Government of South Australia
South Australian Murray-Darling Basin
Natural Resources Management Board



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South Australian Murray-Darling Basin Natural Resources Management Board

# Southern Bell Frog (*Litoria raniformis*) Census and Community Engagement Project in the Lower River Murray, South Australia

Final Report

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The project was managed by the South Australian Murray-Darling Basin Natural Resources Management (SA MDB NRM) Board.

Government of South Australia

**Cover Photos:** Callie Nickolai and Amy Scott (SA MDB NRM Board).

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Martins Bend Wetland Group
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Ramco Lagoon Wetland Group
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Beldora Landholders and wetland group
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## Executive Summary

The Southern Bell Frog, *Litoria raniformis,* census was conducted by the SA MDB NRM Board and DENR in spring/summer 2010-11 to determine the distribution and abundance of this once widespread threatened species along the lower River Murray and associated floodplains and wetlands in South Australia. This information was collected to assist in wetland and floodplain management that aims to enhance and protect Southern Bell Frog populations. Community education was also a large component of this project therefore workshops, publications and media articles were undertaken throughout the project.

The 2010-11 census consisted of 170 monitoring records collected at 115 monitoring sites within 52 wetlands. Southern Bell Frogs were recorded at 26 wetlands and the majority of these had variable watering regimes (ephemeral or temporary wetlands). This wetland type also had the highest abundance of Southern Bell frogs compared to permanent wetlands. Other habitat variables, including vegetation cover and electrical conductivity also appeared to be important determinants of Southern Bell Frog presence and abundance; however a lack of statistical power in the data set prevented any significant relationships to be determined. Further surveys that include the collection of habitat variables will increase the likelihood of determining the significant statistical relationships that can assist in the management of this species.

Historical frog records from the SA border to Wellington during 1992 to 2005 were obtained from existing databases and collated into a central GIS database. This dataset contained 152 site records of Southern Bell Frog presence. The survey effort differed between data sets, however it was determined that Southern Bell Frogs have been recorded in wetlands along the entire length of the River from the SA Border to Wellington.

Additional analysis of 24 wetlands that have been surveyed by DENR since 2004 showed that Southern Bell Frog presence and abundance at these sites varied over time and as a result of hydrological changes at wetlands. Over this period the species were recorded within 21 of the 24 wetlands between 2004 to early 2011. In total 441 surveys were undertaken, with 130 of these surveys having recorded Southern Bell Frogs. Higher abundances of Southern Bell Frogs within some sites in the Chowilla floodplain during 2004 and 2006 are most likely a result of hydrological manipulation of some of the wetlands (i.e. pumping). Similarly, low records during 2007 and 2008 are probably a result of drought and the disconnection of all pool level managed wetlands in the lower River Murray within South Australia during this period.

The 2010-11 census was undertaken during the highest flow event within the region in the 18 years. Therefore the findings in this report may not reflect those that would be found during other years. It is therefore important that annual frog surveys are conducted in subsequent years so that the data collected during the 2010-11 census can be further compared with data collected over time to improve our understanding and management of this species.

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# 1. Project Overview

The Southern Bell Frog, *Litoria raniformis,* was once widespread in wetlands along the Lower River Murray. Prolonged drought in the region and a lack of flooding of temporary wetlands is thought to have resulted in a dramatic decline in this species, such that they are now considered nationally threatened (listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*) and threatened within South Australia (listed as Vulnerable under the *National Parks and Wildlife Act 1972*).

The effects of the recent drought (2006-2010) on Southern Bell Frog populations in the Lower River Murray within South Australia are unknown although some evidence suggests they have declined significantly. With recent improvement of inflows in the catchment there has been a re-wetting of pool connected wetlands and inundation of above pool temporary wetlands (on average for the first time in 4 – 10 years), which has provided critical habitat and may have increased abundance of this species.

It is important for the survival of this species that the distribution and abundance of Southern Bell Frogs along the Lower River Murray in South Australia is properly understood. This information would assist in management targeted at enhancing and protecting Southern Bell Frog populations.

## 1.1 Project Aims

The aims of this project were to:

1. Investigate the response of Southern Bell Frogs to re-inundation of wetlands along the River Murray, particularly after prolonged drought
2. Improve understanding of species distribution and abundance within the Lower River Murray in South Australia
3. Assess the relationship between habitat and presence / abundance of Southern Bell Frogs
4. Collate and analyse historical records of the species in the region
5. Educate the community about Southern Bell Frogs
6. Provide recommendations on management of wetlands for Southern Bell Frog habitat and breeding
7. Promote the importance of wetlands along the River Murray as essential habitat for the species.

## 1.2 Project Scope

The scope of the project included:

- A review of the literature related to the Southern Bell Frog
- A frog monitoring census during spring / summer 2010-11
- A habitat assessment at frog monitoring sites during spring / summer 2010-11
- An analysis of spring / summer 2010-11 data to determine linkages between habitats and presence / abundance of Southern Bell Frogs
- The interpretation of Southern Bell Frog records at selected wetlands that have been surveyed over time from 2004 to 2010
- The collation of all historical records for the SA MDB region between the SA border and Wellington
- The engagement of the community in the project.

## 1.3 Spring / Summer 2010-11 Census

Nocturnal surveys of frog calls and habitat assessments were conducted by the South Australian Murray-Darling Basin Natural Resources Management (SA MDB NRM) Board and the Department of Environment and Natural Resources (DENR) during spring / summer of 2010-11. In total 171 monitoring events were undertaken at 115 sites within 52 wetlands during this census.

Due to floodwaters inundating a large proportion of the floodplain, a number of the sites surveyed in 2010-11 were located within newly inundated areas of floodplain that have not been included within past SA MDB NRM Board and DENR monitoring programs.

Analysis of the 2010-11 survey data was conducted to determine if there were correlations between wetland location, Southern Bell Frog presence/abundance, wetland hydrology and habitat type.

## 1.4 Historical Survey Data

Historical Southern Bell Frog records, from the SA border to Wellington, were collated and presented to show the distribution of the species along the River Murray corridor in SA from 1992 to 2005. Past historical data records and surveys for Southern Bell Frog between the SA border and Wellington include:

- Frog Census (Biological Database of South Australia)
- Murray Valley Biological Survey Impacts of Salinity on Murray River Valley Floodplain Fauna (Stewart *et al.* 2010)
- SA MDB NRM Board Wetland Baseline Surveys (Holt *et al.* 2004)

## 2. Community Engagement

In order for conservation efforts to be successful, it is essential that the community supports and is involved in the management of natural resources. Encouraging community participation in the management of wetlands and communicating the importance of the River Murray, wetlands and dependent biota has become increasingly important. This census has provided an opportunity to engage the community in the conservation of a threatened iconic species whilst educating them on the importance and functions of wetlands.

A community engagement program was conducted in conjunction with the Southern Bell Frog survey. This included workshops and presentations to various local community groups, Local Action Planning Associations and the general public. Community members were invited to participate in the surveys as well as wetland open days held in the Riverland and Murray Bridge. An important component of the program was to engage existing community members involved in wetland management and to encourage new volunteers.

The following community engagement activities and communication materials were delivered through this project:

| | |
|---|---|
| Communication Strategy | Development of Communication Strategy, February 2011 (see Appendix 1). |
| Community group participation in frog surveys | The 2010-11 frog census involved the participation of six Local Action Planning Associations, and 10 wetland community groups undertaking monitoring surveys in conjunction with the SA MDB NRM Board in spring and summer. At total of 30 volunteers participated in the surveys. |
| World Wetlands Day Workshop, 17th February 2011 | A wetland open day was held at Yatco Lagoon on 17th February 2011 to encourage community participation in wetland projects and to provide information and knowledge on the importance of wetlands in particular for the Southern Bell Frog. The wetland day included displays of wetland fauna and tours of the wetland. Approximately 50 people attended the event. |
| Riverglades Open Wetland Day Workshop, 16th April 2011 | A wetland open day was held on 17th April 2011 to encourage community participation in wetland projects and to provide information and knowledge on the importance of wetlands, particularly for the Southern Bell Frog. The open day included a Southern |

| | |
|---|---|
| | Bell Frog display and the distribution of Southern Bell Frog Fact Sheets. Approximately 120 people attended the event. |
| Southern Bell Frog Fact Sheet and survey questionnaire | Distributed 100 fact sheets and survey questionnaires at the Riverglades Wetland Open Day (fact sheet attached in Appendix 2). |
| Media Release | The following media release was developed:<br><br>'*Southern Bell Frog responsive to environmental water*' |
| Newspaper articles | The following articles were published in local newspapers:<br><br>'*Survey of struggling Southern Bell Frog'*, Murray Pioneer.<br><br>'*Eye on our Regional Wetlands'*, Loxton News.<br><br>'*Local Flooding Spurs Frog Frenzy*', Loxton News.<br><br>'*Wetlands wild day a hit'*, Murray Standard. |
| Other media coverage | Worlds Wetland day at Yatco Lagoon was featured on WIN News in the Riverland on 17th February 2011.<br><br>2 radio interviews were conducted with 5MU and ABC radio stations regarding the wetland open days, the recent floods and the significant response of fauna such as the Southern Bell Frog.<br><br>Mid Murray LAP Newsletter featured a wetland article on the Southern Bell Frog and the 2010-11 frog census. |
| Community Action for the Rural Environment (CARE) Team presentations | Presentations were given to the CARE team (attendance 15-20 people) at the commencement of the project in January 2011.<br><br>Presentation on the results of the project will be given at July 2011 CARE Team meeting. |

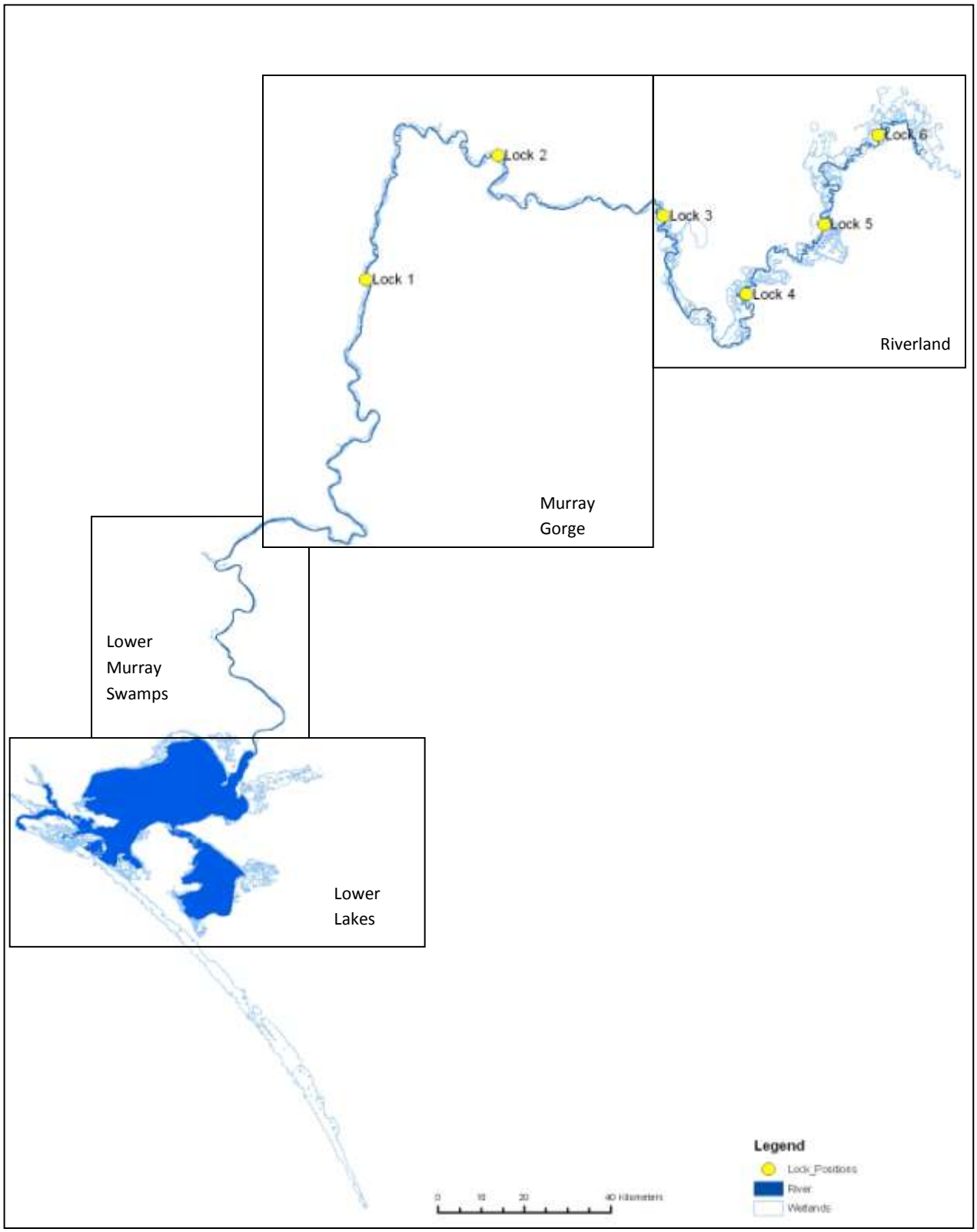



**Figure 1:** Map of the South Australian River Murray

# 3. Literature Review

## 3.1 Distribution

The Southern Bell Frog, *Litoria raniformis* (Hylidae), was once one of the most common frogs in many parts of south-eastern Australia, including Tasmania. The range of this species has declined markedly and the loss of populations has resulted in a fragmented, disjunctive distribution (Clemann and Gillespie 2010), particularly since the early 1990's (Schultz 2007). As a result the species is now considered nationally threatened (listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*) and threatened within South Australia (listed as Vulnerable under the *National Parks and Wildlife Act 1972*). The species is also listed as Endangered in New South Wales (*Threatened Species Conservation Act 1995*), Vulnerable in Tasmania (*Threatened Species Protection Act 1995*) and Threatened in Victoria (*Flora and Fauna Guarantee Act* 1988).

Factors that are thought to have contributed to the decline in Southern Bell Frog populations are:

- habitat loss and habitat fragmentation stemming from a lack of flooding caused by river regulation, over extraction of water from the system and recent prolonged periods of drought
- introduced predators, e.g. Gambusia (*Gambusia holbrooki*)
- environmental pollutants, and
- degradation of aquatic and riparian vegetation (Schultz 2005).

Within South Australia, the species is now restricted to scattered populations in the River Murray corridor and in the south-east of the state (Schultz 2007). The Riverland region (Lock 3 to the SA border) (Figure 1) has the highest concentration of sites where Southern Bell Frogs have been recorded in the South Australian section of the River Murray corridor (Schultz 2006). The next highest concentration is within the Murray Gorge section (Mannum to Lock 3) and the lowest is the Lower Murray swamps (Mannum to Wellington) and the Lower Lakes and Coorong (Schultz 2006) (Figure 1). A possible explanation for the higher concentration of records in the Riverland is that there are more managed wetlands in this region, and hence a more concentrated monitoring effort. However, SA MDB NRM Board baseline surveys (Holt *et al.* 2004; Simpson *et al.* 2006) also showed a greater number of recorded calls within the Riverland region, even though the surveys included an even distribution of sites from Lock 1 to the SA border (Schultz 2008).

## 3.2 Description

The Southern Bell Frog is also known as the Golden Bell Frog, Green and Golden Grass Frog, or the Growling Grass Frog due of their loud growling 'crawaark' calls (Mason and Hillyard 2011). It is the largest (up to 10cm) of the 12 frog species found within the South Australian Murray-Darling Basin (Mason and Hillyard 2011).

The colour of adult Southern Bell Frogs varies from dull olive to bright emerald-green on the dorsum, with large irregular golden-brown blotches. The groin and thighs are usually bluish, and lower sides and underside are off-white (Clemann and Gillespie 2010). They also have numerous large warts, tabernacles and short skin folds on the back (Cogger 2000).

The Southern Bell Frog is a generalist carnivore and opportunistic forager, that will sit and wait to ambush prey (DEC 2005). Foraging can occur during the night and day (Cogger *et al.* 1983) and the species has been observed feeding on a range of aquatic and terrestrial prey, including beetle larvae, beetles, snails, grasshoppers, flies, tadpoles, other frogs (including its own species), small fish, lizards and small snakes (Pyke 2002).

Mating and spawning occurs both day and night over an extended period from August to February, although calling has been recorded as late as March and April (Pyke 2002; Schultz 2005). Males call while floating in standing water or from vegetation close to the water's edge (Pyke 2002). Calls can be heard during day and night, generally in warm and calm conditions (Schultz 2005). The maximum detection of calls within the South Australian River Murray corridor is between November and January (Schultz 2006).

Southern Bell Frog tadpoles have an aquatic period lasting 2-15 months, grow to 11cm in length and have a characteristic green to yellowish colour dorsal surface in later stages of development (Anstis 2002). Tadpoles are known to metamorphose in late summer to autumn. If metamorphosis is not completed before the onset of winter, tadpoles may 'over winter' and metamorphose in the following summer (Gillespie *et al*. 2004). The extent of the tadpole's ability to 'over winter' is unknown and it is thought that individuals forced to delay metamorphosis until the next spring will show low recruitment rates (Mann *et al.* 2010).

Fish may impact on the breeding success of the Southern Bell Frog. Predation by fish, in particular exotic species such as Redfin Perch (*Perca fluviatilis*) and Gambusia, on amphibian larvae and possibly adults may have a significant impact on populations (Gillespie and Hero 1999). The species is also thought to be sensitive to high fish densities and habitat disturbance (Pyke 2002), e.g. high density of Common Carp (*Cyprinus carpio*) may have contributed to poor recruitment during a watering program implemented in 2007 due to disturbance to vegetation (Wassens *et al.* 2008a). Southern Bell Frogs were likely to have been found at sites that excluded Common Carp from the wetland, or had denser submerged habitat that limited the impact of Common Carp on the vegetation habitats (Wassens *et al.* 2008a).

## 3.3 Habitat – Wetland and Hydrology

Southern Bell Frogs are known to be associated with permanent water bodies such as lagoons, farm dams, ponds, marshes, creeks and rivers with emergent vegetation (Schultz 2005), and small permanent water bodies within irrigation areas (Wassens *et al.* 2008b).

This species also uses seasonally and temporarily flooded water bodies (Schultz 2007; Wassens *et al.* 2008a). It is likely that individuals move to seasonally flooded or temporary wetlands for breeding, and

then move back to permanent water bodies as refuges when temporary habitats dry out (Pyke 2002; Wassens *et al.* 2008b; Mason and Hillyard 2011). Individuals will respond to flooding by readily occupying the shallow, newly inundated vegetated areas to breed (Mason and Hillyard 2011). In the Lowbidgee irrigation area of NSW, individuals remain in permanent water bodies in November, but abandon these areas in favour of flooded ephemeral water bodies by January (Wassens *et al.* 2008b). As these temporary water bodies dry, the frogs return to the permanent water bodies.

Individuals may make substantial overland movements from permanent water bodies to take advantage of newly flooded temporary wetlands, possibly up to distances of 500m (Schultz 2005). There is no difference in the movements of females and males, which have been found to move in similar directions and over similar distances (Wassens *et al.* 2008b). Local weather conditions may not influence movement patterns, but individuals are known to disperse further distances when occupying ephemeral water bodies in January than when occupying permanent water bodies in November and April / May (Wassens *et al.* 2008b).

Southern Bell Frogs generally breed following floods in water bodies that are either ephemeral or have significant water level fluctuations. They are considered to be less opportunistic than other sympatric species, and as a result are likely to be affected by changes in flow regimes (Mann *et al.* 2010). It is likely that availability of ephemeral habitats and flooding at smaller spatial and temporal scales influences recruitment success, with the larger scale flooding facilitating dispersal to vacant habitat and gene pool flow (Wassens *et al.* 2008b). Generally, wetlands subject to annual flooding are more likely to support Southern Bell Frogs than those flooded less frequently (Wassens *et al.* 2008a).

Successive dry years and reductions in flooding have substantially reduced and fragmented the wetland habitats on which populations depend and this has also had an impact on breeding events (Schultz 2005; Wassens *et al.* 2008a). Reductions in flood frequency and extent of ephemeral wetlands due to changes in flooding also have the capacity to limit dispersal of the species even when permanent water bodies remain unchanged (Wassens *et al.* 2008b).

During the recent drought period, a number of projects within South Australia have involved the watering of temporary wetlands via pumping, or the drying and re-wetting of permanent wetlands through the operation of wetland infrastructure. In areas such as the Chowilla Floodplain in South Australia, there is a combination of permanent anabranches providing non-breeding season refugia and temporary wetlands and environmental watering programs, which has created ideal breeding conditions for the Southern Bell Frog (Schultz 2007). Large numbers of tadpoles have been recorded in temporary wetlands in the upper SA River Murray that have been artificially watered through pumping (Shultz 2007; SA MDB NRM 2011).

Comparisons of wetlands occupied by the Southern Bell Frog in the South Australian Murray-Darling Basin showed that they were most commonly located in wetlands with fluctuating water levels and in a National Parks, Game Reserves, Bookmark Biospheres or Conservation Parks. Sites at which they were

not recorded were predominantly permanent wetlands located outside of Conservation Reserves (Schultz 2006).

## 3.4 Habitat - Vegetation

Southern Bell Frogs are strongly associated with habitats containing aquatic and emergent vegetation, and an overstorey of River Red Gums (*Eucalyptus camaldulensis*) or Black Box (*E. largiflorens*) (Schultz 2006; Wassens *et al.* 2008a).

A recent survey within the Lower Lakes found that most Southern Bell Frogs records were within recently inundated, vegetated and sheltered areas, featuring inundated terrestrial, emergent and submerged vegetation (Mason and Hillyard 2011). Frogs were recorded calling within Lignum (*Muehlenbeckia florulenta*), floating aquatic plants (*Lemna* spp. and algae) and inundated grasses both floating and along wetland fringes containing grasses, sedges or both (Mason and Hillyard 2011). Generally frogs were found occupying sites that contained diverse plant assemblages that had evidence of trampling by stock.

In a study undertaken in NSW, the species was found in River Red Gum wetlands that were dominated by emergent and floating vegetation, eg Tall Spike Rush (*Eleocharis spacelata*) and Water Primrose (*Ludwigia peploides* ssp*. montevidensis*), and Black Box/Lignum wetlands containing abundant floating and submerged vegetation, typically Nardoo (*Marsilea mutica*) and Common Milfoil (*Myriophyllum papillosum*) (Wassens *et al.* 2008a). The probability of occupancy increased with increasing cover of emergent and submerged vegetation, and individuals were recorded in wetlands with a significantly higher percentage of emergent vegetation rather than vacant sites (Wassens *et al.* 2008a).

Within the South Australian Murray-Darling Basin the majority of sites the species was recorded in were wetlands with shallow banks, clay substrate, a predominantly River Red Gum over-storey, a Lignum dominant mid-story and an understory dominated by sparse grasses. Flooded terrestrial vegetation was the dominant aquatic vegetation (Schultz 2006). Although logistic analysis did not find a significant difference in dominant species of vegetation for Southern Bell Frog presence / absence, it is apparent that the wetlands at which no frogs were recorded were more degraded than those with Southern Bell Frog records (Schultz 2006). Sites at which they were absent were predominantly wetlands with medially sloping banks, an overstorey of predominantly dead River Red Gums, a mid-storey that was generally densely structured and made up of Lignum, Typha (*Typha* spp.) and reeds or no mid storey. Salt tolerant species were the dominant understorey, and Typha and reeds the dominant aquatic vegetation (Schultz 2006).

## 3.5 Implications for Conservation and Wetland Management

The literature indicates that flooding of temporary wetlands is particularly important for the successful breeding and recruitment of the Southern Bell Frogs and the reduction in flooding frequency and inundation of temporary areas has had a negative impact on its populations.

Conservation of the Southern Bell Frog will depend on regular flooding events at some sites to promote recruitment, and this should occur on an annual (Wassens *et al.* 2008a) or biennial basis (Mann *et al.* 2010). Conservation plans should incorporate both permanent and ephemeral wetlands when considering refuge and breeding habitats for this species (Wassens *et al.* 2008b).

It is clear that during periods of low flows and drought, watering programs promoting the inundation of temporary sites or fluctuation of wetland water levels, will be particularly important in the maintenance and recovery of Southern Bell Frog populations. The preferred breeding habitats are likely to be sites that provide diverse submerged and emergent vegetation upon reflooding, with an overstorey of River Red Gum or Black Box. Wetland sites and watering events (such as pumping) that limit fish densities are also likely to have a positive impact on successful recruitment. Timing of inundation is another important consideration, such that enough time is provided for metamorphosis to complete before the onset of winter.

# 4. Methodology

## 4.1 Historical records

Historical records for Southern Bell Frogs, from the SA border to Wellington (1992 to 2005) were mapped as part of this project. Records are from the following surveys:

- Environmental Protection Agency (EPA) Frog Census (Biological Database of South Australia, DENR)
- Murray Valley Biological survey Impacts of salinity on Murray River Valley Floodplain Fauna (Stewart *et al.* 2010)
- SA MDB NRM Board wetland Baseline surveys (Holt *et al.* 2004)
- SA Museum Vertebrate Data (Biological Database of South Australia, DENR).

## 4.2 Census 2010-11

### 4.2.1 Wetland Hydrology Types

Wetlands along the River Murray in South Australia have a range of different hydrological regimes. A defining characteristic influencing the condition, habitats and species is whether the wetland is permanent or temporary.

Wetland projects within the SA River Murray involve the active management of the hydrology (water regime) of the wetland to improve the condition of habitats and biodiversity. A number of methods are used in wetland management including the drying of permanent wetlands through the use of a structure, or inundating temporary wetlands through pumping.

Wetland monitoring programs (DENR and SA MDB NRM Board) and targeted surveys (baseline surveys, River Murray Valley survey) monitor frogs at a range of different wetlands, with varying hydrological regimes, including managed and non-managed wetland sites.

The hydrology of the wetlands surveyed within this project have been characterised as follows:

- Permanent wetlands:
    - permanent pool level wetlands and creek sites (not managed)
    - permanent wetlands below Lock 1 (not managed but underwent prolonged drying phase when River levels below Lock 1 declined during the drought)

- Ephemeral wetlands:
    - pool level managed wetlands (managed to implement wetting and drying, can be permanently connected at pool level)
    - temporary (above pool level) wetlands:
        - pumped wetlands (water pumped into wetland during low river flows / drought)
        - flooded wetlands (inundated during 2010-11 high river flows)

**Permanent Pool Level Wetlands**

Following the construction of the Locks / Weirs and Barrages, a number of the lower lying wetlands along the length of the River Murray in SA, around 70% of the total wetland area (Pressey 1986), became permanently inundated due to the maintenance of water levels (known as pool level) upstream of each Lock. The majority of permanent wetlands do not have any active hydrological management; however they do experience changes in water levels and hydrology, particularly during flooding, eg the 2010-11 high river flows.

**Permanent Wetlands Below Lock 1**

There are an estimated 75-80 permanent wetlands located between Lock 1 and Wellington. A small number of wetlands along this reach have been managed for wetting and drying, however the majority of sites are not hydrologically managed and are permanently connected to the main river channel at pool level (0.75m AHD).

During the recent drought the river levels along this reach were lowered, dropping to as low as approximately -1.165m AHD (1.165m below sea level) in April 2009. This led to disconnection and eventual drying of all but three of the wetlands. Improvements in water resources in 2010 led to the raising of the River Murray to pool level (~ 0.75m AHD) and subsequently the re-inundation of all permanent wetlands. The 2010-11 high river flows has since led to river levels exceeding pool level, and the flooding of all wetlands and parts of the floodplain from Blanchetown to Mannum.

**Ephemeral - Pool Level Managed Wetlands**

A number of pool level permanent wetlands have had structures installed on their inlets which are managed by closing structures to induce occasional drying or partial drying events. The purpose of this type of management is to fluctuate the water levels and dry the wetland beds. Following a dry or partial dry phase the structures are re-opened to inundate the wetland and provide re-connection to the main River channel. The timing of the wetting and drying phases is dependent on the characteristics of the individual wetland such as surface area, depth, water quality and habitat conditions.

The recent drought had a significant impact on the pool level managed wetlands above Lock 1. To achieve evaporative water savings, the wetland structures were closed and the wetlands were dried for prolonged periods of time. Improvements in water resources in 2010 saw the re-connection of all pool level managed wetland sites. Since this time, the 2010-11 high flows has led to the overbank flooding (water spilling out of the wetland onto the surrounding floodplain) at all of these sites.

**Ephemeral – Temporary, Pumped Wetlands**

Temporary wetlands are located above pool level, at higher elevations on the floodplain, or have inlets that have commence-to-flow levels higher than pool. At increasing river flow rates, larger areas of temporary wetlands and floodplain areas are inundated. During the period of 1993 to 2010, there was a significant reduction in the height and occurrence of high flows. As a result the majority of the

floodplain, including temporary wetlands, experienced prolonged periods of dry leading to a decline in their health.

Since 2005, a number of temporary wetlands sites have been identified as requiring environmental watering due to their poor condition, in particular the long-lived vegetation. During the drought many sites were also identified as requiring watering to provide drought refuge for water dependent species, such as the Southern Bell Frog. The watering of temporary wetlands during the period 2005 – 2010 often involved installation of banks, operation of structures and pumping of water to hold water within these wetland basins.

**Ephemeral - Flooded Temporary Wetlands**

During summer 2010-11, river flows reached a maximum rate of 93,000 ML/day at the SA border. This led to the inundation of the majority of temporary wetlands and floodplain areas between the SA border and Mannum. A number of temporary wetlands, which are now inundated due to the high flows, were also part of pumping projects during the drought from 2005 to 2010.

### 4.2.2 Survey Site Selection

Wetlands survey sites within this project were located along the length of the River Murray from the SA border to Wellington. Surveys were undertaken by DENR and the SA MDB NRM Board monitoring programs.

At each wetland a varying number of monitoring sites were surveyed, and were often located within different habitats around the wetland. In total 115 monitoring sites within 52 wetlands were surveyed during spring / summer of 2010-11 (Table 1).

**Table 1: Wetland name, location (Universal Transverse Mercator zone 54H) and type of spring / summer 2010-11 Southern Bell Frog survey sites**

| Site code | Wetland name | Wetland hydrology | Easting | Northing |
|---|---|---|---|---|
| Aku_FR03 | Akuna | Ephemeral – above pool | 430688 | 6210688 |
| BOAFRO1 | Boat Creek | Ephemeral – above pool | 492612 | 6241881 |
| Bre_FR04 | Brenda Park | Ephemeral – pool level managed | 377220 | 6226977 |
| Bre_FR06 | Brenda Park | Ephemeral – pool level managed | 377727 | 6229875 |
| CARFRO1 | Carpark Lagoons | Ephemeral – above pool | 456883 | 6197255 |
| CARFRO2 | Carpark Lagoons | Ephemeral – above pool | 457461 | 6196460 |
| CARFRO3 | Carpark Lagoons | Ephemeral – above pool | 457659 | 6196147 |
| CAUFR01 | Caurnamont | Permanent – recently dried | 372516 | 6142377 |
| CAUFR02 | Caurnamont | Permanent – recently dried | 372059 | 6142777 |
| CAUFRO1 | Causeway Lagoon | Ephemeral – pool level managed | 462908 | 6203457 |
| CAUFRO2 | Causeway Lagoon | Ephemeral – pool level managed | 463724 | 6203288 |
| CH15FRO | Campsite 15 | Permanent – never dried | 488842 | 6243825 |
| CH7FRO | Campsite 7 | Permanent – never dried | 487229 | 6239939 |
| CHBRFRO | Chowilla Bridge | Permanent – never dried | 489496 | 6241430 |
| CRAFR01 | Craignook | Permanent – recently dried | 373646 | 6139580 |

| | | | | |
|---|---|---|---|---|
| CRAFR02 | Craignook | Permanent – recently dried | 374194 | 6139305 |
| DDSFR01 | Devon Downs South | Permanent – recently dried | 372570 | 6161089 |
| DEVFR01 | Devon Downs North | Permanent – recently dried | 376675 | 6164600 |
| DEVFR02 | Devon Downs North | Permanent – recently dried | 373327 | 6161037 |
| ECKFRO1 | Eckerts Creek | Permanent – never dried | 460195 | 6202428 |
| ECKFRO10 | Eckerts Creek | Permanent – never dried | 456576 | 6198481 |
| ECKFRO2 | Eckerts Creek | Permanent – never dried | 459294 | 6202755 |
| ECKFRO3 | Eckerts Creek | Permanent – never dried | 458540 | 6202763 |
| ECKFRO4 | Eckerts Creek | Permanent – never dried | 458032 | 6201926 |
| ECKFRO5 | Eckerts Creek | Permanent – never dried | 458285 | 6202132 |
| ECKFRO6 | Eckerts Creek | Permanent – never dried | 458858 | 6201459 |
| ECKFRO7 | Eckerts Creek | Permanent – never dried | 458508 | 6199625 |
| ECKFRO8 | Eckerts Creek | Permanent – never dried | 457775 | 619782 |
| ECKFRO9 | Eckerts Creek | Permanent – never dried | 456468 | 6200246 |
| Har_FR03 | Hart Lagoon | Ephemeral – pool level managed | 405174 | 6218097 |
| Har_FR04 | Hart Lagoon | Ephemeral – above pool | 403311 | 6218822 |
| HOGFR01 | Hogwash Bend | Ephemeral – above pool | 393178 | 6229390 |
| JURFR01 | Jury Swamp | Permanent – recently dried | 346550 | 6120022 |
| L6CFRO1 | Lock 6 Cumbungi Swamp | Permanent – never dried | 491081 | 6238974 |
| L6CFRO2 | Lock 6 Cumbungi Swamp | Permanent – never dried | 490598 | 6238724 |
| L6DFRO1 | Lock 6 Cumbungi Swamp | Permanent – never dried | 490938 | 6239023 |
| L6DFRO2 | Lock 6 Cumbungi Swamp | Permanent – never dried | 490632 | 6238888 |
| L6WFRO1 | Lock 6 Wetland | Ephemeral – above pool | 490009 | 6238305 |
| L6WFRO2 | Lock 6 Wetland | Ephemeral – above pool | 490465 | 6238305 |
| L6WFRO3 | Lock 6 Wetland | Ephemeral – above pool | 491198 | 6238800 |
| LAKFR01 | Lake Carlet | Permanent – recently dried | 365806 | 6139969 |
| LAKFR02 | Lake Carlet | Permanent – recently dried | 362224 | 6140477 |
| LAKFR03 | Lake Carlet | Permanent – recently dried | 358018 | 6142038 |
| LDUFRO1 | Little Duck Lagoon | Ephemeral – pool level managed | 462740 | 6203356 |
| LDUFRO2 | Little Duck Lagoon | Ephemeral – pool level managed | 462699 | 6203506 |
| LkbFR01 | Lake Bonney | Permanent – never dried | 446436 | 6215518 |
| LkbFR02 | Lake Bonney | Ephemeral – pool level managed | 440710 | 6215885 |
| Lov_FR09 | Loveday Lagoon | Permanent – never dried | 443911 | 6204617 |
| MBIFRO1 | Morgan Back – Bird Lagoon | Ephemeral – above pool | 378412 | 6233825 |
| MMEFRO1 | Morgan Back – Meeting Lagoon | Ephemeral – above pool | 378998 | 6233998 |
| Mol_FR06 | Molo Flat | Ephemeral – above pool | 390990 | 6230934 |
| MORFR01 | Morgan's Lagoon | Permanent – recently dried | 371372 | 6184652 |
| MORFR02 | Morgan's Lagoon | Permanent – recently dried | 371554 | 6185250 |
| MORFR03 | Morgan's Lagoon | Permanent – recently dried | 370998 | 6183989 |
| MORFRO1 | Morgan Conservation Park | Ephemeral – pool level managed | 377984 | 6233094 |
| MORFRO2 | Morgan Conservation Park | Ephemeral – pool level managed | 378277 | 6232825 |
| MORFRO3 | Morgan Conservation Park | Ephemeral – pool level managed | 378008 | 6232735 |
| MORFRO4 | Morgan Conservation Park | Ephemeral – pool level managed | 378423 | 6232433 |
| MPL_FR01 | Murbpook Lagoon | Ephemeral – above pool | 374217 | 6215277 |
| MPL_FR03 | Murbpook Lagoon | Ephemeral – above pool | 374135 | 6214060 |
| MRK_FR01 | Markaranka | Ephemeral – above pool | 394863 | 6229325 |
| Mur_FR05 | Murbko South | Ephemeral – above pool | 376653 | 6218524 |
| MURFR01 | Murrundi | Permanent – recently dried | 352469 | 6090850 |
| NelFR01 | Nelwart Swamp | Ephemeral – pool level managed | 477367 | 6214651 |
| NGAFRO1 | Ngak Indau | Ephemeral – pool level managed | 459866 | 6201480 |

| | | | | |
|---|---|---|---|---|
| NGAFRO2 | Ngak Indau | Ephemeral – pool level managed | 459908 | 6201071 |
| NGAFRO3 | Ngak Indau | Ephemeral – pool level managed | 459642 | 6201173 |
| Nig_FR01 | Nigra Creek | Permanent – never dried | 403088 | 6224519 |
| Nig_FR04 | Nigra Creek | Ephemeral – pool level managed | 400606 | 6228065 |
| NOOFR01 | Noonawirra | Permanent – recently dried | 369143 | 6181781 |
| NOOFR02 | Noonawirra | Permanent – recently dried | 369116 | 6182058 |
| OVEFR02 | Overland Corner | Ephemeral – above pool | 440473 | 6218115 |
| OVEFR04 | Overland Corner | Ephemeral – above pool | 439955 | 6220300 |
| OVEFR05 | Overland Corner | Ephemeral – above pool | 439160 | 6220737 |
| PAIFR01 | Paiwalla Wetland | Ephemeral – pool level managed | 351205 | 6121933 |
| PAIFR02 | Paiwalla Wetland | Ephemeral – pool level managed | 351523 | 6122354 |
| PAIFR03 | Paiwalla Wetland | Ephemeral – pool level managed | 351258 | 6122231 |
| PAIFR04 | Paiwalla Wetland | Ephemeral – pool level managed | 351553 | 6122359 |
| PCRFRO1 | Pilby Creek | Ephemeral – pool level managed | 488983 | 6240178 |
| PCRFRO2 | Pilby Creek | Ephemeral – pool level managed | 488758 | 6240208 |
| PIPFRO1 | Pipeclay Lagoon | Ephemeral – pool level managed | 493204 | 6242611 |
| PLAFRO1 | Pilby Lagoon | Ephemeral – pool level managed | 490168 | 6238610 |
| PLAFRO2 | Pilby Lagoon | Ephemeral – pool level managed | 490751 | 6239548 |
| PpkFR01 | Paringa Paddock | Ephemeral – above pool | 477274 | 6217605 |
| PpkFR02 | Paringa Paddock | Ephemeral – above pool | 478166 | 6217543 |
| PpkFR03 | Paringa Paddock | Ephemeral – above pool | 478582 | 6217602 |
| Ram_FR01 | Ramco Lagoon | Ephemeral – above pool | 399700 | 6220050 |
| Ram_FR02 | Ramco Lagoon | Ephemeral – pool level managed | 400726 | 6218509 |
| Ram_FR03 | Ramco Lagoon | Ephemeral – above pool | 401614 | 6218767 |
| REEFR01 | Reedy Creek | Permanent – recently dried | 340339 | 6131343 |
| REEFR02 | Reedy Creek | Permanent – recently dried | 339741 | 6131517 |
| REEFR03 | Reedy Creek | Ephemeral – above pool | 340004 | 6132065 |
| REEFR05 | Reedy Creek | Ephemeral – above pool | 338875 | 6132277 |
| REEFR06 | Reedy Creek | Permanent – never dried | 337641 | 6132937 |
| SAN_FR01 | Santos Evaporation Basin | Permanent – never dried | 465625 | 6211698 |
| SUGFR01 | Sugar Shack | Permanent – recently dried | 371342 | 6177959 |
| SWAFR01 | Swanport | Permanent – recently dried | 346424 | 6109098 |
| SWAFR02 | Swanport | Permanent – recently dried | 346296 | 6109067 |
| SWAFR03 | Swanport | Permanent – recently dried | 346398 | 6109197 |
| SWAFR04 | Swanport | Permanent – recently dried | 346142 | 6109212 |
| SWEFR01 | Sweeney's Lagoon | Ephemeral – above pool | 373335 | 6195845 |
| SWEFR02 | Sweeney's Lagoon | Ephemeral – above pool | 373221 | 6196426 |
| WINFRO1 | Winding Creek | Ephemeral – pool level managed | 464222 | 6203301 |
| WINFRO2 | Winding Creek | Ephemeral – pool level managed | 465193 | 6203237 |
| WONFR01 | Wongulla | Permanent – recently dried | 368697 | 6157995 |
| WONFR02 | Wongulla | Permanent – recently dried | 367414 | 6157165 |
| WONFR03 | Wongulla | Permanent – recently dried | 366489 | 6156184 |
| YATFR01 | Yatco Lagoon | Ephemeral – pool level managed | 441967 | 6203795 |
| YATFR05 | Yatco Lagoon | Ephemeral – pool level managed | 441240 | 6201470 |
| YATFR06 | Yatco Lagoon | Ephemeral – pool level managed | 441778 | 6203109 |
| YHWFR01 | Younghusband West | Permanent – recently dried | 355797 | 6140939 |
| YHWFR02 | Younghusband West | Permanent – recently dried | 355229 | 6141017 |
| YOUFR01 | Younghusband | Permanent – recently dried | 360095 | 6140572 |
| YOUFR02 | Younghusband | Permanent – recently dried | 360335 | 6140420 |
| YOUFR03 | Younghusband | Permanent – recently dried | 360405 | 6140367 |

### 4.2.3 Habitat Assessment

Habitat assessments were undertaken at each of the survey sites within each of the wetlands surveyed in the 2010-11 census. This involved recording the physical and biological attributes of the site using a method adapted from the habitat assessment developed by Native Fish Australia (Hammer 2005).

Alterations to the Native Fish Australia assessment were made to reflect the wetland types that were being surveyed for frog habitat. A range of habitat variables were recorded (Table 2) typically using cover abundance scores (Table 3).

Water quality monitoring was undertaken in situ using hand-held meters during the habitat assessments surveys. Parameters monitored included salinity, pH, turbidity and temperature.

**Table 2: Habitat variables recorded at each site**

| **Wetland type (e.g. lake edge, marsh/swamp)** | **Submerged biological and physical cover (%)** |
|---|---|
| Pool condition (e.g. dry, concentrated) | Floating vegetation cover (%) |
| Flow environment (e.g. ephemeral) | Emergent vegetative cover (%) |
| Flow | Fringing vegetative cover (%) |
| Land use | Surrounding vegetation cover (%) |
| Bank slope | Canopy cover |
| Time since inundation (months) | Water quality (Salinity, temperature, pH and turbidity) |

**Table 3: Cover abundance scoring used within habitat assessments**

| **Score** | **Cover Abundance (%)** |
|---|---|
| 0 | 0 |
| 1 | < 5 |
| 2 | 5-25 |
| 3 | 25-50 |
| 4 | 50-75 |
| 5 | > 75 |

### 4.2.4 Nocturnal Surveys 2010-11

The methodology used in this survey follows methods outlined in Your Wetland – Monitoring Manual (Tucker 2004). Species were identified via call recognition and recorded on data sheets *in situ*. Calls were recorded using a Sony digital voice recorder (Model ICD-P620), and Yoga shotgun uni-directional microphone (Model EM-2700). An abundance score between 0 and 4 was given to all species recorded at each site (Table 4). As frogs become difficult to count in higher abundances, scoring is an effective way to estimate numbers.

Humidity and temperature were also recorded using a hand-held hygrometer and thermometer (Model LM-81HT) and scores were given to amount of moon, wind, rain and cloud present at the time of each survey (Table 5).

Surveys were conducted at each site during early nightfall (between 8pm and 12am). To prepare for call recognition and call recording, sites were approached as quietly as possible, ensuring cars and lights were turned off. After a few minutes, call recognition and recordings were undertaken for 3 to 5 minutes at each site.

Species identification and abundance scores were primarily from on site call recognition. Call recordings were used so that if a call from a species was not identified at the time of the survey, the recordings could be analysed and the species identified at a later date.

**Table 4: Abundance scores for nocturnal frog surveys**

| Score | Approximate, estimated abundance |
|---|---|
| 0 | 0 (none) |
| 1 | 1 (one) |
| 2 | 2-9 (few) |
| 3 | 10-50 (many) |
| 4 | >50 (lots) |

**Table 5: Atmospheric variables observed and recorded at each location and at each recording**

| Variable | Measure |
|---|---|
| Air temperature | Degrees Celsius |
| Humidity | % relative humidity |
| Moon | 0-4 scale |
| Wind | 0-4 scale |
| Rain | 0-4 scale |
| Cloud | 0-8 scale |

## 4.3 DENR Monitoring Program 2004 to 2011

Regular monitoring has been conducted by DENR (formally Department of Environment and Heritage) at a number of managed wetlands along the River Murray from 2004 to 2011. In total 52 survey sites within 24 wetlands have been monitored during this period. The majority of these sites are located in conservation parks within the Katarapko and Chowilla Floodplains. Other sites are also located in the Morgan Conservation Park and Gurra Floodplain.

The data collected at these sites were chosen as part of this project for assessment of Southern Bell Frog presence, absence and abundance over time.

### 4.3.1 Method

The data were collected using the same monitoring methods described for the 2010-11 census in section 4.2.

As part of the analysis of the DENR data, each survey undertaken during 2004 to 2011 was assigned a code corresponding to the season in which the survey was undertaken:

Q1 = summer: December (of the previous year), January and February (of the current year)

Q2 = autumn: March, April and May

Q3 = winter: June, July and August

Q4 = spring: September, October and November

Note, where surveys are undertaken in December, they are denoted at Q1 of the preceding year, ie Dec-2005 is denoted as 2006-Q1.

Where two surveys were undertaken at the same site during the same season in the same year, the record with the lowest abundance of Southern Bell Frogs was removed from the analysis. Where there were two records with the same abundance score, one of the records was removed from the analysis. Records were deleted to exclude any bias towards the number of absence records in any one season for that year where more than two surveys were undertaken.

### 4.3.2 Wetland Hydrology Descriptions

The DENR wetlands surveyed are categorized as the following wetland hydrology types:

- 6 permanent wetland and creek sites
- 9 ephemeral – above pool level wetlands
- 9 ephemeral – pool level managed wetlands

**Permanent wetland sites**

Permanent wetland and creek sites surveyed on the Katarapko floodplain differ from permanent creek sites surveyed on the Chowilla floodplain. The Eckerts Creek sites (Katarapko: Figure 2) and the Lock 6 Cumbungi Swamp (Chowilla) have an average depth of 80cm. Riparian vegetation is dominated by Black Box and Coobah (*Acacia stenophylla*) with patches of River Red Gum. Common Spike Rush (*Eleocharis acuta)* and Water Couch (*Paspalum* spp.) dominating the littoral zone. Aquatic vegetation is diverse and is dominated by Ribbon Weed (*Vallisneria americana*) and Curly Pondweed (*Potamogeton crispus*) with large patches of Typha along the bank margins. Other species include Floating Pondweed (*Potamogeton sulcatus*), Giant Sedge (*Cyperus exaltatus*) and Three-cornered Bulrush (*Bolboschoenus caldwellii*). Sites surveyed at Chowilla such as Chowilla Bridge, Campsite 7 and Campsite 15 are all permanent water sites located along Chowilla Creek. These sites are deep with riparian vegetation which is dominated by Typha and large River Red Gums. Aquatic vegetation species present include small areas of Ribbon Weed, Floating Pondweed and Water Primrose.

**Figure 2:** Eckerts Wide Water at Katarapko, a permanent water body site

**Ephemeral – above pool wetlands**

These wetlands occur above normal river pool level (e.g. Lake Littra: Figure 3) and management during low flow periods typically involves pumping water into them. These particular wetlands often have stands of juvenile River Red Gums and areas of Lignum growing on the wetland bed, and when the wetlands are inundated the areas of vegetation become partially submerged providing diverse habitat. Fringing and surrounding vegetation communities at these sites are comprised of Black Box, River Red Gum, Lignum and salt bush species such as Ruby Salt Bush (*Enchylaena tomentosa*). Aquatic vegetation species associated with these sites are Nardoo, Red Water Milfoil (M*yrophyllum verrucosum*) and *Azolla* spp.

**Figure 3:** Lake Littra on the Chowilla Floodplain, an ephemeral above pool wetland

### Ephemeral – pool level managed wetlands

Pool level managed wetlands (e.g. Morgan Conservation Park: Figure 4) have a flow control structure which enables hydrological management at pool level flows. A number of pool level wetlands surveyed occur within close proximity to the river (the "flush zone") and therefore generally the surrounding floodplain vegetation consisting of Lignum, River Red Gum and Black Box is in moderate to good health. Riparian vegetation is usually dominated by Phragmites (*Phragmites australis*) or Typha and at some sites Lignum grows to the edge of the water body. Dominant aquatic vegetation species found in these wetland types include Ribbon Weed, Water Primrose and Floating Pondweed.

**Figure 4:** Morgan Conservation Park, an ephemeral pool level managed wetland

# 5. Data Results

## 5.1 Historical Data

Historical survey data were used to generate maps showing the locations of Southern Bell Frog records from the SA border to Wellington during 1992 to 2005 (Figure 5).

From 1992 to 2005 Southern Bell Frogs were present at a total of 152 sites. Whilst the records of location and presence of the species is dependent on survey effort, the map indicates that during the historical record period, Southern Bell Frogs have been recorded in wetlands along the entire length of the River from the SA border to Wellington. The EPA Frog Census was undertaken each year from 1995 to 2005. The Murray Valley Biological Survey and SA MDB NRM Board Baseline Survey were both undertaken in 2003 and 2004.

**Table 6:** Number of Southern Bell Frog records from 1992 to 2005

| Year | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of records | 2 | 3 | 1 | 17 | 15 | 4 | 16 | 8 | 23 | 4 | 0 | 25 | 17 | 17 |

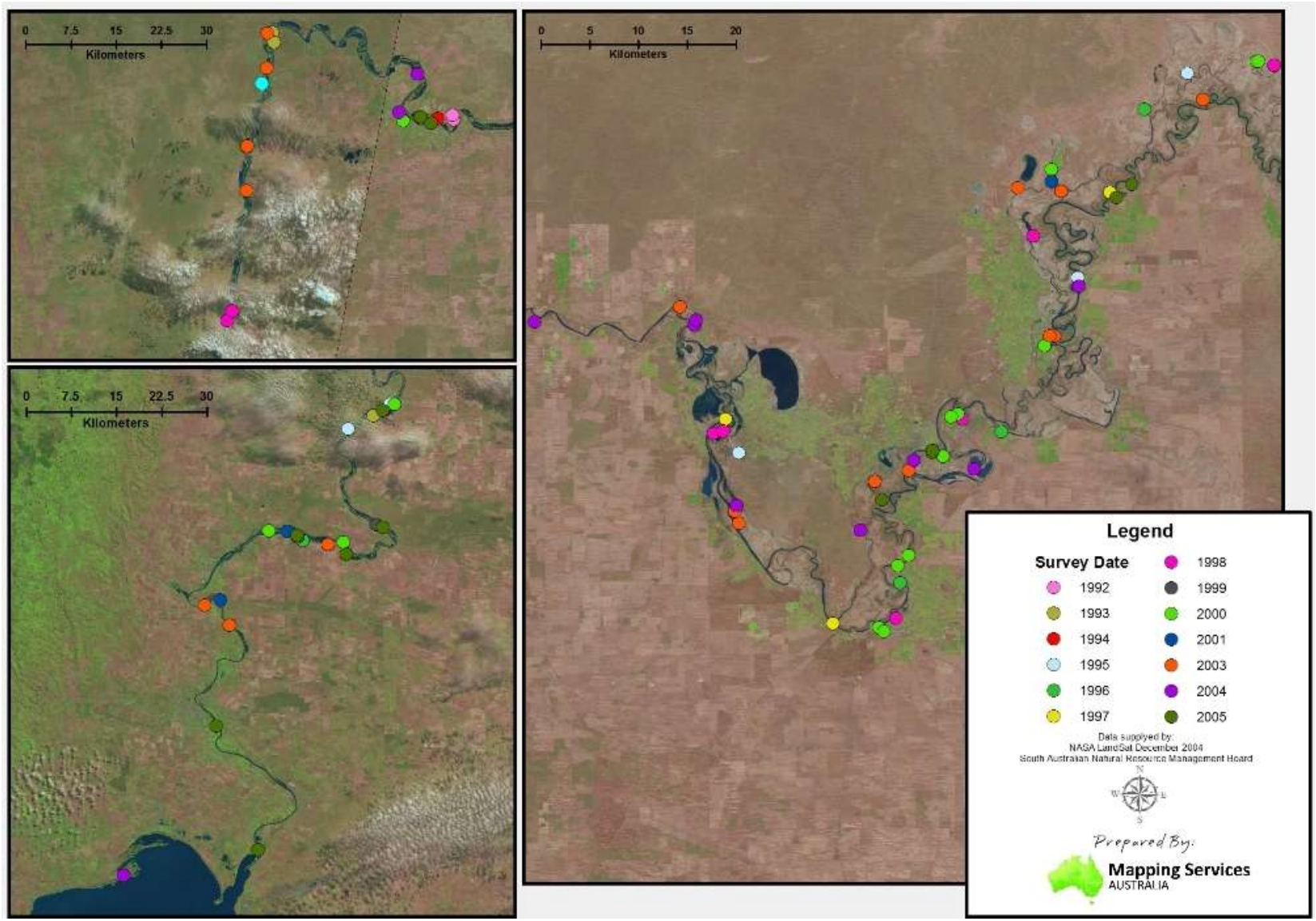



**Figure 5:** Map of all historical Southern Bell Frog records along the SA River Murray corridor from 1992 to 2005

## 5.2 DENR Monitoring Records 2004 to 2011

Monitoring has been undertaken by DENR at 52 survey sites within 24 wetlands since 2004. During the period of 2004 to early 2011, a total of 441 surveys were undertaken, with 130 of these surveys having recorded Southern Bell Frogs. Over this period the species was recorded within 21 of the 24 wetlands, at 41 of the 52 survey sites.

Higher abundances of Southern Bell Frogs within Chowilla sites during 2004 (Figure 6, top right image) and 2006 (Figure 8, top right image) could possibly be attributed to ephemeral - above pool wetlands being recently pumped full (e.g. Lake Littra and Werta Wert), and flow control structures on ephemeral - pool level managed wetlands being opened in September 2006 (e.g. Pilby Creek and Pilby Lagoon), shortly before frog surveys were undertaken. Similarly Southern Bell Frog numbers at Morgan Conservation Park were high during 2005 (Figure 7) when the flow control structure was opened in early September, and also during 2006 (Figure 8) when the flow control structure was opened and the ephemeral - above pool wetlands within the conservation park were pumped full. During 2004 (Figure 6, bottom image) and 2005 (Figure 7, bottom image) high numbers of Southern Bell Frog numbers were recorded in Ngak Indau wetland within the Katarapko National Park. This may also be attributed to the flow control structure on the wetland being opened in September 2004 and September 2005.

During 2007 and 2008 no ephemeral - pool level managed wetlands received water due to drought conditions, which may account for the absence of Southern Bell Frogs at these sites. However, high numbers of Southern Bell Frogs were recorded at permanent wetlands and creek sites within Katarapko (Figure 9 and Figure 10, bottom right image) during these years, which suggest that the frogs may have resorted to using permanent water bodies as breeding habitat due to the lack of preferred temporary water habitats.

During 2008 Chowilla ephemeral - above pool wetlands, such as Lake Littra and Werta Wert, were pumped full and higher abundances of Southern Bell Frogs were recorded at these sites. Higher abundances were also found at permanent creek sites on the Chowilla floodplain during the same period (Figure 10, top right image).

In early 2009 ephemeral - pool level managed wetlands received an environmental water allocation for the wetland to be refilled and then disconnected again. During this time high abundances of Southern Bell Frogs at Morgan Conservation Park (Figure 11) and wetlands within Katarapko National Park (Figure 11, bottom right image) were recorded. In addition high abundances of frogs were also recorded at both permanent and temporary sites within Chowilla during this time.

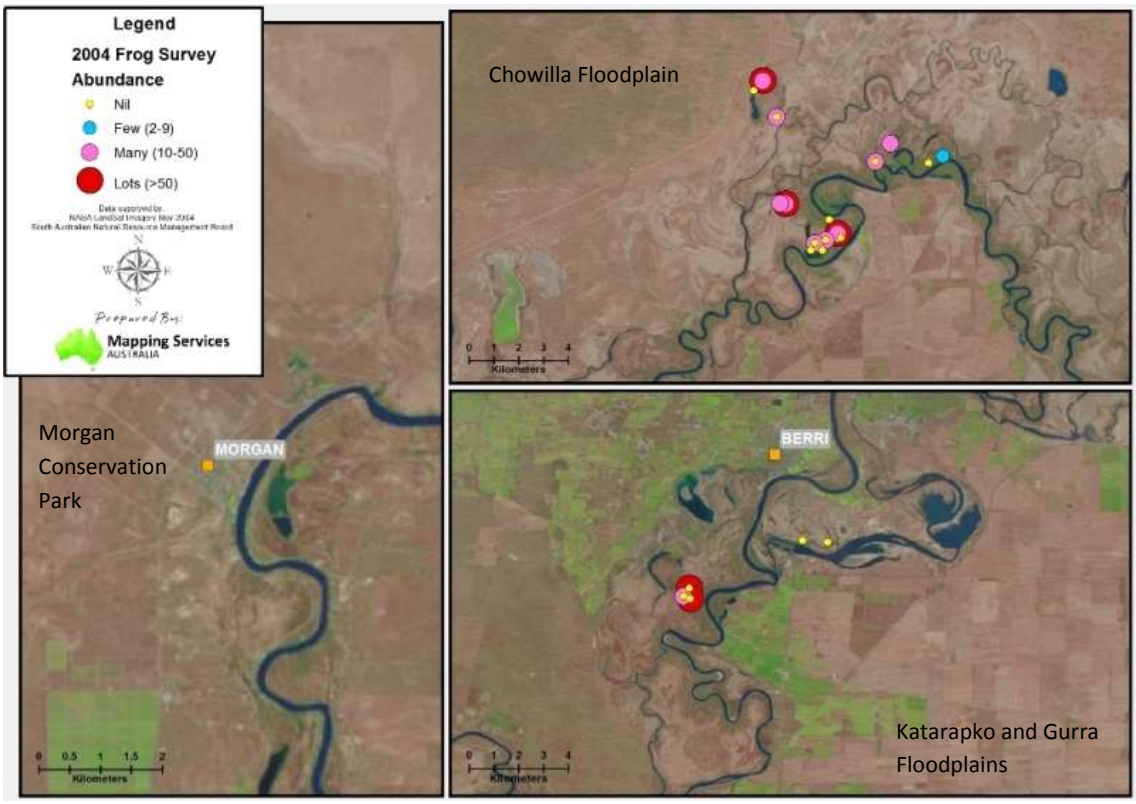



**Figure 6:** Map of Southern Bell Frog abundance records at DENR wetlands, 2004.

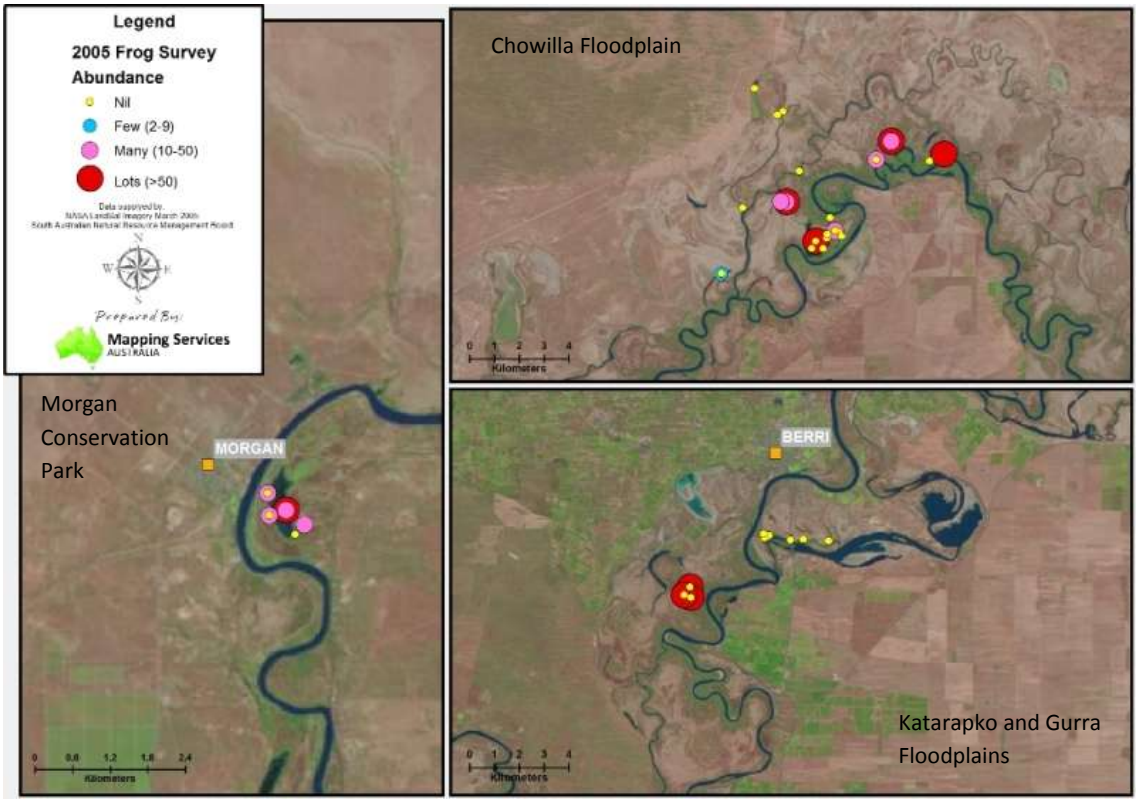



**Figure 7:** Map of Southern Bell Frog abundance records at DENR wetlands, 2005.

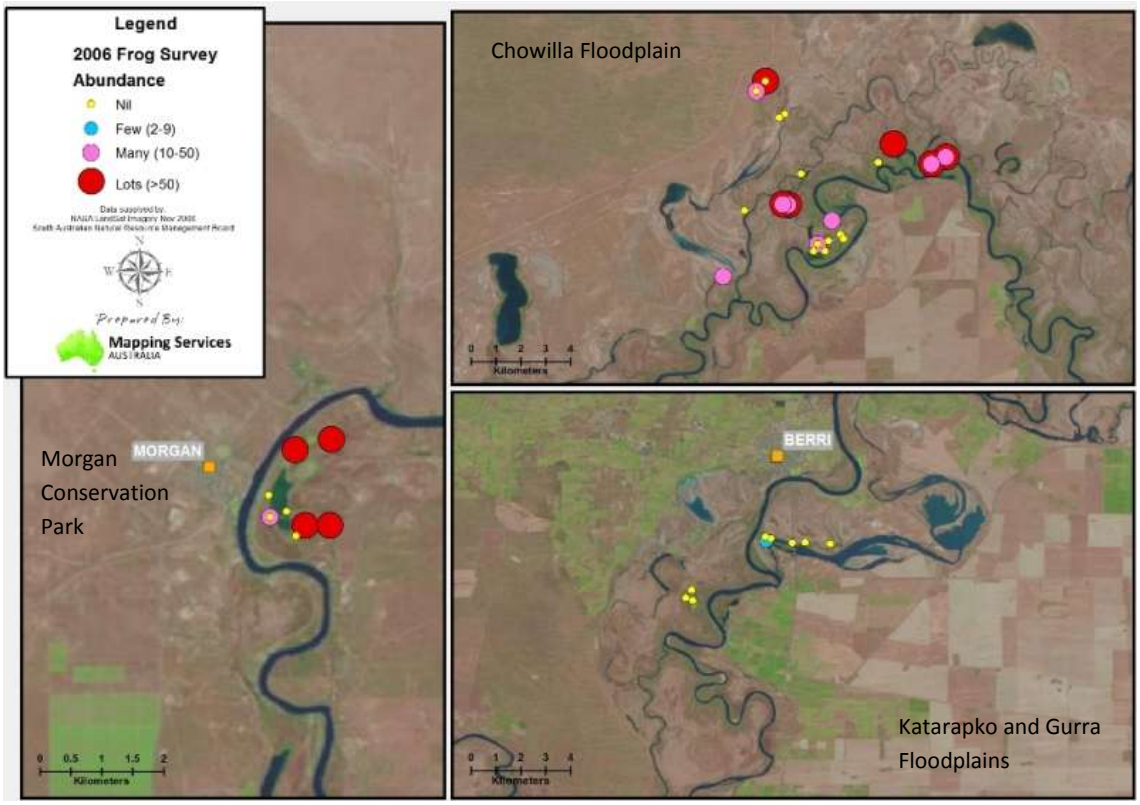



**Figure 8:** Map of Southern Bell Frog abundance records at DENR wetlands, 2006.

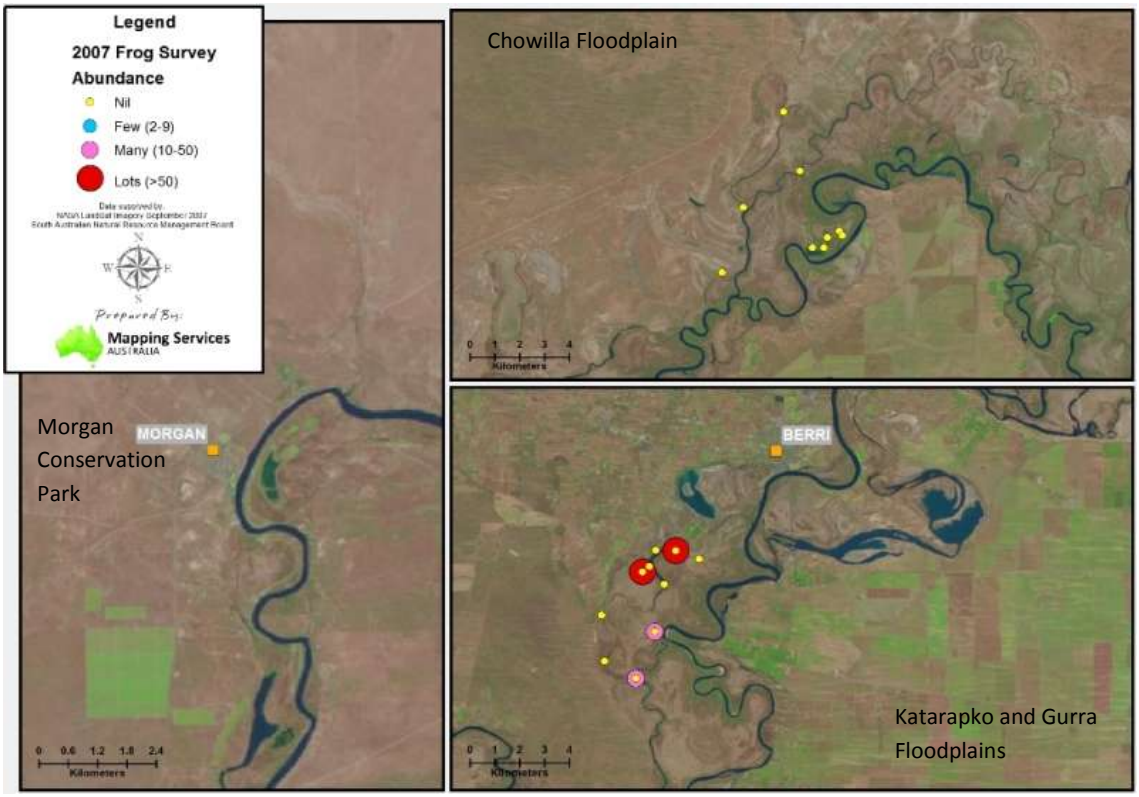



**Figure 9:** Map of Southern Bell Frog abundance records at DENR wetlands, 2007.

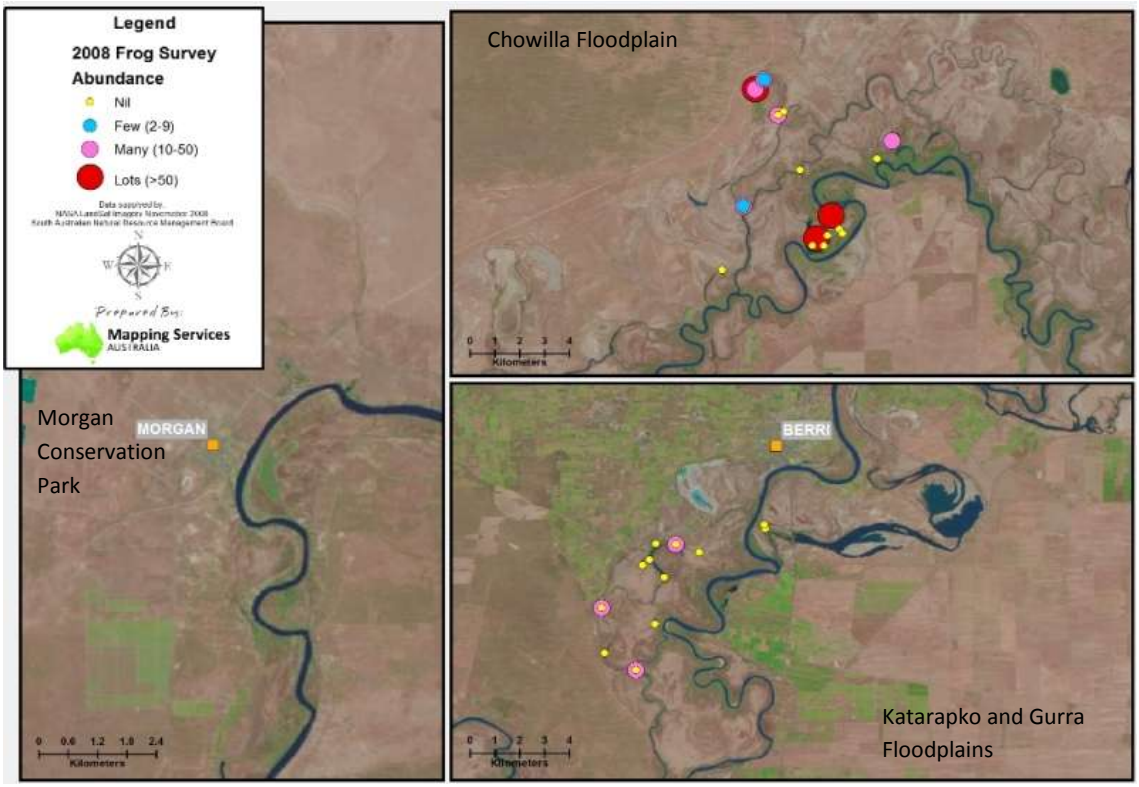



**Figure 10:** Map of Southern Bell Frog abundance records at DENR wetlands, 2008.

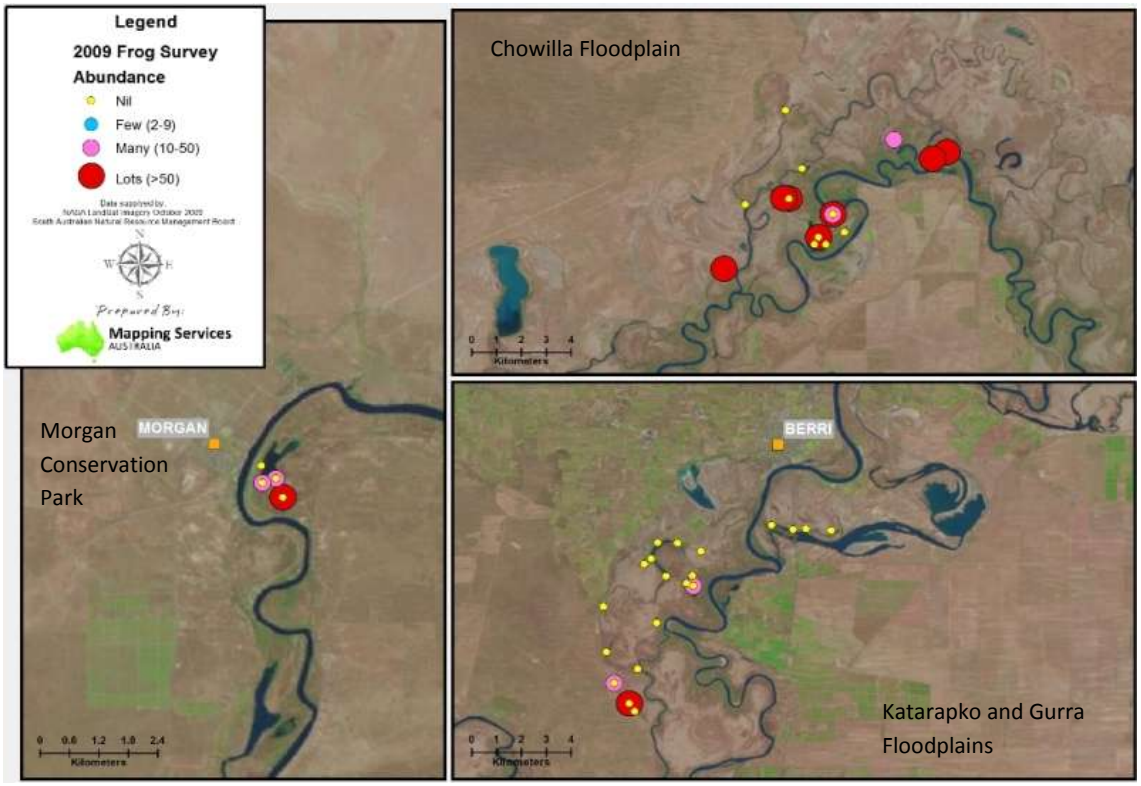



**Figure 11:** Map of Southern Bell Frog abundance records at DENR wetlands, 2009.

### 5.2.1 Wetland Hydrology Based Presence/Absence Results

Over the 2004 to 2011 monitoring period, Southern Bell Frogs were present at 41 of 52 sites. The percentage of Southern Bell Frog presence records at sites within a wetland hydrological type was greatest for ephemeral – pool level managed wetlands (90%) in comparison to sites within ephemeral – above pool wetlands (73%) and permanent wetlands (71%) during the monitoring period (Figure 12).

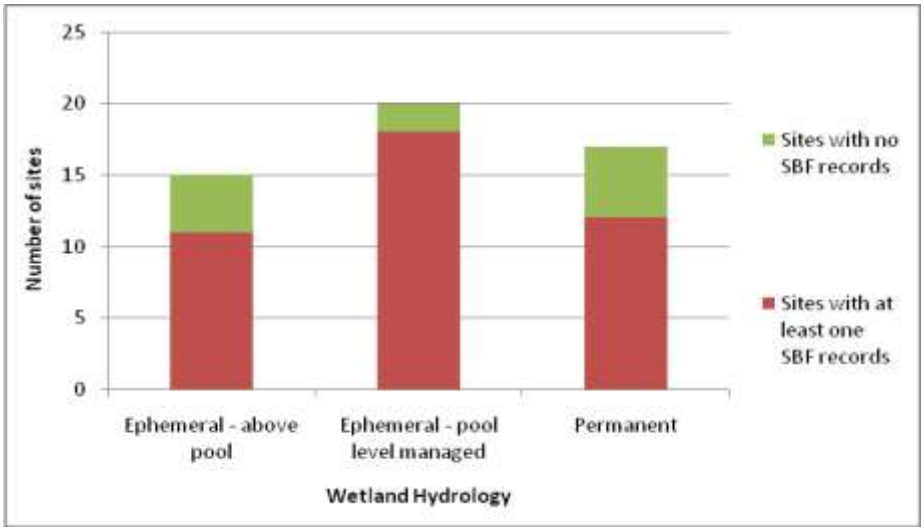



**Figure 12:** Number of survey sites at different wetland hydrology types that have at least one Southern Bell Frog record during 2004 – 2011 compared to sites with no Southern Bell Frog records at DENR wetlands.

Of the 441 surveys conducted from 2004 to 2011, Southern Bell Frogs were recorded on only 130 occasions across all wetland types. The percentage of Southern Bell Frog records at sites within a wetland hydrology type was lowest at permanent wetlands (13%) in comparison to ephemeral – pool level managed wetlands (42%) and ephemeral – above pool wetlands (32%) (Figure 13). Percentages of Southern Bell Frog presence in Figure 13 is lower than shown in Figure 12 because even where Southern Bell Frogs are known to have occupied a site within a wetland, the species was not always recorded during every survey undertaken at the site.

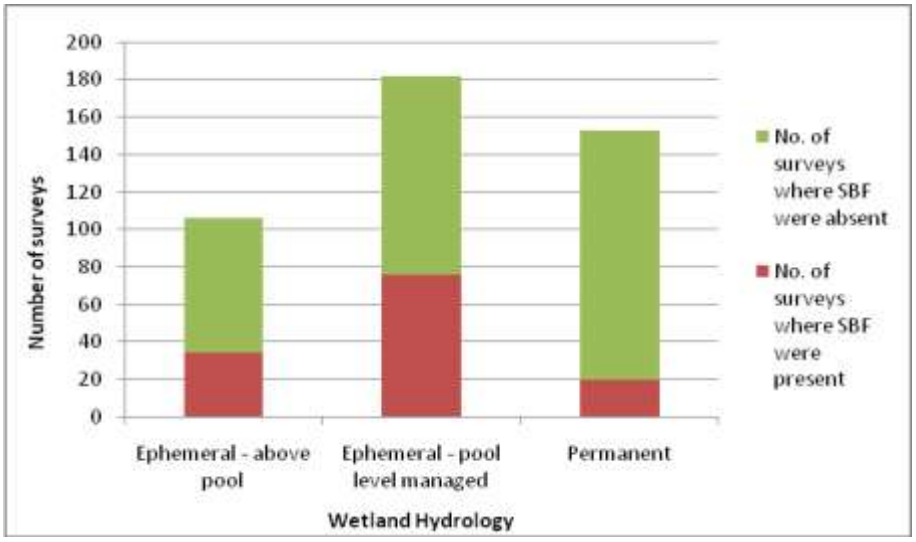



**Figure 13:** Number of Southern Bell Frog presence and absence records at different wetland hydrological types for all surveys at all sites over the period 2004 to early 2011 at DENR wetlands.

### 5.2.2 Wetland Hydrology and Abundance Data Results

Southern Bell Frogs were not detected in most surveys across all wetland types (Figure 14). Permanent wetlands had the highest number of surveys with zero abundance scores. Where Southern Bell Frogs were detected, ephemeral - pool level managed wetlands had more abundance scores (1, 2 (few, 2-9) and 3 (many, 10-50)) than other wetland hydrology types. Only one permanent wetland and nine ephemeral – above pool wetlands recorded abundances scores of 4 (> 50).

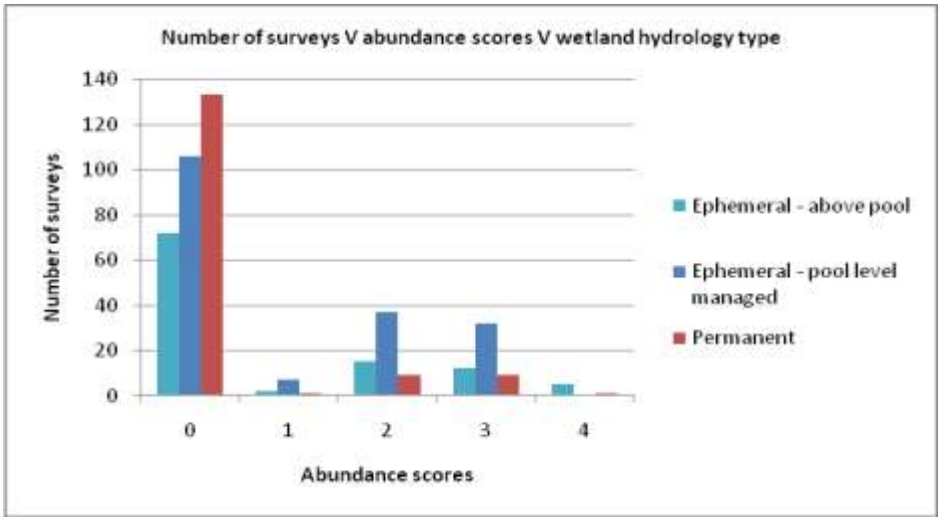



**Figure 14:** Number of surveys with different abundance scores at each wetland hydrology type for DENR wetlands.

### 5.2.3 Emergent Vegetation Data Results

At most sites where Southern Bell Frogs were detected the dominant emergent vegetation type was rushes/reeds/sedges (Figure 15). Emergent vegetation categories are simplified in the figure below, which included an additional category of 'dry wetland bed' and 'N/a' to identify sites where no emergent vegetation description was recorded.

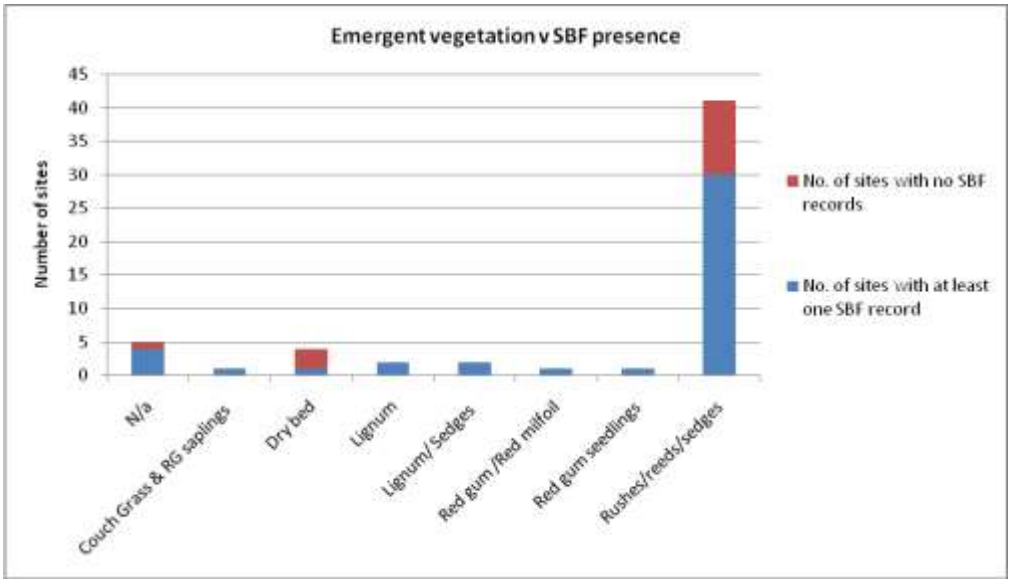



**Figure 15:** Number of sites with Southern Bell Frog presence and absence records with different emergent vegetation.

### 5.2.4 Season Data Results

Southern Bell Frog presence was highest in spring or summer, which corresponds to the main Southern Bell Frog calling period from August to February (Figure 16). The lower percentages correspond to surveys undertaken in either winter or autumn (except for 2007-Q4). Although Southern Bell Frogs are rarely recorded calling during winter and autumn, there was less survey effort during these seasons, which may account for the low percentages.

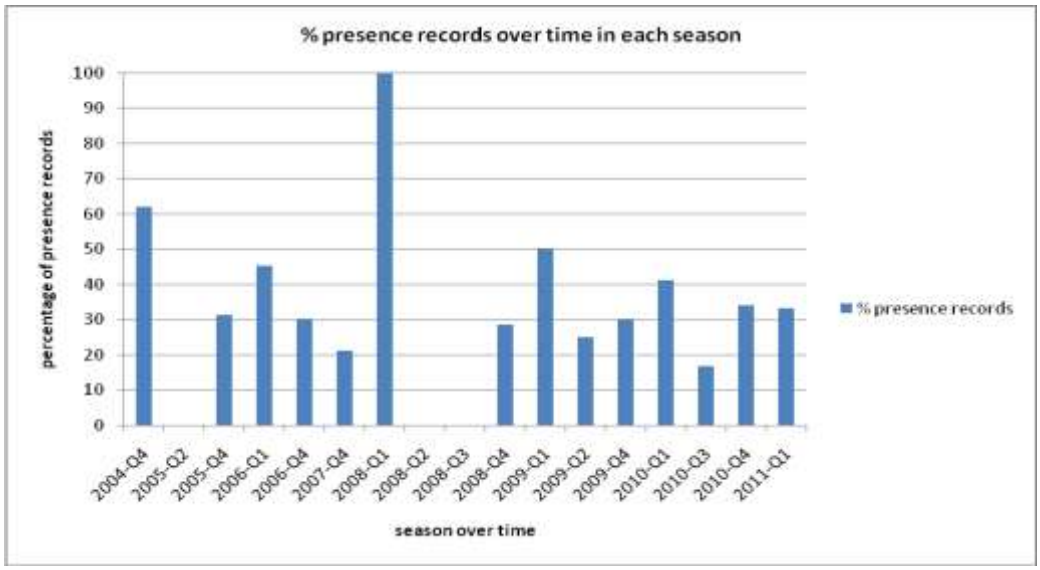



**Figure 16:** Number of Southern Bell Frog presence and absence records for each season for each year from 2004 to 2011 (minus double records) at DENR wetlands.

## 5.3 Census Data 2010-11

Surveys during the 2010-11 census were undertaken by DENR and the SA MDB NRM Board. In total there were 170 monitoring records collected at 115 monitoring sites within 52 wetlands surveyed during the 2010-11 census (Figure 17). Some sites were surveyed twice during this period.

Of the 52 wetlands surveyed, Southern Bell Frogs were recorded as present at 26 wetlands. Of the 115 sites within the 52 wetlands, Southern Bell Frogs were recorded as present at 38 sites.

### 5.3.1 Region

The census was undertaken within three geomorphic regions of the SA MDB:

1. Riverland (Lock 3 to the border),
2. Murray Gorge (Mannum to Lock 3) and
3. Lower Murray Swamps (Wellington to Mannum).

One survey was undertaken outside of the River Murray corridor within the Santos Evaporation Basin. Southern Bell Frogs were not recorded at this site.

Within the Riverland, 51 sites were surveyed at 21 wetlands. The Southern Bell Frog was recorded at 13 of the 21 wetlands, a majority of the wetlands surveyed in this region (62%). However, as a percentage of the sites surveyed, Southern Bell Frogs were recorded at only 20 (39%) of the 51 sites that were surveyed in the Riverland (Table 7).

Within the Murray Gorge region, 48 sites were monitored at 25 wetlands. Southern Bell Frogs occupied 12 (48%) of the 25 wetlands surveyed in this region. Southern Bell Frogs were present at 17 (35%) of the 48 sites, corresponding to a lower percentage of Southern Bell Frog presence than in the Riverland wetlands (Table 7).

Within the Lower Murray Swamps region, 15 sites were monitored at 5 wetlands. There was only one Southern Bell Frog record in one wetland within this region. Although the Lower Murray Swamp wetlands had the lowest percentage of Southern Bell Frog presence, this region had a small number of sites and wetlands surveyed (Table 7).

**Table 7:** Southern Bell Frog presence / absence across regions

| Region | No. of wetlands | Present | Absent | No. of sites | Present | Absent |
|---|---|---|---|---|---|---|
| Riverland | 21 | 13 (62%) | 8 (38%) | 51 | 20 (39%) | 31 (61%) |
| Murray Gorge | 25 | 12 (48%) | 13 (52%) | 48 | 17 (35%) | 36 (65%) |
| Lower Murray Swamps | 5 | 1 (20%) | 4 (80%) | 15 | 1 (7%) | 14 (93%) |
| Outside of River corridor | 1 | 0 | 1 | 1 | 0 | 1 |
| **Grand Total** | **52** | **26** | **26** | **115** | **38** | **77** |

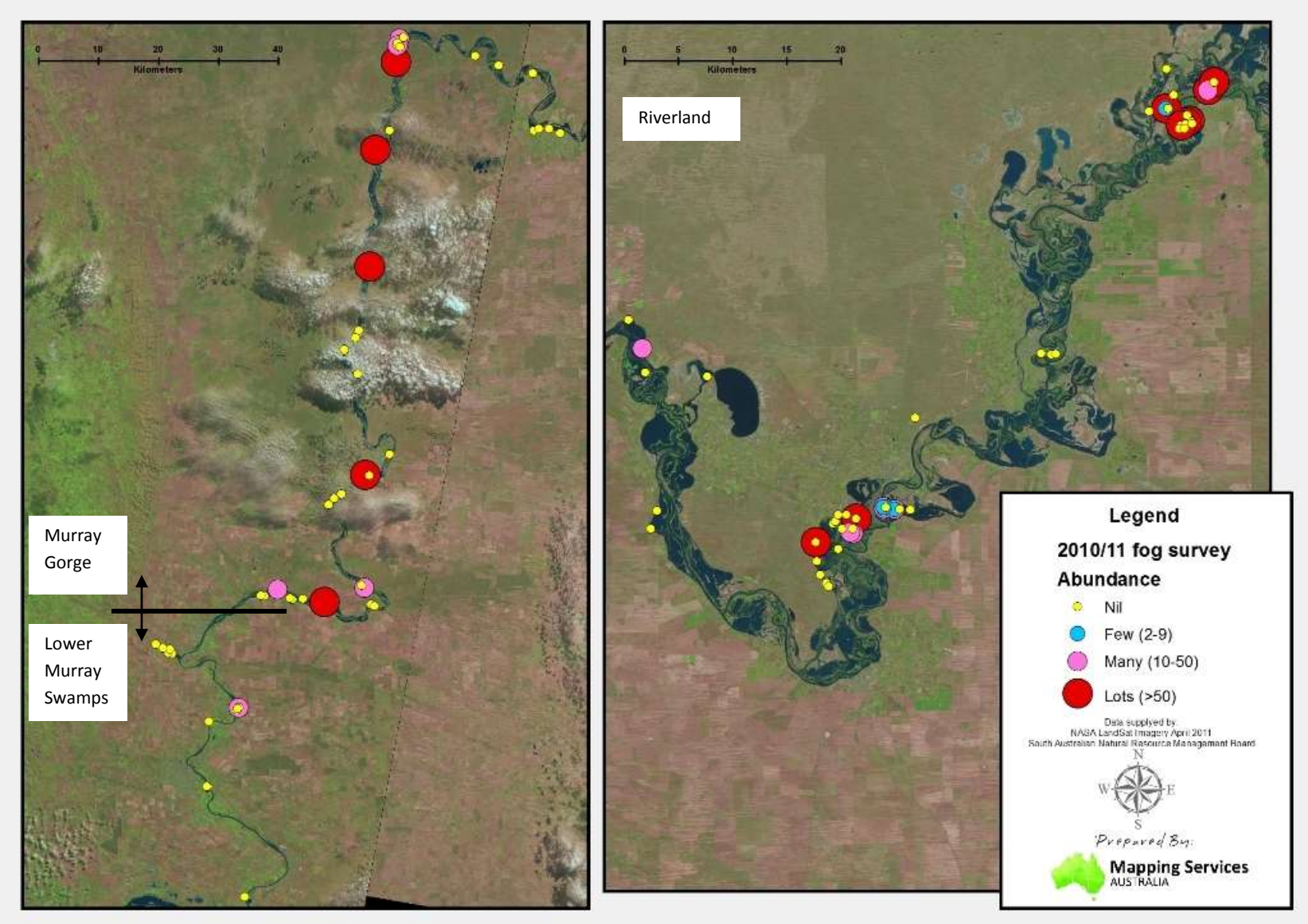



**Figure 17:** Map of Southern Bell Frog records 2010-11 census.

### 5.3.2 Wetland Hydrology

The 115 survey sites were relatively evenly spread over the four different wetland hydrology types: ephemeral – above pool (29 sites), ephemeral – pool level managed (32 sites), permanent – never dried (22 sites) and permanent – recently dried (32 sites).

The wetland hydrology with highest percentage of Southern Bell Frog presence was the ephemeral – pool level managed sites (50%). This was followed by ephemeral – above pool (38%), permanent – never dried (32%) and permanent – recently dried (13%) (Figure 16).

The wetland hydrology type with the lowest percentage of Southern Bell Frog records, 'permanent – recently dried wetlands' are all located between Blanchetown (Lock 1) and Wellington. These sites are referred to as 'permanent – recently dried' due to the fact that they are permanently inundated during normal pool level and have not been managed for wetting and drying, however during the recent drought the pool level decreased to 1m below sea level, and as a result the wetlands dried. The 2010-11 Census was undertaken following a return to pool level and flooding, hence these wetlands were inundated at the time of the survey. The reason for low Southern Bell Frog numbers may be due to the fact that there was limited habitat during the drought and when River levels returned, a reduction in the Southern Bell Frog populations within this reach lead to lower survey records.

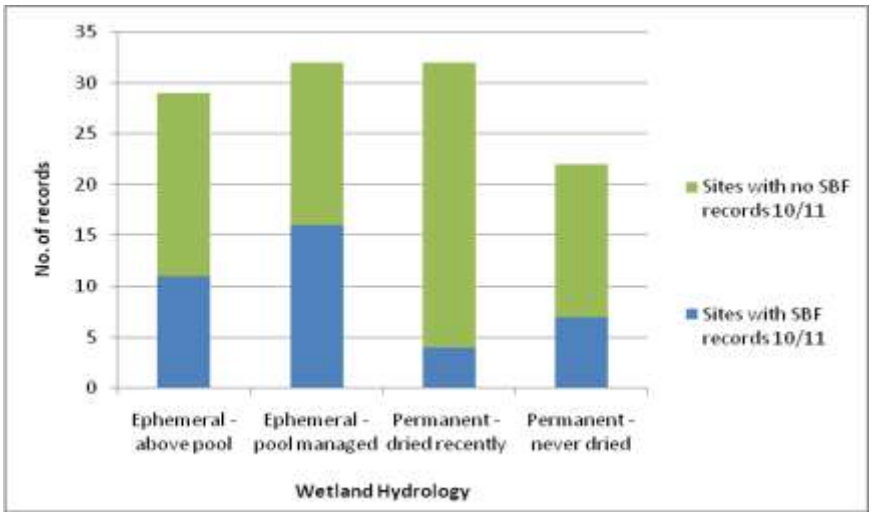



**Figure 18:** Number of Southern Bell Frog presence and absence records at sites within each wetland hydrology type during 2010-11 census.

### 5.3.3 Month

The 2010-11 census was conducted from August 2010 through to March 2011 (Figure 19). Most Southern Bell Frogs were recorded in November 2010.

October had the highest percentage of presence records (67%), although this is an artifact of only 3 surveys in this month (Figure 19).

March 2011 had the next highest percentage of presence records (48%), followed by November (33%) and February (25%). September had the lowest percentage of Southern Bell Frog presence records (11%) (Figure 19).

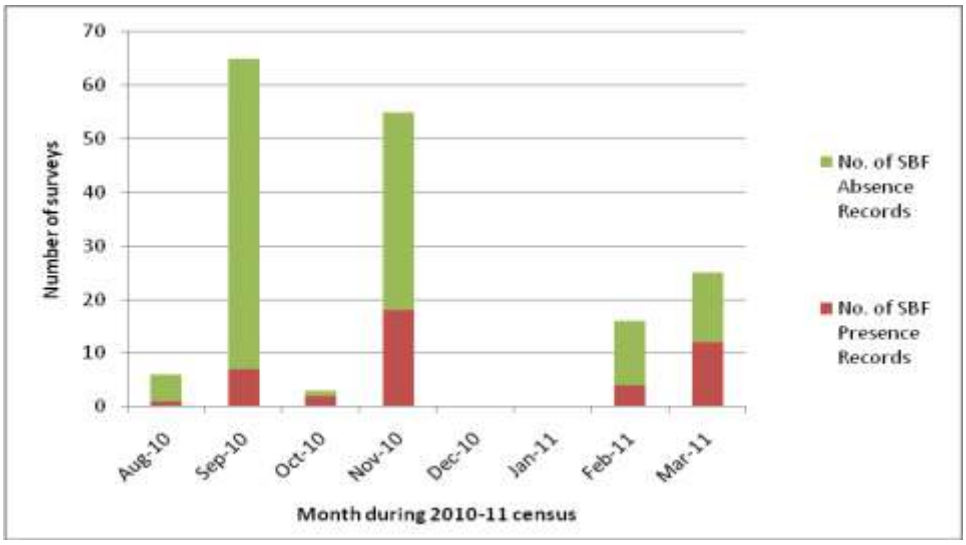



**Figure 19:** Southern Bell Frog presence / absence records at sites within each wetland hydrology type during 2010-11 census.

### 5.3.4 Abundance

All four wetland hydrology types had a high number of occasions when no Southern Bell Frogs were recorded at the site, i.e. the number of zero abundance scores recorded for these sites were higher than for any other abundance scores (Figure 20). Permanent wetlands and permanent wetlands that were recently dried had the highest number of sites where Southern Bell Frogs were absent.

Ephemeral - pool level managed wetlands had more abundance scores of 1, 2 (few, 2-9) and 3 (many, 10-50) than other wetland hydrology types. Ephemeral – above pool wetlands had the most records for the highest abundances score of 4 (lots, >50) (Figure 20).

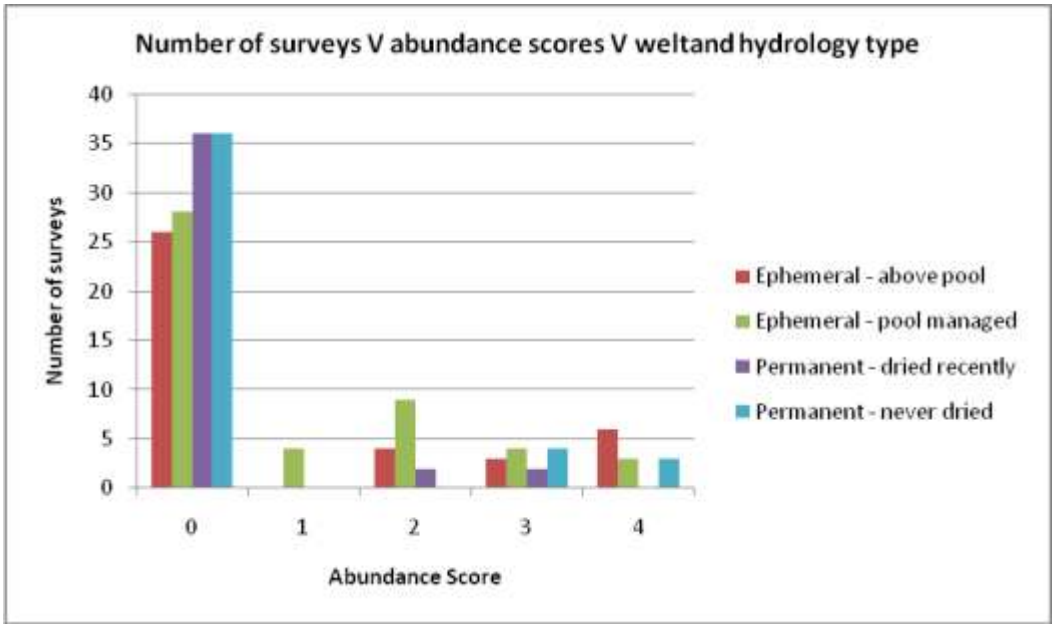



**Figure 20:** Number of Southern Bell Frog survey records for each abundance score for each wetland hydrology type during 2010-11 census.

### 5.3.5 Emergent Vegetation

Reeds were the dominant (86 sites) emergent vegetation type, followed by Lignum +/- reeds & submerged shrubs (31 sites) (Figure 21). The highest number of Southern Bell Frog presence records were at sites where emergent reeds were observed to be the dominant habitat type (25 sites) compared to Lignum (11 sites). However, the highest percentage of Southern Bell Frog presence was at sites with inundated Lignum (35%) compared to reeds (29%) (Figure 21).

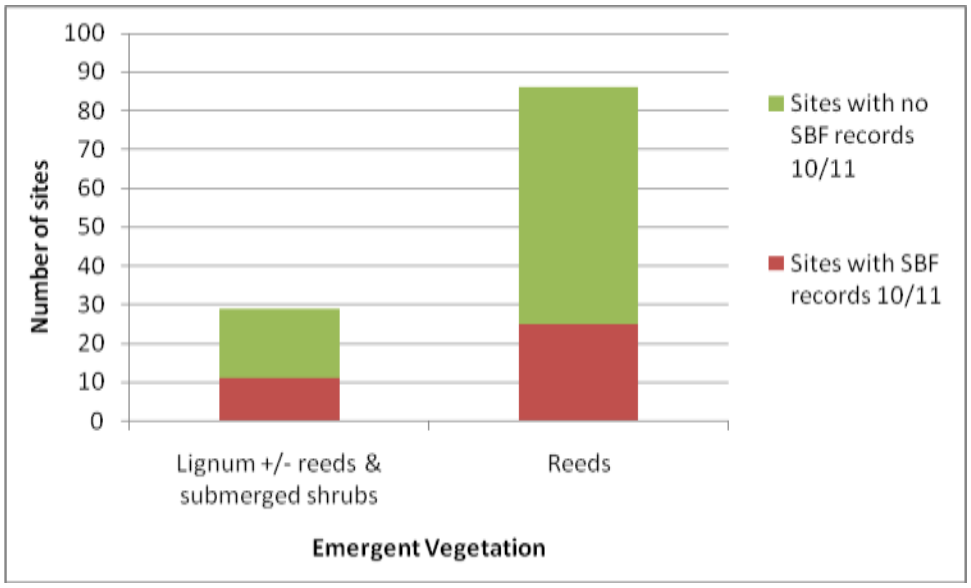



**Figure 21:** Number of sites with different emergent vegetation that have Southern Bell Frog presence and absence records during 2010-11 census.

# 6. 2010-11 Census Data Analysis – Habitat Modelling

This section of the report is reproduced from Souter (2010) and describes an analysis of environmental data collected in 2010-11 by the SAMDB NRM Board and DENR from wetlands along the lower River Murray regarding the habitat preferences of the Southern Bell Frog.

## 6.1 Methods

### 6.1.1 Data

Southern Bell Frog data and habitat variables were collected from a range of wetlands along the River Murray from August 2010 until February 2011. Data were collected by the SA MDB NRM board and DENR. Over the period of sampling a number of sites were visited on more than one occasion. The data collected on the Southern Bell Frog were ordinal categorical data which measured the relative abundance of frogs at a wetland. The habitat parameters were a mixture of numerical and both ordinal and nominal categorical variables (Table 8).

**Table 8:** Explanatory variables used in Southern Bell Frog Habitat modeling

| Explanatory variable | Variable type | Levels |
|---|---|---|
| Easing | Numerical | Continuous |
| Northing | Numerical | Continuous |
| Electrical conductivity | Numerical | Continuous |
| Turbidity | Numerical | Continuous |
| Floating aquatic vegetation cover | Ordinal, categorical | 0, absent; 1, <5%; 2, 5-25%; 3, 25-50%; 4, 50-75%; 5, >75% |
| Submerged vegetation cover | Ordinal, categorical | |
| Emergent vegetation cover | Ordinal, categorical | |
| Emergent vegetation type | Nominal, categorical | Reed, Lignum |
| Habitat type | Nominal, categorical | Floodplain, wetland, creek, swamp |
| Flow environment | Nominal, categorical | Ephemeral: above pool, pool managed. Permanent: above pool, recently dried, never dried |
| Surrounding vegetation | Nominal, categorical | Sedgeland, Woodland, Woodland over shrubland |
| Impacts | Ordinal, categorical | 1, conservation; 2, medium; 3, grazing |

Habitat modelling was undertaken with Southern Bell Frog relative abundance as the response variable and the full suite of habitat parameters as the explanatory variables. As some sites were visited on multiple occasions the data were modified prior to analysis. Only a single data point from each wetland was included in the final dataset. For sites that did not change in any parameters over time it did not matter which dates were excluded. For sites which never recorded frogs the date with the most complete data set was chosen, and for sites with frogs the date with the highest relative frog abundance was chosen.

Habitat modelling was undertaken with Southern Bell Frog relative abundance as the response variable and the full suite of habitat parameters as the explanatory variables. As some sites were visited on multiple occasions the data were modified prior to analysis. Only a single data point from each wetland was included in the final dataset. For sites that did not change in any parameters over time it did not matter which dates were excluded. For sites which never recorded frogs the date with the most complete data set was chosen, and for sites with frogs the date with the highest relative frog abundance was chosen.

The level of spatial autocorrelation in relative frog abundance data was examined by using the easting and northing variables and frog abundance to calculate Moran's *I* statistic.

Prior to analysis correlation between the explanatory variables in each of the two data sets was examined. Correlation between continuous variables and between ordinal variables were tested using Kendalls tau test. Correlation between nominal variables was tested using Cramers V statistic.

Two complimentary methods were used to regress habitat parameters against Southern Bell Frog relative abundance, regression trees; and Southern Bell Frog presence absence, correlation trees. The goal of a regression tree model is to predict or explain the effect of one or more variables on a dependent variable. Regression trees are particularly suited to examining ecological data where relationships between variables may be strongly non-linear and involve high-order interactions (De'ath and Fabricius, 2000). A regression tree is constructed by repeatedly splitting the data, defined by a simple rule based on a single explanatory variable. At each split the data is partitioned into two mutually exclusive groups, these groups are then split (De'ath and Fabricius, 2000). If there is no nonlinearity then a tree with a single terminal node is created with a single multiple linear model (Kara *et al*. 2007). A tree with multiple branches indicates that a single multiple linear model is inadequate and each time the algorithm detects non-linearity it splits the data into two subsets and attempts to fit a linear model to each subset.

Classification trees are an exploratory, descriptive and predictive technique ideally suited to modelling complex and often unbalanced ecological data (De'ath and Fabricius, 2000). Classification trees are nonparametric and explain the variation of a single categorical response variable by a range of explanatory variables, which may be either numerical or categorical. A tree is constructed by repeatedly splitting the data into two mutually exclusive groups, each group is then split itself. Each split is defined by a simple rule based on a single explanatory variable. Each group is characterised by the distribution of the response variable, the group size and the values of the explanatory variables that define it.

Modelling was undertaken using the 'rpart' package in the R software package (R development core team 2008). The 'rpart' package is well suited to modelling the Southern Bell Frog data as it is able to handle missing data. The 'varImp' routine in the R software package 'Caret' was used to determine the relative importance of each explanatory variable in the two models. For regression tree modelling the categorical frog abundance data were considered to be continuous. A further significance test was applied to the regression tree model, the Receiver Operating Characteristic (ROC) score. The regression

tree was used to generate predicted relative abundance scores and these were tested against the actual scores using the 'roc' procedure in the R package 'pROC' (Robin *et al*. 2011).

## 6.2 Results

There were considerable gaps in the data with large numbers of missing values for electrical conductivity, turbidity, floating, submerged and emergent vegetation.

**Table 9** Levels of correlation between Southern Bell Frog habitat and modeling explanatory variables for the spring dataset

| | **Turbidity** | **Submerged vegetation** | **Emergent vegetation** | **Impacts** | **Habitat** | **Flow environment** | **Surrounding vegetation** |
|---|---|---|---|---|---|---|---|
| EC | Kt=-0.31 | - | - | - | - | - | - |
| Floating vegetation | | Kt=0.38 | Kt=-0.11 | Kt=-0.25 | - | - | - |
| Submerged vegetation | | | Kt=-0.02 | Kt=-0.25 | - | - | - |
| Emergent vegetation | | | | Kt=-0.12 | - | - | - |
| Emergent vegetation type | | | | - | V=0.35 | V=0.33 | V=0.35 |
| Habitat | | | | - | | V=0.54 | V=0.40 |
| Flow environment | | | | - | | | V=0.38 |

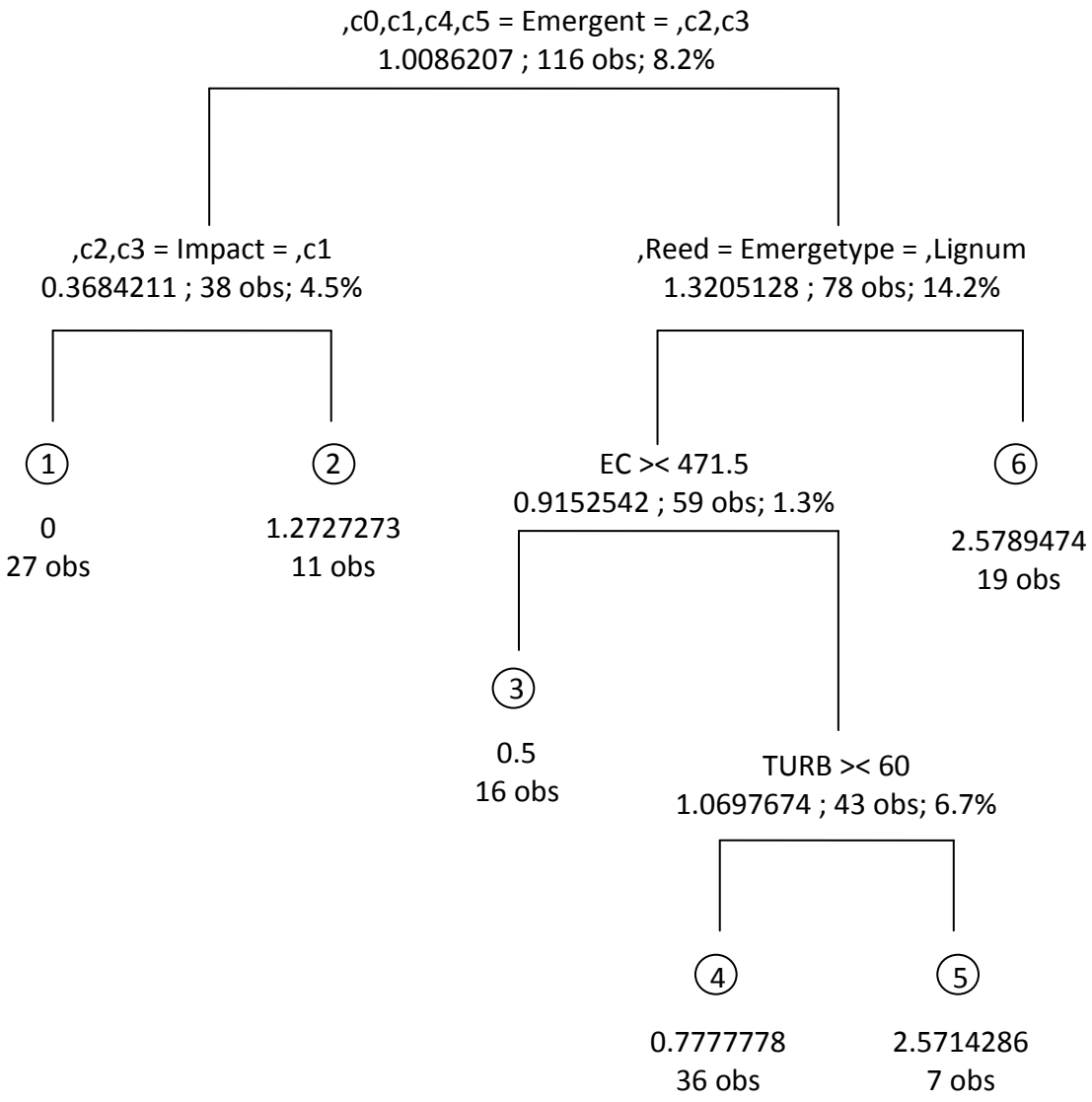
### 6.2.1 Regression Tree

The regression tree produced by 'rpart' had five splits and six nodes (Figure 22). With an $R^2 = 0.35$ the tree explained just over one third of the variation in Southern Bell Frog relative abundance. However the ROC score (0.594) suggests that there is a real relationship between the variables, as an ROC value of <0.5 is the threshold under which the model does not predict the response any better than random. Three variables were used in tree construction: electrical conductivity, emergent vegetation cover and type, impact and turbidity. The most important variables in the final tree were electrical conductivity, flow environment, impact, floating vegetation cover and emergent vegetation type.

Node 1 consisted of 27 wetlands with emergent vegetation in classes 0, 1, 4 and 5 and either medium impact or grazing but no frogs (Figure 22). Node 2 on the other hand predicted the lowest frog abundance in the model in eleven wetlands managed for conservation (and emergent vegetation in classes 0, 1, 4 and 5). The other major split in the model was for wetlands with emergent vegetation in categories 2 and 3. The next split in this branch was for wetlands with Lignum which lead to node 6, which predicted the highest mean frog abundance in the overall model. The reed branch the split according to electrical conductivity with wetlands over 471.5 $\mu Scm^{-1}$ having low frog abundance (node 3). The final split was due to turbidity with turbid wetlands (> 60 NTU and also salinity less than 471.5 $\mu Scm^{-1}$, reeds and moderate emergent vegetation cover) having low frog abundance, clearer wetlands (<60 NTU) on the other hand had higher mean frog abundance.

The Moran's *I* statistic of -0.17 showed neither, significant spatial autocorrelation or dispersion (P=0.77). A Moran's *I* statistic of -1 equates to full dispersion where high and low abundance scores repel one another. A value of 0 equates to random spatial orientation and a value of 1, full spatial autocorrelation. As a result no spatial autocorrelation term was required in the model.

The level of correlation between all comparable parameters was below 0.6 and thus all were used to construct the model.



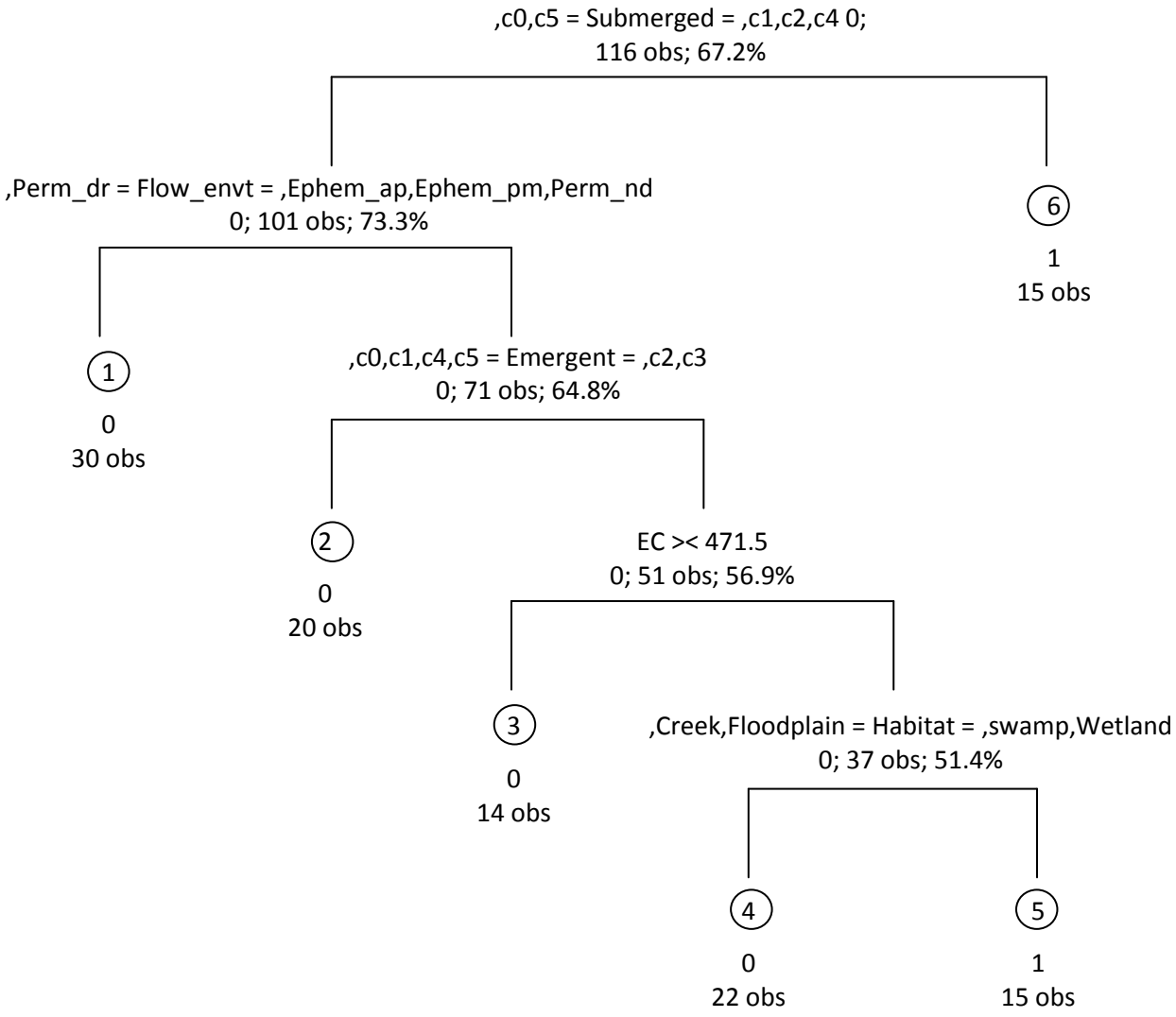

6 Total deviance explained = 34.9 %

**Figure 22:** Southern Bell Frog habitat regression tree. Nodes are numbered in circle at the terminus of each branch, the number below each node is the mean relative frog abundance. The text at each split describes the conditions that need to be met for the right and left hand sides of each branch.

### 6.2.2 Classification Tree

The Southern Bell Frog presence/absence classification tree had five splits and six nodes (Figure 23). The classification tree correctly classified 79.3% of all the samples. The following variables were used in tree construction: electrical conductivity, emergent vegetation cover, flow environment, habitat and submerged vegetation cover. The most important variables in the final tree model were: electrical conductivity, emergent vegetation cover, flow environment, submerged vegetation cover and habitat.
The first split in the tree was according to the cover of submerged vegetation with frogs being present in fifteen wetlands with submerged vegetation cover in classes 1, 2 and 4 (node 6). The other split was for wetlands with either no submerged vegetation or 75-100% cover. These wetlands then split according to the flow environment with no frogs being found in recently dried permanent wetlands (30 observations, node 1). Ephemeral wetlands and permanent wetlands that remained wet split further. On 20 occasions no frogs were found in wetlands with either no or very sparse (category 0 and 1) and very dense (category 4 and 5) emergent vegetation (node 2). Wetlands with intermediate levels of emergent vegetation cover (category 2 and 3) split according to electrical conductivity. Here 14 wetlands with electrical conductivity greater than 471.5 $\mu Scm^{-1}$ had no frogs (node 3).

Wetlands with electrical conductivity of less than 471.5 $\mu Scm^{-1}$ split according to habitat, with frogs absent from creeks and floodplains, but found in swamps and wetland.




Total classified correct = 79.3%

**Figure 23:** Southern Bell Frog classification tree. Nodes are numbered in circle at the terminus of each branch, the number below each node is the mean relative frog abundance. The text at each split describes the conditions that need to be met for the right and left hand sides of each branch.

## 6.3 Discussion

The regression tree that modelled Southern Bell Frog relative abundance data against the predictor variables explained only around one third of the variation in the data. This was a relatively poor fit as two thirds of the variation in bell frog relative abundance could not be explained. One of the most obvious explanations for this was the large amount of missing data provided in the habitat assessments. This appears particularly the case as data with the most missing variables such as electrical conductivity and the cover of emergent and floating vegetation, were amongst the most important variables in the model. It is feasible that a more complete data set would have yielded a better result.

Another reason why the data gave a poor fit is that they are 'zero inflated', that is the tendency to contain many zero values. Zero inflation is a common problem in ecology (Martin *et al.* 2005) and can be modelled. Unfortunately attempts to apply zero inflated models using the R package 'pscl' proved unsuccessful. One of the reasons for this was the large number of missing values in the habitat variables. This meant that there was insufficient data to enable to zero inflated poisson model to reach convergence and thus be fitted to the data. The inability to model this zero inflation means that the results should be interpreted with caution as not accounting for this phenomenon can lead to erroneous conclusions (*cf* Martin *et al.* 2005).

The classification tree which modelled Southern Bell Frog presence absence gave a much better result with only 21% of wetlands misclassified. The most important variables in this model were electrical conductivity, emergent vegetation cover, flow environment, submerged vegetation cover and habitat.

Electrical conductivity was also the most important variable in the regression tree model. In both the classification and regression trees a value of less than 471.5 $\mu Scm^{-1}$ was associated with frog presence and high abundance. This does not however mean that frogs were not found at higher salinities, rather that they were much less abundant or likely to be present than in low salinity wetlands.

Emergent vegetation cover between 5 and 50 percent was also associated with higher frog abundance and presence in both the tree models, suggesting that frogs favored a low to moderate cover of fringing vegetation whilst frogs were less likely to be in wetlands with no or dense vegetation.

Flow environment was also an important variable in both tree models with recently drained permanent wetlands associated with frog absence.

Due to the relatively poor model results these results should be used with caution and it is recommended that a full suite of parameters be collected from each wetland in future to aid analysis. Future monitoring should also consider improving the measurement of habitat variables which this analysis identified as likely to be important such as electrical conductivity and fringing vegetation cover.

## 7. Conclusion

This project aimed to document the locations and abundance of Southern Bell Frogs during spring / summer of 2010-11, and collate this data into a central database for future analysis against annual survey records. Historical records and data from ongoing monitoring programs (DENR and SAM DB NRM Board) have also been collated through this project. The database has been completed and contains the Southern Bell Frog record data as well as micro and meso habitat parameters. By annually re-surveying the sites, this data will enable a more complete understanding of the temporal, spatial, hydrological and structure habitat requirements of this threatened species.

During surveys conducted from 2004 to 2011 (including the 2010-11 census) permanent wetlands and permanent wetlands that were recently dried had the highest number of sites where Southern Bell Frogs were absent. During the survey period Southern Bell Frogs were most often recorded at ephemeral – pool managed wetlands. Ephemeral – above pool wetland surveys had the highest abundances scores of Southern Bell Frogs; 4 (> 50).

During the 2010-11 census the wetland hydrology unit with highest percentage of Southern Bell Frog presence was the ephemeral – pool level managed sites (50%). This was followed by ephemeral – above pool (38%), permanent – never dried (32%) and permanent – recently dried (13%).

As Southern Bell Frogs are known to use seasonally and temporarily flooded water bodies (Schultz 2007; Wassens *et al.* 2008a), and it is known that the species will respond to flooding by readily occupying shallow, newly inundated vegetated areas to breed (Mason and Hillyard 2011), the higher presence records of Southern Bell Frogs in pool level managed wetlands could be attributed to surveys being undertaken shortly after managed pool level wetlands were inundated and the species responding to this cue.

The main calling period for the Southern Bell Frog is from August to February, and the maximum detection of calls within the South Australian River Murray corridor is between November and January (Schultz 2006). The results of the 2010-11 census indicate that September was not an optimal month for detection of Southern Bell Frogs. March 2011 had the highest percentage of presence records during the census which may be due to the warm weather and high river levels inundating riparian vegetation during this month providing good breeding habitat.

The analysis that was undertaken on the 2010-11 frog census data (Souter 2010) found that emergent vegetation cover between 5 and 50 percent was associated with higher frog abundance and presence, suggesting that they may favor a low to moderate cover of fringing vegetation and that frogs were less likely to be in wetlands with no vegetation or wetlands with dense vegetation. In the model showed a positive association between Southern Bell Frog abundance and Lignum emergent vegetation. The data analysis also showed that salinity values of less than 471.5 $\mu Scm^{-1}$ were associated with frog presence and high abundance. This does not indicated that the species was not found at higher salinities rather that they were much less abundant or more likely to be present in wetlands with low salinity.

The results of the habitat modeling data analysis should be used with caution because the predictor variables explained only around one third of the variation in the data, mostly likely due to the gaps for salinity and vegetation in the data (Souter 2010). It is recommended that a full suite of parameters be collected from each wetland in future to aid further analysis. Missing variables such as electrical conductivity and the cover of emergent and floating vegetation were amongst the most important variables in the model. It is feasible that a more complete data set would have yielded a more significant result.

Further sampling of habitat types and associated abundance of Southern Bell Frog is necessary before solid conclusions can be made regarding any potential differences between presence, absence, abundance and vegetation types as a preferred habitat. Future monitoring should also consider improving the measurement of habitat variables which this analysis identified as likely to be important such as electrical conductivity and fringing vegetation cover.

## 7.1 Recommendations for Management

The following recommendations should be taken into consideration in the conservation of the Southern Bell Frog and in the management of wetlands for its habitat and breeding:

- Conservation plans should incorporate both permanent and ephemeral wetlands when considering refuge and breeding habitats for this species (Wassens *et al.* 2008b)
- Wetlands management objectives that incorporate Southern Bell Frog breeding should consider hydrological regimes that will inundate emergent vegetation which has structural diversity, particularly where there is lignum and reeds of medium density
- Management should provide Southern Bell Frog breeding habitats during periods of low flows and droughts through wetting and drying of permanent wetlands and / or pumping into temporary wetlands, particularly those that are located close to permanent water with known Southern Bell Frog presence records.

## 7.2 Recommendations for Further Monitoring

To better understand Southern Bell Frog wetland and habitat preferences it is recommended that the following monitoring and research be undertaken:

- Monitoring in September is not an optimal time for detection and monitoring programs should focus survey efforts after this period, ideally between October to February
- Further sampling of habitat types and associated abundance of Southern Bell Frogs is necessary before solid conclusions can be made regarding any potential differences between emergent vegetation types as a preferred habitat
- The sites surveyed as part of this project should be re-surveyed annually

- An investigation of the importance of habitat connectivity, population clusters and movement to new habitats
- The correlation between surface water salinity and Southern Bell Frog presence and abundance
- Further assessment of vegetation habitat type, and percentage cover
- Understanding the time since inundation of ephemeral wetlands and the use of these sites by Southern Bell Frogs
- Assessment of the presence of fish, in particular exotic species such as Common Carp and Gambusia, and their effect on abundance and recruitment
- Assessment of Southern Bell Frog populations in permanent water sources during low flows and their dispersal to newly inundated habitats during wetland inundation
- Further assessment on Southern Bell Frog presence and wetland hydrology / management, i.e. wetting and drying and pumping, is required so that wetland management actions will improve Southern Bell Frog populations in the SA River Murray.

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**Appendix 1: Communication Strategy**

# Communications Strategy

## for the Southern Bell Frog Project to be implemented between January and July 2011

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Prepared by Kelly Marsland and Rebecca Turner, Aquatic Biodiversity Program, SA MDB NRM Board

# Introduction

This strategy will ensure that a primary aim of this project, to educate the community about the Southern Bell Frogs and to promote the importance of wetlands along the River Murray, is delivered consistently and effectively to river communities, Local Action Planning (LAP) groups and other interested members of the public.

# Background

Southern Bell Frogs were once widespread in wetlands along the Lower River Murray; however, prolonged drought in the region and a lack of flooding of temporary wetlands has resulted in a dramatic decline in this species such that they are now considered nationally threatened (EPBC vulnerable). Recent rain in the catchment has enabled re-wetting of pool connected wetlands, and inundation of above pool wetlands (on average for the first time in 4 – 18 years) that both provide critical habitat for this threatened species. The effects of this extended period of drought on Southern Bell Frog populations in the Lower River Murray are currently unknown although some evidence suggests they have declined significantly. However, it is likely that recent inundation of wetlands may have enhanced numbers of this species.

This project will build upon and link with a census of the species in the Coorong Lower Lakes and Murray Mouth region that was conducted in 2009/10 and is currently being re-surveyed the 2010-11. It will also collate information from historical records of the species in the Region. The aim of this investigation is to determine the response of Southern Bell Frogs to the re-inundation of wetlands in this region.

It is essential for the survival of this species that a thorough census determining their distribution and abundance across the Lower River Murray is conducted. By determining this, management can be targeted towards conservation efforts to enhance and protect Southern Bell Frog populations.

In order for conservation efforts to be successful, it is essential that the community supports and is involved in the efforts. Accordingly this census provides a unique opportunity to engage the community in the conservation of a threatened iconic species whilst educating them on the importance and functions of wetlands. Reduced inflow and low water levels in the River Murray have had significant impacts on irrigation and as such the surrounding communities. During such water-scarce times the needs of the environment has been difficult to communicate to these communities. With the consultation process underway for a Basin Plan, educating and including communities in the management and importance of the River and wetlands and the biota that depend on it has become increasingly important.

The community engagement program will include workshops to various local community groups, LAP groups and the general public (invited to join through widespread advertising in local media). Community members will be invited to participate in field trips during the surveys and a workshop will be held in upper and lower regions communicating the results of the census.

A large component of the program will be engaging current and past community wetland members in the program and encouraging new volunteers to participate. In recent years volunteer numbers and enthusiasm within several wetland groups has declined because of the prolonged drought and resultant dried wetlands. As a consequence retaining and recruiting volunteers in wetland monitoring was difficult. This program will provide an opportunity to encourage and motivate volunteers in wetland monitoring.

Throughout the project information will be distributed to the media through media releases and radio interviews. A communications strategy will be developed that will direct this activity.

# Objectives

The objectives of this communication strategy are to assist the Southern Bell Frog project in achieving the following:

- Educating the broader community in wetland ecology by giving regular interviews with the media on this topic
  - The more times the project is mentioned in the media the more people in the broader community will be aware of wetland ecology issues and Southern Bell Frogs

- Undertaking and promoting interesting and enjoyable workshops on Southern Bell Frogs and wetland ecology to attract a larger number of volunteers participating in the program
  - Records will be kept to determine the number of participants at workshops and increases in volunteer numbers at wetland monitoring days

- Promoting and conducting informative and interactive workshops on Southern Bell Frogs and wetland ecology to increase monitoring skills and knowledge of wetlands in the community
  - Records will be kept to determine the number of participants at workshops and increases in volunteer numbers at wetland monitoring days
  - Surveys will be undertaken after workshops to determine if the knowledge of participants has increased due to the project
- Promote information to a wider public on the Southern Bell Frog status, abundance and distribution within the South Australian Murray Darling Basin

# Target Audiences

Primary stakeholders are:

- Wetland Community group members (existing)
- Wetland Community group members (past)
- Local Action Planning groups (including Committee members)
- Members of the wider river community

Secondary stakeholders are:

- South Australian Murray-Darling Basin Natural Resources Management Board (SA MDB NRM Board)
- Natural Resources Management (NRM) Groups
- Department of Environmental and Natural Resources (DENR) staff and networks

| *Stakeholders* | Key messages / communications needs | Mechanisms |
|---|---|---|
| Wetland Community group members (existing) | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs, particularly within their wetland<br>• Improved knowledge of the management of their wetland to benefit Southern Bell Frog | • Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• Distribution of final report and monitoring data related to the community group wetland |
| Wetland Community group members (past) | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs, particularly within their wetland<br>• Improved knowledge of the management of their wetland to benefit Southern Bell Frog | • Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• LAP groups engaged and information circulated to their networks<br>• Advertisement of workshops and events in local newspaper<br>• Media interviews conducted to reach the broader community (including past members)<br>• Distribution of report and monitoring data related to the community group wetland |
| Local Action Planning groups | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs within each LAP area | • Requesting LAP groups to participate in Southern Bell Frog program including surveys and wetland days<br>• Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• Presentation to LAP groups at CARE team meeting on project updates<br>• Distribution of final report<br>• Articles on project within local publications (LAP newsletters) |

| | | |
|---|---|---|
| Members of the wider river community | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs | • Advertisement of workshops and events in local newspaper<br>• Circulate to wider networks (friends, family, etc.)<br>• Media interviews conducted to reach the broader community (including past<br>• Participation in workshops<br>• Articles on project within local publications (LAP newsletters) |
| SA MDB NRM Board | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of Southern Bell Frogs habitats and distribution<br>• Identification of Southern Bell Frog habitats and potential hotspots to improve wetland management | • Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• Presentation of project results to group<br>• Distribution of final report and monitoring data |
| NRM Groups | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs | • Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• Distribution of final report |
| DENR staff and networks | • Promotion of Southern Bell Frog project<br>• Promotion of SA MDB NRM Board Wetland team activities<br>• Increased knowledge of wetland ecology and Southern Bell Frogs<br>• Identification of Southern Bell Frog habitats and potential hotspots to improve wetland management | • Invitations sent to workshops being held in the region<br>• Participation in workshops<br>• Presentation of project results to groups<br>• Distribution of final report and monitoring data |

## Key messages

Key messages for this communications strategy are:

- We value our working relationships and partnerships with community and key stakeholders and understand the importance of these in achieving effective ongoing NRM.
    - Communities are key stakeholder in NRM.
- We all share a responsibility to take care of our precious soil, water, landscapes, marine environments, native animals and plants and ecosystems. The Board sees its role in enabling and building capacity of our community in this endeavor.
    - Communities have a key role to play in managing our natural resources.
    - Improving the community's knowledge of wetlands, and Southern Bell Frogs, and increasing their skills in NRM, is important for NRM on a landscape scale
- Your investment through the NRM Levy is valued. It provides social, economic and environmental benefits to both rural and urban people across our Region.
    - Educating members of the community through the Southern Bell Frog Project is a valuable and effective project that results in tangible benefits and contributions to Regional NRM targets.

## Issues

| ***Issue*** | **Risk** | **Strategy** |
|---|---|---|
| Large part of communication with the community. | Communication will be ineffective unless methods are appropriate and engaging. | Communication needs to be concise and targeted to a wide range of audiences. |
| Key stakeholders generally inundated with information and communications materials. | Southern Bell Frog project communications will be overlooked. | Targeted delivery of communications to suit stakeholders.<br><br>Multiple methods of communications used.<br><br>Ensure activities are fun to a range of participants. |
| Data analysis and written report not completed within set timelines | Communication of information to stakeholders is delayed | Staff workplans will be prioritised to ensure delivery of project within timelines |

# Communication methods

The following communication methods will be used:

**Advertising:**

- Promotion of Workshops in local print media and radio

**Events:**

- Invitations
- Flyers
- Emails
- website

**Public Consultation/Community Engagement:**

- Southern Bell Frog project Working Group
- Workshops and presentations on Southern Bell Frogs and project outcomes

**Stakeholder Briefings:**

- SA MDB NRM Board Presentations
- SA MDB NRM Board Program Leader Presentations/Updates
- CARE Team Meeting presentations/updates
- Wetland Group Committee meetings

**Media:**

- Media releases distributed to local media
- Media/photo opportunities
- Interviews given
- Media invited to workshops
- Articles developed for local publications (LAP newsletters, SA MDB NRM Board website)

**Report:**

- Final report distributed to all primary and secondary stakeholders

# Budget

Include rough estimate of budget allocation towards communications – not inc staff time.

Workshops - $3000 (across region)

Frog kits - $5000

# Evaluation

Evaluation techniques will include:

- Media monitoring
    - Comms team supply report on media releases picked up by local papers etc.
- Website monitoring.
- Survey of Care team members, NRM Board members (etc) and to determine if their knowledge of wetland ecology and Southern Bell Frogs has increased

- Survey community members at the end of the workshops to determine if their knowledge of wetland ecology and Southern Bell Frogs has increased
- Keep records on numbers of participants at workshops
- Keep records on numbers of returning or new volunteers participating in wetland monitoring

## Action Plan

| *Date* | Activity | Targeting who | Responsible |
|---|---|---|---|
| Ongoing | Prepare media releases – may be prior to event for promotion, immediately following event, or as needed during year to raise awareness of Southern Bell Frog project and activities | Broader community<br>Community groups (existing)<br>Community members (on register) | SA MDB NRM Board Wetland Program staff |
| Ongoing | Provide relevant flyers/posters/updates and stories for upload to the SA MDB NRM Board Website for promotion or immediately after event. | Broader community<br>Community groups (existing)<br>Community members (on register)<br>River Murray Youth Council | SA MDB NRM Board Wetland Program and communications staff |
| Ongoing | Invite stakeholders to events | DENR<br>Department for Water (DfW)<br>Community groups (existing)<br>Community members (on register)<br>LAPs<br>Care team<br>SA MDB NRM Board staff<br>SA MDB NRM Board members<br>NRM Group | SA MDB NRM Board Wetland Program staff |
| Feb 2011 | Establish Southern Bell Frog project working group<br>• Invite DENR, DfW, LAP and SA MDB NRM Board staff | SA MDB NRM Board, DfW, LAP & DENR Staff | Project co-ordinator |
| Feb-March 2011 | Plan Workshops<br>• Send flyers to networks advertising workshops<br>• Send media release to local media to publicise event | Broader community<br>Community groups (existing)<br>Community members (on register) | SA MDB NRM Board Wetland Program staff |

| | | | |
|---|---|---|---|
| | • Undertake radio interviews on local stations to publicise event<br>• Advertise in local media if necessary (i.e. not taken up as a media release) | River Murray Youth Council<br>DENR<br>DfW<br>LAPs<br>Care team<br>SA MDB NRM Board staff<br>SA MDB RM Board members<br>NRM Group | |
| Feb 2011 | Send out NRM Education information package:<br>• Information pack<br>• Calendar | Every school principal<br>SA MDB NRM Board members<br>NRM Group members<br>SA MDB NRM Board GM / DGM / Program Leaders<br>LAP Groups<br>NRM reception (info packs only)<br>Upload to internet (info pack only) | SA MDB NRM Board<br>Wetland Program staff |
| May 2011 | Provide Southern Bell Frog project update as an article for DENR/SA MDB NRM Board newsletters. | SA MDB NRM Board staff<br>SA MDB NRM Board members<br>DENR staff | SA MDB NRM Board<br>Wetland Program and communications staff |
| July 2011 | Present results of Southern Bell Frog project to DENR/SA MDB NRM Board staff | SA MDB NRM Board staff<br>DENR staff | SA MDB NRM Board<br>Wetland Program staff |
| July 2011 | Media release to local media on results of survey | Broader community<br>Community groups (existing)<br>Community members (on register) | SA MDB NRM Board<br>Wetland Program and communications staff |
| July 2011 | Present results of Southern Bell Frog project to Care team | Care team | Project co-ordinator |

## Appendix 2: Southern Bell Frog Fact Sheet

Government of South Australia
South Australian Murray-Darling Basin Natural Resources Management Board

**CARING FOR OUR WETLANDS**

# Southern Bell Frog

**AN IMPORTANT WETLAND SPECIES IN THE SOUTH AUSTRALIAN RIVER MURRAY**

For information contact:

South Australian Murray-Darling Basin Natural Resources Management Board Board

P: (08) 8532 1432

For threatened species listings:

Nationally 'vulnerable' under the *Environment Protection and Biodiversity Conservation Act 1999*.

Listed as 'vulnerable' in South Australia, under the *National Parks and Wildlife Act 1972*.

**Common name:** Southern Bell Frog

**Species name:** *Litoria raniformis*

**Size:** It is the largest (up to 10 cm) of the 12 frog species recorded within the River Murray in South Australia.

**Calls:** loud growling 'crawaark'.

**Habitat:** can be found calling from vegetation on the edges of wetlands, swamps, creeks etc.

**Why is the Southern Bell Frog Important?**

The Southern Bell Frog was once one of the most common frogs in many parts of south-eastern Australia. In more recent years there has been a decline in their population, particularly since the early 1990's.

As a result it is now listed as threatened in South Australia and nationally.

**Why has it declined?**

The contributing factors that are thought to have caused the decline in this species are:

- River regulation, prolonged periods of drought and lack of flooding leading to habitat loss,
- Introduced predators (eg *Gambusia holbrooki*),
- degradation of aquatic and riparian vegetation and
- environmental pollutants

**Southern Bell Frog Project**

Many of the wetland projects along the River Murray in South Australia aim to provide habitat and breeding opportunities for the Southern Bell Frog.

The South Australian Murray-Darling Basin Natural Resources Management Board and the Department of Environment and Natural Resources are currently undertaking a project to better understand the habitat and distribution of this threatened species.

For further information regarding this program please contact SA MDB NRM Board on 8532 1432.

This Project is being undertaken by the Wetland Program of the SA MDB NRM Board and is funded by the South Australian Department for Environment and Natural Resources

Australian Government


Southern Bell Frog, Overland Corner


SBF Habitat, Pelican Lagoon