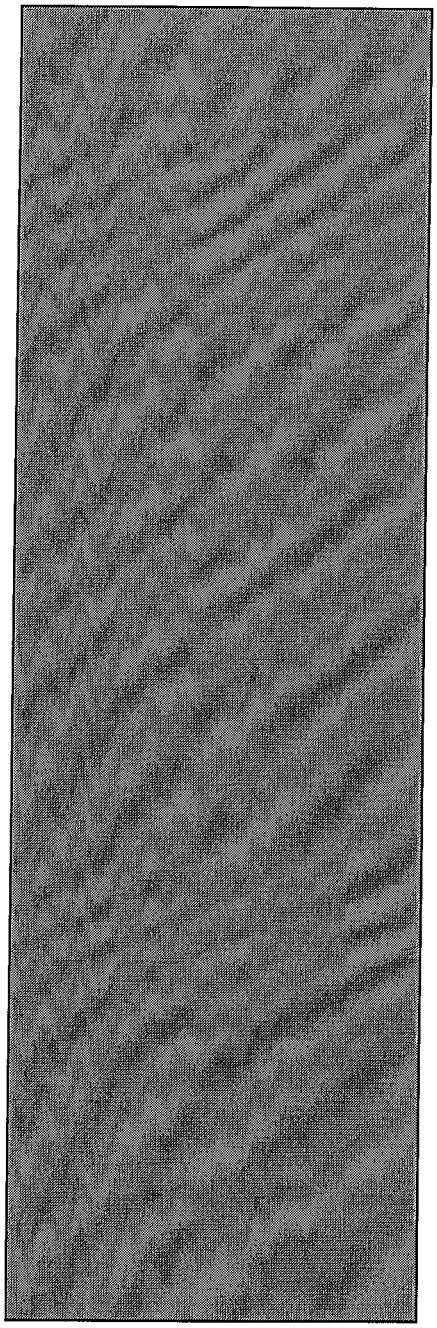

Yarra Yarra Catchment Management Group

Ecological Assessment of the Yarra Yarra Catchment

Final Report

Prepared by

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CONTENTS

SUMMARY

Land salinisation, salinisation of inland waters and maintaining biodiversity are considered the highest priority environmental issues in Western Australia. Salinity poses a threat to the States land, water and biological resources in addition to rural infrastructure assets. The major management issue within the Yarra Yarra catchment relates to increased volumes of surface water entering the lakes system. The effect of this on the lakes is unknown which potentially has far reaching consequences from both an agricultural and conservation perspective.

The Yarra Yarra catchment and lakes system is situated in the Northern Agricultural Region of Western Australia and covers an area of 4,258,102 ha. The key objective of this study was to determine the current status of the biological resources in the catchment. The study involved three main components; a desktop study, ground truthing of remnant vegetation and a fauna assessment. A total of 112,842 ha of remnant vegetation (in over 7,500 individual remnants) was identified in the desktop study for the Yarra Yarra catchment. Of this, 2,852 remnants were visited during the field survey, located within fifteen sub catchments. Overall, this represents 27,165ha or approximately 25% of the remnant vegetation identified in the Yarra Yarra catchment being field assessed. The remnants were broadly assessed for vegetation communities, condition, fencing status, grazing presence and salt status. This data was compiled into the GIS database which is the catchment group houses in its Regional Information Centre (RIC) at Perenjori.

Five dominant vegetation types were recognised and from this the communities most vulnerable to salinity were identified. Over 64% of remnant vegetation assessed in the Yarra Yarra catchment was considered to be in pristine or excellent condition (condition rating 1-2 and 2-3).

Succession of vegetation communities (ie change from one community type to another) is clearly evident in the Yarra Yarra Catchment. The progression of the succession vegetation (ie samphire) is most obvious in areas where water logged woodlands have been replaced by the lower growing succulents. The successional vegetation was most obvious in the valley floors of the sub catchments indicating these are the areas that are the most severely affected by hydrological changes as a result of land clearing. By contrast the woodland and shrubland vegetation associated with the lakes system was mostly unaffected by encroachment of samphire vegetation. Areas surrounding the lakes that showed evidence of successional vegetation are narrow bunds of woodland vegetation often found between seasonally flooded basins at the bottom end of the subcatchments (valley floors) and the adjoining lake. This indicates an altered hydroperiod in the seasonally flooded basin and is affecting woodland vegetation close to the lakes. Woodland and shrubland vegetation surrounding the lakes away from these outlet zones of the subcatchments was generally in good condition with no evidence of samphire encroachment. This indicates that altered hydrology resulting from land clearing has had virtually no impact to date on the woody vegetation associated with the lakes.

Vegetation distribution, representativeness and condition are important considerations in vegetation conservation and management, particularly in relation to setting priorities. With the large size of the catchment, it was necessary to start with a broad brush approach, collating existing data to give an overview for the region and to determine an approach to collect additional meaningful data. This report describes collected and collated base line data and is intended as a starting point for the management of the biological resources of the Yarra Yarra catchment and for future studies on the whole catchment and its sub catchments.

PART ONE - INTRODUCTION

1.1 BACKGROUND

Land salinisation, salinisation of inland waters and maintaining biodiversity have been identified as the three highest priority environmental issues in Western Australia (Western Australian State of Environment Report, 1998). Salinity threatens not only the conservation of the States land, water and biological resources but also rural infrastructure assets (ie: roads, railways, town buildings and services). It is one of the State's most serious environmental problems, with far reaching economic and biological consequences. More than 1.8 million hectares (10%) of cleared farmland in WA is salt affected, with a larger area considered under threat (George et al., 1997; Agriculture WA *et al.*, 1996)

Salinity has developed from the widespread clearing of deep-rooted native vegetation and its replacement with annual crops and pastures. Clearing of native woodland and forest vegetation decreases transpiration and interception, and increases runoff and recharge. George *et al.* (1997) estimated that in low rainfall areas (350 mm/yr) the average annual recharge rate increased from <0.01-0.1 mm/yr to at least 6-10 mm/yr after clearing. This report also estimated that groundwater levels have risen by more than 30m and aquifers now exist where none had before clearing. Salts brought to the surface are washed down streams, river and lake systems, affecting their value as both a potential potable water supply and as environmental and recreational assets. More than 80% (by length) of stream riparian zones are seriously degraded by salinity (Agriculture WA *et al.*, 1996). Salinity in streams is increasing at a rate of 10-90mg/L each year (George *et al.*, 1997). The salinisation of land and water resources also kills native vegetation, causes degradation and loss of flora and fauna habitats, thereby reducing biological diversity both on land and in water ways. Salinity poses a major threat to the remaining remnant vegetation, wetlands, unique species and ecosystems.

Remnant vegetation on both private and public land throughout WA is being rapidly degraded by dryland salinity, inundation, soil structure decline and weed invasion. Previous studies, such as the Western Australian Salinity Action Plan (1996) and George *et al.*, (1997) have found that remnant vegetation in low lying parts of catchments and sub catchments are considered to be most at risk of salinity. Consequently, there is a need to identify those remnants that have high conservation values for which cost effective recovery plans or protection plans can be developed and implemented (Briggs, 2001). It is estimated that without corrective action over 80% of remnant vegetation on private land and as much as 50% within public reserves could be lost over the next 30-50 years (Agriculture WA *et al.*, 1996).

Successful salinity control requires the management of saline groundwater. A variety of methods for addressing salinity and increasing watertables have been proposed. These solutions have been well detailed in the Western Australian Salinity Action Plan (1996). Broadly, they have ranged from revegetation and conservation of remnant vegetation, alternative crops (deep rooted crops) to engineering solutions such as saline drainage systems. Saline drainage systems may be either surface and subsurface (deep) drainage or drainage arising from groundwater pumping (Regeneration Technology, 2000). The beneficial and detrimental effects of agricultural drainage on the long term viability of remnants in representative areas needs to be established. Studies should address both the short term and long term effects of drainage on the remnants. An integrated approach to tackling land degradation problems uses farm planning to:

- reorientate paddock boundaries;
- revegetate and fence drainage lines;

- protect and connect existing vegetation;
- establish windbreaks
- replant on both recharge and degraded areas (Grein, 1994).

One fact is certain, solutions to land degradation, in particular salinity, require an integrated approach, linking planning and actions at effective scales (catchment, sub catchment as well as landholder levels) for landscape and habitat preservation and rehabilitation. Managing landscape processes and conserving species requires cooperation and action across a broad geographic area, encompassing different management groups. Management groups need to have access to cost effective methods of treatments and packages of biophysical information that can be used to design and predict the impact of physical and economic management systems (George *et al.*, 1997).

For effective management, information on the biological and physical resources of an area is essential. An inventory of the biological and physical resources should include but not be limited to remnant vegetation extent, composition and condition, hydrology, tenure and cadastral information. This provides baseline data, which enables short and long term monitoring and assessment of the success of management techniques employed. The information gathered from previous studies, mapping and field surveys leads to the establishment of priority areas that can be targeted for management agreements, fencing subsidies and other incentive schemes.

The major management issues evident within the Yarra Yarra catchment relate to increased volumes of surface water entering the lakes system. The effect of the increased water volumes in the lakes is unknown. This potentially has far reaching consequences from both an agricultural and conservation perspective.

Western Australia's flora and fauna has been greatly diminished by land clearing and is further compromised by salinity.

1.2 Study Area

The Yarra Yarra catchment and lakes system is situated in the Northern Agricultural Region of Western Australia. The Yarra Yarra catchment covers an area of 4,258,102 ha, encompassing several Shire boundaries. It stretches from Three Springs and Yarra Yarra Lake in the east, Lake Moore (not included in Yarra Yarra Catchment) in the west, Pastoral land in the north and to Burakin in the south (Map 1). Land uses are predominately wheat and sheep farming, with some alternative crops including lupins and plantation trees, such as oil mallees. The Yarra Yarra catchment contains 112,842 ha of remnant vegetation (in over 7,500 individual remnants). Approximately 74% (83, 534 ha) of remnants are located on privately owned land.

Study Area Map - include overview of WA, Yarra Yarra Catchments and individual named sub catchments.

The climate is described as warm Mediterranean, with winter dominated average annual rainfall of 388mm. Mean maximum daily temperatures ranged from 36°C in January to 18°C in July (Bureau of Meterology, 2001).

Approximately 60% of the north-eastern area of the catchment remains un-cleared as pastoral lease, and has not been considered in this study. The remainder of the Yarra Yarra catchment was divided up into 56 sub catchments based on ridge divides. Each individual sub catchment is managed by a Land Conservation District (LCD's). The Yarra Yarra Catchment Management Group is a community group that has formed to provide a united approach to the collection and dissemination of data and information to the entire catchment. The catchment group houses the data and referred to in this report in it's Regional Information Centre (RIC) at Perenjori.

According to the Interim Biogeographic Regionalisation of Australia, the Yarra Yarra catchment lies within the Eremaean subregion of Yalgoo (Thackway & Cresswell 1995). The Yarra Yarra Basin is very wide and flat with some of the most arable productive agricultural land lying across the broad valley floors. This is an area of low relief with a 65m decline in elevation from Lake Hillman to the bottom of Yarra Yarra Lake .

The Yarra Yarra lake system is a series of lakes, acting as a vast drainage system, terminating at the Yarra Yarra lakes themselves. The numerous lakes perform a similar function to the Yarra Yarra lakes in that they act as evaporation basins and discharge via groundwater, draining the whole catchment. Water flows through the lake system to the Yarra Yarra lakes.

The Yarra Yarra lakes at the bottom of the catchment extend for 28km in length and are 8.8km at their widest (Yestertener *et al.*, 2000). At full capacity, they have a surface area of 127km^2 and are 2.1m deep. The lake system receives inflow of saline water from Mongers Lake to the east and from local ephemeral waterways such as Darlings Creek (Yesertener *et al.*, 2000). Yesertener *et al.*, (2000) estimated the groundwater throughflow or discharge from the lake system to be approximately 0.3 M m3/yr. Soil types of the lakes include clay and sandy clay.

The presence of a palaeochannel underlying the Yarra Yarra lakes and the groundwater hydrochemistry demonstrate that the Yarra Yarra catchment and the Moore catchment are hydrogeologically linked (Yesertener *et al.*, 2000). The palaelochannel provides a direct pathway for salts concentrated by evaporation in the lakes to flow beneath the surface divide and into the Moore River catchment. The groundwater salinity of the palaeochannel aquifer progressively decreases southwards from 280,000mg/L to 14,000mg/L, due to lateral recharge from Mesozoic sandstone aquifers (Yesertener *et al.*, 2000). Survey of the lake shows that it has a total capacity of 200 M m^3, after which overflow to the Moore catchment will occur (Yesertener *et al.*, 2000). The lakes are not known to have overflowed in recent times, however, in 1999 the lake rose to within 300 mm of overflowing. Generally the catchment is internally drained and discharges via ground water recharge and evaporation of the lakes.

1.3 OBJECTIVES

The key objective of this study was to determine the current status of the biological resources in the catchment. The key questions for the ecological component of this study were:

- What is there?
- How much is there?
- How reliable is existing data (especially Beards vegetation mapping of the region)
- Is it at risk? and
- What management strategies should be considered.

The overall aim of the Yarra Yarra Catchment Project is to prepare Catchment Management Plans for each of the sub catchments as a means of conserving the biological resources of the region while implementing management strategies to deal with salinity.

1.4 Scope

With the total area of the catchment being in excess of 1,000,000 ha it was necessary to start with a broad brush approach, collating existing data to give an overview for the region and to determine an approach to collect additional meaningful data. This report describes collected and collated base line data and is intended as a starting point for management of the biological resources of the Yarra Yarra catchment and future studies on the whole catchment and its sub catchments.

It was beyond the scope of this study to specifically assess what is in the lakes themselves, ie: fauna. Information was collated on water quality and soil type from previous studies and peripheral vegetation from ground truthing.

PART TWO - METHODOLOGY

A project methodology was defined which combined all the necessary steps outlined in the project description. The steps in this process can be separated into 3 main sections and are summarised as follows:

2.1 DESKTOP STUDY

The desktop study consisted of two parts; use of Arcview to identify remnant vegetation in the Yarra Yarra and the production of an inventory of available information. Each procedure is outlined separately.

2.1.1 IDENTIFICATION OF REMNANT VEGETATION BLOCKS.

Remnant vegetation within the Yarra Yarra Catchment was identified from Landsat TM Satellite Imagery obtained from the Spatial Resource Information Group at Agriculture WA. Perennial vegetation cover for the polygonized 1:100,000 scale mapsheets acquired was derived from Landsat Satellite Imagery 1995/96 and updated by AgWA from digital orthophotos acquired post 1995. This data includes principally native vegetation, with some pine and tagasaste plantations.

The remnant vegetation blocks were identified using Arcview software following the procedure outlined in the training session and the procedure brief (Appendix 1). The main steps in the process are outlined as follows:

- The polygonized Landsat imagery was limited to an individual sub catchment and assigned areas, with remnant vegetation blocks less than 1 ha being deleted.
- Each remnant vegetation block was assigned a unique identification number consisting of an abbreviated sub catchment name or number followed by a record number.
- Beard vegetation types and data were assigned to the remnant vegetation polygons.
- The percentage area was calculated for each vegetation association.

This procedure was repeated for each sub catchment, producing an individual shapefile for each sub catchment containing specific information relating to each sub catchment. Sub catchment no 31 and part of sub catchment no's 7 and 12 could not have the remnant vegetation blocks identified, using the above procedure, due to a lack in data coverage for these areas (both the AgWA data and original Landsat Imagery did not cover this part of the Yarra Yarra Catchment).

2.1.2 REVIEW AND COLLATION OF EXISTING DATA.

A thorough literature review was conducted using Biological Abstracts and web searches of agency databases to identify and locate existing reports, relating specifically to the Yarra Yarra Catchment and sub catchments and to salinity in the wheatbelt. Relevant reports and literature were acquired through meeting with key stakeholders from CALM, WRC, AgWA, and local LCDC representatives. Literature was sourced from the appropriate agency (eg CALM, WRC, AgWA, DEP) and University libraries for collation in the Yarra Yarra Catchment GIS system.

Sourced reports and literature were reviewed, summarised and collated within an Excel spreadsheet to compile an inventory of available data that relates to issues within the Yarra Yarra Catchment. The following details were recorded for each document:

- Title of report;
- Author;
- Publication date;
- A short topic summary;
- Number of pages;
- Where the report can be obtained;
- Contact name;
- Contact telephone number;
- Reference sub catchment.

Reports discussing numerous sub catchments were duplicated for each sub catchment. Documents containing tabular data and vegetation information, relating to specific remnant vegetation blocks (identified using the above procedure), had this information reproduced in an spreadsheet, with the new remnant vegetation number being recorded, for inclusion in the GIS system.

2.1.3 LAKE SYSTEM

A literature search was conducted for previous studies conducted on the salt lake ecology as there was no available literature on the Yarra Yarra lakes. The information obtained was summaried into a table outlining the types of flora and fauna typically found in lakes of different salinities.

2.2 GROUND TRUTHING

2.2.1 REMNANT VEGETATION ASSESSMENT

Remnant vegetation in fifteen sub catchments was field assessed, upon completion of the desktop study. Sub catchments selected for ground truthing were Jibberding, Geranium Rock, Goodlands, Burakin, Lower Darling Creek, Mid Darling Creek, Upper Darling Creek, Campbells, Yarra Yarra Lake, East Butine, sub catchment no 15, 16, 38, 47 and 48 (Map 2). Site information was recorded using data sheets developed during the desktop review of the catchment and the project brief (See Appendix 2 for an example of the data sheets). Each accessible remnant vegetation block within a sub catchment was assessed by a single walk through transect. Information recorded in the field assessment of the sub catchments included:

- Dominant species present
- Vegetation association of the remnant vegetation (determined from vegetation structure and community). How closely this matches with Beards vegetation association was also noted.
- Vegetation condition (Trudgen code) ranging from condition rating 1: Pristine or nearly so, (no obvious signs of disturbance) to condition rating 6: Completely degraded vegetation.
- Fencing of remnant vegetation.
- Stock access or evidence of previous stock access.
- Whether the vegetation is salt affected or borders salt affected land.
- Possible connection/linkage of remnant vegetation blocks.
- Any additional comments relating to the status of the remnant vegetation (eg: description of understorey vegetation, presence of drainage and grade banks, weed cover/presence, topography, position in the landscape and other disturbances).

Map 2 - Ground truthed Subcatchments

The data collected in the field survey was entered into the GIS system for each sub catchment with an individual field for each theme. In addition, information on the date the remnant was assessed and whether the remnant was on private or reserve land was included.

The ecological data collated in the GIS system was statistically summarised, producing values for the total area of remnant vegetation within each sub catchment (both on private and reserve land), area of remnant vegetation ground truthed, percentage of remnant vegetation fenced and the amount of remnant vegetation in good/poor condition.

2.2.2 BEARD'S MAPPING

The accuracy of Beards mapping was assessed during the ground truthing process. The vegetation community observed in each assessed remnant was compared to the vegetation community assigned by Beard.

The current Beard map, was identified to have three 'edge joins' in the Yarra Yarra where discrepancies were observed in the vegetation descriptions. The 'edge joins' are located in the:

- northern end of the Yarra Yarra catchment running east/west, near Gutha East Rd (crossing sub catchments 42, 45, 47 and 48).
- southern end of the catchment running east/west, near Leeson Rd (crossing sub catchments 32, 35 and 37).
- southern end of the catchment running north/south, Struggle Rd (crossing sub catchments 22 and 34).

These discrepancies were investigated in the field assessment using remnant vegetation covering the 'edge joins'. The remnant vegetation obtained from the satellite imagery was overlaid on the Beard map. Remnants spanning the 'edge joins' were field checked to determine the vegetation association and hence reclassify Beard's vegetation types.

2.2.3 FIELD WORK

Ground truthing was the most time consuming aspect of this study, but utimately the most important to provide vital field information on individual remnants. Past studies have utilised the knowledge of farmers to complete the majority of field work, which minimises the time spent in the field and subsequent costs. In theory this is a good method, but often not practical due to the low return in survey sheets and reliability of the information (ie: correct species identification). The survey of thirty large vegetation remnants on private land in the Dalwallinu Shire by J-P Orsini (1991) is a typical example of this, where only 20% of farmer questionnaires were completed and returned. The low percentage was attributed to the busy work load of the farmers. The vegetation assessment by a qualified individual also provides consistent and reliable base information over property and subcatchment boundaries. The field work established vegetation community type, condition, fencing status and other noteworthy information.

One of the first steps in the ground truthing process was to contact private landholders in the survey subcatchment. This informed them of the project and provided them with an opportunity to discuss their opinions in addition to obtaining their permission to enter their property. In several instances arrangements were made to visit farmers on their property during the field visit.

2.2.3.1 FARMERS ATTITUDES

Discussing the project with farmers enabled a small community consultation process to be undertaken. By no means is this process complete or adequately started, it merely provided a basis for obtaining a general feeling of farmers attitudes towards the project.

In general, farmers willingness to discuss the project was overwhelming. They also readily provided information on the hydrology of their farm and strategies they had

employed to cope with salinity (ie: gradebanks, contour banks, remnant fencing and tree plantings). They seemed aware of various projects being undertaken in their catchment and what methods were being experimented with by their neighbours and land care groups.

One concern that arose was the level of detail of the vegetation survey and whether threatened and rare species were being targeted. This is attributed to the high conservation aspects of the species that may force them to alter their farming techniques.

2.3 FAUNA ASSESSMENT

A fauna assessment was undertaken on the North Western edge of Lake Goorley, on the Stanley Property, over a three year period (30°04'604"S 117°03'385"E). This site is situated in the upper end of the Yarra Yarra catchment, within the Goodlands sub catchment. The site was chosen as the remnant vegetation community type was considered to be most representative of vegetation in the Yarra Yarra. Beard described the vegetation community type as Succulent steppe with woodland and thicket; York gum over Melaleuca thyoides and samphire. It is also an indicator site for the effects of a management proposal to divert water to a paleo-drainage line in the upper end of the catchment. The expected result of this practice is increased water depths in the Yarra Yarra lake system. Other sites downstream are currently being monitored as part of the Salinity Action Plan. The Salinity Action Plan will compliment our study and will be used as the baseline data for future studies.

Photo 1 : Fauna assessment site (Lake Goorley in the background).

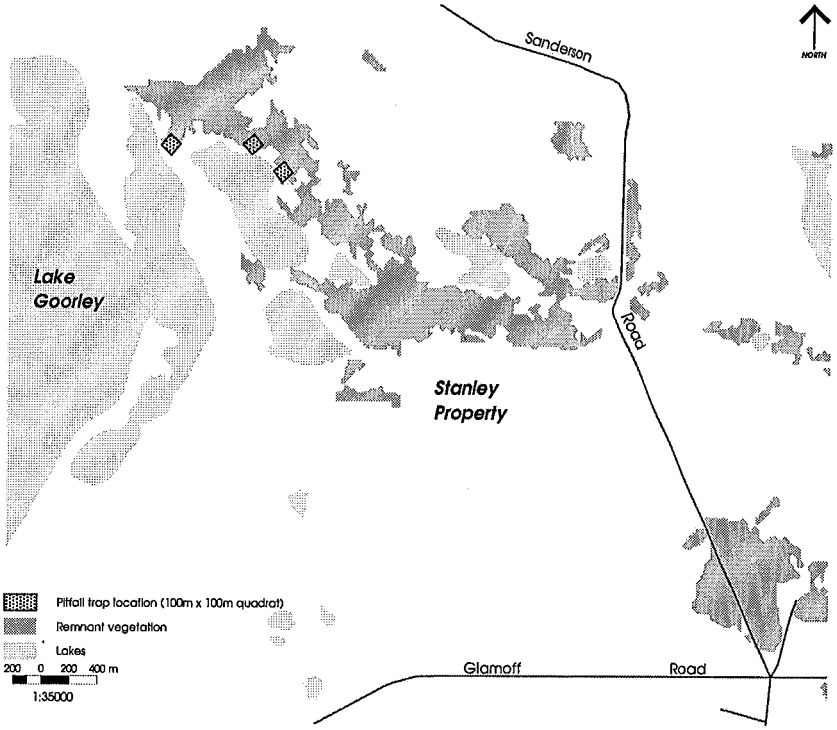
The fauna assessment consisted of pitfall trapping, elliot trapping and an avian assessment. Over the three year period the pitfall and elliot trapping was undertaken three times, in November 1999, May 2000 and November 2000. The avian survey was undertaken only once, on an opportunistic occasion. The methodology for each survey technique is outlined below.

2.3.1 PITFALL TRAPS

Three quadrats of 25 (5x5 quadrats) pitfall traps were installed at the study site, running at a 90°angle from the lake (generally in an easterly direction starting at the lake). Refer to Map 1 below. 20 L buckets with lids were used as pitfall traps, which were dug into the ground until the lids were equal to ground level. The pitfall traps were spaced 25m apart, forming a 100x100m quadrat in total.

The pitfall traps were opened and monitored for 2 nights in November 1999 and May 2000, and for 3 nights in November 2000. The pitfall traps were checked daily. Species

observed in the pitfall traps were identified, photographed and measurements (snout-vent length, tail length) were recorded. Fauna was then removed from the traps and released. Once the monitoring period was completed the traps were securely covered using the lids.



Map 3 : Location of pitfall traps in the Yarra Yarra catchment.

2.3.2 ELLIOT TRAPS

Seventy-five Elliot traps were assembled and arranged in the woodland and lake areas for a 2 night period, for each of the sampling periods. The first survey (Nov 1999), in addition to the 75 traps included 10 large cages, with all the traps being located in the vegetation at the edge of the lake. The traps in the second survey (May 2000) were arranged running into the salt lake. The third survey (Nov 2000) was organised into three lines of twenty-five traps, which ran from the fenceline of the paddock on the Stanley property towards the lake. The location of the Elliot traps was varied due to no fauna being caught. The traps were baited with a mixture of rolled oats and peanut butter, with a small amount of the mixture placed in each trap. The traps were checked each morning and the fauna caught was recorded and measured.

2.3.3 AVIAN SURVEY

An avian survey was undertaken by Rob Davies in May 2000. The bird species observed in a visual assessment, during a walk through the woodland area and salt lake, were noted.

2.3.4 VEGETATION

Vegetation in the vicinity of the fauna assessment was identified and ground truthed, as per the method previously described. The vegetation along the three lines of pitfall traps was recorded.

PART THREE – RESULTS AND DISCUSSION

3.1 REMNANT VEGETATION ASSESSMENT

A total of 112,842 ha of remnant vegetation (in over 7,500 individual remnants) was identified in the desktop study for the Yarra Yarra catchment. The desktop study only took into account remnants greater than 1ha in size.

3.1.1 LAND TENURE OF THE REMNANT VEGETATION

Remnant vegetation within the Yarra Yarra catchment was classified as privately or publicly (reserves) owned land. This classification was based on ground truthing and cadastral information from the GIS database. Public land, or reserves included vacant crown land, road reserves and shire owned property. Appendix 2 contains a list of the areas of remnant vegetation on private and public land for each sub catchment.

Approximately 74% or 83,534ha of remnant vegetation is located on private land within the Yarra Yarra catchment. Sub catchments 6, 10, East Three Springs, 12, Goodlands, Bywaters,40 and Collier-Dingo have no remnants, classified in the desktop study, as reserves or publicly owned land. The Morawa sub catchment has a high percentage of its remnant vegetation vested as reserves (99%), including a large reserve of 1,856 ha (Reserve 40563).

3.1.2 CATCHMENTS

2,852 remnants were visited during this survey of the Yarra Yarra catchment, within the fifteen sub catchments. Overall, this represents 27,165ha or approximately 25% of the remnant vegetation identified in the Yarra Yarra catchment being field assessed. The remnants were broadly assessed for vegetation communities, condition, fencing status, grazing presence and salt status. This data was compiled into the GIS database. The area of remnant vegetation identified, for each field assessed sub catchment is listed in Table 1

The percentage of remnants ground truthed in each sub catchment was greater than 65%, and in the majority of cases (8 sub catchments) more than 85% of remnants were ground truthed. Of the remnants assessed 72% were located on private land.

The main factor limiting ground truthing was access to the remnants. A large percentage of remnants are located on private land and often surrounded by pastures. This makes access to the remnant blocks difficult, especially late in the wheat season when crops are ready to harvest.

198 remnants were noted as being fenced or partly fenced in the assessed sub catchments. Of these 168 are located on private land. The area and percentage of assessed remnant vegetation that was fenced is listed below. Sub catchments 16, 38 and East Buntine had the highest percentage of remnant vegetation fenced (25.9%, 32.2% and 27.6%, respectively). Yarra Yarra Lakes had a very small proportion of its remnants fenced, even though most of the sub catchment (94%) was ground truthed.

Appendix 3 contains spreadsheet summarising information on the sub catchments (ie: areas of remnant veg).

Table 1: Area of remnants, percentage ground truthed and percentage of assessed remnants fenced in each of the 15 ground truthed sub catchments.

Ground truthed Sub catchment	Area of Remnant Vegetation (ha)	Remnant Vegetation Ground truthed		Fenced Remnants	
		Area (ha)	%	Area (ha)	%
Campbells	1021.0	995.5	97.5%	10.5	1.0%
Upper Darling Creek	854.0	835.0	97.8%	106.3	12.4%
Mid Darling Creek	842.1	744.6	88.4%	194.6	17.5%
15	530.0	410.7	77.5%	49.0	5.8%
16	1453.4	1229.0	84.6%	137.5	25.9%
Goodlands	2477.8	2006.2	81.0%	477.1	19.2%
Jibberding	2324.9	1884.2	81.0%	115.5	5.0%
Burakin	2428.9	1711.3	70.4%	480.1	19.8%
Geranium Rock	511.6	337.6	66.0%	74.8	14.6%
38	762.5	696.5	91.3%	245.7	32.2%
47	2674.7	2588.1	96.8%	52.7	2.0%
48	4945.5	3916.2	79.2%	885.9	17.9%
Lower Darling Creek	5673.4	5224.5	92.1%	302.2	5.3%
Yarra Yarra Lake	5037.9	4733.6	94.0%	9.4	0.2%
East Buntine	1784.7	1563.7	87.6%	492.4	27.6%
Total	33322.4	28876.7		3633.7	

3.2 Beards Vegetation Mapping

3.2.1 Accuracy of Beards Vegetation Mapping

Remnant vegetation identified in the desktop study was assigned a vegetation type according to Beards mapping. This vegetation classification was compared to the vegetation type observed during the ground truthing survey. If the vegetation type did not correspond to the vegetation observed, than this was noted on the field survey sheets. The number of 'non-matches' was only 249 out of the 2,852 remnants assessed (<9%). Therefore, overall Beards mapping was found to be quite accurate in all of the sub catchments assessed. The dominant species (ie: Acacia, Melaleuca species, York gum, Salmon gum, etc.) and vegetation structure (ie: shrubland, woodland etc.) closely matched. The discrepancies were mostly associated with vegetation of a low condition rating (ie: 4-5 & 5) and had been degraded by grazing or salinity and the species or structure subsequently changed, ie: to salt vegetation or less species diversity.

3.2.2 Beard's map edge joins

Beard's vegetation mapping of the Yarra Yarra catchment was identified to have 3 'edge joins' in the map sheets.

Remnants spanning the northern 'edge join' were field checked to assess the vegetation type. Remnant numbers 42_177, 42_176 and 48_286 were visited. The southern end of

remnant 42_177 was classified by Beard as Medium woodland: York gum and Salmon gum, with the northern end classified as medium woodland: York gum. During the field assessment, no salmon gums were observed in this remnant and therefore the vegetation type of the whole remnant was noted as Medium woodland: York gum. Remnant 42_176 was classified by Beard as Medium woodland: York gum, although this remnant did not span the edge join, but was field checked as it was adjacent to remnant 47_177. Beard classified the southern section of remnant 48_286 as Shrublands: mixed acacia thicket on sandplain and the northern section as Shrublands: acacia, casuarina and melaleuca thicket. The vegetation in the southern section was observed to have species of casuarina and melaleuca as well as acacia species and also the appearance of the soil did not correspond to sandplain. Therefore this remnant was reclassified as Shrublands: acacia, casuarina and melaleuca thicket. Whilst these individual remnants could be reclassified, there is insufficient remnant vegetation covering the length of the 'edge join' within the Yarra Yarra catchment to confidently amend the original vegetation mapping by Beard. Also the vegetation types described are very similar, often with the same structure but with different species composition, therefore it was felt that reclassification was unnecessary. This was further supported by the high degree of accuracy observed overall in Beards mapping. Subsequently, the other 'edge joins' were not field assessed due to the lack of remnant vegetation traversing the 'edge joins'.

It should be noted that this situation specifically relates to the 'edge joins' within the Yarra Yarra catchment. It is recommended that in other locations where there is a sufficient area of remnant vegetation covering the 'edge joins' of Beards map, the vegetation should be ground truthed and the 'edge join' vegetation type be amended accordingly.

3.3 Vegetation Communities

Within the Yarra Yarra, 42 vegetation communities have been recorded in the remnant vegetation, according to Beards mapping (Table 2). Five dominant (ie: greater than 10,000 ha) vegetation types were recognised and are listed below:

- Succulent steppe with woodland and thicket; york gum over Melaleuca thyroids and samphire (22,644 ha);
- Medium woodland; York gum (15,493 ha);
- Medium woodland; York gum and Salmon gum (10,990 ha);
- Shrublands: Mallee and Casuarina thicket and (10,361 ha);
- Shrublands: Acacia neurophylla, A. beauverdiana and A. resinimarginea thicket (10,122 ha).

6 vegetation communities types are not well represented in the Yarra Yarra catchment, representing less than 0.1% (≥100 ha). With more than half of the vegetation communities (24 out of 42 communities) recording less than 1%.

The distribution and representiveness of plant communities are important considerations in vegetation conservation and mangement, particularly in relation to setting priorities. Representiveness was assessed for two context areas; Yarra Yarra catchment and Conservation Reserves in Western Australia. Table 2 below lists the percentage of remnant vegetation in the Yarra Yarra catchment, each condition rating, each elevation interval and in Western Australia's Conservation Reserves (percentages obtained from Hopkins *et al.*, 1996).

Table 2 Vegetation Community Representativeness

Vegetation Community	% in the Yarra Yarra	% in each Condition Rating					% in each Elevation Interval			% in Conservation Reserves (WA)
		1-2	2-3	3-4	4-5	5	200-300	300-400	400-500	
Bare areas; rock outcrops	0.60%	0.015	0.0	0.019	0.0	0.0	0.042	0.542		17.9
Bare areas; salt lakes	0.90%	0.003	0.059	0.09	0.084	0.0	0.764	0.171		10.1
Medium woodland; York gum	13.70%	0.234	1.218	1.120	0.562	0.173	9.433	4.297		0.9
Medium woodland; York gum & red mallee	0.09%	0.014	0.023	0.008	0.0	0.0		0.095		8.8
Medium woodland; York gum & salmon gum	9.74%	0.118	0.317	0.300	0.490	0.087	6.321	3.419		5.4
Medium woodland; York gum, salmon gum & gimlet	1.11%	0.0	0.018	0.0	0.0	0.0	0.351	0.757		3.8
Mosaic: Medium woodland; York gum/Shrublands; Allocasuarina campestris thicket	11.87%	N/A	N/A	N/A	N/A	N/A	0.438	0.869	0.561	
Mosaic: Low woodland: Allocasuarina heugeliana over mallee and acacia scrub/Allocasuarina campestris thicket	1.73%	N/A	N/A	N/A	N/A	N/A	0.853	0.166	0.707	
Mosaic: Shrublands; scrub-heath Dryandra-Calothamnus assoc. with B. prionotes on limestone in the northern Swan Region/Sparse low woodland; wandoo & powderbark wandoo	0.77%	0.265	0.020	0.010	0.0	0.0		0.768		
Mosaic: Shrublands; Shrublands; jam scrub with scattered York gum in the valleys / Allocasuarina campestris thicket	3.48%	0.010	0.060	0.098	0.014	0.0	1.318	2.168		0.5
Mosaic: Succulent steppe with thicket; Melaleuca thyroids over samphire / Shrublands; bowgada open scrub	0.10%	N/A	N/A	N/A	N/A	N/A	0.102			
Shrubalnds; Mixed acacia thicket on sandplain	4.06%	0.361	0.270	0.076	0.0	0.0	0.539	2.212	1.305	
Shrublands; Acacia neurophylla, A. beauverdiana & A. resinimarginea thicket	8.97%	1.241	1.090	0.511	0.084	0.0	2.920	6.050		14.1
Shrublands; acacia scrub, various species	0.55%	0.0	0.0	<0.001	0.0	0.0	0.449	0.104		11.3
Shrublands; Acacia thicket with patches of heath	0.31%	0.035	0.058	0.079	0.002	0.0		0.313		
Shrublands; acacia, casuarina & melaleuca thicket	2.85%	0.298	0.109	1.425	0.067		0.272	2.573		17.2
Shrublands; Allocasuarina campestris scrub	0.04%		0.018	0.015	0.001		0.037			0.0
Shrublands; Allocasuarina campestris thicket	5.02%	0.260	0.668	0.762	0.109		3.101	1.913		5.4

Table 2 continued

Vegetation Community	% in the Yarra Yarra	% in each Condition Rating					% in each Elevation Interval			% in Conservation Reserves (WA)
		1-2	2-3	3-4	4-5	5	200-300	300-400	400-500	
Shrublands; Allocasuarina campestris thickets with scattered jam & casuarina	0.15%	0.081	0.016				0.133	0.020		
Shrublands; bowgada & jam scrub	0.67%		0.416	0.063	0.035			0.668		0.2
Shrublands; bowgada & jam scrub with scattered York gum	0.01%		0.007					0.007		0.1
Shrublands; bowgada & jam scrub with scattered York gum & red mallee	0.32%	0.050	0.101	0.026	0.016		0.234	0.086		0.0
Shrublands; bowgada and associated spp. scrub	0.41%	N/A	N/A	N/A	N/A	N/A	0.409			17.0
Shrublands; bowgada scrub with scattered York gum	0.13%	N/A	N/A	N/A	N/A	N/A	0.103	0.027		130.3
Shrublands; bowgada, jam and Melaleuca uncinata thicket	1.65%	0.353	0.979	0.123	0.008		0.090	1.557		0.0
Shrublands; casuarina & dryandra thicket with wandoo and powderbark wandoo	0.33%	N/A	N/A	N/A	N/A	N/A		0.327		18.9
Shrublands; casuarina & melaleuca thicket	1.47%	N/A	N/A	N/A	N/A	N/A	1.021	0.381	0.067	1.9
Shrublands; dodonaea scrub	0.14%	N/A	N/A	N/A	N/A	N/A	0.136			
Shrublands; Dryandra quercifolia & Eucalytpus spp. thicket	0.23%	N/A	N/A	N/A	N/A	N/A		0.229		18.2
Shrublands; mallee & casuarina thicket	9.18%	1.081	0.955	0.827	0.075		0.258	8.67	0.257	1.4
Shrublands; Melaeuca thyioides thicket	0.14%	0.072					0.066	0.076		15.6
Shrublands; scrub-heath on lateritic sandplain in the central Geraldton Sandplain Region	1.01%	0.100	0.016					1.014		10.0
Shrublands; scrub-heath on lateritic sandplain in the southern Geraldton Sandplain Region	1.66%	0.996	0.348	0.085	0.026	0.001	0.567	1.088		10.0
Shrublands; scrub-heath on sandplain	0.21%	N/A	N/A	N/A	N/A	N/A	0.003	0.207		30.7
Shrublands; scrub-heath on yellow sandplain banksia-xylomelum alliance in the Geraldton Sandplain & Avon-Wheatbelt Regions	0.06%	N/A	N/A	N/A	N/A	N/A	0.055			46.5
Succulent steppe with open woodland & thicket; york gum over Melaleuca thyiodes & samphire	0.65%	N/A	N/A	N/A	N/A	N/A		0.647		17.8

Table 2 continued

Vegetation Community	% in the Yarra Yarra	% in each Condition Rating					% in each Elevation Interval			% in Conservation Reserves (WA)
		1-2	2-3	3-4	4-5	5	200-300	300-400	400-500	
Succulent steppe with scrub; teatree (Melaleuca thyioides?) over samphire	0.01%	N/A	N/A	N/A	N/A	N/A		0.011		10.5
Succulent steppe with thicket; Melaleuca thyoides over samphire	5.17%	0.009	1.719	0.064	0.052		5.171	0.003		2.5
Succulent steppe with woodland and thicket; york gum over Melaleuca thyoides & samphire	20.07%	0.583	0.078	0.029	0.134		20.05	0.018		4.3
Succulent steppe; saltbush	0.05%	N/A	N/A	N/A	N/A	N/A		0.049		1.6
Succulent steppe; saltbush & samphire	0.36%	N/A	N/A	N/A	N/A	N/A		0.360		0.0
Succulent steppe; samphire	0.002%	N/A	N/A	N/A	N/A	N/A	0.002			11.0

3.3.1 SPECIES

An overall species list was not compiled for the Yarra Yarra catchment as it was not considered a useful tool for the management or revegetation of remnants in individual sub catchments and would have contained an extremely large number of species. A wide variety of previous studies have been conducted on the sub catchment scale or a more focused area which contain specific species lists representative of the remnant vegetation. A list of the reports available relating to each sub catchment can be found in the GIS database. Information provided in the database includes a short summary on the report contents in addition to general information on title, author and where the report can be obtained. Tabular data from the reports on individual remnants in the Glamoff, Goodlands, Jibberding, Geranium Rock, Lake Goorley, Bywaters, 36, Collier-Dingo, Lower Darling Creek and 56 is also available in the GIS system.

3.3.2 WEEDS

In many remnants, the understorey vegetation contained a large percentage of grassy weed species. These weeds appeared to have entered the remnants mainly from the surrounding pastures and have colonised in the understorey, especially where it has been disturbed by stock grazing. However, weed invasion was not considered a major overall problem within remnants, with highly invasive weeds not widely recorded.

3.3.3 THREATENED ECOLOGICAL COMMUNITIES

The vegetation survey completed was a large scale broad brush assessment to ascertain base information on remnant vegetation in the Yarra Yarra catchment. Rare and threatened flora was not specifically assessed. The Department of Conservation and Land Management (CALM) has data on threatened ecological communities for the Yarra Yarra region. The issue of rare and threatened flora should be dealt with in the management of specific remnants and the Department of Conservation and Land Management should be contacted to obtain this information.

3.3.4 SUCCESSIONAL VEGETATION

Succession of vegetation communities (ie change from one community type to another) is clearly evident in the Yarra Yarra Catchment. The progression of the succession vegetation (ie samphire) is most obvious in areas where water logged woodlands have been replaced by the lower growing succulents. It is less obvious in areas where the samphire vegetation has replaced a lower growing vegetation type such as Melaleuca shrublands or encroached on farmland that is no longer being cropped.

During the ground truthing it was difficult in some areas to discern where the boundary of the succulent samphire vegetation as mapped by Beard had encroached on another vegetation type unless there was clear evidence of tree deaths. The Yarra Yarra Catchment has always had extensive areas of samphire/succulent vegetation associated with seasonally flooded margins and basins adjoining the Lake system. With very little evidence of disturbance factors such as weeds and trampling these areas are given a condition rating of 1 as they are considered to be in pristine condition. The dilemma about how to rate what appears to be pristine samphire vegetation in an area that may have once been shrubland or woodland resulted in many of these samphire areas not being given a condition rating. Areas where there were clearly tree deaths were given a condition rating of 5.

The successional vegetation from woodland to samphire was most obvious in the valley floors of the sub-catchments indicating these are the areas that are the most severely affected by hydrological changes as a result of land clearing. By contrast the woodland and shrubland vegetation associated with the lakes system (ie from Lake DeCourcey all the way through to the Yarra Yarra Lakes) was mostly unaffected by encroachment of

samphire vegetation. Areas surrounding the lakes that showed evidence of successional vegetation are narrow bunds of woodland vegetation often found between seasonally flooded basins at the bottom end of the subcatchments (valley floors) and the adjoining lake. This indicates an altered hydroperiod in the seasonally flooded basin is affecting woodland vegetation close to the lakes.

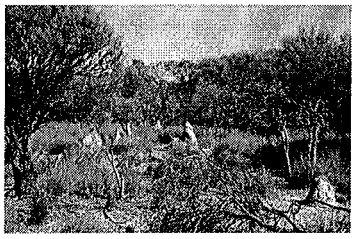


Photo 2 :Vegetation intact

Photo 3: Trees affected by salinity, vegetation starting to degrade.

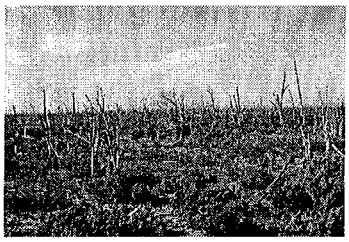


Photo 4: Samphire enroaching into woodland vegetation.

Woodland and shrubland vegetation surrounding the lakes away from these outlet zones of the subcatchments was generally in good condition with no evidence of samphire encroachment. This indicates that altered hydrology resulting from land clearing has had virtually no impact to date on the woody vegetation associated with the lakes.

Photo 5 : Vegetation around salt lakes looking from Goodlands Road

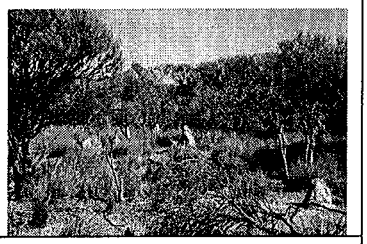
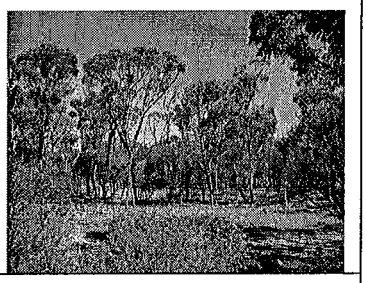
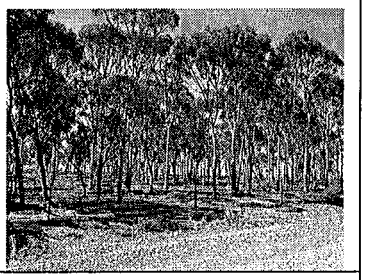
Photo 6 : Vegetation around salt lakes in the Yarra Yarra Lake Sub catchment

3.4 Quality of Remnant Vegetation

3.4.1 Remnant Vegetation Condition

Remnant vegetation was assessed for condition and each assessed remnant was assigned an overall condition rating, based on the condition ratings developed by Trudgen, 1991 and modified by Keighery, 1993 (Brown, 1999). The ratings and associated descriptions are listed in Table 3 The data set (woody perennial 1996 vegetation, updated by Agriculture WA) used to identify the remnant vegetation often does not detect severely degraded or salt affected vegetation. For example if the tree cover decreases or is lost from a vegetation community the satellite imagery may not detect the remnant vegetation, similarly samphire vegetation is not readily pick up. The data set obtained from Agriculture WA was an improvement on the original data set with more samphire vegetation being recognised from the orthophotos although it was still found to be incomplete in some areas.

Table 3: Remnant vegetation condition ratings.

Condition Rating		Description	Photo Example
1-2	'Pristine'	Pristine or nearly so, no obvious signs of disturbance.	
2-3	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.	
3-4	Very good	Vegetation structure altered, obvious signs of disturbance.	
4-5	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or the ability to regenerate.	
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.	
6	Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.	*No vegetation was recorded as condition 6*

Over 64% of remnant vegetation assessed in the Yarra Yarra catchment was considered to be in pristine or excellent condition (condition rating 1-2 and 2-3). Only a very small proportion (just over 1%) was degraded (condition rating 5). No remnant vegetation assessed was given a condition rating of 6. This is attributed to the previously discussed reasons of the data set not detecting severely degraded vegetation or not accurately determining the total area of the vegetation and only a small proportion of the remnant being identified and being selected out as less than 1 ha. Despite the Medium woodland

community type being one of the most dominant within the Yarra Yarra catchment, it is potentially the most degraded community. The canopy cover of this vegetation decreases and disappears through disturbances and the satellite imagery does not adequately sample it. This emphasizes the importance of establishing base data to enable future comparisions and to document further community transitions.

Sub catchments Campbells, Burakin and Yarra Yarra Lakes had the majority of their vegetation classified as 1-2 (in pristine condition). The overall condition of remnant vegetation in the Geranium Rock sub catchment was excellent, with all of the assessed vegetation being classified as 1-2 and 2-3. Only 3 sub catchments recorded the poorest condition rating of 5 (Sub catchment 38, Yarra Yarra Lakes and East Buntine).

A total of 2,282 ha of assessed remnant vegetation was not assigned a condition rating. A large proportion of not rated vegetation was located in the Lower Darling Creek and Yarra Yarra Lake sub catchments (1099.8 and 493.8 ha). This vegetation was mainly samphire vegetation located around the lakes edge or associated with salt affected land. A condition rating was not assigned as there were two ways of assessing the condition, based on the perception of the vegetation community. If the vegetation type was viewed as samphire vegetation then its condition was excellent, however, if the vegetation type was viewed to be York gum changed to samphire vegetation through some disturbance then it was in a degraded condition. In some instances the samphire vegetation was growing into a pasture area which made it difficult to assign a rating to. Therefore, vegetation in these situations were not given a condition rating (refer to Section 3.3.4 - Succession).

Table 4: Area and percentage of assessed remnant vegetation for each condition rating, in each of the 15 ground truthed sub catchments.

Ground truthed Sub catchment	Area of Remnants with each Condition Rating (ha)					
	1-2	2-3	3-4	4-5	5	Not rated
Campbells	771.6	100.7	80.7	28.4	0	0
Upper Darling Creek	93.9	113.4	256.8	299.6	0	0
Mid Darling Creek	113.2	254.5	238.9	39.6	0	94.8
15	43.2	100.4	161.9	91.5	0	13.7
16	39.9	376.6	630.1	182.4	0	0
Goodlands	575.9	897.1	378.0	115.7	0	0
Jibberding	905.7	860.9	102.0	11.3	0	0
Burakin	797.8	235.9	606.4	33.5	0	0
Geranium Rock	66.9	255.8	0	0	0	0
38	75.1	147.0	353.4	14.2	106.8	0
47	826.5	1506.0	161.6	31.9	0	72.2
48	389.6	749.0	2076.2	193.2	0	508.2
Lower Darling Creek	100.8	3143.6	547.7	432.6	0	1099.8
Yarra Yarra Lake	2639.0	521.6	669.5	310.4	100.3	493.8
East Buntine	449.6	578.5	308.0	202.8	24.8	0
Total	7887.7	9840.0	6570.2	1986.1	236.9	2282.5

Several environmental factors potentially pose a threat to remnant vegetation. These include salinity, water and wind erosion, loss of soil fertility and structure, stock grazing and weed invasion, plus many others. The major threats to vegetation in the Yarra Yarra catchment are discussed below.

1. Salinity and Water logging

   Water logging is one of the most critical environmental problems facing agricultural areas. It is caused by replacing deep-rooted native plants with shallow-rooted crops and pastures (Agriculture WA *et al.*, 1996). More rainfall passes below the root zone and accumulates as groundwater so that the watertables rise. The groundwater mobilises natural salts in the soil as it rises and carries them towards the surface, eventually degrading land and streams (Agriculture WA *et al.*, 1996).

2. Stock grazing

   Stock access to remnant vegetation causes extensive damage, primarily through grazing and trampling of the understorey and regenerating seedlings. Larger shrubs and trees are less prone to direct damage in comparison to seedling, although ringbarking and root trampling can cause severe damage in heavy grazing. Stock grazing was also found to cause the introduction of weeds and erosion associated with trampling (Orsini, 1996).

Photo 7 : Effect of stock grazing remnant vegetation..

3. Weed invasion

   Grassy weeds compete with native understorey species and outcompete natives as they rapidly establish in the understorey due to degradation by stock of natural vegetation. Grassy weeds generally enter remnants from pastures.

Photo 8 : Grassy weeds present in a remnant adjacent to pasture.

4. Size of remnants

   Small scattered remnants have less species diversity and are potentially not as efficient at hydrological functions (such as evapotranspiration and groundwater recharge). They may also be more susceptible to degradation through stock grazing and other threats. The edge effect is also more prominent in smaller remnants.

5. Position in the landscape

   The low lying areas of remnant vegetation (valley floors and wetlands) are considered to be most at risk of salinity and water logging as groundwaters approach and/or discharge at the surface. In the Yarra Yarra catchment, the vegetation in the valley floors of the sub catchments are most affected or under threat from salinity. However, the peripheral vegetation of the actual lakes (ie: Yarra Yarra Lakes) did not appear to be suffering from the effects of salinity or other hydrological changes such as increased drainage (ie: it was in quite good condition).

3.4.2 Remnant Vegetation Condition and Position in the Landscape

The condition of the remnant vegetation in relation to their position in the landscape are summarised into three elevation intervals (200-300, 300-400 and 400-500m above sea level) in Table 4 below. Contour data was missing for parts of sub catchment 48 and Yarra Yarra Lake and the remnant vegetation could not be accurately divided into the elevation intervals and were excluded.

Overall, remnant vegetation assessed in the low elevation interval (200-300) had less vegetation classified as condition 1-2 and 2-3 (922.1 and 3601.6 ha, respectively) compared to the medium elevation interval (2378.4 and 4046.5 ha, respectively). There was no vegetation classified as condition 5 in the medium elevation interval, where as 2% (202.9 ha) of remnant vegetation recorded the lowest condition in the low elevation interval. This trend also applied for vegetation with a rating of 4-5. No remnant vegetation was given a condition rating in the highest elevation interval (400-500 m).

In the low elevation interval, 6 out of the 13 sub catchments assessed, had the majority of their remnant vegetation classified as good (condition rating 2-3) or excellent (condition rating 1-2). Sub catchment 38 had approximately 15% of its low lying vegetation rated as 5 (severely degraded). All of the low lying vegetation in the Burakin sub catchment was given a condition rating of 4-5. The Upper Darling Creek and sub catchment 15 had most of their low lying vegetation rated as 4-5. In the medium elevation interval, 9 out of the 13 sub catchments had the majority of their vegetation rated as good or excellent. Upper darling creek, sub catchment 15 and 38 had the majority of their medium positioned vegetation rated as 3-4. Sub catchments 38, Jibberding and Geranium Rock had no medium positioned vegetation in a degraded condition (4-5 or 5 ratings).

Burakin and Goodlands sub catchments were the only sub catchments to have vegetation in the highest elevation interval, although these remnants were not assigned a condition rating.

Remnant vegetation in low lying valley floors was found to be more susceptible to salinity and are at greater risk to this form of degradation. Although this pattern was observed overall in comparing the low lying vegetation to the medium lying vegetation, it was not as obvious on the sub catchment basis. This may be attributed to the position of the sub catchments within the Yarra Yarra catchment, with sub catchments at the bottom of the catchment and the ridge divides not exceeding 400m in elevation and therefore no vegetation was classified in the highest elevation interval. The entire catchment is very flat with only a 65m drop in elevation from one end to the other, which may also affect this relationship. Ideally, approximately the same amount of vegetation should be assessed within each elevation class to give a more accurate picture, however, due to the previously discussed factors this was not possible in this survey.

Table 5 : Area of remnant vegetation with condition ratings in three elevation classes.

Sub catchment	Elevation 200-300						Elevation 300-400						Elevation 400-500					
	1-2	2-3	3-4	4-5	5	Un-rated	1-2	2-3	3-4	4-5	5	Un-rated	1-2	2-3	3-4	4-5	5	Un-rated
Campbells	661.8	48.9	62.5	23.9	0.0	0.0	109.8	51.8	18.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upper Darling Creek	0.0	4.2	125.8	274.6	71.3	0.0	93.9	109.2	131.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mid Darling Creek	51.7	96.3	21.0	1.2	0.0	94.8	61.5	158.2	130.7	38.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	38.0	13.3	70.4	0.0	13.7	43.2	62.4	148.6	21.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	62.2	263.6	135.3	0.0	128.1	39.9	314.4	240.2	47.1	0.0	114.3	0.0	0.0	0.0	0.0	0.0	0.0
Goodlands	155.6	0.0	0.0	0.0	0.0	155.0	420.3	897.1	378.0	115.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.6
Jibberding	51.3	247.7	78.1	11.3	0.0	194.6	854.4	613.2	23.9	0.0	0.0	250.4	0.0	0.0	0.0	0.0	0.0	0.0
Burakin	0.0	0.0	0.0	13.7	0.0	142.0	797.8	235.9	606.4	19.8	0.0	523.1	0.0	0.0	0.0	0.0	0.0	90.2
Geranium Rock	0.0	0.0	0.0	0.0	0.0	0.0	66.9	255.8	0.0	0.0	0.0	188.9	0.0	0.0	0.0	0.0	0.0	0.0
38	0.0	0.0	5.1	14.2	106.8	11.8	75.1	147.0	348.3	0.0	0.0	54.2	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	242.8	60.7	27.4	0.0	74.4	826.5	1263.2	100.9	4.5	0.0	74.3	0.0	0.0	0.0	0.0	0.0	0.0
48	Limited contour data available.																	
Lower Darling Creek	1.7	2653.7	204.6	404	0.0	1417.4	99.1	389.9	343.1	28.6	0.0	131.3	0.0	0.0	0.0	0.0	0.0	0.0
Yarra Yarra Lake	Limited contour data available.																	
East Buntine	0.0	207.8	255.9	148.1	24.8	146.6	449.6	370.7	52.1	54.7	0.0	74.4	0.0	0.0	0.0	0.0	0.0	0.0
Overall	922.1	3601.6	1090.6	1124.1	202.9	2378.4	4046.5	4868.8	2521.4	359.4	0.0	1410.9	0.0	0.0	0.0	0.0	0.0	105.8

3.5 VEGETATION RISK

One of the key outcomes of this study was to determine not only what 's out there but to also assign a vegetation risk factor to aide in decision making regarding the management of remnants within the Yarra Yarra Catchment.

Possible threats and the stability of the vegetation need to be considered in setting management priorities. The key threat (but not the only one) to remnant vegetation in the Yarra Yarra catchment is that of water logging. Both threats and stability may change with or without active intervention

Table 6: Vegetation Risk

		Stability Status (relates to condition)		
		Improving	Stable	Degrading
Threat Status	Currently Threatened		Moderate risk	High risk
	Not Threatened	Very low risk	Low risk	

Using this matrix we can see that vegetation of a good condition, not at risk of water logging (ie high in the landscape) would be considered very low to low risk and would not be considered a high priority for management. On the other hand vegetation of a poorer quality lower in the landscape is at greater risk of irreversible damage. Vegetation that is potentially at risk of water logging (ie: low in the landscape) and that is not typically present in water logged areas (ie: succulent steppe vegetation around the lakes has been eliminated) has been mapped within the Yarra Yarra Catchment (Map 4).

3.6 SETTING PRIORITIES FOR MANAGEMENT

The distribution and representativeness of vegetation communities are important considerations in vegetation conservation and management particularly in relation to setting priorities.

- Representativeness was assessed as a percentage of the total vegetation type within each of the following classes
- percentage of vegetation type protected (ie within a reserve) for the entire state (Hopkins *et al* 1996.
- percentage of the vegetation type within the Yarra Yarra Catchment
- percentage of the vegetation type within three elevation classes the lower in the landscape the more vulnerable it is to the most dominant threat, waterlogging.
- percentage vegetation type in each condition range

Table 7: Vegetation community representativeness – composite ratings

		Reserves within WA	
		Poorly represented	Well Represented
Remnants within the Yarra Yarra Catchement	Poorly represented	A	C
	Well represented	B	D

In conservation terms, communities with rating 'A" are of greatest concern while rating 'D' communities are of least concern.

It is possible to combine both the risk and the representativeness matrixes to determine priorities for conservation. Once these priorities have been determined it is possible to prepare a management response for each remnant.

Once the moderate to high risk remnants have been identified it may be necessary to prioritise remnants to preserve. The criteria we have used for the basis of this assessment is the representativeness of the community both within the Yarra Yarra Catchment and within conservation reserves in WA.

Using the above analysis the following vegetation types were determined to be most vulnerable and should be considered as priorities for management.

- Mosaic: Medium woodland; York Gum/shrublands; Allocasuarina campestris
- Mosaic: Low woodland: Allocasuarina heugeliana over mallee and acacia scrub/Allocasuarina campestris thicket
- Mosaic: Shrublands; Shrublands; jam scrub with scattered York gum in the valleys /Allocasuarina campestris thicket
- Shrublands; Allocasuarina campestris thickets with scattered jam & casuarina
- Shrublands; bowgada & jam scrub with scattered York gum & red mallee

Each one of the above communities is represented in the lower elevation interval and is not represented in conservation reserves in WA. All of the above had remnants in the medium elevation but no remnants in the higher elevations. These vegetation communities were located in the north-west section of the Yarra Yarra Catchment and are shown in Map 5.

Map 4 - Veg at risk

Map 5 - Vulnerable Veg Map

3.7 MANAGEMENT CONSIDERATIONS

3.7.1 INTEGRATED APPROACH TO MANAGEMENT

Priority levels for management recommendations are based on several objectives:

- minimising land degradation;
- conserving a range of native species representative of the flora of the area;
- conserving a representative range of plant communities in the catchment;
- protecting healthy remnants with low disturbance levels in priority to degraded remnants;
- protecting a minimum amount of native vegetation on each property for nature conservation (Read, 1992).

3.7.2 CONNECTING REMNANT VEGETATION

Criteria for linking remnant vegetation with revegetated corridors:

- proximity to other remnants (single remnant or multiple remnants, road reserves/corridors).
- potential size of remnants (ie: possibly no point in putting a lot of effort and funding into connecting two remnants that still create only a small sized remnant).
- condition of the remnants
- vegetation community types (similar or dissimilar).

3.7.3 FENCING OF REMNANT VEGETATION

Fencing is considered to be one of the most important management activities, which would have immediate results in terms of regenerating of native flora. Fencing every remnant, on each farm would prove to be a huge, costly and potentially unrealistic task, which leads to the formation of fencing priorities. Fencing of a remnant may not be necessary if it is unlikely to be grazed.

One of the major causes of remnant degradation is stock grazing. Degradation is visible from the high incidence of grassy weeds and a reduction in native understorey species. The effect of stock grazing includes:

- limited or no regeneration, as seedlings are eliminated as soon as they are produced;
- depletion of the soil seed bank over time;
- increased disturbance through ground compaction, trampling and nutrient enrichment of the soil (Read, 1992).

The fencing of remnants prevents stock access, which limits degradation and allows natural regeneration of the vegetation.

3.7.4 DRAINAGE

Drainage is used throughout the wheat belt to protect arable land but it can be employed to equally to protect remnant vegetation. Consideration for the type and design of the drain will be site dependent. One example of the use of drainage to protect remnant vegetation is at Lake Toolibin not only from rising groundwater but also to prevent saline water entering what is a fresh water lake system. At Lake Toolibin the drains have been designed to carry excess and saline water around the perimeter of the lake conveying it to a saline lake system further down stream.

Drainge into the the Yarra Yarra lake system has been proposed as a method for tackling the rising water and associated salinity in this area. However, there is concern that the increase in surface water from drainage into the lakes will decrease the amount of groundwater evaporation, as the salt crust on the surface of the lakes acts as a wick drawing up more groundwater. The increased volume of surface and ground water may cause the Yarra Yarra Lake to overflow into the Moore River catchment, affecting the hydrology of this region aswell.

The tidal period of the lakes should not vary significantly with the increased amount of water, as the surface water is predicted to evaporate. Therefore there should be no enroachment into the fringing vegetation. The succulent steppe with woodland vegetation located between the small lakes at the catchment outflow areas act as bunds. The concept of utilising drainage to remove saline water from arable land in the Yarra Yarra catchment requires further investigation to assess the potential impact of increased volumes of saline water entering this system.

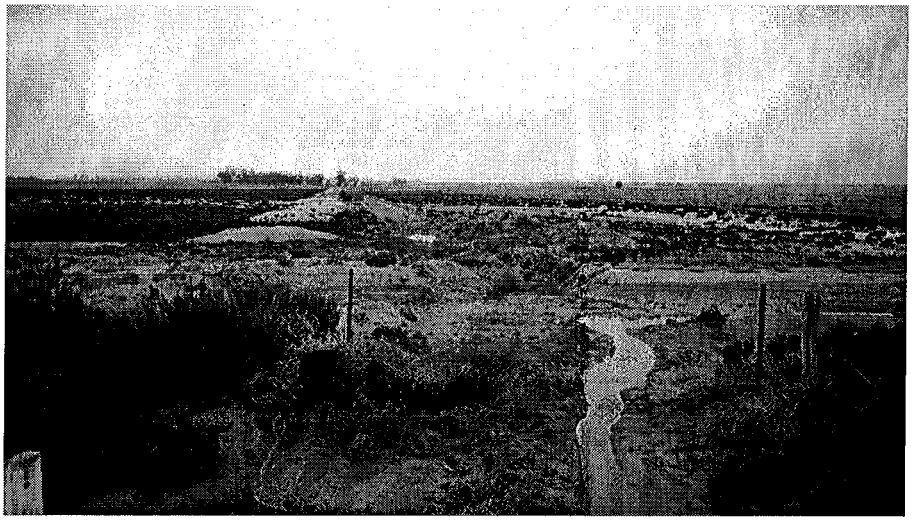


Photo 9: An example of drainage in the Goodlands Sub catchment

3.8 Lake System

The salinity level of Mongers Lake and Lake DeCourcey was analysed from water samples collected from free standing water. This assessment was undertaken on 19th August 2001. The salinity level was 130,000 µS/cm for Mongers Lake and 77,000 µS/cm for Lake DeCourcey. Mongers Lake and Lake DeCourcey are classified as hypersaline and polysaline, receptively. The salinity level of the lakes may vary with the season and when the lakes dry out the salinity level increases. Sampling was undertaken at the end of winter when the salinity level is at its lowest. In general, the lakes of the catchment would be classified as hypersaline.

A literature search was conducted on the lake system to determine what types flora and fauna are typically found in lakes of different salinities levels (Appendix 3). Table * summaries the results of this search and outlines the characteristics of the lakes. The vertebrates, invertebrates and macrophytes of the hypersaline category would be characteristics of the lakes in the Yarra Yarra (Table 6). Limited species typical of the polysaline category may also be found. The lakes in this system are termed salt pans (or evaporative basins) and are dry for part of the year, particularly in summer. Consequently the biological components stated in the table below are ephemeral and would only be found in the lakes at certain times of the year.

Table 8: Ecology of changing salinity for non tidal saline wetlands.

Terms Salinity Range ppm	Meiomesosaline 1,000 – 3,000	Hyposaline 3,000 – 20,000	Mesosaline 20,000 – 50,000	Polysaline 50,000 – 100,000	Hypersaline > 100,000
Diversity Vertebrates	High Frogs numerous, numerous fish species (eg. minnows, *Galaxiella* spp, western pygmy perch, *Edelia vittata)*	High Frogs uncommon	Moderate Estuarine fish species (black bream, *Acanthopagrus butcherii*), numerous bird species (eg. black ducks)	Reduced One or two fish species present of *Chrinodon* and *Atherinosoma* genera. *Galaxias maculatus* Waders very common (eg. stilts, avocets)	Low Waders very common
Invertebrates	Numerous crustaceae (eg. cladocerans, isopods, amphipods, shrimps yabbies, (*Cherax* spp)), damselfly, dragonflys	Few crustaceae, Shield shrimp (*Triops* spp) dominate *Daphnia carinata* *Alona sp.*	Rotifera (*Brachionus, Hexaarthra*) Anostraca (*Parartemia*) *Daphniopsis pusilla* *Daphniopsis australis* *Gladioferens spinosus* *Mytilocypris splendida*	*Artemia/Parartemia* start. Some species of *Diptera,* isopod crustacean *(Haloniscus searlei, Austrochiltonia subtenuis*) at lower range. Species of gastropod *Coxiella*at lower range	Artemia common, Trichoptera (*Symphytoneuria wheeleri*)
Macrophytes	Nardoo *(Marsilea spp)* Duckweed (*Lemna* spp.), Water fern (*Azolla* spp.), Pondweed (*Potamogeton* spp), Water Ribbons (*Triglochin* spp) Sedges & rushes (*Baumea* spp., *Gahnia trifida Juncus* spp, *Typha domingensis*)	Nardoo *(Marsilea spp),* Water Ribbons (*Triglochin* spp), Pondweed (*Potamogeton* spp), *Ruppia* spp Sedges & rushes (*Baumea* spp., *Gahnia trifida, Juncus* spp, *Typha domingensis*)	Estuarine species, *Ruppia* spp.	Rare clumps of *Ruppia, Lepilaena* species	Upper range of *Ruppia, Lepilaena* [1](rarely seen)
			Mainly green algae, *Ulva, Chaetomorpha.* Estuarine species, green algae diatoms, dinoflagellates	Filamentous green algae in small numbers. Diatoms and dinoflagellates dominate biota	*Dunaliella salina, Carteria* sp

3.9 FAUNA ASSESSMENT

3.9.1 VEGETATION

The vegetation of the remnant in which the fauna assessment was undertaken consists of two distinct vegetation communities. The York and Salmon gum woodland is located to the east of the pitfall trap transects, adjacent to the paddock area. The succulent steppe (samphires and saltbushes) with an overstorey of *Melaleuca* species was observed at the lakes edge and surrounding area. A notable stand of *Callitris preissii* was present towards the centre of the remnant. There were few understorey species, although the remnant appeared not to have been grazed recently. The open areas were dominated by *Austrostipa flavescens* (native grass) species.

3.9.2 PITFALL TRAPS

A total of 48 faunal species were captured in the pitfall traps in the three survey periods (Table 7). The two spring sampling times (Nov 1999 & 2000) recorded the highest species diversity (31 and 26 species, respectively), compared to the May 2000 sampling time (8 species). 12 reptile species (geckos and skinks) were identified in sampling. 3 species of dunnarts were recorded, with the highest abundance being captured and released in November 2000 (3 individuals). The highest number of mice were sampled in the May 2000 survey (almost double the number recorded in the November 1999 survey), with no mice being observed in the Nov 2000 survey. Of interest, is the 2 species (6 individuals) of frogs observed in the May 2000.

Photo 10 : Pogona minor

Photo 11 : Sminthopsis dolichura

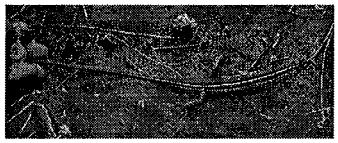


Photo 12 : Ctenotus mimetes

Photo 13 : Diplodactylus pulcher

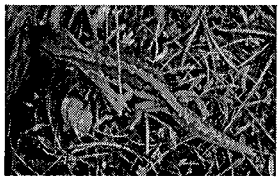


Photo 14 : Diplodactylus granariensis rex

Table 9 Species abundance in pitfall traps in the three sampling periods.

Species	Common Name	Nov 1999	May 2000	Nov 2000
Pogona minor	Bearded Dragon	1	1	2
Heteronotia binoei	Binoe's Gecko		1	
Strophurus spinigerus	Spiny-tailed Gecko		1	
Strophurus granariensis	Wheatbelt stone gecko	1		
Strophurus strophurus	Spiny tailed gecko	1		
Lerista gerrardii		2		1
Lerista distingvenda				1
Ctenophorus caudicincus	Skink			1
Ctenotus mimetes		4		4
Diplodactylus pulcher				1
Diplodactylus granariensis rex				1
Morethia butleri		2	1	
Mus musculus	House Mouse	7	16	
Sminthopsis crassicaudata	Fat-tailed Dunnart		1	
Sminthopsis dolichura	Little Long-tailed Dunnart		1	2
Sminthopsis granulipes	Dunnart	1		1
Neobatrachus sutor	Shoemaker Frog (?)		3	
Neobatrachus sp	Burrowing Frog		3	
	Wolf spider	12		11
	Plate shield bug #1	10		11
	Carob beetle	2		
	Ant	3		> 100
	Tick	1		
	Shield bug #2	2		
	Trapdoor spider	5		
	Red hornet	2		
	Slater beetle	2		
	Black Wolf spider ?	1		
	Cricket	5		1
	Grasshopper	2		
	Small wolf spider	1		
	Centipede	1		
	#3 sandy cow	1		
	Spider	3		
	Orb weaver spider	2		
	Brown beetle	1		
	Scorpion	1		2
	Soldier ant	1		

Christmas beetle	10
Wasp	6
Moth	1
Stick insect	1
Centipede	1
Fang spider	1
Wood Cockroach	1
Red spider	1
Praying mantis	1
Black beetle	1

3.9.3 ELLIOT TRAPS

The results of the elliot trapping was not tabulated as only one species (*Mus musculus* or house mouse) was caught in the first two sampling periods, with no species being caught in the last sampling. It is worth noting that quite a large number of mice were caught in both the elliot and pitfall traps in the first and second survey (Nov 1999 and May 2000), with this number decreasing over the 6 month period, with no mice caught in either the elliot or pitfall traps in Nov, 2000.

3.9.4 AVIAN SURVEY

26 bird species were identified belonging to 18 different families in the remnant vegetation surrounding Lake Goorley. The bird species together with their common name and family are listed in Appendix 4.

CONCLUSION

This report describes collected and collated base line data on the remnant vegetation and fauna of the Yarra Yarra Catchment. It is intended to be used by Landcare and Management Groups as a starting point for the successful management of the biological resources of this region.

Through this study the vegetation communities, areas and condition were assessed. Information was also collected on land tenure, remnant fencing, successional vegetation and areas of vegetation that is potentially at risk of salinity. Beards vegetation mapping was acknowledged to be an accurate data set for use in this region. Over 64% of remnant vegetation assessed in the Yarra Yarra catchment was considered to be in pristine or excellent condition, with only a very small proportion (just over 1%) being degraded. Succession of vegetation communities (ie change from one community type to another) is clearly evident in the Yarra Yarra Catchment. The successional vegetation from woodland to samphire was most obvious in the valley floors of the sub-catchments indicating these are the areas that are the most severely affected by hydrological changes as a result of land clearing. By contrast the woodland and shrubland vegetation associated with the lakes system was mostly unaffected by encroachment of samphire vegetation.

Vegetation distribution, representativeness and condition are the most important considerations in vegetation conservation and management, specifically in regard to setting priorities. This report provides the background statistics and the process by which to assess remnant vegetation status to establish conservation priorities for individual remnants and vegetation over a sub catchment basis. The main management considerations were also outlined to provide initial information of issues facing the Yarra Yarra Catchment.

The subsequent stages in the Yarra Yarra Catchment Project can now be undertaken. These include further field work to prepare Sub catchment Management Plans which outline specific strategies to conserve their biological resources and will analyze methods to deal with salinity

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APPENDIX 1 : PROCEDURE FOR DETERMINING REMNANT VEGETATION FROM THE LANDSAT SATELLITE IMAGE

PART A - PROCESS TO POLYGONIZE LANDSAT WOODY VEGETATION IMAGE.

1. Load *Veggrid*, limit analysis properties to display.
2. Use the map calculator to divide by one and save as grid this will reduce the size of the dataset to a manageable level.
3. Convert the grid created in point 2 to a shapefile. Call the shapefile "*step. Shp*".
4. Use geo- processing wizard to dissolve "*step1. Shp*" by grid code.
5. Delete unwanted polygons. This will leave a shapefile with the polygonized remnant vegetation blocks.
6. Use geo- processing wizard to clip the polygons to the sub catchment boundaries. Call the shapefile "*clipstep. Shp*".
7. Use vector transformations to explode the polygons. Use join field "gridcode" the shapefile "*step1. Shp*".
8. Use WG public to assign area is to these polygons.
9. Delete polygons of less than hectares in area.
10. Fill in any obvious holes in polygons.
11. Re-calculate area is using WG tools.
12. Use Mila tools to create a unique identification for each polygons, name the ID field "Poly _Id". Syntax: "Bell" +recno. As string. Where "Bell" is a unique code for each sub catchment.

PART B - ASSIGN THE BEARD VEGETATION TYPES TO WOODY VEGETATION POLYGONS.

1. Use the geo- processing wizard and clip the Beard map using "*step1. Shp*". Call this file "*step2.Shp*"
2. Use the tool polygon to centriod to generate centriods for all the polygons *in "step2. Shp"*. The file is auto-named "*step2_PT.Shp*".
3. Use the geo- processing wizard spatial join to assign the data from "*step1. Shp* " to "*step2_PT.Shp*". This process will attach the overall area of the remnant vegetation stand to centriod shapefile (*step2_PT.Shp*). Re-name the area field to stand _ area.
4. Load *"vegstrip. Shp"* using geo- processing wizard merge "*step2_PT.Shp"* using the fields in *vegstrip* with *vegstrip* and call the resultant file "*cent. Shp"*.
5. Use the pseudo-spatial join tool button to join the centriod shapefile ("*cent. Shp"*) to "*step 2.Shp*". This process will attach the overall remnant vegetation stand area to each vegetation type within the stand. Syntax Poly _ ID +"_" +veg _ assoc.as string. Note to make this process work both themes must be active in the view, use the Mila tool to add record numbers to both tables highlight the record number field in both tables, make "*step 2.Shp*"active and use the tool.

6. Create new field within the "*step 2.Shp*" (call this field disol) and combine the fields veg _ assoc and Poly _ ID into it, separate the two fields by "_". Dissolve the polygons in "*step 2.Shp*" using this new field, call this file "*step3. Shp*".
7. Load *vegtemp. Shp.* Use in the geo- processing wizard merge "*step3. Shp"* with *vegtemp.shp* using the *vegtemp* fields. Call this shapefile *"step3a.Shp"*
8. Use the overlay attribute tool to update the fields in *"step3a. Shp"* with the values from "*step 2.Shp*". Update the following fields:
   - map ID, cell no,
   - Beard num
   - Beard area
   - grid code
   - veg code
   - ms250k
   - veg assoc
   - H. code
   - super group
   - lbl_load
   - area
   - perimeter
   - Study area
   - Warms_numb
   - Beard code
   - Description
   - Stand_area
   - Poly_id
9. Use WG tools to re-calculate the area for each vegetation type, then calculate the percentage area for each vegetation type. Use the following field names:
   - St_area_ha
   - Area_ha
   - %ofstand.

APPENDIX 2 - AN EXAMPLE OF THE FIELD DATA SHEET

Sub-catchment		Vegetation structure unit	Vegetation community	Dominant species	Vegetation condition	Management issues	Fenced	Stock Present	Connection to other remnants	Comments/Photo Number
Remnant Number	Transect Number									

APPENDIX 3 - AREA OF REMNANT VEGETATION WITHIN EACH SUB CATCHMENT ON PRIVATE LAND AND RESERVES

Sub catchment	Area of remnant vegetation in reserves (ha)	% of remnant vegetation in reserves	Area of remnant vegetation in private land (ha)	% of remnant vegetation in private land	Total area of remnant vegetation (ha)
Morawa	2334	2.069	18.5	0.016	2352.5
2	4.7	0.004	1457.9	1.292	1462.6
3	1844	1.634	1469.5	1.302	3313.5
Campbells	**792.8**	**0.703**	**228.2**	**0.202**	**1021**
5	2565.8	2.274	668.1	0.592	3233.9
6	0	0.000	3470.7	3.076	3470.7
7	1.7	0.002	275.7	0.244	277.4
Upper Darling Creek	**144.7**	**0.128**	**709.3**	**0.629**	**854**
Perenjori	344.5	0.305	1035.5	0.918	1380
10	0	0.000	376.5	0.334	376.5
East Three Springs	0	0.000	1685.8	1.494	1685.8
12	0	0.000	225.7	0.200	225.7
19	527.5	0.468	586.1	0.519	1113.6
Mid Darling Creek	**221.8**	**0.197**	**620.3**	**0.550**	**842.1**
15	**16.1**	**0.014**	**513.9**	**0.455**	**530**
16	**168.8**	**0.150**	**1284.6**	**1.139**	**1453.4**
17	4.3	0.004	873.8	0.774	878.1
Glamoff	34.4	0.030	1428.7	1.266	1463.1
19	172.2	0.153	1055.9	0.936	1228.1
Goodlands	**0**	**0.000**	**2477.8**	**2.196**	**2477.8**
Jibberding	**299.2**	**0.265**	**2025.7**	**1.795**	**2324.9**
22	22.7	0.020	826.8	0.733	849.5
Lake De Courcy North	47.7	0.042	466.1	0.413	513.8
Lake Hillman	179.4	0.159	379.7	0.337	559.1
Lake De Courcy South	55.8	0.049	746.6	0.662	802.4
Kulja	149.1	0.132	884.6	0.784	1033.7
Burakin	**913**	**0.809**	**1515.9**	**1.344**	**2428.9**
28	69.3	0.061	1948.2	1.727	2017.5
29	95.1	0.084	651.1	0.577	746.2
30	57.7	0.051	385.4	0.342	443.1
31		0.000		0.000	N/A
Geranium Rock	**80.9**	**0.072**	**430.7**	**0.382**	**511.6**
Lake Goorley	29.3	0.026	3706	3.285	3735.3
Xantipe	38.4	0.034	2439.9	2.163	2478.3
Bywaters	0	0.000	1037.1	0.919	1037.1
36	42.9	0.038	3789.7	3.359	3832.6
37	26.5	0.023	2469.2	2.189	2495.7
38	**261.9**	**0.232**	**500.6**	**0.444**	**762.5**
Bellaranga	1202.3	1.066	2599.8	2.304	3802.1
40	0	0.000	3000.4	2.659	3000.4
41	18.3	0.016	1144.2	1.014	1162.5
42	577.9	0.512	4614.2	4.090	5192.1
43	1055.2	0.935	5690.1	5.043	6745.3
Pastural		0.000		0.000	N/A
45	1938.6	1.718	1178.9	1.045	3117.5
46	1.6	0.001	1301.5	1.154	1303.1
47	**598.8**	**0.531**	**2075.9**	**1.840**	**2674.7**
48	**1480.1**	**1.312**	**3465.4**	**3.071**	**4945.5**
Collier - Dingo	0	0.000	1236.9	1.096	1236.9
Lower Darling Creek	**5501.6**	**4.876**	**171.8**	**0.152**	**5673.4**
Yarra Yarra Lake	**3002.4**	**2.661**	**2035.5**	**1.804**	**5037.9**
Three Springs	16.6	0.015	2174.3	1.927	2190.9
53	112.3	0.100	1454.1	1.289	1566.4
54	106.4	0.094	3550.1	3.147	3656.5
East Buntine	**445.5**	**0.395**	**1339.2**	**1.187**	**1784.7**
56	1687.6	1.496	1835.9	1.627	3523.5
Yarra Yarra Catchment	29291.4	-	83534.0	-	112825.4

APPENDIX 4 - BIRD LIST FOR 28/5/00 – 29/5/00

Anatidae (swans, geese and ducks)	
Australian Wood Duck	*Chenonetta jubata*
Accipitridae (kites, hawks and eagles)	
Wedge-Tailed Eagle	*Aquila audax*
Charadriidae (lapwings and plovers)	
Banded Lapwing	*Vanellus tricolor*
Columbidae (pigeons and doves)	
Crested Pigeon	*Ocyphaps lophotes*
Common Bronzewing	*Phaps chalcoptera*
Cacatuidae (cockatoos)	
Galah	*Cacatua roseicapilla*
Corella sp.	*Cacatua sp.*
Psittacidae (lorikeets and parrots)	
Australian Ringneck (Twenty-eight Parrot)	*Barnadius zonarius*
Cuculidae (cuckoos)	
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*
Tytonidae (barn owls)	
Barn Owl	*Tyto alba*
Aegothelidae (owlet-nightjars)	
Australian Owlet-nightjar	*Aegotheles cristatus*
Maluridae (fairy-wrens)	
White-winged Fairy-wren	*Malurus leucopterus*
Pardalotidae (pardalotes)	
Striated Pardalote	*Pardalotus striatus*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Meliphagidae (honeyeaters)	
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*
Singing Honeyeater	*Lichenostomus virescens*
Yellow-throated Miner	*Manoria flavigula*
Red Wattlebird	*Anthochaera chrysoptera*
Petroicidae (Australian robins)	
Red-capped Robin	*Petroica multicolor*
Pachycephalidae (whistlers)	
Grey Shrike Thrush	*Colluricincla harmonica*
Dicruridae (flycatchers)	
Magpie-lark	*Grallina cyanoleuca*
Willie Wagtail	*Rhipidura leucophrys*
Grey Fantail	*Rhipidura fuliginosa*
Artamidae (woodswallows)	
Grey Butcherbird	*Cracticus torquatus*
Corvidae (ravens and crows)	
Australian Raven	*Corvus coronoides*
Hirundinidae (swallows)	
Welcome Swallow	*Hirundo neoxena*