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Ecological response of four wetlands to the application of environmental water: Final report on monitoring from May to December 2008

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Above: Ridged Water Milfoil (*Myriophyllum porcatum*) at Moodies Swamp
Centre: Eastern Great Egrets (*Ardea modesta*) at Black Swamp
Below: Painted Burrowing Frog (*Neobatrachus sudelli*) at Moodies Swamp

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1.0 EXECUTIVE SUMMARY

The Goulburn Broken Catchment Management Authority (GBCMA) delivered environmental water allocations to three stressed wetlands in northern Victoria; including Black, Reedy and Kinnairds Swamps in the Goulburn Broken Catchment. Surplus irrigation flows in the Broken Creek were opportunistically diverted to Moodies Swamp, another wetland stressed by prolonged below average rainfall.

Water quality, vegetation, birds and frogs were monitored at each of these wetlands during seven visits. The first of these visits took place within two weeks of the commencement of environmental water delivery to each wetland in mid May. The next two visits were spaced at two week intervals and the forth visit occurred four weeks after the third in mid July. There was then an eleven week gap in monitoring while further funding was secured to continue the project, with monitoring resuming in early October then continuing monthly until December.

The delivery of environmental water resulted in positive ecological outcomes at all of the wetlands including; improvement in the condition of native vegetation, increase in the species-richness of native wetland plants observed, provision of habitat for a diverse range of wetland birds, and the stimulation of breeding behaviour amongst certain frog and water bird species.

At Black Swamp;

The condition of native wetland vegetation improved significantly over the monitoring period in response to inundation. Threatened wetland plant species that responded to environmental watering at Black Swamp included the nationally vulnerable River Swamp Wallaby-grass (*Amphibromus fluitans*), and the rare Riverina Bitter-cress (*Cardamine moirensis*) and Winged Water Starwort (*Callitriche umbonata*). Threatened non-wetland plants observed at this site included the rare Water Bush (*Myoporum montanum*), Smooth Minuria (*Minuria intergerrima*) and poorly-known Bluish Raspwort (*Haloragis glauca*). Fifty-five indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 24 species recorded during the first visit (a 130% increase in species richness).

A total of 75 bird species were recorded at Black Swamp, including 34 wetland species. Threatened wetland birds observed at Black Swamp included the endangered Australasian Bittern and Australian Little Bittern, and the vulnerable Australasian Shoveller, Ballion's Crake, Eastern Great Egret, Royal Spoonbill and White-bellied Sea-Eagle. Near-threatened non-wetland birds observed at Black Swamp included the Brown Treecreeper and Little Button Quail. Wetland birds observed breeding at Black Swamp included Black Swan, Australian Shelduck, Australian Wood Duck, Grey Teal, Pacific Black Duck, Purple Swamphen, Swamp Harrier, Whistling Kite and Australian Reed Warbler. Due to the high diversity of threatened species present and its importance as breeding habitat Black Swamp is considered to be of high conservation significance for water bird conservation.

Six species of frogs; the Common Froglet, Plains Froglet, Spotted Grass Frog, Barking Marsh Frog, Pobblebonk and Peron's Tree Frog were heard calling in this wetland.

The vulnerable Lace Monitor was observed in the Plains Woodland beside Black Swamp.

At Reedy Swamp;

The condition of native wetland vegetation improved slightly over the monitoring period in response to inundation. The only threatened plant species that responded to environmental watering at Reedy Swamp was the rare Grounsel (*Senecio campylocarpus*). Threatened non-wetland plants observed at this site included the nationally endangered Small Scurf-pea (*Cullen parvum*), the vulnerable Riverine Flax-lily (*Dianella sp. aff. longifolia (Riverina)*) and the poorly-known Plains Joyweed (*Alternanthera sp. 1*) and Short-awned Wheat-grass (*Elymus multiflorus*). 28 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 18 species recorded during the first visit (a 55% increase in species richness).

A total of 93 bird species were recorded at Reedy Swamp, including 48 wetland species. Threatened wetland birds observed at Reedy Swamp included the critically endangered Intermediate Egret, the endangered Australian Little Bittern, Blue-billed Duck, Freckled Duck and Little Egret, the vulnerable Australasian Shoveller, Ballion's Crake, Eastern Great Egret,

Hardhead, Lewin's Rail, Musk Duck, Royal Spoonbill and White-bellied Sea-Eagle and the near-threatened Glossy Ibis, Latham's Snipe and Pied Cormorant. Significant non-wetland birds recorded at Reedy Swamp included the vulnerable Powerful Owl and the near-threatened Brown Quail and Black-chinned Honeyeater.

The concentration of large numbers of the vulnerable Hardhead (over 1500 birds) at Reedy Swamp between late May and mid June is considered to be of state significance (Richard Loyn, ARI, pers. comm.). Other threatened species occurring in large numbers at Reedy Swamp included Australasian Shoveler (over 300 birds in mid July) and Glossy Ibis (70 birds in mid Nov).

Wetland birds observed breeding at Reedy Swamp included Australian White Ibis, Straw-necked Ibis, Black Swan, Australian Shelduck, Australian Wood Duck, Grey Teal, Chestnut Teal, Pacific Black Duck, Musk Duck, Dusky Moorhen, Eurasian Coot, Purple Swamphen, Swamp Harrier, Whistling Kite and Australian Reed Warbler. Due to the high diversity of threatened species present, the large numbers of particular rare species it supports, and its importance as breeding habitat and a drought refuge, Reedy Swamp is considered to be of very high conservation significance for water bird conservation.

Six species of frogs were observed at Reedy Swamp, including the locally common Plains Brown Tree Frog, Peron's Tree Frog, Common Froglet, Plains Froglet, Spotted Grass Frog and Pobblebonk. Reedy Swamp was the only wetland where the Plains Brown Tree Frog was recorded during this study. An additional species, the Painted Burrowing Frog (*Neobatrachus sudeli*), may have been detected during acoustic monitoring; however this record cannot be confirmed.

At Moodies Swamp;

The condition of native wetland vegetation improved significantly over the monitoring period in response to inundation. Threatened wetland plant species that responded to environmental watering at Moodies Swamp included the nationally vulnerable Ridged Water Milfoil (*Myriophyllum porcatum*), the endangered Slender Water Milfoil (*Myriophyllum gracile* var.

lineare), the rare Slender Water-ribbons (*Triglochin dubia*), Dwarf Brooklime (*Gratiola pumilio*), Riverina Bitter-cress (*Cardamine moirensis*), Winged Water Starwort (*Callitriche umbonata*) and Grounsel (*Senecio campylocarpus*) and the poorly-known Southern Club-sedge (*Isolepis australiensis*). Threatened non-wetland plants observed at this site included the vulnerable Riverine Flax-lily (*Dianella sp. aff. longifolia (Riverina)*) and the poorly-known Twin-flowered Chocolate Lily (*Arthropodium sp. 3*) and Bluish Raspwort (*Haloragis glauca*). A total of 47 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 13 species recorded during the first visit (a 260% increase in species richness). Due to the high diversity of threatened species present and the intact examples of endangered Ecological Vegetation Classes it supports, Moodies Swamp is considered to be of very high conservation significance for the protection of botanical values.

A total of 58 bird species were recorded at Moodies Swamp over the course of the seven monitoring events, including 17 wetland species. The only threatened wetland bird observed at Moodies Swamp was the vulnerable Brolga. Near-threatened non-wetland birds observed at Moodies Swamp included the Brown Treecreeper.

Wetland bird breeding activity observed at Moodies Swamp included a pair of Brolga calling and displaying, and Golden-headed Cisticola and Swamp Harrier nesting and raising chicks.

Six species of frogs were observed at this wetland including Sloane's Froglet, Common Froglet, Plains Froglet, Spotted Grass Frog, Painted Burrowing Frog and Peron's Tree Frog. Moodies Swamp was the only wetland where Sloane's Froglet and the Painted Burrowing Frog were recorded during this study. Sloane's Froglet is listed by the IUCN as data deficient. In the Atlas of Victorian Wildlife there are 73 records for this species, only six of which have been entered since the year 2000.

At Kinnaird's Swamp;

The condition of native wetland vegetation improved significantly over the monitoring period in response to inundation. Threatened wetland plant species that responded to environmental watering at Kinnairds Swamp included the largest known Victorian populations of the nationally

vulnerable Ridged Water Milfoil (*Myriophyllum porcatum*) and the endangered Slender Water Milfoil (*Myriophyllum gracile* var. *lineare*), and the rare Riverina Bitter-cress (*Cardamine moirensis*), Winged Water Starwort (*Callitriche umbonata*) and Spoon Mud-mat (*Glossostigma cleistanthum*). Threatened non-wetland plants observed at this site included the poorly-known Bluish Raspwort (*Haloragis glauca*). A total of 48 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 17 species recorded during the first visit (a 180% increase in species richness). Due to the high diversity of threatened species present and the intact examples of endangered Ecological Vegetation Classes it supports, Kinnairds Swamp is considered to be of very high conservation significance for the protection of botanical values.

A total of sixty-four bird species were recorded at Kinnairds Swamp, including 35 wetland species. Threatened wetland birds observed at Kinnairds Swamp included the vulnerable Australasian Shoveller, Ballion's Crake, Brolga and White-bellied Sea-Eagle and the near-threatened Glossy Ibis, Latham's Snipe and Pied Cormorant. Near-threatened non-wetland birds observed at Kinnairds Swamp included the Brown Quail. Wetland birds observed breeding at Kinnairds Swamp included Black Swan, Australian Shelduck, Pacific Black Duck and Whistling Kite.

Five species of frogs were heard calling in this wetland; Common Froglet, Plains Froglet, Spotted Grass Frog, Pobblebonk and Peron's Tree Frog.

Due to the timing of this study monitoring of ecological responses to environmental water delivery has been limited to species of flora and fauna that are physiologically active or present within the wetlands from late autumn and early summer. Additional species may occur at the wetlands in late summer and early autumn, particularly if they are still moist or holding water at this time.

The results of this monitoring project suggest that the artificial delivery of environmental water allocations can stimulate reproduction and improvements in the ecological health of indigenous vegetation communities, plants, wetland birds and frogs. The use of such environmental allocations may become a critical management tool to assist the survival of wetland biota and

communities, particularly those which are already stressed and endangered, in future periods of below-average rainfall; whether they are part of natural long-term cycles or caused by human-induced climate change.

Decision making about the delivery of environmental water allocations must be based on sound ecological knowledge and principles. Some of the results of this study provide insights into how environmental water allocations can be planned and prioritised, however further study is required to refine when and how allocations should be made.

2.0 ACKNOWLEDGEMENTS

Thanks are due to Simon Casanelia and Keith Ward of the Goulburn Broken Catchment Management Authority, and Rolf Weber of the Department of Sustainability and Environment, for providing information and input on drafts of this report. Thanks to Paul O'Connor of the Department of Sustainability and Environment for allowing us to incorporate his bird data from the weekly visits he made to the wetlands, and Jo Deretic of the Department of Primary Industries for allowing us to incorporate acoustic data collected at Reedy Swamp. Thanks also to staff at Australian Ecosystems who worked on this project; Ana Backstrom who produced the site maps, Karen Jolly who produced the graphs and formatted and edited the final report, and Dylan Osler for assistance with fieldwork and plant identifications.

3.0 INTRODUCTION

The Goulburn Broken Catchment Management Authority (GBCMA) delivered environmental water allocations to three stressed wetlands in northern Victoria; including Black, Reedy and Kinnairds Swamps in the Goulburn Broken Catchment. Surplus irrigation flows in the Broken Creek were opportunistically diverted to Moodies Swamp, another wetland stressed by prolonged below average rainfall.

Australian Ecosystems was contracted to assess and photograph the biological and hydrological changes in these four wetlands following water delivery. Specific tasks to be performed at each wetland included observing and recording birds, frogs, vegetation and water quality and quantity. Each wetland was assessed during seven separate monitoring events; in the weeks beginning 12th May, 26th May, 9th June, 7th of July, 6th of October, 17th of November and 8th of December 2008.

Australian Ecosystems is authorised to undertake vegetation surveys and collect plant specimens under DSE flora permit number 1/70/97/052. Fauna survey was undertaken under Wildlife Act Research Permit number 10004560. No special permit was required from Parks Victoria for these surveys to proceed (Bruce Wehner, PV Ranger, pers. comm.).

Throughout this report reference is made to the conservation status of indigenous flora and fauna. The following summary explains the meaning of the terms used to describe conservation status;

For fauna (DSE 2003)

cr - Critically Endangered in Victoria. A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Species Survival Commission 2001), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

E – Endangered in Australia**.** A taxon is endangered when it is not critically endangered but is facing a very high risk of extinction in the wild in the near future.

e – Endangered in Victoria. A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Species Survival Commission 2001), and it is therefore considered to be facing a very high risk of extinction in the wild in Victoria.

V – Vulnerable in Australia. A taxon is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future.

v – Vulnerable in Victoria. A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Species Survival Commission 2001), and it is therefore considered to be facing a high risk of extinction in the wild in Victoria.

nt – Near Threatened in Victoria. A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

f – Listed as threatened on the Victorian *Flora and Fauna Guarantee Act 1988* (FFG).

For flora (Walsh and Stasic, 2007)

E Endangered in Australia: at serious risk of disappearing from the wild state within one or two decades if present land use and other casual factors continue to operate.

e Endangered in Victoria: at serious risk of disappearing from the wild state if present land use and other casual factors continue to operate. A plant's status elsewhere in Australia is not considered in this category.

V Vulnerable in Australia: not presently endangered but at risk of disappearing from the wild over the next 20 to 50 years through continued depletion, or which largely occur on sites likely to experience changes in land use that would threaten the survival of the taxon in the wild.

v Vulnerable in Victoria: not presently endangered but likely to become so soon due to continued depletion; occurring mainly on sites likely to experience changes in land use that would threaten the survival of the taxon in the wild; or taxa where total populations are so low that recovery from a local natural disturbance such as drought, landslip or fire is doubtful. A plant's status elsewhere in Australia is not considered in this category.

R Rare in Australia: rare but overall not currently considered endangered or vulnerable. Such species may be represented by by a relatively large population in a very restricted area or by smaller populations spread over a wider range.

r Rare in Victoria: rare but overall not currently considered endangered or vulnerable. Such species may be represented by by a relatively large population in a very restricted area or by smaller populations spread over a wider range.

K Poorly known in Australia: suspected, but not definitely known, to belong to any of the categories endangered, vulnerable or rare. At present field distribution data is inadequate. This category applies only to taxa considered rare or threatened throughout Australia.

k Poorly known in Victoria: suspected, but not definitely known, to belong to any of the categories endangered, vulnerable or rare. Field distribution data is inadequate. A plant's status elsewhere in Australia is not considered in this category.

Plant taxonomy in this report follows the FIS standards (DSE, 2007a), with consideration to the Census of Victoria Vascular Plants (Walsh and Stajsic, 2007). Bird taxonomy follows *Systematics and Taxonomy of Australian Birds* (Christidis and Boles, 2008) while other fauna taxonomy follows the Atlas of Victorian Wildlife (DSE, 2007c). The scientific names of exotic species are preceded by an asterisk in this report.

3.1 The Study Area

Wetlands in the study area occur within the Victorian Riverina bioregion, and the conservation status of the EVCs listed below for each wetland is relevant to this bioregion.

Black Swamp is a floodplain depression on Nine Mile Creek approximately two kilometers east of Wunghnu. The swamp is about 16 hectares in area and occurs within the Black Swamp Wildlife Reserve. 90 megalitres of water was delivered to the swamp from Nine Mile Creek via a pump between the 6th and 15th of May. The swamp was topped-up with another delivery of 31 megalitres of environmental water between the 25th of September and the 2nd of October. This second delivery of water was gravity fed to the wetland via a channel directly connected to the Nine Mile Creek. Black Swamp supports extensive areas of Aquatic Grassy Wetland (EVC# 306) which is regarded as endangered, a fringe of Red Gum Swamp (EVC# 292) which is regarded as endangered, and localised areas of Tall Marsh (EVC #821) which is regarded as endangered. The swamp is surrounded by Riverine Swampy Woodland (EVC #815) which is regarded as vulnerable, and Plains Woodland (EVC #803) which is endangered.

Reedy Swamp is a large backswamp that has formed between a natural levee on the Goulburn River and a sand ridge to the east, and is located on the northern edge of Shepparton township. The swamp is about 130 hectares in area and occurs within the Reedy Swamp Wildlife Reserve. 544 megalitres of water was delivered to the swamp via a spillway from an irrigation channel between the 1st of May and the 2nd of June. The swamp was topped-up with another delivery of 100 megalitres of environmental water between the 3rd October and the 13th October. An additional 100 M/L of Environmental Water was delivered to the wetland between the 2nd of Feb 2009 and the 11th Feb 2009. Drainage inflows from rainfall within the catchment in July and August added 65mm to the water level (90 ML).

Reedy Swamp supports extensive areas of open water fringed by Tall Marsh (EVC #821) which is regarded as endangered. EVCs surrounding the wetland include Riverine Swampy Woodland (EVC #815) which is regarded as vulnerable and Sedgey Riverine Forest (EVC #816), Plains Woodland (EVC #803) and Sand Ridge Woodland (EVC #264) which are all endangered.

Moodies Swamp is located on the floodplain of the upper Broken Creek approximately two kilometers north of Waggarandall. The swamp is about 180 hectares in area and occurs within the Moodies Swamp Wildlife Reserve. 50 megalitres of water was delivered to the swamp from an irrigation channel between the 29th of April and the second week of June. Moodies Swamp supports an extensive area of Cane Grass Wetland (EVC #291) which is regarded as vulnerable and a fringe of Intermittent Swampy Woodland (EVC #813) which is regarded as depleted. The swamp is surrounded by Plains Woodland (EVC #803), Lunette Woodland (EVC #652) and Shallow Sands Woodland (EVC #882), all of which are endangered.

Kinnairds Swamp is located on the floodplain of the lower Broken Creek approximately two kilometers north east of Numurkah. It consists of a natural depression, part of which has been modified into a constructed wetland. The swamp is about 93 hectares in area and occurs on both public and private land. 413 megalitres of water were delivered to the swamp from an irrigation channel from the 30th of April and the 6th of June, however some of this Environmental Water Allocation was lost to the Broken Creek through a regulator.

Kinnairds Swamp supports an extensive area of Plains Grassy Wetland (EVC #125) and Red Gum Swamp (EVC# 292) which are both regarded as endangered and localised areas of Plains Rushy Wetland (EVC #961) which is regarded as vulnerable, Tall Marsh (EVC #821) which is regarded as endangered and Aquatic Herbland (EVC #653) which is regarded as endangered. The swamp is surrounded by Plains Grassy Woodland (EVC #55) which is endangered.

A number of fairly substantial late spring and early summer rainfall events helped to maintain water levels in Reedy, Black and Moodies Swamps.

4.0 METHODOLOGY

The four wetlands were surveyed by a team of two ecologists over two ten hour days (including travel time) during the specified monitoring periods and the following data were collected;

- → Each wetland inlet was inspected to estimate flow and functioning of the regulating structures
- → Water quality attributes – Electrical conductivity (EC), Turbidity and Temperature were recorded using a Horiba U-10 Water Quality Checker. pH and Dissolved Oxygen (DO) were tested using Eutech meters. All testing was carried out in situ and all meters were calibrated prior to use. Samples were tested at least 100 meters from the inlet structure. From 16 June onwards, at the request of the GBCMA, water quality was sampled at each quadrat where water was deep enough. Prior to this sampling was conducted at only one location. Results were compared with water quality guidelines provided by the Government of Victoria (2003), and ANZECC & ARMCANZ (2000) (see Appendix A).
- → Ecological Vegetation Classes (EVCs) in the wetland were identified along with their zone of inundation (i.e. deep marsh, shallow marsh etc). The condition of each EVC was determined using Frood's condition system, which is based on five vegetation categories that consider factors such as major impacts (i.e. logging), ecological stability (within a natural range), biodiversity persisting, presence of serious environmental weeds, and modification of critical ecological processes i.e. flooding (see Appendix B). The pre-European distribution of EVCs was also mapped using DSE's Biodiversity Interactive Mapping Tool (see Appendix C).
- → A permanent 10 X 10 metre vegetation quadrat was established in the three or four most dominant wetland EVCs (depending on the number of EVCs present) (see Appendix D), marked by a star picket at the south west corner and recorded on a handheld GPS. Flora species presence and projective cover (to the nearest 5%, with a minimum of 1%) were recorded in each quadrat (see Appendices E – H). At the request of the GBCMA an additional quadrat was established at Moodies Swamp in an area of Cane Grass Wetland that had not been inundated, so that this could be compared to the quadrats that had been flooded.

- → Photographic records of the three or four dominant EVCs in the quadrats were taken by establishing a photo point based on the south west and north-west corners of each quadrat. A general photograph of the wetland, best capturing the wetland's features, was also taken.
- → A 30 minute bird transect was conducted over approximately 250m (commencing from an established point) to observe water bird species, and their numbers and breeding activity such as courtship, nest building or chick feeding were also recorded. This transect involved a slow walk around the wetlands edge, taking care not to disturb nesting birds and the distance covered estimated and recorded. All birds within visual range of the transect were recorded; if they were flying over the wetland and were not observed landing this was noted. Birds seen or heard while conducting other activities at the wetland were recorded as incidental observations.
- → A 30 minute frog transect was carried out over approximately 250m (commencing from an established point), which focused on identifying calling frogs and an attempt was made to estimate approximate numbers of each species heard. The size of the frog populations were grouped as - less than 10 calling males, between 10 and 100 calling males or over 100 calling males. The occurrence and number of any obvious foam nests of *Limnodynastes* species were recorded along this transect. To maximize the detection of amphibian species each wetland was visited at least once at night during the course of two monitoring cycles, as frogs are generally most active between dusk and dawn. To facilitate this each monitoring event was conducted over two days, including two evenings. This made it possible to conduct nocturnal frog surveys at two of the four wetlands during each event. When examining the results of each frog survey, the time of day it was conducted should be noted.
- → A 30 minute active search for frogs and reptiles in suitable habitats around the wetland, such as under debris or at the base of tussocks, was made. All species detected during the active search were recorded under incidental observations.

Ecological data was collected at some of the wetlands by other researchers at the same time as this study. For the sake of completeness this data has been incorporated into the current report with the permission of the other researchers.

The Department of Primary Industries (DPI) conducted acoustic monitoring fortnightly at Reedy Swamp (see Appendix I). Recorders go on ever 30 minutes for 30 seconds and record for a 24 hour period. Monitoring started on 30th April and has continued ever since and will continue until Reedy Swamp becomes dry again (or at the end of the Environmental Water Allocation). Monitoring is undertaken by DPI staff from the Sustainable Irrigated Landscapes Goulburn Broken - Environment Team.

Paul O'Connor, DSE River Red Gum Forest Ecologist, undertook wetland bird monitoring surveys at three of the Goulburn – Broken wetlands in the Shepparton Irrigation Region. The surveys were conducted weekly where time permitted using a spot and sweep technique. The survey method required the surveyor to go to a number of grid referenced sites (i.e. 3 at Kinnairds Swamp, 1 central point at Black Swamp and 3 Sites at Reedy Swamp), where the site was scanned with binoculars and the number and species of birds identified.

As the vegetation cover increased at each wetland a number of transects were walked at each site / wetland as required to ensure that the total count for each wetland was fully accounted for. The assessment of each wetland took approximately 2 hours. Additional / incidental observations were also recorded where significant species or numbers of species were observed, for example on the reuse dam adjoining site 2 at Reedy Swamp. Observations on water-levels, vegetation and incidental observations of interest were also recorded on the data sheets, which were reported on to management agencies and interested parties on a weekly basis.

4.1 Limitations

The cryptic nature and seasonal growth cycles of certain plant and animal species often hinders the detection of all species during field surveys. A number of factors may affect the diversity of flora and fauna recorded, these include: climatic conditions at the time of the survey, temporal factors (the study was restricted to seasons within May to December and occurred after a prolonged period of below average rainfall) and ecosystems' responses to wetland flood duration and magnitude.

Field work for the current investigation was carried out between late autumn and early summer. Over the course of the monitoring water levels within the wetlands fluctuated depending on follow-up water delivery, natural rainfall and natural evaporation and draw down. By the last monitoring event Moodies and Kinnairds Swamp were mostly dry, while Black and Reedy Swamps still contained water. Further mud flat colonising plant species are likely to become apparent at Black and Reedy Swamps as they continue to dry out.

At the beginning of this study it was difficult at some sites to determine the EVCs present and assess their condition, as prolonged drying of the wetlands had caused many indigenous wetland species to become dormant and allowed the invasion of terrestrial weeds. Following the delivery of environmental flows and as the monitoring project has progressed the condition, composition and distribution of EVCs has become clearer and these attributes have been revised from the previous summary reports.

As the wetlands were quite large and supported areas of dense cover it was difficult to accurately estimate bird numbers and detect all cryptic bird species, particularly if they were not calling. Notwithstanding the above limitations, flora and fauna species were recorded and sites assessed as accurately as possible to address the project objectives and produce meaningful results.

Further monitoring in late summer and autumn would be useful to document the response to the delivery of environmental water allocations of species of flora and fauna active or present during these seasons. In addition monitoring the response to flooding events of different duration and magnitude at each site may also provide further information.

5.0 RESULTS

5.1 BLACK SWAMP

5.1.1 Water

Ninety megalitres of water were delivered to Black Swamp from Nine Mile Creek via a pump between the 6th and 15th of May 2008. At the time of the initial survey, on the 17th of May, the deepest area of the wetland was about 400mm deep. By the fourth survey this level had dropped by 70 mm due to evaporation and possibly absorption into the ground. The swamp was topped-up with another delivery of 31 megalitres of environmental water between the 25th of September and the 2nd of October. This second delivery of water was gravity fed to the wetland via a channel directly connected to the Nine Mile Creek. By the final visit in December water had receded to a maximum depth of 150 mm. No surface water remained in the swamp by early January.

The **pH** ranged from 6.2 in 17 May 2008 to 7.1 in 9 December 2008 with an average of 6.5. On several occasions the pH was lower than the EPA and ANZECC guidelines for pH being ≥6.4-≤7.7 and 6.6-8.0 respectively (see Appendix A). The most frequently low pH was recorded in Quadrat 2 (4 out of 5 occasions) and Quadrat 4 (3 out of 5 occasions). Both of these sites were heavily vegetated and would have been affected by plant matter.

Temperature fluctuated between 8.9 ℃ in July 2008 to 22.4 ℃ in 9 December 2008.

Dissolved oxygen (DO) ranged from 30% to 130% with an average of 82%. DO concentrations recorded at this site were both below and above the EPA objectives of between ≥85-110% on different occasions. Low DO was consistently recorded at quadrat 4 which was located in a clump of *Typha orientalis* and would therefore have been affected by decomposing vegetation. Quadrat 2 also contained dense vegetation and was occasionally affected by plant decomposition. High DO readings may have been due to increased photosynthesis at the sites and/or windy conditions.

Conductivity ranged from 84 to 368 µS/cm^{-1} with an average of 212 µS/cm^{-1}. There was a direct correlation between water levels and Electrical Conductivity, as water levels dropped salt

concentrations became more concentrated and EC increased. On all sampling occasions EC levels exceeded ANZECC & ARMCANZ (2000) guidelines of 20-30 µS/cm^3 but were well within the Government of Victoria (2003) guidelines of 500µS/cm^3, which are regional guidelines which more reflect local conditions. The EC at Black Swamp is consistent with that of other nearby Shepparton wetlands (see Table 47).

Turbidity ranged from 7 to 55 NTU with an average of 19 NTU. Turbidity varied little between May and October 08 at around 10 NTU. These concentrations were well within both Government of Victoria (2003) and ANZECC (2000) guidelines of ≤30 and 1-20 NTU respectively. November and December 2008 had more elevated turbidity levels which exceeded both Government of Victoria (2003) and ANZECC & ARMCANZ (2000). This may have been related to wet and windy conditions prior and during these sampling events.

Table 1. Temporal change in water quality at Black Swamp

Red= exceeds both EPA (2003) and ANZECC & ARMCANZ (2000), Yellow= exceeds Government of Victoria (2003) only, Green exceeds ANZECC & ARMCANZ (2000) only (see Appendix A).

	Units	17-May-08	30-May-08	14-Jun-08			12-Jul-08			6-Oct-08			18-Nov-08			9-Dec-08			Average
Quadrat				Q2	Q3	Q4	Q2	Q3	Q4	Q2	Q3	Q4	Q2	Q3	Q4	Q2	Q3	Q4	
Depth	mm	400	380	250	350	260	230	330	240	350	400	350	110	190	140	80	150	100	–
pH		6.2	6.6	6.4	7.0	6.6	6.3	6.9	6.7	6.5	6.0	6.0	6.5	6.8	6.4	6.6	7.1	6.3	**6.5**
Temp	℃	13.4	13.8	12.0	12.4	11.1	9.2	9.2	8.9	18.0	17.9	16.9	20.0	21.0	18.3	21.5	22.4	20.0	**15.6**
DO	%	76	111	97	107	30	79	108	60	Na	Na	Na	60	85	58	130	100	45	**81.9**
Conductivity	µS/cm^3	84	124	145	126	159	147	129	147	200	200	190	290	293	300	344	359	368	**212**
Turbidity	NTU	10 - 15	≤10*	≤10	≤10	≤10	≤10	7	≤10	10-15	20-30	10-15	17	40	10	49	25	55	**19**

*Change of meter used from turbidity tube to Horiba multi-meter; Na, DO probe damaged in October 2008 monitoring event; Depth measured at south west corner of quadrat.

5.1.2 Vegetation

On the Department of Sustainability and Environment Biodiversity Interactive Maps (DSE, 2008) Black Swamp is shown as supporting Red Gum Swamp (EVC 292). In its pre-European condition this wetland had a canopy of large River Red Gums (*Eucalyptus camaldulensis*), most of which are now dead. The composition and structure of the field-layer of most of the swamp has also been highly modified. Tree death and change in floristics have been caused by human-induced changes to the swamps hydrology, which led to it being inundated for prolonged periods (see Photograph 1).

Photograph 1. Black Swamp. A few living sapling occur around the edge of the wetland, but all large trees in the deepest part of the swamp are dead.

Currently only a fringe of the original Red Gum Swamp vegetation exists around the edge of the wetland, although with the restoration of an appropriate hydrological regime this EVC should recolonise the entire wetland. At this site this EVC consists of a fairly dense canopy of River Red Gum over a field-layer composed of Rush Sedge (*Carex tereticaulis*), Common Blown-

grass (*Lachnagrostis filiformis var. 1*) and Forde Poa (*Poa fordeana*); this EVC was sampled in quadrat 1 (see Appendix E quadrat data). The moderate condition of this EVC remained stable throughout the monitoring period. Moderate condition according to Frood's condition scores means that the EVC is "disturbed but still readily identifiable; extinction-prone species mostly displaced but a substantial component of indigenous flora persisting (at least at low levels); serious environmental weeds often present or otherwise significant ecological invasions occurring; and substantial modifications to critical ecological processes."

Species in the Red Gum Swamp that responded to environmental watering included Common Swamp Wallaby-grass (*Amphibromus nervosus*), Common Spike-rush (*Eleocharis acuta*) and Moira Grass (*Pseudoraphis spinescens*). As water levels receded other species such as Old Man Weed (*Centipeda cunninghamii*), Lesser Joyweed (*Alternanthera denticulata*) and Water Pepper (*Persicaria hydropiper*) germinated in the drying mud.

Two other EVCs can now be recognised within Black Swamp, which have become established under the altered hydrological regime; Aquatic Grassy Wetland and Tall Marsh. These EVCs were sampled in quadrats 2, 3 (Aquatic Grassy Wetland) and 4 (Tall Marsh) and were initially given poor condition scores because they are the result of major disruption to the critical ecological processes of wetting and drying. Poor condition according to Frood's condition scores mean that the EVCs are "degraded, with only a minor component of original flora persisting; structure of the vegetation substantially modified; serious environmental weeds often prevalent within at least part of the system or significant ecological invasions advanced; and system substantially disrupted due loss of critical ecological processes." The condition of these EVCs was beginning to improve by the last monitoring event, and should continue to do so if a wetting and drying cycle mimicking natural conditions is maintained.

The aim of management of this wetland should be to restore the Red Gum Swamp EVC by returning a more natural hydrological regime to the area, which should generally flood the swamp over winter and spring and allow it to draw down and regularly dry out completely over summer and autumn. Such a hydrological regime would encourage River Red Gums to re-colonize the wetland floor, reduce the vigour of Tall Marsh species and aquatic weeds such as Water Couch (**Paspalum distichum*) and Sagittaria (**Sagittaria platyphylla*) and assist the

regeneration of a more natural understorey, therefore improving the swamps ecological condition.

Indigenous species which have been regenerating across the wetland in response to the delivery of environmental water provide an insight into the wetlands original vegetation. On the fringe of the swamp the dominant indigenous species are Common Swamp Wallaby-grass (*Amphibromus nervosus*), Common Spike-rush (*Eleocharis acuta*), Rush Sedge (*Carex tereticaulis*), Tussock Rush (*Juncus aridicola*), Red Pondweed (*Potamogeton cheesemanii*), Common Blown-grass (*Lachnagrostis filiformis var. 1*), Southern Cane Grass (*Eragrostis infecunda*), Common Nardoo (*Marselia drummondii*) and Narrow-leaf Dock (*Rumex tenax*). Deeper central sections of the swamp support Red Water Milfoil (*Myriophyllum verrucosum*), Swamp Lily (*Ottelia ovalifolia*), Blunt Pondweed (*Potamogeton ochreatus*), Eel-grass (*Vallisneria americanai*), River Swamp Wallaby-grass (*Amphibromus fluitans*) and Clove-strip (*Ludwigia peploides subsp. montevidensis*).

A steady increase in the diversity of wetland plant species has occurred over the time since the environmental water delivery to the wetland (see Figure 1).

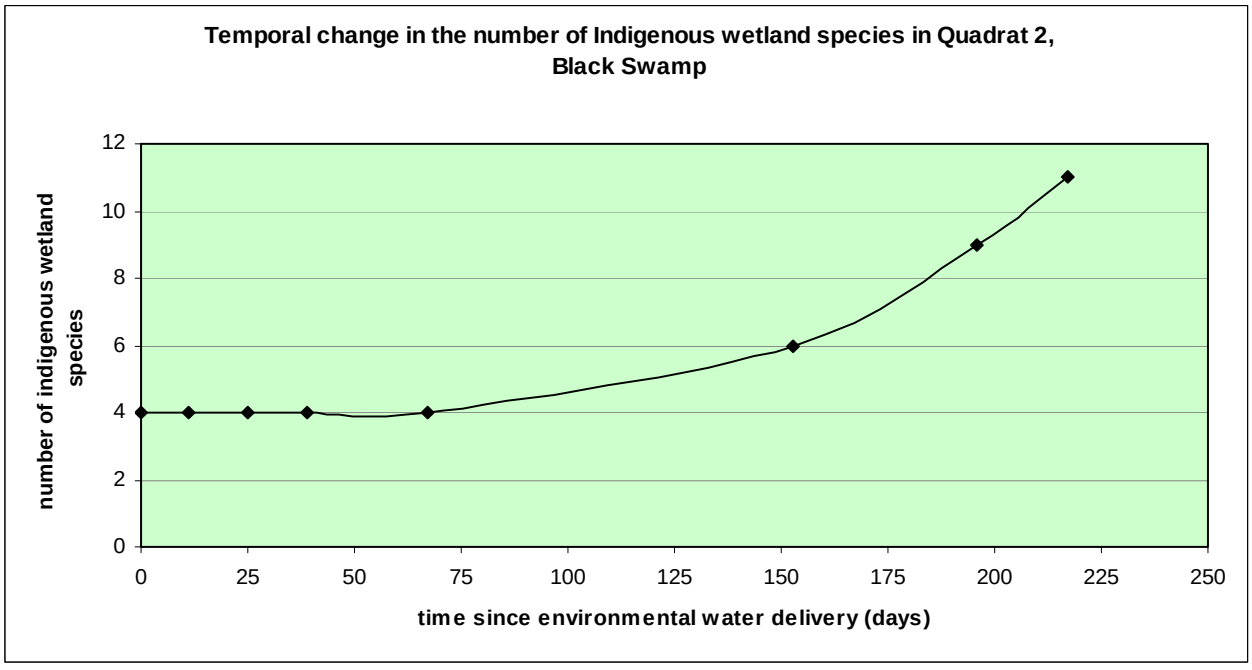


Figure 1. Temporal change in the number of Indigenous wetland plant species recorded in quadrat 2, Black Swamp

Fifty-five indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 24 species recorded during the first visit (a 130% increase in species richness). The 6 threatened species recorded at Black Swamp are listed in Table 2.

Table 2. Threatened species recorded at Black Swamp

Status	Species	Common Name	Location
r	*Callitriche umbonata*	Winged Water Starwort	(UTM WGS84 360692/5999268)
r	*Cardamine moirensis*	Riverina Bitter-cress	(UTM WGS84 360692/5999268)
r	*Minuria intergerrima*	Smooth Minuria	
Vk	*Amphibromus fluitans*	River Swamp Wallaby-grass	(UTM WGS84 360689/5999248) (UTM WGS84 360916/5999571)
r	*Myoporum montanum*	Waterbush	(UTM WGS84 3619019/5999108)
k	*Haloragis glauca*	Bluish Raspwort	

The growth and reproduction of the River Swamp Wallaby-grass, Winged Water Starwort and Riverine Bitter-cress were enhanced by the allocation of environmental water to the swamp.

The Biodiversity Interactive Map (DSE, 2008) shows the area surrounding Black Swamp as Plains Grassy Woodland/Gilgai Wetland mosaic (see Appendix C), however this classification is incorrect. The swamp is actually surrounded in equal amounts by Plains Woodland and Riverine Swampy Woodland.

Photograph 2. Plains Woodland on the southern edge of Black Swamp

Table 3. Indigenous vascular plants recorded at Black Swamp

Status	Species	Common Name	Wetland species
	Acacia dealbata (planted)	Silver Wattle	
	Acacia mearnsii (planted)	Black Wattle	
	Acacia montana	Mallee Wattle	
	Alisma plantago-aquatica	Water Plantain	w
	Alternanthera denticulata	Lesser Joyweed	w
Vk	*Amphibromus fluitans*	River Swamp Wallaby-grass	w
	Amphibromus nervosus	Common Swamp Wallaby-grass	w
	Arthropodium minus	Small Vanilla-lily	
	Atriplex semibaccata	Berry Saltbush	
	Austrodanthonia caespitosa	Common Wallaby-grass	
	Austrodanthonia duttoniana	Brown-back Wallaby-grass	w
	Austrodanthonia setacea	Bristly Wallaby-grass	
	Austrostipa aristiglumis	Plump Spear-grass	
	Austrostipa elegantissima	Feather Spear-grass	
	Austrostipa gibbosa	Spear-grass	
	Austrostipa scabra subs. falcata	Rough Spear-grass	
	Azolla filiculoides	Pacific Azolla	w
	Brachyscome basaltica var. gracilis	Swamp Daisy	w
	Bursaria spinosa (planted)	Sweet Bursaria	
	Callistemon sp (planted)	Bottlebrush	
r	*Callitriche umbonata*	Water-starwort	w
	Calocephalus citreus	Lemon Beauty-heads	
	Calotis scapigera	Tufted Burr-daisy	w
r	*Cardamine moirensis*	Riverina Bitter-cress	w
	Carex gaudichaudiana	Fen Sedge	w
	Carex inversa	Common Sedge	
	Carex tereticaulis	Rush Sedge	w
	Cassinia arcuata(planted)	Drooping Cassinia	
	Centipeda cunninghamii	Common Sneezeweed	w
	Chenopodium pumilio	Clammy Goosefoot	
	Crassula decumbens var. decumbens	Spreading Crassula	
	Crassula sieberiana ssp. tetramera	Australian Stonecrop	

Status	Species	Common Name	Wetland species
	Cyperus difformis	Variable flat-sedge	w
	Damasonium minus	Star-fruit	w
	Dianella admixta	Black-anther Flax-lily	
	Einadia nutans subsp. nutans	Nodding Saltbush	
	Elatine gratioloides	Waterwort	w
	Eleocharis acuta	Common Spike-sedge	w
	Eleocharis pusilla	Small Spike-sedge	w
	Enchylaena tomentosa var. tomentosa	Ruby Saltbush	
	Enteropogon acicularis	Spider Grass	
	Epilobium billardierianum var. cinereum	Grey Willow-herb	w
	Eragrostis infecunda	Southern Cane-grass	w
	Eucalyptus camaldulensis	River Red-gum	w
	Eucalyptus microcarpa	Grey Box	
	Eucalyptus tricarpa (planted)	Red Ironbark	
	Euchiton sphaericus	Annual Cudweed	
k	*Haloragis glauca*	Bluish Raspwort	
	Helichrysum luteoalbum	Jersey cudweed	
	Juncus amabilis	Hollow Rush	w
	Juncus aridicola	Tussock Rush	w
	Juncus bufonius	Toad Rush	w
	Juncus ingens	Giant Rush	w
	Juncus subsecundus	Finger Rush	
	Juncus usitatus	Billabong Rush	w
	Lachnagrostis filiformis var. 1	Common Blown-grass	w
	Lemna disperma	Common Duckweed	w
	Limosella australis	Austral Mudmat	w
	Lobelia concolor	Poison Pratia	w
	Lobelia pratioides	Poison Lobelia	w
	Lomandra effusa	Scented Mat-rush	
	Ludwigia peploides subsp. montevidensis	Clove-strip	w
	Lythrum hyssopifolium	Small Loosestrife	w

Status	Species	Common Name	Wetland species
	Lythrum hyssopifolium	Small Loosestrife	w
	Maireana enchylaenoides	Wingless Bluebush	
	Marsilea drummondii	Common Nardoo	w
	Marsilea hirsuta	Short-fruit Nardoo	w
	Melaleuca lanceolata (planted)	Moonah	
	Mentha satureoides	Creeping Mint	
r	*Minuria integerrima*	Smooth Minuria	
	Muehlenbeckia florulenta	Tangled Lignum	w
r	*Myoporum montanum*	Water bush	
	Myriophyllum crispatum	Upright Milfoil	w
	Myriophyllum papillosum	Robust Milfoil	w
	Myriophyllum verrucosum	Red Milfoil	w
	Ottelia ovalifolia subs. ovafolia	Swamp Lilly	w
	Oxalis perennans	Grassland Wood-sorrell	
	Persicaria hydropiper	Water Pepper	w
	Persicaria lapathifolia	Pale Knotweed	w
	Phragmites australis	Common Reed	w
	Pittosporum angustifolium	Weeping Pittosporum	
	Plantago varia	Variable Plantain	
	Poa fordeana	Forde Poa	w
	Poa labillardierei var. labillardierei	Common Tussock-grass	
	Potamogeton cheesemanii	Red Pondweed	w
	Potamogeton ochreatus	Blunt Pondweed	w
	Pseudoraphis spinescens	Spiny Mud Grass	w
	Ranunculus pumila var. pumilio	Ferny Small-flower Buttercup	w
	Rumex brownii	Slender Dock	
	Rumex tenax	Narrow-leaf Dock	w
	Sida corrugata	Variable Sida	
	Solenogyne dominii	Smooth Solenogyne	
	Spergularia brevifolia	Sea-spurrey	
	Swainsona procumbens	Broughton Pea	w
	Teucrium racemosum	Grey Germander	
	Typha orientalis	Cumbungi	w

Status	Species	Common Name	Wetland species
	Typha domingensis	Narrow-leaf Cumbungi	w
	Vallisneria americana var. americana	Eel Grass	w
	Vittadinia cuneata var. cuneata	Fuzzy New Holland Daisy	
	Wahlenbergia fluminalis	River Bluebell	
	Walwhalleya proluta	Rigid Panic	w
	Total Indigenous Species	**101**	

Table 4. Exotic plants recorded at Black Swamp Survey

Species	Common Name	Wetland species
**Aster subulatus*	Aster-weed	w
**Atriplex prostrata*	Hastate Orache	
**Avena barbata*	Bearded Oat	
**Callitriche hamulata*	Thread Water Starwort	w
**Callitriche stagnalis*	Water Starwort	w
**Cirsium vulgare*	Spear Thistle	
**Conyza bonariensis*	Tall Fleabane	
**Cotula bipinnata*	Ferny Cotula	
**Crassula natans var. minus*	Water Crassula	w
**Cynodon dactylon var. dactylon*	Couch	
**Cyperus eragrostis*	Drain flat-sedge	w
**Helminthotheca echioides*	Ox-tongue	
**Hypochoeris glabra*	Smooth Cat's-ear	
**Hypochoeris radicata*	Cat's Ear	
**Lactuca serriola*	Prickly Lettuce	
**Lilaea scilloides*	Lilaea	w
**Lolium rigidum*	Wimmera Rye-grass	
**Paspalum dilatatum*	Paspalum	
**Paspalum distichum*	Water Couch	w
**Phalaris paradoxa*	Paradoxical Canary-grass	
**Polygonum aviculare*	Prostrate Knotweed	
**Ranunculus muricatus*	Sharp Buttercup	
**Rumex crispus*	Curled Dock	
**Sagittaria platyphylla*	Sagittaria	w
**Sonchus asper*	Prickly Sour Thistle	
**Sonchus oleraceus*	Common Sow-thistle	
**Trifolium arvensis*	Hate's-foot Clover	
**Trifolium dubium*	Suckling Clover	
Total Exotic Species	**28**	

5.1.3 Birds

A total of 75 bird species were recorded at Black Swamp, including 34 wetland species (see Tables 7 and 8 for bird lists). The diversity and numbers of wetland bird species present at Black Swamp peaked in early October 2008. Non-wetland bird diversity increased dramatically around the wetland approximately 2 weeks after it had been filled. This increase in diversity included a number of parrot species examining hollows in dead Red Gums. These birds may normally nest in the dead red gums whether the wetland is full or not, but were possibly specifically seeking out trees surrounded by water as safe nesting sites. The overall increase in non-wetland bird diversity around the wetland may also indicate a response by these species to a general increase in food resources, such as insect prey items, due to the swamp being flooded. Non-wetland bird diversity increased again in November and December 2008 with the arrival of summer migrants from further north.

Due to the high diversity of threatened species present and its importance as breeding habitat Black Swamp is considered to be of high conservation significance for water bird conservation.

Table 5. EPBC Act and AVW threatened fauna species occurring at Black Swamp

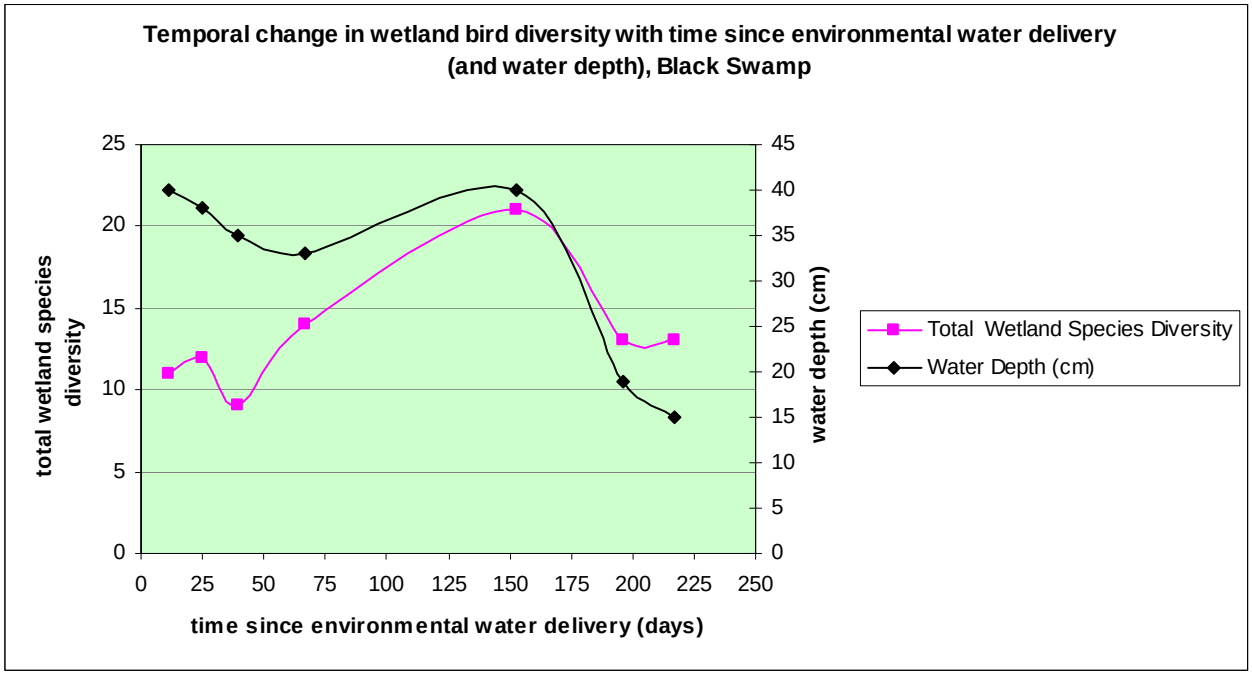
FFG	EPBC	VROT	Common Name	Scientific Name
f		e	Australasian Bittern	*Botaurus poiciloptilus*
		v	Australasian Shoveler	*Anas rhynchotus*
f		e	Australian Little Bittern	*Ixobrychus dubius*
f		v	Ballion's Crake	*Porzana pusilla palustris*
		nt	Brown Treecreeper	*Climacteris picumnus victoriae*
f		v	Eastern Great Egret	*Ardea modesta*
		nt	Little Button-quail	*Turnix velox*
		v	Royal Spoonbill	*Platalea regia*
f		v	White-bellied Sea-Eagle	*Haliaeetus leucogaster*
		v	Lace Monitor	*Varanus varius*

Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site

Table 6. Summary Table of Wetland and non-wetland bird species diversity and abundance at Black Swamp

	17-May-08	30-May-08	14-Jun-08	12-Jul-08	06-Oct-08	17-Nov-08	09-Dec-08
Days since inundation	11	25	39	67	153	196	217
Total Wetland Species Diversity	11	12	9	14	21	13	13
Total Transect Wetland Species Diversity	7	12	7	12	16	13	12
Native Wetland Species Transect Only Abundance	165	108	150	150	186	172	101
Total non-wetland birds Species Diversity	8	18	18	17	17	22	23
Total transect non-wetland birds species diversity	1	14	8	8	13	17	15
Native non-wetland birds Species Transect Only Abundance	11	92	40	94	84	85	99

Figure 2. Graph of bird diversity versus time since inundation



Photograph 3. Eastern Great Egrets in breeding plumage, Black Swamp

Photograph 4. Female Little Button Quail, Black Swamp

Table 7. Wetland Birds observed at Black Swamp

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00-3.30pm	3:00-3.30pm	4:00-4.30pm	3:00 -3.30pm	10.30–11:00am	12:00-12.30pm
e	Australasian Bittern							
	Australasian Grebe				(1)	2		
e	Australian Little Bittern							
	Australian Pelican						2	5
	Australian Reed Warbler				2 calling	1 displaying		
	Australian Shelduck	(2)		(6)	6 three pairs courting	2		
	Australian Wood Duck	18	4	(7) examining hollows	2 (20) some examining hollows	2		
v	Australasian Shoveller			3				
v	Ballion's Crake							
	Black-tailed Native Hen					6	8	
	Black-fronted Plover							1
	Black Swan	2	10	8	12			
v	Eastern Great Egret					(1)	2 with young	2
	Grey Teal	36	25	19	4	44	55	20
	Hoary-headed Grebe		1					

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00-3.30pm	3:00-3.30pm	4:00-4.30pm	3:00 -3.30pm	10.30–11:00am	12:00-12.30pm
	Little Grassbird		1		1	(1)	0	(1)
	Little Pied Cormorant					7	3	
	Masked Lapwing		2					2
	Pacific Black Duck	50	12	12	4	37 observed mating	20	4
	Black-fronted Dotterel							1
	Purple Swamphen	1	1		2	3	11	
	Royal Spoonbill						2	10
	Australian White Ibis		19 flying over			6	32	4
	Sacred Kingfisher				(1)	(1)		
	Spotless Crake							
	Straw-necked Ibis	(2)				(4)		
	Swamp Harrier	(1)	1			1		
	Tree Martin #		2		10	10		
	Welcome Swallow #	50	30	100+	100+	50	20	40
	Whistling Kite #	1		1(3)	2 a pair courting	2 a pair courting		
v	White-bellied Sea-Eagle							
	White-faced Heron	(2)				1	5	4

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00-3.30pm	3:00-3.30pm	4:00-4.30pm	3:00 -3.30pm	10.30–11:00am	12:00-12.30pm
	White-necked Heron			1	3 including 1 immature	5 including 1 in breeding plumage	6 3 adult, 3 juvenile	
	Yellow-billed Spoonbill					(4)	6	7
	Total Wetland Species Diversity	11	12	9	14	21	13	13
	Total Transect Wetland Species Diversity	7	12	7	12	16	13	12
	Native Wetland Species Transect Only Abundance	165	108	150	150	186	172	101

Species shown with a shaded background were observed breeding at this site; Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect.

The Welcome Swallow, Tree Martin and Whistling Kite are not strictly wetland species; however they are often quite closely associated with wetlands. They have been included in this category as they appeared to have been attracted to the wetlands to prey on species that are reliant on the wetlands containing water, and for this reason could be considered to have directly benefited from the delivery of environmental water.

Wetland birds observed breeding at Black Swamp included Black Swan, Australian Shelduck, Australian Wood Duck, Grey Teal, Pacific Black Duck, Purple Swamphen, Swamp Harrier, Whistling Kite and Australian Reed Warbler.

Table 8. Non-wetland Birds observed at Black Swamp

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00 – 3.30pm	3:00 – 3.30pm	4:00-4.30pm	3:00 - 3.30pm	10.30–11:00am	12:00-12.30pm
	Australian Hobby					1		
	Australian Magpie		1	3		2	(1)	4
	Australian Magpie Lark			4 (2)		4	1	4
	Australian Raven			(2)	(2)	1	(4)	(2)
	Barn Owl					(1)		(1)
	Black-faced Cuckoo-shrike	(1)			2			
	Brown Falcon	(2)			(1)	(1)		
	Brown Goshawk		1		(2)	(1)		
nt	Brown Treecreeper		2	(2)	6	6	4	4 (1)
	Cockatiel							1
	Crested Pigeon		(1)				1	
	Crested Shrike-tit				(1)			
	Eastern Rosella			(2)	(4)		2	2
	Flame Robin	(1)		(2)				0
	Galah		2	2 examining hollows	40+ examining hollows	20	26	20
	Grey Fantail	(1)			(1)			

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00 – 3.30pm	3:00 – 3.30pm	4:00-4.30pm	3:00 - 3.30pm	10.30–11:00am	12:00-12.30pm
	Grey Shrike-thrush		1	(1)	(1)			
	Horsefield's Bronze Cuckoo		(1)					
	Kookaburra	(1)			1		2	1
nt	Little Button-quail							(1)
	Little Corella		2	2	(10)	2	3	
	Magpie Lark	2	12	4	12			
	Masked Wood swallow						2	6 nesting
	Nankeen Kestrel					2 pair courting	2 nesting**	
	Noisy Friarbird				1			
	Noisy Miner	(1)	(2)	(4)	4	6		(6)
	Peregrine Falcon	(2)	1			0	2	1
	Pied Butcherbird			(1)		0	(2)	(1)
	Pied Currawong		1					
	Red-rumped Parrot		40	4 (40) examining hollows		10	14	20
	Restless Flycatcher		2	2			1	1

		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	9-Dec-08
Status	Time of Day	2.30-3.00pm	3:00 – 3.30pm	3:00 – 3.30pm	4:00-4.30pm	3:00 - 3.30pm	10.30–11:00am	12:00-12.30pm
	Southern Bookook			(1)			(2)	(2)
	Striated Pardalote		6	2		2	4	10
	Sulphur-crested Cockatoo		14			1	2	4
	Superb Fairy Wren				(4)			
	Tawny Frogmouth						(1)	(1)
	White-plumed Honeyeater		(1)	(1)	2	(2)	5	0
	White-winged Chough							5
	Willie Wagtail		2	3		2	2	2
	Zebra Finch						2 nesting	
	*Starling		(3)	(6)	2		5	6 (1)
	Total non-wetland birds Species Diversity	**8**	**18**	**18**	**17**	**17**	**22**	**23**
	Total Transect non-wetland birds Species Diversity	**1**	**14**	**8**	**8**	**13**	**17**	**15**
	Native non-wetland birds Species Transect Only Abundance	**11**	**92**	**40**	**94**	**84**	**85**	**99**

Species shown with a shaded background were observed breeding at this site; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect. ** Carrying several baby brown snakes to nest

5.1.4 Frogs

Six species of frogs were heard calling in Black Swamp, all of which are regionally common. The abundance of each species of frog calling at the wetland varied due to the timing of each survey (day or night) and environmental conditions such as water temperature. Black Swamp was the only wetland where the Barking Marsh Frog was recorded during this study. This species was only recorded during the final visit, possibly because prior to this water temperatures were not high enough to trigger breeding for this species. In contrast the Common Froglet was only heard calling at this site in cooler conditions up until July.

Table 9. Frogs observed at Black Swamp

Date and Time		17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	17-Nov-08	8-Dec-08
Species heard calling	Common Name	14.30 – 15.00	18.20 – 19.00	19.30 – 20.00	19.00 – 19.30	20.00 – 20.30	22.30 -23.00	23.00-23.30
Crinia signifera	Common Froglet	10-100	>100	>100	>100	O		
Crinia parinsignifera	Plains Froglet	<10	10-100	<10	>100	10-100	<10	
Limnodynastes tasmaniensis (NCR)	Spotted Marsh Frog (northern call race)	<10	10-100	<10	10-100	>100	10-100	10-100
Limnodynastes dumerili	Pobblebonk					>100	<10	(<10)
Litoria peronii	Peron's Tree Frog						10-100	10-100
Limnodynastes fletcheri	Barking Marsh Frog							10-100
Number of egg-masses observed						1		

Estimated abundance heard calling: <10, 10-100, >100, O = observed; Transect length 200m for 30 min; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect

5.1.5 Other Fauna

Table 10. Reptiles observed at Black Swamp

Status	Scientific Name	Common Name
	Chelodina longicollis	Eastern Long-necked Turtle
	Morethia boulengeri	Boulenger's Skink
	Notechis scutatus	Tiger Snake
	Pseudonaja textalis	Eastern Brown Snake
v	*Varanus varius*	Lace Monitor

Table 11. Mammals observed at Black Swamp

Status	Scientific Name	Common Name
	**Felis cattus*	Cat
	**Lepus capensis*	Hare
	**Vulpes vulpes*	Red Fox
	Macropus giganteus	Eastern Grey Kangaroo
	Trichosaurus vulpecula	Common Brushtail Possum
	Wallabia bicolor	Swamp Wallaby

5.2 REEDY SWAMP

5.2.1 Water

Approximately 544 megalitres of water was delivered to Reedy Swamp via a spillway from an irrigation channel between the 1st of May and the 2nd of June 2008. Water levels peaked in the wetland around the end of May with a maximum depth of 700mm (measured at quadrat 3). By the fourth monitoring event on the 13th of July the maximum water level had dropped to 650mm. Drainage inflows from rainfall within the catchment in July and August added 65mm to the water level (90 ML). By the final visit in December water had receded to a maximum depth of 560 mm.

An additional 100 M/L of Environmental Water was delivered to the wetland between the 2nd of February 2009 and the 11th February 2009.

The **pH** ranged from 5.95 to 7.2 in Nov 2008 with an average of 6.5. At quadrat 2, which was shallow and abundant in both live (*Juncus ingens*) and decomposing vegetation pH was lower than the EPA and ANZECC guidelines for pH being ≥6.4-≤7.7 and 6.6-8.0 respectively (see Appendix A).

Temperature fluctuated between 7.8 ℃ in July 2008 to 26.3 ℃ in December 2008.

Dissolved oxygen ranged from 10% to 166% with an average of 98%. DO concentrations fell outside the EPA objectives of between ≥85-110% on all occasions. Quadrat 2 is shallow and full of decaying vegetation and therefore has predominantly low DO concentrations with an exception on 10th of December 2008. Quadrat 3 however is open water and exposed to wind and therefore has predominantly higher DO readings with the exception of on 10th June 2008. The supersaturated conditions at quadrat 3 may be a mixture of turbulence and elevated algal growth.

Low and high dissolved oxygen levels can make it difficult for aquatic species to survive. Tolerances vary between species (Boulton and Brock, 1999), and therefore DO levels will influence the composition and diversity of aquatic communities.

Conductivity ranged from 122 to 327 µS/cm^{-1} with an average of 237 µS/cm^{3}. These levels exceed ANZECC guidelines of 20-30 µS/cm^{3} but are well within the EPA guidelines for this region (500 µS/cm^{3}). These levels are also consistent with EC readings from the other wetlands tested and with nearby Shepparton urban lakes (see Table 36).

Turbidity did not vary greatly at Reedy Swamp, with concentrations between 5 and 30 at the two sites where it was measured. However in December 2008 there were elevated turbidity levels at both sites which exceeded both EPA and ANZECC guidelines. This may have been related to the windy and rainy conditions at the site during monitoring.

Table 12. Temporal change in water quality at Reedy Swamp

Red= exceeds both EPA (2003) and ANZECC & ARMCANZ (2000), Yellow= exceeds GOVERNMENT OF VICTORIA (2003) only, Green exceeds ANZECC & ARMCANZ (2000) only (see Appendix A).

	Units	18-May-08	30-May-08	14-Jun-08		13-Jul-08		6-Oct-08		19-Nov-08		10-Dec-08		Average
Quadrat				Q2	Q3	Q2	Q3	Q2	Q3	Q2	Q3	Q2	Q3	
Depth	mm	600	700	250	650	250	650	180	500	130	530	140	560	-
pH		6.1	7.1	6.2	6.6	6.4	6.6	6.5	6.5	6.0	7.2	6.2	6.9	**6.5**
Temp	℃	12.0	14.0	10.0	10.0	7.8	8.6	13.3	14.0	21.4	22.4	24.2	26.3	**15.3**
DO	%	66.7	166	70	47	68	135	Na	Na	*10	128	125	160	**97.6**
Conductivity	µS/cm^{-1}	122	135	177	174	208	207	300	300	327	306	316	277	**237**
Turbidity	NTU	20-30	10*	≤10#	≤10	≤10	≤10	20-30	20-30	14	24	76	110	**29**

*Change of meter used from turbidity tube to Horiba multi-meter; Na: DO probe damaged in October 2008 monitoring event; Depth measured at south west corner of quadrat. # Full of decomposing vegetation and zooplankton

5.2.2 Vegetation

While the central section of Reedy Swamp is naturally treeless, some areas of the swamp support dead or dying River Red Gums (*Eucalyptus camaldulensis*), some of which are very large (see Photograph 5). The number and size of these dead Red Gums suggests that the hydrology of this wetland has been substantially modified by human-induced disturbances. Death of the River Red Gum canopy across parts of the wetland suggests that the composition and structure of the field-layer of the swamp may also have been modified. In its pre-European condition Reedy Swamp may have in fact been a large Rushy Riverine Swamp (EVC 804).

Photograph 5. Rushy Riverine Swamp at Reedy Swamp. Note the many dead River Red Gums in the centre of the swamp indicating a historic change in water regime.

The condition of indigenous vegetation in and around Reedy Swamp is now generally fairly degraded. The provision of environmental water to this wetland did not have the same effect of dramatically increasing the diversity of indigenous wetland plants as it had on the other monitored wetlands, at least in the short term. This may have been due to its poorer condition. The ecological condition of vegetation at this site may be improved in the longer term through

the re-instatement of a hydrological regime more closely resembling that which it had prior to changes caused by European land use.

Much of the eastern edge of Reedy Swamp is fringed by Riverine Swampy Woodland, and this EVC was sampled in quadrat 1. At this site this EVC has a reasonably dense canopy of River Red Gum (*Eucalyptus camaldulensis*) and a field-layer consisting of Rush Sedge (*Carex tereticaulis*), Warrago Summer Grass (*Paspalidium jubidiflorum*), Rigid Panic (*Homopholis proluta*), Lesser Joyweed (*Alternanthera denticulata*) and Tufted Burr-daisy (*Calotis scapigera*). Riverine Swampy Woodland demonstrated more floristic change over the seven monitoring events than any of the other EVCs on the site. However, this change was not caused by the delivery of environmental water but due to the germination of the winter-growing annual species Ferny Small-flower Buttercup (*Ranunculus pumilio var. pumilio*) and Spreading Crassula (*Crassula decumbens*). The moderate condition of this EVC remained stable throughout the monitoring period.

On the Department of Sustainability and Environment Biodiversity Interactive Maps (DSE, 2008) (see Appendix C) Reedy Swamp is shown as supporting Tall Marsh/Open water mosaic (EVC 1090). Tall Marsh was sampled in quadrat 2 and consisted of a fairly dense sward of Giant Rush (*Juncus ingens*) and a few herbaceous species including Lesser Joyweed (*Alternanthera denticulata*), Slender Knotweed (*Persicaria decipiens*) and Groundsel (*Senecio campylocarpus*). Changes occurring in this EVC over the course of the monitoring period included drowning of terrestrial weeds such as Spear Thistle (**Cirsium vulgare*) and an increase in the cover and diversity of floating, non-attached aquatics including Ferny Azolla (*Azolla filiculoides*), Common Duckweed (*Lemna disperma*) and Thin Duckweed (*Landoltia punctata*) and the attached Water Primrose (*Ludwigia peploides subsp. montevidensis*) (see Figure 3).

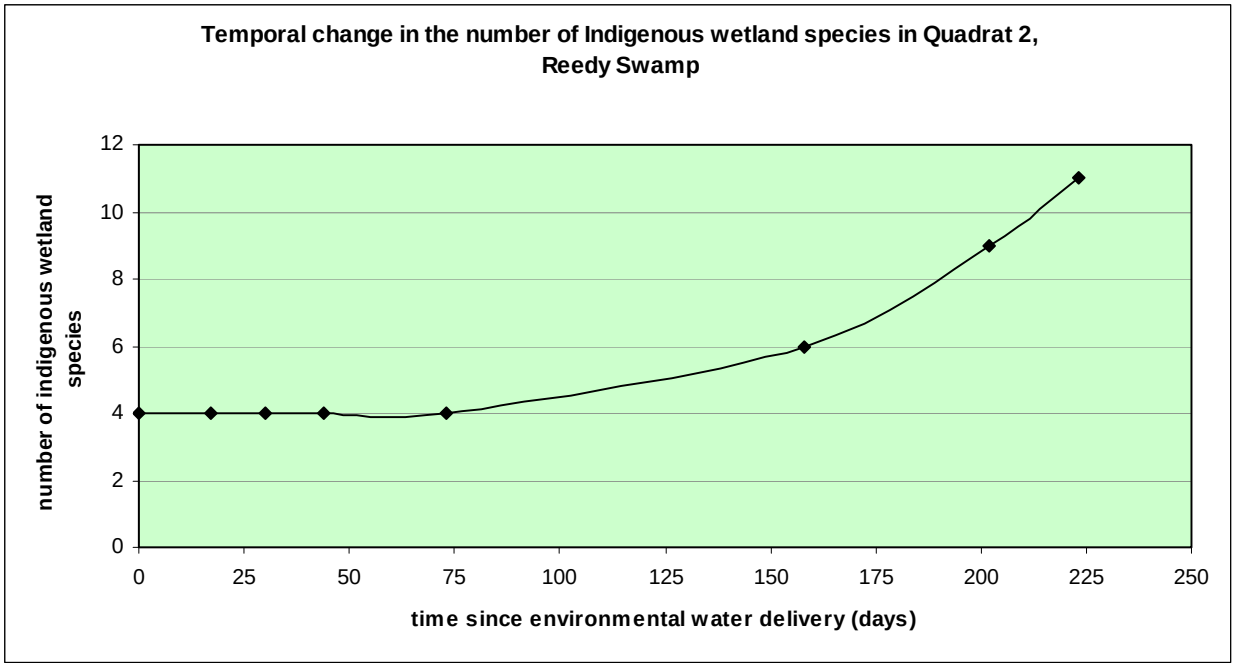


Figure 3. Temporal change in the number of Indigenous wetland plant species recorded in quadrat 2, Reedy Swamp

Open Water was sampled in quadrat 3. This EVC supported a low cover of species characteristic of Floodway Pond Herbland (EVC 810) including Lesser Joyweed (*Alternanthera denticulata*), Pale Knotweed (*Persicaria decipiens*), Water Plantain (*Alisma plantago-aquatica*) and Waterwort (*Elatine gratioloides*), and it is assumed that this EVC occurred on the floor of the wetland prior to it being inundated. Changes to this EVC included the dying back of Lesser Joyweed, Pale Knotweed and Water Plantain; these species will probably only return to this area when water levels drop considerably.

A total of 28 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 18 species recorded during the first visit (a 55% increase in species richness).

Threatened plant species recorded at Reedy Swamp are listed in Table 13.

Table 13. Threatened species recorded at Black Swamp

Status	Species	Common Name	Location
r	*Senecio campylocarpus*	Groundsel	55H 353 523 UTM 5977 008
k	*Elymus multiflorus*	Short-awned Wheat Grass	55H 352 650 UTM 5977 250
k	*Alternanthera sp. 1(Plains)*	Plains Joyweed	55H 0353564 UTM 5976915
k	*Persicaria lanigera*	Woolly Knotweed	Scattered along eastern edge of wetland
Kv	*Dianella sp. aff. longifolia (Riverina)*	Riverine Flax-lily	Scattered on sand ridge east of wetland
Ee	*Cullen parvum*	Small Scurf-pea	55H 0353564 UTM 5976915 200 plants, 30x6m

Some plants with the general appearance of Pale Knotweed (*Persicaria lapathifolia*) at Reedy Swamp are covered in long hairs, and match the description of *Polygonum lanigerum* in Willis (1972). These plants may represent an unrecognized native taxon, which may be quite uncommon in Victoria.

Reedy Swamp is surrounded by moderate to poor condition Sedgy Riverine Forest (50%), Sand Ridge Woodland (25%) and Plains Woodland (25%).

Photograph 6. Sand Ridge Woodland, south eastern edge of Reedy Swamp

Table 14. Sand Ridge Woodland species

Eucalyptus melliodora	*Austrostipa scabra subs. falcata*
Amyema miquelii	*Einadia nutans*
Amyema miraculosa	*Carex bichenoviana*
Amyema quandang	*Hemarthria uncinata*
Acacia implexa	*Oxalis radicosa*
Acacia brachybotrya	*Vittadinia gracilis*
Acacia pycnantha	*Senecio quadridentatus*
Acacia acinacea	*Panicum effusum*
Oxalis perennans	*Lomandra filiformis*
Glycine tabacina	*Aristida ramosa*
Dianella sp. aff. longifolia (Riverina)	

Photograph 7. Riverine Flax-lily, *Dianella sp. aff. longifolia (Riverina),* in Sand Ridge Woodland at Reedy Swamp

Photograph 8. Riverine Swampy Woodland, eastern side of Reedy Swamp

Photograph 9. The nationally endangered Small Scurf-pea (*Cullen parvum*) in Riverine Swampy Woodland at Reedy Swamp.

Table 15. Riverine Swampy Woodland species

Poa labillardierei	*Calotis scapigera*
Carex bichenoviana	*Alternanthera sp 1 (plains)*
Carex tereticaulis	*Rumex brownii*
Austrodanthonia setacea	*Chamaesyce drummondii*
Juncus subsecundus	*Oxalis perennans*
Carex inversa	*Cullen parvum*
Paspalidium jubiflorum	*Einadia nutans*
Wahlenbergia fluminalis	*Mentha diemenica*
Atriplex semibaccata	

Table 16. Indigenous vascular plants recorded at Reedy Swamp

Status	*Scientific Name*	Common Name	Wetland species
	Acacia brachybotrya	Grey Mulga	
	Acacia dealbata	Silver Wattle	
	Acacia implexa	Lightwood	
	Acacia montana	Mallee Wattle	
	Acacia pycnantha	Golden Wattle	
	Alisma plantago-aquatica	Water Plantain	w
	Alternanthera denticulata	Lesser Joyweed	w
k	*Alternanthera sp 1 (plains)*	Plains Joyweed	
	Amphibromus nervosus	Common Swamp Wallaby-grass	w
	Amyema miquelii	Box Mistletoe	
	Amyema miraculosa	Fleshy Mistletoe	
	Amyema pendula subs. pendula	Drooping Mistletoe	
	Amyema quandang	Grey Mistletoe	
	Aristida ramosa	Cane Wire-grass	
	Arthropodium strictum	Chocolate Lily	
	Atriplex semibaccata	Berry Saltbush	
	Austrodanthonia caespitosa	Common Wallaby-grass	
	Austrodanthonia racemosa var. racemosa	Stiped Wallaby-grass	
	Austrodanthonia setacea	Bristly Wallaby-grass	
	Austrostipa scabra subs. falcata	Rough Spear-grass	
	Azolla filiculoides	Pacific Azolla	w
	Boerhavia dominii	Tah-vine	
	Calotis scapigera	Tufted Burr-daisy	w
	Carex bichenoviana	Sedge	
	Carex inversa	Common Sedge	
	Carex tereticaulis	Rush Sedge	w
	Chamaesyce drummondii	Flat Spurge	
	Chenopodium pumilio	Clammy Goosefoot	
	Crassula decumbens var. decumbens	Spreading Crassula	

Status	*Scientific Name*	Common Name	Wetland species
Ee	*Cullen parvum*	Small Scurf-pea	
	Cyperus exaltatus	Tall Flat-sedge	w
Kv	*Dianella sp. aff. longifolia (Riverina)*	Riverine Flax-lily	
	Dillwynia cinerascens	Grey Parrot-pea	
	Einadia nutans subs. nutans	Nodding Saltbush	
	Elatine gratioloides	Waterwort	w
	Eleocharis acuta	Common Spike-sedge	w
k	*Elymus multiflorus*	Short-awned Wheat-grass	
	Elymus scaber var. scaber	Common Wheat-grass	
	Eucalyptus camaldulensis	River Red-gum	w
	Eucalyptus melliodora	Yellow Box	
	Eucalyptus microcarpa	Grey Box	
	Geranium sp 2	Variable Cranesbill	
	Glycine tabacina	Variable Glycine	
	Hemarthria uncinata var. uncinata	Mat Grass	
	Juncus ingens	Giant Rush	w
	Juncus subsecundus	Finger Rush	
	Juncus usitatus	Billabong Rush	w
	Lachnagrostis filiformis var. 1	Common Blown Grass	w
	Landoltia punctata	Thin Duckweed	w
	Lemna disperma	Common Duckweed	w
	Lomandra filiformis subs. coriacea	Wattle Matt-rush	
	Ludwigia peploides subsp. montevidensis	Clove-strip	w
	Maireana enchylaenoides	Wingless Bluebush	
	Mentha diemenica	Slender Mint	
	Muellerina eucalyptoides	Creeping Mistletoe	
	Oxalis perennans	Grassland Wood-sorrel	
	Oxalis radicosa	Wood-sorrel	
	Panicum effusum	Hairy Panic	
	Paspalidium jubiflorum	Warrego Summer-grass	w
	Persicaria decipiens	Slender Knotweed	w

Status	*Scientific Name*	Common Name	Wetland species
	Persicaria lapathifolia	Pale Knotweed	w
	Persicaria praetermissa	Spotted Knotweed	w
k	*Persicaria lanigera*	Woolly Knotweed	w
	Poa labillardierei var. labillardierei	Common Tussock-grass	
	Pseudognaphalium luteoalbum	Jersey Cudweed	
	Ranunculus pumilio var. pumilio	Ferny Small-flower Buttercup	w
	Rumex brownii	Slender Dock	
r	*Senecio campylocarpus*	Groundsel	w
	Senecio quadridentatus	Cotton Fireweed	
	Sida corrugata	Variable Sida	
	Typha domingensis	Narrow-leaf Cumbungi	w
	Typha orientalis	Cumbungi	w
	Vittadinia gracilis	Wooly New Holland Daisy	
	Wahlenbergia fluminalis	River Bluebell	
	Walwhalleya proluta	Rigid Panic	w
	Wolffia australiana	Tiny Duckweed	w
	Total Indigenous Species	**78**	

Table 17. Exotic plants recorded at Reedy Swamp Survey

Status	*Scientific Name*	Common Name	Wetland species
	**Asparagus officinale*	Asparagus	
	**Aster subulatus*	Aster-weed	
	**Atriplex prostrata*	Hastate Orache	
	**Avena sp.*	Oat	
	**Bromus catharticus*	Prairie Grass	
	**Bromus diandrus*	Great Brome	
	**Chondrilla juncea*	Skeleton Weed	
	**Cirsium vulgare*	Spear Thistle	
	**Cyperus eragrostis*	Drain flat-sedge	
	**Fumaria bastardii*	Bastards Fumitory	
	**Galium aparine*	Cleavers	
	**Hypochoeris glabra*	Smooth Cat's-ear	
	**Hypochoeris radicata*	Cat's Ear	
	**Lactuca serriola*	Prickly Lettuce	
	**Leontodon taraxacoides subs. taraxacoides*	Hairy Hawkbit	
	**Lepidium africanum*	Common Pepper-cress	
	**Lolium rigidum*	Wimmera Rye-grass	
	**Lycium ferocissimum*	African Box-thorn	
	**Medicago sativa var. sativa*	Lucerne	
	**Olea europaea subs. europaea*	Olive	
	**Paspalum dilatatum*	Paspalum	
	**Paspalum distichum*	Water Couch	
	**Plantago lanceolata*	Ribwort	
	**Polygonum aviculare*	Prostrate Knotweed	
	**Ranunculus muricatus*	Sharp Buttercup	
	**Romulea rosea var. australis*	Onion Grass	
	**Rorippa palustris*	Yellow Marsh-cress	
	**Rumex crispus*	Curled Dock	
	**Sagittaria platyphylla*	Sagittaria	
	**Sonchus asper*	Rough Sow-thistle	
	**Sonchus oleraceus*	Common Sow-thistle	

Status	*Scientific Name*	Common Name	Wetland species
	**Tribulus terrestris*	Caltrop	
	**Trifolium angustifolium var. angustifolium*	Narrow-leaf Clover	
	**Trifolium arvense var. arvense*	Hare's foot Clover	
	**Vicia sativa*	Common Vetch	
	**Vulpia bromoides*	Squirrel-tail Fescue	
	Total Exotic Species	**36**	

5.2.3 Birds

A total of 93 bird species were recorded at Reedy Swamp between May and December 2008 (see Tables 20 and 21), including 48 wetland species, 20 rare or threatened species, and only one exotic species.

The diversity of wetland bird species present at Reedy Swamp gradually increased with time since flooding. Wetland bird numbers increased from 16 species in May to a peak of 30 in November 2008. A small decline occurred in December 2008 (24 species) despite water levels being slightly higher than November.

Abundance of particular wetland bird species fluctuated greatly over the monitoring period. For example, large numbers of Hardhead were observed at Reedy Swamp during the second and third visits, but had decreased dramatically by the fourth visit. In contrast small numbers of Australasian Shoveler were present during the first, second and third visits but had increased substantially by the fourth visit. These fluctuations possibly occurred as the availability of particular food resources changed over time since flooding. Non-wetland bird diversity also fluctuated between visits.

There is no obvious pattern between non-wetland bird diversity and time since inundation, however abundances did increase from the lowest recorded in May (34 individuals) to the highest recorded in July (92 individuals). November had a low of 40 individuals recorded, with an increase to 72 in December. Weather conditions in November and December may have affected these results.

The concentration of large numbers of the vulnerable Hardhead (over 1500 birds) at Reedy Swamp between late May and mid June is considered to be of state significance (Richard Lyon, ARI, pers. comm.) (see Photograph 10). Other threatened species occurring in large numbers at Reedy Swamp included Australasian Shoveler (over 300 birds in mid July) and Glossy Ibis (70 birds in mid Nov).

Wetland birds observed breeding at Reedy Swamp included Australian White Ibis, Straw-necked Ibis, Black Swan, Australian Shelduck, Australian Wood Duck, Grey Teal, Chestnut

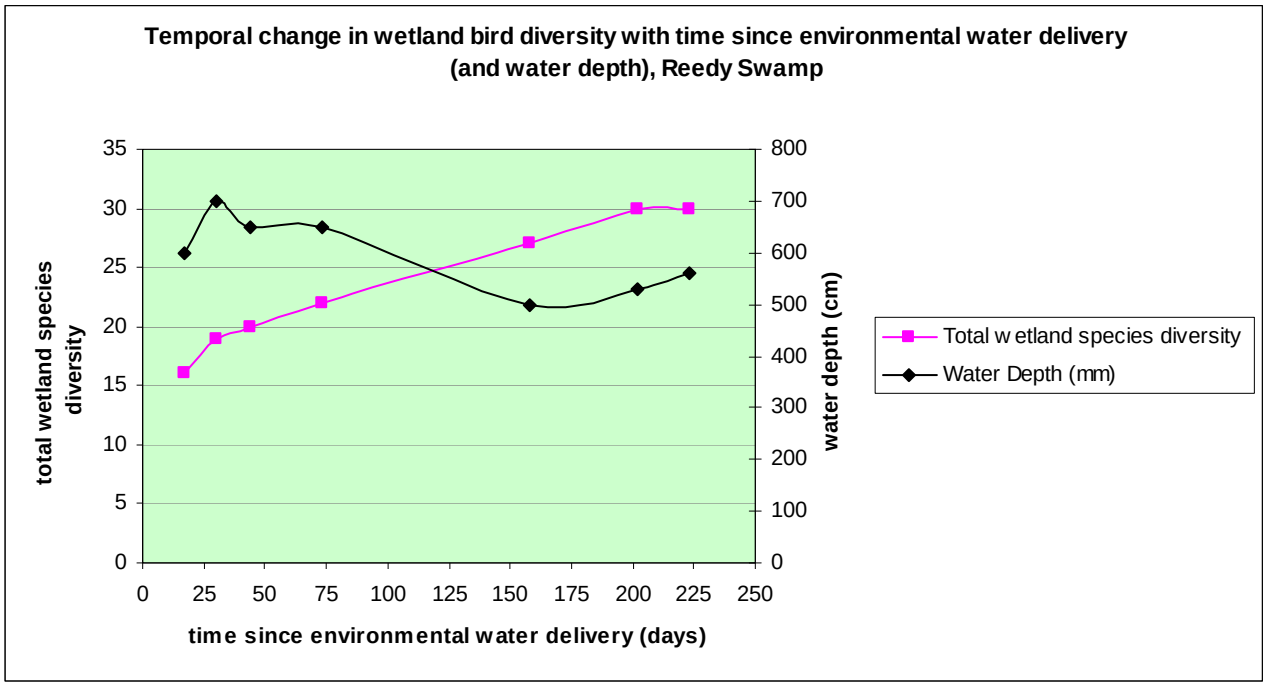
Teal, Pacific Black Duck, Musk Duck, Dusky Moorhen, Eurasian Coot, Purple Swamphen, Swamp Harrier, Whistling Kite and Australian Reed Warbler.

Due to the high diversity of threatened species present, large numbers of particular rare species it supports, its importance as breeding habitat and a drought refuge, Reedy Swamp is considered to be of very high conservation significance for water bird conservation.

Table 18. Summary Table of Wetland and non-wetland bird species diversity and abundance at Reedy Swamp

	18-May-08	30-May-08	14-Jun-08	13-Jul-08	06-Oct-08	19-Nov-08	10-Dec-08
Days since inundation	17	30	44	73	158	202	223
Total wetland species diversity (transect and incidental)	16	19	20	22	27	30	30
Transect only total wetland birds abundance	1073	3345	1028	626	1358	649	1948
Transect only non-wetland birds abundance	39	34	43	92	71	40	72
Transect only wetland species diversity	14	16	16	20	24	24	24
Transect only non-wetland birds species diversity	5	9	6	13	20	4	8

Figure 4. Graph of bird diversity versus time since inundation



Photograph 10. Large flock of Hardhead (*Aythya australis*) and other water fowl at Reedy Swamp

Table 19. EPBC Act and AVW threatened fauna species occurring at Reedy Swamp

FFG	EPBC	VROT	Common Name	Scientific Name
		v	Australasian Shoveler	*Anas rhynchotus*
f		e	Australian Little Bittern	*Ixobrychus dubius*
f		v	Ballion's Crake	*Porzana pusilla palustris*
		nt	Black-chinned Honeyeater	*Melithreptus gularis gularis*
f		e	Blue-billed Duck	*Oxyura australis*
		nt	Brown Quail	*Coturnix ypsilophora australis*
f		v	Eastern Great Egret	*Ardea modesta*
f		e	Freckled Duck	*Stictonetta naevosa*
		nt	Glossy Ibis	*Plegadis falcinellus*
		v	Hardhead	*Aythya australis*
f		cr	Intermediate Egret	*Ardea intermedia*
		nt	Latham's Snipe	*Gallinago hardwickii*
f		v	Lewin's Rail	*Lewinia pectoralis*
f		e	Little Egret	*Egretta garzetta nigripes*
		v	Musk Duck	*Biziura lobata*
		n	Pied Cormorant	*Phalacrocorax varius*
f		v	Powerful Owl	*Ninox strenua*
		v	Royal Spoonbill	*Platalea regia*
		nt	Whiskered Tern	*Chlidonias hybridus javanicus*
f		v	White-bellied Sea-Eagle	*Haliaeetus leucogaster*

Species shown with a shaded background were observed breeding at this site

Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site

Species shown in blue font were recorded during acoustic monitoring by DPI

Table 20. Wetland Birds observed at Reedy Swamp

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	**Time of Day**	3.30 – 4.00 pm	8.30 – 9:00 am	10:00–10.30 am	2:00 – 2.30 pm	9.30 – 10.00 am	14.00-14.30pm	14.30–15.00pm
	Australasian Grebe	1	2	11	12	2	5	4 (10)
v	Australasian Shoveler	2	14	8	16 (300) paired up	40	10	10 (3)
e	Australian Little Bittern							
	Australian Pelican				9		7 (5)	(1)
	Australian Reed Warbler					2	2	5 (5)
	Australian Shelduck	3	(2)	(1)	4	(2)		(2)
	Australian White Ibis	20	1	1	2	32 (50) on nests with eggs	65 (50)	90 (30)
	Australian Wood Duck	50	10	4	10 examining hollows			4
v	Ballion's Crake							
	Black-tailed Native Hen					10		
	Black-winged Stilt					9	(2)	
	Black Swan	40	250	140	40 (100) many on nests	8 including 4 cygnets	2	1
e	Blue-billed Duck							
nt	Brown Quail							

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	**Time of Day**	**3.30 – 4.00 pm**	**8.30 – 9:00 am**	**10:00–10.30 am**	**2:00 – 2.30 pm**	**9.30 – 10.00 am**	**14.00-14.30pm**	**14.30–15.00pm**
	Chestnut Teal	50	40	40	20 paired up	20	10 (70)	10 (10)
	Dusky Moorhen					4	6 (2)	4 (1) 2 young
	Eurasian Coot		1	1	12	142	205	86 (2) some young
e	Freckled Duck							2
v	Eastern Great Egret					1	2 (3)	1 (1)
	Grey Teal	300	1000 (2000)	300 (2000+)	440 (800)	1000 (2000) some with ducklings	220 (30) 3 ducklings	1600 (500)
nt	Glossy Ibis					5	2	3 (3)
v	Hardhead	100	1500 (1500)	300 (1000+)	0 (30)	20	60	20
	Hoary-headed Grebe	(1)	10	2	4			
cr	Intermediate Egret						2	(2)
nt	Latham's Snipe							
v	Lewin's Rail							
e	Little Egret						2	(2)

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	3.30 – 4.00 pm	8.30 – 9:00 am	10:00–10.30 am	2:00 – 2.30 pm	9.30 – 10.00 am	14.00-14.30pm	14.30–15.00pm
	Little Grassbird	1	(1)	1	2	2	1(1)	4 (6)
	Little Pied Cormorant				1		7 (3)	6 (2)
	Masked Lapwing	2			2	2	3	
	Pacific Black Duck	500	500 (1000)	200 (200-300)	14	20	(1)	40 (10)
	Pacific Heron					(2)	2 (2)	(1)
nt	Pied Cormorant	1				3		
	Pink-eared Duck							
	Purple Swamphen		1	3	4	12	(2) plus chick	4 (6) 2 young
	Red-kneed Dotterel							
	Royal Spoonbill						4 (3)	1 (1)
	Sacred Kingfisher						(1)	
	Spotless Crake					1	(1)	
	Straw-necked Ibis		1	(10)	(14)	10		(1)
	Swamp Harrier	1	(1)	(1)	3	(1)	2 (1)	1 (1)
v	Musk Duck				1 male		2 mother with young	
	Welcome Swallow #		6	1	10	2	20	40 (6)

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	**Time of Day**	3.30 – 4.00 pm	8.30 – 9:00 am	10:00–10.30 am	2:00 – 2.30 pm	9.30 – 10.00 am	14.00-14.30pm	14.30–15.00pm
	Whistling Kite #	(1)	4	1	6	4	(2)	1
nt	Whiskered Tern							
v	White-bellied Sea-Eagle							
	White-faced Heron		(1)	(2)		4	2 (1)	1 (1)
	Yellow-billed Spoonbill			1				1 (1)
	Total Wetland Species Diversity	**16**	**19**	**20**	**22**	**27**	**30**	**30**
	Total Transect Wetland Species Diversity	**14**	**16**	**16**	**20**	**24**	**24**	**24**
	Native Wetland Species Transect Only Abundance	**1073**	**3345**	**1028**	**626**	**1358**	**649**	**1948**

Species shown with a shaded background were observed breeding at this site; Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect.

The Welcome Swallow and Whistling Kite are not strictly wetland species; however they are often quite closely associated with wetlands. They have been included in this category as they appeared to have been attracted to the wetlands to prey on species that are reliant on the wetlands containing water, and for this reason could be considered to have directly benefited from the delivery of environmental water.

Table 21. Non-wetland Birds recorded at Reedy Swamp

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	3.30 – 4.00 pm	8.30 – 9:00am	10:00–10.30am	2:00–2.30 pm	9.30– 10.00 am	14.00–14.30pm	14.30–15.00pm
	Australian Magpie		2	1	2	2		1 (6)
	Australian Raven	4	(2)	4		1	(1)	
nt	Black-chinned Honeyeater							
	Black-faced Cuckoo-shrike		1			1 on nest	(2)	(3) 1 juvenile
	Boobook Owl		(1)					
	Brown Falcon						(1)	
	Collared Sparrowhawk					1		
	Crested Pigeon			(2)	1		(1)	(2)
	Eastern Rosella					1		2
	Flame Robin				(3)			
	Galah	10	(2)	8	38	10	(3)	(6)
	Golden Whistler							
	Grey Fantail				(1)			
	Grey Shrike Thrush				(1)			
	Kookaburra		1		3			(1)

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	3.30 – 4.00 pm	8.30 – 9:00am	10:00–10.30am	2:00–2.30 pm	9.30– 10.00 am	14.00–14.30pm	14.30–15.00pm
	Little Corella						1	
	Little Friarbird					20	(6)	(10)
	Little Lorikeet					6 2 courting		
	Little Raven	10	3		3			
	Long-billed Corella							
	Magpie Lark				2	1	(1)	
	White-breasted Woodswallow					2		(6)
	Musk Lorikeet				(4)			
	Noisy Friarbird							
	Noisy Miner		(3)		4	3	(10)	6 (8)
	Olive-backed Oriole							
	Peaceful Dove							
	Peregrine Falcon				2			2 (3)

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	3.30 – 4.00 pm	8.30 – 9:00am	10:00–10.30am	2:00–2.30 pm	9.30– 10.00 am	14.00–14.30pm	14.30–15.00pm
	Pied Butcherbird		(2)			1	1	1 (3)
	Pied Currawong	10	2		2	3		
v	Powerful Owl							
	Red-rumped Parrot		4	20	6 examining hollows	2		(4)
	Red Wattlebird					2	(2)	(6)
	Restless Flycatcher		1					
	Striated Pardalote		4	2	2	2		
	Sulphur-crested Cockatoo							10
	Superb Fairy Wren	3	(2)	5 (1)	5 (1)	6	(6)	4 (6)
	Tawny Frogmouth		(1)					
	White-winged Chough							10
	White-plumed Honeyeater		(2)		(10)	3		(20)
	White-throated Tree Creeper			(1)				
	White-winged Triller						(1)	
	Willie Wagtail		1		1	2	(2)	(2)

		18-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Status	**Time of Day**	**3.30 – 4.00 pm**	**8.30 – 9:00am**	**10:00–10.30am**	**2:00–2.30 pm**	**9.30– 10.00 am**	**14.00–14.30pm**	**14.30–15.00pm**
	Yellow Rosella	(2)			2	2	2	(3)
	*Starling	10	2		(6)	1		(2)
	Total non-wetland birds Species Diversity	**7**	**17**	**8**	**20**	**20**	**15**	**19**
	Total Transect non-wetland birds Species Diversity	**5**	**9**	**6**	**13**	**20**	**4**	**8**
	Native non-wetland birds Species Transect Only Abundance	**39**	**34**	**43**	**92**	**71**	**40**	**72**

Species shown with a shaded background were observed breeding at this site; Species shown in blue font were recorded during acoustic monitoring by DPI; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect.

5.2.4 Frogs

Six species of frogs were heard calling in Reedy Swamp. Reedy Swamp was the only wetland where the Plains Brown Tree Frog was recorded during this study. The Plains Brown Tree Frog and Common Froglet were only here calling during cool conditions from May until July, while the Pobblebonk and Peron's Tree Frog only became active as conditions warmed from October onwards.

Table 22. Frogs observed at Reedy Swamp

Date and Time		18-May-08	31-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Species heard calling	Common Name	9 :00 – 9.30pm	9 :00 – 9.30pm	10.30 – 11 pm	2:00 – 2.30 pm	9.30 – 10.00pm	14.00 – 14.30pm	21.30 – 22.00pm
Crinia signifera	Common Froglet	>100	>100	>100	10 to 100	O		O
Crinia parinsignifera	Plains Froglet			(1)		10 to 100		10 to 100
Limnodynastes tasmaniensis (NCR)	Spotted Grass Frog	10 to 100	>100			>100	10 to 100	>100
Limnodynastes dumerilii	Pobblebonk					>100	10 to 100	>100
Litoria paraewingii	Plains Brown Tree Frog	<10	<10	10 to 100	<10	O	O	O
Litoria peronii	Peron's Tree Frog						<10	>100
Number of egg-masses observed								

Estimated abundance heard calling: <10, 10-100, >100, O = observed; Transect length 250m for 30 min; transect located on eastern edge going south from quadrat; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect

Photograph 11. Plains Brown Tree Frog (*Litoria paraewingii*) at Reedy Swamp

Photograph 12. Peron's Tree Frog (*Litoria peroni*) at Reedy Swamp

5.2.5 Other Fauna

Table 23. Reptiles observed at Reedy Swamp

Status	Scientific Name	Common Name
	Lampropholis guichanoti	Garden Skink
	Cryptoblepharis carnabyi	Carnaby's Wall Skink
	Chelodina longicollis	Eastern Snake-necked Turtle
	Notechis scutatus	Tiger Snake

Table 24. Mammals observed at Reedy Swamp

Status	Scientific Name	Common Name
	Antechinus flavipes flavipes	Yellow-footed Antechinus
	Wallabia bicolor	Swamp Wallaby
	Trichosurus vulpechula	Common Brushtail Possum
	Tadarida australis	White-striped Freetail Bat
	**Lepus capensis*	Hare
	**Oryctolagus cuniculus*	Rabbit
	**Vulpes vulpes*	Red Fox

Photograph 13. Nest of Eastern Long-necked Turtle (*Chelodina longicollis*) that has been destroyed by a Red Fox. Fourteen nest sites that had been destroyed by foxes where observed along the eastern side of Reedy Swamp on the 17th of December 2009.

5.3 MOODIES SWAMP

5.3.1 Water

A total of 50 megalitres of water was delivered to the swamp from an irrigation channel between the 29th of April and the second week of June 2008. This inundated up to about 60% of the area of the wetland to a maximum depth of 200mm (extent of flooding was difficult to determine at this site due to high cover of dense Cane Grass). During the fourth visit on the 11 of July 2008 water was still trickling into the wetland very slowly. Moodies Swamp dried out considerably between July and October, by which time there was no enough surface water to measure water quality.

The **pH** ranged from 6.6 in 17 May 2008 to 7.2 in 11 July 2008 with an average of 6.8. All samples were within both the EPA and ANZECC guidelines for pH being ≥6.4-≤7.7 and 6.6-8.0 respectively (see Table 28). Over the sampling period the pH slowly increased from 6.6 to 7.2 despite water level being constant and temperature being colder.

Temperature fluctuated between 10.3 ℃ to 11.5 ℃.

Dissolved oxygen ranged from 68% to 96% with an average of 83%. DO concentrations fell below the EPA objectives of between ≥85-110% on two occasions, on 18 May 2008 and at quadrat 3 on 11 July 2008. Most readings were close to the lower limits with little variation over the four sampling periods. Low DO concentrations were most likely related to decaying vegetation at this site.

Conductivity ranged from 396 to 468 $\mu S/cm^{-1}$ with an average of 428 $\mu S/cm^{-1}$. These levels far exceeded ANZECC guidelines (20-30 $\mu S/cm^{-1}$) but are just within the EPA guidelines for this region (500 $\mu S/cm^{-1}$). These levels are around 2-3 times higher than the other three wetlands but are consistent with EC readings from the Shepparton urban lakes (see Appendix A). There was a pattern of decreasing conductivity over the sampling period, as the wetland dried out.

Turbidity did not vary at the site and was consistently sampled at around 10 NTU with the exception of a high reading on 18 May 08. These concentrations are well within both EPA and ANZECC guidelines of ≤30 NTU and 1-20 NTU respectively.

Table 25. Temporal change in water quality at Moodies Swamp

Red= exceeds both EPA (2003) and ANZECC & ARMCANZ (2000), Yellow= exceeds GOVERNMENT OF VICTORIA (2003) only, Green exceeds ANZECC & ARMCANZ (2000) only (see Appendix A).

	Units	18-May-08	31-May-08	15-Jun-08		11-Jul-08		7-Oct-08	19-Nov-08	10-Dec-08	Average
Quadrat				Q2	Q3	Q2	Q3	No sampling, not enough water present	No sampling, not enough water present	No sampling, not enough water present	
Depth	mm	100	100	90	120	80	120				
pH		6.6	6.7	6.9	6.9	6.9	7.2				6.8
Temp	℃	11.5	10.3	11.2	11.2	10.5	10.3				10.8
DO	%	68.0	96.0	85.3	85.3	88.0	74.9				82.9
Turbidity	NTU	55	<10*	≤10	≤10	≤10 (5)	≤10 (2)				15
Conductivity	(µS/cm^{-1})	456	468	418	418	410	396				428

*Change of meter used from turbidity tube to Horiba multi-meter; Depth measured at south west corner of quadrat

5.3.2 Vegetation

Indigenous vegetation within and around Moodies Swamp is remarkably intact. The swamp supports an extensive area of Cane Grass Wetland (EVC #291), which is regarded as vulnerable.

Photograph 14. Cane Grass Wetland at Moodies Swamp

Cane Grass Wetland is composed of dense swards of Southern Cane Grass and was sampled in quadrats 2, 3 and 4. In the early stages of this monitoring program, when water had only recently been delivered to the wetland, the condition of this EVC at quadrats 2 and 3 appeared moderate; as these areas only supported a low diversity of indigenous species and a relatively high cover of weeds. As the time since inundation increased many terrestrial weeds drowned and a diversity of indigenous plant species germinated or re-sprouted, raising the condition status of this EVC from moderate to good.

According to Frood's condition scores good condition means "some biodiversity losses within the EVC reasonably presumed or weeds invasions impacting on the indigenous vegetation, but system apparently remaining ecologically stable; and only minor modifications to critical ecological processes."

The diversity of indigenous wetland plant species at Moodies Swamp increased dramatically between the forth and fifth visits, resulting from the germination of Riverine Bitter-cress (*Cardamine moirensis*), Austral Mudwort (*Limnosella australis*), Star-fruit (*Damasonium minus*), Joint-leaf Rush (*Juncus holoschoenus*), Winged Water-starwort (*Callitriche umbonata*) and Ferny Small-flower Buttercup (*Ranunculus pumilio var. pumilio*) and the re-sprouting of Common Spike-rush (*Eleocharis acuta*), Common Nardoo (*Marselia drummondii*), Upright Milfoil (*Myriophyllum crispatum*), Slender Water Ribbons (*Triglochin dubium*) and Red Pondweed (*Potamogeton cheesemanii*). Outside of the quadrats other species that germinated between forty-eight and one hundred and sixty-two days after water delivery began included Dwarf Brooklime (*Gratiola pumilio*), Ridged Water Milfoil (*Myriophyllum porcatum*) and Slender Water Milfoil (*Myriophyllum gracile* var. *lineare*).

These additional species included a population of approximately 1000 plants of the nationally vulnerable Ridged Water-milfoil and a population of approximately 50 plants of Slender Water-milfoil, which is endangered in Victoria.

Photograph 15. Ridged Water-milfoil (Myriophyllum porcatum) at Moodies Swamp

Photograph 16. Germinants on the edge of Moodies Swamp 75 days after inundation, including *Limnosella australis, Damasonium minus, Myriophyllum crispatum* and *Callitriche umbonata*.

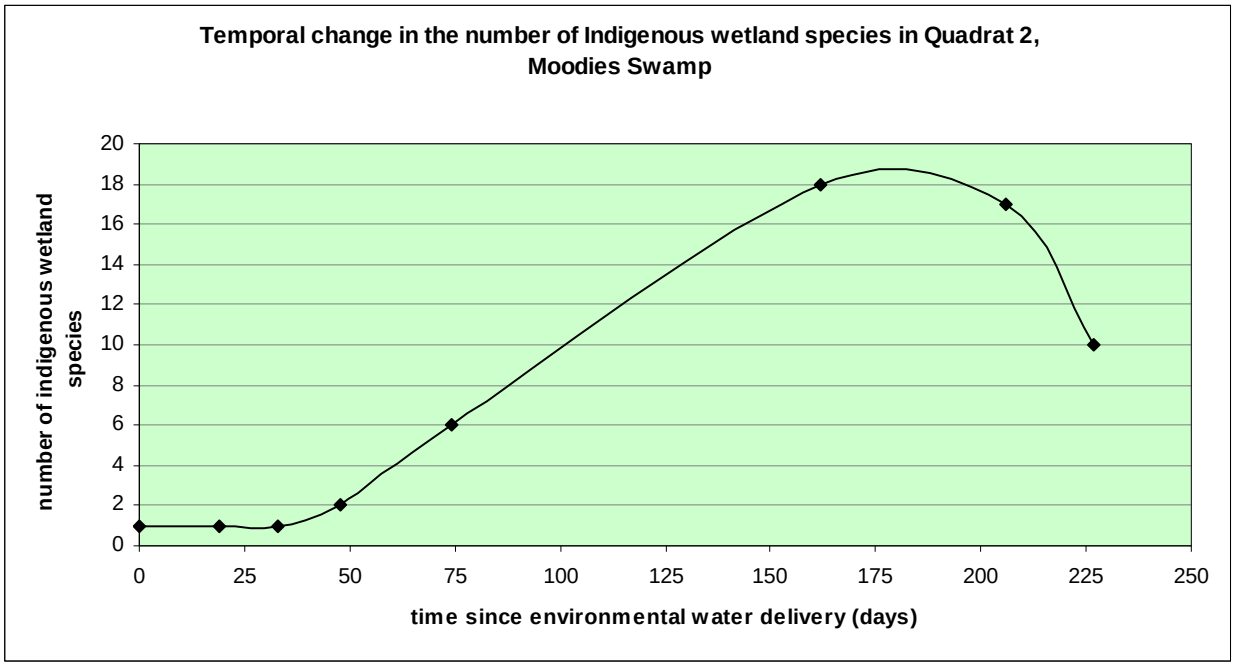


Figure 5. Temporal change in the number of indigenous wetland plant species in quadrat 2, Moodies Swamp

In contrast the Cane Grass Wetland sampled in quadrat 4 had not been inundated and remained species-poor. The cover of weeds in this quadrat increased between the third and seventh visits, while it decreased or remained stable in quadrats 2 and 3.

The Cane Grass Wetland at Moodies Swamp has a fringe of Intermittent Swampy Woodland (EVC #813), consisting of an open canopy of River Red Gum (Eucalyptus camaldulensis) with a field-layer dominated by Spiny Flat-sedge (*Cyperus gymnocaulos*) in association with Common Blown-grass (*Lachnagrostis filiformis var. 1*), River Bluebell (*Wahlenbergia fluminalis*), Woolly New-Holland Daisy (*Vittadinia gracilis*) and Sieber Crassula (*Crassula sieberi ssp. tetramera*); this EVC was sampled in quadrat 1. The moderate condition of this EVC remained stable throughout the monitoring period.

A total of 47 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 13 species recorded during the first visit (a 260% increase in species richness).

Moodies Swamp is surrounded by Plains Woodland (50%) to the south and south-west, Lunette Woodland (20%) to the east (see Photograph 18 and Table 26) and Shallow Sands Woodland (30%) to the west and north.

Due to the high diversity of threatened species present and the intact examples of endangered Ecological Vegetation Classes it supports, Moodies Swamp is considered to be of very high conservation significance for the protection of botanical values.

Photograph 17. Lunette Woodland at Moodies Swamp

Table 26. Lunnete Woodland species at Moodies Swamp

Eucalyptus melliodora	*Austrostipa scabra subs. falcata*
Eucalyptus camaldulensis	*Enneapogon nigricans*
Allocasuarina leuhmannii	*Enteropogon acicularis*
Acacia implexa	*Austrodanthonia racemosa var. racemosa*
Acacia pycnantha	*Austrodanthonia setacea*
Acacia acinacea	*Bothriochloa macra*
Wahlenbergia fluminalis	*Chloris truncata*
Convolvulus erubescens	*Panicum decompositum var. decompositum*
Oxalis perennans	*Lomandra multiflora ssp. multiflora*
Glycine clandestina var. sericea	*Aristida behriana*
Sida corrugata	

Table 27. Threatened plant species recorded at Moodies Swamp

Status	Species	Common Name	Location
k	*Arthropodium sp.3*	Twin-flowered Chocolate Lily	55H 392 000 UTM 5989 650
r	*Callitriche umbonata*	Winged Water-starwort	55H 391 940 UTM 5990 335
r	*Cardamine moirensis*	Riverine Bitter-cress	55H 391 924 UTM 5990 315
Kv	*Dianella sp. aff. longifolia (Riverina)*	Riverine Flax-lily	55H 392 000 UTM 5989 650
r	*Gratiola pumilio*	Dwarf Brooklime	55H 391 940 UTM 5990 335
k	*Haloragis glauca*	Bluish Raspwort	55H 391 944 UTM 5990 350
k	*Isolepis australiensis*	Southern Club-rush	55H 391 924 UTM 5990 315
e	*Myriophyllum gracile var. lineare*	Slender Water-milfoil	55H 391 930 UTM 5990 335 55H 391 722 UTM 5990 106
Vv	*Myriophyllum porcatum*	Ridged Water-milfoil	55H 391 930 UTM 5990 335 55H 391 719 UTM 5990 165 55H 391 824 UTM 5990 521
r	*Senecio campylocarpus*	Groundsel	55H 391 731 UTM 5990 194
r	*Triglochin dubia*	Slender Water-ribbons	55H 391 924 UTM 5990 315

Threatened plant species recorded at Moodies Swamp are listed in Table 27.

Table 28. Indigenous vascular Plants recorded at Moodies Swamp

Status	*Scientific Name*	Common Name	Wetland Species
	Acacia acinacea	Gold-dust Wattle	
	Acacia aspera	Rough Wattle	
	Acacia implexa	Lightwood	
	Acacia montana	Mallee Wattle	
	Acacia pycnantha	Golden Wattle	
	Allocasuarina luehmannii	Buloke	
	Alternanthera denticulata	Lesser Joyweed	w
	Amphibromus nervosus	Veined Swamp Wallaby-grass	w
	Aristida behriana	Brush Wire-grass	
	Arthropodium fimbriatum	Nodding Chocolate-lily	
	Arthropodium minus	Small Vanilla-lily	
k	*Arthropodium sp. 3*	Twin-flowered Chocolate Lily	
	Arthropodium strictum	Chocolate Lily	
	Austrodanthonia caespitosa	Common Wallaby-grass	
	Austrodanthonia duttoniana	Brown-back Wallaby-grass	w
	Austrodanthonia racemosa var. racemosa	Stiped Wallaby-grass	
	Austrodanthonia setacea	Bristly Wallaby-grass	
	Austrostipa gibbosa	Spear-grass	
	Austrostipa scabra subs. falcata	Rough Spear-grass	
	Boerhavia dominii	Tah-vIne	
	Bothriochloa macra	Red-leg Grass	
	Callitriche sonderi	Matted Water-starwort	w
r	*Callitriche umbonata*	Winged Water-starwort	w
	Callitris columellaris	White Cypress-pine	
	Calotis cuneifolia	Burr Daisy	
r	*Cardamine moirensis*	Riverine Bitter-cress	w
	Carex inversa	Common Sedge	
	Carex tereticaulis	Basket Sedge	w

Status	*Scientific Name*	Common Name	Wetland Species
	Cassinia arcuata	Drooping Cassinia	
	Centipeda cunninghamii	Common Sneezeweed	w
	Chenopodium desertorum subs. microphyllum	Goosefoot	
	Chloris truncata	Windmill Grass	
	Convolvulus erubescens	Pink Bindweed	
	Craspedia paludicola	Swamp Billybuttons	w
	Crassula decumbens	Spreading Crassula	
	Crassula sieberi ssp. tetramera	Australian Stonecrop	
	Cyperus gymnocaulos	Spiny Flat-sedge	w
	Damasonium minus	Star-fruit	w
	Dianella admixta	Black-anther Flax-lily	
Kv	*Dianella sp. aff. longifolia (Riverina)*	Riverine Flax-lily	
	Elatine gratioloides	Waterwort	w
	Eleocharis acuta	Common Spike-sedge	w
	Enneapogon nigricans	Nigger-heads	
	Enteropogon acicularis	Spider Grass	
	Epilobium billardierianum var. cinereum	Grey Willow-herb	w
	Eragrostis elongata	Close-headed Love-grass	
	Eragrostis infecunda	Southern Cane-grass	w
	Eucalyptus camaldulensis	River Red-gum	w
	Eucalyptus melliodora	Yellow Box	
	Eucalyptus microcarpa	Grey Box	
	Euchiton sphaericus	Annual Cudweed	w
	Eutaxia microphylla var. diffusa	Common Eutaxia	
	Geranium sp2	Variable Cranesbill	
	Glycine clandestina var. sericea	Twining Glycine	
	Goodenia pinnatifida	Cut-leaf Goodenia	
r	*Gratiola pumilio*	Dwarf Brooklime	w
	Haloragis aspera	Rough Raspwort	
k	*Haloragis glauca*	Bluish Raspwort	
	Helichrysum luteoalbum	Jersey Cudweed	
	Isoetes muelleri	Quillwort	w

Status	*Scientific Name*	Common Name	Wetland Species
	Isolepis hookeriana	Grassy Club-sedge	w
	Isolepis cernua var. platycarpa	Nodding Club-sedge	w
k	*Isolepis australiensis*	Southern Club-sedge	w
	Juncus bufonius	Toad Rush	w
	Juncus flavidus	Yellow Rush	w
	Juncus holoschoenus	Joint-leaf Rush	w
	Juncus semisolidus	Rush	w
	Lachnagrostis filiformis var. 1	Common Blown-grass	w
	Limosella australis	Austral Mudwort	w
	Lobelia pratioides	Poison Lobelia	w
	Lomandra filiformis ssp. coriacea	Wattle Matt-rush	
	Lomandra multiflora ssp. multiflora	Many-flowered Matt-rush	
	Lythrum hyssopifolia	Mediterranean Loosestrife	w
	Maireana enchylaenoides	Wingless Bluebush	
	Marsilea drummondii	Common Nardoo	w
	Minuria leptophylla	Minnie Daisy	
	Muehlenbeckia florulenta	Tangled Lignum	w
	Myriophyllum crispatum	Upright Water-milfoil	w
e	*Myriophyllum gracile var. lineare*	Water-milfoil	w
Vv	*Myriophyllum porcatum*	Water-milfoil	w
	Myriophyllum verrucosum	Red Water-milfoil	w
	Oxalis perennans	Grassland Wood-sorrel	
	Panicum decompositum var. decompositum	Australian Millet	
	Pilularia novae-hollandiae	Austral Pillwort	w
	Pimelea curviflora s.l.	Curved Rice-flower	
	Poa sieberiana var. sieberiana	Grey Tussock-grass	
	Potamogeton cheesemanii	Red Pondweed	w
	Ptilotus spathulatus	Pussy Tails	
	Pycnosorus globosus	Drumsticks	w
	Ranunculus pumilio var. pumilio	Ferny Small-flower Buttercup	w

Status	*Scientific Name*	Common Name	Wetland Species
	Riccia duplex	Crystalwort	w
	Rumex dumosus	Wiry Dock	
	Rumex tenax	Narrow-leaf Dock	w
	Sclerolaena muricata var. villosa	Grey Roly-poly	
r	*Senecio campylocarpus*	Groundsel	w
	Senecio runcinifolius	Tall Fireweed	w
	Sida corrugata	Variable Sida	
	Spergularia brevifolia	Sea-spurrey	
	Swainsona procumbens	Broughton Pea	w
	Teucrium racemosa	Grey Germander	
	Tribulus terrestris	Caltrop	
r	*Triglochin dubia*	Slender Water-ribbons	w
	Vittadinia cervicularis	Annual New Holland Daisy	
	Vittadinia gracilis	Wooly New Holland Daisy	
	Wahlenbergia fluminalis	River Bluebell	
	Wahlenbergia luteola	Yellowish Bluebell	
	Walwhalleya proluta	Rigid Panic	w
	Total Indigenous Species	**110**	

Table 29. Exotic plants recorded at Moodies Swamp Survey

Status	Scientific Name	Common Name	Wetland Species
	**Acacia decurrens*	Early Black Wattle	
	**Aira elegans*	Hair Grass	
	**Aster subulatus*	Aster	w
	**Avena barbata*	Bearded Oat	
	**Briza minor*	Lesser Quaking-grass	
	**Bromus diandrus*	Great Brome	
	**Bromus hordeaceus subs. hordeaceus*	Soft Brome	
	**Callitriche hamulata*	Water Starwort	w
	**Cerastium glomeratum*	Common Mouse-ear Chickweed	
	**Chondrilla juncea*	Skeleton Weed	
	**Cirsium vulgare*	Spear Thistle	
	**Conyza bonariensis*	Tall Fleabane	
	**Cynodon dactylon var. dactylon*	Couch	
	**Echium plantagineum*	Paterson's Curse	
	**Helminthotheca echioides*	Ox-tongue	
	**Hordeum vulgare*	Barley	
	**Hypochoeris glabra*	Smooth Cat's-ear	
	**Hypochoeris radicata*	Cat's Ear	
	**Isolepis hystrix*	Awned Club-sedge	w
	**Isolepis tenellus*	Tiny Flat-sedge	w
	**Lactuca saligna*	Willow-leaf Lettuce	
	**Lactuca serriola*	Prickly Lettuce	
	**Leontodon taraxacoides subs. taraxacoides*	Hairy Hawkbit	
	**Lolium rigidum*	Wimmera Rye-grass	
	**Malva parviflora*	Small-flower Mallow	
	**Marrubium vulgare*	Horehound	
	**Medicago polymorpha*	Burr Medic	
	**Pennisetum clandestinum*	Kikuyu	
	**Phalaris aquatica*	Toowoomba Canary-grass	

Status	Scientific Name	Common Name	Wetland Species
	**Phalaris paradoxa*	Paradoxical Canary-grass	w
	**Physalis viscosa*	Sticky Ground-cherry	
	**Polygonum aviculare*	Prostrate Knotweed	
	**Ranunculus sceleratus*	Celery Buttercup	w
	**Romulea rosea var. australis*	Onion Grass	
	**Rumex crispus*	Curled Dock	w
	**Sonchus asper*	Rough Sow-thistle	
	**Sonchus oleraceus*	Common Sow-thistle	
	**Trifolium dubium*	Suckling Clover	
	**Vulpia bromoides*	Squirrel-tail Fescue	
	**Xanthium spinosum*	Bathurst Burr	
	Total Exotic Species	**41**	

A small infestation of Sticky Ground-cherry (**Physalis viscosa*) was observed in Plains Woodland vegetation to the south of the swamp at 55H 391005 UTM 5989380. This species is highly invasive and has the potential to displace significant native vegetation in this area. This infestation should be eradicated as soon as possible.

5.3.3 Birds

A total of 58 bird species were recorded at Moodies Swamp over the course of the seven monitoring events (see Tables 32 and 33), including 17 wetland species. Numbers of wetland bird species present at Moodies Swamp peaked at the fourth visit, when 15 species were observed. This was almost twice the number seen at any other visit. This diversity included a variety of ducks, a pair of Swamp Harriers and a number of species not seen previously at the wetland including Brolga, White-backed Swallow, Little Grassbird, White-faced Heron and Grey Teal.

The occurrence of White-backed Swallows at Moodies Swamp is noteworthy. This species is generally uncommon in Victoria, particularly during winter when it is thought that part of the population migrates out of Victoria (Emison *et al*, 1987). White-backed Swallows often hawk for flying insects over freshwater wetlands and nest in areas of sandy soil, and have been observed breeding at scattered localities in northern Victoria. Moodies Swamp, with its sandy lunette and the nearby granitic hills may therefore provide potential breeding habitat for this species.

Photograph 18. White-backed Swallow, Moodies Swamp

Non-wetland bird diversity at Moodies Swamp also peaked at the fourth visit. The overall increase in non-wetland bird diversity around the wetland may indicate a response by these species to a general increase in food resources, such as insect prey items, due to the swamp being flooded.

The only threatened wetland bird observed at Moodies Swamp was the vulnerable Brolga, 4 of which were seen on the 6th of October. A local farmer reported that there were 6 Brolga in the vicinity of Moodies Swamp in early June 2008. He recalled seeing many more in wet periods in the past, with a peak of up to 28 in 1956 (Ron Moodie pers. comm.). The near threatened Brown Treecreeper was commonly observed in the surrounding woodland.

Table 30. Summary Table of Wetland and non-wetland bird species diversity and abundance at Moodies Swamp

	18-May-08	31-May-08	15-Jun-08	11-Jul-08	07-Oct-08	19-Oct-08	10-Dec-08
Days since inundation	19	33	48	74	162	206	227
Total wetland species diversity (transect and incidental)	4	8	5	15	8	6	7
Transect only wetland species diversity	3	3	4	8	3	5	6
Transect only total wetland birds abundance	56	49	232	230	128	138	67
Transect only non-wetland birds species diversity	5	10	8	7	6	13	11
Transect only non-wetland birds abundance	47	41	47	87	71	84	34

Figure 6. Graph of bird diversity versus time since inundation

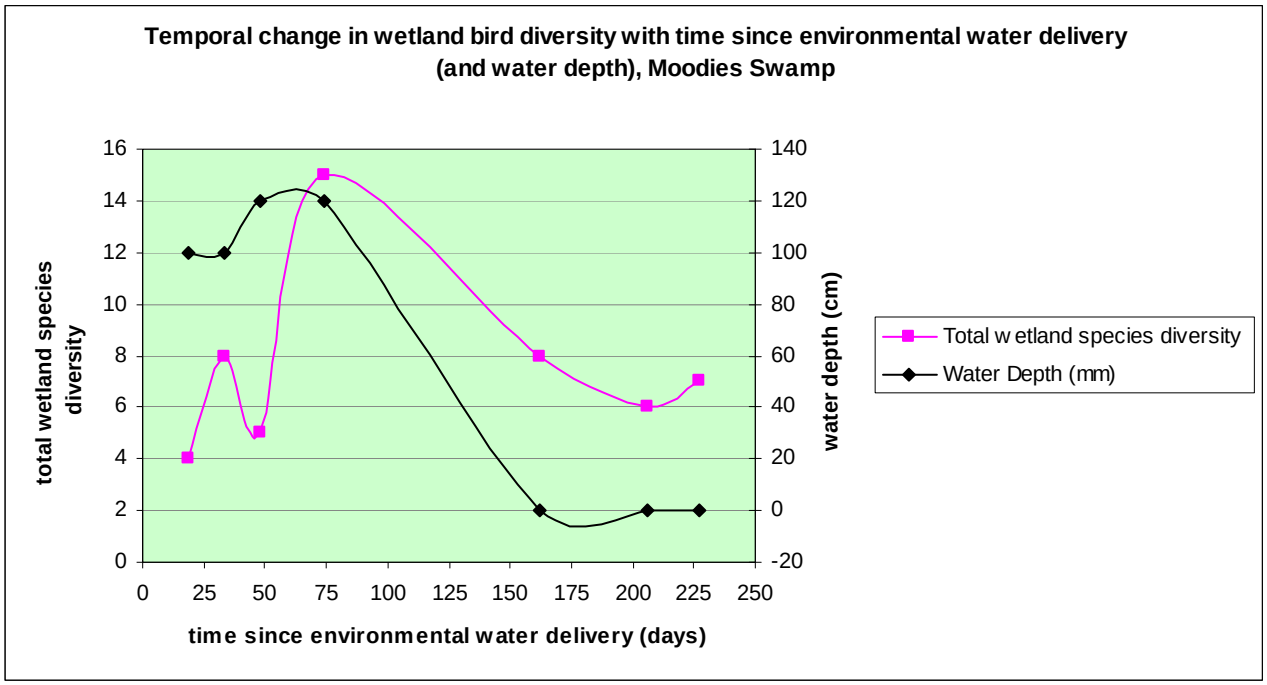


Table 31. EPBC Act and AVW threatened fauna species occurring at Moodies Swamp

FFG	EPBC	VROT	Common Name	Scientific Name
f		v	Brolga	*Grus rubicunda*
		nt	Brown Treecreeper	*Climacteris picumnus victoriae*

Wetland bird breeding activity observed at Moodies Swamp included a pair of Brolga calling and displaying, and Golden-headed Cisticola and Swamp Harrier nesting and raising chicks.

Table 32. Wetland Birds observed at Moodies Swamp

		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	9:00– 9.30 am	10.30-11:00am	1:00- 5:00 pm	4.14 – 4.45 pm	14.00–14.30pm	7.30 – 8.00pm	10.30-11.00am
	Australian Shelduck		(3)		(2)			
v	Brolga				2 nesting?	4		
	Golden-headed Cisticola	50	30	30	20	20	40	40 (6)
	Grey Teal				(2)			
	Little Grassbird				1	(1)		
	Little Pied Cormorant			1	(1)			
	Australian Wood Duck		(1)		(32)			(6)
	Masked Lapwing	(2)	(2)		(2)	(2)	(2)	
	Pacific Black Duck		(2)		(1)			(2)
	Swamp Harrier			(1)	2	2		1 (1)
	Tree Martin #			100+	60	41	60	10 (2)
	Welcome Swallow #	3	4	100+	100+	55	30	6 (20)
	Whistling Kite #		(1)					
	White-backed Swallow #				2		2	2 (1)
	White-faced Heron				(1)	(3)		
	White-fronted Chat	1	6		2			2 (1)

		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Status	Time of Day	9:00– 9.30 am	10.30-11:00am	1:00- 5:00 pm	4.14 – 4.45 pm	14.00–14.30pm	7.30 – 8.00pm	10.30-11.00am
	Fairy Martin						4	
	Total Wetland Species Diversity	4	8	5	15	8	6	7
	Total Transect Wetland Species Diversity	3	3	4	8	3	5	6
	Native Wetland Species Transect Only Abundance	56	49	232	230	128	138	67

Species shown with a shaded background were observed breeding at this site

The Welcome Swallow, White-backed Swallow, Tree Martin and Whistling Kite are not strictly wetland species; however they can be quite closely associated with wetlands. They have been included in this category as they appeared to have been attracted to the wetlands to prey on species that are reliant on the wetlands containing water, and for this reason could be considered to have directly benefited from the delivery of environmental water.

Table 33. Non-wetland Birds observed at Moodies Swamp

		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Oct-08	10-Dec-08
Status	Time of Day	9:00– 9.30 am	10.30-11:00am	1:00- 5:00 pm	4.14 – 4.45 pm	14.00–14.30pm	7.30 – 8:00pm	10.30-11.00am
	Australian Kestrel	1	1			0		
	Australian Magpie	20	14		2	(2)	6	(3)
	Australian Mudlark	(2)	4 (2)	4	4	(2)		(2)
	Australian Raven	3	3 (1)		2		4	(2)
	Barn Owl		(1)					
	Black-faced Cuckoo-shrike			1		(1)		
	Black-shouldered Kite							(1)
	Brown Falcon	1	2	(1)	1	1		
	Brown Songlark					1	(1)	1 (1)
nt	Brown Treecreeper				(2)	(2)	2	1 (2)
	Crested Pigeon				3		1	(2)
	Dollarbird							(1)
	Eastern Rosella	(1)	(2)		(2)	(2)	1	(4)
	Galah	3	2	2	(30)	50	5	2 (26)
	Golden Whistler					(1)		(1)
	Grey Fantail				(1)			
	Grey Shrike-thrush							(1)
	Kookaburra			4	(4)		2	2 (2)
	Little Corella				(6)		(10)	

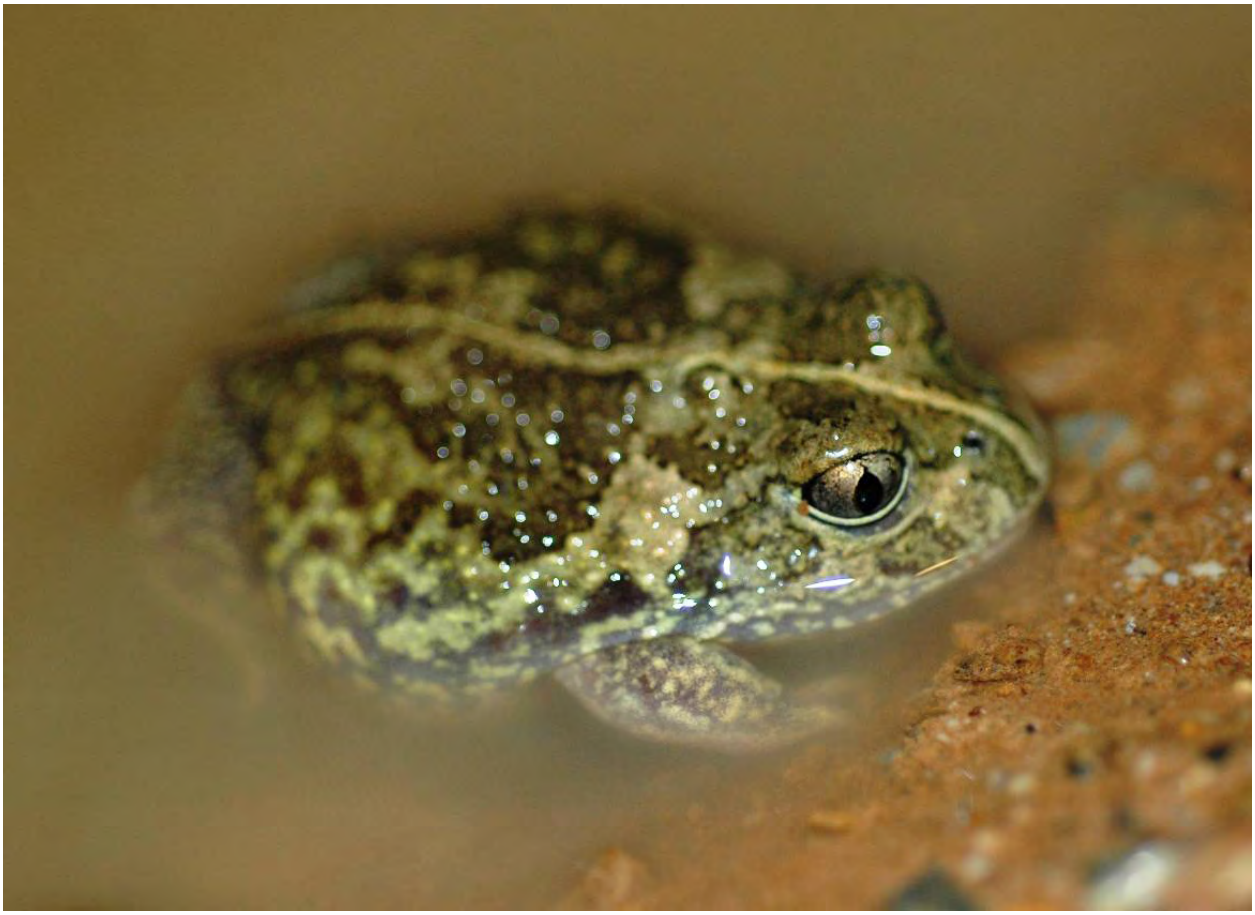
		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Oct-08	10-Dec-08
Status	Time of Day	9:00– 9.30 am	10.30-11:00am	1:00- 5:00 pm	4.14 – 4.45 pm	14.00–14.30pm	7.30 – 8:00pm	10.30-11.00am
	Noisy Miner				4		(2)	(4)
	Olive-backed Oriole							(1)
	Peaceful Dove		(2)					
	Peregrine Falcon				(1)	1		
	Red Wattlebird							2 (6)
	Red-rumped Parrot	(10)			(3)		4 (4)	(20)
	Restless Flycatcher	(2)		2	(1)			(1)
	Richards Pipit				(1)			
	Rufous Whistler							(1)
	Southern Bookook							(2)
	Striated Pardalote	(4)	3 (1)	10	(2)	2	1 (4)	1 (20)
	Striated Thornbill							0 (5)
	Sulphur-crested Cockatoo		2				1	
	Tawny Frogmouth		(1)					
	Weebill					(3)		(3)
	White-browed Woodswallow		3	20 (4)	(10)		(18)	10 (6)
	White-plumed Honeyeater					(2)	20 (2)	10 (30)

		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Oct-08	10-Dec-08
Status	**Time of Day**	**9:00– 9.30 am**	**10.30-11:00am**	**1:00- 5:00 pm**	**4.14 – 4.45 pm**	**14.00–14.30pm**	**7.30 – 8:00pm**	**10.30-11.00am**
	Willie Wagtail		1	3	3	1	1	1 (2)
	Yellow-rumped Thornbill						(2)	
	Zebra Finch							2 (2)
	*Starling				(5)		3	2 (3)
	*Tree Sparrow							(20)
	Total non-wetland birds Species Diversity	**10**	**14**	**9**	**20**	**15**	**15**	**30**
	Total Transect non-wetland birds Species Diversity	**5**	**10**	**8**	**7**	**6**	**13**	**11**
	Native non-wetland birds Species Transect Only Abundance	**47**	**41**	**47**	**87**	**71**	**84**	**34**

Species shown with a shaded background were observed breeding at this site; Numbers in parenthesis indicate incidental observations outside of timed transect.

5.3.4 Frogs

Six species of frogs were observed at Moodies Swamp including Sloane's Froglet, Common Froglet, Plains Froglet, Spotted Grass Frog, Painted Burrowing Frog and Peron's Tree Frog. Moodies Swamp was the only wetland where Sloane's Froglet and the Painted Burrowing Frog were recorded during this study. Sloane's Froglet is listed by the IUCN as data deficient. In the Atlas of Victorian Wildlife there are 73 records for this species, only six of which have been entered since the year 2000. Sloane's Froglet was only heard calling during cool conditions from May until July. The Painted Burrowing Frog was not heard calling at the site but recorded on two occasions; a dead individual was found on the edge of the wetland on the 7th of October and a live individual was observed on the move during heavy rain on the 18th of November. Peron's Tree Frogs were only heard calling at the wetland during November and December.



Photograph 19. Painted Burrowing Frog (*Neobatrachus sudeli*) at Moodies Swamp

Photograph 20. Sloane's Froglet (*Crinia sloanei*) at Moodies Swamp

Table 34. Frogs observed at Moodies Swamp

Date and Time		18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	18-Nov-08	10-Dec-08
Species heard calling	Common Name	9 – 9.30	20.30-21.00	17.00-17.30	20.00 –20.30	14.00 – 14.30	22.00–22.30	21.30-22.00
Crinia parinsignifera	Plains Froglet	>100	>100	>100	>100	O	<10	<10
Crinia signifera	Common Froglet	<10	>100	10-100	>100	O	(19/11)	O
Crinia sloanei	Sloane's Froglet	>100	>100	>100	>100	O	O	O
Limnodynastes tasmaniensis (NCR)	Spotted Grass Frog	>100	>100	>100	>100	O	<10	O
Litoria peronii	Peron's Tree Frog						<10	<10
Neobatrachus sudelli	Painted Burrowing Frog					1 deceased	1 found	O
Number of egg-masses observed								

Estimated abundance heard calling: <10, 10-100, >100, O = observed; Transect length 250m for 30 min; transect located 230° from quadrat; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect

5.3.5 Other Fauna

Table 35. Reptiles observed at Moodies Swamp

Status	Scientific Name	Common Name
	Chelodina longicollis	Eastern Long-necked Turtle
	Ctenotus robustus	Eastern Striped Skink
	Delma inornata	Olive Legless Lizard
	Morethia boulengeri	Boulenger's Skink
	Notechis scutatus	Tiger Snake
	Pseudonaja textalis	Eastern Brown Snake

Table 36. Mammals observed at Moodies Swamp

Status	Scientific Name	Common Name
	Macropus giganteus	Eastern Grey Kangaroo
	Wallabia bicolor	Swamp Wallaby
	Tadarida australis	White-striped Freetail Bat
	Trichosaurus vulpecula	Common Brushtail Possum
	**Lepus capensis*	Hare
	**Oryctolagus cuniculus*	Rabbit
	**Vulpes vulpes*	Red Fox

Photograph 21. Olive Legless Lizard (*Delma inornata*) at Moodies Swamp

5.4 KINNAIRDS SWAMP

5.4.1 Water

A total of 413 megalitres of water was delivered to the swamp from an irrigation channel from the 30th of April and the 6th of June 2008. Water levels peaked in the wetland around the end of May at a maximum depth of approximately 1250mm in the deep constructed channel, though the average depth across most of the wetland at this stage was about 150mm. By the fourth monitoring event on the 12th of July the average water level across the wetland had dropped to 80mm. By the final visit in December the only areas of the wetland still supporting surface water were ponds within the constructed wetlands.

The **pH** ranged from 6.5 in 31 May 2008 and 7 Oct 2008 to 7.2 in 11 July 2008 with an average of 6.8. All samples were within both the EPA and ANZECC guidelines for pH being ≥6.4-≤7.7 and 6.6-8.0 respectively, with the exception of 6.5 on 31 May 2008.

Temperature fluctuated between 8.5 ℃ to 14.2 ℃ with an average of 11.4℃. Monitoring points had dried out by November, thus keeping the average temperature low.

Dissolved oxygen ranged from 60% to 138% with an average of 97%. DO concentrations fell below the EPA objectives of between ≥85-110% on two occasions, on 17 May 2008 and at quadrat 3 on 12 July 2008. Quadrat 3 is composed of Tall Marsh with abundant living and decaying vegetation. DO concentrations exceeded EPA guidelines on 2 occasions on 15 June and 12 July 2008 in Quadrat 4. This quadrat is shallow and exposed so may be exposed to the wind.

Conductivity ranged from 98 to 145µS/cm^{-1} with an average of 110µS/cm^{-1}. These levels exceed ANZECC guidelines (20-30 µS/cm-1), but are well within the EPA guidelines for this region (≤500 µS/cm-1). These levels are the lowest of the four wetlands and slightly lower than most of the EC readings from the Shepparton urban lakes (see Table 50).

There was a rise in conductivity over the sampling period between June and July which is consistent with the drop in water level.

Turbidity did not vary at the site and was consistently sampled at around 10 NTU. These concentrations are well within both EPA and ANZECC guidelines of ≤30 NTU and 1-20 NTU respectively.

Table 37. Temporal change in water quality at Kinnairds Swamp

Red= exceeds both EPA (2003) and ANZECC & ARMCANZ (2000), Yellow= exceeds GOVERNMENT OF VICTORIA (2003) only, Green exceeds ANZECC & ARMCANZ (2000) only (see Appendix A).

	Units	17-May-08	31-May-08	15-Jun-08				12-Jul-08				7-Oct-08				18-Nov-08	9-Dec-08	Average
Quadrat				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Depth	mm	200	450	100	140	400	180	All dry	40	300	80	All dry	All dry	100	dry	All dry	All dry	
pH		6.6	6.5	6.9	6.8	7.1	7.1		7.0	6.6	7.2			6.5				**6.8**
Temp	℃	11.0	14.1	12.2	14.2	10.8	12.8		10.2	9.2	10.9			8.5				**11.4**
DO	%	69	93	109	99	88	114		100	60	138			Na				**96.7**
Turbidity	NTU	20-30	10	≤10	≤10	≤10	≤10		≤10	≤10	≤10			<10				**11.5**
Conductivity	µS/cm^{-1}	104	104	105	100	100	98		145	128	124			100				**111**

**Change of meter used from turbidity tube to Horiba multi-meter; Depth measured at south west corner of quadrat.

5.4.2 Vegetation

Kinnairds Swamp is dominated by a mosaic of Red Gum Swamp and Plains Grassy Wetland, with smaller occurrences of Plains Rushy Wetland, Tall Marsh, Aquatic Herbland and Open Water. Kinnairds Swamp is surrounded by Plains Grassy Woodland/Gilgai Wetland Mosaic.

Plains Rushy Wetland was sampled in quadrat 1. Initially this EVC appeared to be in poor condition, with a low diversity of indigenous species. However, the diversity of indigenous species has steadily increased with time since environmental water delivery so that by the fourth survey it was in moderate condition. Indigenous species that germinated in this EVC included Common Swamp Wallaby-grass (*Amphibromus nervosus*), Ferny Small-flower Buttercup (*Ranunculus pumilio var. pumilio*) and Mediterranean Loosestrife (*Lythrum hyssopifolium*), while species that re-sprouted after water delivery included Common Spike-sedge (*Eleocharis acuta*), Narrow-leaf Dock (*Rumex tenax*) and Narrow-leaf Nardoo (*Marselia costulifera*).

Red Gum Swamp was sampled in quadrat 2. In common with the Plains Rushy Wetland the diversity of indigenous wetland species in this EVC steadily increased with time since water delivery and its condition improved from poor to moderate. Indigenous species that germinated in Red Gum Swamp in response to increased moisture included Riverine Bitter-cress (*Cardamine moirensis*), Common Blown-grass (*Lachnagrostis filiformis var. 1*) and Ferny Small-flower Buttercup (*Ranunculus pumilio var. pumilio*), while both Common Nardoo (*Marselia drummondii*) and Narrow-leaf Nardoo (*Marselia costulifera*) re-sprouted.

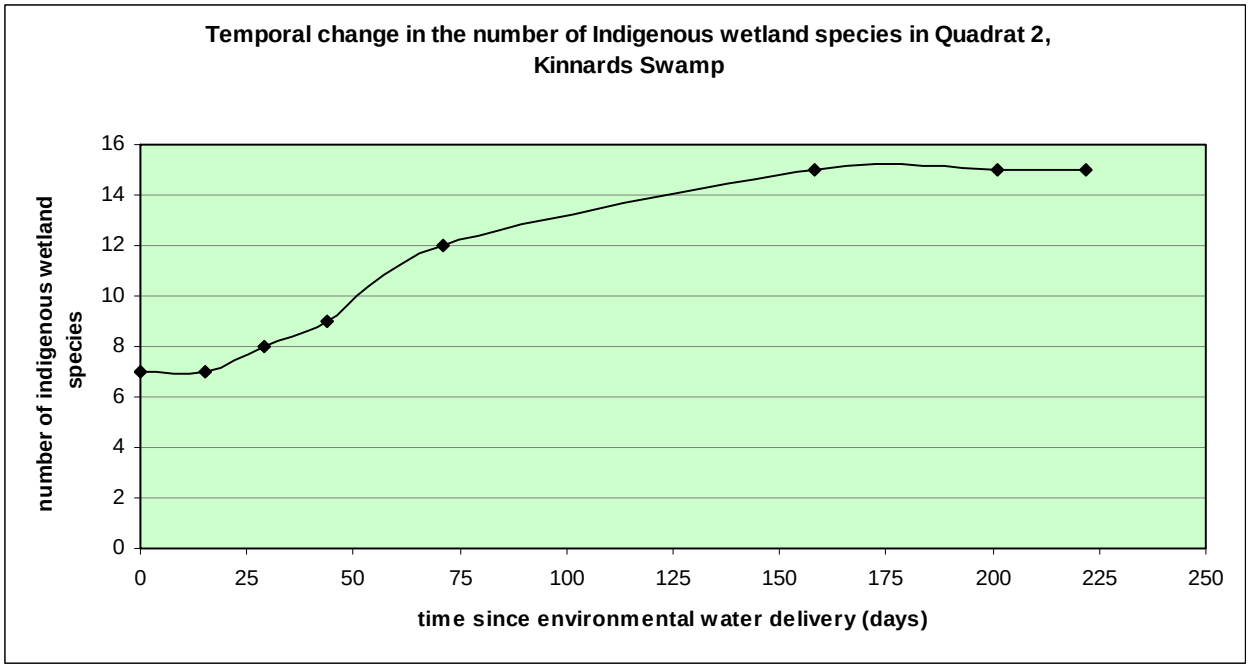
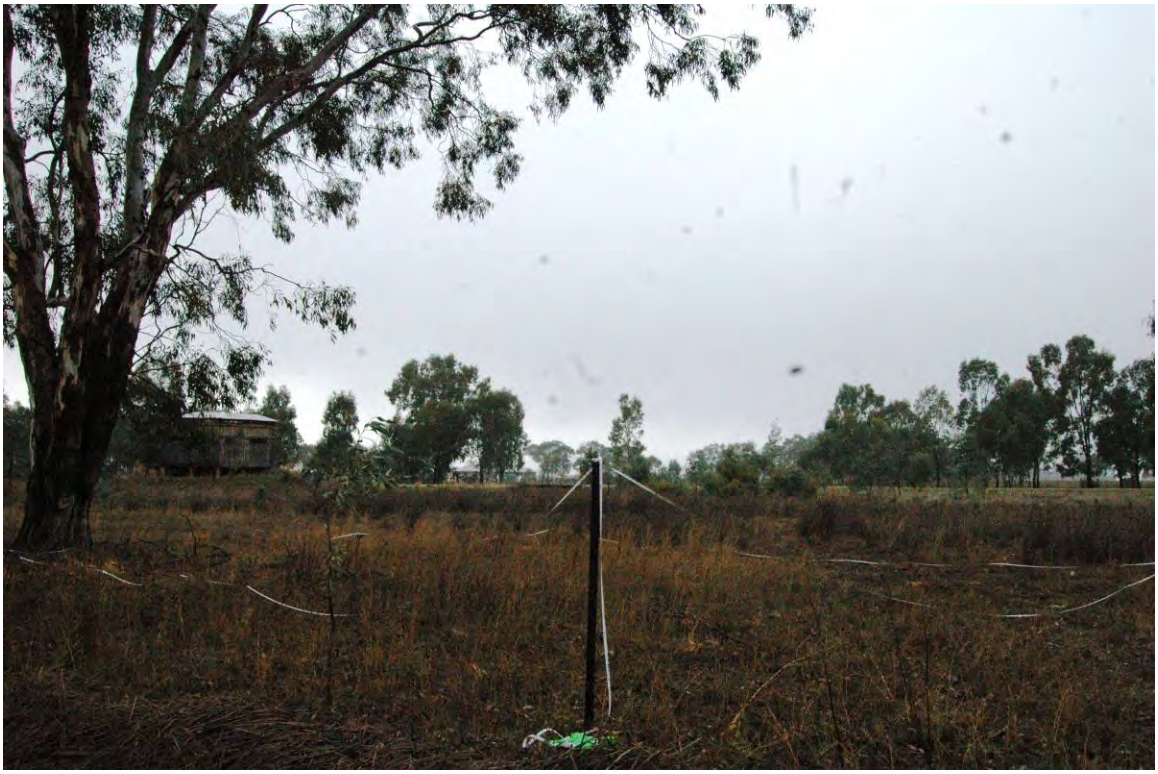


Figure 7. Temporal change in the number of wetland plant species observed in quadrat 2, Kinnairds Swamp



Photograph 22. Kinnairds Swamp quadrat 2, dry on 17/05/08

Photograph 23. Kinnairds Swamp quadrat 2, inundated on 15/06/08

Tall Marsh was sampled in quadrat 3. This EVC is generally species-poor, and although this quadrat only supported 1 indigenous species, the EVC is still regarded as being in moderate condition. There was little change in the condition or diversity of this vegetation type over the monitoring period, apart from some new growth produced by the Giant Rush (*Juncus ingens*).

Plains Grassy Wetland was sampled in quadrat 4. Like the Plains Rushy Wetland and Red Gum Swamp the condition of this EVC improved from poor to moderate after the delivery of environmental water. Inundation of this EVC promoted the growth of the endangered Slender Water Milfoil (*Myriophyllum gracile* var. *lineare*) Common Spike-rush (*Eleocharis acuta*), Common Nardoo (*Marselia drummondii*) and Narrow-leaf Nardoo (*Marselia costulifera*) and Common Swamp Wallaby-grass (*Amphibromus nervosus*).

Prior to the delivery of environmental watering it was difficult to determine the ecological condition of much of Kinnairds Swamp, as prolonged dry conditions meant that most of the indigenous wetland species were dormant. However, 158 days after water delivery began it was clear that parts of the wetland support very significant, relatively intact native vegetation. This includes Red Gum Swamp vegetation in two areas; the first extending south from the northern birdhide (55H 362 191 UTM 6006 204) and the second in the floodway that flows into the swamp from the north (55H 362 201 UTM 6006 333).

Red Gum Swamp in these areas is dominated by an open canopy of River Red Gum (*Eucalyptus camaldulensis*) over a diverse community of semi-aquatic grasses, sedges and herbs. Dominant field-layer species in these areas when they are inundated include the nationally vulnerable Ridged Water-milfoil (*Myriophyllum porcatum*), Common Spike-rush (*Eleocharis acuta*), Common Swamp Wallaby-grass (*Amphibromus nervosus*), Moira Grass (*Psuedoraphis spinescens*) and Tussock Rush (*Juncus aridicola*). Associated species include Upright Water-milfoil (*Myriophyllum crispatum*), Red Water-milfoil (*Myriophyllum verrucosum*), Joint-leaf Rush (*Juncus holoschoenus*), Narrow-leaf Dock (*Rumex tenax*), Star Fruit (*Damasonium minus*), Waterwort (*Elatine gratioloides*), Clove-strip (*Ludwigia peploides subsp. montevidensis*), Red Pondweed (*Potamogeton cheesemanii*), Spoon Mud-mat (*Glossostigma cliesthanthum*), Austral Mudwort (*Limnosella australis*), Large Mudwort (*Limnosella curdiana*), Austral Pillwort (*Pilularia novae-hollandiae*), and the endangered Slender Water-milfoil

(*Myriophyllum gracile var. lineare*). The highest threat environmental weed in these areas is Water Couch (**Paspalum distichum*).

Photograph 24. Slender Water-milfoil (*Myriophyllum gracile var. lineare*) at Kinnairds Swamp

Photograph 25. High quality Red Gum Swamp in the northern floodway at Kinnairds Swamp. Dominant field layer species include Common Spike-rush (*Eleocharis acuta*) and the nationally vulnerable Ridged Water-milfoil (*Myriophyllum porcatum*).

Photograph 26. Red Gum Swamp field-layer dominated by Ridged Water-milfoil, *Myriophyllum porcatum*, Kinnairds Swamp

A total of 48 indigenous wetland plant species had been recorded at this wetland by the seventh visit, in contrast to the 17 species recorded during the first visit (a 180% increase in species richness).

Threatened plant species recorded at Kinnairds Swamp are listed in Table 38.

Table 38. Threatened plant species recorded at Kinnairds Swamp

Status	Species	Common Name	Location
r	*Cardamine moirensis*	Riverine Bitter-cress	55H 362 680 UTM 6005 998
k	*Haloragis glauca*	Bluish Raspwort	
Vv	*Myriophyllum porcatum*	Ridged Water-milfoil	55H 362 201 UTM 6006 333 55H 362 191 UTM 6006 204
e	*Myriophyllum gracile var. lineare*	Slender Water-milfoil	55H 362 658 UTM 6005 981 55H 362 201 UTM 6006 333
r	*Callitriche umbonata*	Winged Water-starwort	55H 362 201 UTM 6006 333
r	*Glossostigma cleistanthum*	Mud-mat	55H 362 201 UTM 6006 333

The population of Ridged Water-milfoil at this site covered a number of hectares in the inflow channel (55H 362 201 UTM 6006 333) and just to the south of the northern bird hide (55H 362 191 UTM 6006 204), and comprised many thousands of plants, making it the largest known population of this nationally vulnerable species.

The population of Slender Water-milfoil at this site numbered approximately 1000 plants, making it the largest known population of this species in Victoria. While Kinnairds Swamp has been subject to human modification both of these rare Milfoil species occurred in species-rich and ecologically intact examples of Red Gum Swamp and Plains Grassy Wetland, which are both endangered EVCs in the Victorian Riverina bioregion.

The provision of habitat for threatened fauna and the presence of large populations of threatened plant species and species-rich, relatively intact examples of endangered plant communities make Moodies and Kinnairds Swamps of very high (national) conservation significance.

Table 39. Indigenous Vascular Plants recorded at Kinnairds Survey

Status	*Scientific Name*	Common Name	Wetland species
	Acacia acinacea	Gold-dust Wattle	
	Acacia dealbata (Planted)	Silver Wattle	
	Acacia montana (Planted)	Mallee Wattle	
	Acacia pycnantha	Golden Wattle	
	Alternanthera denticulata	Lesser Joyweed	w
	Amphibromus nervosus	Common Swamp Wallaby-grass	w
	Asperula conferta	Common Woodruff	
	Austrodanthonia caespitosa	Common Wallaby-grass	
	Austrodanthonia duttoniana	Brown-back Wallaby-grass	w
	Austrodanthonia setacea	Bristly Wallaby-grass	
	Azolla filiculoides	Pacific Azolla	w
	Bursaria spinosa (Planted)	Sweet Bursaria	
r	*Callitriche umbonata*	Water-starwort	w
r	*Cardamine moirensis*	Riverine Bitter-cress	w
	Carex appressa	Tall Sedge	w
	Centipeda cunninghamii	Common Sneezeweed	w
	Chamaesyce drummondii	Flat Spurge	
	Chloris truncata	Windmill Grass	
	Convolvulus erubescens	Bindweed	
	Damasonium minus	Star-fruit	w
	Elatine gratioloides	Waterwort	w
	Eleocharis acuta	Common Spike-sedge	w
	Eleocharis pusilla	Small Spike-sedge	w
	Enteropogon acicularis	Spider Grass	
	Epilobium billardierianum subs. cinereum	Variable Willow-herb	w
	Eucalyptus camaldulensis	River Red-gum	w
	Eucalyptus melliodora	Yellow Box	
	Eucalyptus microcarpa	Grey Box	
	Euchiton sphaericus	Annual Cudweed	
r	*Glossostigma cliestathum*	Spoon Mud-mat	w
	Goodenia gracilis	Slender Goodenia	w

Status	*Scientific Name*	Common Name	Wetland species
	Haloragis aspera	Rough Raspwort	
k	*Haloragis glauca*	Bluish Raspwort	
	Ixiolaena sp.	Plover Daisy (on roadside)	
	Juncus amabilis	Hollow Rush	w
	Juncus aridicola	Tussock Rush	w
	Juncus bufonius	Toad Rush	w
	Juncus flavidus	Yellow Rush	w
	Juncus holoschoenus	Jointed Rush	w
	Juncus ingens	Giant Rush	w
	Juncus semisolidus	Plains Rush	w
	Juncus subsecundus	Finger Rush	w
	Juncus usitatus	Billabong Rush	w
	Lachnagrostis filiformis var. 1	Common Blown-grass	w
	Lemna disperma	Common Duckweed	w
	Limosella australis	Austral Mud-mat	w
	Limosella curdieana	Spoon-leaf Mud-mat	w
	Lobelia concolor	Poison Pratia	w
	Lobelia pratioides	Poison Lobelia	w
	Ludwigia peploides subsp. montevidensis subsp. montevidensis	Clove-strip	w
	Lythrum hyssopifolium	Mediterranean Loosestrife	w
	Marsilea costulifera	Narrow-leaf Nardoo	w
	Marsilea drummondii	Common Nardoo	w
	Melaleuca parvistaminea (Planted)	Rough-barked Honey-myrtle	
	Muehlenbeckia florulenta	Tangled Lignum	w
	Myosurus minimus var. australis	Mouse-tails	w
	Myriophyllum crispatum	Upright Water Milfoil	w
e	*Myriophyllum gracile var. lineare*	Slender Water Milfoil	w
	Myriophyllum papillosum	Robust Water Milfoil	w
Vv	*Myriophyllum porcatum*	Ridged Water Milfoil	w
	Myriophyllum verrucosum	Red Water Milfoil	w

Status	*Scientific Name*	Common Name	Wetland species
	Oxalis perennans	Grassland Wood-sorrel	
	Persicaria lapathifolia	Pale Knotweed	w
	Persicaria prostrata	Creeping Knotweed	w
	Pilularia novaehollandiae	Austral Pillwort	w
	Pittosporum angustifolium (Planted)	Weeping Pittosporum	
	Potamogeton cheesemanii	Red Pondweed	w
	Pseudoraphis spinescens	Moira Grass	w
	Ranunculus pumilio var. pumilio	Ferny Small-flower Buttercup	w
	Rumex tenax	Narrow-leaf Dock	w
	Senecio quadridentatus	Cotton Fireweed	
	Spergularia brevifolia	Sand-spurrey	
	Walwhalleya proluta	Rigid Panic	w
	Total Indigenous Species	**74**	

Table 40. Exotic plants recorded at Kinnairds Swamp Survey

Status	*Scientific Name*	Common Name	Wetland species
	**Alopecurus aequalis*	Orange Fox-tail	w
	**Anagallis arvensis*	Pimpernel	
	**Aster subulatus*	Aster-weed	w
	**Callitriche hamulata*	Thread Water Starwort	w
	**Callitriche stagnalis*	Water Starwort	w
	**Cirsium vulgare*	Spear Thistle	
	**Crassula natans*	Water Crassula	w
	**Helminthotheca echioides*	Ox-tongue	
	**Hypochoeris glabra*	Smooth Cat's-ear	
	**Hypochoeris radiata*	Cat's Ear	
	**Kickxia elatine ssp.crinata*	Sharp-leaved Fluellen	
	**Lactuca saligna*	Willow-leaf Lettuce	
	**Lactuca serriola*	Prickly Lettuce	
	**Leontodon taraxacoides subs. taraxacoides*	Hairy Hawkbit	
	**Lolium rigidum*	Wimmera Rye-grass	
	**Medicago polymorpha*	Burr Medic	
	**Paspalum dilatatum*	Paspalum	
	**Paspalum distichum*	Water Couch	w
	**Phalaris paradoxa*	Paradoxical Canary-grass	
	**Polygonum aviculare*	Prostate Knotweed	
	**Rumex crispus*	Curled Dock	w
	**Solanum nigrum*	Black Nightshade	
	**Sonchus oleracea*	Common Sow-thistle	
	**Spergularia media*	Coast Sand-spurrey	
	**Trifolium michelianum var. michelianum*	Annual-white Clover	
	**Trifolium striatum*	Knotted clover	
	** Trifolium subterraneum*	Subterraneum Clover	
	**Trifolium tomentosum*	Woolly Clover	
	**Veronica peregrina*	Wandering Speedwell	w
	**Xanthium spinosum*	Bathurst Burr	
	Total Exotic Species	**31**	

5.4.3 Birds

A total of sixty-four bird species were recorded at Kinnairds Swamp (see Tables 42 and 43), including 35 wetland species. Numbers of wetland bird species present at Kinnairds Swamp peaked at the fourth visit, when 20 species were observed. This was twice the number seen at any previous visit. Species observed at the wetland for the first time during the fourth visit included Australian Pelican, Australian White Ibis, Little Pied Cormorant, Purple Swamphen, Tree Martin and Swamp Harrier. Non-wetland bird diversity remained fairly consistent between visits.

Table 41. Summary table of wetland and non-wetland bird species diversity and abundance at Kinnairds Swamp

	17-May-08	31-May-08	15-Jun-08	12-Jul-08	07-Oct-08	18-Nov-08	09-Dec-08
Days since inundation	15	29	44	71	158	201	222
Total wetland species diversity (transect and incidental)	8	10	9	20	13	4	6
Transect only wetland species diversity	7	8	9	12	10	2	4
Transect only total wetland birds abundance	61	107	79	399	94	10	14
Transect only non-wetland birds species diversity	0	1	14	11	12	8	13
Transect only non-wetland birds abundance	97	12	30	50	37	36	53

Figure 8. Graph of bird diversity versus time since inundation

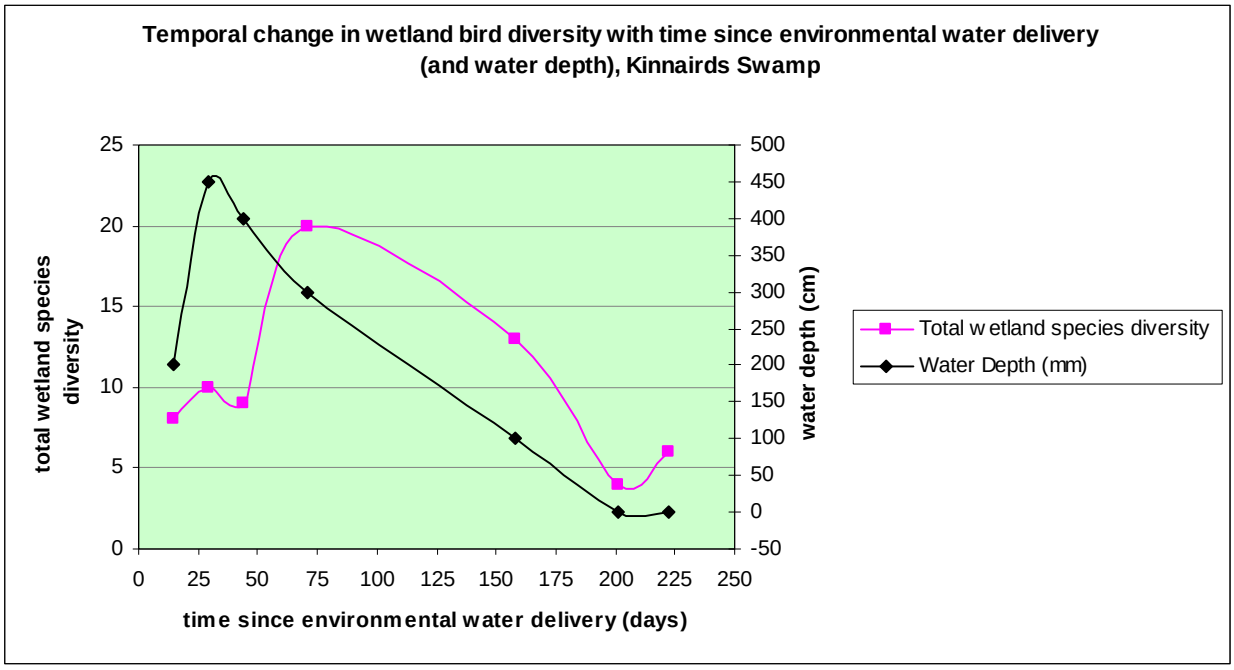


Table 42. EPBC Act and AVW threatened fauna species occurring at Kinnairds Swamp

FFG	EPBC	VROT	Common Name	Scientific Name
		v	Australasian Shoveler	*Anas rhynchotus*
f		v	Ballion's Crake	*Porzana pusilla palustris*
f		v	Brolga	*Grus rubicunda*
		n	Brown Quail	*Coturnix ypsilophora australis*
		n	Glossy Ibis	*Plegadis falcinellus*
		n	Latham's Snipe	*Gallinago hardwickii*
		n	Pied Cormorant	*Phalacrocorax varius*
f		v	White-bellied Sea-Eagle	*Haliaeetus leucogaster*

Species shown with a shaded background were observed breeding at this site

Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site

Wetland birds observed breeding at Kinnairds Swamp included Black Swan, Australian Shelduck, Pacific Black Duck and Whistling Kite.

Photograph 27. Brolga at Kinnairds Wetland, photo courtesy Paul O'Connor, River Red Gum Forest Ecologist, DSE

Table 43. Wetland Birds observed at Kinnairds Swamp

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	Time of Day	3:00– 4.30 PM	3:00-3.30pm	10:00–10.30AM	11.20-11.50 am	7.30-8.00 am	13.30-14.00pm	15.30-16.00pm
	Australasian Grebe	1	3	4	(2)	5	1	(1)
	Australian Pelican				(7)			
v	Australasian Shoveller		2		1			
	Australian Shelduck							
	Australian White Ibis				(1)			
	Australian Wood Duck	(8)	1					
v	Ballion's Crake							
	Black Cormorant							1
	Black Swan	14	54	29	7 (9)			
	Black-fronted Plover					1		
	Black-tailed Native Hen		1					
v	Brolga							
	Golden Headed Cisticola				1			
	Great Black Cormorant		(1)		(1)			

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	Time of Day	3:00– 4.30 PM	3:00-3.30pm	10:00–10.30AM	11.20-11.50 am	7.30-8.00 am	13.30-14.00pm	15.30-16.00pm
	Grey Teal	30	31	30	110	1		2
n	Glossy Ibis							
	Hoary-headed Grebe			3	(1)			
n	Latham's Snipe							
	Little Grassbird			1	1	1		1 (3)
	Little Pied Cormorant				1		(1)	
	Masked Lapwing	2	2		(2)	(2)		
	Pacific Black Duck	4	10	5	2	1	7 1 adult, 6 ducklings	
nt	Pied Cormorant	1					(1)	
	Purple Swamp Hen				14	1		
	Red-kneed Dotterel							
	Spotless Crake							
	Straw-necked Ibis		(2)		(45)			
	Swamp Harrier				1			

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	**Time of Day**	**3:00– 4.30 PM**	**3:00-3.30pm**	**10:00–10.30AM**	**11.20-11.50 am**	**7.30-8.00 am**	**13.30-14.00pm**	**15.30-16.00pm**
	Fairy Martin#					4		
	Tree Martin#				20	50		(8)
	Welcome Swallow#			4	180	20		1
	Whistling Kite#			1	(1)	(1)		
v	White-bellied Sea-Eagle							
	White-faced heron	1		2	1(3)	(3)		
	Yellow-billed Spoonbill					4		
	Total Wetland Species Diversity	**8**	**10**	**9**	**20**	**13**	**4**	**6**
	Total Transect Wetland Species Diversity	**7**	**8**	**9**	**12**	**10**	**2**	**4**
	Native Wetland Species Transect Only Abundance	**61**	**107**	**79**	**399**	**94**	**10**	**14**

Species shown with a shaded background were observed breeding at this site; Species shown in red font were recorded by Paul O'Connor of DSE in his weekly bird counts at this site

The Welcome Swallow, Tree Martin and Whistling Kite are not strictly wetland species; however they are often quite closely associated with wetlands. They have been included in this category as they appeared to have been attracted to the wetlands to prey on species that are reliant on the wetlands containing water, and for this reason could be considered to have directly benefited from the delivery of environmental water.

Table 44. Non-wetland Birds observed at Kinnairds Swamp

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	Time of Day	3:00– 4.30pm	3:00-3.30pm	10:00–10.30am	11.20-11.50am	7.30-8.00am	13.30-14.00pm	15.30 -16.00pm
	*Starling	(10)		2				
	Australian Magpie	(10)	1 (3)	3	4	3	1	4
	Australian Magpie Lark	(2)		1	2	3	(2)	
	Australian Raven	(2)		2		1	2	2
	Black-faced Cuckoo Shrike					1	1	1
	Brown Falcon	(1)			(1)			
	Brown Goshawk	(1)						
nt	Brown Quail							4 2 were chicks
	Dusky Woodswallow							1
	Eastern Rosella	(10)	(2)	1		2	6	4
	Galah	(8)		2		4		4
	Golden Whistler			1				
	Kookaburra	(2)	(1)	1	2	1	1	(2)

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	Time of Day	3:00– 4.30pm	3:00-3.30pm	10:00–10.30am	11.20-11.50am	7.30-8.00am	13.30-14.00pm	15.30 -16.00pm
	Little Raven				3	1		
	Nankeen Kestrel			1				
	Noisy Friarbird			2				
	Noisy Miner	(10)	(2)	1	20	10	10	6
	Peregrine Falcon				1 immature			
	Pied Butcherbird				(1)			
	Red-rumped Parrot	(40)	(4)	4	(5)	(4)	10	10
	Restless Flycatcher	(1)			3			
	Striated Pardalote	(10)	(2)		2	2		2
	Weebill				5	2		
	White-browed Woodswallow							8 (22)
	White-plumed Honeyeater		(4)	2		6	4	6
	White-winged Chough			10				

		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Status	**Time of Day**	**3:00– 4.30pm**	**3:00-3.30pm**	**10:00–10.30am**	**11.20-11.50am**	**7.30-8.00am**	**13.30-14.00pm**	**15.30 -16.00pm**
	Willie Wagtail	(10)	(1)	2	1			1
	Yellow-rumped Thornbill				4			
	Zebra Finch							(2)
	Total non-wetland birds Species Diversity	**14**	**8**	**14**	**14**	**13**	**9**	**15**
	Total Transect non-wetland birds Species Diversity	**0**	**1**	**14**	**11**	**12**	**8**	**13**
	Native non-wetland birds Species Transect Only Abundance	**97**	**12**	**30**	**50**	**37**	**36**	**53**

Species shown with a shaded background were observed breeding at this site; Numbers in parenthesis indicate incidental observations outside of timed transect

5.4.4 Frogs

Five species of frogs were heard calling in this wetland; Common Froglet, Plains Froglet, Spotted Grass Frog, Pobblebonk and Peron's Tree Frog. The abundance of each species of frog calling at the wetland varied due to species and environmental conditions. For example large numbers of Spotted Marsh Frogs (*Limnodynastes tasmaniensis (NCR)*) were calling on the relatively warm, sunny afternoon of the 31st of May in the newly filled wetland, but none were calling on the cool morning of the 12th of July. In contrast large numbers of Common Froglets (*Crinia signifera*) began calling once the wetland had been filled and continued to call in great abundance until October, by which time much of the wetland had dried out.

Table 45. Frogs observed at Kinnairds Swamp

Date and Time		17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Species heard calling	Common Name	7.30 – 8:00 pm	3:00-3.30pm	11:00- 11.30 am	11.20- 11.50 am	8.00 to 8.30 am	13.30 – 14.00 pm	16.00-16.30 pm
Crinia signifera	Common Froglet	10-100	>100	>100	>100	O	O	O
Crinia parinsignifera	Plains Froglet	<10	>100	10-100	10-100	<10	O	O
Limnodynastes tasmaniensis (NCR)	Spotted Marsh Frog	10-100	>100	<10	O	<10	O	O
Limnodynastes dumerilii	Pobblebonk					<10	O	O
Litoria peronii	Peron's Tree Frog						(<10)	
Number of egg-masses observed								

Estimated abundance heard calling: <10, 10-100, >100, O = observed; Transect length 250m for 30 min; Numbers in parenthesis ( ) indicate incidental observations outside of timed transect

6.0 DISCUSSION

Water quality results for all wetlands were compared with the trigger values as stipulated for lakes and reservoirs in the ANZECC and ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and *Government of Victoria (2003) SEPP Waters of Victoria* for rivers and streams. While the EPA guidelines are for rivers and streams they are regional parameters and therefore more accurately reflect local conditions, in particular for electrical conductivity (EC), which is generally elevated in the Goulburn-Broken catchment. These guidelines were used as no water quality objectives for wetlands have been set.

Overall the water quality parameters tested for all four wetlands were within the Government of Victoria (2003) and ANZECC and ARMCANZ (2000) guidelines for all parameters, one exception being that electrical conductivity of the wetlands far exceeded the general EC for lakes and reservoirs in ANZECC and ARMCANZ (2000). These guidelines however do not reflect local elevated groundwater and resultant surface water EC.

Table 46. Comparison with guidelines against average water quality parameters for all wetlands

	pH	Temp (°C)	DO (%)	EC (µS/cm3)	Turbidity (NTU)
Black Swamp	6.6	11.3	83.5	132.6	9.5
Reedy Swamp	6.5	10.4	92.1	170.5	12.5
Moodies Swamp	6.8	10.8	82.9	427.7	15.3
Kinnairds Swamp	6.9	11.7	96.8	112.0	11.7
ANZECC & ARMCANZ, 2000	6.6-8.0			20-30	1-20
EPA SEPP 2003*	≥6.4-≤7.7		≥85-110	≤500	≤30

*EPA SEPP Waters of Victoria (2003) Environmental Guidelines for Rivers and streams for the Murray and Western Plains: lowlands of Kiewa, Ovens, Goulburn & Broken Catchments.

The results of this monitoring project suggest that the artificial delivery of environmental water allocations can stimulate reproduction and improvements in the ecological health of indigenous vegetation communities, plants, wetland birds and frogs. The use of such environmental allocations may become a critical management tool to assist the survival of wetland biota and communities, particularly those which are already stressed and endangered, in future periods of

below-average rainfall; whether they are part of natural long-term cycles or caused by human-induced climate change.

Decision making about the delivery of environmental water allocations must be based on sound ecological knowledge and principles, as the frequency and timing of the flooding of wetlands has profound effects on wetland biota. As a general rule these deliveries must mimic the natural timing, frequency and duration of inundation a wetland would "naturally" experience as closely as possible.

Artificial watering for too long, too frequently or in the wrong season, can cause the death of River Red Gums, change the structure and composition of wetland vegetation and result in the proliferation of environmental weeds and pest animals such as Sagittaria, Water Couch and Carp, and alter nutrient cycles. Carbon cycling is critical in sustaining populations of fish, birds, invertebrates and aquatic plants. Understanding the fluxes of organic carbon and the nature of interactions among producers and consumers is fundamental in Riverine ecology and essential knowledge for the sustainable management of healthy Riverine systems. The timing, period of inundation and drying is critical in determining the availability of labile nutrients and carbon (Lovett and Price 2007).

Ridged Water Milfoil is an excellent example of the threat that some wetland species and communities are under due to climate change. In the current study the largest population of the nationally vulnerable Ridged Water Milfoil ever documented was found at Kinnairds Swamp in an area of Red Gum Swamp that was inundated by an environmental water delivery that occurred in May 2008. Little is known about the ecology of this annual species, yet it has been observed that it only successfully grows and reproduces following autumn or early winter inundation of its seasonal wetland habitat (Eris O'Brian pers. comm.). It does not appear to respond to flooding in late winter or spring, and therefore any environmental water allocation designed to benefit this species should be delivered in autumn.

Modeling of future climate change predicts that over much of Victoria winter and spring rainfall will decrease, while summer rainfall will increase (CSIRO). Under this climate scenario Ridged Water Milfoil and other wetland species and communities dependent on winter inundation will

have fewer opportunities to reproduce or undergo other critical ecological processes and will therefore face a greater risk of extinction. For these species and communities the delivery of environmental water allocations may be an essential management tool in assisting their ongoing survival.

The timing of water delivery also has implications for the breeding of frogs and water birds. Mid to late autumn is obviously an effective time to artificially deliver water to wetlands, as lower evaporation rates over winter mean that inundation will persist for longer. The depth, season and period of inundation in wetlands determines what bird and frog species will be able to reproduce successfully. For example the winter flooding at Reedy Swamp was at an appropriate time, deep enough and persistent enough to allow the successful breeding of Australian White Ibis and Black Swans at that wetland, though it did not trigger breeding of other colonial nesting species such as Egrets.

The shallow flooding at Moodies seemed enough to trigger a breeding attempt by Brolgas, but did not persist long enough for successful raising of chicks. This shallow flooding also allowed for breeding attempts by Sloane's Froglet, Common Froglet, Plains Froglet and Spotted Marsh Frog, but water did not persist for long enough, or wasn't deep enough, for Painted Burrowing Frogs or Pobblebonks to attempt to breed. Species such as the Growling Grass Frog (*Litoria raniformis*) only begin to bred in mid to late spring and require water to persist long enough for the relatively long tadpole stage (> than six months) to be completed, thus would require environmental water allocations that would provide these requirements.

In the current study the size of the frog chorus of each species at each site was used to indicate frog breeding activity. While this method provides an estimate of the number of male frogs attempting to attract mates it does not necessarily indicate breeding success. In a study that monitored frog response to artificial environmental flooding in Gunbower Forest six species of frogs were heard calling, yet only three where found to have produced eggs and tadpoles, and these were in quite low numbers (Ward, 2008). Future frog monitoring in the Goulburn-Broken wetlands should attempt to quantify actual breeding success in response to environmental water allocations, as it seems calling does not necessarily equate to abundant reproduction.

The amount of water available to deliver environmental allocations is a precious and finite resource, and the best use must be made of what is available. Prioritisation for water delivery should be dependent upon the values that each wetland has, and the tolerance of those values to prolonged wetland drying.

For example to maintain viable populations of rare wetland flora such as Ridged Water Milfoil and Slender Water Milfoil in the Red Gum Swamp EVC at Kinnairds wetland this area should be inundated from May until October by between 200 to 300 mm of water at least every ten years and allowed to completely dry annually, to ensure a viable seed bank of the rare species are maintained. In contrast water delivery to Reedy Swamp would need to occur on a much more regular cycle to encourage regular breeding of wetland birds.

An interesting outcome of this study is the comparison between the results obtained by two methods of wetland bird survey. As part of this study a half hour bird transect over one section of each wetland was conducted to record wetland bird presence and breeding activity. These transects were conducted at two week to monthly intervals. At the same time, in parallel with this study, Paul O'Connor of the Department of Sustainability and Environment conducted weekly bird counts at three of the Swamps; Reedy, Black and Kinnairds. During these bird counts a far greater proportion of the wetlands were examined than in the half hour bird transects.

It is interesting to note that a similar diversity of species of common, abundant and obvious species was recorded by both methodologies. However many cryptic, rare and threatened species were only recorded by the more intensive survey method. For example of the 20 rare or threatened fauna species recorded at Reedy Swamp nine were only detected by the more frequent and extensive searches conducted by Paul O'Connor (see Table 20), while 2 were only recorded by acoustic monitoring.

This highlights the greater survey effort required to adequately sample rare and threatened fauna in ecological studies and surveys. This is sobering considering the fact that the ecological significance of many areas under consideration for clearing or development proposals is often based on very limited field survey, often conducted at a sub-optimal time of the year.

7.0 CONCLUSION

The delivery of environmental flows to each of the wetlands has stimulated the activity of wetland dependant biota, including many common and threatened birds, frogs and plants.

Wetland dependant birds occurred at each of the sites in numbers and diversity related to the size of the wetlands and the habitat they provide. For example Reedy Swamp provides a large area of open water habitat and attracted large numbers of a diversity of ducks and Black Swans. In contrast Moodies Swamp supports very little open water habitat, and therefore supports a lower diversity and abundance of typical wetland species than the other sites. However, the dense Barren Cane Grass (*Eragrostis infecunda*) in this wetland provides ideal habitat for cover-dependent species such as the Golden-headed Cisticola and nesting habitat for the vulnerable Brolga.

The condition of some of the wetland EVCs occurring at the four wetlands has improved markedly with the delivery of environmental water. This increase in vegetation condition over time since water delivery illustrates that is difficult to assess the condition of wetlands that are dry or have been recently inundated following a prolonged dry period.

Due to the timing of this study monitoring of ecological responses to environmental water delivery has been limited to species of flora and fauna that are physiologically active or present within the wetlands from late autumn and early summer. Additional species may occur at the wetlands in late summer and early autumn, particularly if they were still moist or holding water at this time.

The results of the current study were limited by time constraints for data collection. While collection of data on vegetation diversity and condition was quite thorough, more time allocated to the collection of bird and frog data would produce more useful results.

8.0 RECOMMENDATIONS

- Develop management and ecological restoration plans for each of the wetlands, which detail appropriate flooding regimes and how they are to be achieved.
- Continue to monitor effects of environmental water allocations. Experiment with flooding in different seasons, with different sized floods
- Monitoring of wetlands should begin before water is delivered and continue until wetlands dry
- The results of the current study were limited by time constraints for data collection. Future monitoring should allow for a two hour bird transect per site, and an hour for sampling tadpoles to measure frog breeding success.

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APPENDIX A. Water quality guidelines

Table 47. Comparison of the water quality of the four wetlands with Victorian and ANZECC guidelines

	pH	Temp (°C)	DO (%)	EC (uS/cm^{-1})	Turbidity (NTU)
Black Swamp	6.5	15.6	81.9	212	19
Reedy Swamp	6.5	15.3	97.6	237.4	29.1
Moodies Swamp	6.8	10.8	82.9	427.7	15.3
Kinnairds Swamp	6.8	11.4	96.7	110.8	11.5
ANZECC & ARMCANZ, 2000	6.6-8.0			20-30	1-20
EPA SEPP 2003*	≥6.4-≤7.7		≥85-110	≤500	≤30

*Source: EPA SEPP Waters of Victoria (2003) Environmental Guidelines for Rivers and streams for the Murray and Western Plains: lowlands of Kiewa, Ovens, Goulburn & Broken Catchments.

Table 48. ANZECC 2000 trigger values for slightly disturbed ecosystems

Source: ANZECC (2000) Australian and New Zealand Guidelines for Fresh and Marie Water Quality, Chapter 3, Table 3.3.2-3.3.3

Freshwater lakes and reservoirs *no data on wetlands	ANZECC 2000 trigger values for slightly disturbed ecosystems
Total phosphorus (TP) (µg/L^{-1})	10
Filterable Reactive Phosphorus (FRP)	5
Total nitrogen (TN) (µg/L^{-1})	350
Electrical conductivity (EC) (uS/cm^{-1})*	20-30
pH	6.5-8.0
Turbidity (NTU)#	1-20
Dissolved Oxygen (%)	90-110

*Conductivity in lakes and reservoirs is generally low, but will vary depending upon catchment geology. Values provided are typical of Tasmanian lakes and reservoirs.

Most deep lakes and reservoirs have low turbidity. However, shallow lakes and reservoirs may have higher natural turbidity due to wind-induced resuspension of sediments. Lakes and reservoirs in catchments with highly dispersible soils will have high turbidity.

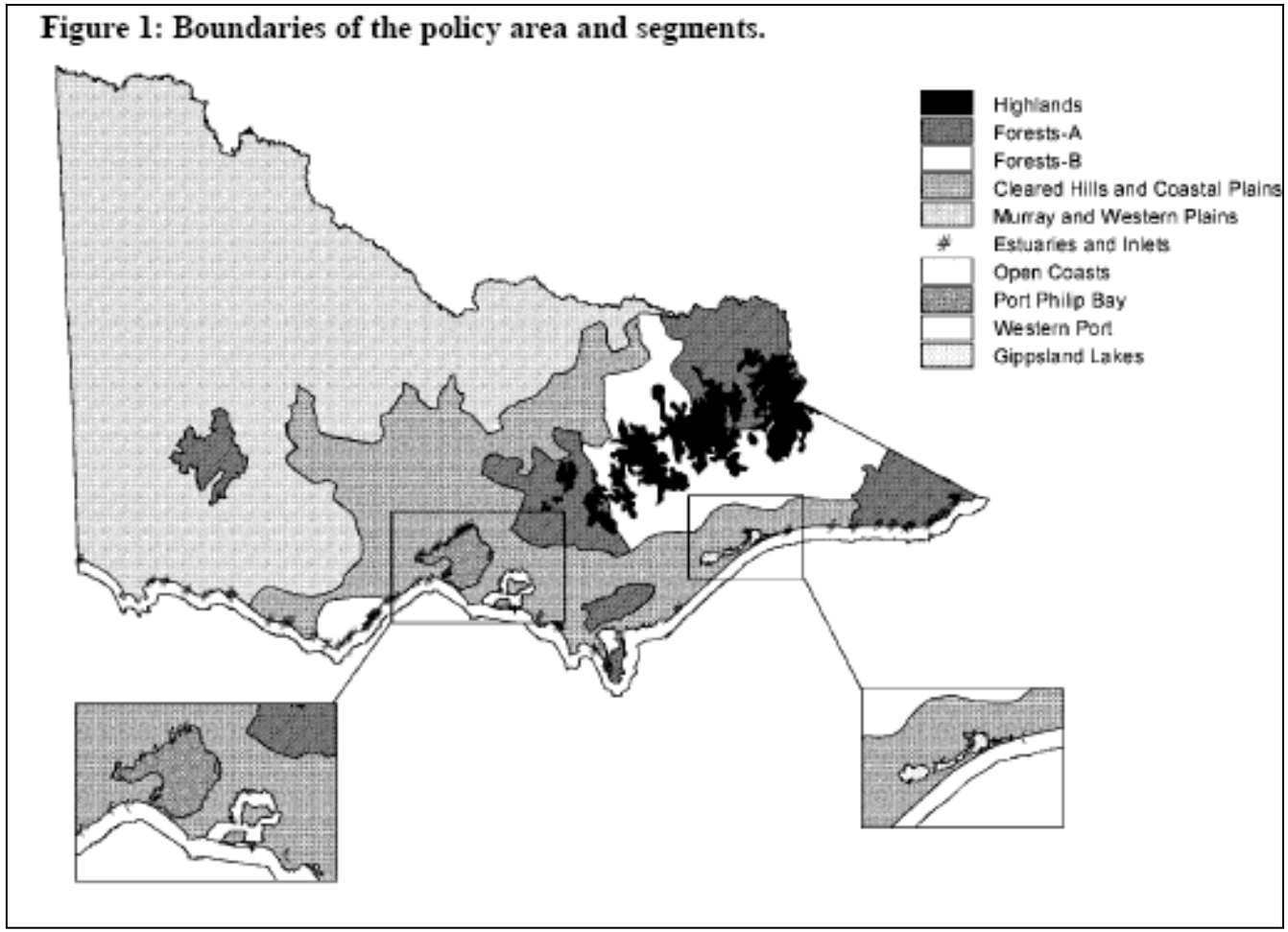


Figure 9. Boundaries of the policy area and segments of water quality for Victoria

Source: Government of Victoria (2003) SEPP Waters of Victoria Guidelines for Rivers and Streams

Table 49. Environmental quality objectives for rivers and streams – water quality

Source: Government of Victoria (2003): SEPP Waters of Victoria Guidelines for Rivers and Streams

Table A1: Environmental quality objectives for rivers and streams – water quality

SEGMENT	INDICATOR							
	Total phosphorus (µg/L)	Total nitrogen (µg/L)	Dissolved oxygen % saturation		Turbidity (NTU)	Electrical conductivity (µS/cm)	pH (pH units)	
	75th percentile	75th percentile	25th percentile	maximum	75th percentile	75th percentile	25th percentile	75th percentile
Highlands								
• all areas	≤20	≤150	≥95	110	≤5	≤100	≥6.4	≤7.7
Forests – A								
• Wilsons Promontory, Strzelecki Ranges & East Gippsland Coast	≤25	≤500	≥90	110	≤5	≤500	≥6.4	≤7.7
• upper Murray, Kiewa & Mitta Mitta catchments	≤25	≤350	≥90	110	≤5	≤100	≥6.4	≤7.7
• the Grampians	≤25	≤350	≥90	110	≤5	≤500	≥6.4	≤7.7
• all other areas	≤25	≤500	≥90	110	≤5	≤100	≥6.4	≤7.7
Forests – B								
• Otway Ranges	≤25	≤350	≥90	110	≤5	≤500	≥6.4	≤7.7
• all other areas	≤25	≤350	≥90	110	≤5	≤100	≥6.4	≤7.7
Cleared Hills and Coastal Plains								
• lowlands of Barwon, Moorabool, Werribee, Maribyrnong, Curdies & Gellibrand catchments	≤45	≤600	≥85	110	≤10	≤1500	≥6.5	≤8.3
• lowlands of Yarra, Western Port, Latrobe, Mitchell, Tambo, Snowy, Thomson & Macalister catchments	≤45	≤600	≥85	110	≤10	≤500	≥6.4	≤7.7
• uplands of Moorabool, Werribee, Maribyrnong, Campaspe, Loddon, Avoca, Wimmera and Hopkins catchments	≤25	≤600	≥85	110	≤10	≤500	≥6.5	≤8.3

Table 50. Comparison of wetland conductivity with other regional lakes

Source: Sinclair, Knight and Merz (2004), Bendigo Urban Lakes Water Quality Management Plan Volume 1, City of Greater Bendigo.

- **Table 5-2 Water quality analysis results from five Bendigo lakes (March 2003)**

Water quality parameter (Range)											
Lake	Sample Location	TP mg/L	TN mg/L	NH_3 mg/L	FRP mg/L	NOx mg/L	pH	Conductivity mS/cm	TSS g/L	Turbidity NTU	TOC mg/L
ANZECC & ARMCANZ Trigger Levels		0.01	0.35	0.90	0.005	0.01	6.5-8.0	0.020-0.030		1-20	
Lake Neangar	Inlet 1	0.28	5	0.53	0.013	0.005	7.8	2.5	0.12	320	28
6/3/2003	Inlet 2	0.26	5	0.66	0.010	0.006			0.11	273	29
	Inlet 3	0.26	5	0.66	0.018	0.006			0.13	327	32
	Centre	0.25	5	0.47	0.009	0.005	8.4	2.5	0.043	169	31
	Outlet	0.26	5	0.46	0.015	0.005	8.5	2.5	0.061	120	31
Lake Tom Thumb	Inlet 1	0.03	1.5	0.53	0.026	0.13	8.0	0.63	0.011	16	12
6/3/2003	Inlet 2	0.04	1.5	0.64	0.029	0.13			0.071	16	12
	Inlet 3	0.07	1.8	0.69	0.034	0.14			0.041	14	12
	Centre	0.06	1.6	0.69	0.037	0.13	7.6	0.60	0.038	11	12
	Outlet	0.05	1.6	0.69	0.033	0.13	7.6	0.58	0.040	12	12
Lake Weeroona	Inlet 1	<0.02	1.2	0.20	0.006	0.037	8.2	0.95			14
5/3/2003	Inlet 2	0.02	1.2	0.21	0.006	0.034					14
	Inlet 3	0.02	1.3	0.20	0.007	0.058					15
	Centre	<0.02	1.4	0.20	0.004	0.030	8.2	0.94			14
	Outlet	<0.02	1.2	0.13	0.005	0.059	8.0	0.64			15
Kennington Reservoir	Inlet 1	0.02	0.76	0.011	0.010	0.009	8.0	0.36			13
5/3/2003	Inlet 2	0.02	0.79	0.007	0.008	0.010					13
	Inlet 3	0.04	0.98	0.006	0.008	0.002					12
	Centre	0.02	0.86	0.007	0.007	0.003	8.0	0.36			12
	Outlet	0.03	0.84	0.007	0.004	0.003	8.1	0.36			13
Gateway Park	Inlet 1	0.15	1.6	0.43	0.080	0.017	7.8	0.30			27
5/3/2003	Inlet 2	0.14	1.6	0.47	0.075	0.036					29
	Inlet 3	0.14	1.6	0.49	0.072	0.017					29
	Centre	0.14	1.6	0.50	0.072	0.013	7.6	0.30			28
	Outlet	0.16	1.6	0.50	0.073	0.010	7.6	0.31			27

Shaded cells indicate concentrations are above ANZECC recommended trigger values

APPENDIX B. Frood's Condition Categories

Vegetation condition was assessed using an adapted version of Frood's Wetland Vegetation Condition Assessment Categories as per collaborative work by Frood and Australian Ecosystems in Australian Ecosystems, (2007) Gunbower Forest Canopy Survey (Unpublished field data provided to the North Central Catchment Management Authority), Australian Ecosystems Pty Ltd, Melbourne.

Category 1 (Excellent) - No major identifiable impacts on vegetation condition; vegetation apparently ecologically stable (temporal and spatial variation remaining within the spectrum of possibilities anticipated for unmodified examples of the relevant system); bio-diversity losses minimal if any; serious environmental weeds absent; and relatively unmodified in terms of ecological processes.

Category 2 (Good) - Some biodiversity losses within the EVC reasonably presumed or weeds invasions impacting on the indigenous vegetation, but system apparently remaining ecologically stable; and only minor modifications to critical ecological processes.

Category 3 (Moderate) - EVC disturbed but still readily identifiable; extinction-prone species mostly displaced but a substantial component of indigenous flora persisting (at least at low levels); serious environmental weeds often present or otherwise significant ecological invasions occurring; and substantial modifications to critical ecological processes.

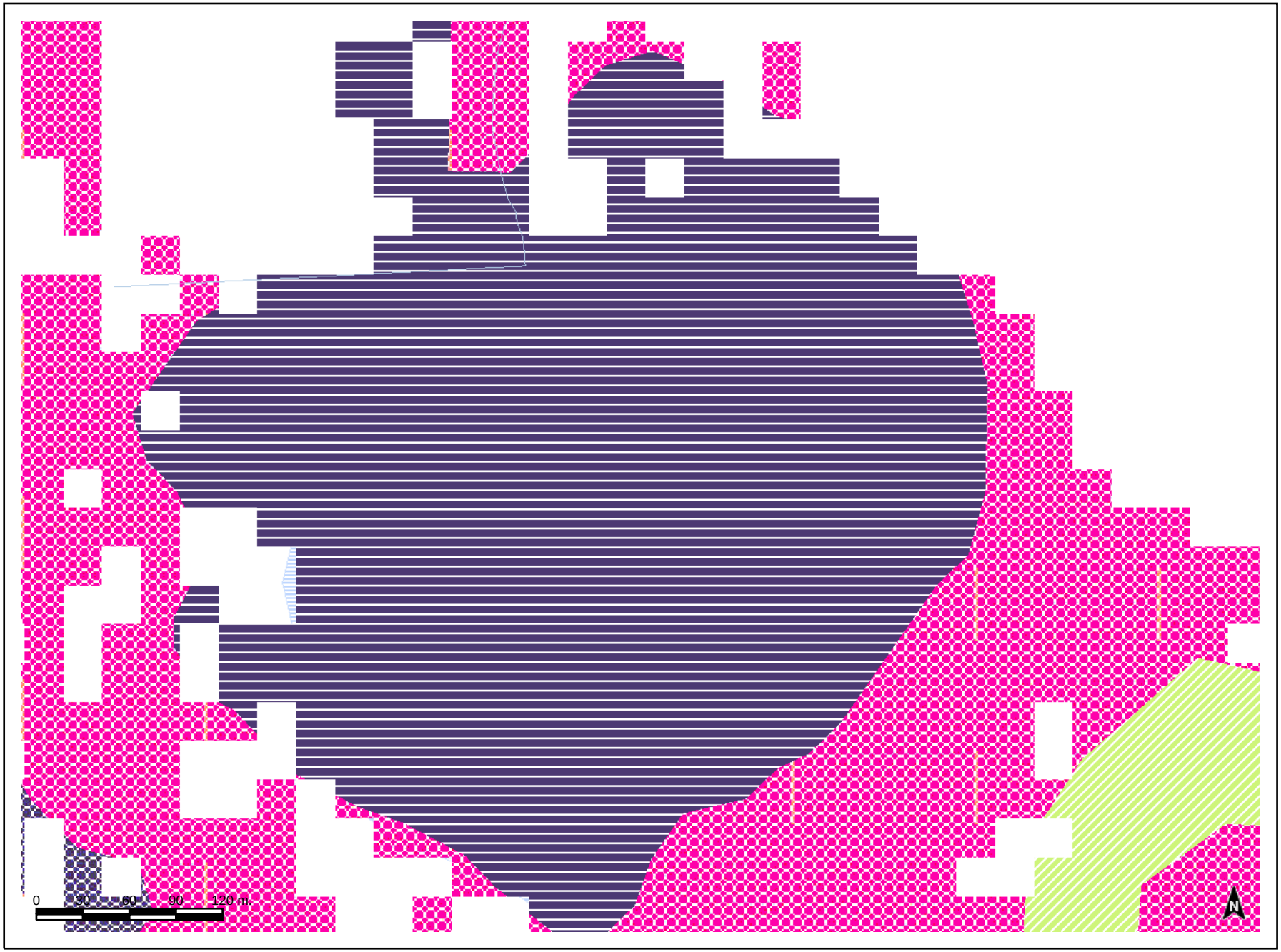
Category 4 (Poor) - EVC degraded, with only a minor component of original flora persisting; structure of the vegetation substantially modified; serious environmental weeds often prevalent within at least part of the system or significant ecological invasions advanced; and system substantially disrupted due loss of critical ecological processes.

Category 5 (Very Poor) - Indigenous vegetation displaced (throughout wetting and drying cycles); introduced species or mixtures including indigenous species from adjacent non-wetland habitats dominated vegetation; and system effectively displaced due to complete loss of all ecological processes associated with the original ecosystem.

APPENDIX C. Extant Ecological Vegetation Class (EVC) Maps (DSE, 2008)

Map of extant EVCs at Black Swamp, Swamp Road, Wunghu

Department of Sustainability and Environment



* Refer to page 2 for legend details

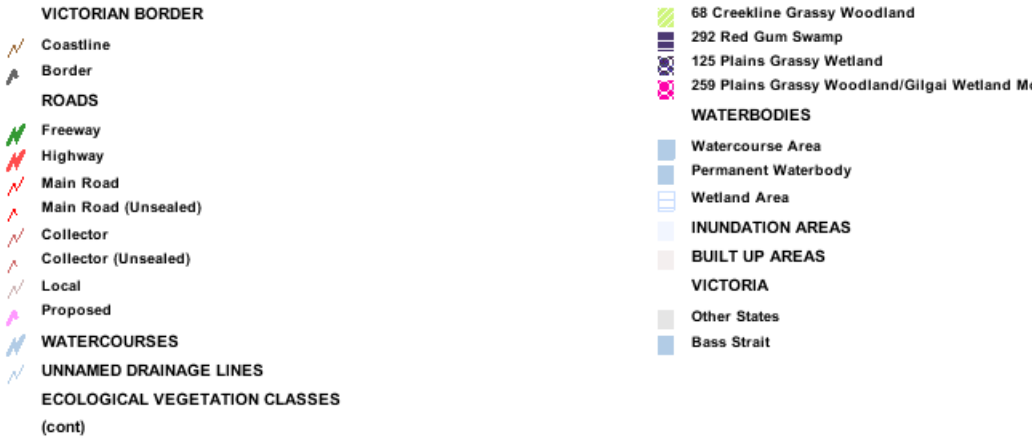
Map Scale 1:3,481

Biodiversity Interactive Map

Produced on Sat Sep 13 14:58:14 EST 2008

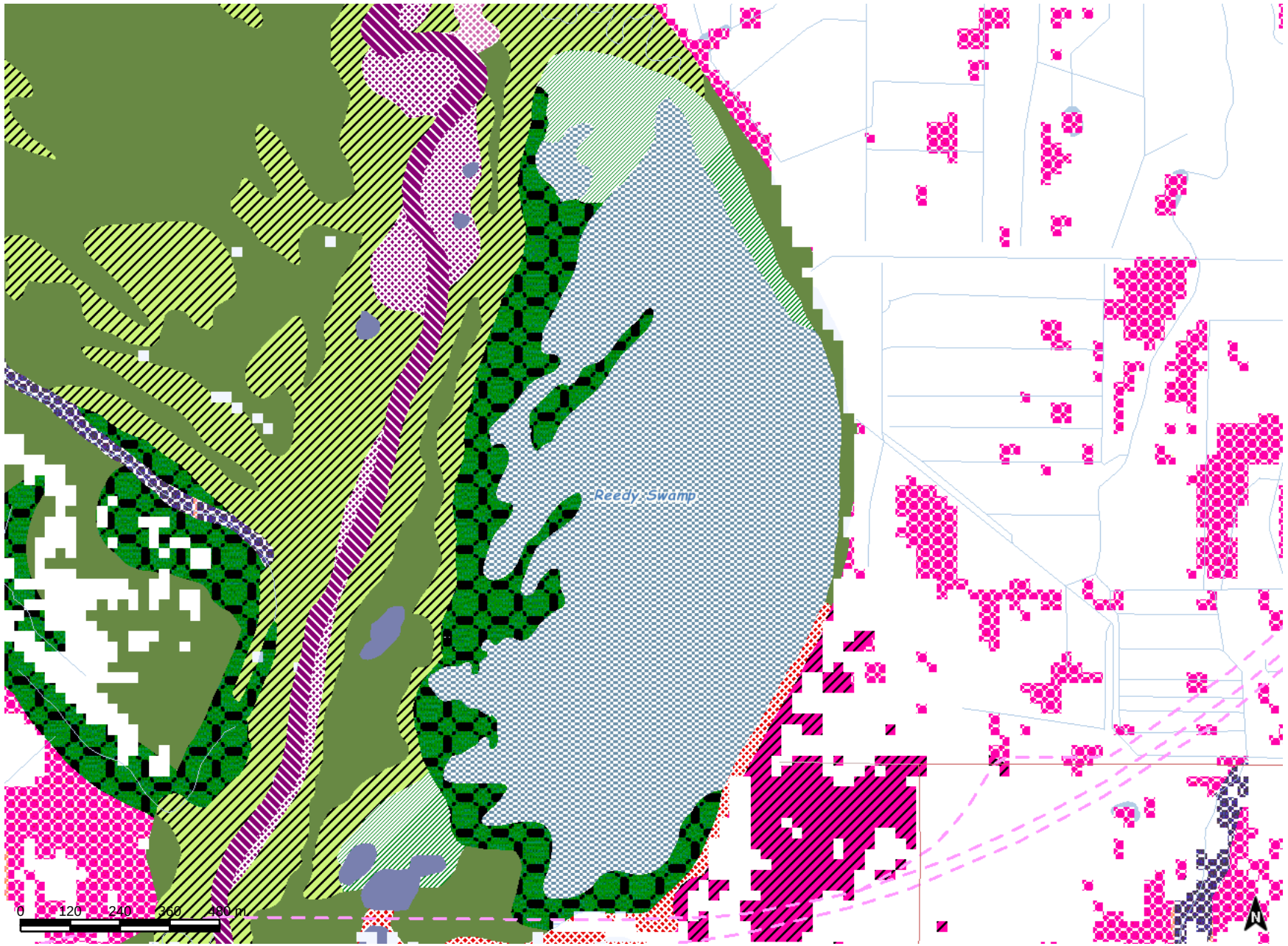
GDA

Victoria The Place To Be


VICTORIAN BORDER
Coastline
Border
ROADS
Freeway
Highway
Main Road
Main Road (Unsealed)
Collector
Collector (Unsealed)
Local
Proposed
WATERCOURSES
UNNAMED DRAINAGE LINES
ECOLOGICAL VEGETATION CLASSES
(cont)
68 Creekline Grassy Woodland
292 Red Gum Swamp
125 Plains Grassy Wetland
259 Plains Grassy Woodland/Gilgai Wetland Mosaic
WATERBODIES
Watercourse Area
Permanent Waterbody
Wetland Area
INUNDATION AREAS
BUILT UP AREAS
VICTORIA
Other States
Bass Strait

Map of extant EVCs at Reedy Swamp, Reedy Swamp Road, Shepparton

Department of Sustainability and Environment



* Refer to page 2 for legend details

Map Scale 1:13,437

Biodiversity Interactive Map

Produced on Sat Sep 13 14:34:35 EST 2008

GDA

Victoria The Place To Be

VICTORIAN BORDER

Coastline

Border

ROADS

Freeway

Highway

Main Road

Main Road (Unsealed)

Collector

Collector (Unsealed)

Local

Proposed

WATERCOURSES

UNNAMED DRAINAGE LINES

ECOLOGICAL VEGETATION CLASSES

814 Riverine Swamp Forest

815 Riverine Swampy Woodland

816 Sedgy Riverine Forest

66 Low Rises Woodland

(cont)

992 Water Body - Fresh

56 Floodplain Riparian Woodland

125 Plains Grassy Wetland

168 Drainage-line Aggregate

172 Floodplain Wetland Aggregate

1090 Tall Marsh/Open Water Mosaic

264 Sand Ridge Woodland

803 Plains Woodland

1040 Riverine Grassy Woodland/Riverine Swampy Woodland Mosaic

295 Riverine Grassy Woodland

WATERBODIES

Watercourse Area

Permanent Waterbody

Wetland Area

INUNDATION AREAS

BUILT UP AREAS

VICTORIA

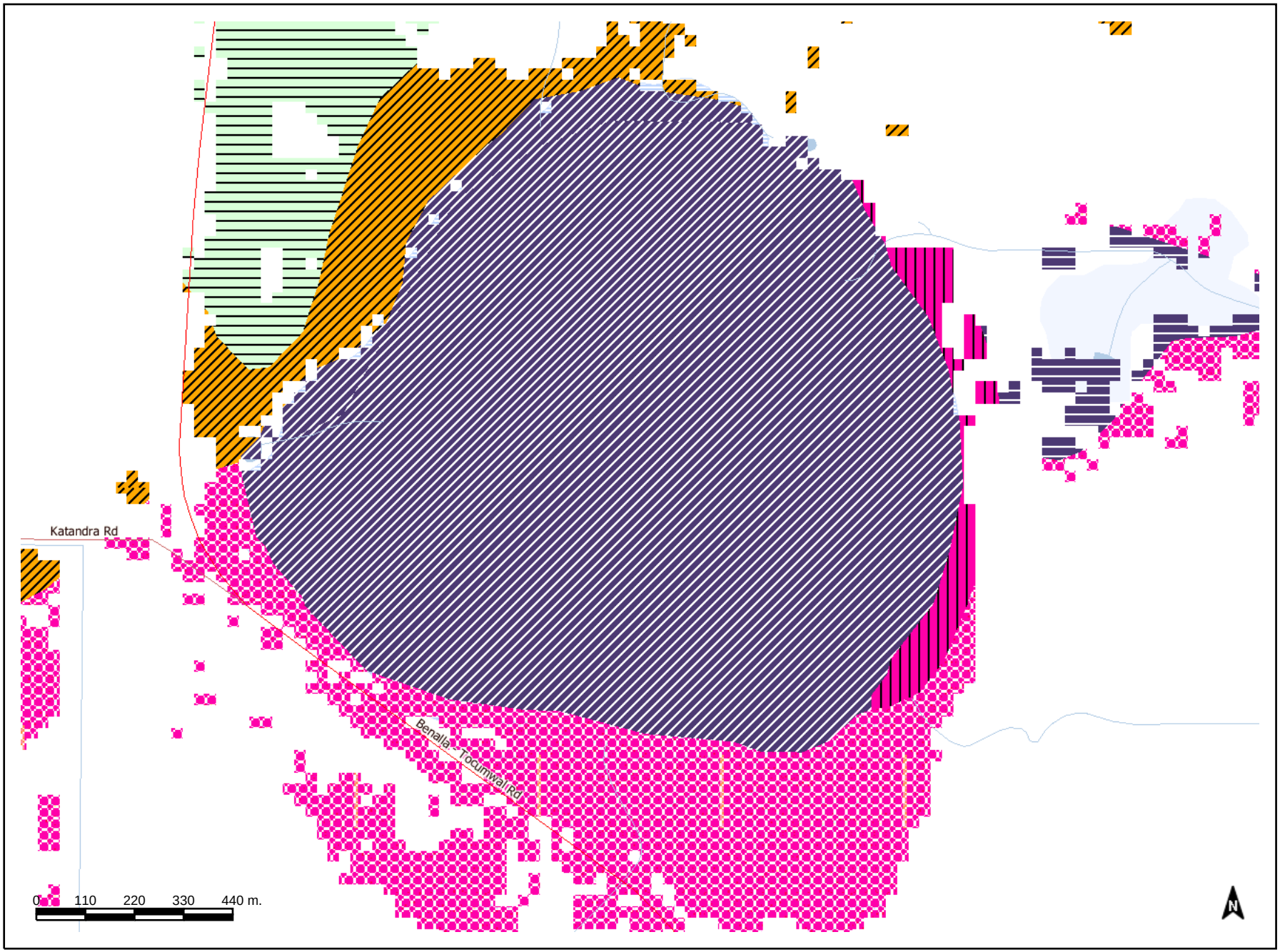
Other States

Bass Strait

Map extant EVCs at Moodies Swamp, Benalla - Tocumwal Road, Waggarandall

Department of Sustainability and Environment

* Refer to page 2 for legend details



Map Scale 1:12,095

Biodiversity Interactive Map

Produced on Sat Sep 13 14:47:22 EST 2008

GDA

Victoria The Place To Be

VICTORIAN BORDER

Coastline

Border

ROADS

Freeway

Highway

Main Road

Main Road (Unsealed)

Collector

Collector (Unsealed)

Local

Proposed

WATERCOURSES

UNNAMED DRAINAGE LINES

ECOLOGICAL VEGETATION CLASSES

(cont)

292 Red Gum Swamp

291 Cane Grass Wetland

175 Grassy Woodland

652 Lunette Woodland

803 Plains Woodland

882 Shallow Sands Woodland

WATERBODIES

Watercourse Area

Permanent Waterbody

Wetland Area

INUNDATION AREAS

BUILT UP AREAS

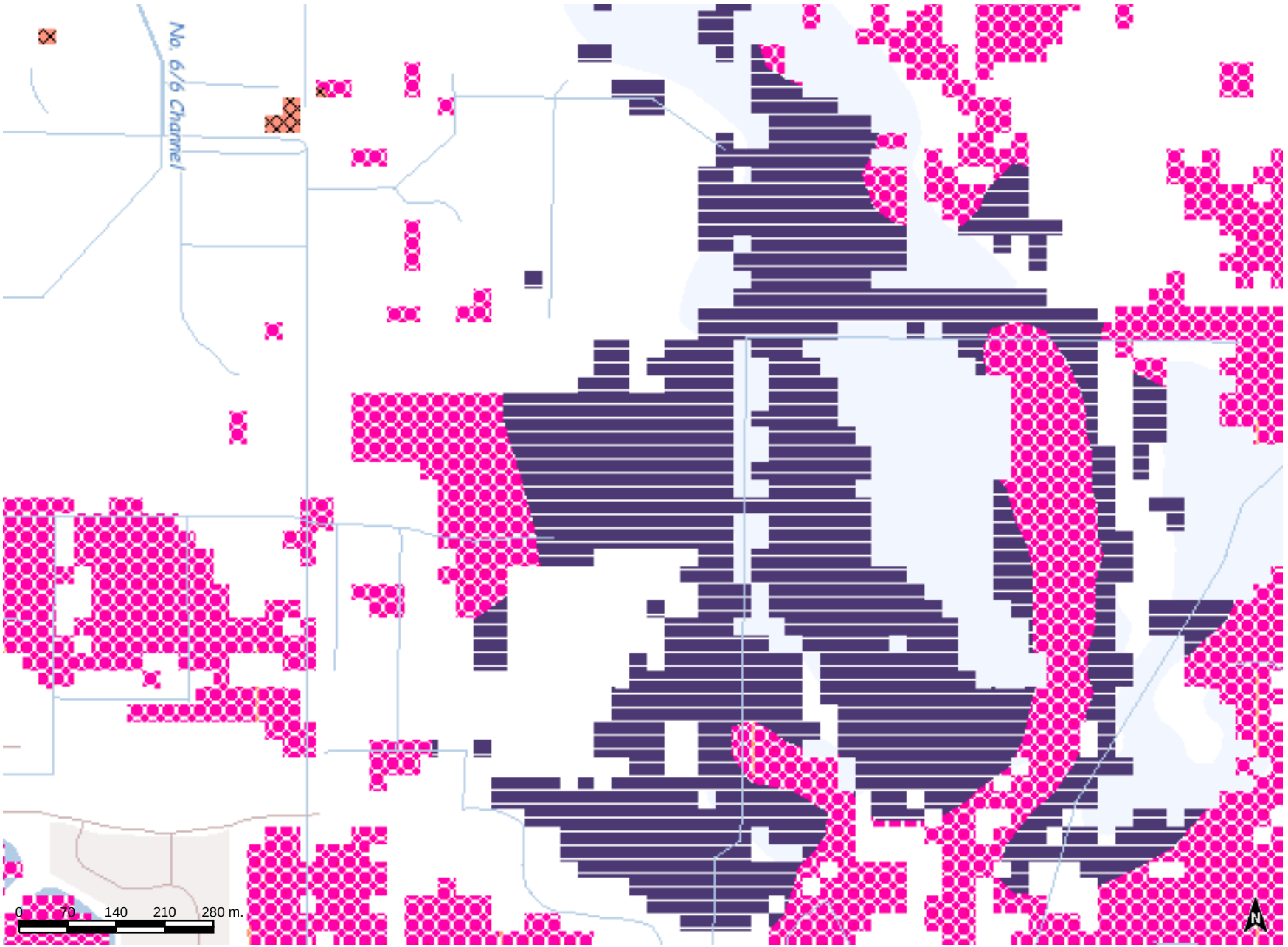
VICTORIA

Other States

Bass Strait

Map of extant EVCs at Kinnairds Swamp, Skidmore Road, Numurkah

Department of Sustainability and Environment



* Refer to page 2 for legend details

Map Scale 1:8,042

Biodiversity Interactive Map

Produced on Sat Sep 13 15:08:04 EST 2008

GDA

Victoria The Place To Be

VICTORIAN BORDER

Coastline

Border

ROADS

Freeway

Highway

Main Road

Main Road (Unsealed)

Collector

Collector (Unsealed)

Local

Proposed

WATERCOURSES

UNNAMED DRAINAGE LINES

ECOLOGICAL VEGETATION CLASSES

(cont)

333 Red Gum Swamp/Plains Grassy Wetland Mosaic

259 Plains Grassy Woodland/Gilgai Wetland Mosaic

867 Shallow Sands Woodland/Plains Woodland Mosaic

WATERBODIES

Watercourse Area

Permanent Waterbody

Wetland Area

INUNDATION AREAS

BUILT UP AREAS

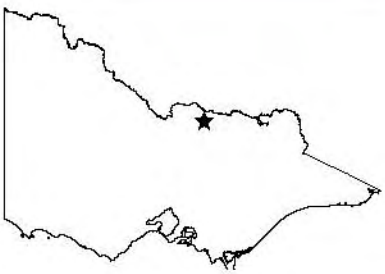
VICTORIA

Other States

Bass Strait

APPENDIX D. Survey Locations

Map of Black Swamp Study Area, Swamp Road, Wunghu



N

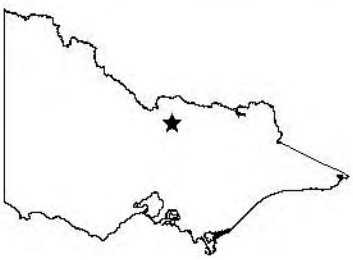
0 125 250

metres

AUSTRALIAN ECOSYSTEMS

CONSULTANCY • NURSERY • WETLANDS • REVEGETATION • MANAGEMENT

Map of Reedy Swamp Study Area, Reedy Swamp Road, Shepparton



N

0 125 250

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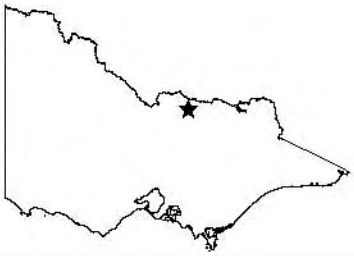
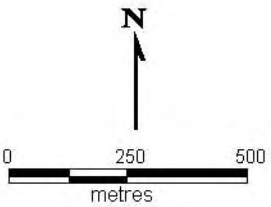
AUSTRALIAN ECOSYSTEMS

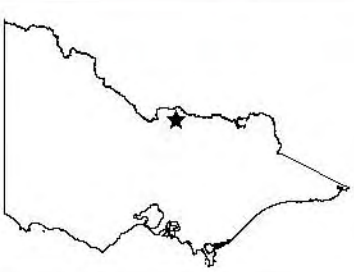
CONSULTANCY • NURSERY • WETLANDS • REVEGETATION • MANAGEMENT

Map of Moodies Swamp Study Area, Benalla - Tocumwal Road, Waggarandall





Map of Kinnairds Swamp Study Area, Skidmore Road, Numurkah



N

0 125 250

metres

AUSTRALIAN ECOSYSTEMS

CONSULTANCY • NURSERY • WETLANDS • REVEGETATION • MANAGEMENT

APPENDIX E. Field Data Black Swamp

Table 51. Field flora survey results for Quadrat 1 Black Swamp

EVC# Red Gum Swamp (Quadrat 1)							
55H 360 678 UTM 5999295	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	3	3	3	3	3	3	3
Depth	saturated	moist	moist	moist	moist	dry to moist	dry
Species and % cover							
Eucalyptus camaldulensis	60	60	60	60	60	60	60
Carex tereticaulis	1	1	1	1	1	2	2
Poa fordeana	1	1	2	1	1	2	2
Walwhalleya proluta	1	1	1	1	1	1	1
Juncus amabilis	1	1	1	1	1	1	1
Juncus aridicola	1	1	1	1	1	1	1
Lachnagrostis filiformis var. 1	1	1	1	1	1	2	5
Carex inversa	1	1	1	1	1	1	1
Enteropogon acicularis	1	1	1	1	1		
**Cynodon dactylon var dactylon*	1	1	1	1	1	1	1
**Cirsium vulgare*	1	1		1	1	1	1
**Aster subulatus*	1	1		1	1	1	1
**Paspalum distichum*	1	1	1	1	1	1	1
**Rumex crispus*	1	1	1	1	1	1	1
**Lactuca serriola*	1	1	1			1	1
**Lolium rigidum*	1	1	5	5	10	10	5
**Hypochoeris glabra*			1	1	1		
Ranunculus pumila var. pumilio			1	1	1		
Eleocharis acuta			1	1	1	1	1
Rumex brownii			1	1			
**Sonchus oleraceus*				1	1	1	1
Amphibromus nervosus				1	1	2	1

EVC# Red Gum Swamp (Quadrat 1)							
55H 360 678 UTM 5999295	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	3	3	3	3	3	3	3
Depth	saturated	moist	moist	moist	moist	dry to moist	dry
Species and % cover							
Ludwigia peploides subsp. montevidensis subsp. montevidensis					1	1	1
**Phalaris paradoxa*					1	1	1
Azolla filiculoides					1		
**Cyperus eragrostis*					1	1	1
**Ranunculus muricatus*					1	1	1
Epilobium billardierianum var. cinereum					1	1	1
Lemna disperma					1		
**Hypochoeris radicata*					1	1	1
Austrodanthonia setacea					1	1	1
Rumex tenax					1	1	
Oxalis perennans					1	1	1
Persicaria hydropiper						1	1
Centipeda cunninghamii						1	1
Alternanthera denticulata						1	1
Lythrum hyssopifolium						1	1
Austrodanthonia caespitosa						1	1
Austrodanthonia duttoniana						1	1
**Sonchus asper*						1	1
Litter	80	80	80	80	80	80	80
Bare Ground	1	1	1	1	1	1	1
Water							
Polygonum aviculare							1

EVC# Red Gum Swamp (Quadrat 1)							
55H 360 678 UTM 5999295	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	3	3	3	3	3	3	3
Depth	saturated	moist	moist	moist	moist	dry to moist	dry
Species and % cover							
Chenopodium pumilio							1
Juncus bufonius							1
Pseudoraphis spinescens							1

Table 52. Field flora survey results for Quadrat 2 Black Swamp

EVC# Aquatic Grassy Wetland (previously Red Gum Swamp) (Quadrat 2)							
55H 360 714 UTM 5999287	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	4	4	4	4	3
Depth	250mm	250mm	250mm	230mm	350mm	110mm	80mm
Species and % cover							
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Ludwigia peploides subsp. montevidensis subsp. montevidensis	5	5	5	5	5	5	10
Persicaria lapathifolia	1	1	1	1		1	1
**Paspalum distichum*	5	1	1				1
**Conyza bonariensis*	1	1	1				
**Cyperus eragrostis*	1	1	1	1			
**Polygonum aviculare*	1	1	1				
**Cirsium vulgare*	1	1					
**Aster subulatus*	1	1	1	1	1	1	1
**Lactuca serriola*	1	1	1	1		1	1
Amphibromus nervosus	45	50	50	50	55	55	60
**Callitriche hamulata*				1	1		
Potamogeton cheesemanii					1	1	1
Lemna disperma					1	1	1
Azolla filiculoides					1	5	5
Ottelia ovalifolia subs. ovafolia						1	1
Helichrysum luteoalbum						1	1
Amphibromus fluitans						1	1
Water						100	100
Alternanthera denticulata							1
Chenopodium pumilio							1

EVC# Aquatic Grassy Wetland (previously Red Gum Swamp) (Quadrat 2)							
55H 360 714 UTM 5999287	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	4	4	4	4	3
Depth	250mm	250mm	250mm	230mm	350mm	110mm	80mm
Species and % cover							
Eleocharis acuta							1
TOTAL: All species	11	11	10	8	8	12	16
TOTAL: Indigenous species	4	4	4	4	6	10	13
TOTAL: Exotic species	7	7	6	4	2	2	3

Table 53. Field flora survey results for Quadrat 3 Black Swamp

EVC# Aquatic Grassy Wetland (previously Red Gum Swamp) (Quadrat 3)							
55H 360 777 UTM 5999285	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	NA	NA	4	4	4	4	3
Depth	400mm	380mm	350mm	330mm	400mm	190mm	150mm
Species and % cover							
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Persicaria lapathifolia	1	1	1	1			1
**Aster subulatus*	1	1	1	1		1	1
**Conyza bonariensis*	1	1	1				
**Lactuca serriola*	1	1	1	1			
**Polygonum aviculare*	1	1					1*
Amphibromus nervosus	20	30	40	40	5	5	10
Ludwigia peploides subsp. montevidensis subsp. montevidensis					1	1	1
Potamogeton ochreatus					1	1	1
**Callitriche hamulata*					1		
Walwhalleya proluta						1	1
Elatine gratioloides						1	1
Azolla filiculoides						60	20
Lemna disperma						5	1
Water						100	100
Amphibromus fluitans							1
Vallisneria americana var. americana							1
*Chenopodium pumilio**							1
*Juncus aridicola**							1

EVC# Aquatic Grassy Wetland (previously Red Gum Swamp) (Quadrat 3)							
55H 360 777 UTM 5999285	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	NA	NA	4	4	4	4	3
Depth	400mm	380mm	350mm	330mm	400mm	190mm	150mm
Species and % cover							
*Typha? sp**							1
*Alternanthera denticulata**							1
Potamogeton cheesemanii							1

Table 54. Field flora survey results for Quadrat 4 Black Swamp

EVC# Tall Marsh (previously Red Gum Swamp) (Quadrat 4)							
55H 360 826 UTM 5999274	17-May-08	30-May-08	14-Jun-08	12-Jul-08	6-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	4	4	4	4	4
Depth	300mm	300mm	260mm	240mm	400mm	140mm	100mm
Species and % cover							
Typha orientalis	50	50	50	50	30	20	5
Persicaria lapathifolia	30	30	25	15	5	5	1 (mostly dead)
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Ludwigia peploides subsp. montevidensis subsp. montevidensis	1	1	1	1	5	5	10
**Aster subulatus*	1	1	1	1	1	1	1
**Rumex crispus*	1			1			
**Cirsium vulgare*	1						
Lemna disperma					5	5	5
Azolla filiculoides					1	40	40
Amphibromus nervosus						1	1
Water						100	100
Alternanthera denticulata							1

APPENDIX F. Field Data Reedy Swamp

Table 55. Field flora survey results for Quadrat 1 Reedy Swamp

EVC# Riverine Swampy Woodland (Quadrat 1)							
55H 353 555 UTM 5977013	1-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	3	3	3	3
Depth	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Species and % cover							
Eucalyptus camaldulensis	40	40	40	40	40	40	40
Acacia pycnantha	1	1	1	1	1	1	1
Carex tereticaulis	5	5	5	5	5	5	5
Juncus usitatus	1	1	1	1	1	1	1
Carex inversa	1	1	1	1	1	1	1
Carex bichenoviana	1	1	1	1	1	1	1
Paspalidium jubiflorum	1	1	1	1			
Einadia nutans subs. nutans	1	1	1	3	3	3	3
Austrodanthonia setacea	1	1	1	1	1	1	1
Elymus scabrous	1	1	1	1	1	1	1
Eucalyptus melliodora	5	5	5	5	5	5	5
Walwhalleya proluta	1	1	1	1	0	0	0
Austrodanthonia racemosa	1	1	1	1	1	1	1
Alternanthera denticulata	1	1	1	1			1
Calotis scapigera	1	1	1	1		1	1
**Paspalum distichum*	1	1	1	1			
**Lolium rigidum*	1	2	5	10	15	10	5
**Plantago lanceolata*	1	1	1	1	1	1	1
Leaf Litter	80	80	80	80	80	80	80
Bare Ground	1	1	1	1	5	5	5
**Sonchus oleraceus*		1	1	1	1	1	1
**Hypochoeris glabra*			1	1			
Ranunculus pumilio var. pumilio			1	1			

EVC# Riverine Swampy Woodland (Quadrat 1)							
55H 353 555 UTM 5977013	1-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	3	3	3	3
Depth	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Species and % cover							
Rumex brownii			1	1			
Crassula decumbens				1			
**Bromus diandrus*					1	1	1
Eleocharis acuta					1	1	1
**Lactuca serriola*					1	1	1
**Cirsium vulgare*					1	1	1
Elymus multiflorus					1	1	1
Poa labillardierei					1	1	1
Atriplex semibaccata					1	1	1

Table 56. Field flora survey results for Quadrat 2 Reedy Swamp

EVC# Rushy Riverine Swamp (Quadrat 2)							
55H 353 523 UTM 5977 008	1-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	3	3	3	3
Depth	200mm	300mm	250mm	250mm	180mm	130mm	200mm
Species and % cover							
Juncus ingens	50	50	50	50	40	40	40
Senecio campylocarpus	5	1	1	1		1	1
Alternanthera denticulata	5	1	1	1	1	5	10
Persicaria decipiens	1	1	1	1	1	1	1
Water	5	50	50	50	30	20	20
Litter	40	30	30	30	60	60	60
**Lactuca serriola*	1	1	1	1	1	1	1
**Atriplex prostrata*	1	1	1				
**Aster subulatus*	1	1	1	1	1	1	1
**Cirsium vulgare*	1	1	1		1	1	1
**Paspalum distichum*	5	5	1	1	1	1	1
**Hypochoeris glabra*				1			
**Ranunculus muricatus*				1	1	1	1
**Cyperus eragrostis*				1			
Lemna disperma					30	20	20
Lachnagrostis filiformis var. 1					1	1	1
Ludwigia peploides subsp. montevidensis					1	1	1
**Rumex crispus*					1	1	1
Eucalyptus camaldulensis						1	1
**Sonchus asper*						1	1
Persicaria lapathifolia						1	1
Landoltia punctata							1
Azolla filiculoides							1
**Sonchus oleraceus*							1

EVC# Rushy Riverine Swamp (Quadrat 2)							
55H 353 523 UTM 5977 008	1-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	3	3	3	3
Depth	200mm	300mm	250mm	250mm	180mm	130mm	200mm
Species and % cover							
**Rorippa palustris*							1
TOTAL: All species	9	9	9	10	12	16	20
TOTAL: Indigenous species	5	5	5	6	6	7	9
TOTAL: Exotic species	4	4	4	4	6	9	11

Table 57. Field flora survey results for Quadrat 3 Reedy Swamp

EVC# Floodway Pond Herbland/Open Water (Quadrat 3)							
55H 353 494 UTM 5977 020	1-May-08	30-May-08	14-Jun-08	13-Jul-08	6-Oct-08	19-Nov-08	10-Dec-08
Condition	NA	NA	NA	NA	NA	NA	NA
Depth	600mm	700mm	650mm	650mm	500mm	530mm	
Species and % cover							
Elatine gratioloides	1	1	1	5	5	10	10
Persicaria lapathifolia	5	1	1	1			
Alternanthera denticulata	1	1					1
Alisma plantago-aquatica	1	1					
Open Water	100	100	100	100	100	100	100
**Paspalum distichum*			2	1	1	1	1
Wolffia australiana						1	
Lemna disperma						1	1
**Aster subulatus*						1	1
Ludwigia peploides subsp. montevidensis						1	1
Persicaria decipiens						1	1
Azolla filiculoides							1

APPENDIX G. Field Data Moodies Swamp

Table 58. Field flora survey results for Quadrat 1 Moodies Swamp

EVC# Intermittent Swampy Woodland (Quadrat 1)							
55H 391 947 UTM 5990 335	18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	3	3	3	3
Depth	moist	moist	moist	moist	dry	dry	dry
Species and % cover							
Eucalyptus camaldulensis	5	5	5	5	5	5	5
Cyperus gymnocaulos	5	5	5	5	5	1	1
Eragrostis infecunda	1	1	1	1	1	1	1
Wahlenbergia fluminalis	1	1	1	1	1	1	1
Vittadinia gracilis	1	1	1	1	1	1	1
Austrostipa scabra subs. falcata	1	1	1	1	5	5	5
Crassula sieberi ssp. tetramera	1	1	1	1	1	1	1
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Bare ground	50	50	50	50	60	55	55
Leaf litter	35	35	35	35	35	35	35
**Lolium rigidum*	1	1	2	2	2	1	1
**Cynodon dactylon var. dactylon*	1	1	1	1	1	1	1
***Chondrilla juncea sp*			1	1	1	1	1
**Lactuca serriola*			1	1	1	1	1
**Cirsium vulgare*				1			
**Trifolium dubium*				1	1		
**Bromus diandrus*					1	1	
**Vulpia bromoides*					1	1	1
**Avena barbata*					1	1	1
**Sonchus oleraceus*					1		

Table 59. Field flora survey results for Quadrat 2 Moodies Swamp

EVC# Cane Grass Wetland (Quadrat 2)							
55H 391 924 UTM 5990 315	18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	2	2	2	2
Depth	50 mm	60 mm	90 mm	80 mm	moist	moist	dry
Species and % cover							
Eragrostis infecunda	70	70	70	70	70	60	60
**Lactuca serriola*	1	1	1	1	1	1	1
**Vulpia bromoides*	1	1	2	2	2	1	1
**Polygonum aviculare*	1	1			1	1	1
**Bromus hordeaceus*	1	1	1	1	1	5	1
**Cirsium vulgare*	1	1	1	1	1	1	1
**Hypochoeris glabra*			1	1	1	1	1
Cardamine moirensis			1	1	5	1	
Ranunculus pumilo var. pumilio				1	1	1	
Callitriche umbonata				1	1	1	
Eleocharis acuta				1	1	1	1
Potamogeton cheesemanii				1	1	1	
**Lolium rigidum*					1	5	5
Damasonium minus					1	1	1
Isoetes muelleri					1		
**Aira elegans*					1		
**Callitriche hamulata*					1		
Elatine gratioloides					1		
**Phalaris paradoxa*					1	1	1
Isolepis cernua var. platycarpa					1	1	1
Isolepis australiensis					1	1	1
Crassula decumbens					1	1	1
Myriophyllum crispatum					1	1	1
**Bromus diandrus*					1		1

EVC# Cane Grass Wetland (Quadrat 2)							
55H 391 924 UTM 5990 315	18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Condition	3	3	3	2	2	2	2
Depth	50 mm	60 mm	90 mm	80 mm	moist	moist	dry
Species and % cover							
**Cerastium glomeratum*					1	1	1
Riccia duplex					1	1	
Lachnagrostis filiformis var. 1					1	5	1
Juncus holoschoenus					1	1	1
Limosella australis					1	1	
Epilobium billardierianum var. cinereum					1	5	1
**Briza minor*					1	1	
Senecio campylocarpus						1	1
**Hordeum*						1	1
**Avena vulgate*						1	1
**Leontodon taraxacoides subs. taraxacoides*							1
**Lactuca saligna*							1
**Sonchus oleraceus*							1
**Aster subulatus*							1
TOTAL: All species	6	6	7	11	31	29	27
TOTAL: Indigenous species	1	1	2	6	18	16	10
TOTAL: Exotic species	5	5	5	5	13	13	17

Table 60. Field flora survey results for Quadrat 3 Moodies Swamp

EVC# Cane Grass Wetland (Quadrat 3)							
55H 391 731 UTM 5990 194	18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Condition	3	2	2	2	2	2	2
Depth	100 mm	100 mm	120 mm	120 mm	Moist saturated	dry	dry
Species and % cover							
Eragrostis infecunda	60	60	60	60	60	50	50
Eleocharis acuta	1	2	5	5	10	15	10
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Senecio campylocarpus	1	1					1
**Lactuca serriola*	1	1	1	1	1		1
**Lactuca saligna*	1	1	1	1		1	1
**Cirsium vulgare*	1	1	1	1	1	1	1
Rumex tenax			1	1	1	1	1
Callitriche umbonata				1	1		
Myriophyllum crispatum				1	5	5	5
Potamogeton cheesemanii				1	1	1	0
Juncus holoschoenus					1	1	1
Damasonium minus					1	1	1
Riccia duplex					1		
Myriophyllum verrucosum					1	1	1
**Callitriche hamulata*					1		
**Phalaris paradoxa*					1	1	1
**Polygonum aviculare*					1	1	1
Epilobium billardierianum						1	1
Amphibromus nervosus						1	1
**Sonchus oleraceus*						1	1
**Bromus hordeaceus*						1	
**Lolium rigidum*						1	1

EVC# Cane Grass Wetland (Quadrat 3)							
55H 391 731 UTM 5990 194	18-May-08	31-May-08	15-Jun-08	11-Jul-08	7-Oct-08	19-Nov-08	10-Dec-08
Condition	3	2	2	2	2	2	2
Depth	100 mm	100 mm	120 mm	120 mm	Moist saturated	dry	dry
Species and % cover							
**Leontodon taraxacoides subs. taraxacoides*						1	1
Bare Ground						1	1
Litter						30	35
Open Water							
**Aster subulatus*							1
Juncus flavidus							1
Helminthotheca echioides							1

APPENDIX H. Field Data Kinnairds Swamp

Table 61. Field flora survey results for Quadrat 1 Kinnairds Swamp

EVC# Plains Rushy Wetland (Quadrat 1)							
55H 362 705 UTM 6006 014	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	3	3	3
Depth	dry	160 mm	100 mm	10 mm	moist	0	0
Species and % cover							
Juncus semisolidus	20	20	20	20	25	25	25
Juncus usitatus	5	5	5	5	5	5	5
Lachnagrostis filiformis var. 1	1	1	1	1	1	1	1
Eleocharis pusilla	1	1	1	1	5	5	1
Oxalis perennans	1	1	1	1	1	1	1
Eucalyptus camaldulensis	1	1	1	1	1	1	1
Juncus flavidus	20	20	20	20	20	20	20
Alternanthera denticulata	1			1	1	1	1
Litter	40	40		40	40	40	40
Bare Soil	1				5	5	5
**Cirsium vulgare*	1	1		1	1	1	1
**Phalaris paradoxa*	1	1			1	5	5
**Ecballium elaterium*	1	1	1	1	1	1	1
**Rumex crispus*	1	1	1	1	5	5	5
**Lactuca serriola*	1	1	1	1	1	1	5
**Sonchus oleracea*	1	1			1	1	1
**Hypochoeris radiata*	1	1			1		
**Aster subulatus*	1	1	1	1	1	1	1
**Lactuca saligna*	5	5	1	1	1	1	1
Open Water		60	60	5			
Ranunculus pumilio var. pumilio		1		1	5	1	1
Eleocharis acuta			1	5	5	5	5
Marsilea costulifera			1	1	1		

EVC# Plains Rushy Wetland (Quadrat 1)							
55H 362 705 UTM 6006 014	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	3	3	3
Depth	dry	160 mm	100 mm	10 mm	moist	0	0
Species and % cover							
**Callitriche hamulata*			1	5	1		
Rumex tenax			1	1	1	1	1
Amphibromus nervosus				1	5	1	1
Lythrum hyssopifolium				1	1	1	1
**Veronica peregrina*					1	1	
**Aloepecurus aequalis*					5		
**Trifolium subterrainium*					1		
**Polygonum aviculare*					1	1	1
**Lolium rigidum*					1	1	1
Juncus bufonius						1	1
Euchiton sphaericus							1
Epilobium billardierianum subs. cinereum							1
**Medicago polymorpha*							1

Table 62. Field flora survey results for Quadrat 2 Kinnairds Swamp

EVC# Red Gum Swamp (Quadrat 2)							
55H 362 680 UTM 6005 998	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	3	3	3
Depth	dry	190 mm	140 mm	40 mm	40 mm	0	0
Species and % cover							
Eleocharis acuta	55	20	20	40	40	35	30
Eleocharis pusilla	1	1	1	5	1	1	1
Eucalyptus camaldulensis	20	20	20	20	20	20	20
Juncus semisolidus	1	1	1	1	1	1	1
Juncus flavidus	1	1	1	1	1	1	1
Rumex tenax	1	0	1	1	1	1	1
Amphibromus nervosus	1	1	1	5	5	5	5
Litter	20			20	25	30	30
Bare Soil	5			5	1	1	1
**Aster subulatus*	1	1	1	1	1	1	1
**Sonchus oleracea*	1					1	1
**Helminthotheca echioides*	1	1	1	1		1	1
**Cirsium vulgare*	1	1			1		1
**Lactuca saligna*	5	1	1	1	1	1	1
Open Water		95+	95+	60			
**Callitriche hamulata*		1	5	5	5	1	
Lachnagrostis filiformis var. 1		1	1	1	1	5	5
Marsilea drummondii			1	1	1	1	1
**Rumex crispus*			1	1	1	1	1
**Leontodon taraxacoides subs. taraxacoides*				1		1	1
Ranunculus pumilio var. pumilio				1	1	1	1
Cardamine moirensis				1	1	1	
**Lolium rigidum*				1	1	5	1

EVC# Red Gum Swamp (Quadrat 2)							
55H 362 680 UTM 6005 998	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	3	3	3
Depth	dry	190 mm	140 mm	40 mm	40 mm	0	0
Species and % cover							
**Hypochoeris glabra*				1	1		
Marsilea costulifera				1	1	1	
Lythrum hyssopifolium					1	1	1
**Veronica peregrina*					1	1	
**Alopecurus aequalis*					1		
**Trifolium tomentosum*					1	1	1
**Polygonum aviculare*					1	1	1
Damasonium minus					1		
Limosella australis					1		
**Crassula natans*					1		
**Lactuca serriola*					1	1	1
Phalaris paradoxa						1	1
Centipeda cunninghamii						1	1
**Solanum nigrum*						1	1
**Anagallis arvensis*						1	1
Alternanthera denticulata							1
Senecio quadridentatus							1
**Trifolium michelianum var. michelianum*							1
TOTAL: All species	12	12	14	20	28	29	29
TOTAL: Indigenous species	7	7	9	12	15	15	15
TOTAL: Exotic species	5	5	5	8	13	14	14

Table 63. Field flora survey results for Quadrat 3 Kinnairds Swamp

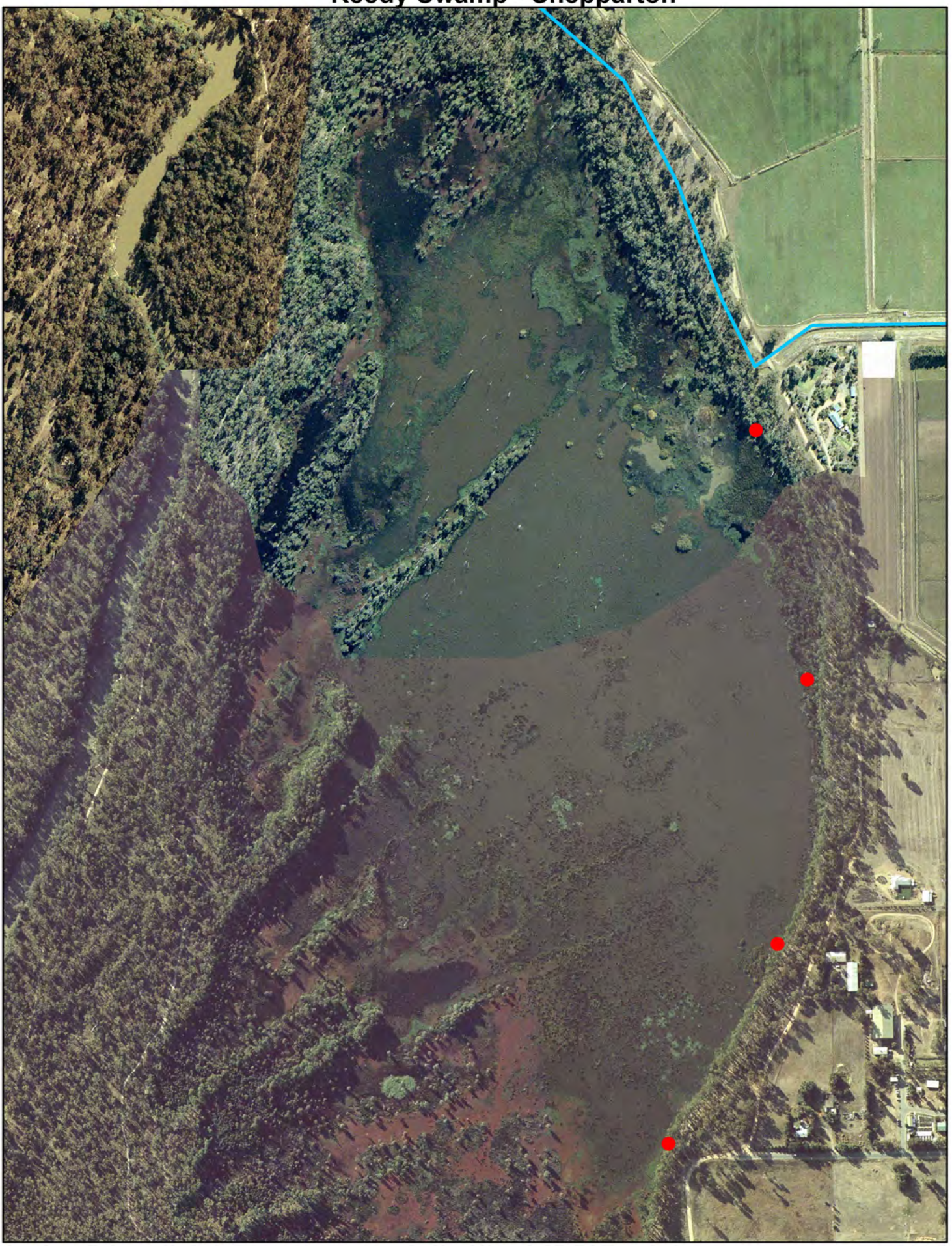
EVC# Tall Marsh (Quadrat 3)							
55H 362 658 UTM 6005 981	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	3	3	3	3	3	3	3
Depth	200 mm	450 mm	400 mm	300 mm	300 mm	dry	dry
Species and % cover							
Juncus ingens	100	100	100	100	100	100	100
Lemna disperma					1		
Azolla filiculoides					1		
Eleocharis acuta					1	1	1
**Callitriche hamulata*					1	1	
Lachnagrostis filiformis var. 1						1	1
**Polygonum aviculare*						1	1
Alternanthera denticulata						1	1
Persicaria lapathifolia						1	1
**Aster subulatus*							1

Table 64. Field flora survey results for Quadrat 4 Kinnairds Swamp

EVC# Plains Grassy Wetland (Quadrat 4)							
55H 362 611 UTM 6005 975	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	2	2	2
Depth	dry	240 mm	180 mm	80 mm	moist	dry	dry
Species and % cover							
Marsilea drummondii	1	5	5	10	30	45	60
Eleocharis acuta	5	5	5	10	10	10	10
Eleocharis pusilla	1	0	5	5	1	1	1
Juncus flavidus	1	1	1	1	1	1	1
Lachnagrostis filiformis var. 1	1	1	5	5	1	10	5
Juncus semisolidus	1	1	1	1	1	1	1
Litter	40				5	5	5
Bare Soil	50				10	10	10
**Lactuca serriola*	1	1	1	1	1	1	1
**Hypochoeris radiata*	1						
**Cirsium vulgare*	1						
**Helminthotheca echioides*	1	1	1	1			
**Lactuca saligna*	1	1	1	1		1	1
Open Water		95+	90+	90+			
**Callitriche hamulata*			1	25	15		
**Rumex crispus*			1	1	1	1	1
Marsilea costulifera			1	1	1	1	1
Amphibromus nervosus				1	5	5	1
**Alopecurus aequalis*					1		
**Aster subulata*					1	1	1
Lythrum hyssopifolium					1	1	1
**Crassula natans*					1	1	
Myriophyllum gracile					1		
Limosella curdieana					1		
Limosella australis					1	1	1

EVC# Plains Grassy Wetland (Quadrat 4)							
55H 362 611 UTM 6005 975	17-May-08	31-May-08	15-Jun-08	12-Jul-08	7-Oct-08	18-Nov-08	9-Dec-08
Condition	4	4	3	3	2	2	2
Depth	dry	240 mm	180 mm	80 mm	moist	dry	dry
Species and % cover							
Ranunculus pumilio var. pumilio					1	1	
**Veronica peregrina*					1		
Rumex tenax					1	1	1
Elatine gratioloides					1		
**Polygonum aviculare*					1	1	1
Cardamine moirensis					1		
Damasonium minus					1		
Juncus bufonius						1	1

Reedy Swamp - Shepparton



0 75 150 300 Meters

Acoustic Monitoring Site

G-MW Channel

N

Victoria
The Place To Be

Disclaimer:
This map is based on publicly available data. The creators do not warrant that this map is definitive nor free of error and do not accept liability for loss arising from the use of this product beyond its intended purpose.

Aerial photograph taken November, 2004