Littoral & Wetland Vegetation at Lake Mokoan, March 2008

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April 2008

COVER PHOTOGRAPH

Green Swamp, after hail, 26 March 2008

Photograph by Jane Roberts

PLEASE CITE THIS REPORT AS:

Roberts, J. and Hale J. (2008). *Littoral and wetland vegetation at Lake Mokoan, March 2008.* A report to the Goulburn Broken Catchment Management Authority. Report JR 23/2008. Canberra, ACT. April 2008.

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LITTORAL & WETLAND VEGETATION AT LAKE MOKOAN, MARCH 2008

A report to the

Goulburn Broken Catchment Management Authority

prepared by

JANE ROBERTS and JENNY HALE

APRIL 2008

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Executive Summary

- CONTEXT

Goulburn-Broken CMA (GBCMA) commissioned Regional Ecosystem Services (RES) to [a] assess the distribution, composition, structure and condition of littoral vegetation at Lake Mokoan in accordance with MP_1, and [b] provide water regime management recommendations based on these results.

MP_1 (Monitoring Porgram_1) is one of three monitoring programs designed to track the development of terrestrial, littoral and wetland vegetation on the slopes, banks, shores and floor of the wetlands exposed by the falling water levels as Lake Mokoan is drawn down then eventually decommissioned. MP_1 is designed to track the development of wetland vegetation on the wetland floor, focusing in particular on River Red Gum and Southern Cane Grass, two target species. The design for MP_1 includes one wetland dominated by Southern Cane Grass (Moodies Swamp) as an ecological target and no control; and no target or control for River Red Gum dominated wetlands. All three monitoring programs are described in a separate report (Roberts and Hale 2007).

- FIELD WORK

Field work was done in March 2008 for task [a]. Task [b] is addressed in a separate report to GBCMA entitled "Regeneration around Lake Mokoan in March 2008" (Roberts, Kobryn & Osler 2008).

At the target site (Moodie's Swamp), six transects were established stretching from the littoral zone 200 m towards the centre of the wetland, as per the design for MP_1. Moodie's Swamp was dry at the time. However, corresponding transects could not be set up at the three treatment sites (Sargents, Winton and Green Swamps) because water levels at Lake Mokoan were too high, making it impossible to work safely.

In lieu of MP_1, a long-term monitoring program was devised and implemented using a similar approach as MP_1, but instead targeting the wetland edge, ie the area above and down to the water line, and beyond. For this, seven transects were set up around Green Swamp and eight transects around Winton Swamp, with none around Sargents Swamp. Fifteen was the maximum number of transects that could be established in the time available and with the resources available. This long-term monitoring program is referred to as MP_WE (for Wetland Edge).

- **DOCUMENTATION**

All transects set up at Moodie's Swamp for MP_1 and around Lake Mokoan for MP_WE were documented by recording the GPS of the start and end of each transect. From these, the elevation of the start and finish, transect distance and bearing were estimated using the DEM. This documentation is given in Appendix 2 for MP_1 and in Appendix 3 for MP_WE.

- **DESCRIPTION**

Same type of data (% frequency per transect: based on presence-absence per 25x25 cm quadrat) was recorded in MP_1 and MP_WE, and hence the same five vegetation attributes per transect are recommended for both monitoring programs. These five vegetation attributes are: Species Characteristics (floristics, nativeness, inferred dispersal mode, plant functional types); Transect composition (for each species, the % of quadrats where it occurred); Vegetatedness (% of quadrats in a transect that were totally bare or that were totally vegetated with no bare soil); Species Abundance patterns (number of species per abundance category); Target Species.

As this was a benchmarking exercise, no comparative or spatial analyses were done. Results are summarised per wetland for the five vegetation attributes.

- **FINDINGS**

The benefit of this benchmarking experience is that it is now apparent that the approach of using frequency data from small quadrats spaced along the transect is relatively quick in the field and returns data suitable for reporting on four of the five proposed vegetation attributes. It is not suitable for the fifth attribute, regeneration of Target Species, especially River Red Gum.

For MP_WE, transects are variable length and positioned at differing elevations around the wetlands. This means that, for monitoring, analyses will be limited to making within transect temporal comparisons, unless transects are standardised.

Ecological targets for the Wetland Edge, arising out of the data, are: reduce the number of quadrats per transect that are unvegetated; increase the abundance of native Cyperaceae, normally associated with wetland Edges.

- **RECOMMENDATIONS**

Two recommendations are made:

[1] Give the wetland Edge a greater priority for resourcing over the wetland Floor, at least until a schedule for manipulating the water regime to promote regeneration across the wetland Floors is worked out.

[2] Extend the scope of MP_WE to fill the gaps identified. This means another 8 transects at least for Winton and Green Swamps, but preferably another 16 transects, so as to include Sargents Swamp.

Acknowledgements

Special thanks to Peter Carter, Goulburn Murray Water, for providing access and showing us around; and to his team. Thanks also to Dylan Osler, Australian Ecosystems, who did the plant identifications.

[1] Introduction

Background

Lake Mokoan was established as a relatively large water storage in northern Victoria. At Full Supply Level (FSL), equivalent to 167 m AHD, it had a surface area of 7850 ha, and a capacity of 365 GL (Souter & Lewin 1999). The last time water was at 100% FSL was in 1989. Lake Mokoan is to be de-commissioned and the wetlands that have been submerged by the storage almost continuously since 1970 are to be rehabilitated and restored. Since 1989, water levels have been gradually, but not continuously, falling, and vegetation has been colonising and developing on the exposed areas. At present, Lake Mokoan is still a storage and will remain a storage until fully de-commissioned in mid 2009.

MP_1 (monitoring program number 1) is one of three monitoring programs designed for the Goulburn Broken CMA to monitor the development of vegetation at Lake Mokoan prior to and following its decommissioning (Roberts and Hale 2007). MP_1 focuses specifically on the development of wetland vegetation on the wetland floor, meaning the relatively flat area at the centre of a wetland: it is designed to be done annually, for 4-5 years and then reviewed. MP_2 focuses on the terrestrial vegetation at discreet elevation bands below 163.5 m AHD: it is also designed to be done annually for 4-5 years, and then reviewed. MP_3 is a mapping exercise for the entire area below 100% FSL, and is intended to be done once after de-commissioning and just prior to a review and be a major input to a review (Roberts and Hale 2007).

Objectives

In November 2007, Goulburn Broken CMA engaged Regional Ecosystem Services to undertake the following tasks.

[a] Assess the distribution, composition, structure and condition of littoral vegetation at Lake Mokoan in accordance with MP_1.

[b] Provide water regime management recommendations based on the monitoring results.

This report addresses Task [a] only, that is the implementation of MP_1 to monitor vegetation development across the wetland floor. At Lake Mokoan, the wetland floor is a very extensive area, as implied by the rating curve of water area for different water levels (Figure 1), plotted from data tabulated in Souter & Lewin (1999). The former natural sill controlling water regime in the wetlands was at 161.14 m AHD (David Pasztaleniec, DSE pers. comm.,) not 161.5 as given

in SKM (2006) which means that the three largest basins within Lake Mokoan had an estimated combined area of approximately 2800 ha when full (Figure 1). On 11th March 2008, at the time of the field work reported here, the water level was at 160.93 m AHD, giving a combined area of approximately 2500 ha for Sargents, Winton and Green Swamps[1].

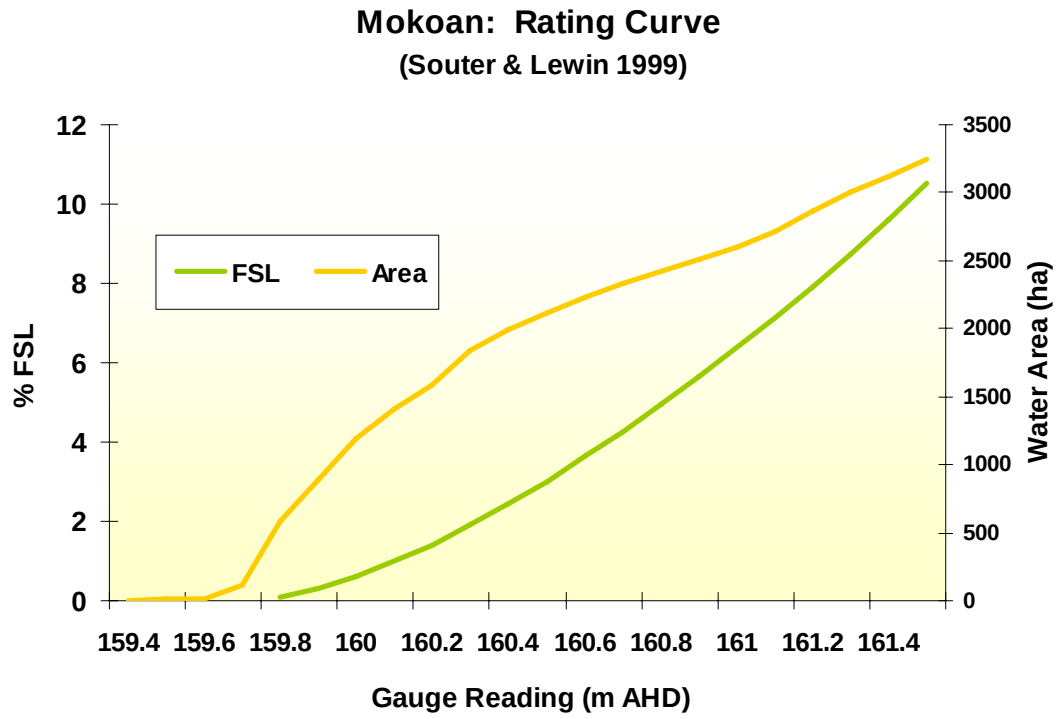

Figure 1: Rating Curve for Lake Mokoan

The rating curve is for Lake Mokoan as a storage so does not partition area remaining between the three wetlands, Sargents, Winton and Green Swamps. Data sourced from Souter & Lewin (1999).

Recommendations on future water regime, Task [b], is addressed in a separate report (Roberts et al. 2008) that considers natural regeneration around the three largest wetlands at Lake Mokoan, as of March 2008.

A description of the provisional targets, the scope of the monitoring program, and a description of other factors forcing changes to the implementation of MP_1 are given below.

[1] **Sargents, Winton and Green Swamps:** These names are revised from Winton West, Winton Central and Green Swamp, following advice from David Pasztaleniec and David Jeffrey (DSE). Note that the names Winton West and Winton Central are used in Roberts and Hale (2007).

Monitoring Program MP_1: Wetland Floor

This section summarises the key characteristics of the Monitoring Program for Wetland Floor (MP_1) as it was originally designed, then outlines the refinements made in March 2008, and finally presents the circumstances that constrained its full implementation.

MP_1 as designed

The key features of MP_1 are that it:

- records abundance as frequency, from 100 evenly-spaced points along a 100 or 200 m long transect, and has 6 or 8 transects per wetland, with transect length and number of transects varying depending on wetland size, whether small (less than 100 ha) or large; the outcome is 600 or 800 data for a wetland;
- focuses on indicator species rather than recording conventional full floristics: the two indicator species suggested, Southern Cane Grass *Eragrostis infecunda* and River Red Gum *Eucalyptus camaldulensis*, were chosen because they are the dominant species in several EVCs likely to have occurred at Winton Wetlands, so were suggested as provisional targets;
- refers specifically to the wetland floor, meaning the relatively flat central area within a wetland. According to the available DEM, for Sargents and for Green Swamp, this lies between 160.0-160.5 m AHD, and for Winton Swamp it lies below 160.0 m AHD;
- uses quality wetlands within the same bioregion (Victorian Riverina) to quantitatively define targets;
- is modelled on work done in the Barmah Forest (Reid and Quin 2004) where the sampling unit was the wetland, with 600 points per wetland;
- is designed to be relatively quick in the field, with the time required expected to be in the order of 2 hours to do six transects in a small wetland;
- was intended to be used on nine wetlands.

A full description of MP_1 is in Appendix 1, taken from Roberts & Hale (2007).

MP_1 as implemented in March 2008

Point frequency data: The original MP_1 recorded what species was present (if any) at a single point spaced 1 m apart along a 100 m transect, giving 100 data points per transect. However, after considering the growth form of one of the target species, Southern Cane Grass, the data collection protocol was modified. It seemed possible that recording frequency based on occurrence at a single point for plant species with a strongly vertical growth habit, such as Southern Cane Grass with its erect stems and narrow leaves, could return data that under-estimated species presence relative to any broad or flat-leaved species present.

Accordingly, the protocol was modified to refer to a small area, not just a single point, whilst retaining the use of frequency as an estimate of abundance suitable for rapid data collection when full floristic are not required. Under the revised design, all species present in or overhanging a small quadrat (25 x 25 cm), placed every 10 m along a 200 m long transect are recorded. The spacing interval was increased from 1 m to 10 m as a trade-off against time required for reading a quadrat, even a small one.

> **Revision #1:** Under the revised protocol, transect length was set at 200 m, a small (25 x 25 cm) quadrat was located beside the tape at 0, 10 m, 20 m etc to 200 m (i.e. 21 times per transect) and all species occurring in or overhanging the quadrat were recorded as present. As well as recording the occurrence of plant species, the occurrence of bare ground, standing dead plants, litter (plant material no longer standing or attached to an underground part), rock, logs, moss and lichens was also recorded.

Fixed Transect: The original MP_1 planned to use a fixed transect, to be re-sampled through time. On consideration, it was decided that the use of a fixed transect with a purpose-specific permanent marker carried risks of vandalism and therefore of data discontinuity should a transect position not be successfully re-located. The northern shoreline of Lake Mokoan is currently unfenced, close to a road, and open to the public, so has little protection against vandalism.

Accordingly, a slightly different approach was adopted that closely follows the original outlined in MP_1 but without the need to be precisely repeating the transect. It uses repeat sampling along the same orientation and for the same fixed distance from within a prescribed but small area, and does not use purpose-specific markers. Instead it uses conspicuous and large existing features as markers, but records their co-ordinates as a back-up.

> **Revision #2:** Wherever possible, the Marker is a natural feature, already on-site. The co-ordinates of the Marker are recorded and a photograph taken as a back-up field guide. The Start of each transect is within 20 m of the Marker, but on the same contour. The transect runs for 200 m on a compass bearing. Quadrats are placed beside the tape at 0 m, 10 m, 20 m etc to 200 m, giving 21 quadrats per transect.

Scope and number of wetlands: MP_1 was intended to be applied to all the wetlands that had been inundated by Lake Mokoan. However, the brief issued by Goulburn Broken CMA contained a Guiding Principle that required the monitoring effort to be scaled down to meet the allocated budget. The options were either three large wetlands (Winton, Sargents and Green Swamps) including the target area, or six smaller ones over 4 days.

> **Revision #3:** It was agreed with Goulburn Broken CMA that MP_1 would be set up for the three large wetlands, and would include also Moodie's Swamp as a reference site for Southern Cane Grass, one of two indicator species recognised in MP_1, and the

dominant species in the two EVCs suggested as preliminary targets for Sargents and Winton Swamps (Roberts and Hale 2007). The decision to focus on the three large basins and do a reference site at Moodie's Swamp gives a certain emphasis to Southern Cane Grass.

Constraints on Implementation

MP_1 is designed specifically for the floor of the wetland meaning the flattish central area (Figure 2), distinct from the wetland Edge. In March 2008, it was possible to set up Markers and record quadrats along transects at the reference site (Moodie's Swamp) which was completely dry, with cracking soils that were almost crab-holes. By chance, the reference site was visited first, on 10th March 2008. However, continuing MP_1 at the three largest wetlands (which had been the intent) was problematic.

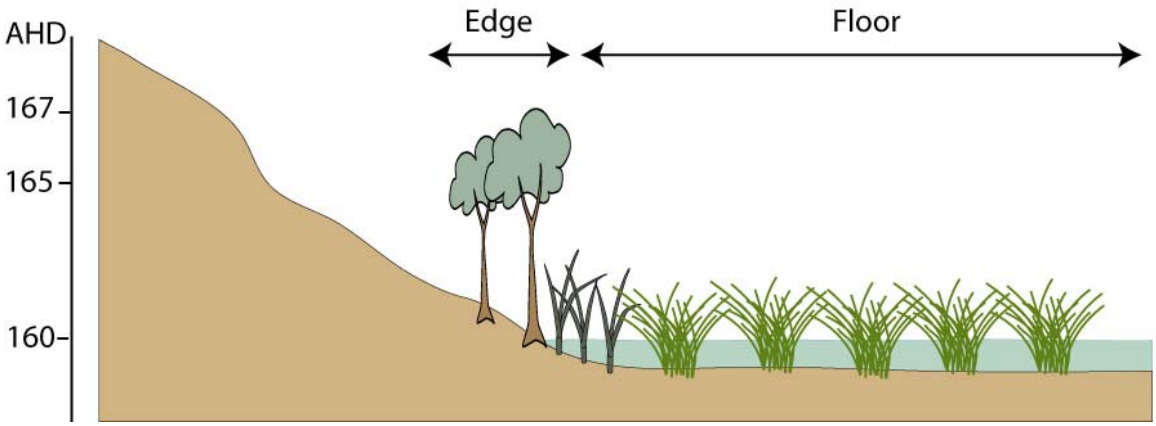

Figure 2: Wetland Edge and Wetland Floor
The Edge and the Floor of a wetland, such as Winton Swamp

There were two constraints. First, water levels in Mokoan storage were higher than anticipated for implementing MP_1. The gauge reading at the Outfall Channel of Lake Mokoan was 160.93 m AHD on 11th March 2008. Thus the probable water depths, as derived from rating curves (Figure 1) and using contours modelled by DEM, over the wetland floors in March 2008 were 0.5-1.0 m water for Sargents and for Green Swamps, and more than 1 m water for Winton Swamp. Such depths are not impossible to survey on foot, but such work is inevitably very slow. Second, there were several places where the sediments at and below the water line were very soft due to being unconsolidated, and apparently deep, making them difficult, if not slightly dangerous, to walk through. The field team found that the maximum depth of soft sediment that could be

trudged through, slowly and laboriously, was about 30 cm and in some places the sediment appeared to be even deeper. In addition to these two constraints, there was no evidence of any wetland plants in the shallow waters or close to the waterline: these areas were completely lacking wetland plants (see cover). It was clear that setting up transects across the wetland floor in accordance with MP_1 would be time-consuming, unproductive and slightly hazardous.

Figure 3: Zonation on lower slopes

Strong zonation patterns, with abrupt shifts in species composition and height are common around Lake Mokoan. Above: northern shore of Green Swamp has a dense 2 m tall band of Aster-weed *Aster subulatus*, behind with an equally dense 30-50 cm tall grassland dominated by Blown Grass *Lachagrostis filiformis*. Below: northern shore of Winton Swamp has a very short dense herbland grading into bare soil with scattered seedlings becoming absent closer to the water line.

Accordingly, another monitoring program was rapidly scoped and substituted in, for immediate implementation, using the resources to hand such as equipment and data sheets. This focused on the vegetation developing on the wetland edge (Figure 2), meaning above the water line of March 2008. This area is currently

being colonised and is showing quite strong zonation patterns with extensive bare areas close to the water line (Figure 3).

> **Revision #4:** In lieu of sampling the wetland floor as under MP_1, a number of transects were established to monitor the vegetation developing above the waterline, in the area referred to as the wetland edge.

Henceforward, this monitoring set up is referred to as MP_WE for Monitoring Program for the Wetland Edge.

The Approach to MP_WE: Wetland Edge

Approach: The ideal monitoring design is one that is structured to test specific hypotheses and compares test sites with controls or targets. Due to logistics, scientific and resource reasons (below), it was not possible to develop a design to this deal. Accordingly a simple monitoring program was developed that would give relevant feedback to management over the next few years on the progress and success of a passive approach to restoring the Winton wetlands at Lake Mokoan. This feedback is in the form of a series of questions as follows (with relevant variables in brackets):

are plants establishing around Lake Mokoan ? (*vegetated cover, bare area*)

are the plants that are establishing part of the regional flora and consistent with EVC targets ? (*floristics, nativeness, presence & abundance of target species*)

what are the ecological characteristics of the species that are establishing ? (*dispersal mode, life-span ie short- versus long-lived species, functional types*)

The focus here is the development of littoral vegetation around the wetland Edge. This is a topic that is not much researched, and is an area for which there are few specific benchmarks (so setting targets is not feasible using EVCs). As a habitat for colonising and establishing plants, this is an area that is dynamic with changing conditions due to water level management, and steep ecological gradients: the result is the strong zonation patterns already evident around Lake Mokoan. However although there is just one water regime for Lake Mokoan, multiple zonation patterns are evident, probably due to other factors such as slope, substrate, disturbance history and aspect. All these are known to influence species composition and growth, in general terms, but not specifically enough to make predictions and formulate testable hypotheses, at least not without a substantial literature review and prior knowledge of the environment around Lake Mokoan, and the species involved. As MP_WE was developed in the field, on arrival at Lake Mokoan, this degree of preparation was not feasible: nor was it possible to locate control and/or reference sites in equivalent wetlands.

Thus the design as implemented is a basic one of tracking changes through time with spatial replication. The sampling unit is a transect, comprising separated (ie independent) small quadrats at regular intervals down the elevation gradient, with the transect to be re-sampled through time. Ideally, the transects should be ecologically standardised in some way to ensure they sample equivalent ecological units (ie by starting and finishing at the same elevation) but this was difficult to implement without pre-planning.

Purpose: The purpose of MP_WE is to track the development of vegetation in the wetland Edge through time: and to provide information that will guide restoration efforts and intensity.

Outline: The sampling unit is a transect, aligned vertically downslope, from amongst the terrestrial vegetation into the water. The intent was to cover wetland Edge and some wetland Floor, extending 50 m beyond the waterline. Sampling is to be repeated annually, using the same transects. Currently there are no targets for wetland Edge.

The underlying assumption is that plant species will colonise the bare areas, and that as water levels are progressively drawn down even further, that this colonisation process will continue. The expectation, based on logic and as demonstrated by analyses in Roberts and Hale (2007), is that through time the colonising species will be dominated by terrestrial species. The ecological questions are: what species will colonise, over what sort of time-frame, how uniform this process is around the major wetlands, and whether this vegetation will begin to look like wetland Edge from other wetlands in the bio-region.

Time: MP_1 and MP-WE are deliberately designed to reduce time in the field, so do not rely on full floristic survey and species-abundance based on cover. The time estimated per transect was in the order of 30-60 minutes, depending on transect length.

However, time available was certainly an issue in March 2008, due to the near complete lack of background information on access, site descriptions and up to date aerial photography to help navigation and on-ground orientation. The photography available was flown in 2004, when all the areas investigated as part of MP_WE were completely underwater.

Access & Site Familiarity: The number of transects that could be set up was restricted by time, lack of familiarity with the site, and background material.

Access: The northern shore of Sargents and Winton Swamp is unfenced and open to the public, so is readily accessible. Accessing the rest of the area requires obtaining a key from Goulburn Murray Water and then making use of a

(unmapped) formed roads or else travelling across paddocks that have been exposed for varying times. Off road travel is not feasible everywhere, and was not advisable after rain or through long grass, given the possibility of driving over buried pickets, bottle dumps and wire. Walking in from an access road, such as the road running along the embankment, is currently the only way to access the southern shorelines of Sargents and Winton Swamps.

Hence, the distribution of transects was heavily influenced by proximity to a serviceable road.

Disturbance: Some significant signs of disturbance by humans around the lake were: old camp sites and fireplaces, typically characterised by bottles and/or broken glass, of two distinct vintages (since commissioning and prior to commissioning Lake Mokoan); rubbish dumps and abandoned trash, some of very recent origin (e.g. while the survey team was working), occurring most notably on the northern side of the lake; remains of a bush saw-log enterprise that would have preceded the commissioning of Lake Mokoan; signs of past farming activities such as iron tanks, fences and farm dams; former roads and easements.

[2] Benchmarking, March 2008

MP_1: Wetland Floor

[a] Setting up Markers & Transects

- MONITORING WETLANDS

Achievement: No transects were set up at Sargents, Winton or Green Swamps: see section 1, Constraints on Implementation.

Conditions: Water levels were higher than expected, and precluded access to the wetland Floor. The weather was very hot, with maxima exceeding 35°C.

Markers: *not applicable*

Transects: *not applicable*

- TARGET WETLAND FOR SOUTHERN CANE GRASS

Achievement: Six transects were set up and read at Moodie's Swamp.

Date: 10th March 2008.

Conditions: Moodie's Swamp was completely dry, when visited; soils were crumbling and cracking. The vegetation was a medium tall (75–100 cm) grassland, dominated by Southern Cane Grass *Eragrostis infecunda*; weeds and annuals appeared to dominate some parts, due mainly to their height (up to 1 m). Cover was not uniform across Moodie's, with small pockets with no cane grass.

Markers: Markers indicate where to start each transect, and are valid for the life-span of the monitoring program. Markers were chosen to be relatively conspicuous or distinctive. Most of the Markers at Moodie's are dead trees, on the swamp-side of the fringe of trees, at the base of the sloping wetland edge. Markers are coded MD_1 through to MD_6.

A Guide to Markers is available in Appendix 2. This has a map showing marker locations, and a tabulation of marker details such as a photograph, description and co-ordinates.

Transects: Transects were positioned so that the start (0 m mark on the tape) was at the transition point between wetland edge and wetland floor, and within 20 m of the Marker and on the same contour or elevation. The transition point is conspicuous at Moodie's Swamp by the change in slope, and by the change in soils, from red and sandy to cracking organic clays. Each transect was 200 m

long, angled at right angles to edge of the swamp and oriented towards the centre of the wetland.

A Documentation of Transects is available in Appendix 2. This has a map showing the location and general orientation (towards the centre) of six transects sampled in March 2008, a table giving details such as bearing, co-ordinates and length of transect.

Data: Occurrence of all live plants within or overhanging a 25 x 25 cm quadrat was recorded at 10 m intervals along each 200 m transect, resulting in 21 quadrats per transect, and 126 quadrats for Moodie's Swamp. Variables recorded as well as species were: standing dead plants, litter, log, bare earth, mosses. All transects started on higher ground, thus giving some ecological consistency between quadrat numbers, with Q0 being relatively higher and always on transitional soils, and Q21 being furtherest into the wetland.

Presentation & Interpretation: Results are discussed under five headings: Species Characteristics, Transect Composition, Vegetatedness, Species-Abundance Patterns and Target Species. These are explained below.

Species characteristics: The characteristics of all species recorded in a wetland site are discussed using five attributes (below). Note that these are essentially the same as were used to explore the vegetation that had already self-established around Lake Mokoan (Roberts and Hale 2007), and uses the same information base developed for that project.

[a] floristics: species present

[b] nativeness: whether species or taxa are native to Victoria or not

[c] dispersal: what the primary means of dispersal is, whether wind, water, gravity or animal vector: note that this is the primary means, not the sole means.

[d] Plant Functional Types (PFT_RES) based on growth-form and resource strategies: a three-part code where the first letter refers to the life form (H = herb, S = Sedge, G = grass), the second letter describes its habit (E = erect, D = decumbent, P = prostrate), and the third letter refers to its life-span (A = annual or very short-lived, B = biennial, P = perennial).

[e] Plant Functional Types (PFT_WR) based on response to water regime: The three primary types are Terrestrial for plants that do not tolerate flooding, Amphibious for plants that tolerate flooding and drying, and Submerged for plants that do not tolerate drying. Terrestrial can be sub-divided into T_dry for plants on dry ground and T-damp for plants found on moist ground; Amphibious can be sub-divided into ATe for fluctuation-tolerators that are emergent, ATl for fluctuation-tolerators that are low-growing, ARp for plants that are fluctuation-responders, with plastic response and ARf for fluctuation responders that are floating.

Transect Composition: Transect composition is the number of quadrats where each species or environmental variable is recorded, expressed as a percentage of the maximum number of quadrats.

Vegetatedness: Two attributes are calculated; ***completely bare***, being the percentage of quadrats per transect where no plants are recorded, and ***vegetated***, being the percentage of quadrats per transect where there are no records of bare ground.

Species-Abundance Patterns: The number of species per abundance category. The five abundance categories are 1-20% of quadrats, 21-40% of quadrats, 41-60% of quadrats, 61-80% of quadrats and 81-100% of quadrats per transect. This draws on information calculated for Transect Composition.

Target Species: Draws out points on target species, where possible.

[b] Results from March 2008

- Reference Wetland for Cane Grass

Species Characteristics: A total of 22 taxa were recorded from Moodie's Swamp (Table 2), from 8 families. Asteraceae and Poaceae are the most species rich families with 10 and 5 taxa respectively. A full species list showing all species recorded is given in Appendix 4.

Most of the species are introduced (13 out of 22), and most of these are in the families Asteraceae and Poaceae. Wind is the primary means of dispersal (10 species) followed by water (6 species).

In terms of plant functional types, the species are mostly herbs and grasses, with just one sedge (indicated by the pre-fix H, G and S), are nearly all erect (indicated by the middle letter E), and live longer than one year (indicated by P and B). The majority of these species are Terrestrial (T_damp and T_dry) with only two species (*Eleocharis acuta*, *Amphibromus nervosus*) are considered to be linked to water regime. Note that under the system of PFT developed by Brock and Casanova (1997), Southern Cane Grass is recognised as a terrestrial species (T_damp).

Table 2: Characteristics of Species Recorded from Moodie's Swamp

Species characteristics considered here are nativeness (N), primary means of seed dispersal, functional type based on resource acquisition and growth form, and functional type in response to water regime, based on Brock and Casanova (1997). Under nativeness (N), N = native and X = introduced. Under Primary Dispersal (PD), WD = wind, WT = water, GR = gravity, AV = animal vector.

Family	Genus & Species	N	PD	PFT_RES	PFT_WR
Asteraeae	*Aster subulatus*	X	Wind	HEA	T_damp
	Centipeda cunninghamii	N	Water	HEP	T_damp
	Cirsium vulgare	X	Water	HEB	T_dry
	Euchiton sphaericus	N	Wind	HEA	T_dry
	Hypochaeris radicata	X	Wind	HEP	T_dry
	Lactuca saligna	X	Wind	HEB	T_dry
	Lactuca serriola	X	Wind	HEB	T_dry
	Scorzonera laciniata	X	Wind	HEB	T_dry
	Sonchus asper	X	Wind	HEB	T_dry
	Sonchus sp. seedling	X			
Cyperaceae	*Eleocharis acuta*	N	Water	SEP	AT e
Gentianaceae	*Centaurium erythraea*	X	Gravity	HEB	T_dry
Juncaceae	*Juncus sp. seedling*				
Lythraceae	*Lythrum hyssopifolia*	N	Water	HAD	T_damp
Onagraceae	*Epilobium billardieria*	N	Wind	HEP	T_damp
Poaceae	*Amphibromus nervosus*	N	A vector	GEP	AT e
	Avena barbata	X	A vector	GEP	T_dry
	Eragrostis infecunda	N	Water	GEP	T_damp
	Lachnagrostis filiformis	X	Wind	GEA	T_damp
	Phalaris aquatica	X	Wind	GEP	T_damp
Polygonaceae	*Polygonum aviculare*	X	Water	HAD	T_dry
	Rumex crispus	X	A vector	HEP	T_damp

Transect Composition: The number of species per transect ranged from 2 to 13. Southern Cane Grass *Eragrostis infecunda* was the most frequently occurring species in each of the six transects, occurring in 81-95.5% of quadrats per transect. Standing dead plant material and litter were recorded nearly as frequently as Southern Cane Grass (76.2 to 95.2% and 85.7 to 100% respectively), indicating some accumulation of organic material at this site.

Vegetatedness: None of the transects had any quadrats that were completely bare (Table 3); all six transects had a high degree of vegetatedness, with 81-100% of quadrats showing no bare ground.

Table 3: Vegetatedness of 6 individual transects

Transect	Max number of Quadrats	Bare Quadrats	Vegetated Quadrats
MD_1	21	0	18
MD_2	21	0	17
MD_3	21	0	19
MD_4	21	0	20
MD_5	21	0	18
MD_6	21	0	21

Species-Abundance Patterns: The six transects had a similar pattern in species abundance, with just one species (Southern Cane Grass) being very frequent. The majority of species occurred infrequently, with 81-100% of quadrats in a transect having only one species (Figure 4); only a few quadrats per transect had 4 or more species.

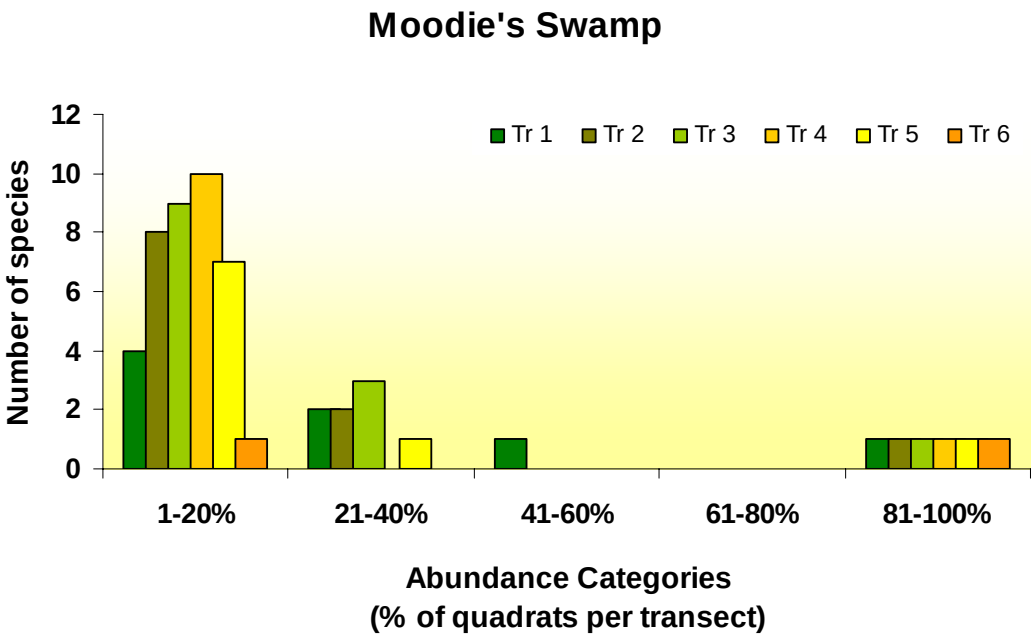

Figure 4: Species-Abundance patterns at the reference site for Southern Cane Grass
Transects are plotted left to right in numerical order.

Target Species: Southern Cane Grass *Eragrostis infecunda* is provisionally recognised as the target species for Sargents and Winton Swamps. The data

presented above (Figure 4) and the information on the abundance of standing dead material and litter will be useful as quantitative targets for a mature and established stand of Southern Cane Grass in a prolonged dry phase in the restoration of Sargents and Winton Swamps.

MP_WE: Wetland Edge

[a] Setting up Markers & Transects

- MONITORING WETLANDS

Achievement: Eight transects were established around Winton Swamp, and seven transects around Green Swamp. Transects were sited so as to cover most of the likely sources of environmental variation, as best could be determined, but ultimately were largely determined by access.

No transects were set up around Sargents Swamp, due to lack of time.

Date: Transects were established on 11-13th March 2008 and 28th March 2008.

Conditions: Water levels were being drawn down through March. The gauge at the Lake Mokoan Outfall Channel was 160.93 m AHD on 11th March 2008, and had fallen to 160.78 m AHD by 27th March 2008.

Most sites showed strong zonation patterns (Figure 3), which were assumed to be driven primarily by recent water level history. None of the sites was subject to grazing by domestic stock. A few sheep were seen near the access gate leading in to Green Swamp but appeared to be having little effect on shoreline vegetation which showed no obvious signs of grazing pressure and no hoofprints. Only a few kangaroos were seen and these were all on the southern side, well-away from the shoreline.

Markers: Markers indicate the general location of where to start each transect, and are valid for the life-span of the monitoring program. As far as possible, markers were chosen to be relatively conspicuous or distinctive. Most of the markers used in MP_WE are dead trees, distinctive stumps or fenceposts. Markers are coded WS_1 to WS_8 for Winton Swamp, and GS_1 to GS_7 for Green Swamp.

A Guide to Markers is available in Appendix 3. The Guide has a map showing marker locations, and a tabulation of marker details such as a photograph, description and co-ordinates, to help re-find Markers and to help setting up transects in the future.

Transects: Transects were positioned so that the start (0 m on the 100-m tape) was within 20 m of the Marker and on the same contour or elevation. Transects ran downslope towards the centre of the wetland, to the waterline then continued for another 50 m (estimated) into the water where this was feasible (i.e. only if sediments were relatively firm and not too deep). Transect length, measured using transect start-end co-ordinates in a GIS, ranged from 63 to 535 m. Transect length was influenced by slope of the shoreline and the position of the Marker. Transects were coded to correspond to their respective markers, i.e. WS_1 to WS_8, and GS_1 to GS_7.

A Documentation of Transects, available in Appendix 3, includes a map showing transect location and general orientation (towards the wetland centre) of all fifteen transects in March 2008, and a tabulation of details such as bearing, co-ordinates (of Start and End points), elevation in m AHD (where known), sampling interval and number of quadrats for that transect.

Transect elevation (start and end) was obtained by plotting transect co-ordinates in a GIS and overlaying with the updated DEM layer developed as part of earlier work (Roberts and Hale 2007). The data sheet used was the same as for MP_1 and a copy is included here.

Note that, unlike MP_1 where transects had very similar positions and were of similar length, transects in MP_WE are not in similar positions and do vary in length, so are not replicates of each other and are not directly comparable.

Data: Occurrence of all live plants within or overhanging a 25 x 25 cm quadrat was recorded along each transect, at regular intervals that varied from 5 to 10 and even 20 m, according to transect length. The number of quadrats per transect ranged from 14 to 52. In addition to species presence-absence, other variables were recorded, namely standing dead plants, litter, log, bare earth, mosses.

Presentation & Interpretation: As with MP_1, results are discussed under five headings: Species Characteristics, Transect Composition, Vegetatedness, Species-Abundance Patterns and Target Species.

Species characteristics: The characteristics of all species recorded in a wetland site are discussed using five attributes (below). Note that these are essentially the same as were used to explore the vegetation that had already self-established around Lake Mokoan (Roberts and Hale 2007), and uses the same information base developed for that project.

[a] floristics: species present

[b] nativeness: whether species or taxa are native to Victoria or not

[c] dispersal: what the primary means of dispersal is, whether wind, water, gravity or animal vector: note that this is the primary, not the sole, means.

[d] Plant Functional Types (PFT_RES) based on growth-form and resource strategies: a three-part code where the first letter refers to the life form (H = herb, S = Sedge, G = grass), the second letter describes its habit (E = erect, D = decumbent, P = prostrate), and the third letter refers to its life-span (A = annual or very short-lived, B = biennial, P = perennial).

[e] Plant Functional Types (PFT_WR) based on response to water regime: The three primary types are Terrestrial for plants that do not tolerate flooding, Amphibious for plants that tolerate flooding and drying, and Submerged for plants that do not tolerate drying. Terrestrial can be sub-divided into T_dry for plants on dry ground and T-damp for plants found on moist ground; Amphibious can be sub-divided into ATe for fluctuation-tolerators that are emergent, ATl for fluctuation-tolerators that are low-growing, ARp for plants that are fluctuation-responders, with plastic response and ARf for fluctuation responders that are floating.

Transect Composition: Transect composition is the number of quadrats where each species or environmental variable is recorded, expressed as a percentage of the maximum number of quadrats.

Vegetatedness: Two attributes are calculated; ***completely bare***, being the percentage of quadrats per transect where no plants are recorded, and ***vegetated***, being the percentage of quadrats per transect where there are no records of bare ground.

Species-Abundance Patterns: The number of species per abundance category. The five abundance categories are 1-20% of quadrats, 21-40% of quadrats, 41-60% of quadrats, 61-80% of quadrats and 81-100% of quadrats per transect. This draws on information calculated for Transect Composition.

Target Species: Draws out points on target species, where possible.

[b] Results from March 2008

Species Characteristics: A total of 37 taxa were recorded from the 8 transects set up around Winton Swamp and the 7 from around Green Swamp (Table 4), and the same species were recorded from both wetlands. A complete list of all species recoded in transects in March 2008 is given in Appendix 4.

Just over half of these (23 out of 37) were native species. The two most species-rich families were Asteraceae with 10 taxa (mostly introduced), and Poaceae with 13 taxa (mostly native). There is a notable lack of species in the family Cyperaceae such as *Carex*, *Cyperus* and *Eleocharis,* such species are common in and around wetlands in this bio-region. Water is the primary means of dispersal for 14 species, and wind for 9 species.

Table 4: Species Characteristics for Edge quadrats from Winton & Green Swamps

Species characteristics considered here are nativeness (N), primary means of seed dispersal, functional type based on resource acquisition and growth form, and functional type in response to water regime, based on Brock and Casanova (1997). Under nativeness (N), N = native and X = exotic. Under Primary Dispersal (PD), WD = wind, WT = water, GR = gravity, AV = animal vector.

Family	Genus & Species	WS	GS	N	PD	PFT_RES	PFT_WR
Amaranthaceae	*Alternanthera denticulata*	√	√	N	WT	HDA	AR p
Asteraceae	*Aster subulatus*	√	√	X	WD	HEA	T_damp
	Centipeda cunninghamii	√	√	N	WT	HEP	T_damp
	Centipeda minima	√	√	N	WT	HPA	T_damp
	Cirsium vulgare	√	√	X	WT	HEB	T_dry
	Conyza bonariensis	√	√	X	WT	HEA	T_dry
	Dittrichia graveolens	√	√	X	WD	HEA	T_dry
	Helminthotheca echioides	√	√	X	WD	HEB	T_dry
	Hypochaeris radicata	√	√	X	WD	HEP	T_dry
	Pseudognaphalium luteo-album	√	√	N	WD	HEB	T_dry
	Senecio quadridentata	√	√	N	WD	HEP	T_dry
Brassicaceae	*Rorippa palustris*	√	√	X	WR	HEB	T_damp
Caryophyllaceae	*Stellaria caespitosa*	√	√	N		HDB	T_damp
Chenopodiaceae	*Chenopodium pumilio*	√	√	N	WT	HPA	T_dry
	Dysphania glomulifera	√	√	N	AV	HPA	T_damp
Fabaceae	*Trifolium angustifolium*	√	√	X	AV	HEA	T_dry
	Trifolium sp. seedling	√	√	X			
Juncaceae	*Juncus semisolidus*	√	√	N	WT	SEP	AT e
	Juncus sp. (seedling)	√	√				
Lythraceae	*Lythrum hyssopifolia*	√	√	N	WT	HDA	T_damp
Molluginaceae	*Glinus lotoides*	√	√	N	WT	HPA	T_damp
Poaceae	*Austrodanthonia setaceae*	√	√	N	AV	GEP	T_dry
	Chloris truncata	√	√	N	WD	GEP	T_dry
	Cynodon dactylon	√	√	N	AV	GDP	T_dry
	Digitaria divaricatissima	√	√	N			
	Enteropogon sp.	√	√				
	Eragrostis infecunda	√	√	N	WT	GEP	T_damp
	Eragrostis parviflora	√	√	N	GR	GEA	T_dry
	Lachnagrostis filiformis	√	√	N	WD	GEA	T_damp
	Lolium sp.	√	√	X	GR	GEA	T_dry
	Panicum decompositum	√	√	N		GEP	T_damp
	Paspalum distichum	√	√	X	AV	GDP	AR p
	Pseudoraphis spinescens	√	√	N	AV	GDP	AR p
	Walwhalleya proluta	√	√	N	WD	GEP	T_dry
Polygonaceae	*Persicaria lapathifolia*	√	√	N	WT	HEB	T_damp
	Persicaria prostrata	√	√	N	WT	HPP	T_damp
	Polygonum aviculare	√	√	X	WT	HDA	T_dry

In terms of Plant Functional Types (PFT_RES), almost all the species were herbs or grasses (as indicated by the first letter in the tri-letter code being H or G). Most had an erect form, although several were either decumbent or prostrate (indicated by the middle letter being D or P), a habit that was noticeably absent from the wetland floor at Moodie's Swamp. In terms of life-span, there were no strong trends with almost equal numbers of annual as perennial species (14 and 13 respectively).

In relation to the Plant Functional Types and response to water regime (PFT_WR), the majority of species were Terrestrial, with 16 T_dry and 13 T_damp species. Only four species were Amphibious, and of these three were AR p, re-enforcing the contrast with forms at Moodie's Swamp. None were Submerged.

Transect Composition: Species per transect ranged from 6 to 20 for Winton Swamp, and 5 to 15 for Green Swamp. Unlike at Moodie's Swamp, no single species dominated the transects. This is attributed to these transects crossing several vegetation zones whereas at Moodie's Swamp all transects are within a zone. In both wetlands, the most frequently occurring species was *Lachnagrostis filiformis.* Species such as *Aster subulatus, Chenopodium pumilio*, *Centipeda cunninghamii*, *Cynodon dactylon, Dittrichia graveolens*, *Juncus semisolidus* and *Stellaria caespitosa* all occurred frequently but only within a few transects.

Standing dead material and litter were quite variable, but consistently less than at Moodie's Swamp (Appendix 5).

Vegetatedness: Water levels in Lake Mokoan storage have been falling, exposing sediments that were previously submerged. Close to the water line, these recently exposed areas were completely bare in March 2008; a little higher up, very small seedlings were noted (generally recorded as unidentified Dicot or Monocot); above this was a dense very short (less than 10 cm tall) herbland, typically with *Dysphania glomulifera*, *Chenopodium pumilio*, *Rorippa palustris* and *Centipeda cunninghamii*.

The percentage of quadrats that were completely bare varied enormously between transects (Table 5), and this is attributed to differences in elevation range, topography and slope.

Although most of the completely bare quadrats were close to the water line, a few did occur further upslope (not shown). Completely bare quadrats dominated most of the transects, accounting for 21-100% of quadrats, but falling to just 4% on one transect at Winton Swamp (WS_4). Conversely, completely vegetated quadrats were relatively unimportant, accounting for 0 to 29% of quadrats in a transect, except for WS_4 where 70% of quadrats were vegetated (Table 5).

The reason WS-4 was so different was due to its length, morphology (a series of sandy rises, presumably former beach deposits, and swales), its longer sampling interval (20 m was used), a relatively short beach, and the presence of an 140-m wide band of dense rushland dominated by *Juncus semisolidus* (Figure 5).

The distinctiveness of WS_4 arises from a combination of factors and is a reminder that the 15 transects in MP_WE are not ecologically standardised as they are in MP_1.

Table 5: Vegetatedness of 15 individual transects

Transect	Max number of Quadrats	Bare Quadrats (%)	Vegetated Quadrats (%)
WC_1	14	71	7
WC_2	15	47	20
WC_3	21	67	5
WC-4	23	4	70
WC_5	52	46	2
WC_6	26	38	8
WC_7	34	41	6
WC_8	39	100	0
GS_1	21	48	19
GS_2	41	66	0
GS_3	27	22	7
GS_4	26	54	12
GS_5	23	78	13
GS_6	29	55	0
GS_7	28	21	29

Figure 5: Distinctive features of Transect WS_4

Left: The transect went through 140 m of Plains Rush *Juncus semisolidus* with a dense understorey of Blown Grass *Lachnagrostis filfiformis*. Right: The transect terminated just at the waterline due to soft deep muds which made walking further out into the water difficult.

Species-Abundance Patterns: Plots of species-abundance emphasise points already made that there is no single dominant species in these Edge transects, and hence transects are composed of a number of species none of which is abundant overall (Figure 6).

Target Species: Currently there are no target species for Wetland Edge. Southern Cane Grass *Eragrostis infecunda*, one of the two target species for Wetland Floor, occurred in Edge transects but very infrequently. It was recorded in just two Edge transects around Winton Swamp (WS_5, and WS_6, in just one and 2 quadrats respectively), and in one Edge transect around Green Swamp (GS_1, in just one quadrat. Seedlings and juveniles (ie trees less than 1.3 m) of River Red Gum *Eucalypts camaldulensis*, the other target species for Wetland Floor, were not recorded in any Edge transects.

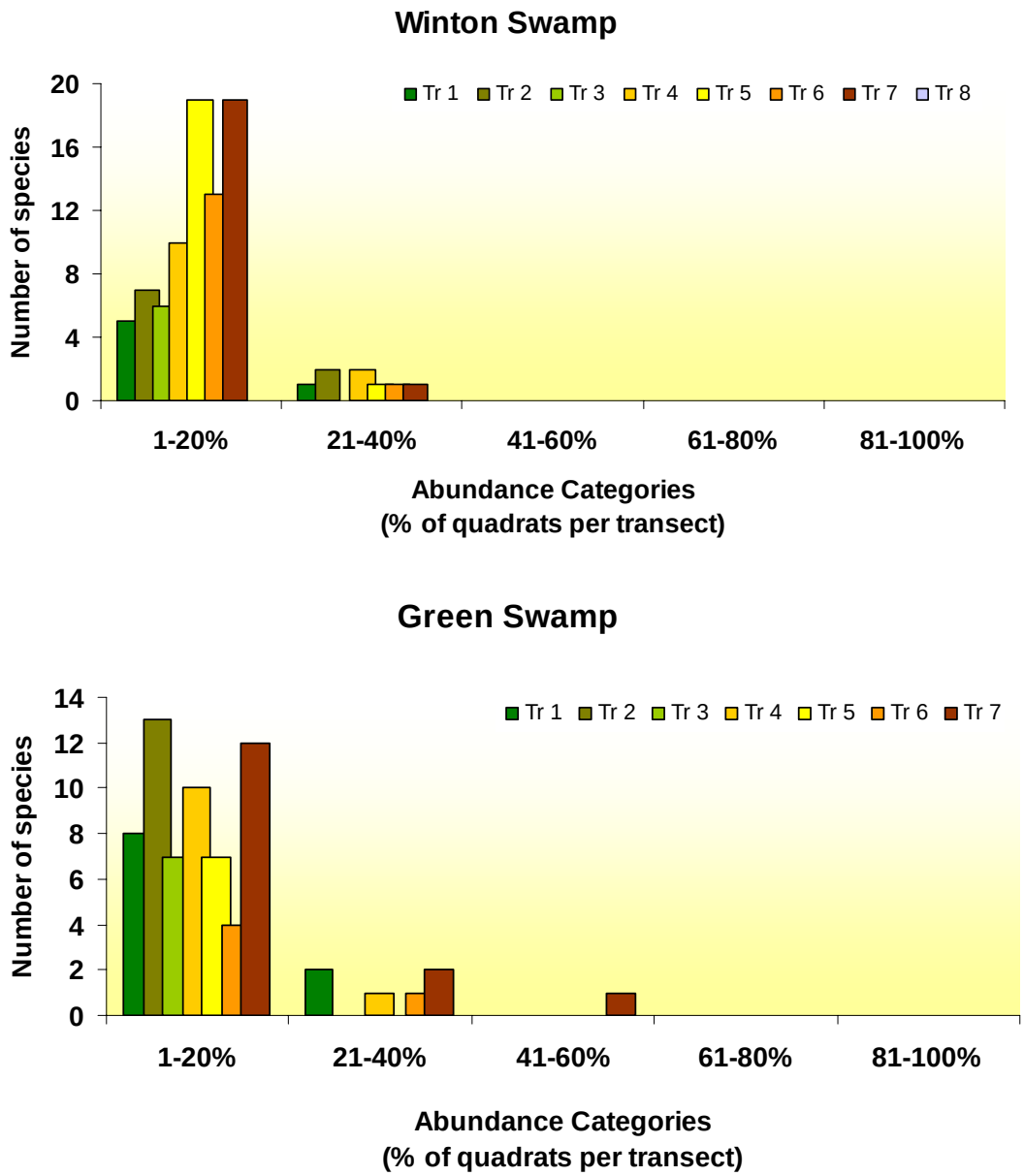

Figure 6: Species-Abundance patters at Winton and Green Swamps

Number of species per abundance category for eight transects at Winton Swamp (the eighth is completely bare and so does not appear in the chart) and for seven transects at Green Swamp in March 2008. Transect 8 for Winton Swamp was completely bare, ie 100% of transects had 0 species, so does not show on this plot.

[3] Assessment

MP_1: Wetland Floor

The following points arise from experience in setting up MP_1 and the direct field experience that this provided.

- As had been anticipated (Roberts & Hale 2007), no regeneration was noticed occurring under water in the main basins. Re-generation across the Floor of Sargents, Winton and Green Swamps is most likely to occur after drawdown, on exposed wet muds, or possibly in very shallow (a few cm) water. There seems no point in implementing MP_1 until water levels have been lowered, and the sediments have firmed.
- The data collected from Moodie's Swamp is a positive step towards developing a small library of quantitative targets for the floor of Sargents and Winton Swamps. As such, it represents a single description of a cane grass wetland under a single set of environmental conditions. Descriptions of cane grass wetlands under other inundation phases and growth stages are also needed, and any opportunity to record these in the same way as MP_1 from cane grass wetlands in northern Victoria should be taken.
- At Lake Mokoan, the area conceptually designated as the wetland Floor was still submerged, as of March 2008. Assuming that the mapped dead trees (Figure 7) once fringed the cane grass wetlands, then the wetland Floor is probably the central tree-less area in Sargents and Winton Swamps. It is clear from the ends of the transects for MP_WE, which were either at the waterline or in shallow water 50 m further in, that the monitoring activities in March 2008 were not close to where the wetland Floor could be considered to begin.
- The situation is different for Green Swamp, which does not have a tree-less centre and therefore no easy indicator of the likely boundary between Floor and Edge. Determining which part of Green Swamp is wetland Floor is expected to be quite difficult, especially because of the changes that have taken place there, with considerable deposition of sediment. This has the potential to mask indicative characteristics such as changes in soil or slope. An alternative interpretation is that there may have been no discreet wetland Floor at Green Swamp, and this will need to be taken into consideration when planning to set up transects as part of MP_1.
- Having now implemented MP_1 at Moodie's Swamp and in the wetland Edge around Green and Winton Swamps, it is clear that the approach is effective in recording commonly occurring or locally-abundant species, but is not suitable for species that are sparse or rarely encountered. Tracking the natural regeneration of River Red Gum at Green Swamp requires a completely different approach. Implementing MP_1 at this stage to monitor River Red Gums at Green Swamp would not be a productive use of resources.

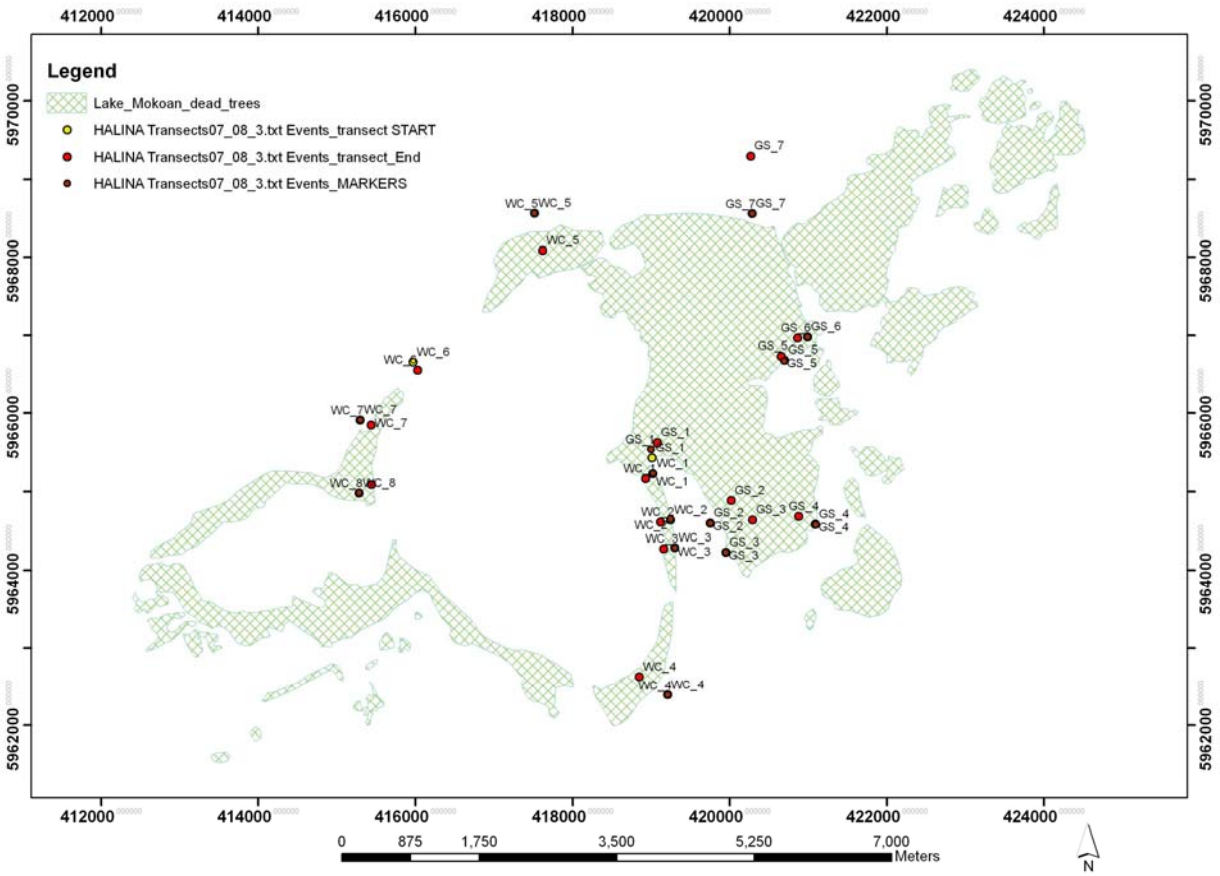

Figure 7: MP_WE transects in relation to mapped dead trees

An early draft map showing how MP_WE transects around Green and Winton Swamps are almost entirely within the area that was once River Red Gum woodland, and well away from the central area referred to as the wetland Floor.

MP_WE: Wetland Edge

The following points arise from experience in setting up MP_WE and the direct field experience that this provided.

- A total of fifteen transects was successfully established around Winton and Green Swamps. These are expected to form the basis of a monitoring program addressing the wetland Edge. The wetland Edge is different from the wetland Floor, and transitional to the adjacent terrestrial uplands. It has a significant role in protecting the core of a wetland, and is important in its own right as it provides a different type of structure around a wetland. Despite this, the wetland Edge was not specifically targeted for monitoring by Roberts and Hale (2007).
- Although the fifteen transects are fairly well distributed (Figure A3.2), they are not a comprehensive network. Notable gaps for Winton Swamp and for Green Swamp respectively occur on the northern shorelines, and on the southern shorelines; Sargents Swamp is a major gap as it is not included at all. Extending the existing network of

transects to include these areas (Figure 8) and to set up a network around Sargents Swamp would greatly improve the value of the monitoring program.

- Unlike MP_1, transects in MP_WE do not cover the same ecological range. As currently set up (Table A3.2) their upper elevations range from 166.4 to 161.3 m AHD, and the lower elevation ranges from 160.7 to 161.3 m AHD. Although slightly 'untidy' in approach, this is not an issue provided subsequent monitoring is careful to restrict itself to temporal comparisons (time_1 versus time_2 for a particular transect) and does not make spatial comparisons (e.g. between transects).

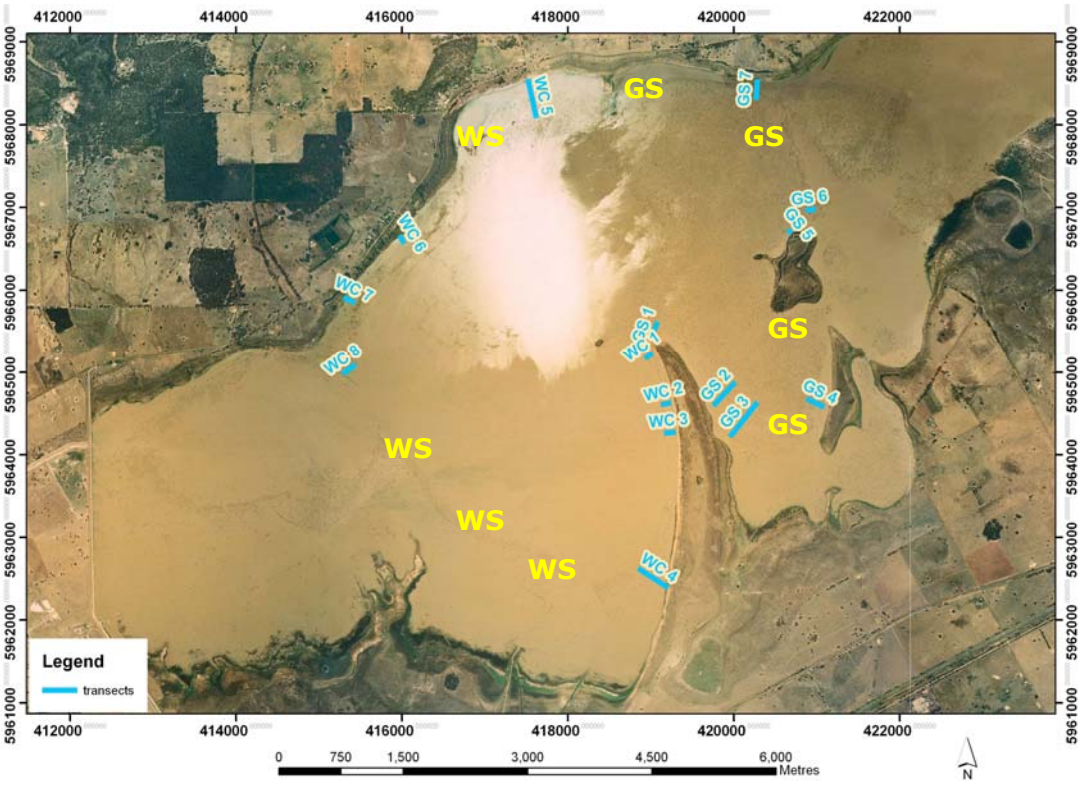

Figure 8: Locations of additional transects

Distribution of suggested additional transects for monitoring the Wetland Edge: four for Winton Swamp, and four for Green Swamp.

Currently, there are no ecological targets for the wetland Edge. Previous approaches to defining targets have generally been based on floristics. A more suitable approach is to put the process of land colonisation into a bigger context by including some non-floristic targets such as:

reduce the number of quadrats per transect that are unvegetated;

increase the abundance of native Cyperaceae, normally associated with wetland Edges.

Recommendations

[1] Give the wetland Edge a greater priority for resourcing over the wetland Floor, at least until a schedule for manipulating the water regime to promote regeneration across the wetland Floors is worked out.

[2] Extend the scope of MP_WE to fill the gaps identified. This means another 8 transects at least for Winton and Green Swamps, but preferably another 16 transects, so as to include Sargents Swamp.

References

Brock, M.A. and Casanova, M.T. (1997). *Plant life at the edge of wetlands: ecological responses to wetting and drying.* In: Nicholas Klomp and Ian Lunt (editors). "Frontiers in Ecology: building the links". Elsevier Science, Oxford, UK.

Reid, M.A. and Quinn, G. P. (2004). Hydrologic regime and macrophyte assemblages in temporary floodplain wetlands: implications for detecting responses to environmental water allocation. *Wetlands* **24**: 586-599.

Roberts, J. and Hale, J. (2007). *Lake Mokoan Littoral Vegetation: Monitoring Program.* Report JR 20/2007. Canberra, ACT. January 2007.

Roberts, J., Kobryn, H. and Osler, D. (2008). (in prep.). *Regeneration around Lake Mokoan, March 2008.* Report JR 24/ 2008.

SKM (2006). *Hydrologic modelling to assess impacts on Latham's Snipe habitat.* Draft V3. Sinclair Knight Merz, Armadale, Victoria 3144.

Souter, N. & Lewin, L. (1999). *Water regime management for Lake Mokoan for 1999/2000.* AWT Victoria. Report 337/99. June 1999.

Appendices

Appendix 1: MP_1 as designed in 2007

This section is taken directly from Section [3.3] in Roberts and Hale (2007), and the original figure numbers retained here.

- MP_1: VEGETATION ON THE WETLAND FLOOR

Issue: An important issue in rehabilitating Winton Wetlands is the potentially high cost of re-vegetating large areas (if using "active" management) versus the unknown potential for wetland plants to establish naturally. Although it is not explicitly stated in the Brief that passive regeneration is to be the means, the lack of any other plans indicates that wetland rehabilitation is expected to proceed in this way. At present there is no satisfactory way to anticipate just what the potential is for passive regeneration or for target wetland species to successfully establish.

Purpose: This monitoring program will provide the information necessary to evaluate whether passive regeneration is a feasible management strategy for the wetland floor, and in which wetlands it is not.

Hypothesis: [i] that River Red Gum and/or Southern Cane Grass will establish across the floor of the Winton Wetlands and/or Winton Swamp respectively:
[ii] that they will establish so effectively that they become the most abundant species.

Ecological Target: The provisional targets for Winton Swamp are EVC 291 Cane Grass Wetland and/or EVC 602 Cane Grass Wetland / Aquatic Herbland Complex. The provisional EVC targets for Green, Ashmeads, Humphries, Taminick, Black and Saddlers Swamps (and probably also Lindsay) are combinations of EVC 292 Red Gum Wetland, EVC 815 Riverine Swampy Woodland, EVC 809 Floodplain Grassy Wetland and EVC 125 Plains Grassy Wetland, all with River Red Gum present.

Ecological targets for monitoring need to be quantitative, and there are two options for this. One is to use cover and life-form groupings as given in the benchmark descriptions of these wetland EVCs. Because this provides a reference description, theoretically this should provide a perfect data set. practically, however, this is not a strong option as the benchmark descriptions for wetland EVCs are currently minimalistic. The other is to record the relevant information from high quality (good condition) sites in the region, preferably 2-3 examples per major inundation phase (dry, post-filling, recession).

The second option is recommended for MP_1 because it limits data collection to the relevant variables, and provides data that can be included in the analyses.

Method Outlined: Point counts of species presence/absence along fixed transects done annually giving mean abundance (as frequency) per species per wetland. Analysis using multi-variate techniques to determine similarity with target wetlands and/or benchmarks, and changes to this through time.

Sampling: Species presence is recorded at 100 evenly-spaced points along a fixed transect; water depth is recorded at every 5th point. All nine wetlands specified in the brief are included. For smaller wetlands (less than 100 ha) there should be six fixed transects, each 100 m long (points are 1 m apart): for larger wetlands (greater than 100 ha), there should be eight fixed transects, each 200 m long (points are 2 m apart).

Data should be collected from 3 wetlands in good-very good condition in the region (to serve as reference points and targets in data analyses). This should be collected at the same time in the first year, and at least once more in subsequent years, to provide inter-annual variability and different inundation phases (if feasible). Recording should follow the standard procedure of zero mark (0 m) closest to the wetland edge, and gradually move into the wetland.

Frequency: Annually, at same season each year. Recommended season is either early summer (December) or end-of-summer (February going into March).

Analysis: Multi-variate techniques (ordination) with between group significance testing using ANOSIM or equivalent should be used to address the following key questions, for each wetland and for all wetlands: Is the target species present and increasing in abundance through time ? Are the plants present in each wetland similar to those in target wetlands ? What are the characteristics of the plants recorded in each wetland ? and is this changing through time ?

Time-frame: The usefulness of passive regeneration as a rehabilitation strategy should be evaluated for each wetland individually in 2012, at the 5th Year Review.

Field Sheet: A paper-based system of recording transect data is given in Appendix 5: this can be a guide for electronic data recording. The field sheet as presented is generic, and can be used for transects of different lengths: in which case, distance along the transect will depend on transect length.

Documentation: Location and orientation of transects at Winton Wetlands and at wetlands where target data are collected (GPS and compass bearing) should be recorded separately and lodged with GB CMA.

Indicative Costs: For routine monitoring, it is estimated that each of the three large wetlands (Winton, West Basin and Green) will take most of a full day (so 2-3 days altogether), that the six smaller wetlands could be completed in 2-3 days, and that one full day be allowed for nearby reference or target sites (such as

Moodie's Swamp). Therefore, costs should be based on a putting a two-person team in the field for a total of 6-7 days (12-14 person days). Post-field processing (data tidy and identification) is allowed 2 person-days.

Additional time is needed in the first year for establishing the sites. Preparation prior to going in the field includes consultation with GB CMA, permits if necessary, preparation of maps, organising access; allowance is 1.5 person days. Establishment in the field includes setting up markers, geo-locating: allowance is one team x 1 day is 2 person days. Written documentation and submission of site and quadrat location: allowance is 0.5 person days.

Data analysis, interpretation, report writing and revisions are expected to require more time in the first year to establish the routine and to accommodate recommendations arising from first years' experience: a total of 10 person days is allowed. In subsequent years, this would become more efficient, once routines are established, and should drop down to 8 days.

Thus the total effort for Year One is 30 person days; and for Years Two-Four is 24 person days. To this needs to be added costs of vehicle, fuel, travel, accommodation and meals. Any requirements for site inductions will be additional to this estimate.

Notes: [i] The sampling protocol and suggested analyses draw on the effectiveness of using point samples along fixed transects as demonstrated for wetlands in Barmah Forest (Reid and Quinn 2004). The advantage of this method is that it is rapid in the field, taking about 2 hours per wetland if quite small (Mike Reid, University of Canberra, pers. comm.). The measure of abundance used is count frequency which does not directly translate into percentage cover. The number of points used by Reid and Quinn (2004) was 600 per wetland. This was satisfactory for their study wetlands, which were all less than 100 ha in area. A bigger sampling effort is suggested here for wetlands that are larger than 100 ha: this could be trimmed at a later stage if analysis shows unnecessary effort.

[ii] Ecological characteristics of plants establishing could be described in a number of ways: using the life-forms which are the bases of some EVC benchmarks; using the water regime functional types of Brock and Casanova (1997) as implemented by Reid and Quinn (2004) and as used for Lake Mokoan littoral vegetation (Section 2.3, Appendix 4); using dispersal characteristics; by longevity and origin. All or some of these should be considered. Final documentation should include a species list and tabulate the ecological characteristics used for each species.

[iii] Including species phenology (vegetative, flowering seeding) of the two target species would boost the level of ecological knowledge as an indicator of vigour and whether a seed bank is being built up. However, recording such information adds to field time, so this would be worthwhile only for species that are important and little known, specifically Southern Cane Grass: this would require a modification to the data sheet.

[iv] Wetland floor is (Figure 2) the relatively flat central area within a wetland. This is equivalent to elevation band [E] 160.5-160.0 m AHD for Winton Swamp and Green Swamp, and elevation band [F] below 160.0 m AHD in Sargents Swamp (Figure 14).

Appendix 2: MP_1 Wetland Floor (2008)

Guide to Markers

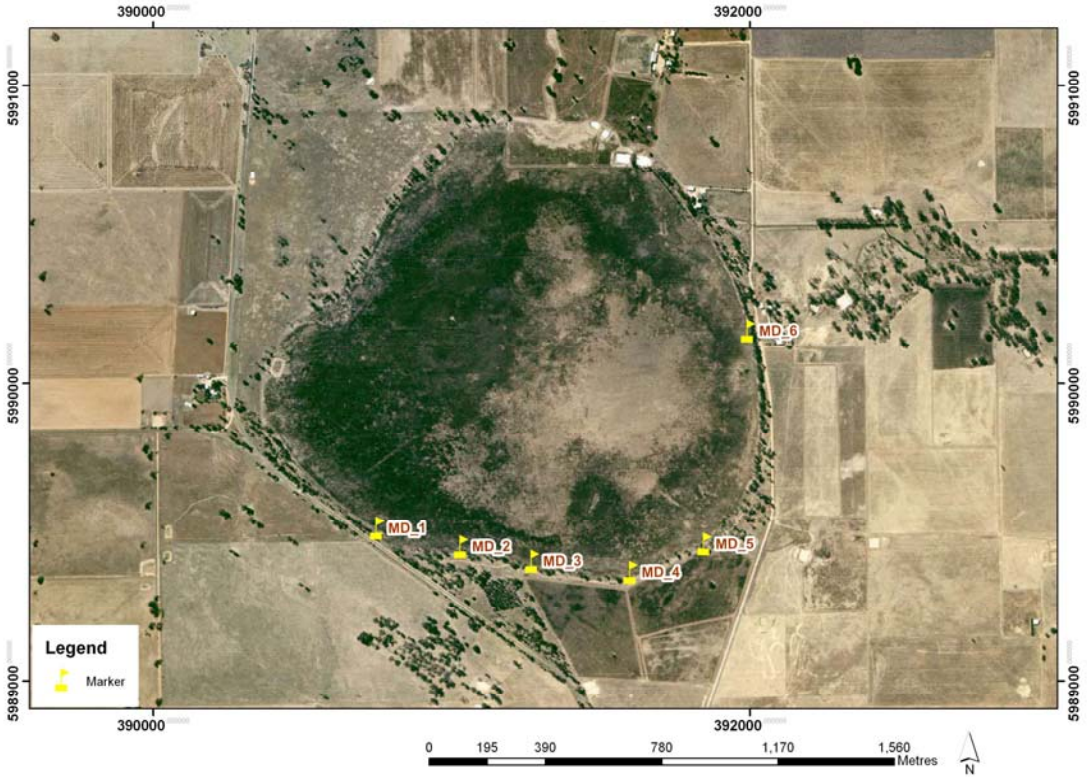

Figure A2.1: Location of markers at Moodie's Swamp

Markers are coded MD_1 through to MD_6, and arranged from west to east.

Table A2.1: Detail of Markers

MOODIE'S SWAMP		Marker in March 2008
Code	**MD_1**	
Elevation (m AHD)	n.a.	
Marker	55 H 0390751 5989513	
Marker Description	Tall dead tree at base of slope, near yellow post marked F191 (to foreground, left). Starting point is where reddish sandy slope soils change to clays.	
		Marker in March 2008
Code	**MD_2**	
Elevation (m AHD)	n.a.	
Marker	55 H 0391033 5989451	
Marker Description	Tall dead tree on wetland floor, with yellow post marked F192 (in foreground) nearby. Starting point is where soils change from reddish sandy on slope to clays.	
		Marker in March 2008
Code	**MD_3**	
Elevation (m AHD)	n.a.	
Marker	55 H 0391271 5989402	
Marker Description	Isolated dead tree on wetland floor. Starting point is where soils change from reddish-sandy on slope to clays of wetland floor.	

MOODIE'S SWAMP		Marker in March 2008
Code	**MD_4**	
Elevation (m AHD)	n.a.	
Marker	55 H 0391601 5989365	
Marker Description	Tall dead tree on wetland floor, with yellow post marked F194 (in background). Starting point is where soils change from reddish sandy on slope to clays.	
		Marker in March 2008
Code	**MD_5**	
Elevation (m AHD)	n.a.	
Marker	55 H 0391849 5989460	
Marker Description	Dead tree midslope, near track.	
		Marker in March 2008
Code	**MD_6**	
Elevation (m AHD)	n.a.	
Marker	55 H 0391995 5990176	
Marker Description	Pine post in front of River Red Gum fringe, within 20 m of gate in fence beside road (just visible in background).	

Transect Documentation, March 2008

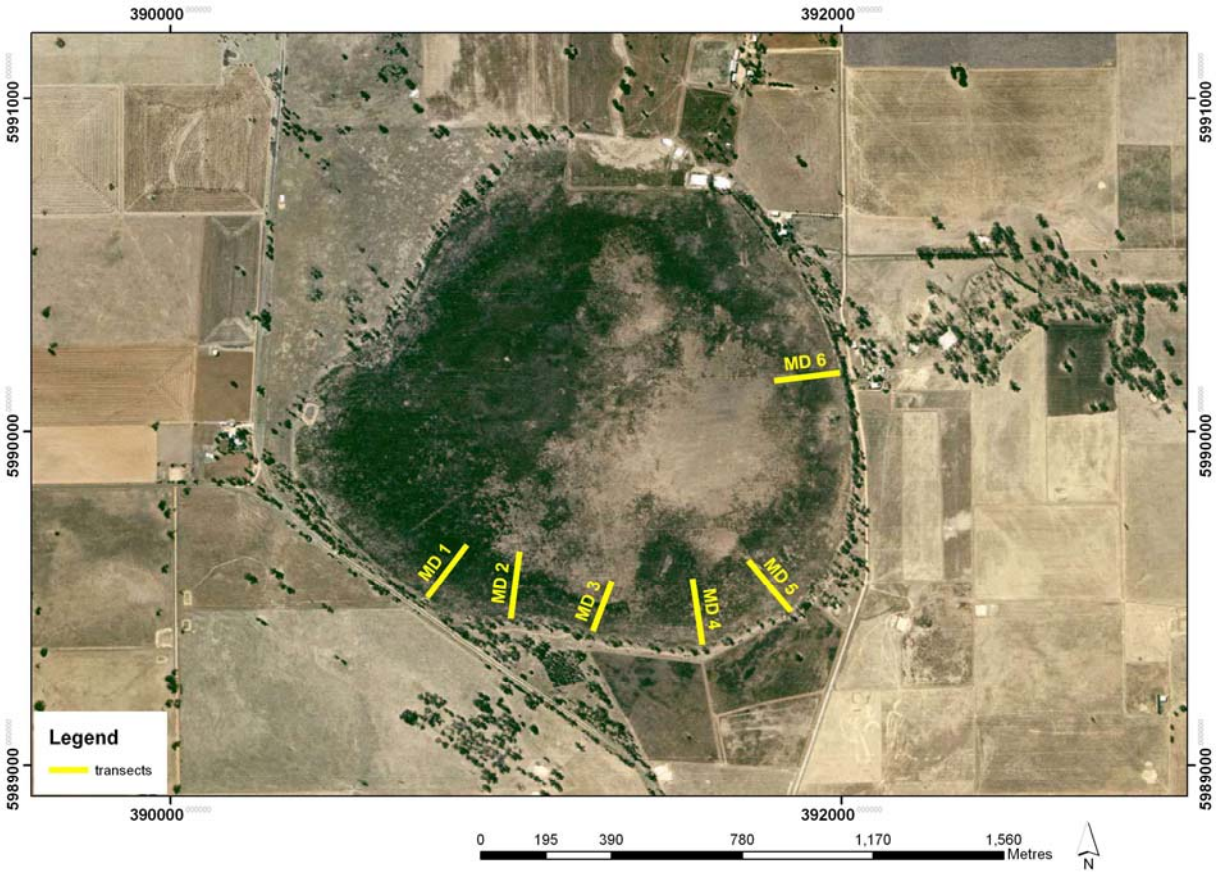

Figure A2.2: Location of Transects, March 2008

Table A2.2: Details of Transects, March 2008

	Start		End		
Transect	**Co-ordinates**	**Elevation**	**Co-ordinates**	**Bearing from north**	**Transect Length (m) from GIS**
MOODIE'S SWAMP (MD)					
MD_1	55 H 0390765 5989503	n.a.	55 H 0390884 5989662	37	199 m
MD_2	55 H 0391014 5989438	n.a.	55 H 0391040 5989641	7	205 m
MD_3	55 H 0391258 5989400	n.a.	55 H 0391315 5989552	21	162 m
MD_4	55 H 0391585 5989361	n.a.	55 H 0391556 5989559	352	200 m
MD_5	55 H 0391849 5989460	n.a.	55 H 0391722 5989614	320	200 m
MD_6	55 H 0391996 5990177	n.a.	55 H 0391799 5990153	263	199 m

MP_1: Monitoring the Wetland Floor

Wetland.....Transect Number.....Date.....Recorder.....Marker Notes .....

GPS at Start (top).....GPS at Waterline .....GPS at End (bottom).....Water depth at end .....cm

Quadrat no at Start(top) .....Quadrat number at Waterline.....Quadrat number at End (bottom).....

1																																				
2																																				
3																																				
4																																				
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19																																				
20																																				
21																																				
22																																				
Position	Distance (m)	Depth (cm)	BARE	Standing Dead	Fallen litter	Altern. dentic	Aster subulatus	Centipeda cunn	Chenopod pum	Conyza bon	Cynodon dactyl	Dittrichia	Eragrostis infec	Hypoch radic	Juncus semi-sol	Lachnagr filiform	Lactuca saligna	Paspalim dist	Persicaria lapath	Phalaris aquatic	Ririppa palust	Sonchus	Trifolium														

Appendix 3: MP_WE Wetland Edge (2008)

Guide to Markers

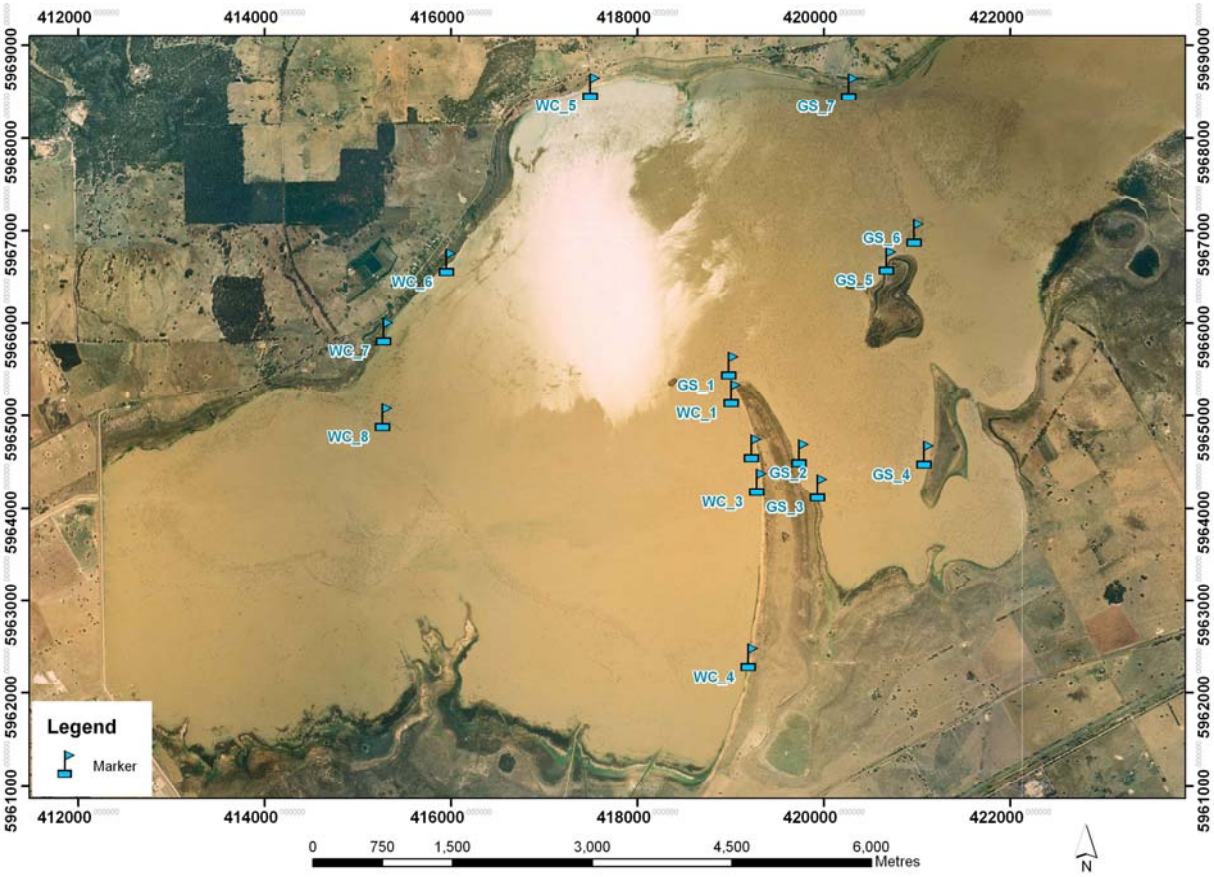

Figure A3.1: Location of markers at Winton Swamp and Green Swamp

Markers are coded WC_1 through to WC_8 for Winton Swamp (the same as WS_1 to WS_8 in the text), and GS-1 through to GS_7 for Green Swamp. Markers are numbered in chronological order of being set up and do not follow a clear sequence around either wetland.

Table A3.1: Details of Markers at Winton Swamp

WINTON SWAMP		Marker in March 2008
Code	**WS_1**	
Elevation (m AHD)	163.7	
Marker	55 H 0419023 5965239	
Marker Description	Isolated long-dead River Red Gum on slope	
		Marker in March 2008
Code	**WS_2**	
Elevation (m AHD)	163.9	
Marker	55 H 0419243 5964654	
Marker Description	Fallen River Red Gum to south of peppercorn trees	
		Marker in March 2008
Code	**WS_3**	***No photo available***
Elevation (m AHD)	162.8	
Marker	55 H 0419299 5964285	
Marker Description	Next to fallen log	

WINTON SWAMP		Marker in March 2008
Code	**WS_4**	
Elevation (m AHD)	164.4	
Marker	55 H 0419206 5962392	
Marker Description	An isolated long-dead River Red Gum.	
		Marker in March 2008
Code	**WS_5**	
Elevation (m AHD)	164.1	
Marker	55 H 0417510 5968556	
Marker Description	Isolated standing long-dead River Red Gum	
		Marker in March 2008
Code	**WS_6**	
Elevation (m AHD)	166.4	
Marker	55 H 0415968 5966663	
Marker Description	Cluster of two live young-mature River Red Gums mid-slope, west of boat ramp.	

WINTON SWAMP		Marker in March 2008
Code	**WS_7**	
Elevation (m AHD)	163.8	
Marker	55 H 0415294 5965911	
Marker Description	Marker is westerly of pair of dead trees, next regenerating eucalypts, upper slope	
		Marker in March 2008
Code	**WS_8**	
Elevation (m AHD)	161.0	
Marker	55 H 0415281 5964985	
Marker Description	Highest point of sandbar above jagged large burnt-out stump, about 1 m high	

Table A3.2: Details of Markers at Green Swamp

GREEN SWAMP		Marker in March 2008
Code	**GS_1**	
Elevation (m AHD)	161.2	
Marker	55 H 0418997 5965542	
Marker Description	Upslope from long dead River Red Gum with white reflector up high	
		Marker in March 2008
Code	**GS_2**	
Elevation (m AHD)	162.5	
Marker	55 H 0419751 5964599	
Marker Description	Dead eucalypt woodland form; area partly cleared, high stumps	
		Marker in March 2008
Code	**GS_3**	
Elevation (m AHD)	161.9	
Marker	55 H 0419949 5964227	
Marker Description	Line of dead eucalypt re-growth, near an old fence coming in at an angle, downhill.	

GREEN SWAMP		Marker in March 2008
Code	**GS_4**	
Elevation (m AHD)	162.2	
Marker	55 H 0421092 5964582	
Marker Description	Dead River Red gum on outer edge, close to track	
		Marker in March 2008
Code	**GS_5**	
Elevation (m AHD)	163.3	
Marker	55 H 0420691 5966679	
Marker Description	Lone dead spreading eucalypt, mid-slope	
		Marker in March 2008
Code	**GS_6**	
Elevation (m AHD)	161.3	
Marker	55 H 0420988 5966981	
Marker Description	1-m tall stump of two-boled tree, to west of road, causeway	

GREEN SWAMP		Marker in March 2008
Code	**GS_7**	***No photo available***
Elevation (m AHD)	163.8	
Marker	55 H 0420284 5968552	
Marker Description	Sapling River Red Gum towards upper slope, above isolated fence post next to trail	

Transect Documentation, March 2008

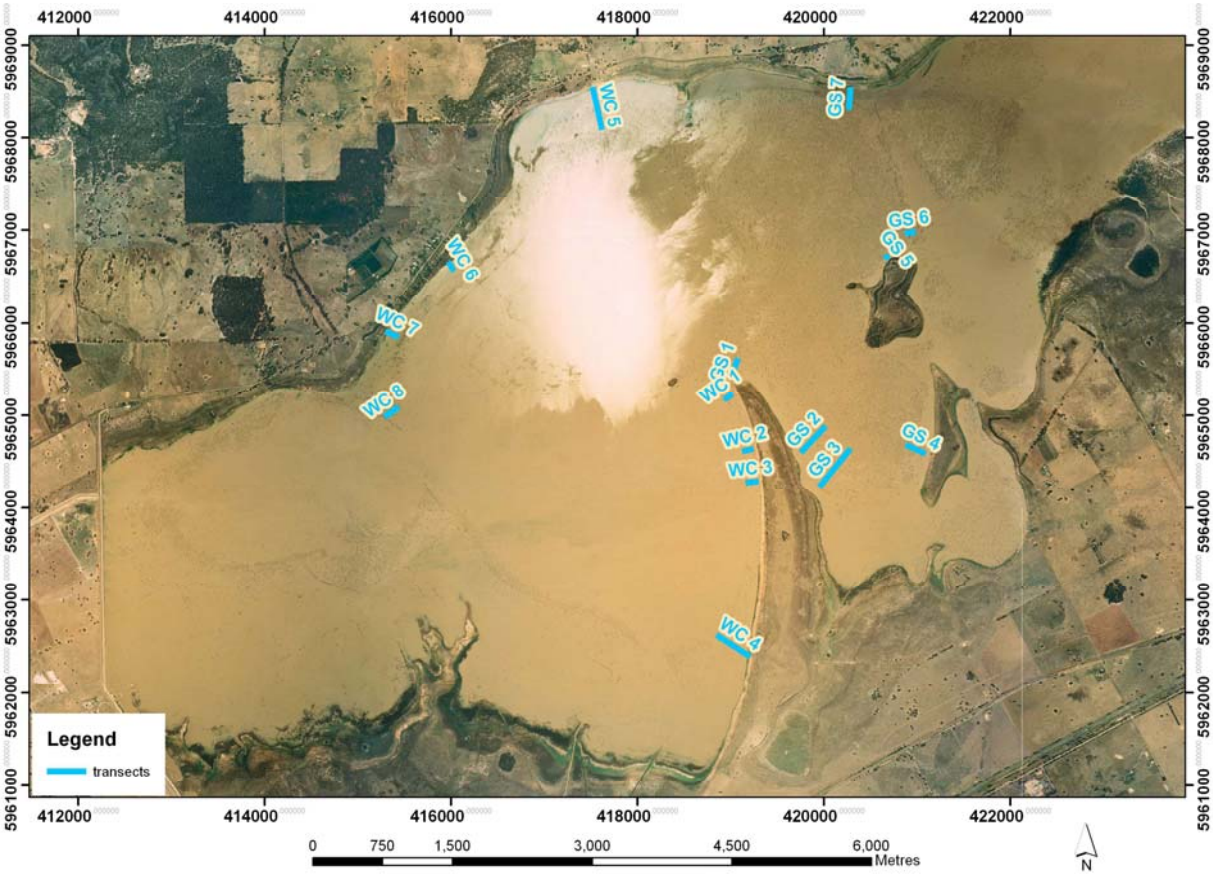

Figure A3.2: Location of Transects, March 2008

Blue line indicates length of each transect, as derived from co-ordinates: line width is arbitrary. Transects are coded WC_1 to WC_8 and refer to WS_1 to WS_8 in text.

Table A3.2: Details of Transects, March 2008

Transect length is derived from co-ordinates using GIS.

	Start		End			
Tran-sect	**Co-ordinates**	**Elevation (m AHD)**	**Co-ordinates**	**Elevation (m AHD)**	**Bearing**	**Transect Length (m)**
WINTON SWAMP (WS)						
WS_1	55 H 0419019 5965232	163.7	55 H 0418926 5965166	160.7	235	114 m
WS_2	55 H 0419244 5964638	163.9	55 H 0419118 5964610	161.3	257	129 m
WS_3	55 H 0419299 5964285	162.8	55 H 0419158 5964272	160.7	265	142 m
WS_4	55 H 0419206 5962392	164.4	55 H 0418847 5962626	160.8	303	429 m
WS_5	55 H 0417514 5968556	164.1	55 H 0417617 5968081	160.8	168	486 m
WS_6	55 H 0415968 5966663	166.4	55 H 0416027 5966561	161.1	150	118 m
WS_7	55 H 0415294 5965910	163.8	55 H 0415433 5965847	161.0	114	153 m
WS_8	55 H 0415281 5964981	161.0	55 H 0415440 5965092	160.5	55	194 m
GREEN SWAMP (GS)						
GS_1	55 H 0419008 5965434	161.9	55 H 0419078 5965620	161.1	21	199 m
GS_2	55 H 0419751 5964599	162.5	55 H 0420018 5964886	160.7	43	392 m
GS_3	55 H 0419949 5964226	161.9	55 H 0420287 5964641	160.8	39	535 m
GS_4	55 H 0421088 5964584	162.2	55 H 0420877 5964683	160.9	295	233 m
GS_5	55 H 0420694 5966687	163.3	55 H 0420655 5966736	161.1	321	63 m
GS_6	55 H 0420988 5966981	161.3	55 H 0420863 5966965	161.0	263	126 m
GS_7	55 H 0420284 5968552	163.8	55 H 0420266 5968297	160.8	4	256 m

Appendix 4: Species List, March 2008

Species recorded from quadrats along six transects established in MP_1 at Moodie's Swamp, and along the eight and seven transects established at Winton and Green Swamps, respectively, for MP_WE, in March 2008.

AMARANTHACEAE
Alternanthera denticulata

ASTERACEAE
(*) Aster subulatus
Centipeda cunninghamii
Centipeda minima
(*) Cirsium vulgare
(*) Conyza bonariensis
(*) Dittrichia graveolens
Euchiton sphaericus
(*) Helminthotheca echioides
(*) Hypochaeris radicata
(*) Lactuca saligna
(*) Lactuca serriola
Pseudognaphalium luteo-album
(*) Scorzonera laciniata
Senecio quadridentatus
(*) Sonchus asper
(*) Sonchus sp

BRASSICACEAE
(*) Rorippa palustris

CARYOPHYLLACEAE
Stellaria caespitosa

CHENOPODIACEAE
Chenopodium pumilio
Dysphania glomulifera subsp. glomulifera

CYPERACEAE
Eleocharis acuta

FABACEAE
(*) Trifolium angustifolium var angustifolium
(*) Trifolium sp.

GENTIANACEAE
(*) Centaurium erythraea

GERANIACEAE
Erodium sp.

JUNCACEAE
Juncus semisolidus
Juncus sp

LYTHRACEAE
Lythrum hyssopifolia

MOLLUGINACEAE
Glinus lotoides

ONAGRACEAE
Epilobium billardierianum subsp. cinereum

POACEAE
Amphibromus nervosus
Austrodanthonia setacea var setacea
(*) Avena barbata
Chloris truncata
Cynodon dactylon var dactylon
Digitaria divaricatissima **VROT**
Enteropogon sp.
Eragrostis infecunda
Eragrostis parviflora
Lachnagrostis filiformis var 1
(*) Lolium sp.
Panicum decompositum
(*) Paspalum distichum
(*) Phalaris aquatica
Pseudoraphis spinescens
Walwhalleya proluta

POLYGONACEAE
Persicaria lapathifolia
Persicaria prostrata
(*) Polygonum aviculare
(*) Rumex crispus

Appendix 5: Data for Individual WE Transects, March 2005

Transect Composition; the number of quadrats where a species or other attribute occurs, as a percentage of all quadrats for that transect.

The species list and list of environmental variables is the same for all three wetlands (Moodie's Swamp, Winton Swamp, Green Swamp). For clarity, species and environmental variables for which there are no records (ie score = 0) for a wetland are left blank.

Appendix 5: Transect Composition Data

MOODIES SWAMP March 2008	data are % of quadrats per transect where recorded					
Transect	1	2	3	4	5	6
bare	9.5	19.0	9.5	4.8	14.3	0.0
Standing dead	81.0	95.2	76.2	90.5	85.7	95.2
Litter (fallen dead)	85.7	95.2	85.7	95.2	100.0	90.5
Rocks, rubble						
Fallen log, branch						
moss						
Alteranthera denticulata	0.0	0.0	4.8	0.0	0.0	0.0
Amphibromus nervosus	0.0	4.8	0.0	0.0	0.0	0.0
Aster subulatus	0.0	0.0	4.8	0.0	4.8	0.0
Austrodanthonia setaceae						
Avena barbata	14.3	0.0	4.8	0.0	0.0	0.0
Centaurium erythraea	14.3	0.0	0.0	0.0	0.0	0.0
Centipeda cunninghamii	0.0	0.0	4.8	0.0	0.0	0.0
Centipeda minima						
Chenopodium pumilio						
Chloris truncata						
Cirsium vulgare	38.1	14.3	4.8	14.3	14.3	14.3
Conyza bonariensis						
Cynodon dactylon						
Digitaria divaricatissima						
Dittrichia graveolens						
Dysphania glomulifera						
Eleocharis acuta	0.0	9.5	28.6	14.3	4.8	0.0
Enteropogon sp.						
Epilobium billardieri	0.0	0.0	0.0	9.5	4.8	0.0
Eragrostis infecunda	85.7	90.5	81.0	90.5	95.2	95.2
Eragrostis parviflora						
Erodium sp.						
Euchiton sphaericus	0.0	4.8	4.8	9.5	0.0	0.0
Glinus lotoides						
Helminthotheca echioides						
Hypochaeris radicata	0.0	9.5	23.8	4.8	23.8	0.0
Juncus semisolidus						
Juncus seedling	0.0	9.5	0.0	0.0	0.0	0.0
Lachnagrostis filiformis	9.5	19.0	23.8	9.5	0.0	0.0
Lactuca saligna	38.1	38.1	9.5	19.0	4.8	0.0
Lactuca serriola	0.0	14.3	0.0	0.0	0.0	0.0
Lolium sp seedling						
Lythrum hyssopifolia	0.0	0.0	4.8	0.0	0.0	0.0
Panicum decompositum						
Paspalum distichum						
Persicaria lapathifolia						
Persicaria prostrata						
Phalaris aquatica	0.0	0.0	0.0	9.5	4.8	0.0
Polygonum aviculare	0.0	0.0	4.8	4.8	0.0	0.0
Pseudognaphalium luteoalbum						
Pseudoraphis spinescnes						
Rorippa palustris						
Rumex crispus						
Scorzonera laciniata						
Senecio quadridentata						
Sonchus asper	4.8	0.0	0.0	0.0	0.0	0.0
Sonchus sp. Seedling	52.4	38.1	0.0	14.3	9.5	0.0
Stellaria caespitosa						
Trifolium angustifolium						
Trifolium sp.						
Walwhalleya proluta						
Dicot seedling						
Monocot seedling						

Appendix 5: Transect Composition Data

WINTON SWAMP March 2008	data are % of quadrats per transect where recorded							
Transect	1	2	3	4	5	6	7	8
bare	92.9	80.0	95.2	30.4	98.1	96.2	94.1	100.0
Standing dead	14.3	20.0	4.8	78.3	26.9	23.1	26.5	0.0
Litter (fallen dead)	0.0	6.7	4.8	39.1	7.7	11.5	5.9	0.0
Rocks, rubble								
Fallen log, branch	7.1	6.7	9.5	0.0	1.9	0.0	0.0	0.0
moss								
Alteranthera denticulata	7.1	6.7	9.5	8.7	1.9	7.7	11.8	0.0
Amphibromus nervosus								
Aster subulatus	7.1	0.0	0.0	26.1	3.8	0.0	2.9	0.0
Austrodanthonia setaceae	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Avena barbata								
Centaurium erythraea								
Centipeda cunninghamii	0.0	13.3	0.0	8.7	3.8	0.0	8.8	0.0
Centipeda minima								
Chenopodium pumilio	7.1	0.0	0.0	0.0	26.9	7.7	0.0	0.0
Chloris truncata	0.0	0.0	0.0	0.0	0.0	3.8	5.9	0.0
Cirsium vulgare	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Conyza bonariensis	0.0	0.0	0.0	13.0	7.7	3.8	0.0	0.0
Cynodon dactylon	0.0	20.0	4.8	17.4	7.7	7.7	8.8	0.0
Digitaria divaricatissima	0.0	6.7	0.0	0.0	0.0	3.8	0.0	0.0
Dittrichia graveolens	0.0	0.0	0.0	0.0	1.9	23.1	0.0	0.0
Dysphania glomulifera	0.0	0.0	0.0	0.0	0.0	0.0	11.8	0.0
Eleocharis acuta								
Enteropogon sp.								
Epilobium billardieri								
Eragrostis infecunda	0.0	0.0	0.0	0.0	1.9	11.5	0.0	0.0
Eragrostis parviflora	0.0	0.0	0.0	8.7	5.8	3.8	11.8	0.0
Erodium sp.	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Euchiton sphaericus								
Glinus lotoides	7.1	6.7	4.8	0.0	7.7	3.8	8.8	0.0
Helminthotheca echioides								
Hypochaeris radicata	0.0	0.0	0.0	8.7	0.0	0.0	2.9	0.0
Juncus semisolidus	0.0	6.7	0.0	43.5	5.8	0.0	8.8	0.0
Juncus seedling	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0
Lachnagrostis filiformis	21.4	33.3	19.0	21.7	9.6	11.5	20.6	0.0
Lactuca saligna								
Lactuca serriola								
Lolium sp seedling								
Lythrum hyssopifolia	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Panicum decompositum	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0
Paspalum distichum	0.0	0.0	0.0	0.0	7.7	0.0	2.9	0.0
Persicaria lapathifolia	0.0	0.0	4.8	4.3	1.9	0.0	0.0	0.0
Persicaria prostrata	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Phalaris aquatica								
Polygonum aviculare	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0
Pseudognaphalium luteoalbum	0.0	0.0	0.0	4.3	1.9	0.0	2.9	0.0
Pseudoraphis spinescnes	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0
Rorippa palustris	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Rumex crispus								
Scorzonera laciniata								
Senecio quadridentata								
Sonchus asper								
Sonchus sp. Seedling	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0
Stellaria caespitosa								
Trifolium angustifolium	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0
Trifolium sp.								
Walwhalleya proluta	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0
Dicot seedling	7.1	13.3	0.0	4.3	0.0	7.7	11.8	0.0
Monocot seedling	0.0	6.7	0.0	4.3	1.9	0.0	0.0	0.0

Appendix 5: Transect Composition Data

GREEN SWAMP March 2008	data are % of quadrats per transect where recorded						
Transect	1	2	3	4	5	6	7
bare	81.0	100.0	92.6	88.5	87.0	100.0	67.9
Standing dead	33.3	24.4	44.4	26.9	8.7	34.5	53.6
Litter (fallen dead)	19.0	2.4	11.1	0.0	0.0	3.4	32.1
Rocks, rubble							
Fallen log, branch	0.0	0.0	0.0	0.0	4.3	3.4	0.0
moss	0.0	0.0	0.0	0.0	0.0	13.8	7.1
Alteranthera denticulata	4.8	2.4	14.8	0.0	0.0	0.0	7.1
Amphibromus nervosus							
Aster subulatus	4.8	0.0	0.0	0.0	0.0	0.0	21.4
Austrodanthonia setaceae							
Avena barbata							
Centaurium erythraea							
Centipeda cunninghamii	19.0	7.3	11.1	15.4	4.3	10.3	10.7
Centipeda minima	0.0	0.0	0.0	3.8	0.0	0.0	0.0
Chenopodium pumilio	23.8	9.8	59.3	3.8	0.0	0.0	7.1
Chloris truncata							
Cirsium vulgare	0.0	0.0	0.0	3.8	0.0	0.0	0.0
Conyza bonariensis	0.0	0.0	0.0	0.0	0.0	3.4	14.3
Cynodon dactylon	0.0	0.0	0.0	0.0	4.3	0.0	3.6
Digitaria divaricatissima							
Dittrichia graveolens							
Dysphania glomulifera	4.8	0.0	0.0	3.8	4.3	0.0	7.1
Eleocharis acuta							
Enteropogon sp.	0.0	0.0	0.0	0.0	0.0	0.0	3.6
Epilobium billardieri							
Eragrostis infecunda	4.8	0.0	0.0	0.0	0.0	0.0	0.0
Eragrostis parviflora	0.0	7.3	0.0	0.0	0.0	0.0	10.7
Erodium sp.							
Euchiton sphaericus							
Glinus lotoides	4.8	0.0	0.0	0.0	4.3	0.0	10.7
Helminthotheca echioides							
Hypochaeris radicata	0.0	0.0	0.0	0.0	0.0	0.0	7.1
Juncus semisolidus	0.0	2.4	0.0	0.0	0.0	17.2	0.0
Juncus seedling	0.0	12.2	7.4	11.5	4.3	0.0	21.4
Lachnagrostis filiformis	28.6	14.6	11.1	30.8	13.0	24.1	46.4
Lactuca saligna							
Lactuca serriola							
Lolium sp seedling	0.0	0.0	0.0	0.0	0.0	0.0	3.6
Lythrum hyssopifolia							
Panicum decompositum							
Paspalum distichum							
Persicaria lapathifolia	0.0	0.0	7.4	0.0	0.0	0.0	0.0
Persicaria prostrata	0.0	2.4	0.0	0.0	0.0	0.0	0.0
Phalaris aquatica							
Polygonum aviculare							
Pseudognaphalium luteoalbum	0.0	7.3	0.0	0.0	0.0	3.4	3.6
Pseudoraphis spinescnes							
Rorippa palustris	4.8	4.9	3.7	3.8	0.0	0.0	0.0
Rumex crispus							
Scorzonera laciniata							
Senecio quadridentata	0.0	2.4	0.0	0.0	0.0	0.0	0.0
Sonchus asper							
Sonchus sp. Seedling	0.0	2.4	0.0	0.0	0.0	0.0	0.0
Stellaria caespitosa	0.0	4.9	25.9	3.8	0.0	0.0	0.0
Trifolium angustifolium							
Trifolium sp.	0.0	0.0	3.7	0.0	0.0	0.0	0.0
Walwhalleya proluta							
Dicot seedling	4.8	0.0	0.0	11.5	4.3	0.0	0.0
Monocot seedling	0.0	0.0	0.0	7.7	0.0	0.0	0.0