2006 River Murray Wetlands Baseline Survey

Vegetation Component

Kelly Marsland and Jason Nicol

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Executive Summary

Baseline vegetation and tree health surveys were conducted at six wetlands along the South Australian River Murray (Lake Bonney RM, Pyap Lagoon, Big Toolunka Flat, Noonawirra, Devon Downs and Saltbush Flat). Quantitative vegetation surveys were undertaken in the permanently inundated areas and riparian zones of each wetland and a species list 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 108 species, including 35 exotics and two species listed as rare in South Australia (*Myoporum parvifolia* and *Myriophyllum papulosum*), were recorded in the wetlands surveyed. Devon Downs was the most species rich site with 59 species, and Big Toolunka the least species rich with 42. Noonawirra had the largest number of exotic species (22).

Tree health generally improved as distance downstream increased with larger numbers of stressed trees present in the Riverland wetlands than the Murray Gorge wetlands. *Eucalyptus largiflorens* trees showed less 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 six wetlands selected for the 2006 River Murray Wetlands Baseline Survey; Lake Bonney RM, Pyap Lagoon, Big Toolunka Flat, Noonawirra, Devon Downs and Saltbush Flat.

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 and were identical to those used for the 2005 River Murray Wetlands Baseline Survey (Nicol *et al.* 2006):

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

2.1. Quantitative Vegetation Surveys

Quantitative vegetation surveys were undertaken in areas 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 edges). 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. *Typha* spp. sedgelands and *Phragmites australis* grasslands in Big Toolunka Flat and Pyap Lagoon), the association was split into two or more associations and surveyed accordingly to give the quantitative survey a 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, which captured at least 95% of the species present in an association and enabled narrow riparian zones to be surveyed.

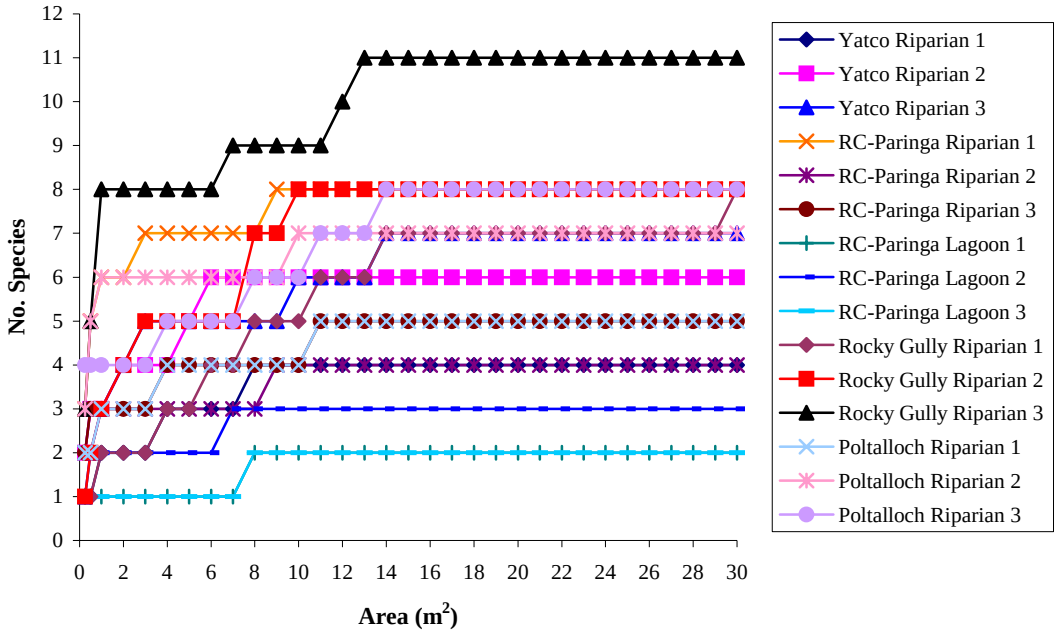

Figure 1: Species area curves for Yatco Lagoon, Reedy Creek-Paringa, Poltalloch and Rocky Gully Wetlands (from Nicol *et al.* 2006).

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 so statistics may 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; therefore, any species encountered in the survey area (to the 1956 flood level) 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 much 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 Jessop (1993). The terminology used to describe different vegetation associations (e.g. herbland, shrubland, woodland, grassland) follows that of the 2004 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 by Tucker *et al.* (2003) (Table 2).

Table 2: Tree health scale for *Eucalyptus camaldulensis* var. *camaldulensis* and *Eucalyptus largiflorens* (from 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 (if <50 trees were present in the survey area all trees were assessed) were 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 108 species (surveyed quadrats and opportunistic observations) were recorded across all sites, including 35 exotics and two species listed as rare in South Australia (*Myoporum parvifolia* and *Myriophyllum papulosum*). Devon Downs was the most species rich site with 59 species and Big Toolunka the least species rich with 42. Noonawirra had the largest number of exotic species (22).

Tree health generally improved as distance downstream increased with larger numbers of stressed trees present in the Riverland wetlands than the Murray Gorge wetlands. *Eucalyptus largiflorens* trees showed less signs of stress than *Eucalyptus camaldulensis* var. *camaldulensis*. The wetland with the largest number of healthy *Eucalyptus camaldulensis* var. *camaldulensis* trees present was Noonawirra.

3.2. Riverland Wetlands

Two wetlands in the Riverland (Lake Bonney and Pyap Lagoon) were surveyed and a total of 70 species, including 20 exotics and one species listed as rare in South Australia (*Myoporum parvifolia*) were recorded.

The permanently inundated areas in each wetland were very different: dense beds of submergent species (*Potamogeton crispus, Myriophyllum verucossum* and *Vallisneria spiralis*) were present in Pyap Lagoon and Lake Bonney was generally devoid of submergent species except for a few small isolated patches. The edges of the wetlands were also very different: dense stands of emergent species (*Typha* spp. and *Phragmites australis*) fringed most of Pyap Lagoon and Lake Bonney was almost devoid of fringing emergent species with the exception of the south-western shore and around the inlet creek.

The remaining floodplain of each wetland however, was similar: *Eucalyptus camaldulensis* var. *camaldulensis* health was generally poor and *E. largiflorens* health, whilst generally better than *Eucalyptus camaldulensis* var. *camaldulensis,* was also poor. The understorey was either bare or dominated by salt tolerant species such as *Halosarcia pergranulata* ssp. *pergranulata, Carpobrutus rossii* and *Pachycornia triandra.*

3.3. Murray Gorge Wetlands

Four wetlands in the Murray Gorge (Big Toolunka, Noonawirra, Devon Downs and Saltbush Flat) were surveyed and a total of 106 species, including 35 exotics and one species listed as rare in South Australia (*Myriophyllum papulosum*) were recorded.

The permanently inundated areas of the wetlands (except Saltbush Flat, which was generally devoid of submergent vegetation) were densely vegetated with submergent species (mainly *Vallisneria spiralis*). Extensive stands of *Typha* spp. and *Phragmites australis* fringed most the permanently inundated areas.

The floodplain surrounding the wetlands differed between sites: tree health generally improved as distance downstream increased, although the largest numbers of healthy *Eucalyptus camaldulensis* var. *camaldulensis* trees were observed at Noonawirra. No *Eucalyptus largiflorens* were observed in the study area at Noonawirra, but at the other sites individuals of this species were generally healthier than *Eucalyptus camaldulensis* var. *camaldulensis*. The floodplain at Big Toolunka was dominated by *Eucalyptus largiflorens* and *Eucalyptus camaldulensis* var. *camaldulensis* open woodlands with chenopod shrub understorey, *Muehlenbeckia florulenta* closed shrublands and salt tolerant species. At Noonawirra the main floodplain community was *Eucalyptus camaldulensis* var. *camaldulensis* open woodland with an understorey of mainly exotic species. At Devon Downs and Saltbush Flat the main communities present on the floodplain were *Eucalyptus largiflorens* and *Eucalyptus camaldulensis* var. *camaldulensis* open woodlands with chenopod shrub understorey and *Muehlenbeckia florulenta* closed shrublands.

3.4. Lake Bonney RM

A total of 46 species were observed in the survey area including 13 exotics and one rare species (Table 3).

The floodplain surrounding Lake Bonney was highly modified and dominated by *Eucalyptus camaldulensis* var. *camaldulensis/Eucalyptus largiflorens* open woodland over a sparse grassy understorey (mainly *Paspalum distichum* and terrestrial weeds) (Figure 2). The understorey was also scattered with open chenopod shrubland dominated by *Atriplex* sp., *Enchylaena tomentosa* and *Maireana microcarpa,* particularly along the western side of Lake Bonney (Figure 2). The riparian edge around the lake was also significantly altered, with the most common species being *Paspalum distichum* and *Halosarcia pergranulata* ssp. *pergranulata* interspersed with terrestrial weeds including *Aster subulatus, Lactuca saligna, Lactuca serriola, Asphodelus fistulosus* and *Mesembryanthemum crystallinum* (Figure 2).

The inundated area of the lake was devoid of submerged aquatic vegetation with the exception of a small bay on the western shore (pelican point) where fragments of *Lepilaena australis* were observed. As no direct evidence was found, *Lepilaena australis* has been omitted from the species list (Figure 2). In this location, there was also evidence of the charophytes *Nitella* sp. and *Chara* sp. (Figure 2).

Surveyed quadrats

Twelve different vegetation associations were quantitatively surveyed (Table 3):

1) *Phragmites australis* sedgeland along the edge of the northern part of the lake
2) *Paspalum distichum* grassland along the edge of the northern part of the lake
3) *Phragmites australis* sedgeland along the edge of the eastern part of the lake
4) *Phragmites australis* sedgeland along the edge of the southern part of the lake
5) *Paspalum distichum* grassland along the edge of the southern part of the lake
6) *Phragmites australis* sedgeland along the edge of the western part of the lake
7) *Typha* spp. sedgeland along the edge of the western part of the lake
8) *Paspalum distichum* grassland along the edge of the western part of the lake
9) *Paspalum distichum* grassland along the edge of the lake, northeast of Barmera
10) *Typha* spp. sedgeland along the edge of the lake, northeast of Barmera
11) *Paspalum distichum* grassland along the edge of the lake, west of Barmera
12) *Phragmites australis* sedgeland along the edge of the lake, west of Barmera

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

Species	Common name	Association number											
		1	2	3	4	5	6	7	8	9	10	11	12
Acacia stenophylla	River Cooba												
*Asphodelus fistulosus**	Onion Weed									x			
*Aster subulatus**	Aster Weed			x		x			x			x	x
Atriplex nummularia	Old Man Saltbush												
Atriplex prostrata	Creeping Saltbush												
Atriplex sp.	Saltbush												
Atriplex vesicaria	Bitter Saltbush												
Azolla filiculoides	Pacific Azolla												
*Bromus diandrus**	Great Brome												
*Bromus rubens**	Red Brome												
Carpobrotus rossii	Angular Pigface												
Chara sp.	Skunkweed												
Cyperus gymnocaulos	Spiny Flat-sedge												
Unidentified Daisy 1													
Dodonaea attenuata	Narrow-leaf Hopbush												
Enchylaena tomentosa	Ruby Saltbush												
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum	x											
Eucalyptus largiflorens	River Black Box												
*Euphorbia terracina**	False Caper												
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire		x			x	x			x		x	
*Heliotropium curassavicum**	Smooth Heliotrope												
*Lactuca saligna**	Wild Lettuce					x			x			x	
*Lactuca serriola**	Prickly Lettuce		x			x			x	x		x	
Ludwigia peploides ssp. *montevidensis*	Water Primrose												
*Lycium ferocissimum**	Spiny Box-thorn												
Maireana macrocarpa	Swamp Bluebush												
Medicago sp.	Medic		x							x			
*Mesembryanthemum crystallinum**	Common Iceplant									x			
Muehlenbeckia florulenta	Lignum												
Myoporum parvifolia[#]	Creeping Boobialla												
Myriocephalus stuartii	Poached-egg Daisy												
Myriophyllum verrucosum	Red Milfoil												
Nitella sp.	Stonewort												

Species	Common name	Association number											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Pachycornia triandra	Desert Glasswort												
Paspalum distichum	Water-couch	x	x	x	x	x	x		x	x		x	x
*Pennisetum clandestinum**	Kikuyu Grass												
Phragmites australis	Common Reed	x	x	x	x		x			x	x		x
*Picris hieracioides**	Ox-tongue											x	
Potamogeton crispus	Curly Pondweed												
Schoenoplectus validus	River Club-rush												
Sclerolaena divaricata	Tangled Bindy												
*Sonchus oleraceus**	False Sow Thistle					x				x			
Sporobolus mitchellii	Rat-tail Couch												
Tetragonia tetragonoides	New Zealand Spinach												
Typha sp.	Bulrush							x			x		
Vallisneria spiralis	Ribbon Weed												

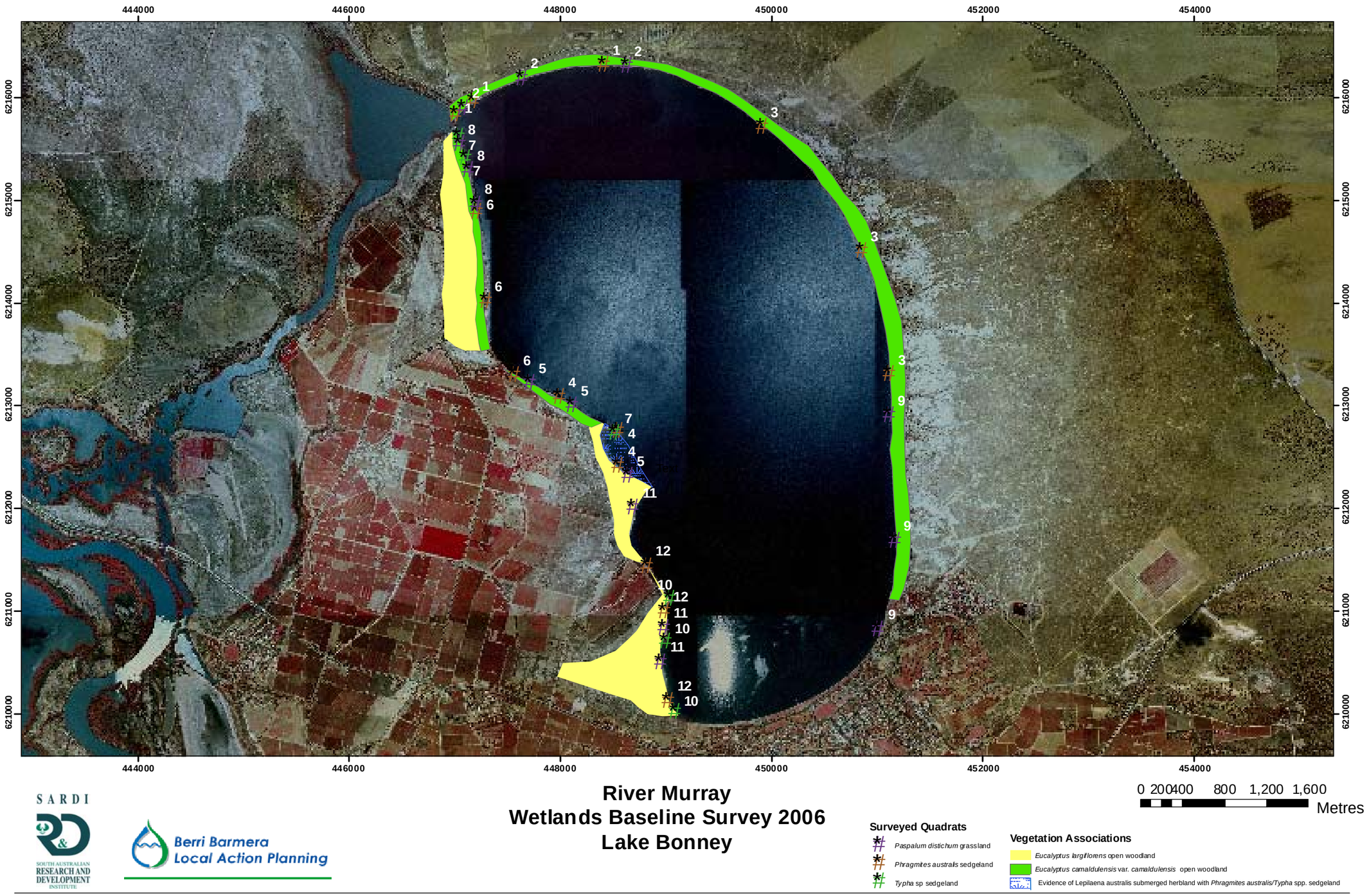

Figure 2: Vegetation map of Lake Bonney RM showing the quantitatively surveyed quadrats (numbers refer to associations in Table 3) and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was variable across the floodplain (Figure 3). The majority of trees were in moderate health but in some areas there were signs of decline (Figure 3). In particular, on the western shore many trees were found to be in very poor health or dead. Along the eastern floodplain most of the trees surveyed were in moderate to good health (Figure 3).

Eucalyptus largiflorens tree health was also variable across the floodplain (Figure 4). Although, in contrast to the pattern observed for *Eucalyptus camaldulensis* var. *camaldulensis,* the majority of individuals were in moderate to good health (Figure 4).

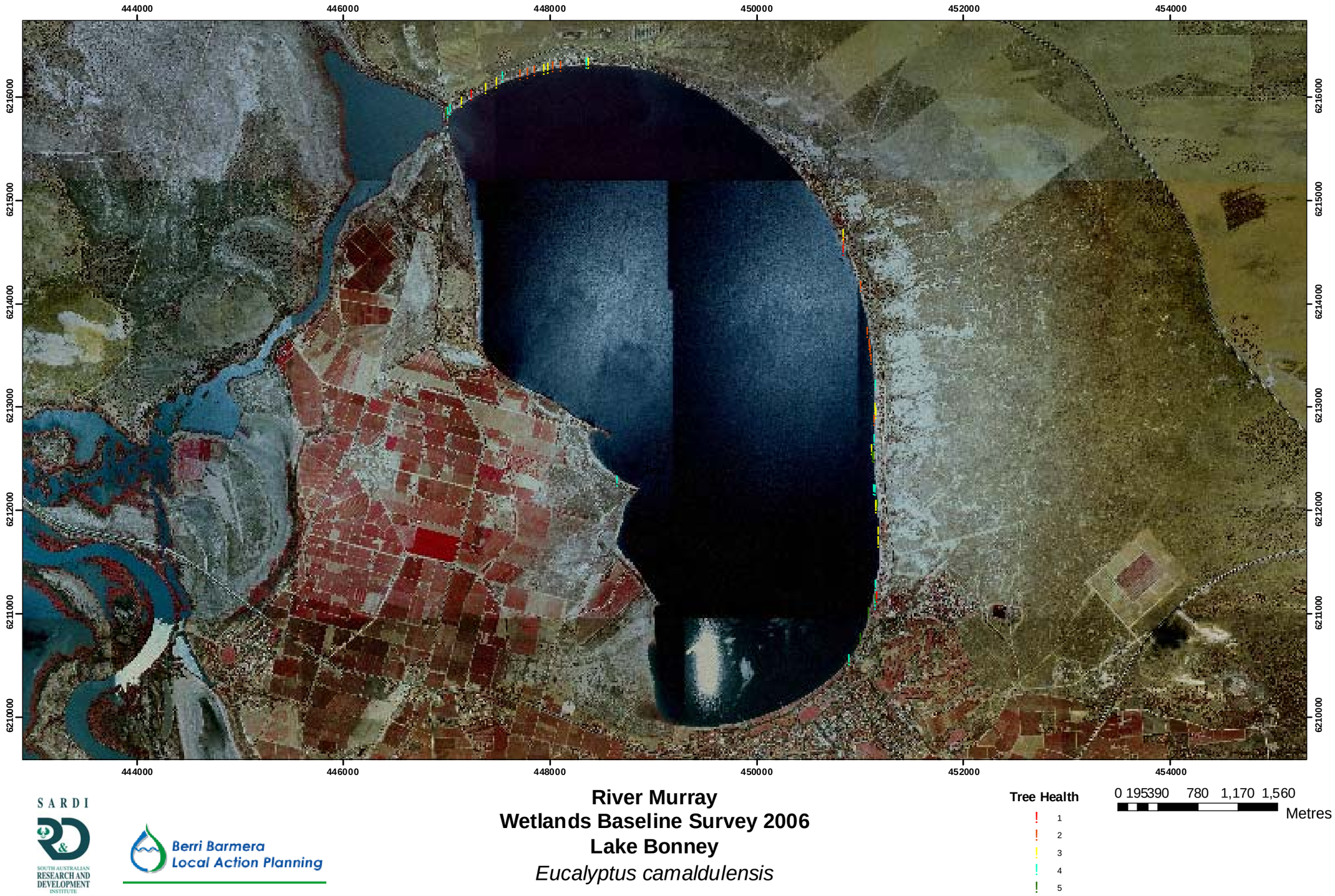

Figure 3: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Lake Bonney RM.

Figure 4: Map of *Eucalyptus largiflorens* tree health at Lake Bonney RM.

Implications of the data

The inundated and riparian areas of the wetland were generally poorly vegetated with native species. The current land usage in the survey area seems to have heavily impacted the species present at this location and encouraged the proliferation of invasive species. Bare soil and salt scalds were also observed throughout the floodplain. Therefore, the floodplain needs to be protected from further degradation.

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 (i.e. areas of the floodplain show evidence of soil salinisation). River regulation has also reduced the natural drying cycle of these systems, allowing the proliferation of exotic species. 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; however, this is not possible for the majority of the Lake Bonney floodplain because of the potential salinity impacts to the River Murray.

3.5. Pyap Lagoon

A total of 55 species were observed in the survey area (the permanent lagoon and adjacent floodplain, the pumped area was not surveyed) including 16 exotics (Table 4).

Pyap lagoon contained a diverse community of submergent species, including dense beds of *Potamogeton crispus* and *Vallisneria spiralis,* interspersed with *Potamogeton tricarinatus* and *Myriophyllum verrucosum* (Figure 5). The riparian edge of the main lagoon was dominated by alternating stands of *Phragmites australis* and *Typha* sp. along with more open areas characterised by grazed *Paspalum distichum* grasslands (Figure 5).

The remainder of the floodplain in the survey area was characterised by open *Eucalyptus camaldulensis* var. *camaldulensis* / *Eucalyptus largiflorens* woodland over *Muehlenbeckia florulenta* shrubland (Figure 5). Although in the south east of the floodplain, where salt scalds were observed, understorey species were absent (Figure 5).

Surveyed quadrats

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

1) Grazed riparian zone toward the end of Pyap Lagoon

2) *Vallisneria spiralis* submerged herbland toward the end of Pyap Lagoon

3) *Potamogeton crispus* submerged herbland toward the end of Pyap Lagoon

4) *Typha* spp. sedgeland toward the end of Pyap Lagoon

5) *Phragmites australis* sedgeland near the River Murray

6) *Vallisneria spiralis* submerged herbland in the middle of Pyap Lagoon

7) *Potamogeton crispus* submerged herbland near the River Murray

8) *Typha* spp. sedgeland mid-way along the edges of the lagoon

9) Grazed riparian grassland mid-way along the edges of the lagoon

Table 4: Species list for Pyap 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	7	8	9
Acacia stenophylla	River Cooba									
Agrostis avenacea	Common Blown-grass	x								
Alternanthera denticulata	Lesser Joyweed									x
*Asphodelus fistulosus**	Onion Weed									x
*Aster subulatus**	Aster Weed	x								x
Atriplex prostrata	Creeping Saltbush									
Azolla filiculoides	Pacific Azolla		x	x	x	x	x	x	x	
Bolboschoenus caldwellii	Salt Club-rush									
Carpobrotus rossii	Angular Pigface									
Centaurea sp.*	Thistle	x								x
Chenopodium pumilio	Small Crumbweed									
*Conyza bonariensis**	Flax-leaf Fleabane									x
Cotula coronopifolia	Water Buttons	x								
Craspedia chrysantha	Billybuttons	x								x
Cyperus exaltatus	Giant Sedge					x				
Cyperus gymnocaulos	Spiny Flat-sedge	x								x
Unidentified Daisy 1										
Unidentified Daisy 2										
Enchylaena tomentosa	Ruby Saltbush									
Eremophila scoparia	Emu Bush									
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum									
Eucalyptus largiflorens	River Black Box									
*Euphorbia terracina**	False Caper									
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire									
*Heliotropium curassavicum**	Smooth Heliotrope	x								
*Hypochaeris glabra**	Smooth Cat's-ear	x								x
Juncus usitatus	Common Rush	x								
*Lactuca saligna**	Wild Lettuce									x
*Lactuca serriola**	Prickly Lettuce	x								
Ludwigia peploides ssp. *montevidensis*	Water Primrose									
*Lycium ferocissimum**	Spiny Box-thorn									
Maireana macrocarpa	Swamp Bluebush									
Muehlenbeckia florulenta	Lignum	x								
Myriophyllum verrucosum	Red Milfoil		x	x	x		x	x		
Nitella sp.	Stonewort									
Osteocarpum acropterum var. *acropterum*	Water Weed									
Paspalum distichum	Water-couch	x				x				x
Phragmites australis	Common Reed	x				x				x

Species	Common name	Association number								
		1	2	3	4	5	6	7	8	9
*Phyla canescens**	Lippia									
*Picris hieracioides**	Ox-tongue									
*Polypogon monspeliensis**	Annual Beard-grass	x								x
Potamogeton crispus	Curly Pondweed		x	x	x	x	x	x	x	
Potamogeton tricarinatus	Sago Pondweed					x	x	x	x	
*Reichardia tingitana**	False Sow Thistle									x
*Salix babylonica**	Weeping Willow									
Schoenoplectus validus	River Club-rush									
Sclerolaena brachyptera	Bindy									
Sclerolaena divaricata	Tangled Bindy									
Senecio sp.	Groundsel									x
Sporobolus mitchellii	Rat-tail Couch									x
Trachymene cyanopetula	Purple Trachymene	x								x
Typha sp.	Bulrush	x			x				x	
Vallisneria spiralis	Ribbon Weed		x				x			
*Vicia sativa**	Vetch									x
Wahlenbergia fluminalis	River Bluebell									x

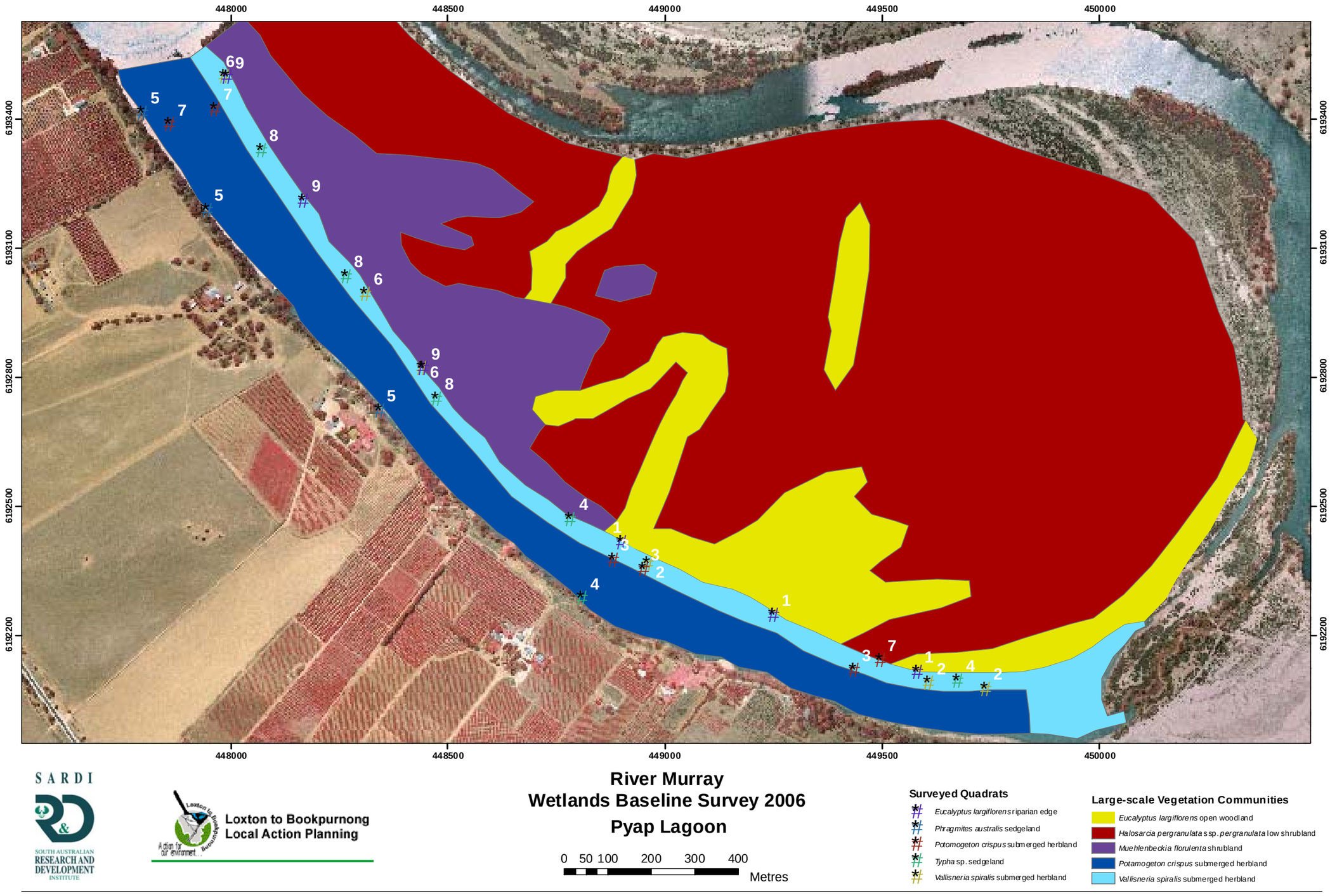

Figure 5: Vegetation map of Pyap Lagoon showing the quantitatively surveyed quadrats (numbers refer to associations in Table 4) and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was variable across the floodplain (Figure 6). The majority of trees were in moderate to good health but in some areas there were signs of stress (Figure 6). In areas of the floodplain closest to the River Murray most of the trees surveyed were in moderate to good health (Figure 6). As distance from the River Murray increased, trees surveyed showed escalating signs of stress (very poor to moderate condition) (Figure 6).

Only 45 *Eucalyptus largiflorens* individuals were observed in the study area (Figure 7). Of these, the majority were in poor to moderate health with only 10 individuals found to be in good health at various locations across the floodplain (Figure 7).

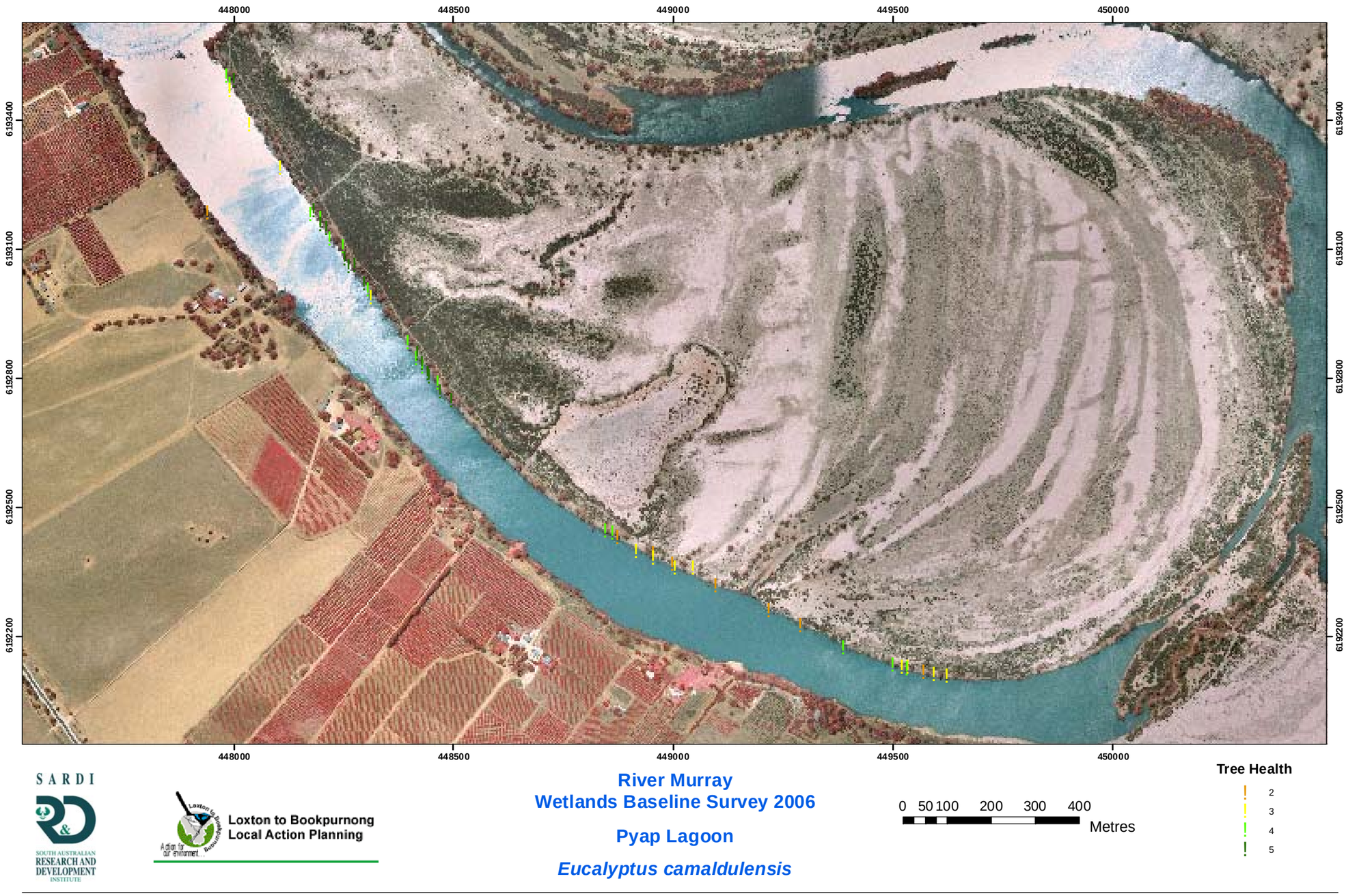

Figure 6: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Pyap Lagoon.

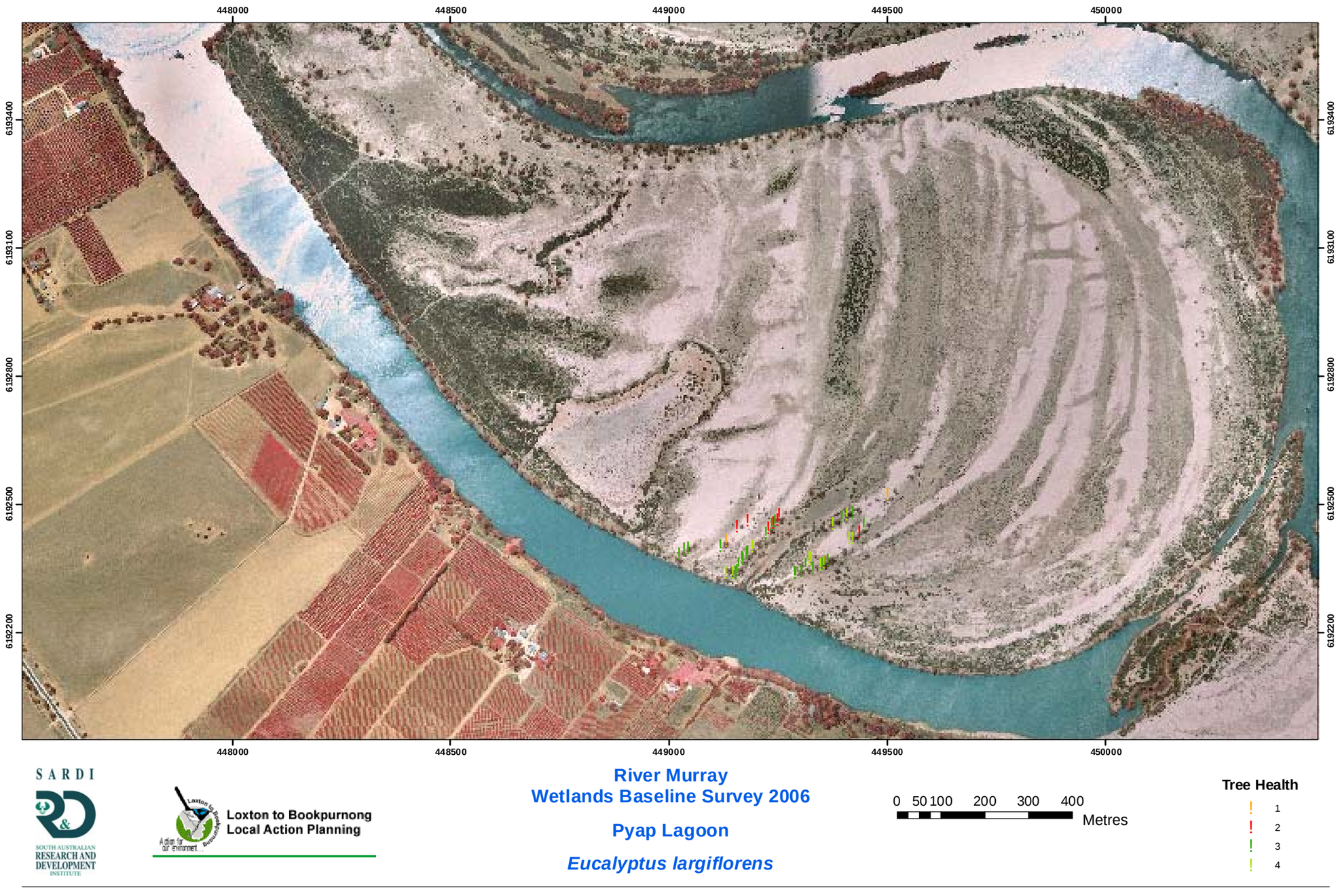

Figure 7: Map of *Eucalyptus largiflorens* tree health at Pyap Lagoon.

Implications of the data

The inundated and riparian areas of the wetland were generally well vegetated with native species. The current grazing regime does not seem to have heavily impacted the species present at this location. Conversely, as the distance from the lagoon increased the vegetation became more depauperate as was evident by poor tree health and a sparse understorey. Bare soil and salt scalds were also observed in this part of the floodplain.

Hydrological manipulation of the permanently inundated area is not recommended because there are extensive beds of submergent species, which will die if the wetland is dried. In addition, the wetland bed may become salinised if the wetland is dried.

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. Weir pool manipulations may result in localised improvement in tree health and floodplain condition.

3.6. Big Toolunka Flat

A total of 42 species were observed in the survey area including 12 exotics and one rare species (Table 5).

Large beds of submerged aquatic macrophytes (*Potamogeton crispus* and *Vallisneria spiralis*) dominated the submergent vegetation in the permanently inundated areas (Figure 8). *Potamogeton crispus* dominated the deeper areas of the lagoon; *Valisneria spiralis* was less common and present in shallow sections and around the edges of the inundated areas (Figure 8). Charophytes (*Nitella* sp. and *Chara* sp.) were also observed in the study site and the floating aquatic plant, *Azolla filiculoides*, was present throughout the inundated areas.

Monospecific stands of *Typha* sp. dominated the edges of the open water areas except at the eastern end of the wetland, where a section of bank was dominated with *Phragmites australis, Paspalum distichum* and *Schoenoplectus validus* (Figure 8).

Eucalyptus largiflorens/Eucalyptus camaldulensis var. *camaldulensis* open woodland; interspersed with dense *Muehlenbeckia florulenta* closed shrubland were the dominant vegetation communities on the floodplain between the wetland and the River Murray (Figure 8).

The northern floodplain contained a narrow riparian zone that preceded a steep incline. The vegetation along the incline has been highly modified (mowed and planted); hence, the vegetation in this area was not surveyed past the riparian zone.

It should also be noted that a stand of *Salix babylonica* (weeping willows) was observed in the study area, which could easily be eradicated (Easting: 54401051; Northing: 6220154).

Nine different vegetation associations were quantitatively surveyed (Figure 8):

1) *Typha* spp. sedgeland toward the inlet
2) *Potamogeton crispus* submerged herbland toward the inlet
3) *Potamogeton crispus* submerged herbland in the middle of the lagoon
4) *Typha* spp. sedgeland along the northern edge of the lagoon
5) *Typha* spp. sedgeland along the southern edge of the lagoon
6) *Typha* spp. sedgeland along the western edge (the end) of the lagoon
7) *Potamogeton crispus* submerged herbland toward the end of the lagoon
8) *Vallisneria spiralis* submerged herbland toward the end of the lagoon
9) *Phragmites australis* sedgeland along the western edge (the end) of the lagoon

Table 5: Species list for Big Toolunka Flat and vegetation association 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	7	8	9
Acacia stenophylla	River Cooba									
*Aster subulatus**	Aster Weed									
*Atriplex prostrata**	Creeping Saltbush									
Atriplex stipitata	Bitter Saltbush									
Azolla filiculoides	Pacific Azolla	x			x	x	x	x	x	
Bolboschoenus caldwellii	Salt Club-rush									
*Bromus diandrus**	Great Brome									
*Bromus rubens**	Red Brome									
Chara sp.	Skunk Weed									
*Conyza bonariensis**	Flax-leaf Fleabane									
Craspedia chrysantha	Billybuttons									
*Cynodon dactylon**	Bermuda Grass									
Cyperus gymnocaulos	Spiny Flat-sedge									
Dodonaea attenuata	Narrow-leaf Hopbush									
*Echium plantagineum**	Salvation Jane									
Enchylaena tomentosa	Ruby Saltbush									
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum									x
Eucalyptus largiflorens	River Black Box									
Euphorbia terracina	False Caper									
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire									
*Heliotropium curassavicum**	Smooth Heliotrope									
Lepilaena australis	Austral Water Mat									
*Mesembryanthemum crystallinum**	Common Iceplant									
Morgania floribunda	Bluerod									
Muehlenbeckia florulenta	Lignum									
Myoporum parvifolia#	Creeping Boobialla									
Myriocephalus stuartii	Poached-egg Daisy									
Nitella sp.	Stonewort									
Paspalum distichum	Water-couch									x
Phragmites australis	Common Reed									x
Potamogeton crispus	Curly Pondweed	x	x	x	x	x	x	x		
Pseudognaphalium luteo-album	Cudweed									
*Reichardia tingitana**	False Sow Thistle									
*Salix babylonica**	Weeping Willow									
Schoenoplectus validus	River Club-rush									x
Sclerolaena divaricata	Tangled Bindy									
Senecio sp.	Groundsel									
Sporobolus mitchellii	Rat-tail Couch									
Typha spp.	Bulrush	x			x	x	x			
Vallisneria spiralis	Ribbon Weed	x			x	x	x	x		
*Vicia sativa**	Vetch									
Wahlenbergia fluminalis	River Bluebell									

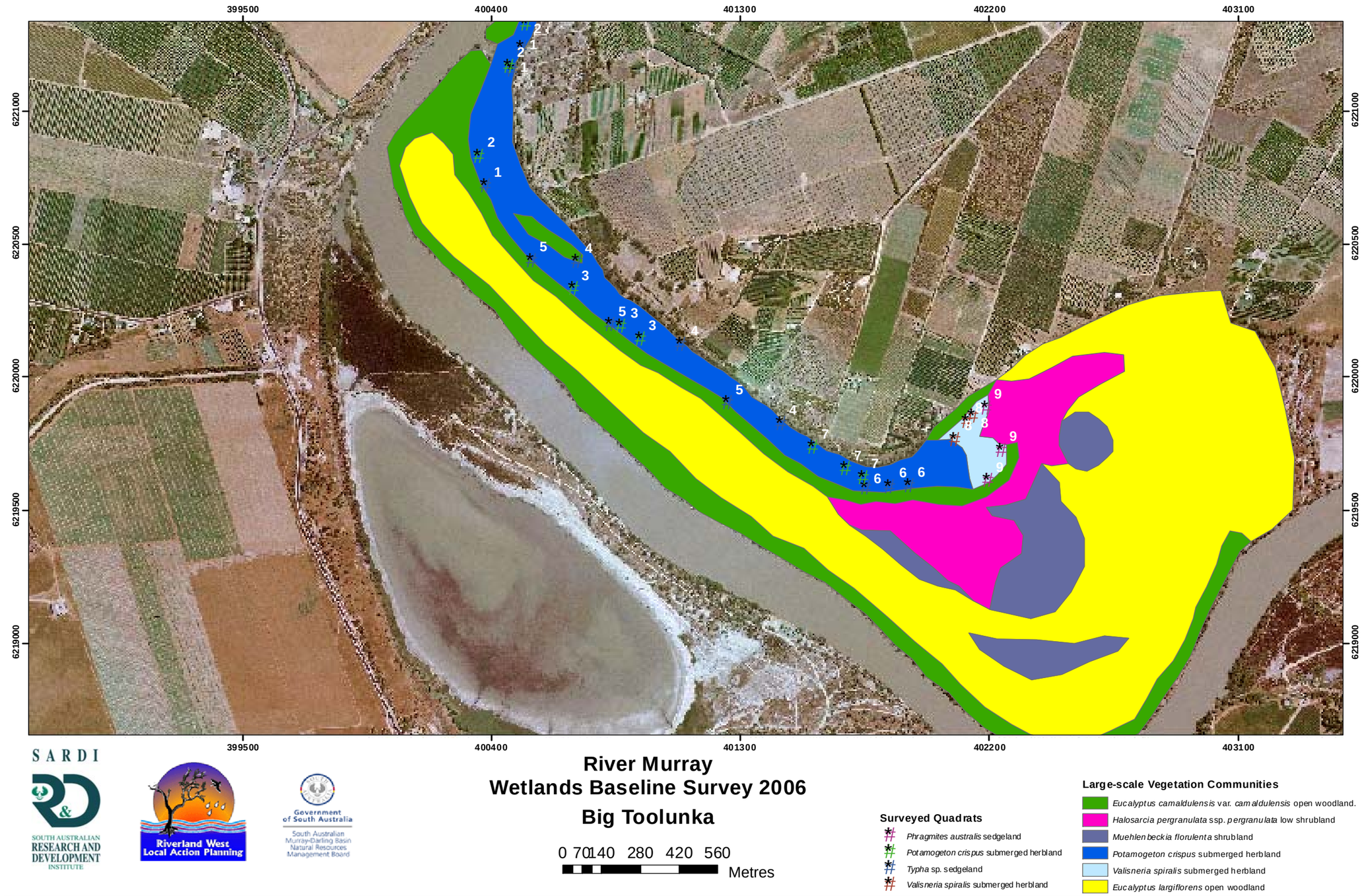

Figure 8: Vegetation map of Big Toolunka Flat showing the quantitatively surveyed quadrats (numbers refer to associations in Table 5) and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was variable across the floodplain (Figure 6). The majority of trees were in moderate to good health but in some areas there were signs of decline. In southern areas of the floodplain, closest to the River Murray, most of the trees surveyed were in moderate to good health. However, individuals closer to the lagoon, in particular those along the edges, showed escalating signs of stress despite the close proximity to water (very poor to moderate condition).

The majority of *Eucalyptus largiflorens* trees in the study area were coppiced, but despite this the majority of trees surveyed appeared to be in good to excellent condition (Figure 7).

Figure 9: Map *of Eucalyptus camaldulensis* var. *camaldulensis* tree health at Big Toolunka Flat.

Figure 10: Map of *Eucalyptus largiflorens* tree health at Big Toolunka Flat.

Implications of the data

The inundated and riparian areas of the wetland were generally well vegetated with native species and in good condition. The current grazing regime does not seem to heavily impact on these areas. The poor health of *Eucalyptus camaldulensis* var. *camaldulensis* trees close to the lagoon requires further investigation to determine the cause and suggest ways to improve tree health in this area.

Hydrological manipulation of the permanently inundated area is not recommended because there are extensive beds of submergent species that will die if the wetland is dried. In addition, the wetland bed may become salinised if the wetland is dried and there are several pumps that would beed to be relocated.

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. Weir pool manipulations may result in localised improvement in tree health and floodplain condition.

3.7. Noonawirra

A total of 56 species were observed in the survey area including 22 exotics and one rare species (*Myriophyllum papulosum*) (Table 6).

The inubndated area in Noonawirra contained a diverse community of submerged vegetation, including patches of *Potamogeton crispus* and *Vallisneria spiralis,* and occasional *Ludwigia peploides* ssp. *montevidensis* and *Myriophyllum verrucosum* (Figure 11). The riparian edge of the lagoon near the causeway was dominated by alternating stands of *Phragmites australis* and *Typha* sp. (Figure 11). The remaining riparian zone was fairly open and more diverse with patches of *Juncus usitatus, Schoenoplectus validus, Eleocharis acuta, Cyperus exaltatus* and grazed grasslands (*Paspalum distichum* and *Agrostis avenacea*) with a large proportion of exotic species (Figure 11).

The remainder of the floodplain in the survey area was characterised by *Eucalyptus camaldulensis* var. *camaldulensis* woodland over a dense understorey dominated by *Muehlenbeckia florulenta* as well as exotic annual herbs, grasses and ground covers (Figure 11).

Surveyed quadrats

Six different vegetation associations were quantitatively surveyed (Table 6):

1) *Typha* spp. sedgeland near the causeway
2) *Phragmites australis* grassland near the causeway
3) Grazed riparian grassland along the edges of the lagoon
4) *Juncus usitatus* sedgeland along the edges of the lagoon
5) *Vallisneria spiralis* submerged herbland
6) *Schoenoplectus validus* sedgeland along the edges of the lagoon

Table 6: Species list for Noonawirra 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
Agrostis avenacea	Common Blown-grass			x	x		
Alternanthera denticulata	Lesser Joyweed				x		
Ammania multiflora	Jerry Jerry			x			
Asperula gemenifolia	Twin-leaf Bedstraw			x			
*Asphodelus fistulosus**	Onion Weed						
*Aster subulatus**	Aster-weed			x			
Atriplex stipitata	Bitter Saltbush						
*Avena barbata**	Bearded Oat			x			
Azolla filiculoides	Pacific Azolla	x	x		x	x	x
Bolboschoenus caldwellii	Salt Club-rush			x			
*Bromus rubens**	Red Brome						
*Bromus unioloides**	Prairie Grass			x			
Centaurea sp.*	Centaurea						
*Conyza bonariensis**	Flax-leaf Fleabane						
*Critesion marinum**	Barley Grass			x			
Cyperus exaltatus	Umbrella Sedge			x	x		
Cyperus gymnocaulos	Spiny Flat-sedge						
Unidentified Daisy 1				x	x		
Eleocharis acuta	Common Spike-rush			x	x		
Enchylaena tomentosa	Ruby Saltbush						
Eremophila scoparia	Emu Bush						
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum			x	x		
*Euphorbia terracina**	False Caper						
Haloragis aspera	Grey Raspwort						
*Marrubium vulgare**	Horehound						
*Hypochaeris radicata**	Smooth Cat's-ear						
Juncus usitatus	Common Rush			x	x		
*Lactuca saligna**	Wild Lettuce						
Ludwigia peploides ssp. *montevidensis*	Water Primrose	x		x			
*Lupinus cosentinii**	Lupin						
Maireana macrocarpa	Swamp Bluebush						
*Malva parviflora**	Small-flowered Marshmallow						
Medicago sp.*	Medic			x			
*Melilotus alba**	Bokhara Clover			x			
Morgania floribunda	Bluerod			x			
Muehlenbeckia florulenta	Lignum						
Myriophyllum papulosum[#]	Milfoil						

Species	Common name	Association number					
		1	2	3	4	5	6
Myriophyllum verrucosum	Red Milfoil	x	x			x	x
Paspalum distichum	Water-couch			x	x		
Persicaria lapathifolium	Pale Knotweed			x			
Phragmites australis	Common Reed		x				
*Phyla canescens**	Lippia						
*Picris hieracioides**	Ox-tongue						
Potamogeton crispus	Curly Pondweed	x	x				x
Psuedognaphalium luteo-album	Jersey Cudweed						
Rhodanthe pygmaeum	Pigmy Sunray						
*Rorippa nasturtium-aquaticum**	Watercress			x			
Schoenoplectus validus	River Clubrush		x	x			x
Sclerolaena divaricata	Tangled Bindy						
Senecio sp.	Groundsel						
*Solanum nigrum**	Black Nightshade						
*Sonchus oleraceus**	Common Sow-thistle			x			
Typha sp.	Bulrush	x					
Unknown 1				x			
Vallisneria spiralis	Ribbon Weed	x	x			x	
Wahlenbergia fluminalis	River Bluebell						

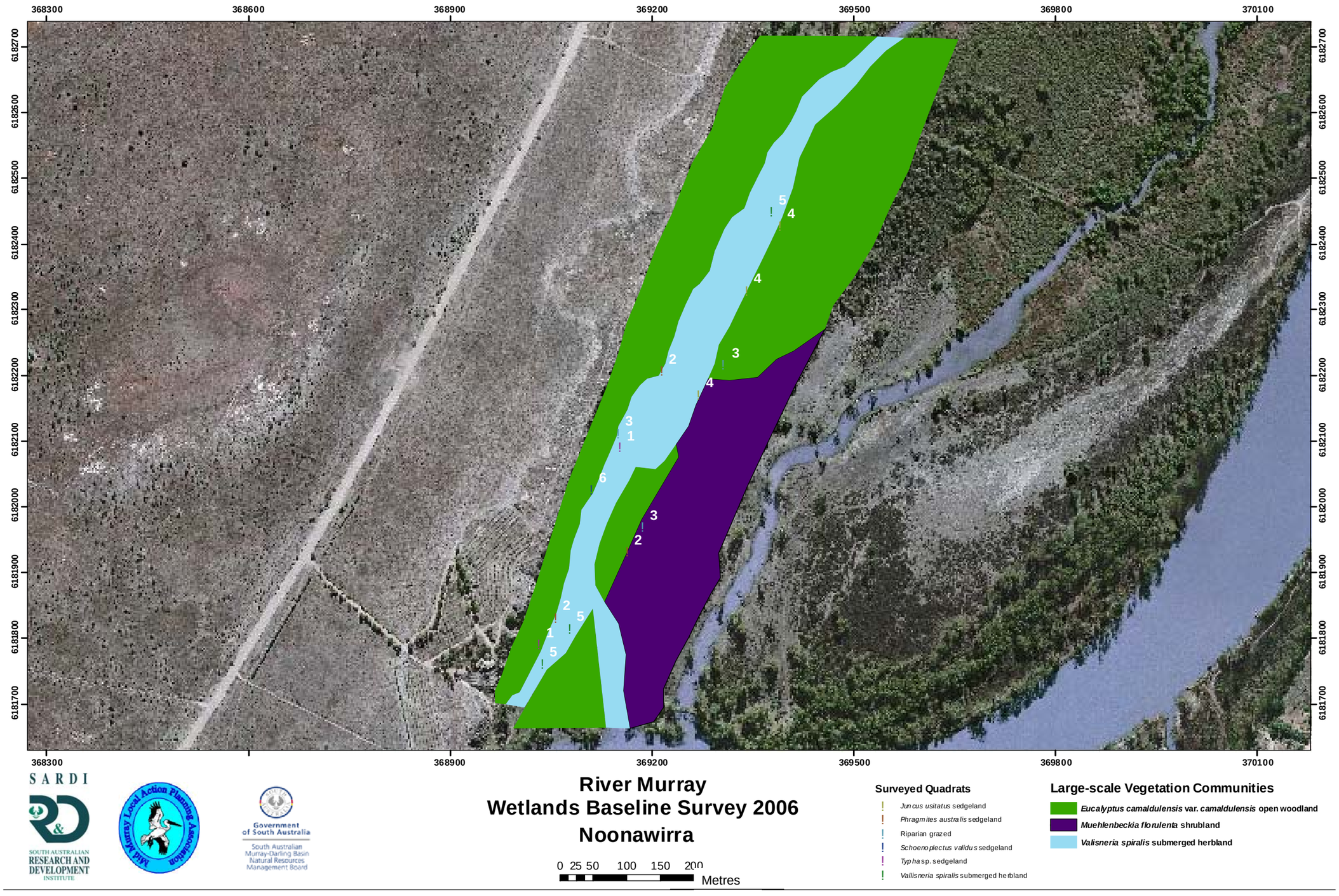

Figure 11: Vegetation map of Noonawirra showing the quantitatively surveyed quadrats (numbers refer to associations in Table 6) and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was variable across the floodplain but the majority of trees were in good to excellent health (Figure 12). Young *E. camaldulensis* individuals were also observed on the floodplain, particularly on the eastern side where recruitment is likely to have occurred in the last five years.

No *Eucalyptus largiflorens* trees were present in the study area.

Figure 12: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Noonawirra Lagoon.

Implications of the data

The riparian and floodplain area of the wetland were dominated by exotic species. The previous grazing regime seems to have heavily impacted the species present at this location and encouraged the growth of exotics. Therefore, the floodplain needs to be managed in such a way that invasive plant species can be suppressed.

The evidence of *Eucalyptus camaldulensis* var. *camaldulensis* recruitment and good tree health suggests that some areas of the floodplain may have been inundated in recent years and there is fresh groundwater in the root zone of many trees.

Hydrological manipulation of the inundated areas is not recommended because there are extensive beds of submergent species that will die if the wetland is dried. In addition, exotic species may expand their distribution from the floodplain to the wetland bed if the wetland is dried.

3.8. Devon Downs

A total of 59 species were observed in the survey area including 11 exotics (Table 7).

The inlet channel that joins the River Murray and lagoon in Devon Downs had a riparian edge dominated by *Phragmites australis* and occasional *Schoenoplectus validus*. No submerged vegetation was observed in this channel (Figure 13).

The northern lagoon contained a diverse community of submerged vegetation, dominated by dense patches of *Vallisneria spiralis* interspersed with *Potamogeton crispus* and *Myriophyllum verrucosum*. The riparian edge of the northern lagoon was dominated by alternating stands of *Phragmites australis, Schoenoplectus. validus* and *Typha* sp. (Figure 13).

The middle lagoon supported a less diverse community of submerged aquatic vegetation that was mainly composed of *Vallisneria spiralis* with a small amount of *Myriophyllum verrucosum*. The emergent sedgelands along the edge of the lagoon followed a similar pattern to those found in the northern lagoon, i.e. alternating stands of *Phragmites australis, Schoenoplectus validus* and *Typha* sp. (Figure 13).

The aquatic macrophyte community in the southern lagoon was more diverse than the aforementioned lagoons. *Vallisneria spiralis* dominated the submerged vegetation and occurred in dense beds, although *Myriophyllum verrucosum*, *Ludwigia peploides* ssp. *montevidensis* and *Potamogeton crispus* and *Nitella* sp. was also present throughout the lagoon (Figure 13). The riparian edge of this lagoon was dominated by emergent sedgelands, alternating between stands of *Typha* spp. and *Schoenoplectus validus*. However, the eastern edge was also characterised by open *Eucalyptus camaldulensis* var. *camaldulensis* woodland above P*aspalum distichum* grassland understorey (Figure 13).

The floodplain of the survey area was generally dominated by *Eucalyptus camaldulensis* var. *camaldulensis*/*Eucalyptus largiflorens* open woodland, over open *Muehlenbeckia florulenta* shrubland (Figure 13). In contrast, the understorey vegetation on the floodplain adjoining the southern lagoon was dominated by more salt tolerant taxa including Chenopods (*Atriplex* spp., *Enchylaena tomentosa*). In this region the understorey vegetation was generally more sparse (Figure 13).

Surveyed quadrats

Fifteen different vegetation associations were quantitatively surveyed (Table 7):

1) *Phragmites australis* sedgeland along the edge of the inlet channel

2) *Schoenoplectus validus* sedgeland along the edge of the northern lagoon

3) *Vallisneria spiralis* submerged herbland in the northern lagoon

4) *Phragmites australis* sedgeland along the edge of the northern lagoon

5) *Typha* spp. sedgeland along the edge of the northern lagoon

6) *Typha* spp. sedgeland along the edge of the middle lagoon

7) *Schoenoplectus validus* sedgeland along the edge of the middle lagoon

8) *Vallisneria spiralis* submerged herbland in the middle lagoon

9) *Vallisneria spiralis* submerged herbland toward the northern end of the southern lagoon

10) *Phragmites australis* sedgeland along the northern edge of the southern lagoon

11) *Schoenoplectus validus* sedgeland along the edge of the middle lagoon

12) *Schoenoplectus validus* sedgeland along the northern edge of the southern lagoon

13) *Typha* spp. sedgeland along the edge of the southern lagoon

14) *Vallisneria spiralis* submerged herbland in the southern lagoon

15) *Schoenoplectus validus* sedgeland along the edge of the southern lagoon

Table 7: Species list for Devon Downs and the vegetation associations 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	7	8	9	10	11	12	13	14	15
Acacia stenophylla	River Cooba															
Agrostis avenacea	Common Blown-grass															
Alternanthera denticulata	Lesser Joyweed															
Asperula gemenifolia	Twin-leaf bedstraw															
*Aster subulatus**	Aster Weed															
Atriplex nummularia	Old Man Saltbush															
Atriplex prostrata	Creeping Saltbush															
Atriplex stipitata	Bitter Saltbush															
Atriplex vesicaria	Bladder Saltbush															
Azolla filiculoides	Pacific Azolla															x
Bolboschoenus caldwellii	Salt Club-rush															
Centaurea sp.*	Thistle															
Centipeda minima	Spreading Sneezeweed															
Cotula coronopifolia	Water Buttons															
Cyperus exaltatus	Giant Sedge															
Cyperus gymnocaulos	Spiny Flat-sedge															
Unknown Daisy 1																
Unknown Daisy 2																
Dodonaea attenuata	Narrow-leaf Hopbush															
Eleocharis acuta	Common Spike-rush															
Enchylaena tomentosa	Ruby Saltbush															
Epaltes australis	Spreading emubush															
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum															
Eucalyptus largiflorens	River Black Box															
*Euphorbia terracina**	False Caper															
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire															

Species	Common name	Association number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
*Heliotropium curassavicum**	Smooth Heliotrope															
Juncus usitatus	Common Rush															
*Lactuca saligna**	Wild Lettuce															
Lepilaena australis	Austral Water Mat															
Limosella australis	Australian Mudwort															
Lomandra leucocephala ssp. *robusta*																
Ludwigia peploides ssp. *montevidensis*	Water Primrose															x
*Lycium ferocissimum**	Spiny Box-thorn															
Maireana macrocarpa	Swamp Bluebush															
*Malva parviflora**	Small-flowered Marshmallow															
*Mesembryanthemum crystallinum**	Common Iceplant															
Muehlenbeckia florulenta	Lignum															
Morgania floribunda	Bluerod															
Myoporum montanum	Boobialla															
Myriocephalus stuartii	Poached-egg Daisy															
Myriophyllum verrucosum	Red Milfoil			x			x	x	x			x	x	x	x	x
Nitella sp.	Stonewort															
Opuntia sp.*	Prickly Pear															
Parahebe decorosa	Parahebe															
Paspalum distichum	Water-couch															
Persicaria lapathifolium	Pale Knotweed															
Phragmites australis	Common Reed	x			x					x		x				
Potamogeton crispus	Curly Pondweed		x	x	x	x	x						x	x		x
Potamogeton tricarinatus	Sago Pondweed															
*Salix babylonica**	Weeping Willow															
Schoenoplectus validus	River Club-rush		x		x			x		x		x	x			x
Senecio sp.	Groundsel															

Species	Common name	Association number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sporobolus mitchellii	Rat-tail Couch															
Swainsona swainsonoides	Swainsona															
Typha spp.	Bulrush					x	x							x		
Unknown 1																
Unknown 2																
Vallisneria spiralis	Ribbon Weed		x	x	x	x	x	x	x		x	x	x	x	x	x
Wahlenbergia fluminalis	River Bluebell															
*Xanthium occidentale**	Noogoora Burr															

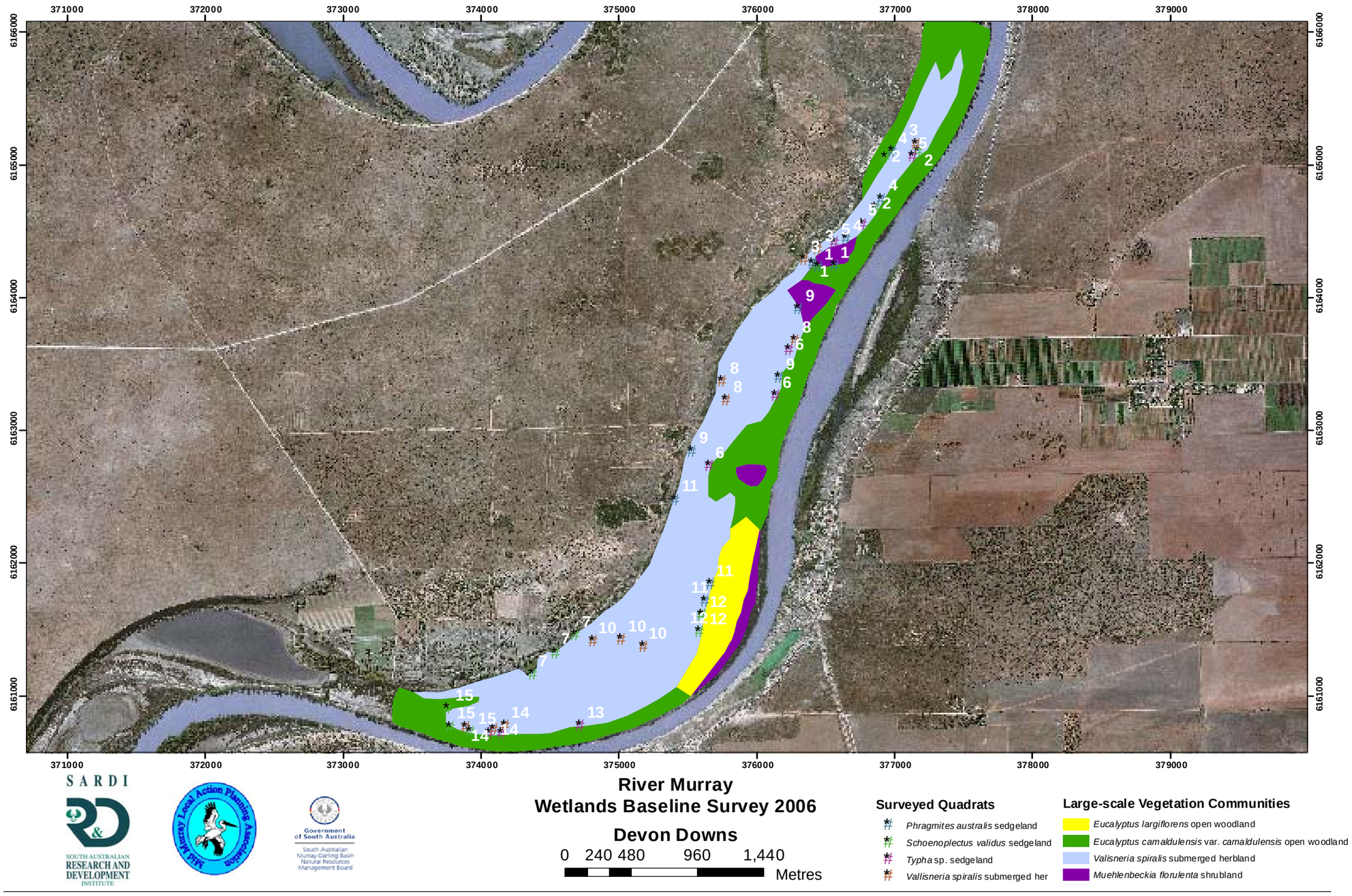

Figure 13: Vegetation map of Devon Downs showing the quantitatively surveyed quadrats (number refers to association in Table 7) and large-scale vegetation communities.

Tree health

Eucalyptus camaldulensis var. *camaldulensis* tree health was not consistent across the floodplain (Figure 14). The majority of trees were in moderate to good health but in some areas there were signs of decline. In areas of the floodplain where salt tolerant species were found most of the trees surveyed were in poor to moderate health. Closer to the inlet channel, trees surveyed showed less sign of stress (moderate to good condition) (Figure 14).

Eucalyptus largiflorens tree health was less variable across the floodplain. Most individuals observed in the study area were in moderate to good health (Figure 15).

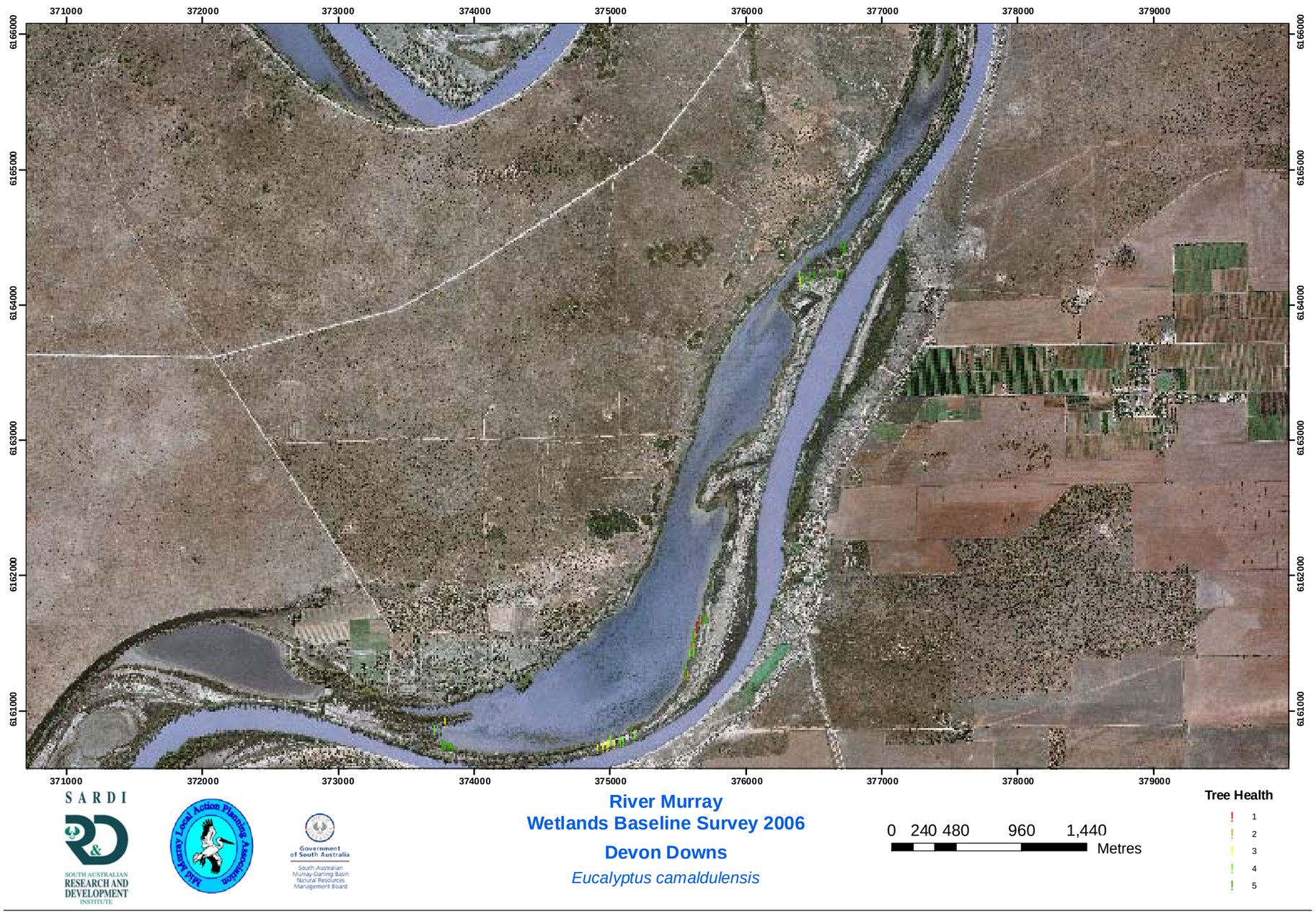

Figure 14: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Devon Downs.

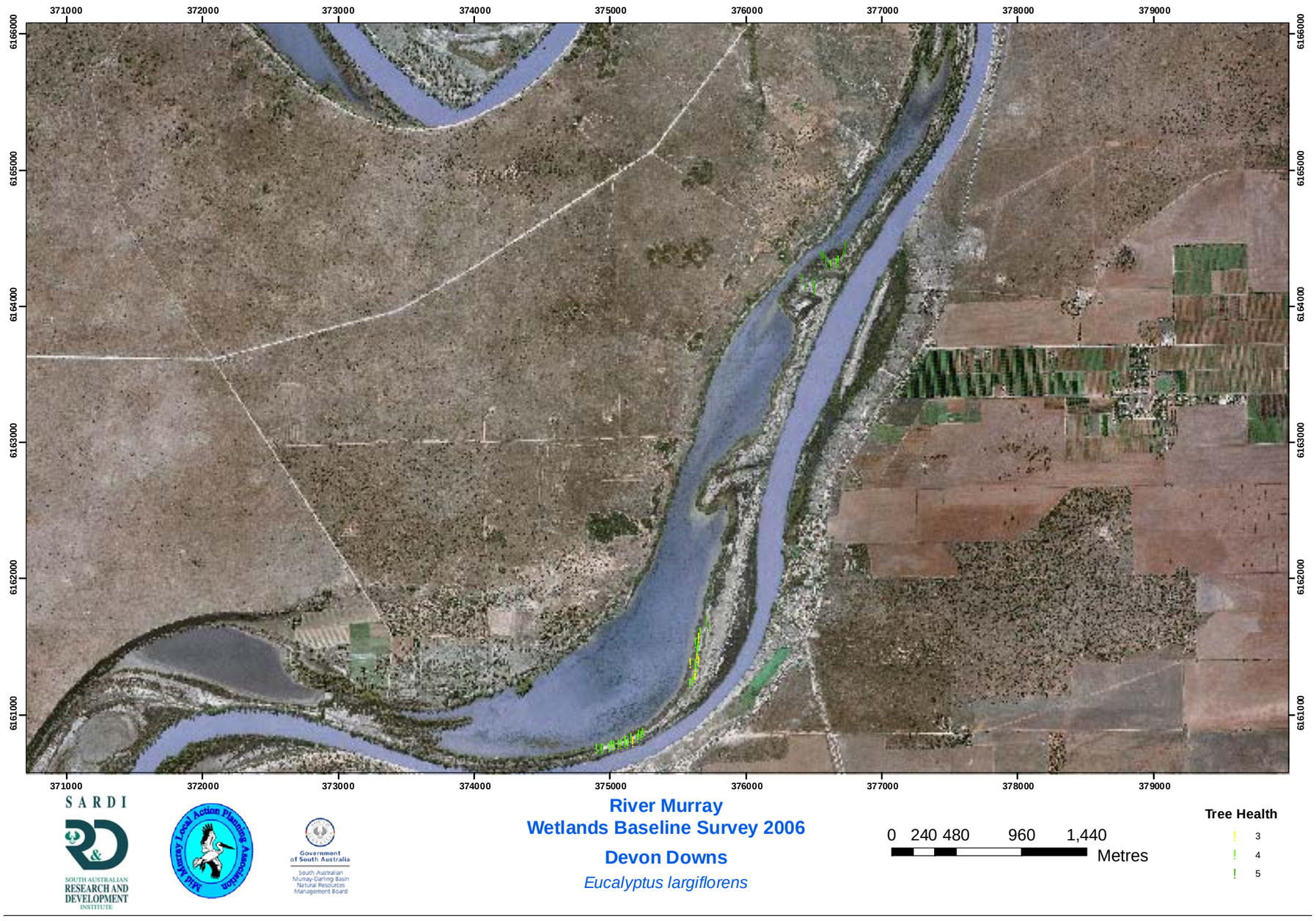

Figure 15: Map of *Eucalyptus largiflorens* tree health at Devon Downs.

Implications of the data

The inundated and riparian areas of the wetland were generally well vegetated with native species. Conversely, as the distance from the lagoon increased the vegetation became more depauperate as was evident by poor tree health and a sparse understorey. Bare soil and salt scald were also observed in the southeastern part of the 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 (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. Weir pool manipulations may result in localised improvement in tree health and floodplain condition.

3.9. Saltbush Flat

A total of 54 species were observed in the survey area including 17 exotics (Table 8).

The small, shallow lagoon at Saltbush Flat contained both submerged vegetation, specifically dense beds of *Myriophyllum verrucosum,* and floating aquatic plants (*Lemna* sp. and *Azolla filiculoides*) (Figure 16). The edges of the small lagoon were dominated by stands of *Typha* spp., and more open areas were characterised by grazed *Sporobolus mitchellii* grasslands (Figure 16).

The larger, deeper lagoon did not support any submerged vegetation (Figure 16). The riparian edge was dominated by alternating monospecific stands of *Typha* spp. and *Phragmites australis,* with *Schoenoplectus validus* interspersed at some locations (Figure 16).

The floodplain along the fringes of the lagoon was characterised by open *Eucalyptus camaldulensis* var. *camaldulensis* woodland over an understorey dominated by *Muehlenbeckia florulenta, Eleocharis acuta, Phragmites australis* and *Sporobolus mitchelli* (Figure 16). Understorey vegetation was sparse immediately south of the main lagoon, but closer to the River Murray the diversity of understorey vegetation increased (Figure 16). At higher elevations, away from the water bodies, the floodplain was characterised by *Eucalyptus largiflorens* open woodland over a shrubland dominated by *Atriplex* spp., *Enchylaena tomentosa, Maireana microcarpa, Carpobrutus rossii* and *Heliotropium curassivicum* (Figure 16).

The survey area also contained pockets of open *M. florulenta* shrubland, and one discreet area dominated by *Halosarcia pergranulata* ssp. *pergranulata* (Figure 16).

Surveyed quadrats

Nine different vegetation associations were quantitatively surveyed (Table 8):

1) *Sporobolus mitchellii* grassland along the northern edge of the small lagoon
2) *Myriophyllum verrucosum* submerged herbland in the small lagoon
3) *Typha* spp. sedgeland along the edges of the small lagoon
4) Riparian grassland along the edges of the inlet channel
5) *Typha* sp. sedgeland along the edges of the southernmost part of the lagoon
6) *Phragmites australis* sedgeland along the edges of the southernmost part of the lagoon
7) *Typha* sp. sedgeland along the edges of the northernmost part of the lagoon
8) *Phragmites australis* sedgeland along the edges of the northernmost part of the lagoon

9) *Schoenoplectus validus* sedgeland along the edges of the northernmost part of the lagoon

Table 8: Species list for Saltbush Flat and the vegetation associations 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	7	8	9
Agrostis avenacea	Common Blown-grass	x								
Asperula gemenifolia	Twin-leaf bedstraw									
*Aster subulatus**	Aster Weed	x								
Atriplex nummularia	Old Man Saltbush									
Atriplex prostrata	Creeping Saltbush									
Atriplex semibaccata	Berry Saltbush									
Azolla filiculoides	Pacific Azolla		x	x			x	x		x
*Bromus rubens**	Red Brome									
*Bromus unioloides**	Prairie Grass									
Carpobrotus rossii	Angular Pigface									
*Carrichtera annua**	Carrichtera									
Centaurea sp.*	Thistle									
Cotula coronopifolia	Water Buttons	x								
*Critesion marinum**	Barley Grass									
Cyperus gymnocaulos	Spiny Flat-sedge	x								
Unknown Daisy 1										
Unknown Daisy 2										
Eleocharis acuta	Common Spike-rush	x	x		x					
Eleocharis sphacelata	Tall Spike-rush	x								
Enchylaena tomentosa	Ruby Saltbush									
Eucalyptus camaldulensis var. *camaldulensis*	River Red Gum									
Eucalyptus largiflorens	River Black Box									
*Euphorbia terracina**	False Caper									
Halosarcia pergranulata ssp. *pergranulata*	Black-seed Samphire									
*Heliotropium curassavicum**	Smooth Heliotrope									
Hydrocotyle verticillata	Shield Pennywort	x			x					
*Hypochaeris glabra**	Smooth Cat's-ear									
*Hypochaeris radicata**	Flat Weed									
Lemna sp.	Duck Weed		x	x						
Lepilaena australis	Austral Watermat									
Lolium sp.*	Rye Grass									
Ludwigia peploides ssp. *montevidensis*	Water Primrose			x						
*Lycium ferocissimum**	African Boxthorn									
Maireana microcarpa	Swamp Bluebush									
Medicago sp.*	Medic	x			x					
*Melilotus indica**	Bokhara Clover									
Mimulus repens	Creeping Monkey-flower	x					x			
Mollugo cerviana	Wirestem Chickweed									

Species	Common name	Association number								
		1	2	3	4	5	6	7	8	9
Muehlenbeckia florulenta	Lignum				x					
Myoporum montanum	Boobialla									
Myriophyllum verrucosum	Red Milfoil		x	x						
Parahebe decorosa	Parahebe									
Paspalum distichum	Water-couch						x			
Phragmites australis	Common Reed	x		x	x		x		x	
*Reichardia tingitana**	False Sow Thistle									
Rumex bidens	Mud Dock									
*Salix babylonica**	Weeping Willow									
Schoenoplectus validus	River Club-rush			x	x		x		x	x
Schoenus sp.										
Sonchus oleraceus	False Sow Thistle									
Sporobolus mitchellii	Rat-tail Couch	x			x					
Tetragonia tetragonoides	New Zealand Spinach									
Trachymene cyanopetula	Purple Trachymene									
Triglochin procerum	Water Ribbons	x			x					
Typha spp.	Bulrush			x	x	x		x		
*Urtica urens**	Nettle	x								

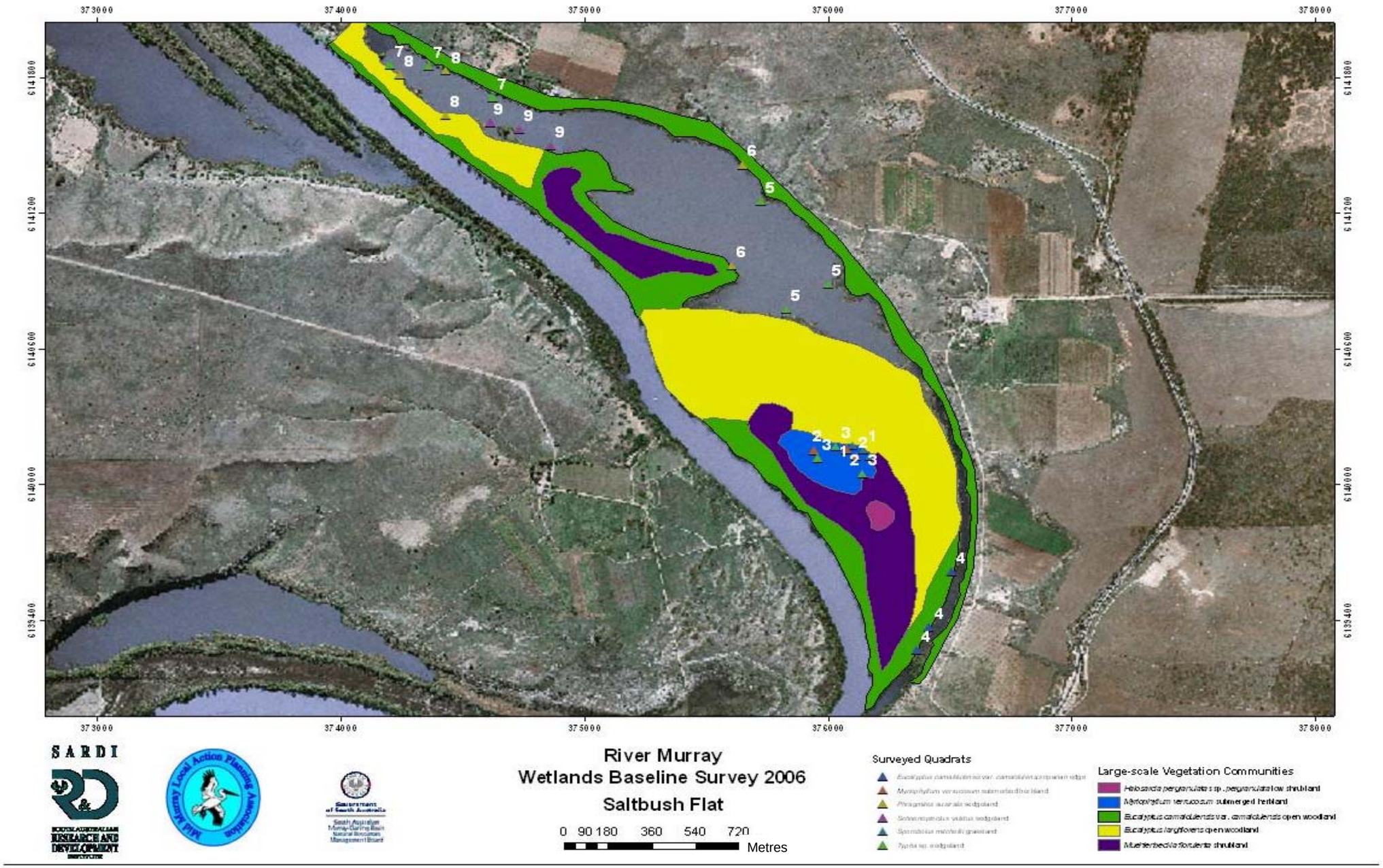

Figure 16: Vegetation map of Saltbush Flat showing the quantitatively surveyed quadrats (numbers refer to associations in Table 8) and large-scale vegetation communities.

Tree health

The majority of *Eucalyptus camaldulensis* var. *camaldulensis* were in good to excellent health (Figure 17). However, a few individual trees were observed to be in moderate to poor health at random locations throughout the survey area.

Similarly, *Eucalyptus largiflorens* trees were found to be in good to excellent health across the survey area (Figure 18).

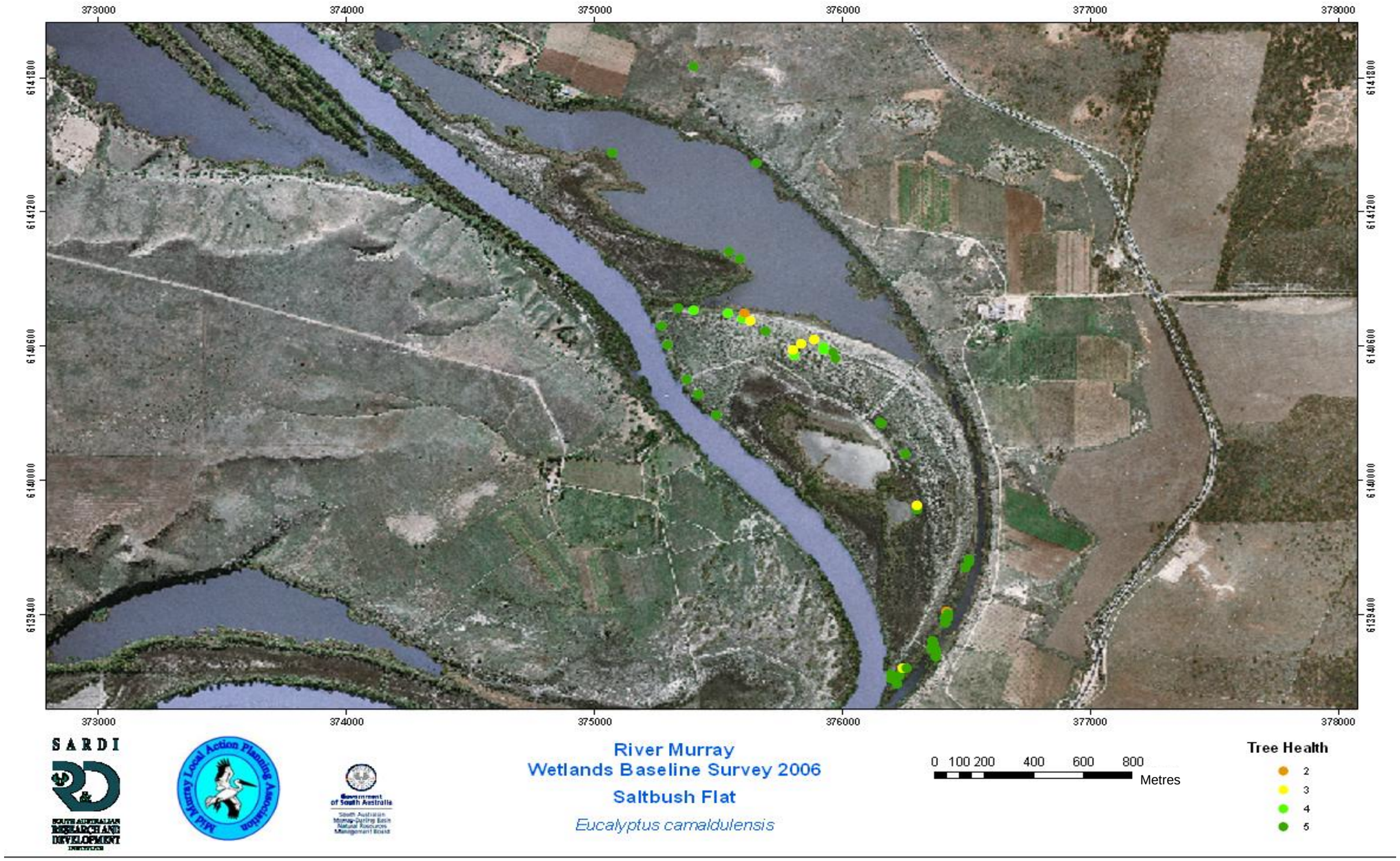

Figure 17: Map of *Eucalyptus camaldulensis* var. *camaldulensis* tree health at Saltbush Flat.

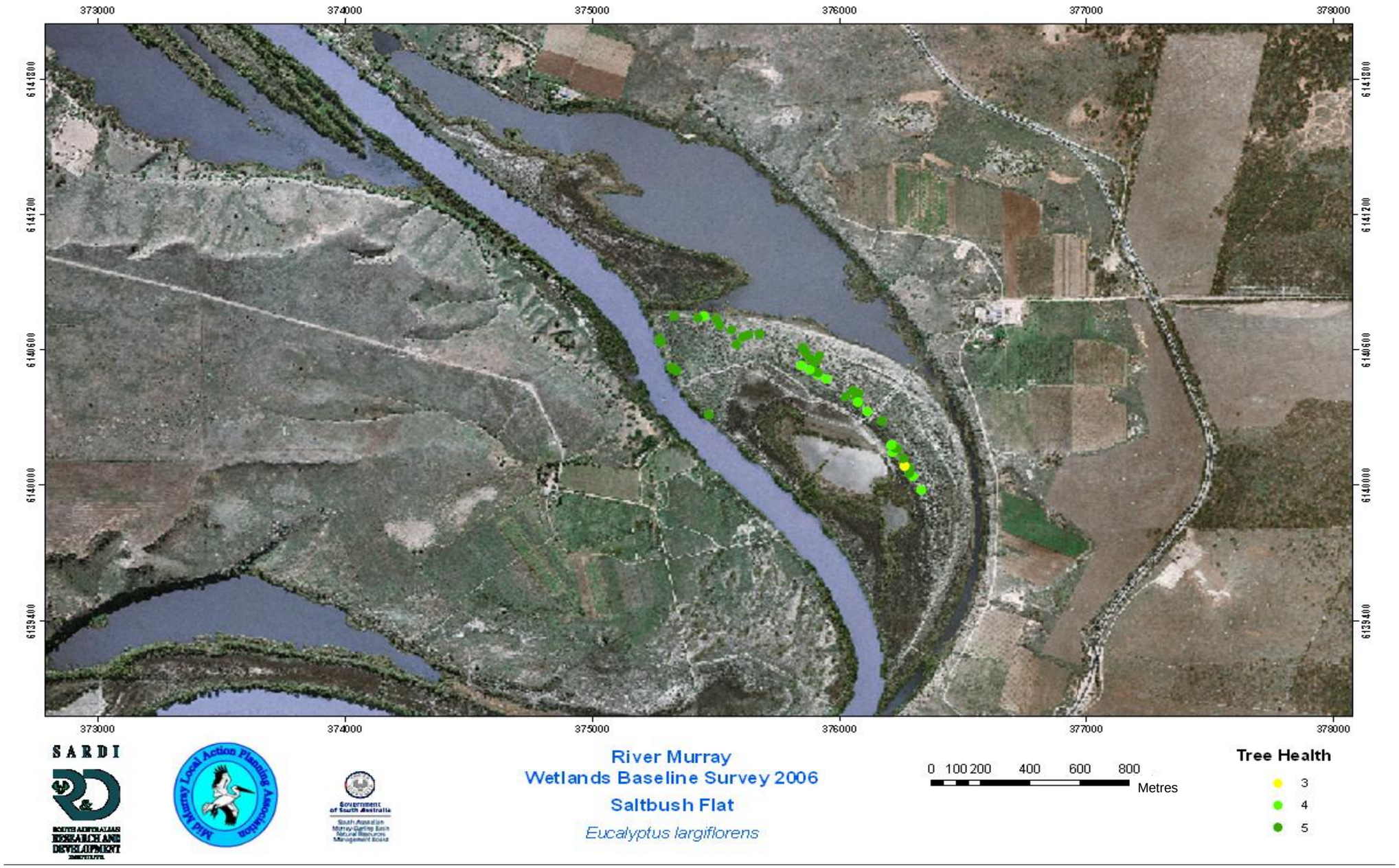

Figure 18: Map of *Eucalyptus largiflorens* tree health at Saltbush Flat.

Implications of the data

The large lagoon was devoid of aquatic vegetation, and the edges supported monospecific stands of sedges. It is unclear why a large shallow lagoon does not support a diverse submergent vegetation community.

The riparian and floodplain areas of the wetland were in areas sparsely vegetated with native species. Bare soil, salt scalds and areas dominated by salt tolerant species (e.g. *Halosarcia pergranulata* ssp. *pergranulata*) were also observed in areas of the floodplain indicating that some areas have become salinised.

In contrast to most floodplains in this region tree health is generally good; however, overall floodplain condition has declined (areas of the floodplain show evidence of soil salinisation). High river flows may result in an improvement in 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 floodplain condition.

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