Department for Environment and Heritage

Murraylands Region

Recovery Plan for the Golden Bell Frog *Litoria raniformis* in the South Australian River Murray Corridor

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Summary

The Golden Bell Frog *Litoria raniformis* also commonly known as the Southern Bell Frog is a large frog (up to 10 cm long) associated with permanent and temporary water bodies. This frog was once found across a large portion of south-eastern Australia and Tasmania, but has suffered a dramatic decline throughout its distribution since the early 1990s. In South Australia it is now restricted to scattered populations in the River Murray corridor and in the south-east. As a result of this decline the Golden Bell Frog has been listed as 'Endangered'' under the IUCN (2000) Red List of Threatened Species, 'Vulnerable' under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In South Australia it is listed as 'Vulnerable' under the National Parks and Wildlife Act 1972.

The reasons for the decline of the Golden Bell Frog are not well understood and may constitute multiple factors. Certainly habitat loss and habitat fragmentation have played a major role, other contributing factors could include, river regulation and high levels of consumptive water use which may be exacerbated by prolonged periods of drought, predation of eggs and tadpoles by introduced fish, diseases such as Chytridiomycosis, toxins including herbicides polluting wetlands and pressures from grazing and other forms of habitat degradation. In addition, in the long-term climate change also has the potential to contribute to the decline of this species.

This recovery plan aims in the short-term to identify the breeding and refuge habitat requirements of the Golden Bell Frog within the South Australian River Murray corridor and initiate management programs to stop further population declines and provide conditions favourable to population increases. In the long term this plan aims to improve the conservation status and recovery potential of the Golden Bell Frog. These aims are to be achieved by determining the distribution and habitat preferences of this frog in the River Murray corridor in South Australia, so that these areas may be protected. Initiating research into threatening processes so that these threats may be better managed; identifying the role that managed wetlands can play in the conservation of Golden Bell Frogs. And involving the broader community in Golden Bell Frog Conservation.

In addition to other frog species, wetlands provide valuable habitat for a wide range of nationally listed and state listed fauna and flora. In recent surveys of four wetlands in the Murraylands region in which Golden Bell Frogs were recorded, one nationally listed bird species and 17 state listed bird species were recorded. In addition the state listed Broad-shelled Tortoise *Chelodina expansa* has been recorded in temporary wetlands where Golden Bell Frogs have been recorded breeding.

The protection of Golden Bell Frog habitat, including temporary and permanent wetlands, will have benefits for a wide range of other important flora and fauna species. The wetland areas where this frog has been recorded provide important breeding areas for native fish, breeding areas and refuge for notable water birds and provide areas for the regeneration of key floodplain plant species.

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1.0. INTRODUCTION

1.1 Conservation status

The Golden Bell Frog *Litoria raniformis* is listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and is listed as 'Endangered' under the IUCN (2000) Red List of Threatened Species.

In South Australia it is listed as 'Vulnerable' under the *National Parks and Wildlife Act* 1972. The Golden Bell Frog is also listed as 'Endangered' in NSW under the *Threatened Species Conservation Act* 1995. It is listed as 'Threatened' in Victoria under the *Flora and Fauna Guarantee Act* 1988 and its status is given as 'Endangered' on the Advisory List of Threatened Vertebrate Fauna in Victoria (Department of Sustainability and Environment 2003) It is listed as 'Vulnerable' in Tasmania under the *Threatened Species Protection Act* 1995.

A 2003 review of the status of threatened species in South Australia has proposed that all threatened species are classified using the IUCN Red List Categories and Criteria, Version 3.1. Using this criteria it is proposed that the Golden Bell Frog be listed as 'Vulnerable' based on ''an observed, estimated, inferred, projected or suspected population size reduction of ≥ 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years), where the time period includes both the past and future, and where the reduction or its causes may not have ceased or may not be understood or may not be reversible, based on a decline in area of occupancy, extent of occurrence and/or quality of habitat'' (National Parks and Wildlife Council & Department for Environment and Heritage 2003).

1.2 Reasons for decline

A combination of river regulation and water extraction resulting in habitat loss and fragmentation is likely to have been a major contributor to the decline of this species. However, predation by introduced predators such as the Eastern Gambusia *Gambusia holbrooki*, environmental pollutants (e.g., herbicides), and degradation of aquatic and riparian vegetation are also likely to have contributed to the species declines in some parts of the South Australian River Murray system.

1.3 Recovery actions to date

To date recovery actions have focussed on baseline surveys, which have primarily contributed information on the distribution and abundance of the species:

- 1995 – 2004: Frog censuses were conducted by the South Australian Environment Protection Authority (EPA). These community-based surveys rely on volunteers to record frog calls at as many locations as possible for one week in September. Over the 10 years the program has existed it has provided locations of Golden Bell Frogs both in the River Murray corridor and in the south-east of the State.

- 2002: The EPA conducted a survey within South Australia to determine the distribution and status of the Golden Bell Frog. (Walker & Goonan 2002).

- 2005: A fact sheet promoting Golden Bell Frog conservation was produced by the South Australian Department for Environment and Heritage (DEH).

2.0. ECOLOGY AND BIOLOGY

2.1 Taxonomy

This species has a wide range of common names it can be referred to as the Southern Bell Frog in both South Australia and New South Wales, the Growling Grass Frog in Victoria and the Green and Gold Frog in Tasmania. It can also be called the Green or Warty Swamp Frog, or the Warty Frog.

The Golden Bell Frog belongs to the Family Hylidae, which has an almost worldwide distribution. Although this family is known as the tree frogs, the Golden Bell Frog is largely terrestrial in habit (Tyler 1978). There are six other members of the Genus *Litoria* in South Australia, Green Tree Frogs *Litoria caerula*, Brown Tree Frogs *Litoria ewingi*, Red Tree Frogs *Litoria rubella,* Peron's Tree Frog *Litoria peroni*, and the Broad-palmed Frog *Litoria latopalmata*. The Golden Bell Frog is a member of the *Litoria aurea* or bell frog species group, which consists of six species in Australia (Tyler & Davis 1978). It is the only member of this group that occurs within South Australia (Robinson *et al*. 2000).

2.2 Description

Adult frogs

The Golden Bell Frog is a medium to large sized terrestrial frog; the female is larger than the male, ranging in size from 60.0 to 104.2mm long, while the male can range between 55.2 – 64.8mm in length (Tyler 1978). Individual frogs can be olive to bright emerald green, gold, brown or a combination of these colours, although the hind side of the thighs tends to be bright bluish and there is usually a pale green mid-dorsal stripe (Tyler 1978, Robinson 1993, Cogger 2000). They can be distinguished from the similar looking Green and Golden Bell Frog *Litoria aurea* by the presence of numerous large warts, tubercles and short skin folds on the back (Cogger 2000). The fingers are long with small circular discs and the webbing between the fingers is restricted to the base, giving the appearance that there is no finger webbing. In contrast the toe webbing extends to the base of the toes terminal disc. These frogs have small vomerine teeth that are used for holding prey (Tyler 1978, Barker *et al*. 1995).

Tadpoles

Golden Bell Frog tadpoles are larger than other tadpoles recorded in River Murray wetlands with specimens as long as 110mm being recorded, although maximum sizes of 85 – 90mm are more common. They are initially pinkish-grey with yellowish fins, but are close to adult colours by the time metamorphoses occurs (Anstis 2002, Amphibian Research Centre 2005). The freshly metamorphosed frogs range between 28 – 34mm in length (Tyler 1978, Anstis 2002).

2.3 Distribution

The historic distribution of the Golden Bell Frog covers a large portion of the south-eastern Australian mainland and Tasmania. This frog was found across south-western New South Wales, most of the Australian Capital Territory and Victoria, north and east Tasmania and south-eastern South Australia as shown in Figure 2.1 (Tyler 1998). Introduced populations of Golden Bell Frogs also occur in New Zealand.

However this species has suffered a dramatic decline across its entire Australian distribution since the early 1990s (Pyke 2002). In New South Wales the distribution appears to have contracted to a few sites along the Murray and Murrumbidgee

Rivers with the only currently known populations occurring in the Coleambally Irrigation Area and the Lowbidgee floodplain (Department of Environment and Conservation 2005). In the ACT the species appears to have disappeared altogether, while in Victoria there have been local extinctions and population declines in the south and central areas, although there are still large populations around Melbourne and some regional areas (Tyler 1998). In Tasmania, population declines have been reported from all areas of its distribution in the last 15 years (Department of Primary Industries, Water and Environment 2001).

In South Australia the historic distribution of the Golden Bell Frog includes several distinct locations along the length of the River Murray and in the lower south-east extending northwards towards Keith. It has also been reported in two areas around Adelaide where it is thought to have been introduced, in drainage ditches at the Defence Research Centre at Salisbury and within the Mount Lofty Ranges (Tyler 1978). However recent surveys suggest that these two populations have declined (Walker & Goonan 2002). In the south-east it has declined and become scarce, although it still remains abundant in a few scattered areas (Walker *In lit*.). It may also remain abundant in scattered locations along the River Murray corridor (Tyler 1998).

2.4 Population estimates

Golden Bell Frogs have been recorded along the River Murray corridor at 38 locations, between 1995 and 2004 in the annual EPA Frog Census, (EPA un-published data). The number of sites where the frog was recorded varied considerably between years ranging from no records in 2002 to 26 sites in 2000 (Figure 2.3). However these data do not necessarily show a pattern of decline as not only was there some variation in the sites sampled between the years, calling in the Golden Bell Frog may be affected by local rainfall and flooding patterns (Walker 2003). Additionally these frogs may call later than the September Frog Census week in some years, as a result of low temperatures or other factors.

Figure 2.1 The current distribution of the Golden Bell Frog in the South Australian River Murray Corridor.

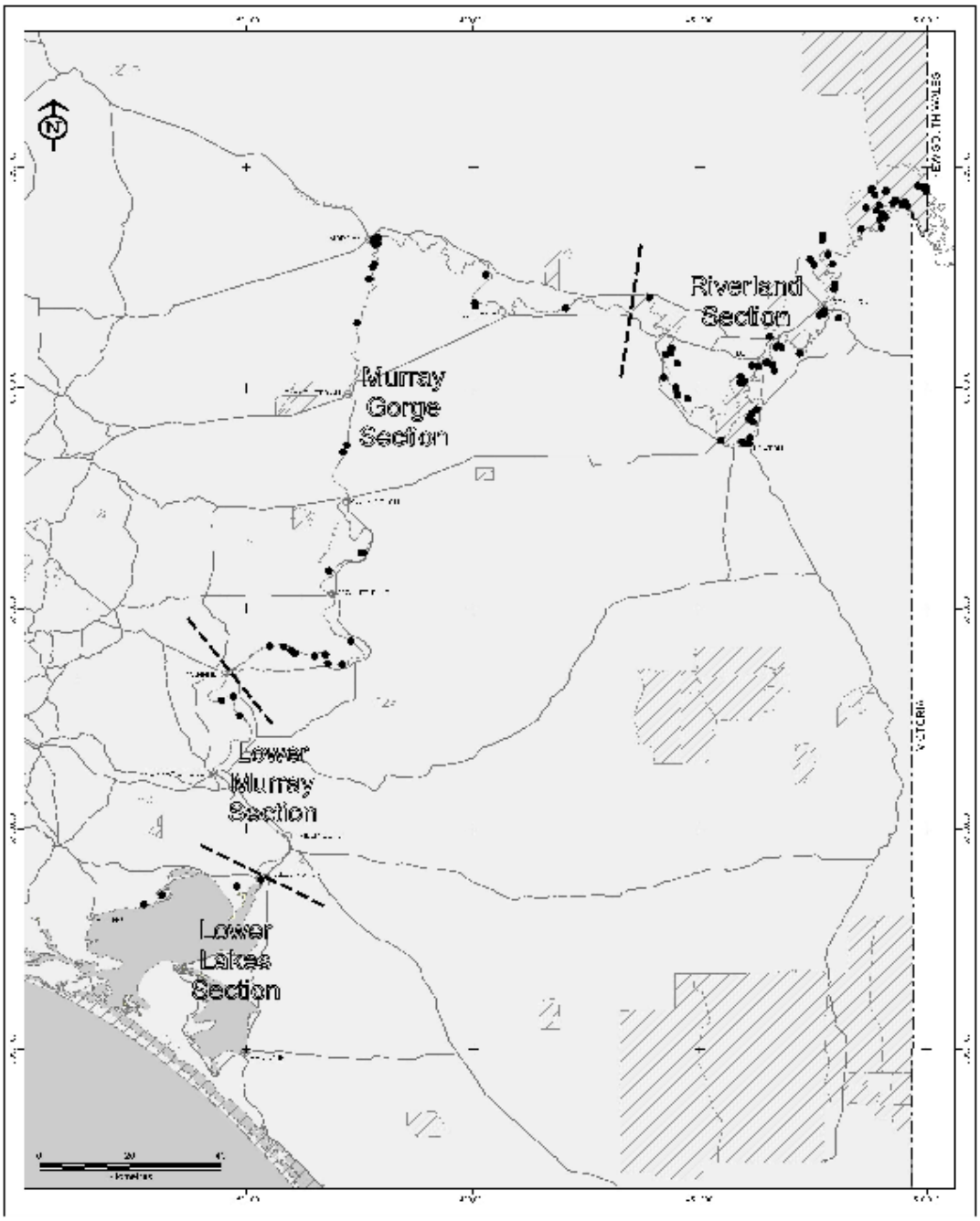
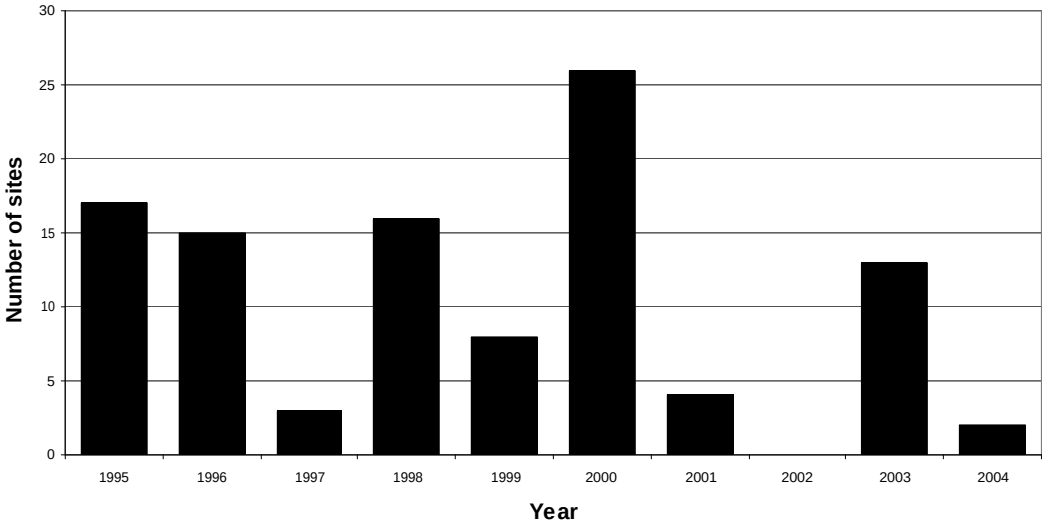


Figure 2.2 Number of sites along the South Australian River Murray corridor in which the Golden Bell Frog was recorded in 10 EPA Frog Censuses' between 1995 and 2004.



2.5 Habitat requirements

The Golden Bell Frog has usually been associated with permanent water bodies such as lagoons, farm dams, ponds, marches or slowly flowing creeks or rivers, most commonly in areas with emergent vegetation. Tyler (1978) notes that this species is confined to areas within a reasonable distance of permanent swamps or rivers. Recent studies in NSW have demonstrated that Golden Bell Frogs can be found in small permanent water bodies within irrigation areas. When flooding occurrs they spread out into surrounding areas and use the temporarily flooded wetlands for breeding (Department of Environment and Conservation 2005).

In South Australia these frogs have also been recorded both in association with semi-permanent water bodies (Suter *et al.* 1993) and within temporary wetlands. In 2004 Golden Bell Frogs were recorded breeding at Lake Littra when it had been artificially flooded after a four-year dry period (Department for Environment and Heritage 2004[a]). They have also been recorded breeding at other River Murray corridor wetlands, which are managed to have dry phases. These wetlands include the Ngak Indau wetlands, near Berri and at the Morgan Conservation Park wetlands (Department for Environment and Heritage 2004[b,c]).

Although the type of water body used by these frogs may vary widely—they are strongly associated with extensive areas of sedges, rushes and reeds from which they call when breeding (Gillespie *et al.* 2004). Tadpoles also demonstrate a strong association with emergent vegetation and are usually found amongst vegetation at, or near the edge of the water body in the mid-water to surface area, diving deeper if disturbed (Tyler 1978, Anstis 2000). Refuge areas for adults can include soil cracks, fallen timber, other debris and dense vegetation (Department of Environment and Conservation 2005).

2.6 Critical habitat

At present there is no reliable information on what constitutes critical habitat. Given the extensive range and movements of the species at present it would be premature to conclude that all occupied habitat is critical.

2.7 Movements and home range

Golden Bell Frogs are known to make substantial overland movements. These movements may be associated with local rainfall or flooding and prolonged wet weather, these movements can assist in the colonisation of new areas (Department of Environment and Conservation 2005). In 2004, Golden Bell Frogs were recorded in Lake Littra—the site of a River Red Gum *Eucalyptus camaldulensis* watering trial in which water was pumped into a temporary wetland. In order to reach this site the frogs would have had to move at least 500m overland from the nearest permanent water (Department for Environment and Heritage 2004[a]). Another South Australian study recorded Golden Bell Frogs in pitfall traps several hundreds metres from the nearest water on Katarapko Island (Herbert 2000).

2.8 Diet and foraging behaviour

The Golden Bell frog has been described both as a generalist carnivore and an opportunistic forager. It is a sit and wait predator—that is a predator—which sits and waits to ambush its prey when it comes within feeding range (Department of Environment and Conservation 2005). Foraging may occur both during the night or day (Cogger *et al*. 1983) and it has been observed feeding on both aquatic and terrestrial prey. This prey includes both invertebrates and vertebrates, such as aquatic beetle larvae, terrestrial invertebrates such as beetles, snails, grasshoppers, flies and other insects, aquatic vertebrates such as tadpoles other frogs including members of its own species, and small fish, and terrestrial vertebrates including lizards and small snakes (Pyke 2002).

2.9 Social organisation and reproduction

Breeding occurs over an extended period from about August, September to January, February, although calling has been recorded as late as March and April. Males can call while floating in standing water or from vegetation close to the waters edge—and while calling may occur during the night or day—it is generally restricted to warm and calm conditions. Mating and spawning have also been observed both during the night and day (Pyke 2002). Approximately 2000 eggs are laid in a loose clump contained in a floating jelly raft, which latter breaks up and sinks (Gillespie *et al*. 2004, Amphibian Research Centre 2005).

The tadpoles are free swimming and are usually found in vegetation close to the waters edge (Anstis 2002). They may be found in the water at any time of the year as breeding generally occurs over an extended period, with tadpole metamorphose occurring in late summer or autumn. However, in some instances tadpoles may over winter and metamorphose in the following summer (Gillespie *et al*. 2004). Immature frogs are generally observed between January and April (Cree 1984 in Pyke 2002).

Golden Bell Frogs are active by day and will often bask in sunlight, although basking may decline in hotter regions (Department of Environment and Conservation 2005).

3.0. THREATS TO SPECIES PERSISTENCE OR RECOVERY

3.1 River Regulation and Habitat Fragmentation

River regulation and high levels of consumptive water use have altered the timing and reduced the frequency, magnitude and duration of flooding along the entire length of the South Australian River Murray (Carter & Nicolson 1993, Sharley & Huggan 1995). Particularly low flows have occurred from the year 2000 onwards—a result of an extended drought and demands for consumptive water use, which have been higher than in any previous drought (Murray-Darling Basin Commission 2002).

Local flooding which fills temporary wetlands on the floodplain can be a trigger for breeding in this species (Pyke 2002), indeed breeding has been recorded in four managed wetlands in the South Australian River Murray corridor after introduced flooding events (Department for Environment and Heritage 2004[a], 2004[b], 2004[c] 2004[d]). Hence a reduction in flood frequency will significantly reduce the area of available breeding habitat and reduce the number of breeding opportunities. While a reduction in flood duration may reduce breeding success if wetlands dry before tadpoles have metamorphosed.

Given that flood frequency and duration can be controlled in managed river pool level wetlands with flow control structures and that flood duration can be controlled in managed wetland above pool level. It would be appropriate to investigate the occurrence of Golden Bell Frogs in managed wetlands in the River Murray corridor and identify the factors including flooding regimes and habitat features that favour successful breeding of this frog.

3.2 Drought

The decline of the Golden Bell Frog was consistent with drought in Victoria and there has been some evidence of recovery in wetter years (Tyler 1997). Similarly in South Australia recordings of the Golden Bell Frog has been greater during wetter years than in dry years (Walker 2003). However, Mahoney (1999) cautions that, although drought has been linked to declines in the bell frog complex in the New South Wales northern and southern tablelands, drought is a regular feature of these areas. Suggesting that other factors are involved with the decline of bell frogs in these areas, or that drought is acting in combination with other existing pressures to produce the observed decline. The role of drought in the decline of the Golden Bell Frogs in the South Australian River Murray corridor has not been determined nor have the possible interactions between drought and other threatening processes been assessed.

3.3 Eastern Gambusia

Eastern Gambusia *Gambusia holbrooki* formerly known as *Gambusia affinis*, and also widely called Mosquito Fish were introduced to Australia around the 1920s initially as an aquarium fish, and then into the wild as an unsuccessful control for mosquitos. They are now widely spread and common throughout New South Wales, South Australia and Victoria (McDowall 1980). They are most abundant in still warm waters 25 – 38º C, but can survive under ice and in temperatures up to 44º C. They mature rapidly and may breed several times per year—given suitable temperatures—resulting in rapid population increases (McDowall 1980). They are widespread and common in South Australian River Murray wetlands.

Eastern Gambusia are a well-known threat to small native fish such as carp gudgeons, which they attack, compete with for resources and consume their eggs and young. They are also known to have adverse effects on macro invertebrate populations (Bence 1998) and are considered a major factor in the decline of several

species of frogs including the Green and Golden Bell Frog *Litoria aurea* (Pyke & White 2000). Although this relationship is not simple, in controlled experiments examining the effects of Eastern Gambusia on Green and Golden Bell Frog tadpoles it was found that where aquatic vegetation was absent tadpole survival was significantly reduced in a 24-hour period. When aquatic vegetation was present no significant impacts could be detected after three days (Morgan & Buttemer 1996).

However, in this study only deceased tadpoles where counted as prey while those with tail damage where not. Tail damage can result in increased risk of disease, increased risk of predation, as a result of lost mobility and reduced growth rates resulting in poorer survival rates. Additionally the presence of predators may change foraging patterns also resulting in reduced growth rates (NSW National Parks & Wildlife Service 2003[a]). Morgan and Buttemer's (1996) study concluded that remnant Green and Golden Bell Frog population are susceptible to predation by Eastern Gambusia and suggested that removal of them from Green and Golden Bell Frog breeding areas was an appropriate management action.

It still remains to be established the effect that predation by Eastern Gambusia on Golden Bell Frogs eggs and tadpoles has on South Australian River Murray populations.

3.4 Disease: Chytridiomycosis

Chytridiomycosis is a disease fatal to a wide range of frog species, and has been observed in both the Golden Bell Frog and the closely related Green and Golden Bell Frog *Litoria aurea* (Bishop 2000, Mahony & Wekerman 2001 in NSW National Parks & Wildlife Service 2003). Infection occurs through waterborne zoospores—which can remain viable for over 24 hours. These spores invade the superficial layers of the epidermis. Experimentally infected frogs have become terminally ill 10 – 47 days after exposure (Berger *et al.* 1999).

Chytridiomycosis occurs globally and has been found in New Zealand, Europe, North America, Central America, South America and Africa. In Australia it has been recorded in four zones, along the east coast extending from Cooktown to Melbourne, in Tasmania, in the south-west of Western Australia. In South Australia it has been recorded in a zone around Adelaide, but not yet in the River Murray corridor (Speare & Berger 2005). In the Adelaide zone one species of frog the Spotted Grass Frog *Limnodynastes tasmaniensis* has been recorded with this infection and two species of frog the White-lipped Tree Frog *Litoria infrafraenata* and the Golden Bell Frog held in captivity in Adelaide have been recorded with this disease.

Chytridiomycosis has been declared a key threatening process in New South Wales where the disease has been a known cause of death in the Green and Golden Bell Frog and six other frog species (NSW National Parks & Wildlife Service 2003[b]). The New South Wales Parks and Wildlife Service currently has in place hygiene protocols for the control of disease in frogs, which are intended for use by all people handling frogs (NSW National Parks and Wildlife Service 2001). Consideration should be given to introducing similar protocols in South Australia to prevent the spread of this disease.

3.5 Toxins

Frogs are highly susceptible to environmental pollutants throughout their life cycle. Both frog eggs and tadpoles can absorb toxic water born pollutants such as insecticides, while adult frogs, that also have soft permeable skin are similarly vulnerable (White 1995). Hence the introduction of chemicals such as herbicides and insecticides into frog habitat can pose a serious threat to that frog population

(Robertson et al. 1994, Ehmann & White 1996 in Department of Environment and Conservation 2005).

It has been suggested that a herbicide containing a dispersant has been directly responsible for some declines of the Golden Bell Frog when used around farm dams (Tyler 1997). Studies of the of the closely related Western Green Tree Frog *Litoria moorei* conducted in Western Australia have found that the tadpoles of this species are particularly sensitive to glyphosate a broad spectrum non-selective herbicide (Tyler 1997). In addition the surfactant used in the formulation of commonly used herbicides can be more harmful to aquatic animals than the glyphosate. The toxicity of these compounds increases significantly with rising pH and temperature (Bidwell & Gorrie 1995), which may present a potential hazard for frogs and tadpoles occurring in shallow water bodies along the river corridor.

3.6 Grazing and other habitat degradation

Grazing of wetlands has the potential to seriously degrade frog habitat by removing surrounding vegetation—hence reducing the area available for foraging and shelter (Pyke 2002). Additionally grazing around a wetland can slow seedling establishment, increase water turbidity, through trampling and pugging and reduce aquatic productivity (Bacon *et al.* 1994). While the removal of aquatic vegetation may remove shelter and foraging areas for tadpoles. In addition vegetation clearing and removal of fallen timber and other ground debris removes shelter and possible foraging sites for adult frogs (Department of Environment and Conservation 2005).

3.7 Climate Change

In the future the threats associated with reduced River Murray flows owing to river regulation may be exacerbated by climate change. Climate predictions suggest that overall, climate change may bring lower rainfall and higher evaporations rates to the Murray-Darling Basin, resulting in even lower River Murray flows than those that occur at present (Jones *et al*. 2002). Global warming as a result of an enhanced green house effect may reduce tadpole survival owing to increasing water temperature. Indeed, it is suggested that further global warming will reduce the overall distribution of the Golden Bell Frog (Ashworth 1998, Bennett *et al.* 1991 in Pyke 2002). Additionally frog species that bask in the sun like the Golden Bell Frog may be susceptible to increasing levels of UVB radiation on adults (Tyler 1997), however this has not yet been demonstrated for this frog species.

3.8 Knowledge Gaps

There has been little scientific research of the Golden Bell Frog in the South Australian River Murray corridor. As a result there is a paucity of published information on their habitat requirements in this region, breeding biology and ecology. In addition the reasons for the decline of this species is poorly understood.

In the absence of this information it is difficult to predict or monitor the efficacy of a range of management actions. In particular more information is required on the role that managed wetlands can play in Golden Bell Frog conservation as these wetlands may offer a unique opportunity to manipulate habitat to favour this species.

4.0. RECOVERY OBJECTIVES

4.1 Broad goals

Short-term Goal

- Within five years identify the breeding and refuge habitat requirements of the Golden Bell Frog within the South Australian River Murray corridor. Initiate during this time period, management programs to stop further population declines and provide conditions favourable for population increases.

Long-term Goal

- Within ten years, improve the conservation status and recovery potential of the Golden Bell Frog In the South Australian River Murray corridor.

4.2 Specific objectives

1. Determine the current distribution and habitat preference of the Golden Bell Frog in the South Australian River Murray Corridor.

2. Increase the level of knowledge of the Golden Bell Frogs breeding biology, ecology and reasons for decline.

3. Investigate the role that managed wetlands within the South Australian River Murray corridor can play in the conservation of the Golden Bell Frog.

4. Implement strategies to mitigate identified threats to the Golden Bell Frog in South Australian River Murray corridor.

5. Increase community awareness and involvement in the conservation of the Golden Bell Frog and other threatened wetland fauna.

6. Form of a Regional Recovery Team for the Golden Bell Frog.

5.0. RECOVERY CRITERIA AND ACTIONS

Objective 1: Determine the current distribution and habitat preference of the Golden Bell Frog in the South Australian River Murray Corridor.

Criteria 1.1: The distribution of the Golden Bell Frog in the South Australian River Murray Corridor is determined.

Actions

1.1 Collate Golden Bell Frog sightings from existing records such as EPA Frog Census, Wetland Management plans and community sightings. Conduct additional targeted surveys as required.

Regular monitoring of Golden Bell Frog distribution will provide the baseline information necessary to evaluate the efficacy of recovery actions. In addition this information will help to identify threats to specific populations and will be a valuable aid in guiding future management actions.

Objective 2: Increase the level of knowledge of the Golden Bell Frogs breeding biology, ecology, habitat preference and reasons for decline.

Criteria 2.1: Habitat features necessary for successful breeding and refuge are determined and threatening processes are better understood.

Actions

2.1 Undertake studies within a variety of different wetland types where Golden Bell Frogs have been recorded, to determine essential habitat and hydrological regimes where applicable.

2.2 Undertake studies of Golden Bell Frog breeding biology and ecology, including threatening processes.

A greater understanding of the Golden Bell Frog's biology and ecology particularly in relation to essential breeding habitat and hydrological regimes will help to guide management actions where active management is required. Additionally improved knowledge of the species breeding biology and ecology will also help to inform future recovery actions.

Objective 3: Investigate the role that managed wetlands within the South Australian River Murray corridor can play in the conservation of the Golden Bell Frog.

Criteria 3.1: Document the occurrence of Golden Bell Frogs in managed wetlands in the South Australian River Murray corridor.

Criteria 3.2: Factors that influence the occurrence of Golden Bell Frogs in managed wetlands are better understood.

Actions

3.1 Include managed wetlands in the surveys outlined at Objective 2.

3.2 Determine habitat features including hydrological regimes in managed wetlands that favour Golden Bell Frog breeding.

A greater understanding of the role that managed wetlands can play in Golden Bell Frog conservation may offer a unique opportunity to manipulate habitat to favour this species where active management is required.

Objective 4: Implement strategies to mitigate identified threats to Golden Bell Frogs in the South Australian River Murray corridor.

Criteria 4.1: Golden Bell Frog breeding habitat is identified mapped and protected.

Actions

4.1 Surveys of Golden Bell Frog distribution are conducted with sufficient frequency to determine changes in its distribution.

4.2 Land tenure of existing Golden Bell Frog breeding areas is determined.

4.3 Liaise with wetland managers including private landholders where the Golden Bell Frog occurs to promote protection of frog breeding habitat.

Existing Golden Bell frog populations are identified and protected. Consistent monitoring of this species will allow the efficacy of recovery actions to be measured. Working with wetland managers and landholders, will assist with the recovery of the species and elevate its public profile.

Objective 5: Increase community awareness and involvement in the conservation of the Golden Bell Frog and other threatened wetland fauna.

Criteria 5.1: Increase awareness and community participation in the Golden Bell Frog Recovery Program across a broad range of community groups

Actions

5.1 Studies of the Golden Bell Frogs breeding biology, ecology, and habitat preference and threatening processes are published in peer-reviewed journals.

5.2 Results / outcomes from programs are reported to interested community groups such as wetland managers, Local Action Planning groups, and the South Australian Murray River CARE Team.

5.3 Develop a manual for wetland managers, which outlines methods of conserving Golden Bell Frogs in managed wetlands in which they are located.

5.4 Develop educational fact sheets and posters that promote the conservation of the Golden Bell Frog.

5.5 Report recovery program results to the local community through the local media.

These actions will raise the public profile of the species and assist in the collection of research data and the implementation of recovery actions.

Objective 6: Formation of a Regional Recovery Team for the Golden Bell Frog.

Criteria 6.1: A Regional Recovery Team is formed.

Actions

6.1 Form a Recovery Team that includes DEH River Corridor Threatened Fauna Officers, community members and wetland managers.

The establishment of a Recovery Team will help with the co-ordination of research and recovery actions and the dissemination of information to the broader community.

6.0. Implementation Schedule

Table 6.1, provides a summary of the implementation schedule for the recovery actions identified in Section 5 of this plan. Table 6.2 provides a summary of the parties responsible for implementing the actions and an estimate of the costs involved.

This plan is to be reviewed within five years of the date of publication.

Table 6.1: Implementation and costing schedule for the Golden Bell Frog Recovery Plan.

Action No:	Description	Priority	Stakeholders	Estimated Cost/yr. (in $1000)					Wages	In Kind	Cash	Total
				2006	2007	2008	2009	2010				
1.1	Collate Golden Bell Frog sightings from existing records.	**1**	DEH, Wetland Managers, Community Groups.	2.5	1.6	1.6	1.7	1.7	6.6	2.5		9.1
2.1	Undertake studies within a variety of different wetland types where Golden Bell Frogs have been recorded, to determine essential habitat and hydrological regimes where applicable.	**1**	DEH, Wetland Managers, Community Groups.	5.5	6.7	7.4			11.6	3.0	5.0	19.6
3.3	Undertake studies of Golden Bell Frog breeding biology and ecology, including threatening processes.	**2**	DEH, Wetland Managers, Community Groups.			6.4	6.7	6.9	14.0	3.0	3.0	20.0
3.1	Include managed wetlands in the surveys outlined at Objective 2.	**1**	DEH, Wetland Managers, Community Groups.	4.0	5.2	5.4			11.6	3.0		14.6
3.2	Determine habitat features including hydrological regimes in managed wetlands that favour Golden Bell Frog breeding.	**1**	DEH	4.5	5.7	6.4			11.6		5.0	16.6

Table 6.1: Implementation and costing schedule for the Golden Bell Frog Recovery Plan.

Action No:	Description	Priority	Stakeholders	Estimated Cost/yr. (in $1000)					Wages	In Kind	Cash	Total
				2006	2007	2008	2009	2010				
4.1	Surveys of Golden Bell Frog distribution are conducted with sufficient frequency to determine changes in its distribution.	**2**	DEH, Wetland Managers, Community Groups.	9.0		10.0		10.2	13.1	13.1	3.0	29.2
4.2	Land tenure of existing Golden Bell Frog breeding areas is determined.	**2**	DEH.		1.1	1.15	1.2	1.3	4.75			4.75
4.3	Liaise with wetland managers including private landholders where the Golden Bell Frog occurs to promote protection of frog breeding habitat.	**3**	DEH, Regional Recovery Team, Wetland Managers, Community Groups, Landholders.		1.1	1.15	1.2	1.3	4.75			4.75
5.1	Studies of the Golden Bell Frogs breeding biology, ecology, and habitat preference and threatening processes are published in peer-reviewed journals.	**3**	DEH		1.1	1.15	1.2	1.3	4.75			4.75

Table 6.1: Implementation and costing schedule for the Golden Bell Frog Recovery Plan.

Action No:	Description	Priority	Stakeholders	Estimated Cost/yr. (in $1000)					Wages	In Kind	Cash	Total
				2006	2007	2008	2009	2010				
5.2	Results / outcomes from programs are reported to interested community groups such as wetland managers, LAP groups, and the South Australian Murray River Care Team.	**2**	DEH, Regional Recovery Team, Wetland Managers, Community Groups, Landholders.	1.0	1.1	1.15	1.2	1.3	5.75			5.75
5.3	Develop a manual for wetland managers, which outlines methods of conserving Golden Bell Frogs in managed wetlands in which they are located.	**1**	DEH, Regional Recovery Team, Wetland Managers.		4.4		6.9		6.9		4.4	11.3
5.4	Develop educational fact sheets and posters that promote the conservation of the Golden Bell Frog.	**3**	DEH	3.0		3.4			4.3		2.1	6.4

Table 6.1: Implementation and costing schedule for the Golden Bell Frog Recovery Plan.

Action No:	Description	Priority	Stakeholders	Estimated Cost/yr. (in $1000)					Wages	In Kind	Cash	Total
				2006	2007	2008	2009	2010				
5.5	Report recovery program results to the local community, through the local media.	**3**	DEH, Local Community.	1.0	1.1	1.15	1.2	1.3	5.75			5.75
6.1	Form a Recovery Team that includes DEH River Corridor Threatened Fauna Officers, community members and wetland managers.	**3**	DEH, Wetland Managers, Community Groups, Landholders.	1.3	1.4	1.5	1.55	1.6	5.7		1.65	7.35
Totals				**30.8**	**30.5**	**47.5**	**24.2**	**26.9**	**111.1**	**24.6**	**24.1**	**159.9**

7.0. Biodiversity Benefits to Non-target Species

The Golden Bell Frog usually occurs in conjunction with other frog species (Pyke 2002, Walker & Goonan 2002), hence management actions to protect Golden Bell Frog habitat will also benefit the conservation of other frogs. In managed wetlands in the South Australian River Murray corridor, the Golden Bell Frog has been observed in the same wetlands as Peron's Tree Frog *Litoria peroni,* Painted Frog *Neobatrachis pictus*, Eastern Banjo Frog *Limnodynastes dumerilli,* Eastern Sign Bearing Froglet *Crina parinsignifera* and the Spotted Grass Frog *Limnodynastes tasmaniensis* (Department for Environment and Heritage 2004[a], 2004[b], 2004[c] 2004[d]).

In addition to other frog species, wetlands provide valuable habitat for a wide range of nationally listed and state listed fauna and flora. In recent surveys of four wetlands in the Murraylands region in which Golden Bell Frogs were recorded, one nationally listed bird species and 17 state listed bird species were recorded (Table 2.1). In addition the state listed Broad-shelled Tortoise *Chelodina expansa* has been recorded in temporary wetlands such as Lake Littra (Nichols & Gilligan 2004) where Golden Bell Frogs have been recorded breeding.

The protection of Golden Bell Frog habitat, including temporary and permanent wetlands, will have benefits for a wide range of other important flora and fauna species. The wetland areas where this frog has been recorded provide important breeding areas for native fish such as Carp Gudgeon *Hypseleotris Sp.*, Fly-Specked Hardyhead *Craterocephalus stercus muscarum* and Bony Bream *Nematalosa erebi*, and breeding areas and refuge for notable water birds such as Royal Spoonbills *Platalea regia*, Yellow-billed Spoonbills *Platalea flavipes*, Sacred Ibis *Threskiornis aethiopicus* and other species. In addition temporary wetlands provide areas for the regeneration of key floodplain plant species such as River Red Gum, River Coobah *Acacia stenophylla* and Lignum *Muehlenbeckia cunninghamii.*

Table 7.1: Species of conservation significance recorded in three managed wetlands in the Murraylands Region of South Australia at which the Golden Bell Frog was recorded.

Common Name	Scientific Name	National Status	South Australian Status
Great Crested Grebe	*Podiceps cristatus*		Rare
Australasian Shoveler	*Anas rhynchotis*		Rare
Blue-billed Duck	*Oxyura australis*		Rare
Musk Duck	*Biziura lobata*		Rare
Freckled Duck	*Stictonetta naevosa*		Vulnerable
Australasian Shoveler	*Anas rhynchotis*		Rare
Glossy Ibis	*Plegadis falcinellus*		Rare
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		Vulnerable
Peregrine Falcon	*Falco peregrinus*		Rare
Bush Stone-curlew	*Burhinus grallarius*		Vulnerable
Major Mitchell Cockatoo	*Cacutua leadbeateri*		Vulnerable
Regent Parrot	*Polytelis anthopeplus*	Vulnerable	Vulnerable
Flame Robin	*Petroica phoenicea*		Rare
Redthroat	*Pyrrholaemus brunneus*		Rare
Striped Honeyeater	*Plectorhyncha lanceolata*		Rare
Little Friarbird	*Philemon citreogularis*		Rare
Blue-faced Honeyeater	*Entomyzon cyanotis*		Rare

8.0. Relevant Legislation

Commonwealth Legislation

Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999: The Golden Bell Frog is listed as Nationally 'Vulnerable' under this act, which provides for the regulation of actions that can result in a significant impact on nationally listed threatened species and / or ecological communities.

South Australian Legislation

National Parks and Wildlife Act 1972: This act allows for the reservation, protection and management of natural areas and the flora and fauna contained within them. The act also has provision for the licensing of scientific investigation of these species. The Golden Bell Frog is listed as 'Vulnerable' under this act and has been recorded nesting in the following parks and reserves in the South Australian River Murray corridor, Murray River National Park, Chowilla Game Reserve, Moorook Game Reserve and Morgan Conservation Park.

Native Vegetation Act 1991: This act allows for the protection of native vegetation on free hold land by providing incentives and assistance to land holders to conserve native vegetation, limit clearance, encourage revegetation and give landholders the opportunity to enter into Heritage Agreements. Schedule 1 of this act states the principles of native vegetation clearance that relate to the conservation of biodiversity. In addition to making provision for the retention of significant flora and vegetation associations, it also states that vegetation should not be cleared if the vegetation is growing in or in association with a wetland environment or the clearance of the vegetation is likely to cause deterioration in the quality of the surface or underground water. Additionally, native vegetation should not be cleared if it has significance as a habitat for wildlife.

The Water Resources Act 1997: The purpose of this act is to provide for sustainable management of South Australia's water resources. This act has provision for protecting watercourses from degradation and for restoration where degradation has already occurred.

Pastoral Land Management and Conservation Act 1989: This act provides for the monitoring of the grazed lands condition to prevent degradation. A lease can also contain conditions that provide for the rehabilitation of degraded land.

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