2007 River Murray Wetlands Baseline Survey

Vegetation Component

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5 March 2008
SARDI Publication Number F2008/000058

This publication may be cited as:

Marsland, K.B. and Nicol, J.M. (2008). 2007 River Murray Wetlands Baseline Survey. Vegetation Component. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 36pp. SARDI Publication Number F2008/000058.

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Printed in Adelaide March 2008

SARDI Aquatic Sciences Publication Number F2008/000058
SARDI Research Report Series Number 270
ISBN Number 978 0 7308 5385 5

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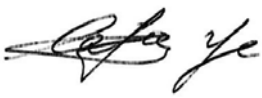

Signed:
Date: 5 March 2008
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Circulation: Public Domain

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Acknowledgements

The authors thank Aimee Linke, Paul Stribley and the landholders and managers of all of the surveyed wetlands for their assistance, Aimee Linke and Leigh Thwaites for comments on early drafts of this report and Arron Strawbridge for field assistance. The National Action Plan for Salinity funded this project.

Executive Summary

Baseline vegetation and tree health surveys were conducted at three wetlands along the South Australian River Murray (Caurnamont, Wongulla and Lyrup Forest). Quantitative vegetation surveys were undertaken in areas that were permanently inundated at normal pool level and riparian zones of each wetland. A species list was compiled for the remainder of the floodplain. In addition, visual health estimates of 50 *Eucalyptus camaldulensis* var. *camaldulensis* and 50 *Eucalyptus largiflorens* trees were undertaken at each site.

The data were collected to assist managers to identify management objectives and provide the basis for ongoing monitoring to determine temporal trends and changes brought about by management actions. Methods were designed to be scientifically robust but straightforward to allow community groups or non-specialists to undertake monitoring in the future.

A total of 98 species, including 39 exotics and one species listed as rare in South Australia (*Myoporum parvifolia*) were recorded in the wetlands surveyed. Wongulla was the most species rich site with 73 species and Lyrup the least with 52 species. Caurnamont had the largest proportion of exotic species (41%).

Tree health varied between the three wetlands, although a greater number of stressed trees were found in Lyrup Forest than the Murray Gorge wetlands. *Eucalyptus largiflorens* trees generally showed greater signs of stress than *Eucalyptus camaldulensis* var. *camaldulensis*.

1. Background and Aims

The major aim of this survey was to provide baseline data on the vegetation communities and tree health of three wetlands selected for the 2007 River Murray Wetlands Baseline Survey; Caurnamont Lagoon, Wongulla Lagoon and Lyrup Forest.

The data collected in this survey will assist in identifying management objectives and provide the basis for continued monitoring of the vegetation to identify temporal trends as well as the response of the vegetation to any future management actions. The methods used were designed to be repeatable, scientific and statistically robust. They were also intended to be straightforward enough for future implementation by community groups and non-specialists with minimal technical assistance.

The present survey focussed on the vegetation of the wetlands with a particular emphasis on the aquatic and riparian zones. These areas are the most likely to be affected by changes in wetland hydrology, either by direct management actions at the wetland itself, or by changes to regional flow regimes.

2. Methods

The vegetation surveys in each wetland consisted of three components:

- Quantitative vegetation surveys
- Vegetation mapping and species list
- Tree health assessment

The method used were identical to those used for the 2005 (Nicol *et al.,* 2006) and 2006 (Marsland and Nicol 2007) River Murray Wetlands baseline surveys.

2.1. Quantitative Vegetation Surveys

Quantitative vegetation surveys were undertaken in areas of the survey area that have the potential to be managed under regulated conditions (i.e. permanent wetlands, areas that are inundated by weir pool manipulations, areas under the influence of structures that can retain floodwaters and riparian zones). These areas were divided on the basis of the plant communities that were initially identified from aerial photographs then ground truthed in the field. In wetlands where there were the same vegetation associations covering large areas (e.g. *Juncus usitatus* sedgelands in Wongulla Lagoon), the association was split into two or more associations and surveyed accordingly to give the quantitative survey better spatial coverage of the wetland. Three randomly located quadrats were surveyed in each vegetation association (n = 3).

Quadrat size was determined using species area curves (Figure 1). The most appropriate quadrat dimensions were 1 x 15 m (positioned parallel to the shoreline), which captured at least 95% of the species present in an association and enabled narrow riparian zones to be surveyed.

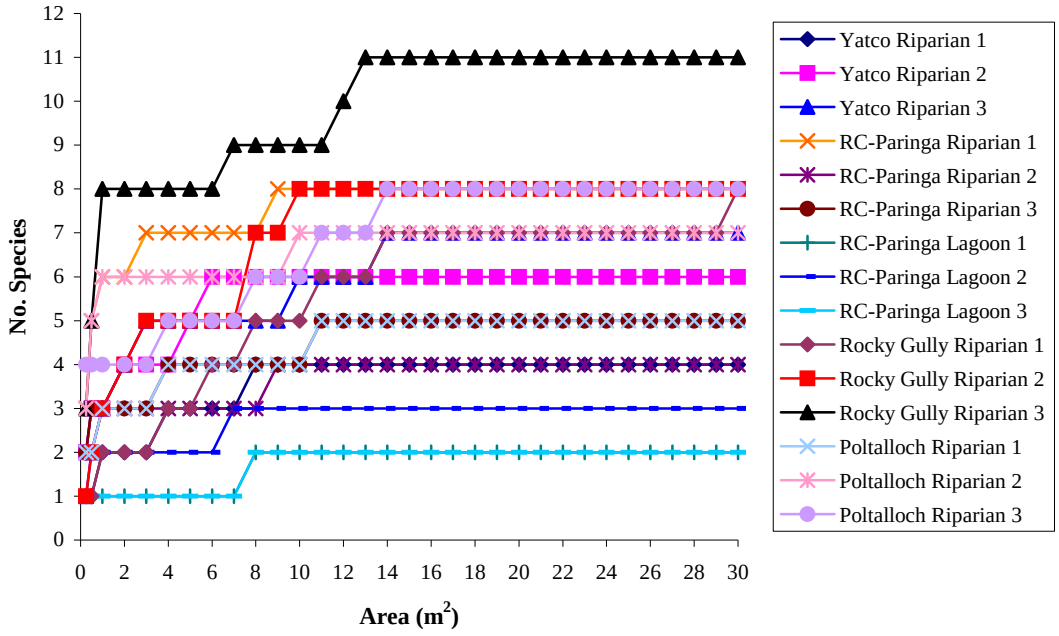

Figure 1: Species area curves for Yatco Lagoon, Reedy Creek-Paringa, Poltalloch and Rocky Gully Wetlands (Nicol *et al.* 2006).

Cover and abundance of each species present in the quadrat was estimated using the method outlined in Heard and Channon (1997) except N and T were replaced by 0.1 and 0.5 respectively to enable statistics to be undertaken on the data in the future (Table 1).

Table 1: Modified Braun-Blanquet (1932) scale estimating cover/abundance from Heard and Channon (1997).

Score	Modified Score	Description
N	0.1	Not many, 1-10 individuals
T	0.5	Sparsely or very sparsely present; cover very small (less than 5%)
1	1	Plentiful but of small cover (less than 5%)
2	2	Any number of individuals covering 5-25% of the area
3	3	Any number of individuals covering 25-50% of the area
4	4	Any number of individuals covering 50-75% of the area
5	5	Covering more than 75% of the area

The location of the central point in each quadrat was marked by GPS so the same 1 x 15 m area can be surveyed on repeat surveys.

Comparisons within and between vegetation associations can be made between this survey and subsequent surveys using multivariate statistical analyses such as NMS ordination (McCune *et al.* 2002), Indicator Species Analysis (Dufrene and Legendre 1997), Multi Response Permutation

Procedures, Analysis of Similarity (McCune *et al.* 2002) and Non-parametric Multivariate Analysis of Variance (Anderson 2001) to determine whether the floristic composition has changed (through time or in response to management actions) and how it has changed.

2.2. Vegetation Mapping and Species Lists

It was not possible to detect every species in the survey area (the area between the river and 1956 flood level); therefore, any species encountered in the survey area were recorded. This increased the chances of detecting any species of conservation significance, not just in the wetlands but also over the whole floodplain. In addition, it provided a more comprehensive list of species for the survey area.

Areas with different plant communities that were not quantitatively surveyed were mapped using ground truthed aerial photography (areas that were quantitatively surveyed were also included on the vegetation map). Polygons were then drawn on the aerial photographs using Arc GIS (ESRI 2006) and a GIS layer of the major vegetation communities produced, which was included in the vegetation map.

Areas of interest in the survey area (e.g. an infestation of weeds or an area that is more species rich than the surrounding areas) that were too small to fit three quadrats were noted. A list of the species in the area was recorded, the location marked by GPS and the information incorporated into the vegetation map.

Plants were identified using keys in Jessop and Tolken (1986), Jessop *et al.* (2006), Cunningham *et al.* (1981) and Sainty and Jacobs (1981; 1994). Nomenclature follows Barker *et al.* (2005). The terminology used to describe different vegetation associations (e.g. herbland, shrubland, woodland, grassland) follows that of the 2004 River Murray Wetlands baseline survey (Holt *et. al.* 2005).

2.3. Tree Health

Health of *Eucalyptus camaldulensis* var. *camaldulensis* and *Eucalyptus largiflorens* was assessed visually using the method described in Tucker *et al.* (2003) (Table 2).

Table 2: Tree health scale for *Eucalyptus camaldulensis* var. *camaldulensis* and *Eucalyptus largiflorens* (Tucker *et al.* 2003).

Tree Health Rating	Tree Health Rating Description
5-Excellent	Tree with >75% of original canopy present Less than 5% epicormic growth May include some dead branchlets and leaves.
4-Good	Tree with 50 – 75% of original canopy present Epicormic growth less than 10% of remaining canopy Some dead branchlets (<50% of canopy)
3-Moderate	Tree with 25 – 49% of original canopy present Some epicormic growth (<50% of remaining canopy) Some small dead branches.(<50% canopy)
2-Poor	Tree with < 25% of original canopy present, Predominantly epicormic growth (>50% of remaining canopy) Some main branches dead (<50% canopy)
1-Very Poor	Unhealthy tree with no original canopy All epicormic growth Most main branches dead. (>50% canopy)
0-Dead	Dead tree

Fifty trees of each species were chosen randomly and assessed in each wetland (long term dead trees were not assessed). The location of each tree was marked by GPS and the location and health of each tree surveyed was used to produce a GIS layer and tree health map for each species using Arc GIS (ESRI 2006).

3. Results

3.1. Regional Summaries

A total of 98 species (surveyed quadrats and opportunistic observations) were recorded across all sites, including 39 exotics and one species listed as rare in South Australia (*Myoporum parvifolia*). Wongulla was the most species rich site with 73 species and Lyrup Forest the least species rich with 52. Caurnamont had the largest number of exotic species (28).

3.2. Riverland Wetland

Lyrup Forest was surveyed in October 2007 and a total of 52 species, including 15 exotics and one species listed as rare in South Australia (*Myoporum parvifolium*) were recorded.

The permanently inundated areas in the wetland consisted of a series of hypersaline and anoxic pools that were devoid of aquatic plants. The fringes of the permanent pools tended to be bare with significant areas of salt-scald. In less salt affected areas, including dry creek beds, *Halosarcia pergranulata* ssp. *pergranulata*/*Carpobrutus* sp. shrublands were present.

On the remainder of the floodplain, *Eucalyptus camaldulensis* var. *camaldulensis* health was generally good whilst *Eucalyptus largiflorens* health tended to be poor, especially in individuals adjacent to the permanent pools. The understorey was either sparse and dominated by *Muehlenbeckia florulenta, Atriplex* spp., *Sclerolaena* spp. and salt tolerant species such as *Halosarcia pergranulata* ssp. *pergranulata* and *Carpobrutus* sp..

3.3. Murray Gorge Wetlands

The permanently inundated areas of the wetlands were generally devoid of submergent vegetation; however, the water level in both lagoons was lower than would be expected under entitlement flows in the River Murray. Extensive stands of *Typha* spp. and *Phragmites australis* fringed most of the permanently inundated areas at each site and *Juncus usitatus* had colonised the drying wetland bed in the northern part of Wongulla Lagoon.

The adjacent floodplain differed between sites: trees were generally healthy in each wetland with the largest numbers of unhealthy *Eucalyptus camaldulensis* var. *camaldulensis* trees observed at Caurnamont on part of the floodplain, which had been recently burnt. There were significantly less *Eucalyptus largiflorens* trees than *Eucalyptus camaldulensis* var. *camaldulensis* in both wetlands with their distribution generally restricted to the edge of the floodplain. *Eucalyptus largiflorens* tended to

be in better health on the Wongulla floodplain compared to Caurnamont. The floodplain at Wongulla and Caurnamont was dominated by *Eucalyptus largiflorens* and *Eucalyptus camaldulensis* var. *camaldulensis* open woodlands with chenopod shrub understorey, *Muehlenbeckia florulenta* open shrublands and salt tolerant species. The floodplain community at Caurnamont had a larger number of exotic species.

3.4. Lyrup Forest

A total of 52 species were observed in the survey area including 15 exotics and one rare species, *Myoporum parvifolium* (Table 3).

The floodplain of Lyrup Forest was predominantly characterised by open *Eucalyptus largiflorens* woodland, over a sparse *Muehlenbeckia florulenta, Atriplex* spp., *Halosarcia pergranulata* ssp. *pergranulata* and *Carpobrutus* sp. understorey (Figure 2). At higher elevations, the floodplain was dominated by *Muehlenbeckia florulenta* shrubland with *Halosarcia pergranulata* ssp. *pergranulata* and *Carpobrutus* sp. understorey (Figure 2). The north eastern portion of the floodplain, closest to the River Murray, and the area of floodplain adjacent to Gurra Gurra Lakes were dominated by open *Eucalyptus camaldulensis* var. *camaldulensis/Eucalyptus largiflorens* woodland with *Acacia stenophylla, Atriplex* spp. and *Sclerolaena* spp. understorey (Figure 2). A small area of closed *Eucalyptus camaldulensis* var. *camaldulensis* woodland with *Acacia stenophylla, Phragmites australis* and *Cyperus gymnocaulos* understorey was present along the eastern edge of the lagoon (Figure 2). This community was markedly different to the surrounding area probably due to an influx of freshwater from a drainage outlet channel.

During the survey, the inundated areas of Lyrup Forest were concentrated in the southern area of the wetland and were a series of shallow, anoxic, hypersaline pools devoid of aquatic vegetation. The riparian zone of the largest pool was predominantly bare, salt-scalded soil with dead *Eucalyptus largiflorens* overstorey and occasional *Halosarcia pergranulata* ssp. *pergranulata* plants. A series of flood runners in this area of the wetland, and those connecting the lagoon to Gurra Gurra Lakes at high flows, were dominated by *Halosarcia pergranulata* ssp. *pergranulata/Carpobrutus* sp. herblands. Further north, the lagoon narrowed and the pools became more intermittent. Discreet patches of *Phragmites australis* interspersed with *Halosarcia pergranulata* ssp. *pergranulata* were found along the eastern side of these pools. The channel that connects the lagoon to the River Murray was dry with dense stands of *Phragmites australis*.

Surveyed quadrats

Six different vegetation associations were quantitatively surveyed:

1) *Halosarcia pergranulata* ssp. *pergranulata* herbland near Gurra Gurra Lakes
2) *Halosarcia pergranulata* ssp. *pergranulata* herbland near the inlet channel
3) *Halosarcia pergranulata* ssp. *pergranulata* herbland near Emu crossing
4) *Halosarcia pergranulata* ssp. *Pergranulata/Carpobrutus* sp. herbland near Emu crossing
5) *Halosarcia pergranulata* ssp. *pergranulata* herbland near tortoise crossing
6) *Phragmites australis* sedgeland near the inlet channel

Table 3: Species list for Lyrup Forest and the vegetation associations where they were present (includes opportunistic observations not surveyed in quadrats) (*denotes exotic species, #denotes listed as rare in South Australia).

Species	Common name	Association number					
		1	2	3	4	5	6
Acacia stenophylla	River cooba						
Agrostis avenacea	Blown grass						
*Asphodelus fistulosus**	Onion weed						
Atriplex nummularia	Old man saltbush						
Atriplex paludosa	Marsh saltbush						
Atriplex prostrata	Creeping saltbush						
Atriplex sp.	Saltbush			x	x	x	
Atriplex stipitata	Bitter saltbush						
*Avena barbata**	Wild oat						
Bolboschoenus caldwellii	Club rush						
*Bromus rubens**	Red brome						
Carpobrutus sp.	Angular pigface	x		x	x	x	
Centaurea sp.*	Thistle						
*Chenopodium glaucum**	Glaucous goosefoot						
Chenopodium sp.	Goosefoot						
*Conyza bonariensis**	Flax-leaf fleabane						
Cyperus gymnocaulos	Spiny flat-sedge						
*Echium plantagineum**	Salvation Jane						
Eleocharis acuta	Common spike-rush						
Enchylaena tomentosa	Ruby saltbush						
Eucalyptus camaldulensis	River red gum						
Eucalyptus largiflorens	Black box						
*Euphorbia terracina**	False caper						
Halosarcia pergranulata ssp. *pergranulata*	Black-seed samphire	x	x	x	x	x	x

Species	**Common name**	**Association number**					
		1	**2**	**3**	**4**	**5**	**6**
*Heliotropium curassavicum**	Smooth heliotrope						
*Heliotropium europaeum**	Common heliotrope	x				x	x
*Hordeum vulgare**	Barley						
Maireana microcarpa	Swamp bluebush						
Melaleuca halmaturorum	Swamp paper-bark						
*Mesembryanthemum crystallinum**	Small ice-plant						
Mimulus repens	Creeping monkey-flower						
Mollugo cerviana	Wire-stem chickweed						
Morgania floribunda	Blue rod						
Muehlenbeckia florulenta	Lignum						
Myoporum montanum	Boobialla						
Myoporum parvifolium[#]	Creeping boobialla						
Myriocephalus stuartii	Poached-egg daisy						
Opuntia sp.*	Prickly pear						
Pachycornia triandra	Desert glasswort					x	
Phragmites australis	Common reed						x
Picris hieracioides var. *hieracioides**	Ox-tongue						
*Polypogon monspeliensis**	Annual beardgrass						
Psuedognaphalium luteo-album	Jersey cudweed						
Scleroblitum atriplicinum	Purple goosefoot						
Sclerolaena blackiana	Black's copperburr						
Sclerolaena brachyptera	Short-winged copperburr						
Sclerolaena divaricata	Tangled bindy						
Senecio runcinifolius	Tall groundsel						
Senecio sp.	Groundsel						
Sporobolus mitchelli	Rat's-tail couch						
Typha spp.	Bulrush/Cumbungi						
Wahlenbergia fluminalis	River bluebell						

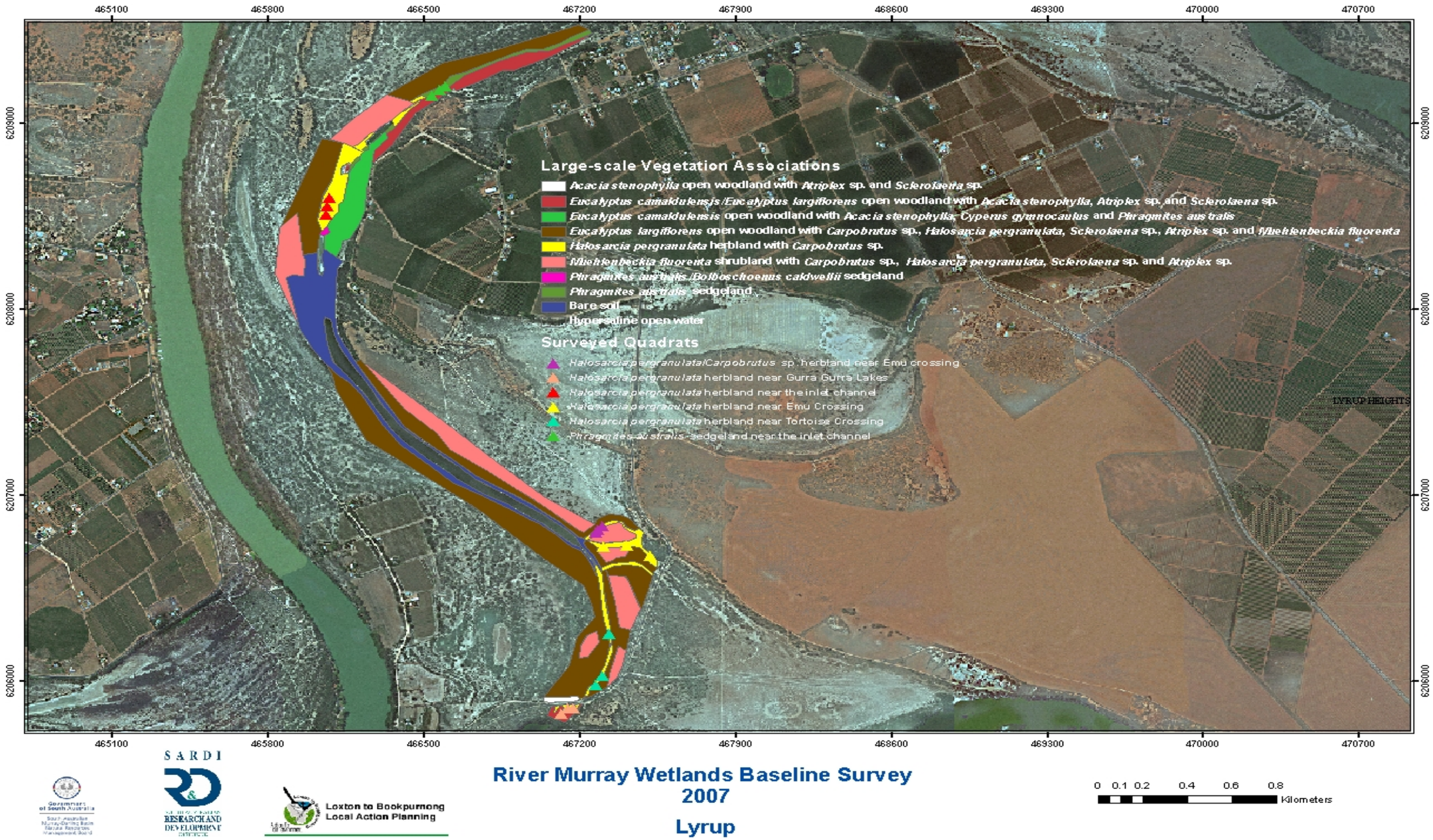

Figure 2: Vegetation map of Lyrup showing the quantitatively surveyed quadrats and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* trees were not widely distributed across the floodplain; individuals were restricted to the area adjacent to Gurra Gurra lakes and the northern section of the floodplain (Figure 3). Of the five individuals surveyed near Gurra Gurra Lakes, one was in poor health, one in good and the remaining three in moderate condition. In the northern part of the floodplain *Eucalyptus camaldulensis* var. *camaldulensis* tree health also varied from poor to good, with the majority of individuals found to be in moderate health (Figure 3). An exception to this was observed in the area subjected to freshwater influx due to an irrigation flush drain. In this location tree health was found to be either good or excellent (Figure 3).

Eucalyptus largiflorens tree health was variable across the floodplain (Figure 4). The majority of individuals were in poor to moderate health with individuals along the southern part of the floodplain exhibiting the greatest signs of stress (Figure 4). In general, *Eucalyptus largiflorens* individuals closest to the hypersaline water bodies were in poor health (Figure 4). It was also noted that dead *Eucalyptus largiflorens* trees lined the riparian zone of this area. As was observed for *Eucalyptus camaldulensis* var. *camaldulensis* trees, *Eucalyptus largiflorens* individuals adjacent to the drain were in good health (Figure 4).

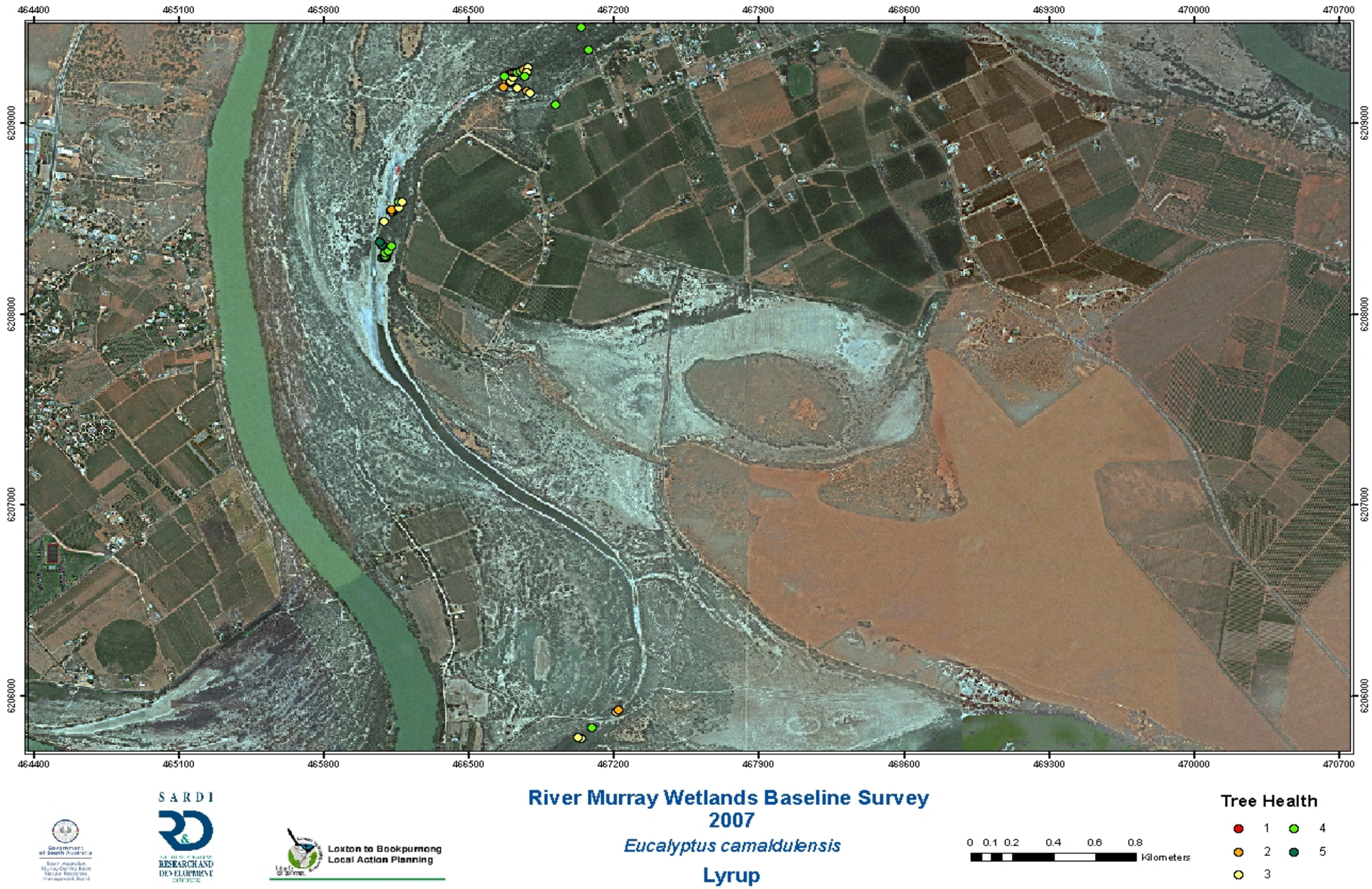

Figure 3: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Lyrup Forest.

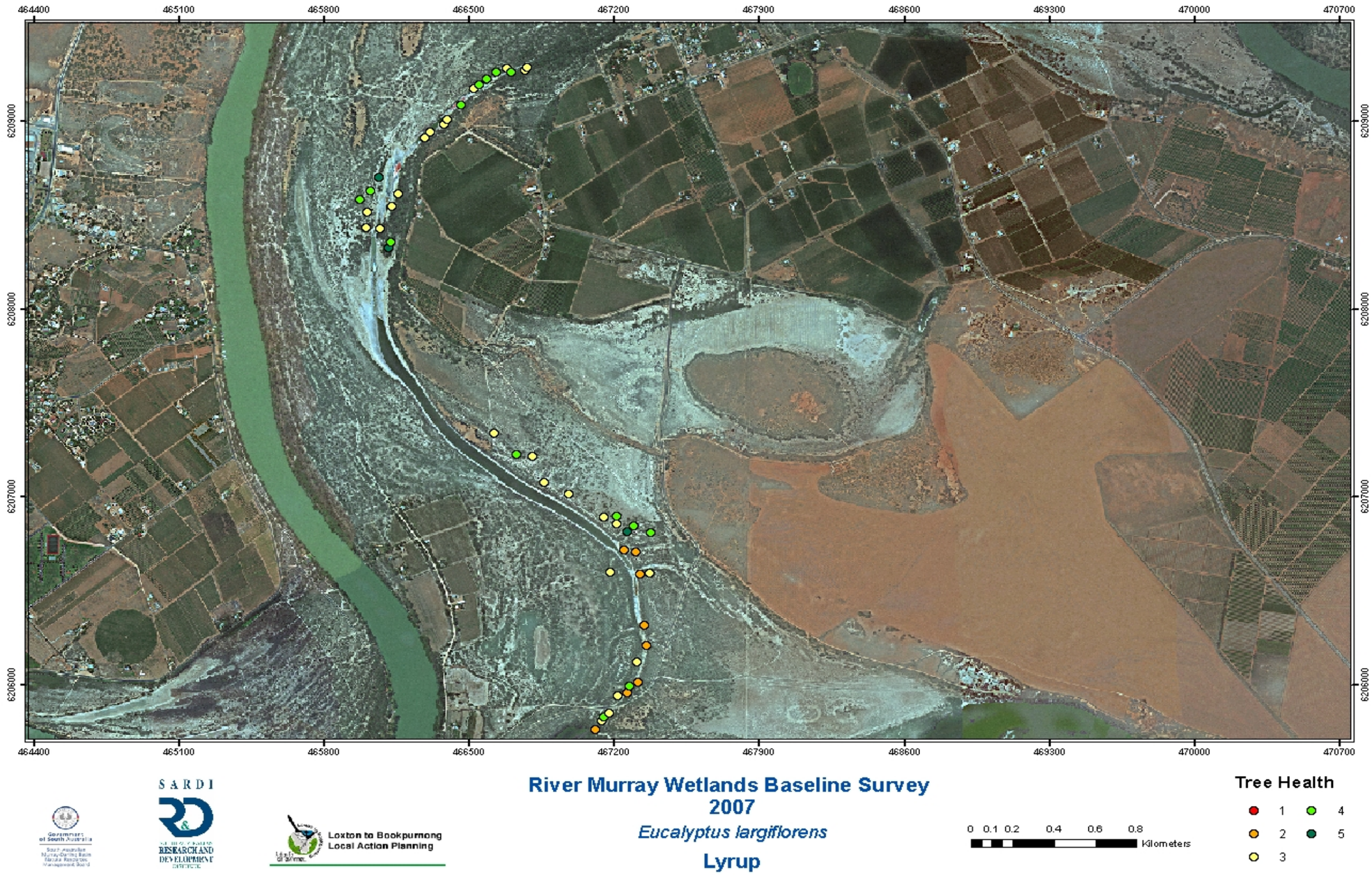

Figure 4: Map of *Eucalyptus largiflorens* tree health at Lyrup Forest.

Implications of the data

The floodplain and riparian zones of Lyrup Forest were sparsely vegetated with native species and bare soil and salt scald dominated the dry creek beds and riparian zones. Poor health of *Eucalyptus largiflorens* in the survey area was also evident. Both past and current land usage and salinisation of the soil in the survey area seems to have heavily impacted the species present at this location. Grazing by domestic stock has ceased in most of Lyrup Forest (except the western part of the floodplain); however, grazing by native and feral animals continues. Consequently the understorey vegetation in the western region was more sparse and depauperate to the adjacent areas of floodplain. The floodplain needs to be protected from increased degradation to prevent further salinisation of the soil and consequent loss of species.

Similar to most wetland systems in this region, the lack of flooding in the past 10 years has led to a significant decline in tree health and overall floodplain condition (areas of the floodplain show evidence of soil salinisation). Evaporation of the remnant pools is increasing the salinity in these already hypersaline water bodies. An over bank flood is required to lower salinity levels in the lagoon and floodplain soil, and promote germination and growth of floodplain species. High river flows may also result in an improvement in tree health and floodplain condition; however, this is dependent on flows from upstream reaching the South Australian section of the River Murray. Weir pool manipulations may result in localised improvement in tree health and floodplain condition; however, the potential salinity impacts to the River Murray and Gurra Gurra Lakes must be considered.

3.5. Wongulla Lagoon

A total of 74 species were observed in the survey area including 26 exotics (Table 4).

Due to low water levels below Lock 1, Wongulla Lagoon was partially full when surveyed. The inundated area was devoid of submerged aquatic vegetation; however, remnants of *Myriophyllum verucossum* were observed along the shoreline (Figure 5). During the survey the drying lagoon bed and the main inlet channel, both in the north of the lagoon, were dominated by *Juncus usitatus* (Figure 5). Dense stands of *Phragmites australis,* with scattered *Typha* spp. dominated riparian edges of the smaller inlet channel (Figure 5). The riparian zone of the main lagoon was dominated by stands of *Phragmites australis,* with scattered *Typha* spp. and *Schoenoplectus validus*.

The area of floodplain between the lagoon and River Murray was dominated by *Muehlenbeckia florulenta* shrubland, with sparse *Pachycornia triandra/Carpobrutus* sp. shrubland at higher elevations (Figure 5). A thin strip of floodplain close to the lagoon and main inlet channel was dominated by *Eucalyptus camaldulensis* var. *camaldulensis* woodland with a dense *Muehlenbeckia florulenta* understorey (Figure 5). The area adjacent to the smaller inlet channel was characterised by open *Eucalyptus camaldulensis* var. *camaldulensis/Eucalyptus largiflorens* woodland with a sparse *Sclerolaena* sp./*Atriplex* spp. understorey (Figure 5). On the opposite side of the lagoon, the floodplain was dominated by open *Eucalyptus largiflorens* woodland with a sparse *Muehlenbeckia florulenta/Sclerolaena* spp. understorey. Some areas of the floodplain and riparian zone along the southern section of this side of the lagoon had salt-scald and were devoid of vegetation.

Surveyed quadrats

Six different vegetation associations were quantitatively surveyed (Table 4):

1) *Typha* sp. sedgeland along the edge of the northern side of the lagoon
2) *Phragmites australis* sedgeland along the edge of the small inlet
3) *Juncus usitatus/Limosella australis* sedgeland along the northern edge of the Lagoon
4) *Juncus usitatus* sedgeland along the southern edge of the Lagoon
5) *Juncus usitatus* sedgeland mid way along the southern edge of the Lagoon
6) *Phragmites australis/Schoenoplectus validus* sedgeland in the small northern inlet

Table 4: Species list for Wongulla Lagoon and vegetation association where they were present (includes opportunistic observations not surveyed in quadrats) (*denotes exotic species).

Species	Common name	Association number					
		1	2	3	4	5	6
Acacia stenophylla	River cooba						
Agrostis avenacea	Common blown-grass		x	x			
Asperula gemenifolia	Twin-leaf bedstraw						
*Asphodelus fistulosus**	Onion weed						
*Aster subulatus**	Aster weed		x				
Atriplex nummularia	Creeping saltbush						
Atriplex paludosa	Marsh saltbush						
Atriplex prostrata	Creeping saltbush						
Atriplex stipitata	Bitter saltbush						
Bolboschoenus caldwellii	Club rush	x		x			
*Bromus rubens**	Red brome						
Carpobrutus sp.	Angular pigface						
Centaurea sp.*	Thistle		x				
*Chenopodium glaucum**	Glaucous goosefoot						
Chenopodium pumilio	Small crumbweed						
Chenopodium sp.	Foetid goosefoot						
*Conyza bonariensis**	Flax-leaf fleabane						
Craspedia uniflora	Common billy-buttons						
*Cucumis myriocarpus**	Paddy melon						
Cyperus gymnocaulos	Spiny flat-sedge						
*Echinochloa crus-galli**	Barnyard grass						
*Echium plantagineum**	Salvation Jane						
Eleocharis acuta	Common spike-rush						
Enchylaena tomentosa	Ruby saltbush						
Eremophila divaricata	Spreading emubush						

Species	Common name	Association number					
		1	2	3	4	5	6
Eucalyptus camaldulensis	River red gum						
Eucalyptus largiflorens	Black box						
*Euphorbia terracina**	False caper						
Halosarcia pergranulata ssp. *pergranulata*	Black-seed samphire		x				
*Heliotropium curassavicum**	Smooth heliotrope						
*Heliotropium europaeum**	Common heliotrope		x				
*Hypochaeris glabra**	Smooth cat's-ear						
*Hypochaeris radicata**	Flatweed						
Juncus usitatus	Common rush	x		x	x	x	
*Lactuca serriola**	Prickly lettuce		x				
Limosella australis	Australian mudwort	x		x	x	x	
Ludwigia peploides ssp. *montevidensis*	Water primrose						x
Lycopus australis	Australian gypsywort						
Maireana microcarpa	Swamp bluebush						
Melaleuca halmaturorum	Swamp paper-bark						
*Melilotus indica**	Bokhara clover						
Mimulus repens	Creeping monkey-flower						
Morgania floribunda	Blue rod						
Muehlenbeckia florulenta	Lignum						
Myoporum montanum	Boobialla						
Myriophyllum verrucosum	Red milfoil						
Opuntia sp.*	Prickly pear						
Pachycornia triandra	Desert glasswort						
Paspalum distichum	Water couch					x	
Persicaria decipiens	Slender knotweed		x		x		
Persicaria lapathifolium	Pale knotweed	x		x	x	x	
Phragmites australis	Common reed		x				x
*Phyla canescens**	Lippia						
Picris hieracioides var. *hieracioides**	Ox-tongue						
Polygonum plebeium	Small knotweed						
*Polypogon monspeliensis**	Annual beardgrass						
Psuedognaphalium luteo-album	Jersey cudweed		x				
*Reichardia tingitana**	False sow thistle						
Rorippa islandica	Marsh watercress						
*Salix babylonica**	Weeping willow						
Schoenoplectus validus	River club-rush	x					x
Scleroblitum atriplicinum	Purple goosefoot						
Sclerolaena blackiana	Black's copperburr						
Sclerolaena brachyptera	Short-winged copperburr						
Sclerolaena divaricata	Tangled bindy						
Senecio sp.	Groundsel						

Species	Common name	Association number					
		1	2	3	4	5	6
Senna artemisiodes ssp. *filiofolia*	Punty bush						
*Sinapis alba**	White mustard						
*Sisymbrium erysimoides**	Smooth mustard						
*Sonchus oleraceus**	Common sow thistle						
Sporobolus mitchelli	Rat-tail couch						
Triglochin procerum	Water ribbons						
Typha spp.	Bulrush/Cumbungi	x		x	x		x
*Urtica urens**	Stinging nettle						
Vittadinia sp.	Fuzzweed						
Wahlenbergia fluminalis	River bluebell						

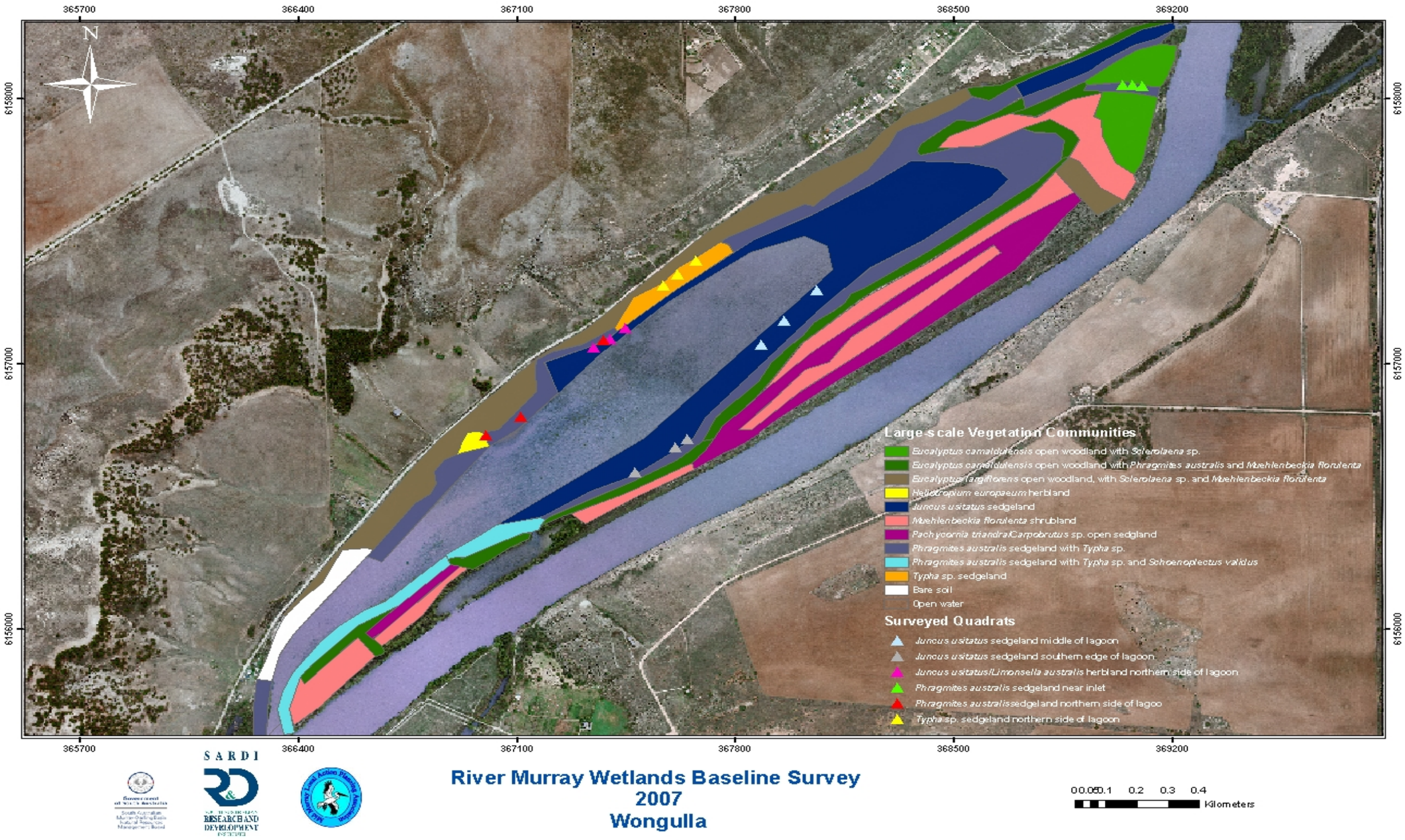

Figure 5: Vegetation map of Wongulla showing the quantitatively surveyed quadrats and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was variable across the floodplain (Figure 6). The majority of trees were in good health; however, along the southern lagoon edge some individuals were in moderate health (Figure 6).

Eucalyptus largiflorens tree health was also variable across the floodplain (Figure 7). The majority of individuals were in moderate to good health along the northern and southern edges of the floodplain; however, the individuals on the north eastern corner were in poor to moderate health (Figure 7).

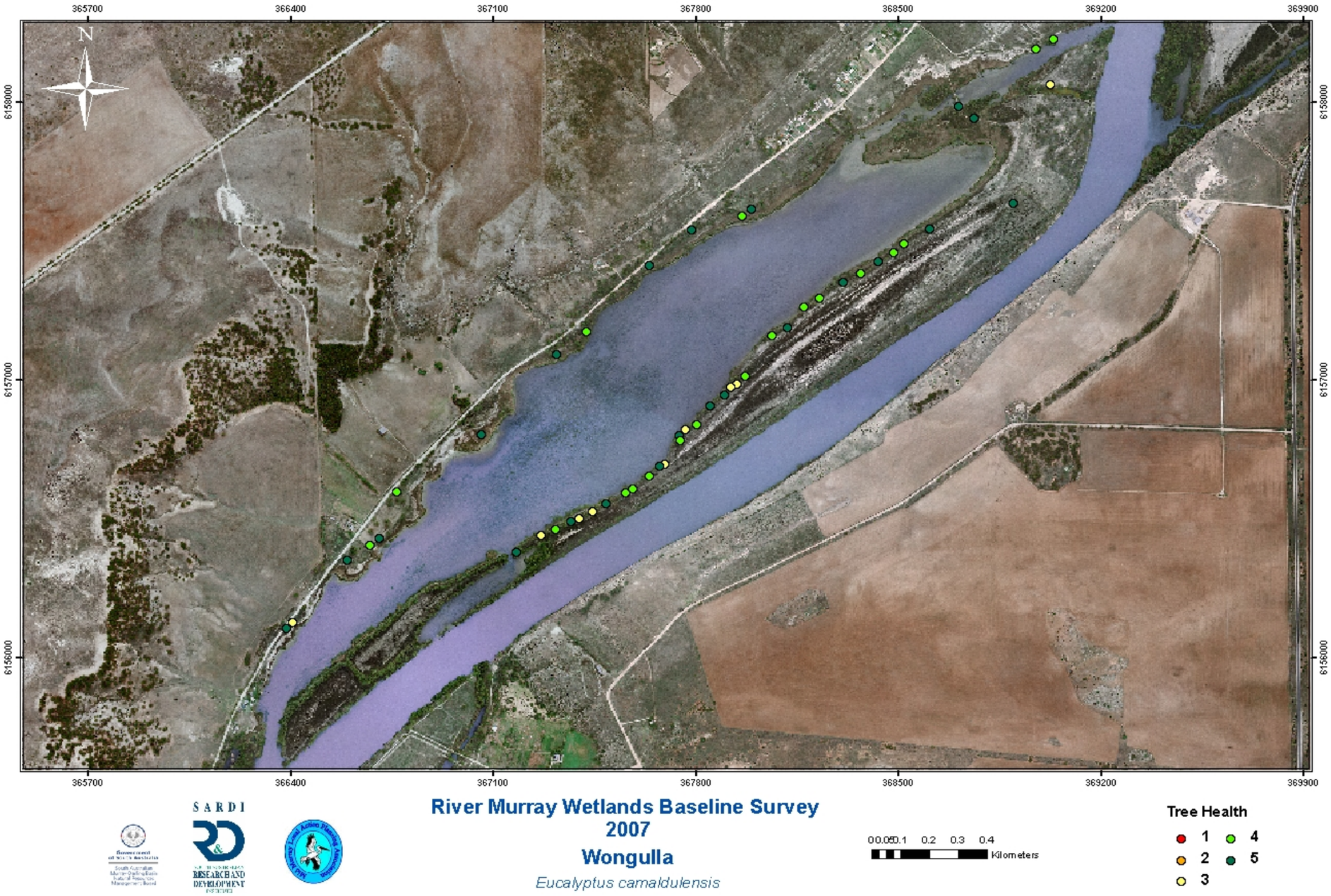

Figure 6: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Wongulla.

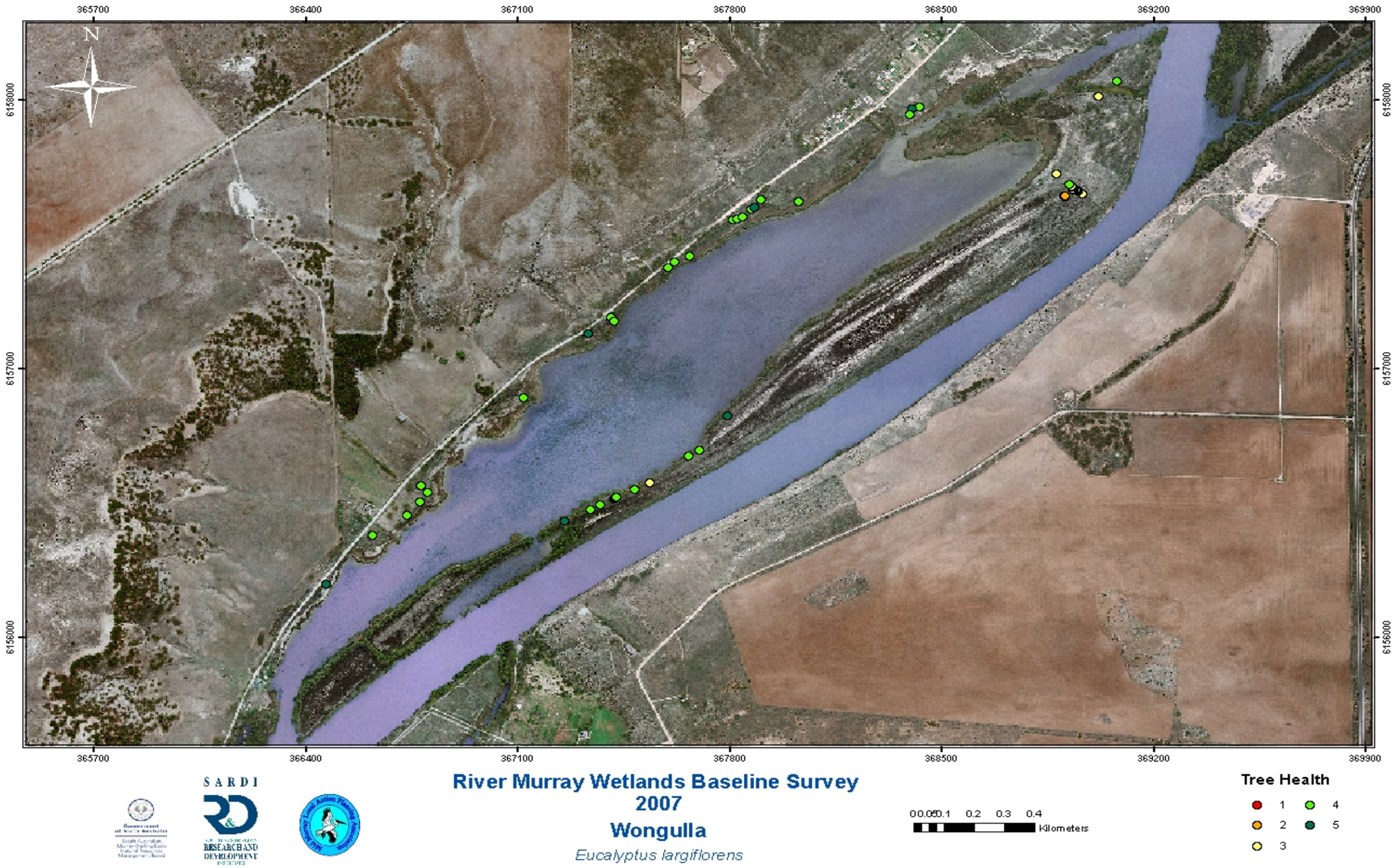

Figure 7: Map of *Eucalyptus largiflorens* tree health at Wongulla.

Implications of the data

Wongulla wetland had the greatest species richness of the three wetlands surveyed (73 species). The riparian areas of the wetland were generally well vegetated with native species and in good condition; however, in the exposed banks along the northern side of the lagoon, a high number of exotic species were present (*Heliotropium europaeum, Heliotropium curassavicum, Aster subulatus, Lactuca saligna* and *Centaurea* sp.). The number of exotic species was significantly higher in this area and the northern corner of the floodplain and it is likely that the current land usage (specifically shacks) has caused the proliferation of exotic species. Active removal of exotic species is required in such areas to prevent further proliferation of exotics and a subsequent decline in native species.

The large lagoon was devoid of aquatic vegetation (except for a small amount of *Myriophyllum verrucosum*), it is unclear why a large shallow lagoon does not support a diverse submergent vegetation community.

The vegetation on the majority of the floodplain was sparse and depauperate. Conversely, most trees (*Eucalyptus camaldulensis* and *Eucalyptus largiflorens)* were found to be in good health across the floodplain. Nevertheless, it is likely that some areas of the floodplain have become salinised as was evident by a sparse understorey, the dominance of salt tolerant species (*Pachycornia triandra* and *Carpobrutus* sp.), bare soil and salt scalds.

Similar to most floodplains in this region, the lack of flooding in the past 10 years has led to a significant decline in tree health and overall floodplain condition (areas of the floodplain show evidence of soil salinisation). High river flows may result in an improvement in tree health and floodplain condition; however, this is dependent on flows from upstream reaching the South Australian section of the River Murray.

3.6. Caurnamont

A total of 67 species were observed in the survey area including 28 exotics (Table 5).

Due to low water levels below Lock 1, Caurnamont Lagoon was partially full when surveyed. The southern and northern sections of the larger lagoon were dry as was the southern area of the small lagoon (Figure 8). Submerged aquatic vegetation was not observed in the inundated areas of the lagoon; however, fragments of *Myriophyllum verrucosum* were noted along the western shoreline.

Stands of *Typha* spp. with scattered *Phragmites australis* and *Schoenoplectus validus* dominated the riparian edges of the lagoon (Figure 8). The drying lagoon bed along the edges of the larger part of the lagoon supported a *Persicaria lapathifolium* herbland with *Typha* spp., *Ranunculus sceleratus, Limosella australis, Lactuca saligna* and *Craspedia uniflora.* The dry creek bed that is separated from the main lagoon by a causeway was dominated by a *Heliotropium europaeum* herbland with exotic species including *Heliotropium curassivicum, Sonchus oleraceus* and *Chenopodium glaucum* (Figure 8).

An open *Muehlenbeckia florulenta* shrubland with sparse *Pachycornia triandra, Carpobrutus* sp., *Sclerolaena* spp. and *Atriplex* spp. understorey dominated the floodplain between the wetland and the River Murray and the northern section of the middle peninsula (Figure 8). In the northern part of the aforementioned areas of floodplain, open *Eucalyptus camaldulensis* var. *camaldulensis* woodland with *Phragmites australis* and *Muehlenbeckia florulenta* fringed the smaller section of lagoon (Figure 8). Further south, the middle peninsula was dominated by a sparse *Pachycornia triandra, Carpobrutus* sp., *Sclerolaena divaricata* low shrubland. The floodplain along the southern edge of the large lagoon was dominated by a sparse *Eucalyptus largiflorens* open woodland with *Muehlenbeckia florulenta, Sclerolaena* spp. and *Atriplex* spp. understorey; however, some locations along this edge were highly modified (e.g. mowed lawns, private land) consequently this portion of floodplain contained the highest proportion of exotic species (Figure 8).

It should also be noted that a stand of exotic species *Olea europaea* ssp. *europaea* (Common olive), *Schinus molle* (Pepper tree) and *Myrsiphyllum asparagoides* (Bridal creeper) were observed in the study area (Northing: 54729342, Easting: 6140401).

Four different vegetation associations were quantitatively surveyed (Table 5):

1) *Typha* spp. sedgeland along the northern edge of the lagoon
2) *Typha* spp. sedgeland along the southern edge of the lagoon
3) *Persicaria lapathifolium* herbland
4) *Heliotropium europaeum* herbland

Table 5: Species list for Caurnamont Lagoon and vegetation association where they were present (includes opportunistic observations not surveyed in quadrats) (*denotes exotic species).

Species	Common name	Association number			
		1	2	3	4
Acacia stenophylla	River cooba				
*Asphodelus fistulosus**	Onion weed				
Atriplex paludosa	Marsh saltbush				
Atriplex prostrata	Creeping saltbush	x			
Atriplex stipitata	Bitter saltbush				
Atriplex vesicaria	Bladder saltbush				
*Bromus rubens**	Red brome				
Carpobrutus sp.	Angular pigface				
Centaurea sp.*	Thistle				
Centipeda minima	Spreading sneeze weed				
*Chenopodium glaucum**	Glaucous goosefoot	x			x
Chenopodium sp.	Foetid goosefoot				
*Conyza bonariensis**	Flax-leaf fleabane				
Craspedia uniflora	Billy buttons			x	
Cyperus gymnocaulos	Spiny flat-sedge		x		
*Echium plantagineum**	Salvation Jane				
Enchylaena tomentosa	Ruby saltbush				
Eucalyptus camaldulensis var. *camaldulensis*	River red gum	x			
Eucalyptus largiflorens	Black box				
*Euphorbia terracina**	False caper				
*Heliotropium curassavicum**	Smooth heliotrope				
*Heliotropium europaeum**	Common heliotrope				x
Juncus usitatus	Common rush			x	
*Lactuca saligna**	Wild lettuce				
*Lactuca serriola**	Prickly lettuce				
Limosella australis	Australian mudwort			x	
Lolium sp.*	Ryegrass				
Ludwigia peploides	Water primrose				
Lythrum hyssopifolia	Hyssop loosestrife				
Maireana microcarpa	Swamp bluebush				
*Marrubium vulgare**	Horehound				
*Melilotus indica**	Bokhara clover		x		

Species	Common name	Association number			
		1	2	3	4
*Mesembryanthemum crystallinum**	Small ice-plant				
Mimulus repens	Creeping monkey-flower			x	x
Mollugo cerviana	Wire-stem chickweed				
Morgania floribunda	Blue rod				
Muehlenbeckia florulenta	Lignum				
Myoporum montanum	Boobialla				
Myriocephalus stuartii	Poached-egg daisy				
*Myrsiphyllum asparagoides**	Bridal creeper				
Olea europaea ssp. *europaea**	Common olive				
Opuntia sp.*	Prickly pear				
Pachycornia triandra	Desert glasswort				
Persicaria decipiens	Slender knotweed	x		x	
Persicaria lapathifolium	Pale knotweed	x	x	x	
*Phalaris paradoxa**	Paradoxa grass				
Phragmites australis	Common reed				
Picris hieracioides var. *hieracioides**	Ox-tongue				
Pimelea glauca	Smooth rice flower				
*Polypogon monspeliensis**	Annual beardgrass				
Psuedognaphalium luteo-album	Jersey cudweed				
*Ranunculus sceleratus**	Celery buttercup		x	x	
*Reichardia tingitana**	False sow thistle				
*Schinus molle**	Pepper tree				
Schoenoplectus validus	River club-rush				
Sclerolaena blackiana	Black's copperburr				
Sclerolaena brachyptera	Short-winged copperburr				
Sclerolaena divaricata	Tangled bindy				
Senecio cunninghamii	Bushy groundsel				
*Sinapis alba**	White mustard				
*Sonchus oleraceus**	Common sow thistle	x			
Sporobolus mitchelli	Rat-tail couch				
Swainsona swainsonoides	Darling pea				
Typha spp.	Bulrush/Cumbungi	x	x	x	
Unknown citrus*					
*Vicia sativa**	Vetch				
Wahlenbergia fluminalis	River bluebell				

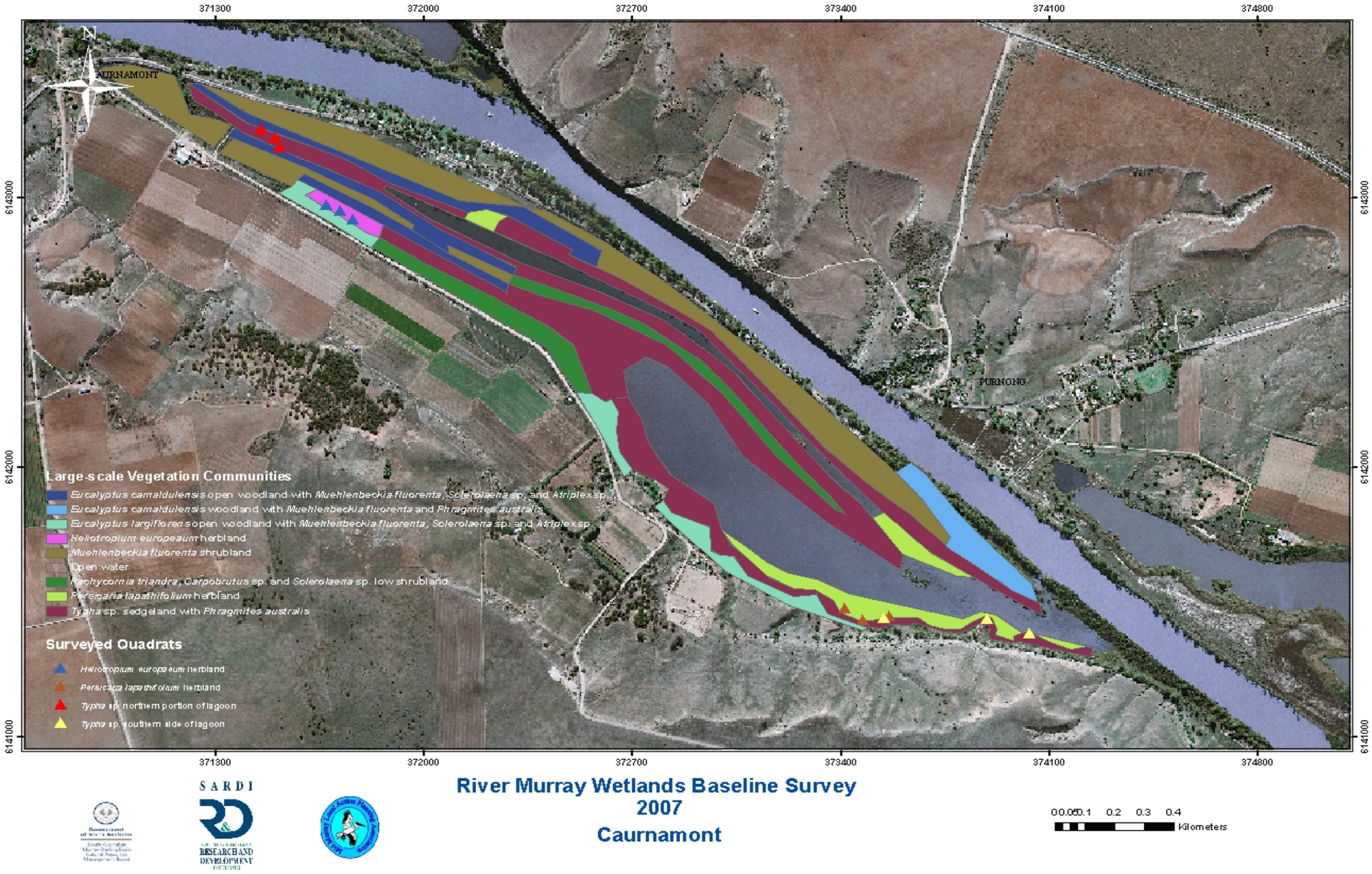

Figure 8: Vegetation map of Caurnamont showing the quantitatively surveyed quadrats and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health varied from good to poor across the floodplain (Figure 9). Trees on the northern corner of the floodplain and along the southern edge were in good to moderate health (Figure 9). However, individuals along the middle peninsula and northeastern edge of the floodplain had been recently burnt and exhibited signs of stress (very poor to moderate health) (Figure 9).

Eucalyptus largiflorens distribution was restricted to the southern end of the floodplain, with a few scattered individuals present on the middle peninsula (Figure 10). Individuals were in good health at the northern tip of this area (Figure 10). In the middle to southern area of the floodplain *Eucalyptus largiflorens* trees tended to be in moderate to good health, although a few individuals exhibited signs of stress (very poor to poor health) (Figure 10).

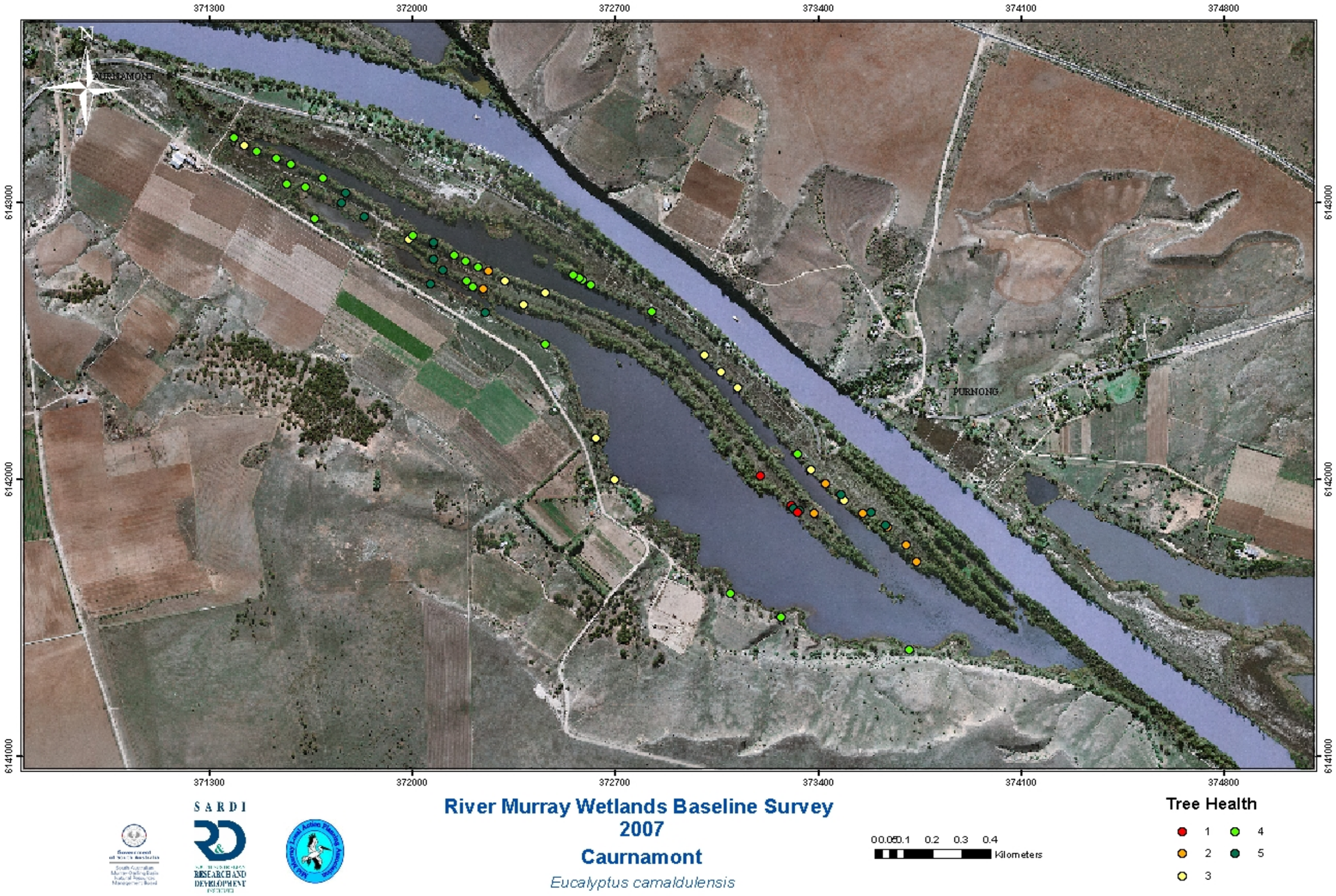

Figure 9: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Caurnamont.

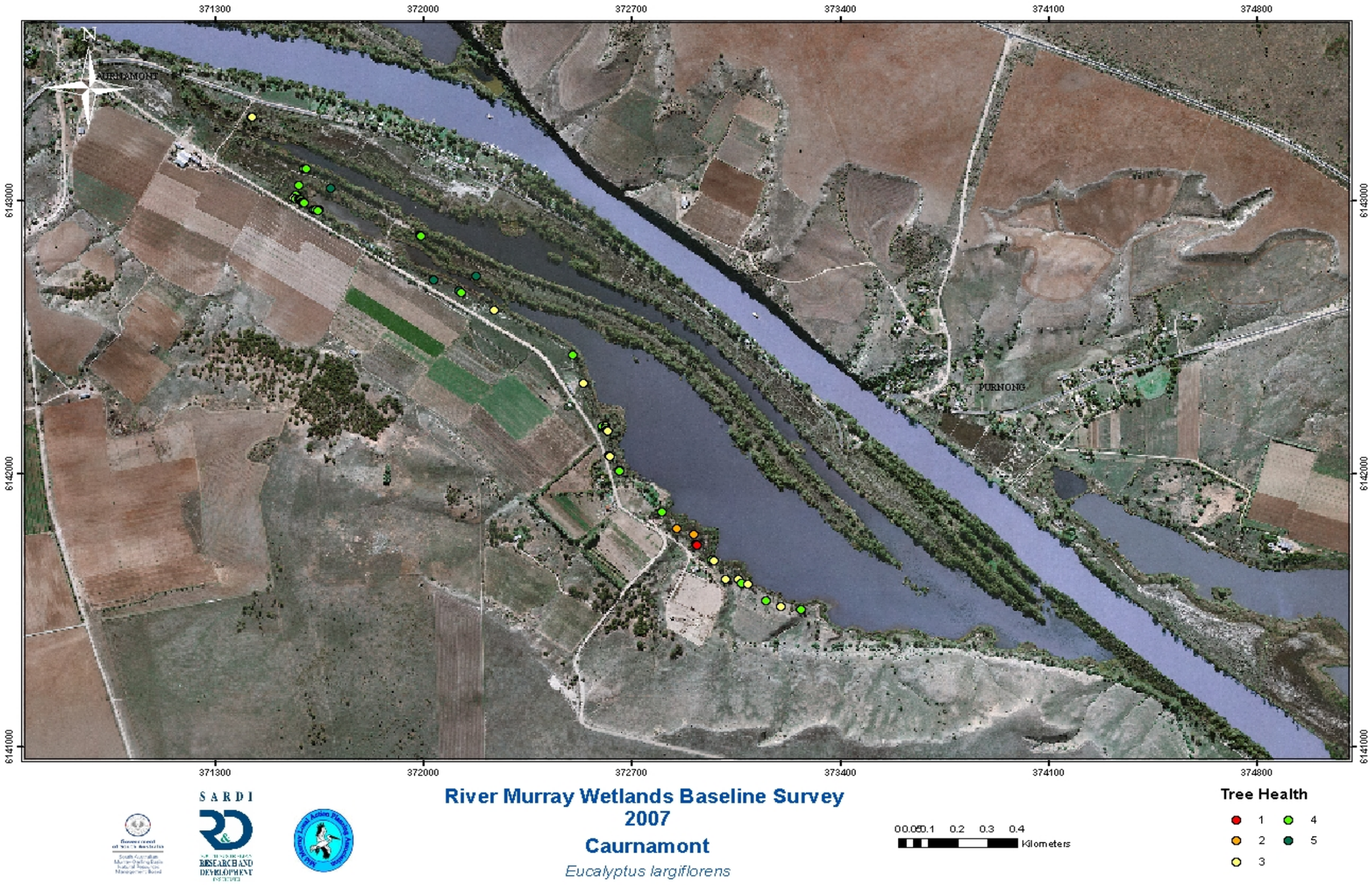

Figure 10: Map of *Eucalyptus largiflorens* tree health at Caurnamont.

Implications of the data

Caurnamont Lagoon was found to have the largest proportion of exotic species of the three wetlands surveyed (42%). The riparian areas of the wetland were generally well vegetated with native species and in good condition; however, the areas of the lagoon bed that were dry, or drying, supported a high number of exotic species (*Heliotropium europaeum, Heliotropium curassavicum, Melilotus indica* and *Sonchus oleraceus*). The number of exotic species was higher in the southern portion of the floodplain; therefore, it is likely that the current land usage (specifically human habitation) has caused the proliferation of exotic species in the survey area. Active removal of exotic species is required in the southern section of the floodplain to prevent further proliferation of exotics and a subsequent decline in native species.

The large lagoon was devoid of aquatic vegetation (except for a small amount of *Myriophyllum verrucosum*), it is unclear why a large shallow lagoon does not support a diverse submergent vegetation community.

Bare soil and areas sparsely dominated by salt-tolerant shrubs, suggests some areas of the floodplain, especially along the middle peninsula and between the lagoon and the River Murray, have become salinised. However, most trees were in good health, with the exception of those subjected to a recent fire, indicating that soil salinisation has not significantly affected the tree species on this floodplain.

Similar to most floodplains in this region, the lack of flooding in the past 10 years has led to a significant decline in tree health and overall floodplain condition. High river flows may result in an improvement in tree health and floodplain condition; however, this is dependent on flows from upstream reaching the South Australian section of the River Murray. Weir pool manipulations may result in localised improvement in tree health and floodplain condition.

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