Management Plan

The Green and Golden Bell Frog Parramatta Key Population

August 2008

Catchment Management Authorities
CMA NEW SOUTH WALES

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Cover photograph: Aerial photo of the Parramatta River floodplain at Parramatta, western Sydney

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The Green and Golden Bell Frog (GGBF) *Litoria aurea* is a large, muscular species with a robust form. Adult frogs range from approximately 45mm to 100mm, with most individuals being in the 60-80mm size class.

The colouration of the back is variable, ranging from a vivid pea green splotched with almost metallic brass brown or gold (Figure 1) to almost entirely green (Figure 2a), or having golden bronze markings that almost cover the whole back (Figure 2b).

Tadpoles of the species reach up to 35mm in length and, at that size, can be readily identified (Figure 3). Smaller tadpoles are more difficult to distinguish from the tadpoles of other species and identification may need to rely on mouth part features (for details, refer to Anstis, 2002).

The former distribution of the GGBF ranged from the NSW north coast near Brunswick Heads southwards along the NSW coast to Victoria, where it extended into East Gippsland and west to Bathurst, Tumut and the ACT. In the 1960s, the species was considered widespread, abundant and commonly encountered. Today, the species exists as a series of isolated populations within its former range (Figure 4).

Figure 1: ***Green and Golden Bell Frog***
Photo © Garry Daly

The GGBF is listed as 'endangered' under Schedule 1 of the NSW *Threatened Species Conservation Act 1995* (TSC Act), and 'vulnerable' under Schedule 1 Part 2 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. As a consequence of its status, a recovery plan has been prepared under the TSC Act, while under the NSW *Environmental Planning and Assessment Act 1979* (EPA Act) consideration of this species is required when assessing the impact of development and activities on populations of the species and its habitats.

The Green and Golden Bell Frog *Litoria aurea* (Lesson 1829) Recovery Plan (draft) defines key populations as conservation management units and lists 43 such populations in NSW. The actions within the Recovery Plan are also listed as actions within the NSW Department of Environment and Climate Change (DECC) Priorities Action Statement for amphibians found at:

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_speciestype_details.aspx?type=Amphibians&kingdom=Animal

a) b)

Figures 2a & 2b: ***Colour variants of the Green and Golden Bell Frog***
Photos © (a) Garry Daly (b) Dave Hunter

Figure 3: ***Tadpole of the Green and Golden Bell Frog***
Photo © Mark Parsons

The Parramatta Management Plan

This Management Plan has been prepared to satisfy Action 11.3.4 of the Recovery Plan and Priority Action Statement (PAS) Action 21 for the GGBF. These require the DECC to prepare and implement a 'GGBF Management Plan' for each key population on DECC estate and to liaise with other public authorities (e.g. local councils, government departments) to encourage the preparation and implementation of a 'GGBF Management Plan' for key populations occurring on other public lands.

This Management Plan covers three key populations located within the Sydney Green and Golden Bell Frog (GGBF) Management Region as defined in the Recovery Plan. These key populations are:

1. Homebush Bay key population - taking in the Sydney Olympic Parklands area
2. Clyde/Rosehill key population - taking in the Camellia peninsula
3. Merrylands key population - taking in the Holroyd Gardens and Walpole Street Park along A' Becketts Creek at Holroyd.

For the purposes of this Management Plan, the three key populations are strategically treated as the 'Parramatta' key populations, whilst recognising their distinct and likely isolated elements.

This Parramatta GGBF Management Plan has been prepared to ensure that the key populations occurring in the Parramatta area are successfully managed and monitored such that the species continues to persist at the locations and measures of the population's viability are maintained or improved over time. It is also the scope of this Management Plan to, wherever possible, maintain or create connectivity between population elements and provide opportunity for the extent of the population to expand.

The purpose of this Management Plan is:

1. To identify and, where possible, address the threats and other issues/factors affecting or likely to affect the conservation of the species in the Parramatta area.
2. To manage the species in accordance with the strategies outlined within the draft GGBF Recovery Plan.

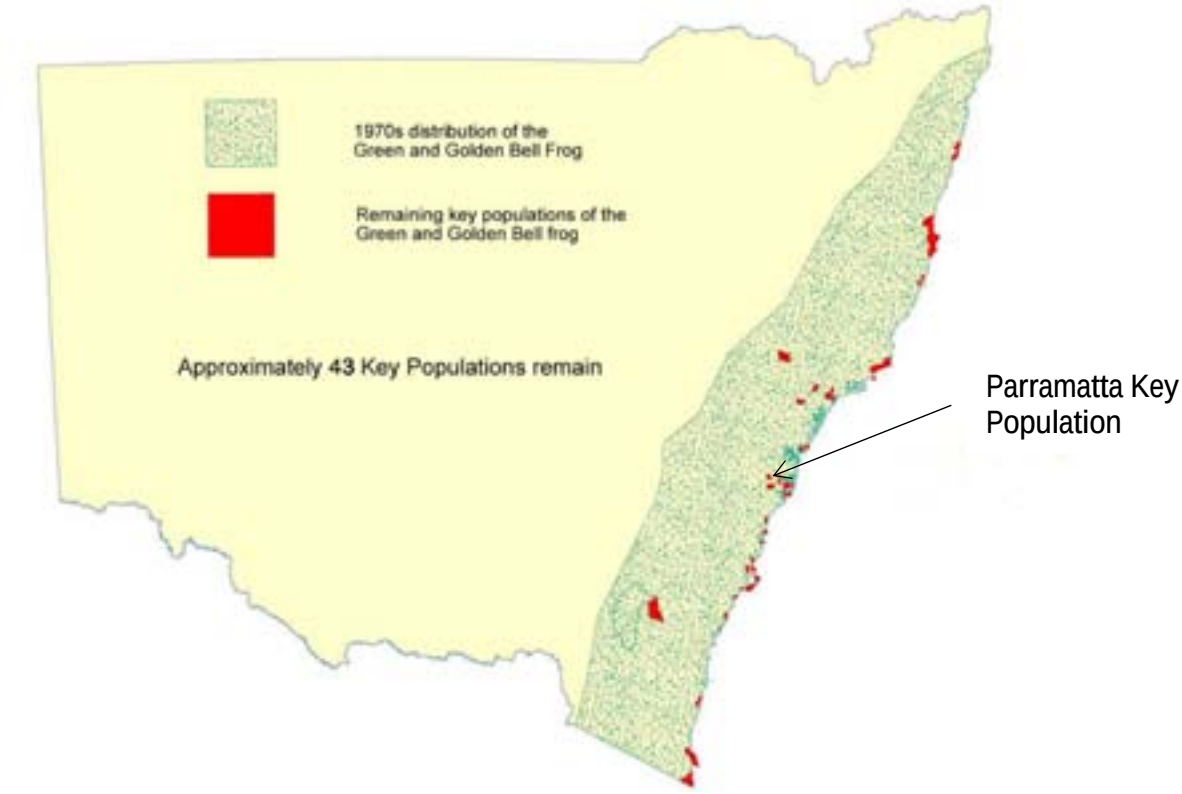


Figure 4: ***Previous and current distribution of the GGBF in NSW***

Management Objectives and Strategies

The objectives of the Parramatta GGBF Management Plan are as follows:

1. To maintain the GGBF populations and their outliers.
2. Where possible, enhance existing GGBF habitat and thus measures of population viability.
3. To increase connectivity within and between populations.

The following strategies will be used to achieve these objectives:

1. Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands.
2. Improvement of habitat within the GGBF key populations.
3. Education and communications to develop awareness of the GGBFs and encourage further on-ground actions.
4. Reduction of external threats to GGBFs.
5. Monitoring and research to better understand the extent and dynamics of the Parramatta River GGBF population.
6. Coordination and communication between the various stakeholders, land managers and the community.

Stakeholder Consultation

The development of this Management Plan included a stakeholder workshop (15 November 2007) with the focus of identifying existing and possible management initiatives to support the draft GGBF Recovery Plan. Workshop attendance included representatives from:

- Auburn Council
- Australian Museum
- Downer EDI Works (CSR Emoleum)
- Friends of Duck River Bush Reserve
- Holroyd Council
- NSW Maritime
- NSW Roads and Traffic Authority (RTA)
- Parramatta City Council
- Parramatta Park Trust
- SAMI Bitumen Technologies
- Shell
- Sydney Olympic Park Authority (SOPA)
- Sydney Metropolitan Catchment Management Authority (SM CMA)
- University of Newcastle

A draft Plan was distributed to the above participants and following additional stakeholders:

- Australian Wetlands Pty Ltd
- Frog and Tadpole Study Group (FATS)
- Parramatta River Catchment Group (PRCG)
- Taronga Zoo

Plan Duration

The duration of this plan will be three years from September 2008 to August 2011. Following this, the outcomes will be reviewed and the Plan revised.

Relationship with Other Plans

This Management Plan integrates with a number of the state-wide targets for natural resource management (NRM) set out as Priority E4 in the NSW Government's State Plan (2006), including:

- *By 2015 there is an increase in native vegetation extent and an improvement in native vegetation condition.*
- *By 2015 there is an increase in the number of sustainable populations of a range of native fauna species*.
- *By 2015 there is an increase in the recovery of threatened species, populations and ecological communities*.
- *By 2015 there is a reduction in the impact of invasive species.*

Similarly, the successful implementation of this Plan should contribute to a number of the Catchment Targets identified in the Sydney Metropolitan Catchment Management Authority (SMCMA) Catchment Action Plan (CAP) (draft as at 12/06/08). These include:

Biodiversity: Enhance ecological resilience and connectivity of bushland and aquatic habitats

- *CTB1 By 2016 the extent and condition of terrestrial native vegetation in all landscapes is maintained or improved.*
- *CTB3 By 2016 there is an increase in the connectivity of terrestrial native vegetation.*
- *CTB4 By 2016 aquatic and terrestrial threatened species and Endangered Ecological Communities (EECs) and populations are better conserved by implementing actions identified in the Priority Action Statements.*
- *CTB5 By 2016 the impact of terrestrial and aquatic invasive species on biodiversity is reduced by decreasing the number, distribution and impact of invasive weeds, pest animals and pathogens.*

Water: Enhance the positive connectivity of aquatic processes

- *CTW1 By 2016 there is a net improvement in the health of modified waterways and riparian corridors and conservation of natural waterways.*
- *CTW2 By 2016 there is an improvement in the condition and extent of wetlands.*
- *CTW3 By 2016 there is measurable progress towards achieving the Water Quality and River Flow Objectives adopted for each waterway.*

This Management Plan also supports local NRM plans. SOPA has developed management plans specifically focused on the GGBF and wetlands within the Homebush Bay / Sydney Olympic Parklands. These plans have set benchmarks in the detail and the extent of management actions for the GGBF at Homebush, as well as for managing other biodiversity assets. Within its precinct these management plans set the framework by which SOPA manages its lands and directs development outcomes. This Management Plan is not intended to supersede or provide the detailed on-ground management framework for GGBFs that exists within SOPA's Biodiversity and GGBF Management Plans. It is intended to provide an over-arching strategy that both recognises the SOPA Plans and identifies management actions for neighbouring GGBF populations.

The Parramatta River Catchment Group (PRCG) is a collaborative group of thirteen local councils and various government agencies that aims to coordinate NRM within the Parramatta River Catchment. One of the actions in the PRCG's Implementation Plan is to "support the implementation of threatened species recovery plans across the catchment". This Management Plan will assist in the implementation of this action.

Background

Location

The Parramatta GGBF populations are located within an area centred (on latitude/longitude 33^{o} 49' 52 S, 151^{o} 00' 45 E) approximately nineteen kilometres west northwest of the Sydney central business district, as shown in Figure 5.

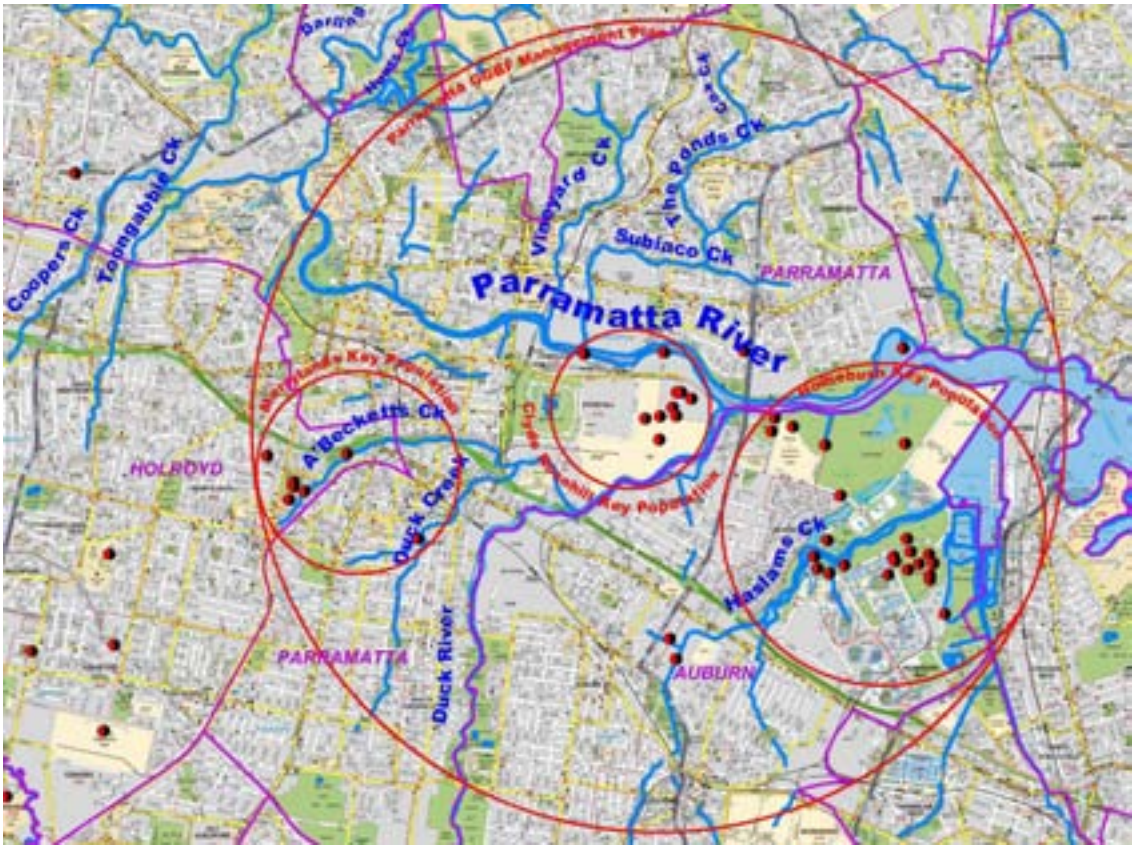
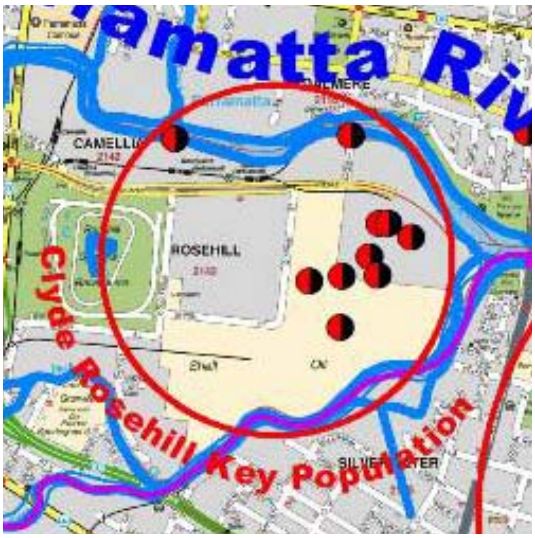


Figure 5: ***Map of the Parramatta area indicating the extent of the three key GGBF populations based on recorded sightings (red/black circles)***

Figure 6 shows the three key populations in the Parramatta area:

1. Homebush Bay
2. Clyde/Rosehill
3. Merrylands

Homebush Bay



Clyde/Rosehill

Merrylands

Figure 6: ***The three key populations within the Parramatta area: Homebush Bay, Clyde/Rosehill and Merrylands***

The Parramatta key populations are located within the local government areas (LGAs) of Parramatta, Holroyd and Auburn but would historically have been spread more extensively across these areas.

The Parramatta key populations occupy both publicly-owned land and privately-owned residential and industrial land. Areas with connectivity value between the populations are predominantly privately-owned lands and infrastructure easements/corridors.

The private and public entities that own, manage or have decision making responsibility for land that either contains GGBF population elements or appropriate habitat include:

- Parramatta City Council
- Holroyd Council
- Auburn Council
- SOPA
- Sydney Water Corporation
- NSW Maritime
- PRCG
- Department of Lands (Crown Reserves)
- Australian Government
- SMCMA
- Silverwater Correctional Complex
- NSW Department of Planning
- RTA
- Private residents
- Various industries on the Camellia Industrial Estate

Habitat

The Parramatta GGBF populations use a 'mosaic' of remaining wetlands, waterbodies and drainage features that provide the various habitat components necessary for them to persist in the area. Urbanisation in the Parramatta area has removed much of the natural habitat that once likely connected the current separate populations as a single expansive population.

The GGBF habitat in the area is now comprised largely of created waterbodies and other landscape features. Many of these features do or may require ongoing active management to remain suitable as habitat. Such features include artificial or altered wetlands, waterbodies and ponds that are interspersed amongst green space (public reserves and playing fields), residential development and along drainage lines that have been heavily altered or channelized.

The majority of remaining wetland habitat areas for the GGBF occurs within the SOPA site. Most of this habitat has been created or enhanced from existing features that were colonised and occupied by the species. Considerable habitat has also been specifically constructed for the GGBF at the SOPA site as part of the Sydney 2000 Olympic Games preparations, as offsets for subsequent developments and as an ongoing habitat management regime developed primarily for the species in the SOPA precinct.

The other notable wetland habitat area is located at the tip of the Rosehill/Camellia peninsula. In this area, GGBFs have been recorded in the wetland near the confluence of Duck and Parramatta Rivers as well as associated with artificial habitat provided by industrial site features and structures such as safety bunds around storage tanks.

Other smaller areas of habitat occur at Merrylands in the vicinity of the Holroyd Gardens estate that was formerly the Goodlet and Smith Brickworks. Habitat also exists in the vicinity of the Walpole Street Reserve, along A' Beckett's Creek and along the adjacent main southern railway corridor. The species has been recorded foraging and breeding in artificial water bodies adjacent to the Walpole Street Reserve and specific habitat areas including vegetated breeding swales that have been created and managed as part of that site's redevelopment.

The 2KY broadcasting tower site has depressions which fill with water and therefore has potential as ephemeral breeding habitat. There is also potential habitat in the gardens within the low security area at the rear of the Silverwater Correctional Facility. Another site with significant potential is Parramatta Park. This site has no recent GGBF records but retains ponds and dams from previous farms and also contains an area which has potential to be rehabilitated as wetlands.

GGBFs have survived in the Parramatta area by using various components of this habitat such as:

- Breeding habitat. This includes permanent to semi-permanent water bodies including ponds, dams and creeks. Breeding habitat has been previously found within decommissioned 'tank farms' on the Shell Clyde Refinery and within a detention pond on the adjacent CSR Emoleum site. CSR constructed a breeding pond as part of that sites redevelopment and the Shell refinery premises also have detention structures and drainage features that may operate from time to time as breeding habitat. A large number of ponds, scrapes, swales, detention structures and other features have been provided at Sydney Olympic Park for the GGBF and these are managed with a cyclic disturbance regime that includes development of new breeding sites and decommissioning of others. This has proved to be a highly successful strategy in providing ongoing functional breeding habitat. At Holroyd Gardens, Merrylands, breeding ponds were provided as part of that sites redevelopment.
- Foraging habitat. This includes areas of native or introduced grasses, tussock vegetation and emergent sedges and reeds bordering water features. Examples of suitable foraging habitat are evident in the surrounds of the wetland located at the tip of the Camellia peninsula and in stormwater drainage swales and other grassy vegetation on various sites at Camellia. Foraging habitat also occurs along A' Beckett's Creek, within Walpole Street Reserve and surrounding ponds built at the Holroyd Gardens site. The SOPA site has a wide extent of foraging habitat that has been developed and managed. Other foraging habitat also occurs along and in the vicinity of the Parramatta River and its tributaries.
- Shelter habitat. This includes similar vegetation to that used for foraging as well as rocks, ground timbers, crevices in the ground, around plant root systems and amongst ground debris. Significant areas of shelter habitat occur in the rock piles in the brickpit site at Sydney Olympic Park and amongst the wide array of dense clustered plantings of sedges and other tussock plant species.

Figure 7: ***Green and Golden Bell Frogs sheltering in an Elkhorn Fern***
Photo © S. Marks

- Movement habitat. This is generally typified by wet areas such as creek lines, drains, stormwater canals, connecting or partially connecting vegetation, easements, laneways and open areas that do not restrict movement. Movement habitat was factored into the design of the Holroyd Gardens development to provide for potential habitat connectivity between the development site and A' Beckett's Creek, the railway corridor and the Walpole Street reserve. This has included the specific provision of vegetated areas along culverts to the channel of A' Beckett's Creek. At Sydney Olympic Park, movement habitat has been a major consideration in the design, construction and maintenance of that population and has included road underpasses.
- Over-wintering habitat. In some instances, this shares common features with shelter habitat, such as rock and rubble piles, ground timbers and logs and dense tussock vegetation. However, the sexes quite often differ in their selection of over-wintering habitat and may seek to shelter in different areas and in less obvious locations such as amongst overgrown or dense and moist vegetation. This may include gardens and landscaped areas of houses and business premises where they will lie dormant amongst suitable plants or even amongst building materials such as bricks and timber.

Species Status

GGBFs were once very widespread and abundant in the Sydney region, inhabiting the various coastal wetlands of the Botany Bay catchment including the Cooks River, Georges River and those associated with the Parramatta and Hawkesbury Nepean drainages. The former distribution of GGBFs has contracted to only eight known locations at:

- Homebush Bay/Sydney Olympic Park
- Clyde/Rosehill (Parramatta River)
- Merrylands (Parramatta River)
- Kurnell
- Greenacre (Upper Cooks River)
- Arncliffe/Lower Cooks River
- St Marys/Mt Druitt/Riverstone
- Hammondville (Georges River).

Prior to large scale urban development and the concreting of sections of tributaries, the GGBFs along the Parramatta River, Duck River, Duck Creek, A' Beckett's Creek and Haslam's Creek most likely interacted to form a larger population.

Currently, GGBFs occur throughout the area managed by SOPA - Sydney Olympic Park, which includes Bicentennial Park, Kronos Hill, Wentworth Common, Haslams Creek Flats, Woo-la-ra and Blaxland Riverside Park. The SOPA site includes 70 hectares of primary frog habitat with over 70 constructed ponds and 70km of frog fencing.

GGBFs have been found at sites close to the SOPA site such as Newington Wetland, Reserve and Armory. GGBF reports have also been made of frogs within residential backyards in Newington and at the 2KY broadcasting tower site. GGBFs have previously been recorded within the Silverwater Correctional Facility in 1999. GGBF records further upstream in Parramatta River are scarce.

An important component of the current Parramatta GGBF populations is found on the Shell Refining Pty Ltd site, located at the tip of the Camellia peninsula. CSR Emoleum is located directly adjacent to the Shell Refinery and GGBFs have also been found on these premises.

Another significant component of the Parramatta GGBF populations is located near the old Merrylands Brickworks site at Merrylands. This site has been re-developed as the Holroyd Gardens residential estate which now includes two constructed frog ponds and other habitat elements. This site and parts of the neighboring Walpole Street Reserve along A' Becketts Creek constitute the GGBF population areas in this locality.

Threat Assessment

The major threats to the Parramatta GGBF key populations include:

1. Loss of habitat. Expansions of existing developments, redevelopment of sites and increasing urbanisation have caused significant losses in habitat area. The potential for habitat loss is further exacerbated by an incomplete knowledge of the full extent of current GGBF distribution.
2. Introduced Predators. These may prey on GGBF eggs, tadpoles or adults and include:
    - The Plague Minnow (*Gambusia holbrooki*) – this fish is listed as a Key Threatening Process [KTP] and is present in many of the permanent water bodies inhabited by the GGBF, including within the Shell Refinery wetlands.
    - Carp (*Cyprinus carpio)* - also present in various waterbodies.
    - The Red Fox *(Vulpes vulpes)* - listed as a KTP and has been sighted in the area covered in this plan.
    - Feral and Domestic Cats (*Felis catus).*
3. Frog Chytrid disease (*Batrachochytrium dendrobatidis*). This frog fungal disease is listed as a KTP at both state and national levels, and is rapidly emerging as possibly the single greatest threat to the species (as well as for many other frog species). The disease is thought to have been largely responsible for the failure of reintroduction efforts in the Sydney area and has been previously recorded on individuals within the SOPA brickpit site. Recent re-sampling has been unable to detect the disease within the population there. See Appendix 1: Frog Hygiene Protocol for advice on preventing the spread of this disease.
4. Habitat degradation. This includes weed invasion or general vegetation overgrowth in foraging and breeding areas. Poor management practices on public reserves, along waterways and on golf courses have the potential to inhibit GGBF expansion into areas of suitable habitat. In particular, vegetation overgrowth in artificial habitat ponds can reduce the habitat value by reducing the area of open water. The lack of water as a result of drought or poor artificial habitat construction (e.g. leakage through pond liners) can also result in habitat degradation or loss.
5. Water quality. The wetland areas on the Camellia peninsula and surrounding the suburb of Silverwater receive urban runoff which potentially contains pollutants, excess sediments and nutrients. The use of chemicals (herbicide, insecticide and fertiliser) on public reserves and golf courses may also influence the presence and movement of the GGBF.
6. Native predators. These are particularly a threat where GGBF populations have declined to a small size and are no longer robust. Native predators may include Eels (*Anguilla spp*.), Red-bellied Black Snake (*Pseudechis porphyriacus),* the Australian White Ibis (*Threskiornis molucca)*, and, potentially, the Silver Gull (*Larus novaehollandiae*) and other wader bird and snake species that may occur within the region.

7. Anthropogenic climate change (listed as a KTP) may result in changes to rainfall patterns that could affect the breeding habitat of the GGBF, in particular the presence of ephemeral ponds and the extent of wetland areas. The impact on reduced recruitment may lead to population decline or collapse at some sites, especially where populations are represented only by mature adults due to previous repeated breeding failures. Senescent populations may be unable to recover even if and when conditions do become suitable.
8. Fire and fire management has the potential to adversely impact frogs through the destruction of vegetation used for refuge, foraging or as shelter habitat. In conducting fire management practices, efforts should be made to restrict burning in low lying areas and wetlands predominated by sedge and emergent macrophyte growth. These areas form important shelter and foraging habitat for the GGBF and generally pose a limited fire risk anyway. The use of chemical fire suppressants may also have negative impacts on the GGBF, and their use should be avoided in the vicinity of known or potential breeding sites.

Past and Current Management

This Management Plan builds upon a range of past and current actions to manage the GGBF in the Parramatta area. Past efforts at managing the species on private land has largely been development driven and lacking coordination and integration with other actions. This plan aims to overcome this situation.

Management actions along with other measures undertaken for GGBF within the Parramatta area include:

1. Sydney Olympic Park Authority (SOPA)

- SOPA has developed and implemented a detailed and leading practice management plan for the Sydney Olympic Park GGBF population since it was re-discovered in 1992 (see 'Species Status' section for more details).

  Landscape management practices are implemented across the SOPA site to cater for the frog and include guidelines/restrictions on the use of chemicals near waterways. The design of the stormwater recycling and reticulation systems also incorporate frog habitat components.

  As part of an ongoing program for habitat enhancement, SOPA undertakes Plague Minnow (*Gambusia)* control through cyclic draining of waterbodies prior to the breeding season and conducts three to four habitat redevelopments each year. SOPA maintains habitat connectivity by constructed road underpasses and other corridors.

  SOPA's comprehensive GGBF monitoring program has been in place since 1996. The estimated population of GGBFs within the old brickpit at the site suggests there is a stable population of approximately 250 individuals, however due to estimation and sampling uncertainties, this may be as great as 2000 individuals. The estimated population outside the brickpit is also approximately 250, however again there is large variability in estimates.

2. Department of Environment and Climate Change (DECC)

- DECC is working to develop an understanding of the extent of the Parramatta GGBF populations and to develop relevant actions for Councils to include in development consents. DECC also has a role in regulating industry and is currently working with Shell (and other industries) to address and mitigate the problem of Chromium contamination at Camellia. DECC has also had

considerable input and liaison with SOPA (and its predecessor OCA) in the management regime SOPA has successfully implemented. Ongoing liaison with SOPA is envisaged as establishing a GGBF demonstration site for others to learn from.

3. Sydney Metro Catchment Management Authority (SMCMA)
   - SMCMA coordinates projects to achieve effective NRM outcomes. One such project currently underway is the Sydney Harbour Riverine Corridor Ecology program. This project involves the mapping of riverine terrestrial vegetation to assist future management and identify areas where corridors can be enhanced.
4. Parramatta City Council
   - Parramatta City Council has investigated the potential for areas along Duck River to be reconstructed as wetland areas. It also conducted a frog survey of these areas, however, the only species recorded was the Striped Marsh Frog.
   - Parramatta City Council developed a Biodiversity Plan in 2003 to outline actions to protect and conserve local biodiversity. The biodiversity principles listed include to give a high priority to threatened species conservation and recovery and to promote corridor linkages. Outcomes of the project included effective planning, local community involvement and updated biodiversity information.
5. Holroyd Council
   - Holroyd Council was the consent authority for the Holroyd Gardens Estate development. Council required that the developers create and maintain two compensatory GGBF habitat ponds and conduct ongoing monitoring of the species at the site.
6. The Camellia Business Committee
   - The Camellia Business Committee coordinates actions across industry landholders on the Camellia peninsula. Shell, owners of the Clyde Refinery, is working as a member of this committee with other landholders in the vicinity to collaboratively address issues, such as Chromium contamination. This includes a groundwater monitoring program.
7. Shell
   - Shell conducted a GGBF survey on its premises and found six individuals. This survey was accompanied by recommendations which Shell is incorporating into its site plan along with actions for management of the eight hectare area of wetland. Shell agreed to undertake the development of a site GGBF Management Plan with guidance and assistance from DECC.
8. CSR Emoleum
   - CSR Emoleum (directly adjacent to the Shell Refinery) made modifications on its premises to compensate for removal of existing habitat to partly redevelop the site as an asphalt recycling facility. This included construction of a frog bridge, frog-proof fencing and frog pond. In 2001, CSR developed a site habitat management plan that included habitat maintenance, monitoring and reporting considerations for the GGBF.

Future Management

The main focus of future management for the Parramatta GGBF key populations is discussed below and further detailed as management actions in the Implementation Plan section of this document.

1. Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands.

Systematic surveying of former or potential habitat areas where GGBF records are either known or presumed is desirable. This could take the form of a community doorknock, FATS surveys, local school competitions, Streamwatch program, TAFE and university studies, feedback pages on Council websites and local newspaper articles encouraging reporting of sightings.

Areas with potential for GGBF habitat to be created and/or enhanced would benefit from such survey effort. These survey areas include sites along Duck River, A' Beckett's Creek and Duck Creek, surrounding Walpole Street Reserve (Merrylands), within Parramatta Park and other sections along the Parramatta River and its tributaries, the 2KY broadcast tower site at Homebush Bay, Newington/Haslams Creek residential areas, RTA road reserves, Main Southern Rail corridor and the rear of Silverwater Correctional Facility. Such systematic and coordinated surveys may result in further GGBF rediscovery and perhaps identify additional elements or areas being utilised as habitat. Some of these areas may be considered for reintroduction once threatening processes have been eliminated or are able to be better managed.

In addition to survey efforts, it would also be beneficial to conduct a mapping initiative to identify areas which have existing and potential habitat and connectivity value. This would enable sites to be prioritised for rehabilitation works to create or enhance habitat and its connectivity, such as has been done by SOPA. It would be beneficial to enhance or artificially create more wetland area along Parramatta River and its tributaries to ensure that this GGBF population is not restricted to areas where conditions are sub-optimal. It is envisaged that this mapping initiative would also include areas further upstream on Parramatta River, including Parramatta Park which contains ponds, dams and potential wetland areas that may provide opportunities for reintroduction, expansion and/or have connectivity value.

2. Improvement of habitat within the GGBF key populations.

Existing GGBF habitat will require on-going management to ensure that the quality of the habitat is maintained or improved. This includes the management of all types of habitat used by the GGBF, breeding, foraging, refuge and connectivity. For details of specific habitat requirements of the GGBF refer to the Best Practice Guidelines GGBF Habitat booklet available from the DECC.

3. Education and communications to develop awareness of the GGBFs and encourage further on-ground actions.

Education of on-ground staff and environmental volunteers in identification of the GGBF is also recommended to further assist in the reporting of frogs and to develop a more comprehensive understanding of its distribution in the area. In the event that the GGBF occurs on an industrial site it may be beneficial to train selected staff in identification and reporting along with a protocol on what to do if the frogs are found on a particular site.

Raising awareness of the GGBF to industry could be initiated through the Camellia Business Committee. Landholders on the Camellia Industrial Estate have collaborated to establish this Committee to enable them to more strategically address issues in common to them all, including the widespread Chromium contamination issue. These meetings could provide an excellent opportunity to educate landholders about the presence of the GGBF and appropriate management actions. The committee meetings may also provide an opportunity to encourage adoption of the GGBF as an opportunity for businesses to boost their environmental credentials. This has proven a successful venture for an Illawarra industry which has used the presence of the GGBF as a successful public relations opportunity.

There is potential for SOPA to act as a 'lighthouse' to educate neighboring landholders about managing the GGBFs. The SOPA site provides an excellent example of ongoing monitoring, implementation of responsible management practices and successful creation and ongoing maintenance of GGBF habitat components. The site is therefore also useful as a demonstration site to educate and assist other land managers to do the same. The provision of tours and workshops could be used to further disseminate this information. SOPA has already worked collaboratively with other landholders in the vicinity, including the Silverwater Correctional facility, to develop habitat areas (swale) at the rear of the site.

4. Reduction of external threats to GGBFs.

As identified previously, the biggest threat to the GGBF is habitat loss and degradation. The Auburn, Holroyd and Parramatta Councils can assist in the protection of this species through the preservation of any existing wetlands in this area and in the rehabilitation or construction of wetlands through development application conditions.

Visitors to any site where GGBF are found should adhere to the Hygiene Protocol for the Control of Disease in Frogs to reduce the spread of Chytrid fungus. Regular surveys of currently used sites (e.g. SOPA, Walpole St Reserve, Rosehill/Camellia peninsula) for Gambuzia (Plague Minnow) and Carp should be conducted and if detected, measures to remove these species should be undertaken immediately. Areas of potential habitat such as Parramatta Park should also be surveyed for Plague Minnow and Carp and abatement measures implemented as necessary.

5. Monitoring and research to better understand the extent and dynamics of the Parramatta River GGBF population.

Monitoring of GGBF populations, habitats and threats is important to enable land managers to continue to provide good quality breeding, foraging, refuge and movement habitat that is free of threats such as Gambuzia (Plague Minnow) and Chytrid fungus. It is also necessary to monitor the frogs to determine the size and extent of the population.

Further research into the GGBF, its habitat components and threats etc. is required to enable good, adaptive management programs to be implemented.

6. Coordination and communication between the various stakeholders, land managers and the community.

The Merrylands key population occurs within a relatively restricted area at the end of A' Beckett's Creek. This small population was placed under significant pressure with the redevelopment of the Holroyd Gardens residential development. A detailed

GGBF PoM was prepared as a component of the conditions of consent and the document outlines management issues and other requirements of the frog (Biosis Research, 1999). The development was required to create two GGBF ponds and other habitat components and was commended in the way the initial components were implemented (Biosphere, 2002).

The PoM also included post development commitments and detailed a monitoring program planned for two to five years after completion of the construction. This included GGBF surveys twice a year during spring and summer. In addition, the plan outlined assessments regarding general and aquatic habitat condition including monitoring of water quality and the presence of *Gambusia*. Holroyd Council indicated that if the GGBF was not found during monitoring within the first three years then the Council would review the need for monitoring and habitat maintenance works to continue. In the instance that no GGBF are found it was recommended that habitat maintenance should be continued to maintain the areas value as potential habitat, particularly given the created habitat caters specifically for the GGBFs requirements in an identified key population area.

The project was completed in 2002 and responsibility of the GGBF habitats was handed over to Holroyd Council at that time. It is recommended that Holroyd Council meet with DECC to develop suitable management practices for the site, such as mowing restrictions and any need for frog fencing. It may be that additional habitat components should be provided in the reserve adjacent to A' Beckett's Creek. It is also recommended that this area along with other GGBF habitats be rezoned as dedicated conservation areas to afford it greater protection.

Council's considering development applications that have GGBF implications should use the following hierarchy:

- avoid the disturbance or destruction of GGBF habitat
- if habitat is to be disturbed, minimise the disturbance and ensure appropriate rehabilitation occurs
- if habitat is to be lost, ensure that appropriate offsets are provided

Review

A review of the plan is required after 2.5 years (eg. early 2011) as a basis for its next iteration. This should include a meeting of stakeholders to discuss recent results and recommendations for adding to and modifying management actions.

Informal review of the plan is also encouraged both within organisations and through networks and partnerships. All recommendations to improve the plan should be directed to the DECC contact on the inside front cover.

Implementation

The Implementation Plan in the following table provides a framework of actions for the management focus outlined above. The Implementation Plan should be read and actioned with reference to the draft GGBF Recovery Plan and Priority Action Statement (PAS).

For each management action, the Implementation Plan describes:

- the linkages to the draft Recovery Plan and PAS
- the stakeholders responsible for the management action (lead organisation/group in bold)

- the estimated cost associated with the management action, and possible sources of funding
- the time frame for undertaking the various tasks is also provided.

Some management actions apply to more than one strategy (see 'Objectives and Strategies' section) in the plan.

Actions attributed to certain parties will be subject to available funding and resourcing, unless they are conditions of existing approvals or proposals, or are a result of a statutory requirement.

In the tables below, the acronyms under "Responsibility" and "Funding Sources" stand for the following organisations/groups:

- ARC = Australian Research Council
- COC = Caring for Our Country program by the Federal Government (which replaced the the Natural Heritage Trust on 1 July 2008).
- CMA = Catchment Management Authority
- DECC = NSW Department of Environment and Climate Change
- DoP = Department of Planning
- DPI = Department of Primary Industries (Fisheries)
- FATS = Frog and Tadpole Study Group
- Fox TAP = Fox Threat Abatement Plan for NSW
- PRCG = Parramatta River Catchment Group
- SOPA = Sydney Olympic Park Authority
- SM CMA = Sydney Metropolitan Catchment Management Authority
- TSN = Threatened Species Network

Implementation Plan

Strategy 1: *Further development of GGBF breeding and other habitat components, where appropriate, on public and private lands*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
1.1 Investigate areas with potential for GGBF habitat to be created and/or enhanced.	Action 11.3.3 / PAS 9	DECC, relevant land owners, Parramatta, Holroyd and Auburn Councils, SM CMA and PRCG	$20,000	COC, Environmental Trusts, development driven assessment requirements	2008 – 2009
1.2 Investigation / surveys of areas with historical GGBF records.	Action 12.3.1 / PAS 31	DECC, relevant land owners, Parramatta, Holroyd and Auburn Councils, SM CMA and PRCG	$10,000	COC, Environmental Trusts	2008 – 2009
1.3 Consent authorities to ensure losses of habitat resulting from proposed and future developments are avoided if at all possible.	Actions 10.3.1, 11.3.1, 11.3.3, 14.3.1 / PAS 1, 5, 30	Consent authorities - DECC, Parramatta, Holroyd and Auburn Councils, DoP	Recurrent funding for statutory functions	N/A	2008 – 2011
1.4 Investigate and encourage the use of recycled / excess industrial or even harvested stormwater as a water supply to enable water security at created habitats.	Action 11.3.3	DECC, Parramatta, Holroyd and Auburn Councils, Sydney Water, local industries, Universities	Undetermined	N/A	2009-2011
1.5 Engage Sydney Water and other relevant authorities to cooperate in projects to restore concrete lined channels to more natural state waterways.	Actions 11.3.3, 10.3.1 / PAS 9	DECC, Parramatta, Holroyd and Auburn Councils, Sydney Water	Nil	In-kind	2009-2011

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
1.6 (a)Mapping of the edges of Parramatta River, Duck Creek and Duck River to identify areas with existing or potential habitat and connectivity value. (b) Creation and enhancement of areas identified as having potential habitat value.	Action 11.3.2 / PAS 9	DECC, Parramatta, Holroyd and Auburn Councils, SMCMA, PRCG	$50,000	COC, Environmental Trusts, SMCMA	2008-2010
1.7 Improve connectivity of habitat along creek and other drainage lines.	Action 11.3.3 / PAS 9	**Parramatta, Holroyd and Auburn Councils**, PRCG, Bushcare Groups, other environment groups	Undetermined	COC, Environmental Trusts	2008 -2011
1.8 Development of a set of guidelines required for GGBF habitat design.	Action 11.3.3 / PAS 20	DECC	underway	COC, SMCMA	2008-2009

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

Strategy 2: *Improvement of habitat within the GGBF key populations*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
2.1 Identification and protection of ephemeral and permanent habitat.	Actions 11.3.3, 11.3.1 / PAS 18	DECC, Parramatta, Holroyd and Auburn Councils, Sydney Water, SOPA, other relevant landowners	Partly included in costing for Action 1.1	Recurrent	2008-2009
2.2 Identification and protection of areas with potential to strengthen habitat connectivity.	Actions 11.3.3, 11.3.1	DECC, Parramatta, Holroyd and Auburn Councils, Sydney Water, SOPA, other relevant landowners	Partly included in costing for Action 1.1 and Action 1.7	COC, SMCMA, Parramatta, Holroyd and Auburn Councils	2008-2010
2.3 Development of guidelines for creek management.	Action 11.3.3 / PAS 9	SMCMA, Parramatta, Holroyd and Auburn Councils, DECC	Undetermined	SMCMA, PRCG, Councils	2009-2011
2.4 Rezoning of GGBF areas as 'dedicated conservation areas' to afford them greater protection.	Actions 11.3.1, 10.3.1 / PAS 1	Parramatta, Holroyd and Auburn Councils, DoP	Undetermined	In-kind	2008-2011
2.5 Holroyd Council and DECC to develop a management strategy to maintain created GGBF habitat within the Holroyd Gardens.	Action 10.3.1 / PAS 18,1	Holroyd Council, DECC	Minimal	In-kind	2008-2009
2.6 Thorough auditing of biodiversity related development consent conditions.	Action 11.3.1 / PAS 18	DECC, DoP, Parramatta, Holroyd and Auburn Councils	Recurrent functions	In-kind	2008-2011
2.7 Generate a register of consent conditions to ensure continued compliance	Actions 11.3.1, 10.3.1	Parramatta, Holroyd and Auburn Councils	Recurrent functions	In-kind	2008-2011
2.8 Joint council effort at reducing the amount of rubbish entering local waterways, including more widespread installation of gross pollutant traps, trash racks and other similar devices.	Actions 11.3.3, 14.3.2	Parramatta, Holroyd and Auburn Councils, PRCG, Sydney Water, DECC	Recurrent functions	PRCG, SMCMA, Sydney Water, Environmental Trust, COC	2008-2011

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
2.9 Land managers to adopt environmental management guidelines that ensure minimal effects on water bodies from herbicide, pesticide and fertilizer application or through any other chemical use.	Action 14.3.1 / PAS 20	Parramatta, Holroyd and Auburn Councils, Local Industry, Bushcare and other environmental groups, Golf Courses, Parramatta Park Trust	Recurrent functions	In-kind	2008-2011

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

Strategy 3: *Education and communications to build awareness of the GGBFs and encourage further on-ground actions*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
3.1 Conduct GGBF education programs targeting schools and residents, particularly those close to Duck River and Duck Creek (or other significant waterbodies) that could incorporate access and use of GGBF habitat areas as education aids. Where possible to link with existing programs.	Action 14.3.2 / PAS 32	DECC, Parramatta, Holroyd and Auburn Councils, SOPA	$30,000	Environmental Trusts, CMA, Parramatta, Holroyd and Auburn Councils, DECC, SOPA	2008-2011
3.2 Training of council staff, industry staff, land managers, volunteers and other on-ground staff in the identification, handling, monitoring and reporting of frogs.	Actions 14.3.2, 14.3.1 / PAS 32	DECC, Parramatta, Holroyd and Auburn Councils, SOPA, Industry	$50,000	Environmental Trust, SMCMA, COC, Industry	2008-2010
3.3 Develop guidelines on what to do if frogs are found on site and implement into the management plan for the site	Actions 14.3.1, 14.3.2	DECC, Relevant Land owner/managers	Recurrent functions	Relevant site owner/manager funds	2008-2011
3.4 SOPA to provide training sessions to educate industry staff / land managers on how to create, enhance and maintain GGBF habitat. This may be achieved through demonstrations and/or field services days	Actions 14.3.1, 14.3.2/ PAS 20	SOPA	Undetermined	DECC (in part through field demonstration days)	2008-2010
3.5 Distribution of GGBF information to relevant Councils and industry landholders to ensure they are aware of the GGBF and can make informed decisions on appropriate zoning and management practices.	Actions 10.3.1, 11.3.1 / PAS 1, 30	DECC, Parramatta, Holroyd and Auburn Councils, SOPA	Recurrent functions	In-kind	2008-2011

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
3.6 Councils to increase community education and awareness through initiatives such as Council website, local newspaper, Streamwatch.	Actions 14.3.1, 14.3.2 / PAS 25	**Parramatta, Holroyd and Auburn Councils**, Sydney Water, PRCG, SM CMA, SOPA, DECC	$15,000	PRCG, SMCMA, Environmental Trust, Industry	2008-2009
3.7 Utilise the Camellia Business Committee to encourage local landholders to create GGBF habitat creation so that management actions can be coordinated. This may include a SOPA demonstration.	Action 14.3.1, 10.3.1 / PAS 18, 30	Local Industry, DECC, SOPA	Committee Function	In-kind	2008-2009
3.8 Liaise with local media (newspapers, newsletters, radio, TV) so as to encourage GGBF reporting (e.g. implementation of management plan) and to raise awareness.	Action 14.3.1 / PAS 33	DECC, Parramatta, Holroyd and Auburn Councils, SOPA, PRCG	Recurrent Function	In-kind	2008-2011

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

Strategy 4: *Reduction of external threats to GGBFs*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
4.1 Implementation of the NPWS Frog Hygiene Protocol during any interaction with GGBF or its habitat to prevent the spread of chytrid fungus.	Action 11.3.5 / PAS 15	All Stakeholders	Nil	In-kind	2008 – 2011
4.2 Survey of GGBF habitat for presence of *Gambusia holbrooki* and, with reference to the *Gambusia* Threat Abatement Plan (TAP), and where possible remove Gambusia from sites as well as reduce further spread to unoccupied GGBF habitat.	Action 11.3.2 / PAS 6	DECC, Parramatta, Holroyd and Auburn Councils, Landowners, DPI Fishing and Aquaculture	$20,000	DECC, COC, CMA	2008-2009
4.3 Survey of potential GGBF habitat that *Cyprinus carpio* occupy and examine opportunities to eradicate and prevent further spread to unoccupied habitat (Link to Action 4.2)	Action 11.3.2 / PAS 14	DECC, Parramatta, Holroyd and Auburn Councils, Landowners, DPI Fishing and Aquaculture	Part of Action 4.2 costs	COC, SMCMA, industry sponsorship	2008 -2009
4.4 DECC to contact relevant landholders, using existing council networks, in relation to synchronisation of any fox baiting programs currently in place.	Action 10.3.1 / PAS 3	DECC, relevant landowners, DECC, Parramatta, Holroyd and Auburn Councils	Undetermined	Existing funding, recurrent funding and Fox TAP	2008 – 2011
4.5 Investigate presence of White Ibis populations near GGBF habitat areas to determine whether they are of significant enough numbers to cause disturbance to GGBF and its habitat. Implement control measures as necessary.	Action 11.3.2 / PAS 3, 14, 26	DECC, Parramatta, Holroyd and Auburn Councils, Universities	Dependent on findings	COC, DECC, SMCMA, Research Grants	2008-2010

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

Strategy 5: *Monitoring and research to better understand the extent and dynamics of the Parramatta River GGBF population*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
5.1 Monitor remnant populations and potential habitat areas as identified from Strategy 1 and 2.	Action 12.3.1 / PAS 31	Landholder, DECC, Post Graduate University Students, Consultants, Parramatta, Holroyd and Auburn Councils, Industry	$25,000 for initial survey $20,000 per year for monitoring	COC, CMA, DECC, Parramatta, Holroyd and Auburn Councils, Industry, SOPA	2008-2009
5.2 Establish community monitoring programs (link to Action 5.1).	Action 14.3.2 / PAS 31	DECC, FATs, DECC, Parramatta, Holroyd and Auburn Councils, SOPA, environment groups, local schools	$10,000 seeding funds	TSN, DECC, Parramatta, Holroyd and Auburn Councils, SOPA	2008 -2011
5.3 Conduct a review of GGBF genetic studies that works on, among other things, determining variability within and between Parramatta GGBF populations to identify evolutionary significant units, so as to inform possible future interconnection initiatives and establish definitive baseline data.	Action 12.3.2 / PAS 26	DECC, **Expert conservation geneticist**	$10,000	COC, ARC	2009-2010
5.4 Investigate options and likely corridors that could be used to ultimately link local GGBF populations. Link to Action 1.5	Action 12.3.2	DECC, Consultant, PRCG, DECC, Parramatta, Holroyd and Auburn Councils	$20,000	COC, Environmental Trust, PRCG, CMA, SOPA	2008 - 2010

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

Strategy 6: *Coordination and communication between the various stakeholders, land managers and the community*

ACTION	RECOVERY PLAN LINKS / PAS LINKS	RESPONSIBILITY†	COST*	FUNDING SOURCES	TIMEFRAME
6.1 Development of a feedback mechanism which encourages and enables the community, volunteers and other on-ground staff to report if GGBFs are seen or heard.	Action 14.3.2 / PAS 31	DECC and other stakeholders	$10,000 to set up interactive website	TSN, DECC	2008-2009
6.2 DECC to continue to liaise with local councils, Parramatta, Holroyd and Auburn regarding future development proposals on current and potential GGBF habitat. This will ensure that GGBF is adequately considered in any future development proposals. (Link to Actions 2.5 to 2.7)	Actions 10.3.1, 11.3.1 / PAS 1	DECC, Parramatta, Holroyd and Auburn Councils	Recurrent functions	In-kind	2008 - 2011
6.3 Link Council Plans of Management to more strategically address large scale GGBF issues e.g. connectivity	Action 10.3.1 / PAS 1	PRCG, DECC, **Parramatta, Holroyd and Auburn Councils**	Minimal	In-kind	2008-2010
6.4 Creation of an electronic email forum that will facilitate coordination of the Parramatta GGBF Management Plan.	Action 14.3.2 / PAS 24	DECC, SMCMA, PRCG, Parramatta, Holroyd and Auburn Councils, Industry, Community Groups	Undetermined	In-kind (host required)	2008-2011

***Note: Costs are indicative only and subject to available funding; † lead organisation or group responsibility in bold**

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Appendices

Appendix 1: Frog Hygiene Protocol

Individuals studying or surveying frogs often travel and collect samples of frogs from multiple sites. Green and Golden Bell Frogs can be particularly sensitive to the introduction of infectious pathogens, such as the frog chytrid fungus. Therefore, it is important that frog workers recognise the boundaries between sites and undertake measures that reduce the likelihood of spreading infection. Detailed procedures, measures and background are provided in the *"Hygiene Protocol for the Control of Disease in Frogs"*, which can be obtained from the Department of Environment and Climate Change, or downloaded from:
http://www.nationalparks.nsw.gov.au/pdfs/hyprfrog.pdf

Appendix 2: GGBF Captive Breeding and Translocation

The Department and Environment and Climate Change is currently guided by a Policy for the Translocation of Threatened Fauna in NSW that will apply to all proposals to translocate threatened fauna species (see NPWS 2001 - Policy and Procedures Statement No. 9). This Policy outlines four possible justifications for translocation of threatened fauna that include: species recovery, biodiversity reconstruction, emergency transfer and research.

The merits and usefulness of captive breeding and translocation for GGBFs to supplement or re-establish a population as a conservation measure have also been identified in the draft GGBF Recovery Plan. Whilst captive breeding and reintroduction or supplementation may be deemed a desirable initiative as part of this Management Plan, *in situ* conservation of the existing population is always a priority, even if later focus is drawn to reintroduction or supplementation initiatives. In any event all proposals for reintroduction/supplementation will have to be subject to the Policy for the Translocation of Threatened Fauna in NSW. It should not be assumed that such measures will be a simple solution to the decline or disappearance of a local population or population sub-unit and gain automatic approval from the DECC.

Several trials have already been undertaken to determine the feasibility and merits of undertaking captive breeding and release as reintroduction or supplementation exercises. Such trials have been undertaken both in concert with habitat creation/enhancement measures as well as without any habitat manipulation. To date there have been several reintroduction failures where releases of tadpoles or juvenile frogs have shown initial promise and survived to transformation or early adult stage but have then failed to survive to maturity and establish a self sustaining population e.g. Sir Joseph Banks Reserve, Botany and Long Reef Golf Course, Dee Why. Other sites have had supplementation releases of captive bred stock but where there was also a remaining residual element of the population in that area. At such sites releases have appeared to initially benefit the local population. However because releases have also been in concert with habitat creation initiatives it is difficult to determine whether the habitat creation has benefited and boosted breeding success of the remnant population, or if apparent increases can be attributed to recruitment of released captive bred specimens e.g. Arncliffe M5 East site and Edgewood site Woonona.

It should be emphasised here that the Policy for the Translocation of Threatened Fauna in NSW indicates that in no way should translocation be considered as a mitigative measure when determining the significance of a proposal on a local population of a threatened species. The NSW DECC has prepared Environmental Impact Assessment (EIA) Guidelines that provide guidance to development proponents, consultants and consent authorities. These guidelines further reaffirm the DECC position on translocation and the general inappropriateness of it being considered as a component of development proposals.

Ultimately decisions to conduct GGBF translocations and captive breeding are at the NSW DECC's discretion and will be assessed on merit and on a site-by-site basis. Factors such as the provenance of translocated individuals, whether threatening processes continue to operate at a site, as well as costs and an ability to monitor outcomes for an extended period will all be considerations for the benefit of improved understanding and future proposals.