be conducted over four consecutive nights and traps checked early in the morning and late in the afternoon.

### **Insectivorous Bats**

Harp traps can be used to trap bats that forage closer to the ground, whereas Anabat ultrasonic call recorders can be employed to survey bats that feed higher above the tree canopy. Harp traps are set up to intercept the suspected flight paths of bats, generally at the terminal end of a vegetation corridor or in close proximity to water. Traps are checked early in the morning and bats removed, weighed, forearm length measurements taken. Insectivorous bat activity may vary depending on whether a wetland is wet or dry and as this species group is poorly studied, the incorporation of bat survey into the monitoring program is important. The program should incorporate the following:



- » One harp trap should be set up at each of the pitfall/Elliott sites (these should correspond to the three sites assessed in the present investigation, in addition to 1-3 other sites). The Harp traps should be established for two consecutive nights at each of the locations and cleared of animals early each morning;
- » Anabat ultrasonic call recorders should be used in conjunction with the Harp trapping, with one unit set up for a minimum of one night at each of the survey sites.

### **Woodland and Wetland Birds**

Diurnal bird surveys should be conducted to incorporate either the early morning or late afternoon active period for local species. Bird surveys for the current program should be conducted for a duration of between 40 to 60 minutes at the three locations visited during the present assessment. An area of between 2-5 hectares should be covered during the survey. Bird surveys should incorporate the following:

- » Woodland bird surveys at the sites surveyed during the present assessment, in addition to other sites selected for pitfall/Elliott/Harp trapping. Surveys conducted for 40 to 60 minutes over an area of 2-5 ha. Attempts should be made to identify species and abundance if a visual identification is made;
- » During inundation events, surveys of waterbirds visiting Margooya Lagoon should be conducted. The three sites assessed during the present investigation could be used as effective vantage points to undertake waterbird identification and counts. The surveyors should site themselves in an area that provides a good view over the wetland (or the various 'arms' of the wetland). A one hour bird observation should be conducted at dawn or dusk, with birds identified, counted and recorded as present within the wetland, flying overhead or outside the habitat.

### **Macroinvertebrates**

When the lagoon is inundated, standard stream assessment methodologies such as the Rapid Biological Assessment, which is used as a standard protocol set by the Victorian Environmental Protection Authority based upon AUSRIVAS methodologies, can be used to enumerate and evaluate the macroinvertebrate fauna of the systems. The application of this method will give an assessment of the current condition of the waterbody with the aim to detect changes in aquatic communities over space and time.

Alternatively, artificial substrates in conjunction with edge samples using RBA standard sampling methodology can be sampled at each site. Each artificial substrate should be spread out in areas that suitably represent a range of habitat types while paying due respect to the dominant habitat.

The Artificial Substrates are 'rock basket' substrates based upon the De Pauw *et al.* (1986) substrate. The substrates are approximately 2500 cm<sup>3</sup> in area, and made of an open wire mesh and filled with plastic wire mesh (potato/orange bags) and rocks to the size of half a house brick. These substrates should be placed into the water at sites of suitable depths and be allowed to colonise for a period of six weeks. The substrates are then collected into the 250 µm sweep net and rinsed. The samples should be preserved into sample jars filled with 70% ethanol.

After each substrate sample has been collected an edge sample will be obtained from suitable areas in the immediate vicinity to where the substrate was.



### ***Fish***

A corresponding fish survey should also be conducted. The exact location of the sites may vary slightly and are dependent on the best available habitat, which should be determined prior to undertaking the survey.

The aims of the proposed fish survey are:

- » Assessment of presence or likely presence of listed fauna species. The survey should aim to target Nationally or State listed species with relevance to the EPBC Act 1999 and FFG Act 1988. Additionally the habitat surveys will be undertaken with particular reference to specific requirements and level of existing habitat integrity. Each listed species will be addressed separately during reporting with regard to known distribution, general habitat and breeding habitat requirements, and potential impacts upon these species;
- » Determination of the overall significance of the communities present, density and structure; and
- » To determine the presence and density exotic species within the area will be recorded.

The following survey methods should be employed to ensure a rigorous and accurate assessment of community assemblages:

- » Electrofishing;
- » Fyke nets;
- » Bait Traps;
- » Light traps; and
- » Seine Net.

**Table 21 Monitoring program for Margooya Lagoon, detailing the timing, frequency and applicability for particular water regimes.**

Tasks	Regime		Timing		Frequency	
	Wet	Dry	Spring	Autumn	Annual	Biannual
<b>Flora</b>	Quadrat Sampling					
	Tree Health					
	Aquatic Vegetation				Whenever inundation occurs	
	Targeted Surveys for Threatened Flora	Once only			Once only	
	Photo-point Monitoring					
	Frog Surveys				Whenever inundation occurs	
<b>Fauna</b>	Pitfall Trapping					
	Harp/Anabat					
	Woodland Birds					
	Wetland Birds				Whenever inundation occurs	
	Macroinvertebrates / fish				Whenever inundation occurs	



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## Appendix A

# Field recording sheet for tree health method by Wallace et al. 2007

**Wetland name:**

**Location:**

**Date:**

**Observer:**

**Transect number:**

Tree #	Easting	Northing	Photo #	Bark condition	Canopy condition	New growth	Canopy density	Reproductive status	Leaf condition	Mistletoe load	DBH	Tree tagged
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												

Tree #	Easting	Northing	Photo #	Bark condition	Canopy condition	New growth	Canopy density	Reproductive status	Leaf condition	Mistletoe load	DBH	Tree tagged
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												



## RIVER RED GUM CONDITION ASSESSMENT: KEY TO CATEGORIES

### Bark condition

Category	Description and range
0	Long Term Dead (no bark or fine branches)
1	Cracked Bark
2	Intact Bark

### Canopy condition

Category	Description and range	% cover
0	No canopy or sparse dead leaves (near dead)	0%
1	Full or substantial canopy of dead leaves (near dead)	0%
2	Sparse canopy of live leaves (highly stressed)	<10%
3	Minimal cover (stressed)	10-25%
4	Moderate cover (moderately stressed)	26-75%
5	Full cover (healthy)	75-100%

### New growth

Category	Description and range	% Cover
0	None	0%
1	Sparse	<10%
2	Minimal Cover	10-25%
3	Moderate Cover	26-75%
4	Dense Cover	75-100%

### Canopy density

#### Canopy density (20% increments)

Category	Description and range	% Cover
0	None	0%
1	Sparse	1-20%
2	Minimal Cover	21-40%
3	Moderate Cover	41-60%
4	Dense Cover	61-80%
5	Full cover	81-100%



### **Reproductive status**

Reproduction evident yes / no (i.e. woody capsules, buds and / or flowers)

### **Leaf condition**

Category	Description and range
0	Red-brown dominant
1	Some red brown
2	Green

### **Mistletoe load**

Category	Description and range
0	Present and severe
1	Present but low cover
2	None present



## Appendix B

# The Living Murray Methodology for Field Assessment of Tree Condition (DSE in preparation)





## ***Draft: The Living Murray Methodology for Field Assessment of Tree Condition***

### **1. Introduction**

The assessment of River Red Gum (RRG) and Black Box (BB) condition is fundamental to informing progress toward the ecological objectives of The Living Murray across the majority of the Icon Sites. To ensure reporting of RRG and BB condition is consistent throughout The Living Murray, this methodology is to be incorporated into the Icon Site Condition Monitoring plans and all field assessments of RRG and BB condition are to be carried out using this method.

Components of this methodology also provide critical data for incorporation into the model used to map stand condition of RRG and BB across The Living Murray Icon Sites. There are eleven assessments that form the minimum requirements for TLM assessment of RRG and BB condition. These assessments will form the basis for reporting on RRG and BB condition across the Icon Sites.

The method presented here has been initially developed by the South Australian Department of Water, Land and Biodiversity Conservation (Souter et al. in prep.) and modified, in consultation with ecologists and Icon Site monitoring staff, by the Murray-Darling Basin Commission to provide a common method for assessing RRG and BB condition within The Living Murray Icon Sites.

### **2. Establishing Assessment Sites (developed from Cunningham et al. 2007)**

The sites selected for permanent monitoring are to be representative of each Icon Site. Sites should be stratified so that the full range of vegetation types and landscape positions are covered (riverside, creekline, floodplain, wetland). This will allow accurate mapping of condition across each site, comparisons among landscape positions, and assessment of the effectiveness of management actions for stands in different conditions.

Ideally, trees that have previously been used for condition monitoring should be retained to ensure continuity of data. However as this method is used for both on-ground assessment of condition and ground truthing of the TLM remote sensing method, trees should be selected from within a defined spatial area.

Assessment sites of 0.25 ha are to be established at each site; however the shape of the quadrat can be varied according to the vegetation structure of the site being assessed. Optimum quadrat shape should be a 50m x 50m square, or circle with a radius of 28.2 m. However, rectangular quadrats of various dimensions can be used to assess linear stands along riverbanks and creeklines provided they equal 0.25 ha in area (e.g. 62.5 x 40 m, 83.3 x 30 m, 125 x 20 m). GPS locations of the four corners of a quadrat, or centre of a circular plot are to be recorded to calculate accurate point locations for each quadrat. A total of 30 trees, live or dead, with DBH greater than 10 cm are to be randomly selected within the plot, given a unique identifier and permanently marked using plastic cattle tags. These 30 trees are to be used in the condition assessment.

Where transects already exist, a rectangular quadrat of the appropriate width can be overlain. It is important to note that if the transect length is shorter than required to make a quadrat of 0.25 ha, any trees not included in the original transect but are included within the quadrat should be assessed where appropriate (i.e. DBH measured; and trees included within site assessments). When quadrats contain fewer than 30 trees, additional representative trees are to be chosen within 20 m either side of a transect extended from one corner of the quadrat and continued until the 30 tree quota is reached. The number of trees inside the quadrat should be recorded to determine density of trees per unit area.



If new quadrats are being created, the following key components should be considered:

- » Trees assessed for condition within the quadrat are to be greater than 10 cm DBH;
- » Trees assessed for condition should be randomly selected from within the quadrat area;
- » When quadrats contain fewer than 30 trees, additional representative trees can be selected by extending a transect from one corner of the quadrat and selecting trees within 20m either side of the transect until the 30 tree quota is reached.
- » Where possible, each quadrat should be more than 500m away from the next nearest quadrat; and
- » GPS locations of individual trees should be recorded and trees permanently marked using plastic cattle tags with a unique identifier.

### **3. Site Assessments**

Site assessments provide information relating to condition by informing on disturbance, Diameter at Breast Height (DBH) of all trees, presence of seedlings and saplings, and Plant Area Index. Photo points should also be established at each site.

#### **3.1 Assessment of Percentage Live Basal Area**

Live Basal Area is a fundamental component of the remote sensing model. Two field assessments enable percentage Live Basal Area to be calculated: Diameter at Breast Height and Live/Dead Assessment. Every tree within the quadrat must have DBH measures and be assessed as Live or Dead.

##### **3.1.1 Diameter at Breast Height (adapted from Forests NSW Operations, Miller pers. comm.)**

Record the DBH of *every tree* within the quadrat in centimetres at 1.3 m above the ground. Where a tree has multiple stems at 1.3 m, the DBH of each stem is to be recorded.

Rules for measuring DBH are:

- » Breast height is 1.3 m above ground measured along the stem, where the tree is on a slope, 1.3 m is measured on the uphill side of the tree. Where the tree is on a lean, 1.3 m is measured on the underside of the lean.
- » Where a swelling occurs at 1.3 m, two points unaffected by swellings or limbs equally spaced above and below 1.3 m should be selected, measured then averaged to give an estimate of DBH.
- » The measurer should paint the point(s) on the tree where the diameter measurement(s) have been made.
- » The measuring tape should be at 90° to the axis of the stem at 1.3 m, if there is lichen or loose bark at 1.3 m it should be gently cleared so as not to remove any firm bark from the tree.

##### **3.2 Seedlings/Saplings Size and Condition (developed from Scholz et al., 2007)**

Within the quadrat, observers record the following:

- » GPS location of sapling stand,
- » Size group based on the following groupings:
  - saplings >3 m high but < 10 cm DBH;
  - saplings 0.25 – 3 m high; and
  - seedlings < 0.25 m high.



- » approximate number of saplings in each size group
- » condition of each size group based on the following groupings:
  - Dead (Majority of seedlings/saplings in the stand appear to be dead)
  - Moderate (Majority of seedlings/saplings in the stand show some level of stress)
  - Good (Majority of seedlings/saplings in the stand appear to be in good condition)

### **3.3 Plant Area Index – (Cunningham et al., 2007)**

Plant Area Index (PAI) is defined as the area of leaves and stems per unit ground area without adjustment for clumping of canopy components (also defined as effective PAI by Chen (1996)). Plant area index (PAI) is estimated from hemispherical photographs taken using a digital camera and fisheye lens adaptor. Two photographs are to be taken in each plot (evenly spaced along the longest axis) to include potential variation in PAI across the plot. Photographs should be taken to avoid direct sunlight (ideally within 90 min of first light). The hemispherical photos of the canopy are assessed using the photo interpretation program Winphot 5.0 (ter Steege 1996).

### **3.4 Photo Points**

Photo points of vegetation quadrats should be taken to document change through time. Digital photography is the recommended method for photo points as it provides a method to capture high resolution images that are easily stored and incorporated into reports. The TLM Communications Unit may also use such photos in brochures, reports, websites etc.

Photo points should be selected so that they provide representative coverage of each plot. The camera should be positioned on the same point, pointing along the same bearing, at the same height and set to the same zoom level on each occasion. Photo points should be clearly marked to ensure photos are consistent. Ideally photos would be taken on the same day that vegetation sampling is conducted and at a similar time of day to complement vegetation data and to maximise comparability of images. When taking photos, care should be taken to prevent direct sunlight creating glare on the lens by shading the lens with a hat or folder. Appropriate metadata must be recorded with all photos. Essential metadata for photos are: date and time, direction bearing in degrees (from compass), GPS coordinates, and name of photographer. Additional metadata should be recorded as required to document special or unusual conditions.

## **4. Individual Tree Assessments (Souter et al., in prep.)**

At each assessment site, using the assessment techniques outlined below, assess the individual condition of the 30 marked trees within each quadrat. All assessments should be undertaken by experienced observers to maintain consistency over the length of the project. New observers should be provided with thorough training and reference materials (eg. photographs) prior to undertaking monitoring surveys, including calibration against experienced observers to ensure standardisation of measurement estimation.

Visual assessments of each of these condition and behavioural attributes are assessed against an imaginary, absolute reference tree. The absolute reference tree is a red gum or black box in full health, with an intact and dense crown. The departure, if any, of the tree being assessed from this hypothetical state is assessed. The use of an absolute reference tree enables comparison across sites and consistency of assessment on repeat visits to a site.



#### **4.1 Bark Condition (Scholz et al., 2007)**

Bark condition is assessed by observing the main stem of the tree and rating the extent of cracking as per the categories presented in Table 1. Long term dead trees have no bark and have lost all of their medium and fine branches. Very stressed trees have cracked bark, which are deep vertical cracks in the bark, generally found on the main stem which exposes the heartwood. Trees with cracked bark have generally lost all of their leaves or only have dead leaves. Bark Cracking is assessed on the category scale presented in Table 1.

**Table 1 Assessment of bark condition**

Category	Description
0	No bark (long term dead)
1	Extensive areas of Cracked Bark
2	Minor areas of Cracked Bark
3	Intact Bark

#### **4.2 Crown Condition Assessment (Souter et al., in prep.)**

Condition is the combined assessment of crown extent and crown density. When a tree responds to a change in environment, a change in crown density will be noticeable prior to a change in crown extent. *As the tree responds, crown density may equal, be less than, but not exceed crown extent.*

The combination of descriptive terms and percent divisions (e.g. sparse = 11-20%) is intended to assist assessment of condition, particularly where difficulty in defining differences at the edges of categories exists. It should also be noted that data may need to be categorised in future as knowledge and practices improve. Consequently, it is recommended that observers also record an actual estimate of both Crown Extent and Crown Density percentage value (e.g. to within 5%). This approach allows for expansion or contraction of the number of divisions (or to retrospectively analyse data using other scales/methods) if desired.

##### **4.2.1 Crown Extent (Souter et al., in prep.)**

Crown extent is assessed as the degree to which the actual crown outline fills the space that would be occupied by a normally foliated crown of a tree in full health. Crown extent will diminish as foliage is progressively lost from the branch tips leading to larger gaps appearing as whole branches become completely defoliated. Crown extent can be assessed using the scale presented in Table 2.

**Table 2 Category scale for reporting Crown Extent and Crown Density Assessments**

Score	Description	Percentage of Absolute Reference Tree
0	None	0 %
1	Minimal	1-10 %
2	Sparse	11-20 %
3	Sparse - Moderate	21-40 %



Score	Description	Percentage of Absolute Reference Tree
4	Moderate	41-60 %
5	Moderate - Major	61-80 %
6	Major	81-90 %
7	Maximum	91-100 %

#### **4.2.2 Crown Density (Souter et al., in prep.)**

Density is assessed as the amount of skylight blocked by the live, normally foliated portion of the crown i.e. the higher the density, the higher the amount of skylight blocked by the crown. Crown density is assessed on the same category scale as crown extent (Table 3).

**Table 3 Category scale for reporting Crown Density Assessments**

Score	Description	Crown Density
0	None	0 %
1	Minimal	1-10 %
2	Sparse	11-20 %
3	Sparse - Moderate	21-40 %
4	Moderate	41-60 %
5	Moderate - Major	61-80 %
6	Major	81-90 %
7	Maximum	91-100 %

#### **4.3 Attributes Indicating Recovery – Minimum Requirement (Souter et al., in prep.)**

These attributes provide context for the degree of changes in Crown Extent & Crown Density and hence tree condition. Trees producing epicormic growth and new tip growth, indicate recovery from stress and a likely future increase in condition.

##### **4.3.1 Epicormic Growth (Cunningham et al. 2007)**

Epicormic growth is the growth of new shoots from the main trunk or major support branches of the tree. Shoots are to be considered as epicormic if they have initiated from old stems and are less than 3cm in diameter. The epicormic growth assessment records the presence and visual effect of epicormic growth as per the categories presented in the attributes indicating recovery category scale (Table 4). In cases where trees that have lost their entire crown respond to favourable conditions, epicormic growth will constitute the entire crown of the tree. This should be recorded separately as a comment and/or in a tick box on the proforma.



#### **4.3.2 New Tip Growth (Souter et al., in prep.)**

New tip growth is defined as the growth of new shoots from the tips of the tree branches at the edge of the crown. New Tip Growth is assessed on the category scale for reporting attributes indicating recovery presented in Table 4). Observers may require binoculars to accurately assess new tip growth.

**Table 4 Category scale for reporting attributes indicating recovery**

Score	Description	Definition
0	Absent	Effect is not visible
1	Scarce	Effect is present but not readily visible
2	Common	Effect is clearly visible
3	Abundant	Effect dominates the appearance of the tree

#### **4.4 Attributes indicating decline– Minimum Requirement (Souter et al., in prep.)**

These attributes provide context for the degree of changes in Crown Extent & Crown Density and hence tree condition. Trees that have leaves dying off or mistletoe loads are under stress and may be declining in condition.

##### **4.4.1 Leaf Die Off (Souter et al., in prep.)**

Leaf die off is defined as the relative abundance of dead leaves on the tree. Leaf Die Off is assessed on the attributes indicating decline category scale presented in Table 5).

##### **4.4.2 Mistletoe (Souter et al., in prep.)**

Assess the abundance of mistletoe on the tree against the categories on the attributes indicating decline category scale presented in Table 5).

**Table 5 Category scale for reporting attributes indicating decline**

Score	Description	Definition
0	Absent	Effect is not visible
-1	Scarce	Effect is present but not readily visible
-2	Common	Effect is clearly visible
-3	Abundant	Effect dominates the appearance of the tree

#### **5. Interpretation (Souter et al., in prep.)**

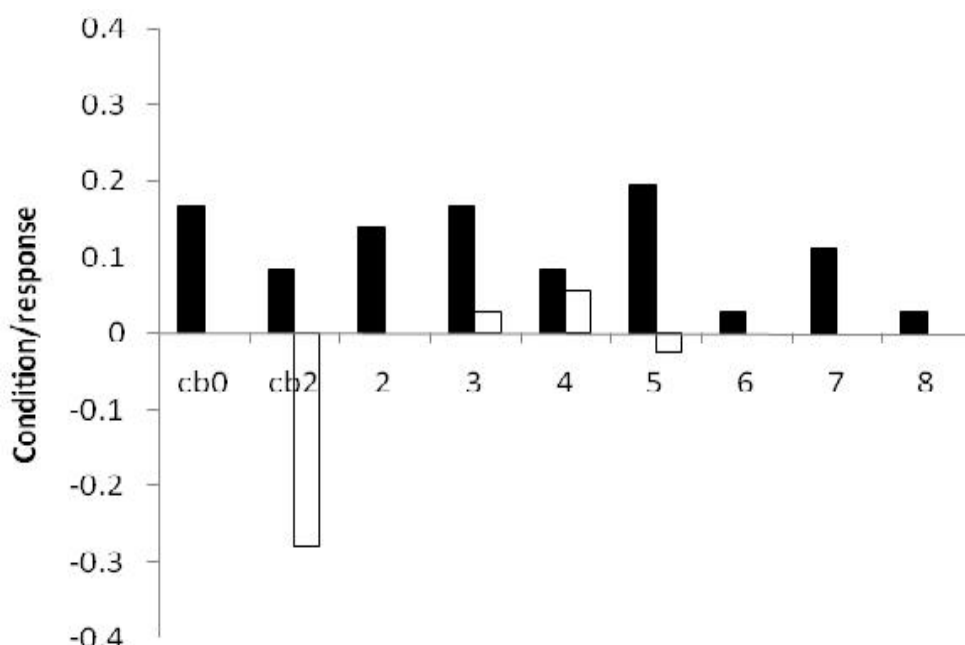
Condition is measured as the sum of the crown cover and density scores, with cracked bark and intact bark trees recorded separately. Condition is presented as the frequency of cracked and intact bark trees within each of the condition categories.

Response is measured as the mean of the behavioural attribute scores for each condition category. The response measure is divided by 6 (the maximum response score possible) to convert it to a number between 0 and 1.



Condition and response are depicted together. The frequency of trees in each condition class describes the current status of the population. Response provides an indication of the likely future trajectory of condition.

In the example from Souter et al. (in prep) (Figure 1) red gums were observed in a range of condition classes from severely stressed to healthy (Note: Souter et al. uses condition categories from 1-10). However, the frequency distribution showed that a greater number of trees were in poorer health. The behavioural characteristics varied, healthy trees were showing a neutral response and thus would be expected not to change state over time if conditions remain the same. Category 5 stressed trees were showing a negative response and thus could be expected to decline, whilst category 3 and 4 trees were responding positively. The category 2 cracked bark trees were responding negatively.



**Figure 1.** Red gum condition and trajectory at Rillies floodplain, Loxton. Black bars are frequency of trees in each condition class (0-10, crown cover plus density score). Clear bars are mean response for each condition class (sum of three positive and three negative response variables scored as 0, score or absent; 1 present; 2 dominant). (Souter et al., in prep)

## 6. Data Protocols

It is expected that the agency conducting the assessment will collect and store data according to best practice. Data return to the MDBC will be conducted in a similar manner to current SRA data return protocols. Specifications for data return are under development.

## 7. Back Compatibility

The proposed method assesses crown condition differently to other methods that have been used at the Icon sites in the past. There will be some data that has not been collected in the past (e.g. crown density, bark cracking) and there will be some incompatibility between previous categories and the proposed categories. Previous assessments may contain sufficient raw data to enable the method to be applied



(eg. Crown Extent % value rather than categorical ranking). If photos of individual trees have been kept on file, trees could also be reassessed using the new assessment scales to provide uniformity of data.

## **8. Additional Assessments**

These assessments will provide additional information on the condition of trees assessed as part of The Living Murray Condition and Intervention Monitoring. The assessments listed are not part of the core components of Condition Monitoring for The Living Murray, however, they provide additional context for the trajectory of tree condition at the Icon Sites and hence should be considered when designing the Icon Sites' monitoring plan.

### **8.1 Disturbance**

Provide comment on the occurrence and extent of natural and man-made disturbances within the quadrat. Forest operations such as thinning and logging should be noted as well as natural disturbances such as flooding and fire.

### **8.2 Insect Damage (developed from Souter et al., in prep.)**

Numerous insects will feed on River Red Gum and Black Box leaves and it is rare not to observe a tree without some leaf damage. The most commonly observed form of leaf damage is irregular shaped leaves with jagged edges.

Insect attack is assessed over the quadrat as a whole and categorised as per Table 6. Some level of leaf damage is commonly observed in healthy trees and is unlikely to be causing trees in the plot undue stress (Minimal). Thus for a quadrat to be assessed as having a Common level of damage, the effect must be clearly visible and obviously affecting the majority of trees in the plot; to be classed as Abundant, all trees in the plot should be suffering significant insect attack.

*Table 6: Insect Damage Categories for Plot Assessment*

**Table 6 Insect Damage Categories for Plot Assessment**

<b>Category</b>	<b>Description</b>
Absent	Not visible or minor damage to some trees
Scarce	Some trees have scattered damage within the crown
Common	Most trees have significant damage within the crown
Abundant	All trees have significant damage within the crown

### **8.3 Other Biological Stresses**

Other biological causes of stress should be assessed to provide context for the extent of recovery or decline. Other biological stresses could include disease or significant weed infestation (for example native cherry). The quadrat is assessed for the type of stresses visible and rated based on the categories in Table 7.



**Table 7 Categories for Other Biological Stresses observed during Plot Assessment**

Category	Description
Absent	Not visible or minor presence within the plot
Scarce	Scattered occurrence throughout the plot
Common	Present throughout the majority of the plot
Abundant	Present throughout the entire plot

#### **8.4 Dominance**

Each of the 30 trees in the condition assessment are assessed for its dominance class. The definitions of the dominance class are the same as NSW Forests' PGP system outlined in Table 8. Dominance is particularly important at forested Icon Sites to provide additional context to the condition of individual trees.

**Table 8 Categories for Assessing Tree Dominance (Forests NSW Operation, Miller pers. comm.)**

Category	Description
Dominant	Tree with a crown extending above the general canopy, receiving full light from above and partly from the sides; a larger than average tree in the stand.
Codominant	Tree with crown forming part of the general canopy, receiving full light from above but comparatively little from the sides.
Subdominant	Tree Shorter than the previous classes, but with a crown extending into the canopy of the Codominant trees, receiving little light from above but none from the sides.
Suppressed	Tree with a crown entirely below the canopy, receives no direct light from above or from the sides.

#### **8.5 Extent of Reproduction (Souter et al., in prep.)**

Each of the 30 trees in the condition assessment is assessed for extent of reproduction. Due to the confounding nature of seasonality and the cyclical nature of the bud crop the reproductive behaviour is recorded as the combined relative abundance of buds, flowers and or fruit. Combining the different reproductive states increases the rapidity at which a tree can be assessed. Extent of reproduction is assessed on the category scale presented in Table 9.

**Table 9 Category scale for reporting extent of Reproduction**

Score	Description	Definition
0	Absent	Reproductive behaviour is not visible
1	Scarce	<b>Reproductive behaviour is present but not readily visible</b>
2	Common	Reproductive behaviour is clearly visible



Score	Description	Definition
3	Abundant	Reproductive behaviour dominates the appearance of the tree

## 9. References

- Chen JM (1996) Optically-based methods for measuring seasonal variation of leaf area index in boreal conifer stands. *Agricultural and Forest Meteorology* 80, 135–163.
- Cunningham, S.C., Mac Nally, R., White, M., Read, J., Baker, P.J., Thomson, J. and Griffioen, P. (2007) Mapping the current condition of river red gum (*Eucalyptus camaldulensis* Dehnh.) stands along the Victorian Murray river floodplain. A report to the Northern Victorian Catchment Management Authorities and the Department of Sustainability and Environment.
- Scholz O., Reid J.R.W., Wallace T. and Meredith S. (2007). The Living Murray Initiative: Lindsay-Mulcra-Wallpolla Islands and Hattah Lakes Icon Sites condition monitoring program design. Report to the Mallee Catchment Management Authority. Murray-Darling Freshwater Research Centre.
- Souter, N.J., Watts, R.A., White, M.G., George, A.K., and McNicol, K. (in prep.) DWLBC Tree Health Assessment Method: red gum and black box.
- ter Steege H (1996) 'WINPHOT 5.0: a programme to analyse vegetation indices, light and light quality from hemispherical photographs.' Tropenbos Guyana Programme, Report 95-2., Tropenbos, Guyana



## Appendix C

Field recording sheet developed by GHD  
for assessing tree health according to  
method by DSE

## FIELD RECORDING SHEET FOR ASSESSING RIVER RED GUM CONDITION

Wetland name:

Treatment:

Location:

Date:

Observer:

Quadrat/Transect number:

Quadrat/transect size:

Photo no.:

No. of trees (>10 cm DBH) in quadrat:

### Saplings

Saplings size group	Description	No. of saplings	Condition (dead, moderate or good)
1	Saplings >3m high but < 10 cm DBH		
2	Saplings 0.25-3.0 m high		
3	Seedlings <0.25 m high		

**Dead:** majority of seedlings/saplings in the stand appear to be dead

**Moderate:** majority of seedlings/saplings in the stand show some level of stress

**Good:** majority of seedlings/saplings in the stand appear to be in good condition

### Disturbance

Comment on occurrence and extent of natural and man-made disturbances within quadrat/transect eg. flooding, fire, logging and thinning

### Insect damage

### Other biological stresses



Tree #	Easting	Northing	Alive/ dead	Bark condition	Crown extent	Crown density	Recovery: Epicormic growth	Recovery: New tip growth	Decline: Leaf die off	Decline: Mistletoe	Tree dominance	Reproduction	DBH
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													

Tree #	Easting	Northing	Alive/ dead	Bark condition	Crown extent	Crown density	Recovery: Epicormic growth	Recovery: New tip growth	Decline: Leaf die off	Decline: Mistletoe	Tree dominance	Reproduction	DBH
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													



## RIVER RED GUM CONDITION ASSESSMENT: KEY TO CATEGORIES

### Bark condition

Category	Description and range
0	No bark (long term dead)
1	Extensive areas of cracked bark
2	Minor areas of cracked bark
3	Intact bark

### Crown extent and crown density (measurement for each parameter)

Category	Description and range	% Cover
0	None	0%
1	Minimal	1-10%
2	Sparse	11-20%
3	Sparse-moderate	21-40%%
4	Moderate	41-60%%
5	Moderate-major	61-80%
6	Major	81-90%
7	Maximum	91-100%

### Recovery: Epicormic growth and new tip growth (measurement for each parameter)

Category	Description and range	Definition
0	Absent	Effect is not visible
1	Scarce	Effect is present but not readily visible
2	Common	Effect is clearly visible
3	Abundant	Effect dominates the appearance of the tree

### Decline: leaf die-off and mistletoe

Category	Description and range	Definition
0	Absent	Effect is not visible
-	Scarce	Effect is present but not readily visible
-2	Common	Effect is clearly visible
-3	Abundant	Effect dominates the appearance of the tree



### Insect damage

Category	Description and range
Absent	Not visible or minor damage to some trees
Scarce	Some trees have scattered damage within the crown
Common	Most trees have significant damage within the crown
Abundant	All trees have significant damage within the crown

### Other biological stresses

Category	Description and range
Absent	Not visible or minor presence within the plot
Scarce	Scattered occurrence throughout the plot
Common	Present throughout the majority of the plot
Abundant	Present throughout the entire plot

### Dominance

Category	Description and range
Dominant	Tree with a crown extending above the general canopy, receiving full light from above and partly from the sides; a larger than average tree in the stand.
Co-dominant	Tree with crown forming part of the general canopy, receiving full light from above but comparatively little from the sides.
Subdominant	Tree Shorter than the previous classes, but with a crown extending into the canopy of the Codominant trees, receiving little light from above but none from the sides.
Suppressed	Tree with a crown entirely below the canopy, receives no direct light from above or from the sides.

### Reproduction

Score	Description	Definition
0	Absent	Reproductive behaviour is not visible
1	Scarce	Reproductive behaviour is present but not readily visible
2	Common	Reproductive behaviour is clearly visible
3	Abundant	Reproductive behaviour dominates the appearance of the tree



## Appendix D

# Flora species recorded at Margooya Lagoon April 2008



FFG EPBC VROTS Origin	Scientific Name	Common Name	Family Name
r	<i>Acacia stenophylla</i>	Eumong	Mimosaceae
	<i>Alternanthera denticulata</i> s.l.	Lesser Joyweed	Amaranthaceae
	<i>Asperula gemella</i>	Twin-leaf Bedstraw	Rubiaceae
	<i>Atriplex semibaccata</i>	Berry Saltbush	Chenopodiaceae
	<i>Austrodanthonia</i> spp.	Wallaby Grass	Poaceae
	<i>Austrostipa</i> spp.	Spear Grass	Poaceae
	<i>Brachyscome basaltica</i> var. <i>gracilis</i>	Woodland Swamp-daisy	Asteraceae
	<i>Chenopodium nitrariaceum</i>	Nitre Goosefoot	Chenopodiaceae
	<i>Cynodon dactylon</i>	Couch	Poaceae
	<i>Cyperus exaltatus</i>	Tall Flat-sedge	Cyperaceae
	<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge	Cyperaceae
	<i>Dodonaea viscosa</i> subsp. <i>angustissima</i>	Slender Hop-bush	Sapindaceae
	<i>Eclipta platyglossa</i>	Yellow Twin-heads	Asteraceae
	<i>Einadia nutans</i> subsp. <i>nutans</i>	Nodding Saltbush	Chenopodiaceae
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	Ruby Saltbush	Chenopodiaceae
	<i>Eragrostis</i> spp.	Love Grass	Poaceae
	<i>Eremophila divaricata</i> subsp. <i>divaricata</i>	Spreading Emu-bush	Myoporaceae
	<i>Eucalyptus camaldulensis</i>	River Red-gum	Myrtaceae
	<i>Eucalyptus largiflorens</i>	Black Box	Myrtaceae
	<i>Euchiton sphaericus</i>	Annual Cudweed	Asteraceae
r	<i>Glinus lotoides</i>	Hairy Carpet-weed	Molluginaceae
	<i>Glycyrrhiza acanthocarpa</i>	Southern Liquorice	Fabaceae
	<i>Juncus aridicola</i>	Tussock Rush	Juncaceae
	<i>Lachnagrostis filiformis</i>	Common Blown-grass	Poaceae
	<i>Ludwigia peploides</i>	Water Primrose	Onagraceae
	<i>Maireana brevifolia</i>	Short-leaf Bluebush	Chenopodiaceae
	<i>Muehlenbeckia florulenta</i>	Tangled Lignum	Polygonaceae
	<i>Olearia pimeleoides</i>	Pimelea Daisy-bush	Asteraceae
	<i>Persicaria decipiens</i>	Slender Knotweed	Polygonaceae
	<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	Asteraceae
	<i>Rumex brownii</i>	Slender Dock	Polygonaceae
	<i>Sclerochlamys brachyptera</i>	Short-wing Saltbush	Chenopodiaceae
	<i>Senecio pinnatifolius</i>	Variable Groundsel	Asteraceae
	<i>Senecio quadridentatus</i>	Cotton Fireweed	Asteraceae
	<i>Senecio runcinifolius</i>	Tall Fireweed	Asteraceae
	<i>Senna</i> form taxon ' <i>zygophylla</i> '	Narrow-leaf Desert Cassia	Caesalpiniaceae
	<i>Sporobolus mitchellii</i>	Rat-tail Couch	Poaceae
	<i>Teucrium racemosum</i> s.l.	Grey Germander	Lamiaceae
	<i>Typha orientalis</i>	Broad-leaf Cumbungi	Typhaceae
	<i>Vittadinia cervicalis</i>	Annual New Holland Daisy	Asteraceae
	<i>Vittadinia cuneata</i>	Fuzzy New Holland Daisy	Asteraceae
	<i>Vittadinia dissecta</i> s.l.	Dissected New Holland Daisy	Asteraceae
	<i>Vittadinia</i> spp.	New Holland Daisy	Asteraceae
	<i>Wahlenbergia fluminalis</i>	River Bluebell	Campanulaceae





FFG EPBC VROTS Origin	Scientific Name	Common Name	Family Name
	<i>Wahlenbergia</i> spp.	Bluebell	Campanulaceae
	<i>Whalleya proluta</i>	Rigid Panic	Poaceae
#	<i>Atriplex suberecta</i>	Sprawling Saltbush	Chenopodiaceae
#	<i>Chamaesyce drummondii</i>	Flat Spurge	Euphorbiaceae
#	<i>Rhagodia spinescens</i>	Hedge Saltbush	Chenopodiaceae
*	<i>Aster subulatus</i>	Aster-weed	Asteraceae
*	<i>Bromus rubens</i>	Red Brome	Poaceae
*	<i>Cirsium vulgare</i>	Spear Thistle	Asteraceae
*	<i>Chondrilla juncea</i>	Skeleton Weed	Asteraceae
*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane	Asteraceae
*	<i>Cyperus eragrostis</i>	Drain Flat-sedge	Cyperaceae
*	<i>Dittrichia graveolens</i>	Stinkwort	Asteraceae
*	<i>Hedypnois cretica</i>	Cretan Hedypnois	Asteraceae
*	<i>Lactuca serriola</i>	Prickly Lettuce	Asteraceae
*	<i>Marrubium vulgare</i>	Horehound	Lamiaceae
*	<i>Olea europaea</i>	Olive	Oleaceae
*	<i>Opuntia</i> spp.	Prickly Pear	Cactaceae
*	<i>Paspalum distichum</i>	Water Couch	Poaceae
*	<i>Phyla canescens</i>	Fog-fruit	Verbenaceae
*	<i>Polygonum aviculare</i> s.l.	Prostrate Knotweed	Polygonaceae
*	<i>Sonchus oleraceus</i>	Common Sow-thistle	Asteraceae
*	<i>Verbena supina</i>	Trailing Verbena	Verbeneaceae



## Appendix E

# Flora quadrat data Margooya Lagoon April 2008



Scientific name	Common name	Quad 1 M27650	Quad 2 M27651	Quad 3 M27652	Quad 4 M27653	Quad 5 M27654	Quad 6 M27655	Quad 7 M27656
<i>Acacia stenophylla</i>	Eumong	+	2	2	1	+		
<i>Alternanthera denticulata</i> s.l.	Lesser Joyweed	+						
<i>Asperula gemella</i>	Twin-leaf Bedstraw			1				
<i>Aster subulatus</i>	Aster-weed			+	+		+	
<i>Atriplex semibaccata</i>	Berry Saltbush		2	+		1		2
<i>Atriplex suberecta</i>	Sprawling Saltbush				+			
<i>Austrodanthonia</i> spp.	Wallaby Grass		+					
<i>Austrostipa</i> spp.	Spear Grass							+
<i>Brachyscome basaltica</i> var. <i>gracilis</i>	Woodland Swamp-daisy		1			1		
<i>Bromus rubens</i>	Red Brome		1					
<i>Chamaesyce drummondii</i>	Flat Spurge			+	+			
<i>Cirsium vulgare</i>	Spear Thistle			1	1	2	1	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane					1		+
<i>Cynodon dactylon</i>	Couch	2	1	1	1	2	2	1
<i>Cyperus eragrostis</i>	Drain Flat-sedge				1			
<i>Cyperus exaltatus</i>	Tall Flat-sedge	3			1		1	
<i>Cyperus gymnocaulos</i>	Spiny Flat-sedge		2	2	2		1	1
<i>Dittrichia graveolens</i>	Stinkwort					2		
<i>Eclipta platyglossa</i>	Yellow Twin-heads		2	2		+		1
<i>Einadia nutans</i> subsp. <i>nutans</i>	Nodding Saltbush		1	+		1		1
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	Ruby Saltbush		1	1		+		2
<i>Eremophila divaricata</i> subsp. <i>divaricata</i>	Spreading Emu-bush	+						
<i>Eucalyptus camaldulensis</i>	River Red-gum	2	2	2	1	2	2	1
<i>Eucalyptus largiflorens</i>	Black Box							2
<i>Euchiton sphaericus</i>	Annual Cudweed					1		
<i>Glinus lotoides</i>	Hairy Carpet-weed	3					2	
<i>Glycyrrhiza acanthocarpa</i>	Southern Liquorice		1	1		1		+
<i>Hedypnois cretica</i>	Cretan Hedypnois		1	1		+		
<i>Juncus aridicola</i>	Tussock Rush						+	
<i>Lactuca serriola</i>	Prickly Lettuce		+			1		
<i>Ludwigia peploides</i>	Water Primrose	1				+	1	
<i>Maireana brevifolia</i>	Short-leaf Bluebush		+					+
<i>Marrubium vulgare</i>	Horehound							+
<i>Muehlenbeckia</i>	Tangled Lignum							2



Scientific name	Common name	Quad 1 M27650	Quad 2 M27651	Quad 3 M27652	Quad 4 M27653	Quad 5 M27654	Quad 6 M27655	Quad 7 M27656
<i>florulenta</i>								
<i>Olea europaea</i>	Olive		+					
<i>Opuntia spp.</i>	Prickly Pear							+
<i>Paspalum distichum</i>	Water Couch						2	+
<i>Persicaria decipiens</i>	Slender Knotweed	2					2	
<i>Phyla canescens</i>	Fog-fruit		2					
<i>Polygonum aviculare s.l.</i>	Prostrate Knotweed	2						
<i>Pseudognaphalium luteoalbum</i>	Jersey Cudweed	+				1	1	
<i>Rhagodia spinescens</i>	Hedge Saltbush		+	1		1		2
<i>Sclerochlamys brachyptera</i>	Short-wing Saltbush							1
<i>Senecio pinnatifolius</i>	Variable Groundsel	+						
<i>Senecio quadridentatus</i>	Cotton Fireweed		+	+		2	+	
<i>Senecio runcinifolius</i>	Tall Fireweed	1		1		1	1	1
<i>Sonchus oleraceus</i>	Common Sow-thistle			+	+	2		
<i>Sporobolus mitchellii</i>	Rat-tail Couch						1	1
<i>Typha orientalis</i>	Broad-leaf Cumbungi				4		4	
<i>Vittadinia cervicalis</i>	Annual New Holland Daisy			1				
<i>Vittadinia cuneata</i>	Fuzzy New Holland Daisy		1	1		1		1
<i>Vittadinia dissecta s.l.</i>	Dissected New Holland Daisy		1	1		1		
<i>Wahlenbergia fluminalis</i>	River Bluebell		1	1		2	1	
<i>Wahlenbergia spp.</i>	Bluebell		1					
<i>Whalleya proluta</i>	Rigid Panic				+			



## Appendix F

# Tree health data Margooya Lagoon April 2008

Tree Health data Margooya Lagoon 14th-15th May 2008					Transect 1		Assessors SDB and AH				
Tree number	WP	bark condition	canopy condition	new growth	canopy density	reproductive status	leaf condition	mistletoe load	DBH	size class	total score
1	3	2	4	2	3	no	1	2	155	very large	14
2	4	1	4	2	4	no	1	2	96.5	very large	14
3	5	1	3	1	2	no	0	2	126	very large	9
4	6	1	2	1	1	no	1	2	122.5	very large	8
5	7	2	4	3	4	no	2	2	154.5	very large	17
6	8	2	4	3	4	no	2	2	162	very large	17
7	9	2	4	2	2	no	2	2	89	very large	14
8	12	0	0	0	0	no	0	2	71	large	2
9	11	2	3	1	2	no	1	2	123	very large	11
10	13	2	4	3	4	no	2	2	153	very large	17
11	14	2	3	1	2	no	2	2	38.5	small	12
12	15	2	4	3	4	no	1	2	61.5	medium	16
13	16	1	4	2	3	no	1	2	25.5	small	13
14	17	2	3	1	2	no	2	2	61.5	medium	12
15	18	2	3	2	2	no	2	2	66	medium	13
16	19	2	3	3	2	no	2	2	61	medium	14
17	20	0	0	0	0	no	0	2	37.5	small	2
18	21	1	4	3	3	no	2	2	56	medium	15
19	22	2	4	2	4	no	2	2	50	small	16
20	23	1	3	1	2	no	2	2	35	small	11
21	24	2	4	2	2	no	2	2	50.5	small	14
22	25	2	4	3	4	no	1	2	67	medium	16
23	26	2	4	3	4	no	2	2	89	very large	17
24	27	0	0	0	0	no	0	2	97.5	very large	2
25	28	1	4	2	3	no	2	2	111	very large	14
26	29	1	3	1	2	no	2	2	202	very large	11
27	30	2	4	3	4	no	2	2	116	very large	17
28	31	1	3	1	2	no	2	2	72	large	11
29	32	2	4	3	4	no	2	2	96	very large	17
30	33	2	4	2	4	no	2	2	53.5	medium	16



Transect 2											
Tree number	WP	bark condition	canopy condition	new growth	canopy density	reproductive status	leaf condition	mistletoe load	DBH	size class	total score
1	101	2	4	2	4	no	2	2	240	very large	16
2	102	2	4	2	4	no	1	2	185.5	very large	15
3	103	2	4	2	4	no	2	2	156	very large	16
4	104	0	0	0	0	no	0	2	82.5	large	2
5	105	2	5	3	5	no	2	2	36.5	small	19
6	106	2	4	2	4	no	2	2	37	small	16
7	107	2	4	2	3	no	2	2	84	large	15
8	108	2	4	2	4	no	2	2	27	small	16
9	109	2	4	3	4	no	2	2	29	small	17
10	110	2	4	2	3	yes	2	2	88	very large	15
11	111	2	5	2	5	no	2	2	41.5	small	18
12	112	1	2	1	1	no	1	2	160	very large	8
13	113	2	4	2	2	yes	2	2	126.5	very large	14
14	114	2	4	3	4	yes	2	2	169.5	very large	17
15	115	2	4	2	4	yes	2	2	174	very large	16
16	116	2	4	3	4	no	2	2	29.5	small	17
17	117	2	5	2	5	no	2	2	20.5	small	18
18	118	2	4	3	4	yes	2	2	77.5	large	17
19	119	0	0	0	0	no	0	2	143.5	very large	2
20	120	2	5	1	5	no	1	2	20.5	small	16
21	121	2	4	2	4	yes	2	2	87.5	very large	16
22	122	2	5	3	5	yes	2	2	54.5	medium	19
23	123	2	5	2	5	no	2	2	48.5	small	18
24	124	2	4	2	4	no	2	2	54.5	medium	16
25	125	2	3	0	1	no	2	2	24	small	10
26	126	1	4	2	3	yes	2	2	238.5	very large	14
27	127	0	0	0	0	no	0	2	130	very large	2
28	128	2	5	2	5	yes	2	2	52.5	medium	18
29	129	2	5	3	5	yes	2	2	42	small	19
30	130	2	4	3	3	yes	2	2	95	very large	16



Appendix G

# Photo monitoring points – Margooya Lagoon



**Figure 23** Photo point 15 (669387, 6166130), from south bank of northeast ‘arm’ of wetland, looking north-east to monitor abundance of Cumbungi (*Typha* sp.) and condition of River Red Gums (*Eucalyptus camaldulensis*).



**Figure 24** Photo point 16 (N) (669393, 6166139), looking north toward the north-western ‘arm’ of wetland to monitor abundance of Cumbungi (*Typha* sp.) and condition of River Red Gums (*Eucalyptus camaldulensis*).



**Figure 25** Photo point 16 (S from same point as above) (669387, 6166130), looking south toward the southern ‘arm’ of wetland to monitor condition of River Red Gums (*Eucalyptus camaldulensis*) and terrestrial vegetation.



**Figure 26** Photo point 17(669789, 6166387), looking northeast toward the north-eastern ‘arm’ of wetland to monitor abundance of Cumbungi (*Typha* sp.)





**Figure 27** Photo point 18 (669451, 6165943), looking north along the southern ‘arm’ of wetland to monitor abundance of Cumbungi (*Typha* sp.) and condition of River Red Gums (*Eucalyptus camaldulensis*).



**Figure 28** Photo point 19 (669818, 6165879), looking south across the southern ‘arm’ of wetland to monitor abundance of Cumbungi (*Typha* sp.), condition of River Red Gums (*Eucalyptus camaldulensis*) and terrestrial vegetation.



Appendix H

**Fauna Species Lists Margooya Lagoon**

**April 2008**



**Table 22 Fauna species recorded at Site 1 during the present assessment, 14 May 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = Flora and Fauna Guarantee Act 1988

DSE = Advisory List of Threatened Vertebrate Fauna in Victoria 2007

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

L = Listed under the Flora and Fauna Guarantee Act 1988

CE = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs =- Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			hrd	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	
			obs	<i>Artamus cyanopterus</i>	Dusky Woodswallow	2 adults flying above canopy
			obs	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	2 adults observed in RRG
			obs	<i>Cacatua roseicapilla</i>	Galah	20 adults observed flying over canopy
		NT	hrd	<i>Climacteris picumnus</i> %	Brown Treecreeper	
			hrd	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
			obs	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	1 adult observed in canopy of RRG
			hrd	<i>Corcorax melanorhamphos</i>	White-winged Chough	
			hrd	<i>Corvus mellori</i>	Little Raven	
			obs	<i>Cracticus nigrogularis</i>	Pied Butcherbird	1 adult observed at top of RRG
			hrd	<i>Cracticus torquatus</i>	Grey Butcherbird	
			hrd	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	
			hrd	<i>Geopelia striata</i>	Peaceful Dove	
			hrd	<i>Grallina cyanoleuca</i>	Magpie-lark	
			obs	<i>Haliastur sphenurus</i>	Whistling Kite	1 adult observed flying over canopy
			obs	<i>Hirundo nigricans</i>	Tree Martin	observed flying above canopy
			hrd	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	
			hrd	<i>Malurus cyaneus</i>	Superb Fairy-wren	





FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
			hrd	<i>Manorina melanocephala</i>	Noisy Miner	
			obs	<i>Ocyphaps lophotes</i>	Crested Pigeon	2 adults observed flying above canopy
			obs	<i>Oriolus sagittatus</i>	Olive-backed Oriole	1 adult observed in canopy of RRG calling
			hrd	<i>Philemon citreogularis</i>	Little Friarbird	
			obs	<i>Platycercus elegans</i>	Crimson Rosella	3 adults observed in RRG
L	VU	VU	obs	<i>Polytelis anthopeplus</i> %	Regent Parrot	2 adults observed in BB tree and group of 7 birds observed flying over wetland
			obs	<i>Psephotus haematonotus</i>	Red-rumped Parrot	6 adults observed in RRG
			hrd	<i>Rhipidura leucophrys</i>	Willie Wagtail	
			obs	<i>Sturnus vulgaris</i> *	Common Starling	2 adults observed in RRG
<b>Mammals</b>						
			obs	<i>Macropus fuliginosus</i>	Western Grey Kangaroo	1 adult observed on ground
			ind	<i>Oryctolagus cuniculus</i> *	European Rabbit	
<b>Reptiles</b>						
			obs	<i>Cryptoblepharus carnabyi</i>	Carnaby's Wall Skink	1 juvenile, 1 subadult and 1 adult observed on tree and fallen log
			obs	<i>Morethia boulengeri</i>	Boulenger's Skink	1 adult observed on ground amongst fallen debris
<b>Frogs</b>						
			hrd	<i>Crinia parinsignifera</i>	Plains Froglet	



**Table 23 Fauna species recorded at Site 2 during the present assessment, 15 May 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = Flora and Fauna Guarantee Act 1988

DSE = Advisory List of Threatened Vertebrate Fauna in Victoria 2007

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

L = Listed under the Flora and Fauna Guarantee Act 1988

CE = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs =- Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			obs	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	6 adults observed in BB
			hrd	<i>Cacatua roseicapilla</i>	Galah	
		NT	hrd	<i>Climacteris picumnus</i>	Brown Treecreeper	
			hrd	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
			obs	<i>Cracticus torquatus</i>	Grey Butcherbird	1 adult observed in RRG
			hrd	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	
			hrd	<i>Geopelia striata</i>	Peaceful Dove	
			obs	<i>Grallina cyanoleuca</i>	Magpie-lark	1 adult observed on dry wetland bed
			hrd	<i>Gymnorhina tibicen</i>	Australian Magpie	
			obs	<i>Haliastur sphenurus</i>	Whistling Kite	2 adults observed at nest in RRG upper canopy at wetland edge
			obs	<i>Hirundo neoxena</i>	Welcome Swallow	observed flying over canopy
			obs	<i>Hirundo nigricans</i>	Tree Martin	observed flying over canopy
			hrd	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	
			obs	<i>Lichenostomus virescens</i>	Singing Honeyeater	2 adults observed in RRG recruits and Cumbungi at edge of lagoon
			hrd	<i>Malurus cyaneus</i>	Superb Fairy-wren	
			hrd	<i>Ocyphaps lophotes</i>	Crested Pigeon	



FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
			hrd	<i>Pardalotus striatus</i>	Striated Pardalote	
			obs	<i>Passer domesticus</i> *	House Sparrow	Small flock observed in Cumbungi
			obs	<i>Platycercus elegans</i>	Crimson Rosella	30 adults observed throughout site
L	VU	VU	obs	<i>Polytelis anthopeplus</i> %	Regent Parrot	28 adults observed flying over wetland and in trees
			obs	<i>Psephotus haematonotus</i>	Red-rumped Parrot	5 adults observed on ground
			hrd	<i>Rhipidura fuliginosa</i>	Grey Fantail	
			hrd	<i>Rhipidura leucophrys</i>	Willie Wagtail	
			hrd	<i>Smicrornis brevirostris</i>	Weebill	
L		VU	obs	<i>Stagonopleura guttata</i> %	Diamond Firetail	3 adults observed, perched in RRG and fallen debris, near confluence of N, E and S arms of Margooya Lagoon
<b>Mammals</b>						
			ind	<i>Macropus sp.</i>	A Kangaroo	scat observed
			ind	<i>Sus scrofa</i>	Pig (Feral)	Rooting observed
<b>Reptiles</b>						
			obs	<i>Phyllodactylus marmoratus</i>	Marbled Gecko	juvenile observed under small piece of tin at base of RRG
<b>Frogs</b>						
			hrd	<i>Crinia parinsignifera</i>	Plains Froglet	



**Table 24 Fauna species recorded at Site 3 during the present assessment, 15 May 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = Flora and Fauna Guarantee Act 1988

DSE = Advisory List of Threatened Vertebrate Fauna in Victoria 2007

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

L = Listed under the Flora and Fauna Guarantee Act 1988

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EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs = Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			hrd	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater	
			obs	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	40+ adults observed in RRG
			obs	<i>Cacatua sanguinea</i>	Little Corella	2 adults flying above canopy
			hrd	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
			obs	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	1 adult in BB
			obs	<i>Corvus coronoides</i>	Australian Raven	4 adults on ground
			hrd	<i>Cracticus torquatus</i>	Grey Butcherbird	
			obs	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	1 adult in RRG
			hrd	<i>Gymnorhina tibicen</i>	Australian Magpie	
			hrd	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater	
			obs	<i>Malurus cyaneus</i>	Superb Fairy-wren	1 male and 2 females observed in Cumbungi at lagoon fringe
			obs	<i>Pardalotus striatus</i>	Striated Pardalote	2 adults in RRG
			hrd	<i>Phaps chalcoptera</i>	Common Bronzewing	
			hrd	<i>Philemon citreogularis</i>	Little Friarbird	
			obs	<i>Platycercus elegans</i>	Crimson Rosella	4 adults in RRG
L	VU	VU	obs	<i>Polytelis anthopeplus</i> %	Regent Parrot	26 adults observed flying over site and in RRG
			obs	<i>Rhipidura fuliginosa</i>	Grey Fantail	2 adults in BB
			hrd	<i>Rhipidura leucophrys</i>	Willie Wagtail	
<b>Mammals</b>						
			obs	<i>Canis vulpes</i> *	Red Fox	1 adult observed on ground



**Table 25 Fauna species recorded at Site 4 during the present assessment, 15 May 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = *Flora and Fauna Guarantee Act 1988*

DSE = *Advisory List of Threatened Vertebrate Fauna in Victoria 2007*

EPBC = *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*

L = Listed under the *Flora and Fauna Guarantee Act 1988*

CE = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs =- Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			hrd	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	
			hrd	<i>Cracticus nigrogularis</i>	Pied Butcherbird	
			obs	<i>Rhipidura fuliginosa</i>	Grey Fantail	1 adult in BB
			hrd	<i>Smicronis brevirostris</i>	Weebill	
<b>Frogs</b>						
			hrd	<i>Crinia parinsignifera</i>	Plains Froglet	



**Table 26 Incidental fauna species recorded at Margooya Lagoon during the present assessment, 14-15 May 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = Flora and Fauna Guarantee Act 1988

DSE = Advisory List of Threatened Vertebrate Fauna in Victoria 2007

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

L = Listed under the Flora and Fauna Guarantee Act 1988

CE = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs =- Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			obs	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	60+ adults observed in RRG
	NT		hrd	<i>Climacteris picumnus</i>	Brown Treecreeper	
			obs	<i>Corcorax melanorhamphos</i>	White-winged Chough	20+ group observed in BB and on ground
			hrd	<i>Corvus coronoides</i>	Australian Raven	
			obs	<i>Cracticus torquatus</i>	Grey Butcherbird	1 adult observed in RRG lower canopy
			hrd	<i>Gymnorhina tibicen</i>	Australian Magpie	
L		VU		<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	2 adults perched in dead RRG, W side of lagoon, seen on 14/05/08 and again on 15/05/08
			obs	<i>Hirundo nigricans</i>	Tree Martin	observed flying above canopy
			hrd	<i>Malurus cyaneus</i>	Superb Fairy-wren	
			hrd	<i>Pardalotus striatus</i>	Striated Pardalote	
			hrd	<i>Phaps chalcoptera</i>	Common Bronzewing	
			obs	<i>Platycercus elegans</i>	Crimson Rosella	4 adults in RRG
L	VU	VU	obs	<i>Polytelis anthopeplus</i>	Regent Parrot	3 adults observed in RRG, 6 adults flying over canopy
			hrd	<i>Rhipidura fuliginosa</i>	Grey Fantail	



FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Mammals</b>						
			obs	<i>Canis vulpes</i>	Red Fox	2 adults observed feeding on dead European Carp in dry wetland bed
<b>Fish</b>						
			obs	<i>Cyprinus carpio</i> *	European Carp	Numerous large adults, some alive, many dead in residual pools within Margooya Lagoon





**Table 27 Incidental fauna species recorded at Margooya Lagoon during the present assessment, 5 September 2008, Margooya Lagoon, Robinvale, North-west Victoria.**

Key to Table:

FFG = Flora and Fauna Guarantee Act 1988

DSE = Advisory List of Threatened Vertebrate Fauna in Victoria 2007

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

L = Listed under the Flora and Fauna Guarantee Act 1988

CE = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

DD = Data Deficient

Obs =- Observed on the ground or in vegetation

Hrd = Heard only

% = State or nationally listed threatened species

\* = Introduced species

FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
<b>Birds</b>						
			obs	<i>Anas gracilis</i>	Grey Teal	94 individuals observed
			obs	<i>Anas superciliosa</i>	Pacific Black Duck	7 individuals observed
			obs	<i>Cygnus atratus</i>	Black Swan	4 individuals observed
			obs	<i>Circus approximans</i>	Swamp Harrier	
			obs	<i>Elseyornis melanops</i>	Black-fronted Dotterel	
			obs	<i>Pelecanus conspicillatus</i>	Pelican	8 individuals observed
			hrd	<i>Cuculus pallidus</i>	Pallid Cuckoo	
			hrd	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	
			obs	<i>Tadorna tadornoides</i>	Australian Shelduck	6 individuals observed
			obs	<i>Chenonetta jubata</i>	Wood Duck	3 individuals observed
L		VU	obs	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	1 adult and 1 sub-adult observed
L	VU	VU	obs	<i>Polytelis anthopeplus</i>	Regent Parrot	
<b>Mammals</b>						
			ind	<i>Tachyglossus aculeatus</i>	Echidna	
<b>Reptiles</b>						
			obs	<i>Morethia boulengeri</i>	Boulenger's Skink	




FFG	EPBC	DSE	Type	Scientific Name	Common Name	Notes
Frogs						
			hrd	<i>Crinia parinsignifera</i>	Plains Froglet	
			hrd	<i>Crinia signifera</i>	Common Froglet	
			hrd	<i>Limnodynastes dumerilii dumerilii</i>	Southern Bullfrog	
			hrd	<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog	



Appendix I

## Habitat Assessment Results and Field Data Sheets.

	<b>Habitat Attribute Assessment and 50 x 20m quadrat</b>	
<b>Location and Site Number:</b> Margooya Lagoon (NW Arm)	<b>Name of Assessor:</b> Alex Holmes and Sjaan Bidwell	
<b>Date of Assessment:</b> 14/05/08	<b>Tenure:</b> Crown Land	
<b>Start Time:</b> 14:00 hrs	<b>Finish Time:</b> 16:30 hrs	
<b>Easting:</b> 669256	<b>Northing:</b> 6166735	
<b>Average Cloud Cover:</b> <b>0-10%</b> 10-30%   30-50%   50-70%   70-90%   90-100%	<b>Wind Direction and Conditions:</b> <b>Calm</b> Light Breeze   Moderate   Heavy   Gusty   Other?	
<b>Minimum temp during survey:</b>	<b>Max temp during survey:</b> Approx 25°C	
<b>Precipitation on day (mm) / previous days?:</b> None		
<b>% water in wetland on day/s of assessment:</b> < 1% - currently almost dry	<b>If water present, maintain waterbird count:</b> (Maximum number of each species seen – no double counts) Waterbirds not present as too little water present	
<b>Wetland Habitat Types Present (using Environment Australia 2001) (circle at least one)</b>	Permanent Rivers and Streams; Permanent Freshwater Lakes (including oxbows); Seasonal/Irregular Rivers and Streams; <b>Seasonal/Intermittent Freshwater Lakes;</b> Riverine Floodplains (river flats, seasonally flooded grassland); Other?	
<b>Presence of Wildlife Movement Corridors?</b> Murray River acts as a wildlife movement corridor.		
<b>Disturbance:</b>		
<b>Grazing:</b> Low / Moderate / High	<b>Feral Animals (type):</b> Rabbits	
<b>Recreational intensity:</b> Low / Moderate / High	<b>Clearing / timber extraction:</b> Low / Moderate / High	
<b>Pest Plants:</b> Low / Moderate / High	<b>Infrastructure (type):</b> Some temporary levee structures associated with inlet (N)	
<b>Actions currently operating at site reducing values for wetland/terrestrial fauna (Inappropriate hydrological regimes, CWD removal, inappropriate stock management, other pest plants and animals, salinity, tree dieback/death?)</b> <ul style="list-style-type: none"> <li>» Actions occurring include inappropriate hydrological regimes (i.e. permanently inundated), although the Mallee CMA is seeking to re-introduce a drying phase to the wetland;</li> <li>» Possible saline groundwater impacts due to irrigation water drainage from agricultural land to the west of the lagoon;</li> <li>» Tree dieback / death possibly due to saline groundwater (as mentioned above);</li> <li>» European Rabbit activity in area.</li> </ul>		

<b>Existing rehabilitation activities (type):</b> Reintroduction of a drying cycle				
<b>Cultural Features (Aboriginal / European / Other):</b> Cultural Features Identified (e.g. scar trees, midden etc): Possible scar tree observed on east bank of north-west arm of Margooya Lagoon.				
<b>Description of Vegetation (community):</b> Fringing River Red Gum, with Black Box Woodland further away from the fringes on the floodplain.				
<b>Dominant Canopy Species</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Understorey Species:</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Groundcover Species:</b>				<b>% Cover abundance</b>
Refer to vegetation assessment				
<1% = +,    1-5% = 1,    6-25% = 2,    26-50% = 3,    51-75% = 4,    76-100% = 5.				
<b>Early Regrowth</b>	<b>Advanced Regrowth</b>	<b>Uneven Age</b>	<b>Mature Age</b>	<b>Old Growth</b>
		Mixed age classes, some old growth, younger cohorts and new recruitment		
<b>Average No. of Trees by Size Class (Diameter at Breast Height [DBH])</b>				
<10 cm	10 – 20 cm	21 – 40 cm	41 – 60 cm	>61 cm
<b>Large Woody Debris (High / Moderate / Low – Photo Standards)</b> Generally moderate to high levels of woody debris, although this may be due to poor tree health.				


Attribute	<1%	1-5%	6-25%	26-50%	51-75%	76-100%
Rock	√					

Habitat attribute	Yes/No	No/quad
Large Stags	√	3-4

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Leaf litter				√		
Bare ground		√				
Cryptogams etc	√					

Large Hollows (trunk)	√	4-5
Small Hollows (branch)	√	10+
Mistletoes	-	
Fleshy fruits (native or exotic)	-	

	<b>Habitat Attribute Assessment and 50 x 20m quadrat</b>	
<b>Location and Site Number:</b> Margooya Lagoon (NE Arm)	<b>Name of Assessor:</b> Alex Holmes and Sjaan Bidwell	
<b>Date of Assessment:</b> 15/05/08	<b>Tenure:</b> Crown Land	
<b>Start Time:</b> 07:45 hrs	<b>Finish Time:</b> 09:30 hrs	
<b>Easting:</b> 669800	<b>Northing:</b> 6166349	
<b>Average Cloud Cover:</b> 0-10%   10-30%   30-50%   50-70%   70-90% <b>90-100%</b>	<b>Wind Direction and Conditions:</b> <b>Calm</b> Light Breeze   Moderate   Heavy   Gusty   Other?	
<b>Minimum temp during survey:</b>	<b>Max temp during survey:</b> Approx 18°C	
<b>Precipitation on day (mm) / previous days?:</b> Yes, <1mm		
<b>% water in wetland on day/s of assessment:</b> < 1% - currently almost dry	<b>If water present, maintain waterbird count:</b> (Maximum number of each species seen – no double counts) Waterbirds not present as too little water present	
<b>Wetland Habitat Types Present (using Environment Australia 2001) (circle at least one)</b>	Permanent Rivers and Streams; Permanent Freshwater Lakes (including oxbows); Seasonal/Irregular Rivers and Streams; <b>Seasonal/Intermittent Freshwater Lakes;</b> Riverine Floodplains (river flats, seasonally flooded grassland); Other?	
<b>Presence of Wildlife Movement Corridors?</b> Murray River acts as a wildlife movement corridor.		
<b>Disturbance:</b>		
<b>Grazing:</b> Low / Moderate / High	<b>Feral Animals (type):</b> Pigs (Feral), Foxes	
<b>Recreational intensity:</b> Low / Moderate / High	<b>Clearing / timber extraction:</b> Low / Moderate / High	
<b>Pest Plants:</b> Low / Moderate / High	<b>Infrastructure (type):</b> Access track running alongside site.	
<b>Actions currently operating at site reducing values for wetland/terrestrial fauna (Inappropriate hydrological regimes, CWD removal, inappropriate stock management, other pest plants and animals, salinity, tree dieback/death?)</b> <ul style="list-style-type: none"> <li>» Actions occurring include inappropriate hydrological regimes (i.e. permanently inundated), although the Mallee CMA is seeking to re-introduce a drying phase to the wetland;</li> <li>» Possible saline groundwater impacts due to irrigation water drainage from agricultural land to the west of the lagoon;</li> <li>» Tree dieback / death possibly due to saline groundwater (as mentioned above);</li> <li>» Feral Pig and Red Fox activity.</li> </ul>		



<b>Existing rehabilitation activities (type):</b> Reintroduction of a drying cycle				
<b>Cultural Features (Aboriginal / European / Other):</b>				
Cultural Features Identified (e.g. scar trees, midden etc):				
<b>Description of Vegetation (community):</b> Fringing River Red Gum, tending to River Red Gum forest, with Black Box Woodland further away from the fringes on the floodplain.				
<b>Dominant Canopy Species</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Understorey Species:</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Groundcover Species:</b>				<b>% Cover abundance</b>
Refer to vegetation assessment				
<1% = +,    1-5% = 1,    6-25% = 2,    26-50% = 3,    51-75% = 4,    76-100% = 5.				
<b>Early Regrowth</b>	<b>Advanced Regrowth</b>	<b>Uneven Age</b>	<b>Mature Age</b>	<b>Old Growth</b>
		Mixed age classes, some old growth, some older cohorts		
<b>Average No. of Trees by Size Class (Diameter at Breast Height [DBH])</b>				
<10 cm	10 – 20 cm	21 – 40 cm	41 – 60 cm	>61 cm
<b>Large Woody Debris (High / Moderate / Low – Photo Standards)</b> Generally moderate to high levels of woody debris, although this may be due to poor tree health.				


Attribute	<1%	1-5%	6-25%	26-50%	51-75%	76-100%
Rock	√					

Habitat attribute	Yes/No	No/quad
Large Stags	√	1

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Leaf litter					√	
Bare ground		√				
Cryptogams etc	√					

Large Hollows (trunk)	√	4-5
Small Hollows (branch)	√	10+
Mistletoes	-	
Fleshy fruits (native or exotic)	-	

	<b>Habitat Attribute Assessment and 50 x 20m quadrat</b>	
<b>Location and Site Number:</b> Margooya Lagoon (NE Arm)	<b>Name of Assessor:</b> Alex Holmes and Sjaan Bidwell	
<b>Date of Assessment:</b> 15/05/08	<b>Tenure:</b> Crown Land	
<b>Start Time:</b> 12:20 hrs	<b>Finish Time:</b> 14:00 hrs	
<b>Easting:</b> 669736	<b>Northing:</b> 6165787	
<b>Average Cloud Cover:</b> 0-10%   10-30%   30-50%   50-70%   70-90% <b>90-100%</b>	<b>Wind Direction and Conditions:</b> <b>Calm</b> Light Breeze   Moderate   Heavy   Gusty   Other?	
<b>Minimum temp during survey:</b>	<b>Max temp during survey:</b> Approx 18°C	
<b>Precipitation on day (mm) / previous days?:</b> Yes, <1mm		
<b>% water in wetland on day/s of assessment:</b> < 1% - currently almost dry	<b>If water present, maintain waterbird count:</b> (Maximum number of each species seen – no double counts) Waterbirds not present as too little water present	
<b>Wetland Habitat Types Present (using Environment Australia 2001) (circle at least one)</b>	Permanent Rivers and Streams; Permanent Freshwater Lakes (including oxbows); Seasonal/Irregular Rivers and Streams; <b>Seasonal/Intermittent Freshwater Lakes;</b> Riverine Floodplains (river flats, seasonally flooded grassland); Other?	
<b>Presence of Wildlife Movement Corridors?</b> Murray River acts as a wildlife movement corridor.		
<b>Disturbance:</b>		
<b>Grazing:</b> Low / Moderate / High	<b>Feral Animals (type):</b> Red Fox observed	
<b>Recreational intensity:</b> Low / Moderate / High	<b>Clearing / timber extraction:</b> Low / Moderate / High	
<b>Pest Plants:</b> Low / Moderate / High	<b>Infrastructure (type):</b>	
<b>Actions currently operating at site reducing values for wetland/terrestrial fauna (Inappropriate hydrological regimes, CWD removal, inappropriate stock management, other pest plants and animals, salinity, tree dieback/death?)</b> <ul style="list-style-type: none"> <li>» Actions occurring include inappropriate hydrological regimes (i.e. permanently inundated), although the Mallee CMA is seeking to re-introduce a drying phase to the wetland;</li> <li>» Possible saline groundwater impacts due to irrigation water drainage from agricultural land to the west of the lagoon;</li> <li>» Tree dieback / death possibly due to saline groundwater (as mentioned above);</li> <li>» Red Fox activity.</li> </ul>		

<b>Existing rehabilitation activities (type):</b> Reintroduction of a drying cycle				
<b>Cultural Features (Aboriginal / European / Other):</b>				
Cultural Features Identified (e.g. scar trees, midden etc):				
<b>Description of Vegetation (community):</b> Fringing River Red Gum, with Black Box further back on the floodplain.				
<b>Dominant Canopy Species</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Understorey Species:</b>				<b>% Foliage cover</b>
Refer to vegetation assessment				
<b>Dominant Groundcover Species:</b>				<b>% Cover abundance</b>
Refer to vegetation assessment				
<1% = +,    1-5% = 1,    6-25% = 2,    26-50% = 3,    51-75% = 4,    76-100% = 5.				
<b>Early Regrowth</b>	<b>Advanced Regrowth</b>	<b>Uneven Age</b>	<b>Mature Age</b>	<b>Old Growth</b>
		Mixed age classes, some old growth, some older cohorts		
<b>Average No. of Trees by Size Class (Diameter at Breast Height [DBH])</b>				
<10 cm	10 – 20 cm	21 – 40 cm	41 – 60 cm	>61 cm
<b>Large Woody Debris (High / Moderate / Low – Photo Standards)</b> Generally lower levels of woody debris.				

Attribute	<1%	1-5%	6-25%	26-50%	51-75%	76-100%
Rock	√					

Habitat attribute	Yes/No	No/quad
Large Stags	√	4-5+ (due to

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Leaf litter			√			
Bare ground		√				
Cryptogams etc	√					

		poor health of RRGs)
Large Hollows (trunk)	√	1-2
Small Hollows (branch)	√	4-5
Mistletoes	-	
Fleshy fruits (native or exotic)	-	



Condition Variable		Score	Weighting	Health Deductions
Large Trees	High = abundant trees >40cm dbh and some >60cm dbh; Moderate = scattered trees >40cm dbh; Low = few trees >40cm dbh present	1; 0.66; 0.33; 0	1	-0.5 of total score if large trees are in poor health
Hollows	High = Numerous large trees with hollows in trunk and branches (trees with hollows have multiple hollows); Moderate = Trees with hollows present within site, though scattered at low densities throughout; Low = Very few hollows, occasional tree with hollow present	1; 0.66; 0.33; 0	1.5	
Woody Debris	High, Moderate, Low (Refer to photo standards for RRG)	1; 0.66; 0.33; 0	1.5	-0.5 of total score if woody debris is the result of overall poor tree health
Hollow-bearing Stags	High = >4 stags / plot; Moderate = 1-3 stags / plot; Low = 1 stag / plot	1; 0.66; 0.33; 0	1	-0.5 of total score if stags are result of overall poor tree health
Vegetation Structural Diversity	High = canopy, shrub and ground layer well represented and in good condition; Moderate = canopy and ground layer relatively intact, possibly with minor representation of shrub layer; Low = canopy layer present, with shrub layer absent and ground layer in poor condition.	1; 0.66; 0.33	1.5	
Leaf Litter	High = 51-100% cover; Moderate = 26-50%; Low = 1-25%	1; 0.66; 0.33; 0	1	
Connectivity Score	High = Native vegetation belt >=100m. Also excellent connectivity to vegetation on all sides of the wetland/floodplain area. 'edge effects' minimal, no connection to cleared, cropped or heavily grazed vegetation; Moderate = Native vegetation area <100m but >50m. Connected to surrounding vegetation, but may not be extensive. May have some connection to open grazing / cropping paddocks, increasing 'edge effects' to wetland area; Low = Vegetation belt less than 50m. Wetland surrounded by cleared, cropped or heavily grazed vegetation on all sides and generally with few connections to existing vegetation.	1; 0.66; 0.33; 0	1.5	

Condition Variable	Site 1	Site 2	Site 3
Large Trees	0.50	1.00	0.66
Hollows	1.00	1.00	0.17
Woody Debris	0.50	0.66	0.33
Stags	0.50	0.33	0.50
Vegetation Structural Diversity	0.66	0.66	0.17
Leaf Litter	0.66	0.66	0.17
Connectivity Score	0.66	1.00	0.66
<b>Overall Score (unweighted)</b>	<b>4.48</b>	<b>5.31</b>	<b>2.65</b>
<b>Overall Score (weighted)</b>	<b>5.89</b>	<b>6.97</b>	<b>3.31</b>



## GHD

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## Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
	A Holmes S Bidwell	J Davies	***	D Grzan		24/10/08